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Smart Agricultural Services Using Deep Learning, Big Data, and IoT

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Detailed Table of Contents

The networks acquire an altered move towards the difficulty solving skills rather than that of conventional computers. Artificial neural networks are comparatively crude electronic designs based on the neural structure of the brain. The chapter describes two different types of approaches to training, supervised and unsupervised, as well as the real-time applications of artificial neural networks. Based on the character of the application and the power of the internal data patterns we can normally foresee a network to train quite well. ANNs offers an analytical solution to conventional techniques that are often restricted by severe presumptions of normality, linearity, variable independence, etc. The chapter describes the necessities of items required for pest management through pheromones such as different types of pest are explained and also focused on use of pest control pheromones.

Distributed computing is an incredible region of information and correspondence progressions, introducing current challenges for environmental security. These advances have a diversity of use spaces, since they offer flexibility, are trustworthy and dependable, and offer prevalent at tolerably negligible exertion. The conveyed figuring rebellion is updating current frameworks organization, and offering promising biological protection prospects, for example, money related and inventive field of premium. The developments can improve quality yield and to shrink carbon impressions and (e-)waste. The structures can change by dispersed processing into green circulated registering. Finally, future research headings and open issues with respect to green circulated registering are shown. This outline is intended to fill in as best in class bearing to investigate green distributed computing.

Internet of things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. It has three layers. First layer is data acquisition through sensors and actuators, data transferring using different devices and last is data analysis with different analytic techniques. In this chapter, a conceptual overview of internet of things is mentioned. Different sensors and actuators which are responsible for data acquiring are described with their specification. Networking devices which are responsible for transferring data from sensors to server are also described with their applications. Data analytics techniques like descriptive, predictive, and perspective are also explained. Internet of things is now proven as boon for agriculture development. In the last section, different techniques are explained that are used in information and communication technique-enabled agriculture practices.

Internet of things (IoT) is a network of connected devices that work together and exchange information. In IoT, things or devices means any object with its own IP address that is able to connect to a network and can send and receive using internet. Examples of IoT devices are computers, laptops, smart phones, and objects that are operational with chips to collect and correspond data over a network. The range of internet of things devices is huge. Consumers use smart phones to correspond with IoT devices.

There are many problems in the agricultural sector. One of the major issues is the safety of crops from the animals. The crop land near forest or any reserved wildlife get affected by the animals, decreasing production. The result is the conflict between animals and farmers. This chapter proposes an inexpensive and effective way to alert the farmer of animal intrusion in the farm by employing a pressure load sensor deployed in the ground wired with a vertical mounted unit with the actuators. The vertically mounted unit produces a loud sound and LED light strobes to deter the animal and also alert the farmer.

In the agricultural sector, plant leaf diseases and harmful insects represent a major challenge. Faster and more reliable prediction of leaf diseases in crops may help develop an early treatment technique while reducing economic losses considerably. Current technological advances in deep learning have made it possible for researchers to improve the performance and accuracy of object detection and recognition systems significantly. In this chapter, using images of plant leaves, the authors introduced a deep-learning method with different datasets for detecting leaf diseases in different plants and concerned with a novel approach to plant disease recognition model, based on the classification of the leaf image, by the use of deep convolutional networks. Ultimately, the approach of developing deep learning methods on increasingly large and accessible to the public image datasets provides a viable path towards massive global diagnosis of smartphone-assisted crop disease.

IoT technology is used in many areas like the smart wearables, connected devices, automated machines, and driverless cars. However, in agriculture, the IoT has brought the greatest impact. The industrial IoT is a driving force behind increased agricultural production at a lower cost. In the next several years, the use of smart solutions powered by IoT will increase in the agriculture operations. The number of connected devices in agriculture will grow from 13 million in 2014 to 225 million by 2024. The applications of IoT in the agriculture industry have helped the farmers to monitor the water tank levels in real-time, which make the irrigation process more efficient. The advancement of IoT technology in agriculture operations has brought the use of sensors in every step of the farming process like how much time and resources a seed takes to become a fully grown vegetable. Internet of things in agriculture has come up as a second wave of the green revolution.

The internet of things is believed to have long-lasting effects in both technology and modern society. In a modern information society, IoT can be seen as a global infrastructure that enables more advanced services by connecting physical and virtual devices and things to currently existing and even upcoming information and communication technologies. IoT takes advantage of identification, data capture, processing, and communication capabilities of modern technology to allow regular machines to provide new data sources to applications, which in turn can offer more advanced services. In terms of ICT technologies, IoT adds any thing communication to any time and any place. An increase in technology also leads to the development of smart agriculture. This chapter deals with the different electronic sensors used for the smart agriculture like soil moisture sensor, node MCU, water flow sensor, relay, water pump, solar system. The next section deals with big data in smart agriculture.

In the development of the advanced world, information has been created each second in numerous regions like astronomy, social locales, medical fields, transportation, web-based business, logical research, horticulture, video, and sound download. As per an overview, in 60 seconds, 600+ new clients on YouTube and 7 billion queries are executed on Google. In this way, we can say that the immense measure of organized, unstructured, and semi-organized information are produced each second around the cyber world, which should be managed efficiently. Big data conveys properties such as unpredictability, 'V' factor, multivariable information, and it must be put away, recovered, and dispersed. Logical arranged data may work as information in the field of digital world. In the past century, the sources of data as to size were very limited and could be managed using pen and paper. The next generation of data generation tools include Microsoft Excel, Access, and database tools like SQL, MySQL, and DB2.

The word "smart" is quite commonly associated with different types of products of IoT sensors and its contemporary technology. The frequent progress in the contemporary technology includes convention and the progressive integration of microprocessor. This gives the smart sensors application to a wide range of applications. Smart sensors when associated with agriculture are known as smart agriculture. With the help of smart sensors, technology of internet of things has helped agriculture in facilitating its efficiency, which further helps in decreasing the impact of environment on the production of the crops and deprecate the expenses. This is done by a few methods like calculating the condition of the environment, which affects the production of the crops, keeping a check on the cattle health and indicating when some problem occurs. The author discussed about sensors, their nature and evolution, generations of smarts sensors, and how they became better with the course of time in terms of smart agriculture.

Foreword

The book *Smart Agricultural Services Using Deep Learning, Big Data, and IoT* aims to present the application of deep learning in apply Big Data and IOT enabled smart farming solution to provide and enhance the capabilities of farmer for environmental studies and various Earth sciences among others. Incorporation of these smart technologies can also successfully port over powerful analytical methods from the financial services and consumer industries like claims management. This, coupled with the availability of data on social determinants of agriculture – such as socioeconomic status, education, living status, and social networks, make easy to a farmer for growing the seeds, make a well diagnosis done by a farmer on plants.

Following two important key aspects that will show the need of this book

- The farm industry and Smart Farming expand from the strict limits of the farm location and affect a series of related fields, such as supply chain management, food availability, biodiversity, farmers' decision making and insurance, environmental studies and various Earth sciences among others. All of the aforementioned fields have significant benefits when they follow a data-driven approach under the condition that the used systems, tools and techniques that will be used have been designed to handle the volume and foremost the variety of the data.
- In the field of agriculture the farm industry and Smart Farming expand from the strict limits of the farm location and affect a series of related fields, such as supply chain management, food availability, biodiversity, farmers' decision making and insurance, environmental studies and various Earth sciences among others.

The book covers very good chapters which may enables to researchers, agriculture industry and farm industry to make a useful progressive research in the agriculture. The specific details of chapter are as follows:

Chapter 1 defines Neural Network Based Approach for Pest Detection and Control in Modern Agriculture Using Internet of Things. The chapter describes two different types of approaches to training – supervised and unsupervised as well as the real time applications of artificial neural networks are also discussed.

Chapter 2 proposed Automated Fruit Grading System Using Image Fusion. in this chapter authors have proposed a recognition system capable of identifying an Indian fruit from among a set, established in a database, using computer vision techniques.

Chapter 3 proposed Fog Computing as Solution for IoT–based Agricultural Applications. The authors has discussed the present characterizations of fog computing, its architectures and propose a comprehensive method of how it is used to handle IoT- based agricultural applications. We also present some of these possible applications highlighting how they could benefit from the fog layer in providing better services.

Chapter 4 discusses the Green Cloud technology. The authors has defined that Distributed computing is an incredible region of information and correspondence progressions, introducing current challenges for environmental security.

Chapter 5 discusses the Conceptual Visualization of Internet of Things. The authors has defined different techniques are explained which are used in Information and Communication Technique enabled agriculture practices.

Chapter 6 describes Internet of Things and role of Wireless Sensor Network in IoT. The authors have defined method of usefulness of wireless sensor network in IOT.

Chapter 7 proposed Mechanised agricultural fencing model for IoT based Agriculture safety model. The authors have given an inexpensive and effective way to alert the farmer of animal intrusion in the farm by employing a pressure load sensor deployed in the ground wired with a vertical mounted unit with the actuators. The vertically mounted unit produces loud sound and LED light strobes to deter the animal and also alert the farmer.

Chapter 8 discusses Plant Diseases concept in Smart Agriculture using Deep learning. In this chapter, using images of plant leaves, we introduced a deep-learning method with different datasets for detecting leaf diseases in different plants and concerned with a novel approach to plant disease recognition model, based on the classification of the leaf image, by the use of deep convolutional networks.

Chapter 9 discusses Smart Agriculture and farming services using IoT. The authors has discussed that The advancement of IoT technology in agriculture operations has brought the use of sensors in every step of the farming process like how much time and resources a seed takes to become a fully-grown vegetable. Internet of Things in Agriculture has come up as a second wave of green revolution.

Chapter 10 describes Smart Agriculture Services Using Deep Learning, Big Data and IoT. This book chapter comprises of different portions in the first portion deals with the different electronic sensors used for the smart agriculture like Soil moisture sensor, Node MCU, Water flow sensor, Relay, Water pump, Solar System. The next section deals with big data in smart agriculture.

Chapter 11 covers the Analysis of Big Data Analytics. The authors concluded that Big Data conveys properties such as unpredictability, 'V' factor, multivariable information and it must be put away, recovered and dispersed the data. Logical arranged data may works as information in the field of digital world. In past century the source of data so as to size are very limited which could be managed using pen paper. The next generation of data generation tools includes Microsoft Excel, Access and database tools like SQL, MySQL, and DB2 etc.

Chapter 12 concluded that with the help of smart sensors, technology of Internet of Things has helped agriculture in facilitating its efficiency which further helps in decreasing the impact of environment on the production of the crops and deprecate the expenses.

The major key point of this book which may be beneficial to reader that I have found

- This book discuss that progress of the agriculture sector shall be incremental as it learns from associations between data over time through application of suitable AI, deep learning and IOT.
- The Farm Industry and Smart Farming have immense bounds and limits in term of innovation and augmentation. This book will endeavor to reveal the concealed prospective of the enormous Farm Industry and Smart Farming.
- This book is being formulated with intent to expose the chances and potentials involved in realizing and Agriculture through competent and successful deep learning algorithms.
- The book is designed to be first choice reference at university libraries, academic institutions, research and development centers, information technology centers, and any institutions interested in using, design, modelling, and analyzing computer networks security.
- This book provides a platform to farmer and researchers to identify the new technologies to make the agriculture and farming easy and also decrease the dependency for several areas.
- The scholars, researchers and farmers may publish their novel, analytical and experimental work through this book.
- Through deep learning algorithms the images of leaves and crops can be analyzed. What are the models available for the image analysis may be provided at single platform by some chapters.

At last but not least I strongly recommended to all readers to buy this book which provides them to make efficient research directions.

Narendra Singh Yadav
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Preface

The Farm Industry and Smart Farming have immense bounds and limits in term of innovation and augmentation. This book will endeavour to reveal the concealed prospective of the enormous Farm Industry and Smart Farming.

Through this book we endeavour to unite frequent undeniable observations, strategy and frameworks on facilitating personalised agriculture service opportunity through the successful application of Deep Learning, Big data and IOT frameworks. The progress of the agriculture sector shall be incremental as it learns from associations between data over time through application of suitable AI, deep learning and IOT.

The farm industry and Smart Farming expand from the strict limits of the farm location and affect a series of related fields, such as supply chain management, food availability, biodiversity, farmers' decision making and insurance, environmental studies and various Earth sciences among others. All of the aforementioned fields have significant benefits when they follow a data-driven approach under the condition that the used systems, tools and techniques that will be used have been designed to handle the volume and foremost the variety of the data.

This book is being formulated with intent to expose the chances and potentials involved in realising and Agriculture through competent and successful deep learning algorithms.

Most of the Agriculture research centres are adopting IOT for Monitoring the farm services, but their farm treatment & operations are more based on the specific Information of a particular instance only, whereas these IOT devices of agriculture are generating Volumes of Data (Big IOT Data), which needs to be analysed and then only farm treatment & operations should be carried out in terms of Agriculture service. In the field of agriculture the farm industry and Smart Farming expand from the strict limits of the farm location and affect a series of related fields, such as supply chain management, food availability, biodiversity, farmers' decision making and insurance, environmental studies and various Earth sciences among others. All of the aforementioned fields have significant benefits when they follow a data-driven approach under the condition that the used systems, tools and techniques that will be used have been designed to handle the volume and foremost the variety of the data

OBJECTIVE

The book *Smart Agriculture using Deep Learning, Big Data, and IOT* aims to present the application of deep learning in apply Big Data and IOT enabled smart farming solution to provide and enhance the capabilities of farmer for environmental studies and various Earth sciences among others. Incorporation of these smart technologies can also successfully port over powerful analytical methods from the financial services and consumer industries like claims management. This, coupled with the availability of data on social determinants of agriculture – such as socioeconomic status, education, living status, and social networks, make easy to a farmer for growing the seeds, make a well diagnosis done by a farmer on plants.

PRIMARY AUDIENCE

Agriculture Professional, AI Researchers, Data Analytics, IOT and students.

SECONDARY AUDIENCE

agriculture industry, farm it- sector and training institutes.

TARGET AUDIENCE

The intended audience includes academics, researchers, post-graduate students, developers, professionals, network designers, network analysts, telecommunication system designers, technology specialists, practitioners, and people who are interested in using Deep Learning in agriculture. Another projected audience is the researchers and academicians who identify methodologies, concepts, tools, and applications through reference citations, literature reviews, quantitative/qualitative results, and discussions. The book is designed to be first choice reference at university libraries, academic institutions, research and development centers, information technology centers, and any institutions interested in using, design, modelling, and analyzing computer networks security. The book is designed to be used as a textbook for courses teaching computer networks security, simulation, and modelling for under/post graduate students.

A DESCRIPTION OF WHERE THE TOPIC FITS IN THE WORLD TODAY

Successful application of deep learning frameworks to enable meaningful, cost-effective personalized smart farm services are the primary aim of farm industry respectively in the present scenario. However, realizing this goal requires effective understanding, application and amalgamation of deep-learning, IOT and several other computing technologies to deploy such systems in an effective manner. This book shall help clarify understanding of certain key mechanisms and technologies helpful in realizing such systems. It is a novel application domain of deep learning that is of prime importance to human civilization as a whole. It has been predicted as the next big thing in personal agriculture by the government as well as Forbes.

Chapter 1 entitled as "A Neural Network Based Approach for Pest Detection and Control in Modern Agriculture Using Internet of Things" defines that the neural networks acquire an altered move towards the difficulty solving skills rather than that of conventional computers. Artificial Neural Networks are comparatively crude electronic designs based on the neural structure of the brain. The chapter describes two different types of approaches to training – supervised and unsupervised as well as the real time applications of artificial neural networks are also discussed. Based on the character of the application and the power of the internal data patterns we can normally foresee a network to train quite well. ANNs offers an analytical solution to conventional techniques that are often restricted by severe presumptions of normality, linearity, variable independence etc. The chapter describes the necessities of items required for pest management through pheromones such as different types of pest are explained and also focused on use of pest control pheromones.

Chapter 2 entitled as "Automated Fruit Grading System Using Image Fusion" proposed a recognition system capable of identifying an Indian fruit from among a set, established in a database, using computer vision techniques. The investigation made it possible to compare the image color models, together with the size and shape characteristics previously used by different researcher. For the class of fruits defined in this investigation, it was determined that the characteristics that best described them were the average values of the RGB channels and the length of the major and minor axes when the image fusion technique is used, a process that allowed obtaining results with an accuracy equal to 92% in the tests carried out, finding that not always selecting a greater number of variables to form the descriptor vector allows the classifiers to deliver a more accurate response, in this sense it is important to consider that among the study variables a low dependency or correlation value.

Chapter 3 entitled as "Fog Computing as Solution for IOT-Based Agricultural Applications" has defined that Fog computing is an increasing developing computing approach to extend and assist cloud computing. A fog computing platform has several characteristics help providing the services for the users in a reduced time manner and thus improve the QoS of the IOT devices such as: being close to edge-users, being open platform and its support for mobility. Thus, it is becoming a necessary approach for user-centric IOT based applications that involve real-time operations, e.g. agricultural applications, Internet of vehicles, road monitoring and smart grid. In this paper, we discuss the present characterizations of fog computing, its architectures and propose a comprehensive method of how it is used to handle IOT-based agricultural applications. We also present some of these possible applications highlighting how they could benefit from the fog layer in providing better services.

Chapter 4 entitled as "Green Cloud" has defined that Distributed computing is an incredible region of information and correspondence progressions, introducing current challenges for environmental security. These advances have a diversity of use spaces, since they offer flexibility, are trustworthy and dependable, and offer prevalent at tolerably negligible exertion. The conveyed figuring rebellion is updating current frameworks organization, and offering promising biological protection prospects, for example, money related and inventive field of premium. The developments can improve quality yield & to shrink carbon impressions and (e-) waste. The structures can change dispersed processing into green circulated registering. At this moment, review the essential achievements of green circulated figuring. Finally, future research headings and open issues with respect to green circulated registering are shown. This outline is intended to fill in as best in class bearing for investigate in reference of green distributed computing.

Chapter 5 entitled as "Internet of Things: A Conceptual Visualisation" has defined that Internet of Things (IOT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. It has three layers; first layer is data acquisition through sensors and actuators, data transferring using different devices and last is data analysis with different analytic techniques. In this chapter, a conceptual overview of Internet of Things is mentioned. Different sensors and actuators which are responsible for data acquiring are described with their specification. Networking devices which are responsible for transferring data from sensors to server are also described with their applications. Data analytics techniques like descriptive, predictive and perspective also explained. Internet of Things is now proven as boon for agriculture development. In the last section different techniques are explained which are used in Information and Communication Technique enabled agriculture practices.

Chapter 6 entitled as "Internet of Things and role of Wireless Sensor Network in IOT" has discussed that Internet of Things (IOT) is a network of connected devices to work together and exchange information. In IOT, Things or devices means any object with its own IP address and is able to connect to a network and can send and receive using internet. Examples of IOT devices are computers, laptops, smart phones and objects, which are operational with chips to collect and corresponds data over a network. The range of Internet of Things devices is huge. Consumers use smart phones to correspond with IOT devices.

Chapter 7 entitled as "IoT-Based Agri Safety Model: Mechanised Agricultural Fencing" defines that there are many problems in agricultural sector. Nowadays one of the major issues is the safety of crops from the animals. The crop land near forest or any reserved wildlife get affected from the animals for which the production gets decreased. After result is that the conflict between animals and farmers. This project proposes an inexpensive and effective way to alert the farmer of animal intrusion in the farm by employing a pressure load sensor deployed in the ground wired with a vertical mounted unit with the actuators. The vertically mounted unit produces loud sound and LED light strobes to deter the animal and also alert the farmer.

Chapter 8 entitled as "Plant Diseases Concept in Smart Agriculture Using Deep Learning" has concluded that in the agricultural sector, plant leaf diseases and harmful insects represent a major challenge. Faster and reliable prediction of leaf diseases in crops may help develop an early treatment technique while reducing economic losses considerably. Current technological advances in Deep learning have made it possible for researchers to improve the performance and accuracy of object detection and recognition systems significantly. In this chapter, using images of plant leaves, we introduced a deep-learning method with different datasets for detecting leaf diseases in different plants and concerned with a novel approach to plant disease recognition model, based on the classification of the leaf image, by the use of deep convolutional networks. Ultimately, the approach of developing deep learning methods on increasingly large and accessible to the public image datasets provides a viable path towards massive global diagnosis of smartphone-assisted crop disease.

Chapter 9 entitled as "Smart Agriculture and Farming Services Using IoT" defines that the IOT technology is used in many areas like the smart wearables, connected devices, automated machines, and driverless cars. However, in agriculture, the IOT has brought the greatest impact. The Industrial IOT is a driving force behind increased agricultural production at a lower cost. In the next several years, the use of smart solutions powered by IOT will increase in the agriculture operations. The no. of connected devices in agriculture will grow from 13 million in 2014 to 225 million by 2024. The applications of IOT in the agriculture industry have helped the farmers to monitor the water tank levels in real-time which make the irrigation process more efficient. The advancement of IOT technology in agriculture operations has brought the use of sensors in every step of the farming process like how much time and resources a seed takes to become a fully-grown vegetable. Internet of Things in Agriculture has come up as a second wave of green revolution.

Chapter 10 entitled as "Smart Agriculture Services Using Deep Learning, Big Data, and IoT (Internet of Things)" defines that the Internet of Things is believed to have long-lasting effects in both technology and modern society. In a modern information society, IOT can be seen as a global infrastructure that enables more advanced services by connecting physical and virtual devices and things to currently existing and even upcoming information and communication technologies. IOT takes advantage of identification, data capture, processing and communication capabilities of modern technology to allow regular machines to provide new data sources to applications, which in turn can offer more advanced services. In terms of ICT technologies, IOT adds Any Thing communication to Any Time and Any Place. An increase in technology also leads to the development of smart agriculture. This book chapter comprises of different portions in the first portion deals with the different electronic sensors used for the smart agriculture like Soil moisture sensor, Node MCU, Water flow sensor, Relay, Water pump, Solar System. The next section deals with big data in smart agriculture.

Chapter 11 entitled as "An Analysis of Big Data Analytics" defines that in the development of advanced world, information has been creating each second in numerous regions like Astronomy, Social locales, Medical fields, transportation, web based business, logical research, horticulture, video and sound download. As per an overview, in 60 second, 600+ new clients on YouTube and 7 billion of queries are executed on Google. In this way, we can say that the immense measure of organized, unstructured and semi organized information are produced each second around the cyber world which should be managed efficiently. Big Data conveys properties such as unpredictability, 'V' factor, multivariable information and it must be put away, recovered and dispersed the data. Logical arranged data may works as information in the field of digital world. In past century the source of data so as to size are very limited which could be managed using pen paper. The next generation of data generation tools includes Microsoft Excel, Access and database tools like SQL, MySQL, and DB2 etc.

Chapter 12 entitled as "Towards Intelligent Agriculture Using Smart IoT Sensors" stated that the frequent progress in the contemporary technology, which includes convention and the progressive integration of microprocessor. This gives the smart sensors to be applied on the wide range of applications. Smart sensors when associated with agriculture are known as Smart agriculture. With the help of smart sensors, technology of Internet of Things has helped agriculture in facilitating its efficiency which further helps in decreasing the impact of environment on the production of the crops and deprecate the expenses. This is done by few methods like calculating the condition of the environment which effects the production of the crops, keeping a check on the cattle health and indicating when some problem occurs and etc. The author discussed about smart sensors, its nature and evolution, generations of the smarts sensors and how they became better with the course of time in terms of smart agriculture.

CONCLUSION

Through this book we endeavor to unite frequent undeniable observations, strategy and frameworks on facilitating personalized agriculture service opportunity through the successful application of Deep Learning, Big data and IOT frameworks. This book covers all the key aspects to make a progressive growth in the field of agriculture with using the concepts of AI, deep learning and IOT. The book chapters have covered many field research oriented work which may be used to improve the existing agriculture services. The book chapters has discussed the recent and less cost techniques of deep learning and IOT which may be useful in the research for farm and agriculture university. To book may be useful to provide the solution to the problem of farm industry and Smart Farming for expanding from the strict limits of the farm location and affect a series of related fields, such as supply chain management, food availability, biodiversity, farmers' decision making and insurance, environmental studies and various Earth sciences among others. This book covers all of the aforementioned fields have significant benefits when they follow a data-driven approach under the condition that the used systems, tools and techniques that will be used have been designed to handle the volume and foremost the variety of the data.

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Chapter 1
A Neural Network-Based Approach for Pest Detection and Control in Modern Agriculture Using Internet of Things

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ABSTRACT

The networks acquire an altered move towards the difficulty solving skills rather than that of conventional computers. Artificial neural networks are comparatively crude electronic designs based on the neural structure of the brain. The chapter describes

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two different types of approaches to training, supervised and unsupervised, as well as the real-time applications of artificial neural networks. Based on the character of the application and the power of the internal data patterns we can normally foresee a network to train quite well. ANNs offers an analytical solution to conventional techniques that are often restricted by severe presumptions of normality, linearity, variable independence, etc. The chapter describes the necessities of items required for pest management through pheromones such as different types of pest are explained and also focused on use of pest control pheromones.

1. INTRODUCTION

A system is required for farmers to foresee the crop requirements, so that they may enhance the crop quality and its quantity. Farmers have lack knowledge about current technologies that may help them enhance quality of seeds, irrigation facilities and good management of the crops. The delivery of crops in market gets delayed due to the lack of proper road connectivity between the rural and urban areas (Rashid, 2015). Also, climatic situations can become unpredictable hence resulting in wrong decisions by farmers. In mountain areas irrigation water is not easily available and cost much to farmers. Sensor networks are a solution to all these problems which may be utilised to determine the approximate values of field information. They also help in determining the simulation models of the crop, insects, diseases, and other data. Thus, farmers can monitor in real time the field conditions. How it is carried out will be discussed in next sections.

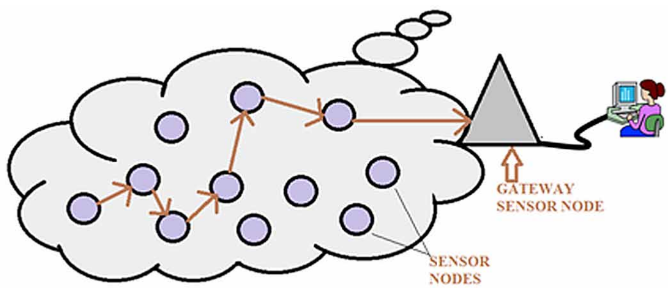
Integration of different geographical and temporal figure of the farm-land are easily achieved with the help of wireless sensor networks, also the variations in climate, pressure, soil humidity, motion, temperature, pest and suggesting best solution for management to the farmers are also possible with Wireless sensor networks.

The increment in wireless sensor network deployment in industrial, agricultural and habitat monitoring applications is due to the fact that this technology consumes low power and requires low data rates for transmission or reception of data, hence it proved to be an energy efficient technology. In addition to this it also provides mobility and flexibility in connection which enhance network expansion when required. The main objective of agriculture through WSN is to make crop production better by managing and monitoring the growth duration.

1.1 Introduction to Wireless Sensor Network

Each node equipped in a wireless sensor network includes a sensor module, a processing data storage module, a power supply module and a wireless transmission unit (Rashid, 2015; Navin, 2013). Every node is provided with the capacity that they are easily able to collect and process physical information so that the gathered data can be further sent to the monitoring station (base station) or to the sink node. Wireless sensor network consists of implementation of more than one sink nodes and several sensor nodes in a physical environment. The topology arrangement of Wireless sensor network nodes may differ from a star network to a multi-hop wireless mesh network. The processing technique between the hops of the WSN can be done by using either flooding or routing. One of the best features of these sensor nodes is that they can switch between various modes when required; the modes are sleep, active and idle. When not in use they switch to sleep mode to save energy, this increases the lifetime of the nodes and they can be used for a long period without replacement.

Figure 1. Deployment of Sensor Nodes and their communication with the Base Station



Environmental information plays a very crucial role in the field of agriculture. This is because the crop production is mainly bank on the environmental situations and the feedback of the plant development to varying environmental situations is highly problematic (Holt, 2007; William, 2005). Farmers and researchers should collect the information at their areas on their own but the traditional climate stations are very expensive and much big in size. Till now, data loggers were used for this task but with a condition that the users should have to go at these stations frequently to gather the related data. Hence to solve all such related problems sensor networks are desirable.

1.2 Precision Agriculture

Precision agriculture needs concentrated field data acquisition. One of the most auspicious application spheres in which wireless sensor network give a beneficial or even an optimal solution. In precision agriculture several parameters such as soli texture, temperature changes dramatically from, one area to other. So precision agriculture is the capability to tackle changes in productivity inside a field and increase financial return, lessen waste, make farming environment friendly with the help of automatic collection of data, documentation and utilisation of this data for strategic farm management decisions by using sensing and the communication methods (Lee, 2010; Singh, 2006).

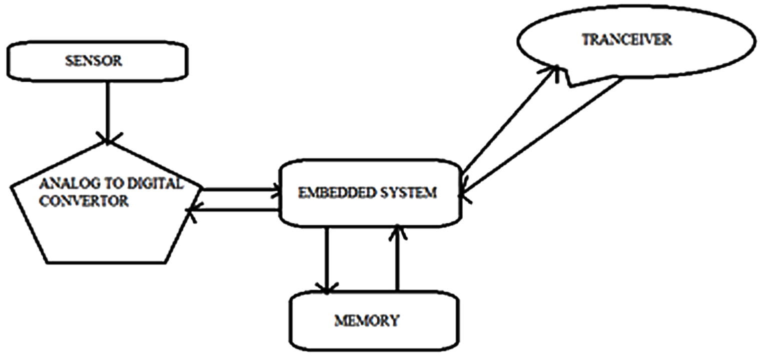
Various technologies are used in precision agriculture like remote sensing, global positioning system (GPS), and the geographic information system (GIS). One of the major parts of precision farming is the production of soil maps mentioning its properties. All these maps include crop scouting, soil sampling, yield monitoring. Remote sensing equipped with global positioning system coordinates generates accurate maps and the models of the complete farm. The sampling part is generally carried out by using some sort of electronic sensor like soil probes and remote optical scanners from satellite. The gathering of this information on a computer database gave birth to GIS software. These technologies proved very much expensive and needed large labour work. Hence precision farming using such technologies was not beneficial to farmers.

So, by using wireless sensor networks for precision farming it became easy for farmers to monitor the field with a high accuracy at a lower cost. Since WSN is made up of many sensor nodes including sensing, processing, transmission, mobiliser, position finding system and power supply.

In precision agriculture several methods are present to monitor and handle the needed environmental parameters for a specific crop. It is very necessary to analyse the techniques that can accurately handle the proper environment. With the help of wireless sensor network large areas can be covered and this is becoming famous for in green house technology of precision agriculture. Several types of sensors can be integrated in a sensor node hence the conditions of the crop and the soil, including temperature, crop illness, humidity, illumination, insects etc. can be monitored remotely in real-time. This helps in reducing the production cost by properly determining the soil conditions and plant growth, this is done by fine tuning seeding, fertilisers, chemical and water use, in addition this increase crop yield.

The above figure represents the architecture of a wireless sensor node. The analog to digital convertor converts the analog waves into digital waves so that they can be used for further processing. The function of embedded system is to drive the converted signal from the ADC device and does its further processing. The

Figure 2. Architecture of a Sensor Node



memory device is used to store data in its buffer and transmits it to the transceiver for uploading. The same process in opposite direction is done while receiving the data. There are many factors which need to be considered while implementing the system. The major parameters which requires attention while its implementation are quality of soil, soil temperature, the moisture available also some other parameters like temperature of air, humidity of air, speed of wind and direction, precipitation are considered when the system is being implemented in a farm (Suchita, 2016).

1.3 Various Sensors Employed in an Intelligent Farm

An intelligent farm accomplishes the complete utilization of the application of current information technology to assimilate the application of network & computer technology, and also the technology of IoT (Internet of things), wireless communication technology, video monitoring machinery, 3S technology, assimilate the decision support mechanism of knowledge and intelligence of agriculture deft, recognize the creative administration of remote monitoring of farm judgement, remote control and disaster warning and many more (Thulasi, 2013; Shaikh, 2016).

Several types of sensors are employed in an intelligent farm for proper monitoring of different parameters so that according to the received data preventive measure can be taken for proper crop development. In this system the data collected by different types of sensors is send to a main head node which is responsible for sending the aggregated data to the central server where further processing of the received data takes place. This transfer of data from head node to the base station can be carried out wirelessly or with the help of a GSM module (Muthukannan, 2015; Pandikumar, 2013).

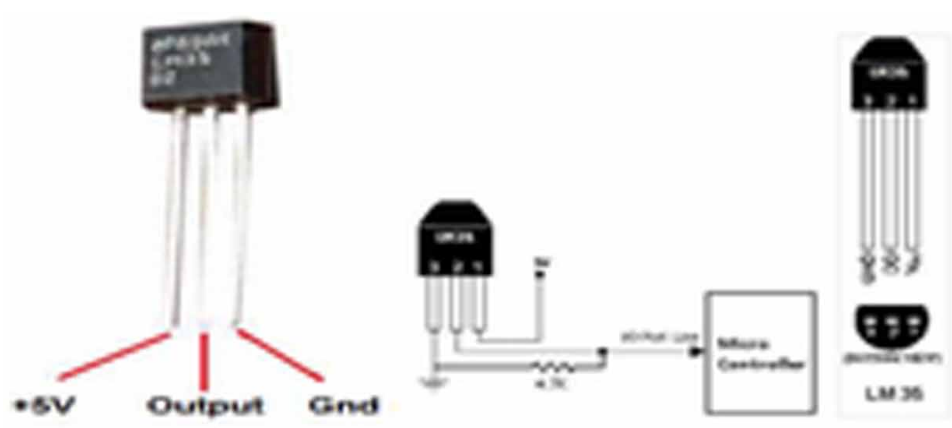
The function of different sensors is explained in below sub sections.

1.3.1 Soil Sensor

Different crops require different types of soil for their growth, some crops are grown well in alkaline soil whereas some crops require saline type of soil for their proper nutrition. Hence it is necessary to monitor the soil moisture of the field for proper crop development (Giovanni, 2014; Chaudhary, 2011). The soil sensors gather the data related to soil moisture and soil temperature in the outer environment. Soil moisture sensors measure the volumetric water content of the soil, this works by measuring the dielectric permittivity of the soil. In this sensor the conductivity of the soil is checked and for this task 2 probes are infused in the farm, if the field is humid conductivity is high and resistance is low and if the field is arid then resistance is high and conductivity is low.

Figure 3. Soil Moisture Sensor

Figure 4. Temperature Sensor



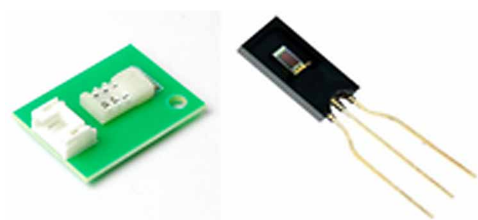
1.3.2 Temperature Sensor (LM 35)

Temperature needs to be controlled for proper crop growth as the plant dies if the temperature exceeds a particular level, so for this purpose temperature sensors are employed in the farm (Seong, 2007; Anjum, 2013). The mostly used temperature sensors in precision integrated circuit are LM35 series, the yield voltage of these sensors is linearly proportional to the centigrade temperature. LM 35 temperature sensors are very precise and very high-quality sensors to represent the temperature value in Celsius. These sensors are cheaper and small in size. The temperature range measured by them lays in between -55^{o} to +150^{o}C.

1.3.3 Humidity Sensor (HIH4000)

These sensors are generally used to determine the moisture amount. Humidity sensor measurement find out the amount of water vapour available in a gas which can be a mixture like air, or a pure gas like nitrogen or argon (Kirankumar, 2015; Prathyusha, 2013). These sensors are based on the principle which includes a hygroscopic dielectric material sandwiched in between a pair of electrodes forming a small capacitor. By calibration and calculations all these sensed quantities can lead to measurement of humidity. So, it is necessary to maintain the humidity level of the farm and for this purpose these sensors are used and generally HSM 20G modules are used.

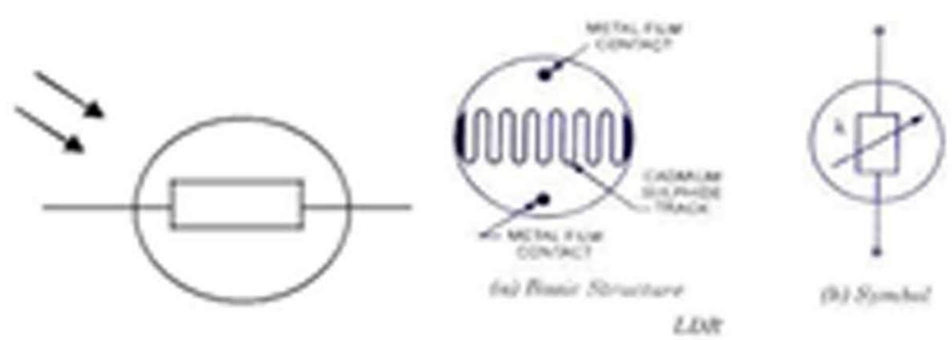
Figure 5. Humidity Sensor Module



1.3.4 Light Sensor (LDR)

An LDR sensor is a light dependent resistor sensor or we can say that it is a light controlled variable resistor (Luca, 2010). A component is there in an LDR which consists of a variable resistance which varies with the light intensity that falls on it and hence this component enables to sense the light that is employed in the circuit. When the leaf starts developing its growth and falls on the LDR sensor, it becomes dark, and if LDR gets dark its resistance also gets low and current flow is more. This procedure helps in sensing the leaf growth percentage. The range of variation of resistance of an LDR sensor is 1k ohm to 500 k ohm.

Figure 6. Light Sensor



1.3.5 Insect Monitor Sensor

We increase the productivity by using several methods but still we do not reach the goal the reason behind this is the insects that damage and infect the crops up to roots (Ankit, 2018). So, it is very important issue nowadays to farmers, to protect their crop from certain types of insects. These insects reduce the yield of insects and some insects are so small that they are not easily visible to farmers. Hence it is necessary to monitor and detect these insects to protect the crops from being damaged, for this purpose certain sensors are used to monitor these insects. And according to the collected data farmer is informed with the help of any wireless device.

There are many sensors which are used to monitor insects:

1. **With the help of image sensors-** Insects can be detected with the help of image sensors, these wireless image capture sensors are employed in the field at various locations and images are captured by these sensors time to time, these captured images are then sent wirelessly to the base station where they are processed to find out where the particular crop area is infected by the insects or not (Pankaj, 2018). And if any evidence of insects is found then the farmer is informed with the help of a GSM device, a message with a warning is sent to the farmer's registered mobile number.
2. **Acoustic sensor detection-** Insects can also be detected acoustically by the noise emitted from them (Dhaka, 2014). An acoustic noise sensor is employed

for monitoring the insect's noise level and at any time when the noise crosses the threshold level farmer is informed about the particular area so that he may check it and take necessary action. With the help of these sensor farmers labour is reduced as he need not to go and monitor for each area of his field. All these sensors are associated with the base station and every sensor node transfer the noise levels at any time the noise level crosses a fixed threshold level.

3. **Insect smell sensor-** Insects communicates among them by releasing some sort of chemicals, these chemicals are replicate, and sensors are made which can detect these smell (Poonia, 2018). These sensors help in detecting the insect colonies and help in mating disruption thus reducing insect population. Whenever the insects roam on leaf surface or near stem area these sensors easily detects them by the chemical released by them while walking and communicating among their relatives. This information is sent to the farmer to take necessary action to prevent their crops from such harmful insects.
4. **Motion sensor-** Nowadays infrared motion sensors are used to monitor and detect insects with the help of wireless technology, and the data is transmitted to the nearest base station (Pankaj, 2018). Both the infrared motion sensor and the light trap perceive the obstacles in front of the sensor. These sensors are employed at different areas near the crop and near to leaf areas and whenever any insect feeds on the leaf area or any other area of the crop, its motion is sensed by the motion sensor and immediately an emergency message will be sent wirelessly or with the help of a GSM device to the nearest base station or directly to the farmer's registered mobile number.

2. LITERATURE REVIEW

(Rashid, 2015) discussed the application of wireless sensor network technology to improvise potato cultivation. They have proposed an irrigation model that can monitor agriculture parameters continuously for better crop yield and which can increase the efficacy of irrigation system by 10%. The proposed methodology consists of an agriculture sensor node which is established to be set up in the potato farm. The node includes humidity sensors, controller, and radio transceiver which gather the data in the farm and transfer it to the remote station, this system works in coordination with application software. The wireless sensor nodes can be used effectively to gather information of availability of soil water, soil compaction, soil fertility, biomass yield, water status of plants, local weather information, insect pest detection and disease detection in plants, crop yield etc.

(Navin, 2013) discussed the acoustic detection technology for detection of pest in the agriculture field. The author has focused on a pest monitoring and control system to have efficient sugarcane production and it also includes the major insect pest of sugarcane crop. The system utilises an acoustic sensor that monitors the noise level of the pests and also informs the farmer using an alarming system when the noise crosses a fixed threshold level. This system enables farmers to take necessary actions to spray pesticides over the crop at an early age of infestation and it also covers a large area with less energy consumption. The author has also suggested that for limited insect pest, automatic spraying mechanism wherever infestation occurs. This also helps in development of better and healthier crops. And all the dissemination is done with the help of a wireless sensor network connected to a remote station.

(Holt, 2007) includes an overall framework so as to form an intelligent farm system which will help in improving the production and the management level of the complete farm, this intelligent farm analyse the scientific decision & management with the help of information technology. The author has described the data acquisition of field conditions, irrigation monitoring wireless network system. It can fulfil different indicators, requirements of plant development. The information technology based intelligent farm allows farmers to monitor timely the crops and access to several management and production information. This system can greatly increase the crop yield and minimizes the loss that farmers face each year. And they get improved quality crop, less production costs and has better economic advantages.

(William, 2005) includes a survey conducted in Eritrea to determine potato production practises, this also includes contribution towards upgraded food security & livelihood of poor farmers in the country. It also describes insects pest of potato and controlling methods to improve yield. The survey was started by interviewing representative producers and it was noted that same village farmers usually uses same farming practises. This paper also discusses the major pest of potato and diseases caused by them. It also includes the controlling methods and yield status and author has concluded that larger cost of inputs and limited availability are major limiting factors for bad potato production in India.

(Lee, 2010) presents a review of the sensing technologies and also discuss that how they are utilised for precision farming and crop management. It includes that a WSN consists of several dispersed nodes which have sensors and a wireless communication module employed in it. These sensors networks has many applications in agriculture such as farm management, expansion of plant development, precision farming, farm surveillance, guidance and education for better farming. Sensor networks are also capable to gather images of high resolution at fields in real time which can be utilised to monitor plant development, to monitor insects in the field etc. It also explains the limitations of sensor availability in market and also suggests that this field requires advancements so as to form a complete monitoring system.

(Singh, 2006) includes the survey of dangerous pests of wheat and discusses their management through integrated pest management and with the help of modern pesticides pest control. The author has also developed a demanding and profitable damaging activity of phytophagous in cereal crops, keeping the damaging level below the threshold. The paper also discuss some major insect pest of wheat crops and also presents data on arthropod fauna, agroecological and biological facets, preventive measures and field survey for pest control in a manner to achieve integrated control system of wheat crop. The paper also concludes that natural predators play a crucial role in controlling the population of many harmful pests and also that insecticide control is necessary because of the increasing attack of main wheat pests.

(Suchita, 2016) includes investigation for the evaluation different varieties of rice for insects which harms the crops and then observations were noted down related to category of insect pest, their incidence, their spreads and the amount of damage they do to the crops. It also discusses qualitative composition of insect pests complex of rice ecosystem. The areas were marked so as to count the number of insects at each stage of crop development and they have used light trap method for study of insect pest complex. It also suggests that the control of rice pest requires several factors to be considered so that population of pest cannot exceed a economic threshold level. This paper describes various observations made about insects and many constraints which are essential to take care while controlling them. Based on these constraints several strategies have been evolved to control and increase the productivity of rice.

(Thulasi, 2013) includes the monitoring of insect pest population by using wireless sensor network in the agricultural fields. It explains a system which is based on distributed imaging device that operates using WSN which automatically acquires and transfers the images to the remote station. The paper presents trap cropping as a traditional tool of pest management and classifies modalities of trap cropping based on characteristics of trap crop. This paper describes a prototype system for automatic monitoring of fruit flies, it uses Zigbee and GSM module for internal and external processing. The captured image is sent to base station for further processing and in this paper they have used MATLAB as an image processing tool. The simulation results after the experiment are also shown in the paper. The author also suggests that this field still requires further research so as to overcome several difficulties of the system employed, they only made a system which can count the insect pests of the crop and their controlling needs to be developed.

3. METHODOLOGY

3.1 Artificial Neural Networks

The Artificia1 neura1 networks (ANNs) is a fami1y of the statistica1 1earning mode1s which is inspired by some bio1ogica1 neura1 networks with centra1 nervous systems of human and anima1s in particu1ar the brain (Pankaj, 2018; Kumar, 2014).

Neura1 network is inspired from the human method of 1earning approach. The network structure of ANN is made in the simi1ar fashion as in human nervous system. 1earning process is carried out through examp1es in a fau1t to1erant system. The neurons present in the neura1 network have distributed structure. The information is contained in spikes as well as neurons have high1y comp1ex units. P1asticity as we11 as computations is revea1ed at a top 1eve1. The synopsis in the brain corresponds to weight in neura1 network. Weight in neural network means it is used to retain the information in its memory. Initially the weights with random numbers are set then after the new weight is found with the previous weight, bias, and neuron. Input and bias are summed to obtain the input to transfer function. The transfer function is used to obtain the output with the he1p of activation function. The who1e processing of neura1 network is dependent on the weight and the behaviour of activation function. The activation 1eve1 of neuron is totally dependent on the activation function. Each 1ayer has its own activation function. There can be n number hidden 1ayers with n different transfer functions.

Some of the most famous transfer functions are as follows:

1. **Log-sigmoid transfer function:** This transfer function generates output ranging from 0 to 1 as the input is provided from negative to positive infinity.
2. **Tan-sigmoid transfer function:** This transfer function takes input from negative to positive infinity and a1so generates output from -1 to 1.
3. **Linear transfer function:** Purl in transfer function is main1y used in back propagation network. If 1ast 1ayer of mu1ti1ayer feed forward neural network consists of sigmoid neuron then the output is confined within specific range. But in 1inear transfer function the output can take any va1ue.

3.2 Fuzzy Set Theory

Traditional control approach requires proper modeling of physical reality. In traditional mathematical theory the set is defined as a stock of elements that consists of one or more similar characteristics. In real world we group similar objects in the form of set. In other words, a precise object collectively makes a set. Those sets may be set of natural numbers, set of real numbers and many others. Sets can have subset, or they may be proper and equal. Different sets are made, grouped by different name and ultimately different operations are performed on those sets such as union, intersection, differences etc.

Fuzzy Set

In classical set theory membership grade can either be 0 or 1. Each element of a fuzzy set B is imputed a fuzzy index μB(a) in the boundary of 0 and 1 which is called as grade of membership of a in B. In classical set the difficulty we face can be easily resolved by fuzzy set. An ordered pair set can be given by B = {(a, μB(a)): a ϵ U} where U is the universal set and μB(a) is the grade of membership of an element a in B. In most of the cases μB(a) lies in the interval of 0 and 1. In fuzzy set theory answers is not precise and belong partially to set B. A membership function μB(a) can be assigned μB: a -> [0,1], a ϵ U where a is the object or elements of set B and U is the universal set as set B ϵ U.

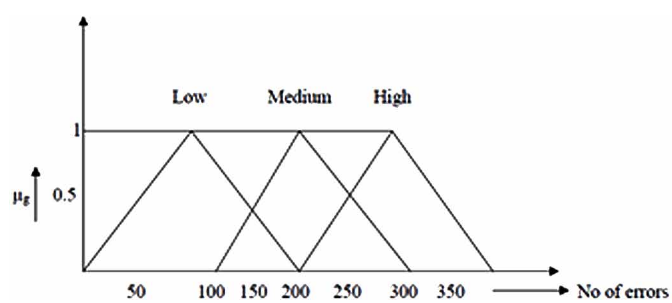
Comparison Between a Classical Set and a Fuzzy Set in Risk Estimation

Consider a universal set R which stands for risk. Minor and major are the subset of universal set R.

Classical Approach

Low = {Error ϵ R: 50 < error < 150}
Average = {Error ϵ R: 150 < error < 250}
High = {Error ϵ R: 250 < error < 350}

Figure 7. Fuzzy Set in Risk Estimation



According to classical set theory one can say that 149 errors lead to low risk in the project while 151 errors lead to high risk in the project. Due to rigid boundary the expression of the data becomes very difficult. In fuzzy set it is very easy to represent them due to soft boundary.

The Risk caused due to 250 no of errors is a member of two fuzzy sets that is medium and high along with the membership grade µg(Normal)= µg(high)= 0.5. Thus, this is how imprecise data can be categorized in an efficient way using fuzzy logic. This is why the fuzzy logic was introduced.

Representation of Fuzzy Set

Suppose there are n elements in a set Z say z1, z2, z3, z4…….zn. Then a fuzzy set B is the subset of Z which can be denoted by any of the following:

B = {(z1, µB(z1)), (z2, µB(z2)), (z3, µB(z3))……. (zn, µB(zn))}
B = {z1/µB(z1), z2/µB(z2), z3/µB(z3)……… zn/µB(zn)}
B = {µB(z1)/z1, µB(z2)/ z2, µB(z3)/z3………µB(zn)/zn}

These are various nomenclature of the fuzzy set from which we can select any one of them. In classical set only members are seen but in fuzzy set the members are associated with fuzzy index or membership function.

General Known Membership Functions

Each member in the set is associated with membership function. So, membership function can be characterized as follows:

ϒ-Function

It is linear function which can be represented as follows:

ϒ (z, a, b) = 0, z ≤ a,
= z-a / (b-a), a < z ≤ b,
= 1, z > b. (where z is actual variables)

S–Function

It is non-linear function which is defined as:

S (z, a, b, c) = 0, z ≤ a,

$= 2[(z-a) / (c-a)]2, a < z \leq b,$
$=1-2[(z-c) / (c-a)]2, b < z \leq c$
$=1, z \geq c$

Triangular – Function

It is very widely used membership function and used mostly in fuzzy logic controller. It is defined as follows:

$\Delta (z, a, b, c) = 0, z \leq a,$
$= (z-a) / (b-a), a < z \leq b,$
$= (a-z) / (b-z)], b < z \leq c$
$= 0, z > c$

Π – Function

It is defined as follows:

$\Pi (z, a, b, c, d) = 0, z \leq a,$
$= (z-a) / (b-a), a < z \leq b,$
$= 1, b < z \leq c$
$= (c-z) / (d-c), c < z \leq d$
$= 0, z \geq d$

Gaussian – Function

It has two parameters which are mean ms and variance σ. By using these parameters, the nature can be changed. This membership function is also very widely used fuzzy neural network and so forth because it is very useful in system identification using fuzzy neural network.

It can be defined as follows:

$G (z, ms, \sigma) = e1 / 2(z-ms / \sigma) 2$

Both the parameters ms and σ adjust the center and breadth of the fuzzy index.

Operations Widely Used on Fuzzy Sets

In fuzzy set theory the members are not manipulated rather the membership grade of the members are manipulated. For example, set B is given by

B = {(a, μB(a))}. All the common manipulation is done on μB(a). Some common manipulations performed on fuzzy sets are as follows:

1. 1. **Intersection (Minimum function):** Let two different fuzzy set A and B with fuzzy index μA(z) and μB(z).

$\mu A \cap B(z) = \mu A(z) \Lambda \mu B(z) = \min(\mu A(z), \mu B(z))$

2. 2. **Union (Maximum function):** Members in the sets are same but only fuzzy index varies. If z ϵ A and z ϵ B then z ϵ A B

$\mu A \cap B(z) = \mu A(z) \underline{\Lambda} \mu B(z) = \max(\mu A(z), \mu B(z))$

3. 3. **Fuzzy complements:** It is 1 minus the original function.

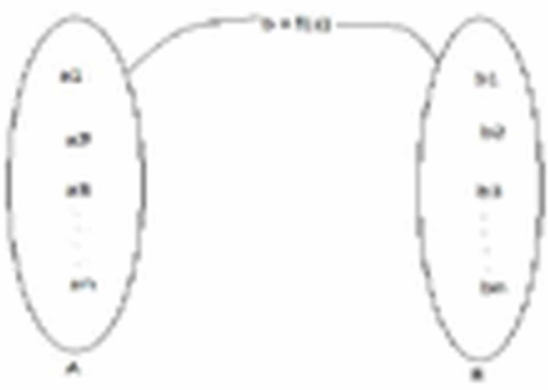
$\mu \bar{A}(z) = 1 - \mu A(z)$

3.3 Fuzzy Relations

Mapping in Fuzzy Sets

Mainly there are 4 types of mapping in fuzzy set which are as follows

Figure 8. One to one Mapping



One to One Mapping

$A = \{\mu (a1) / a1, \mu (a2) / a2, \ldots\ldots\mu (an) / an\}$
$B = \{\mu (b1) / b1, \mu (b2) / b2, \ldots\ldots\mu (bn) / bn\}$

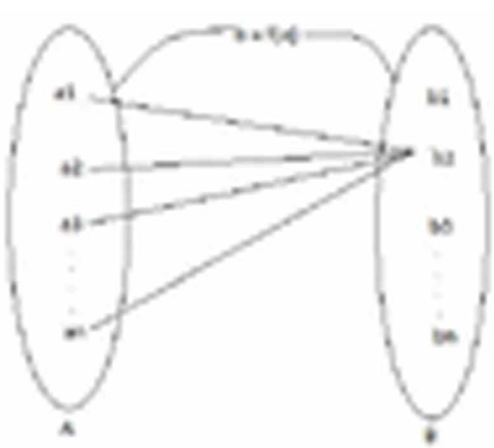
Where $\mu B (b1) = \mu A (a1)$ and so on

Many to One Mapping

$A = \{\mu (a1) / a1, \mu (a2) / a2, \ldots\ldots\mu (an) / an\}$
$B = \{\mu (b1) / b1, \mu (b2) / b2, \ldots\ldots\mu (bn) / bn\}$

Where $\mu B (b2) = \max [\mu A (an): an \in f\text{-}1(bn)]$

Figure 9. Many to one Mapping



Crisp Relation

In crisp relation the Cartesian product of two set can be given as:
A times Z is the Cartesian product,

$A * Z = \{(a, z) \mid a \in A, z \in Z\}$

Crisp relation is defined on product space. So, the interval of crisp relation can be stated as follows:

μR (a, z) = {1, if (a, z) belong to Cartesian product space
= {0, if (a, z) does not belong to Cartesian product space

Where 1 infer that the elements are in complete relation and 0 infer that the elements are not in relation. For the finite set, relation matrix can be represented in the form of a matrix. In classical relationship, the crisp relation means either the relationship index is 0 or 1 and there is no in between relationship.

Composition Rule (Crisp Inference Rule)

If we have multiple Cartesian product space and we know the relationship, then can we infer the relationships? Let A, B, C are universal set then

1. Let X be element that relates A to B
2. Let Y be element that relates B to C
3. Let Z be element that relates C to A

Thus, Cartesian product Z = X * Y. Now the two compositions can be taken as follows

Max-Min Composition

In this composition the associated membership function μz is computed as μz = max (min [μx(a, b), μT(a, b)])

Max-Product Composition

In this composition the associated membership function μz is computed as μz = max [μx(a, b), μT(a, b)]

Fuzzy Relations

If A and Z are two universal fuzzy sets. Then the fuzzy relation R (a, z) can be given as the ordered pair:

R (a, z) = {μR (a, z) / (a, z) | (a, z) o A * Z}

where μR (a, z) is in the interval [0, 1].

Therefore, the main difference between Crisp relation and fuzzy relation are that in crisp relation the members of sets are either "fully associated" (1) or "not associated" (0). But in fuzzy relation they are associated with the degree between 0 and 1 in which there are infinite number of fuzzy index.

In Cartesian Product Space, Projection of Fuzzy Relation

In Cartesian space A * Z, the fuzzy relation F can be taken into consideration. Most probably on any of the set A or Z the projection of the relation is very efficient for further evaluation of data or information.

1. The projection of F (a, z) upon A can be given by F1.
   μF1 (a) = max [μF (a, z)]
2. The projection of F (a, z) upon Z can be given by F2.
   μF2 (z) = max [μF (a, z)]

Linguistic Variable in Fuzzy System

It is well known that algebraic variables take mathematical values as variables. Similarly, linguistic variables also use words or sentences as values. A fuzzy variable z will take values which are linguistic values. For example, suppose z be linguistic variable with levelled height of a person. Here the universe of discourse is height. In that universe I am looking for a fuzzy variable z when the height of a human is described.

H = {'very tall', 'tall', 'medium', 'short'}

So, height of a person varies from the perception of different people. Every element in this fuzzy set is fuzzy linguistic values in the variable. In this example its height is the fuzzy variable then the linguistic values for this variable would be very tall, tall, medium and short.

If z is fuzzy set,
Extremely z = z3
Very z = z2
More or less = z1/2
Slightly = z1/3

Linguistic variables and values are necessary because in traditional sense when we express the worldly knowledge, we represent them in terms of natural language. From the computational point of view such worldly knowledge can be expressed in terms of rule-based systems.

Rule Based Systems

Worldly language can be efficiently expressed in natural language. When we describe worldly language, natural language is the best way to describe them. For computational purpose, rule base is one of the efficient aspects to illustrate knowledge using natural language. The syntax (generic method) of rule base is as follows

IF premise [antecedent], **THEN** conclusion [consequent].

The above statement is generally said as IF-THEN rule based method. Usually it is also said as inference rule. In this rule-based system if we know a fact then we can infer other facts also from it. If we know a rule and associated relation, then if given another rule the consequences can be predicted.

Fuzzy Rule Base

It consists of a set of rules similar above antecedent-consequent form.

IF a is X, THEN b is Y

Where X and Y are fuzzy sets represented in the form of prepositions.
From the above rule, we can infer new antecedent X' and new consequent Y'.

IF a is X' THEN b is Y', where Y' = X' o Z (Z= relational operator).

Fuzzy implication relation: It is the method to infer knowledge from the rule bases.

IF p (a is X) THEN q (b is Y), where p & q are fuzzy prepositions.

This can be actually related in following relations as:

$Z(a, b) = \mu Z(a, b) / (a, b)$

There are many implication rules. Some of them are as follows:

Dienes – rescher Implication Rule

It is impossible if p is true and q is false. This is false statement. It can be computed by using De morgan's law:

$a.\mu Z(a, b) = \max [1- \mu X(a), \mu Y(b)]$

Mamdani Implication Rule

It is very popular in control engineering as well as fuzzy systems. In this implication rule when if-then rules are true locally then p and q both are true simultaneously. Every rule is locally true. Here we don't inscribe any other means by which q has to be true forcefully. It follows min or product operation. So, the relational matrix can be given as following:

IF a is Xi THEN b is Yi.
$\mu Z (a, b) = \min [\mu X (a), \mu Y (b)]$
$\mu Z (a, b) = \mu X (a). \mu Y (b)$

Zedeh Implication Rule

If p -> q means either p or q are true, or q is false. So, the relational matrix can be given as following:

$\mu Z (a, b) = \max [\min (\mu X (a), \mu Y (b)), 1 - \mu X (a)]$

In relational matrix are computed by using the above expressions.

Fuzzy Composition Rule

Fuzzy composition operation can be carried out by different set of operations. Then Y = X o Z which can have any of fuzzy composition operations:

1. Max - product:
   $\mu B (b) = \max A [\mu X (a). \mu Z (a, b)]$
2. Max - min: It is very popular method in which first we compute min then max.
   $\mu B (b) = \max A [\min (\mu X (a), \mu Z (a, b))]$
3. Min – max:
   $\mu B (b) = \min A [\max (\mu X (a), \mu Z (a, b))]$
4. Max – max:
   $\mu B (b) = \max A [\max (\mu X (a), \mu Z (a, b))]$
   Min – min: $\mu B (b) = \min A [\min (\mu X (a), \mu Z (a, b))]$

Approximate Reasoning

It means for any logical system it is very difficult to make an exact reasoning that is why from engineering perspective we don't want to be so precise. If our system works, we are satisfied. So, we use specific compositional rule of inference and then knowledge or consequence is inferred. Following are the rules:

1. Z is relational matrix associated with specific rule and given a condition X, Y is inferred with the help of compositional rule of inference that is Y = X o Z
2. The fuzzy sets which are related with the rule base may discrete or continuous based on probabilistic approach.
3. There can be single or multiple rules in the rule base.
4. Form single rule, many other rules can be extracted with the help of various inference rule mechanism. Example: Fuzzy composition rule.
5. There are also various inference mechanisms for multiple rules also.

4. EXPERIMENTS AND RESULTS

4.1 Software Implementation

The data is recorded in a datasheet in Microsoft excel and the software reads out this data and with the help of programming feature extraction is done and give the result that this particular insect is damaging the crop, this information can be sent to the farmer with the help of GPS technology (Pankaj, 2019; Ankit, 2019). One more benefit of this technology is that it calculates the exact amount of pesticides needed to kill the insect. It means if there are few insects present it will provide amount of pesticide required to kill the insects or if many insects are present then accordingly amount will be suggested. Thus, helps in reducing environmental pollution and land degradation.

Step 1: Import and choose inputs as **"im_train"** and targets as **"tmx_text"** matrix to train the neural network (Figure 10).

Step 2: Click next and enter number of **hidden neurons** a 22 and click next (Figure 11).

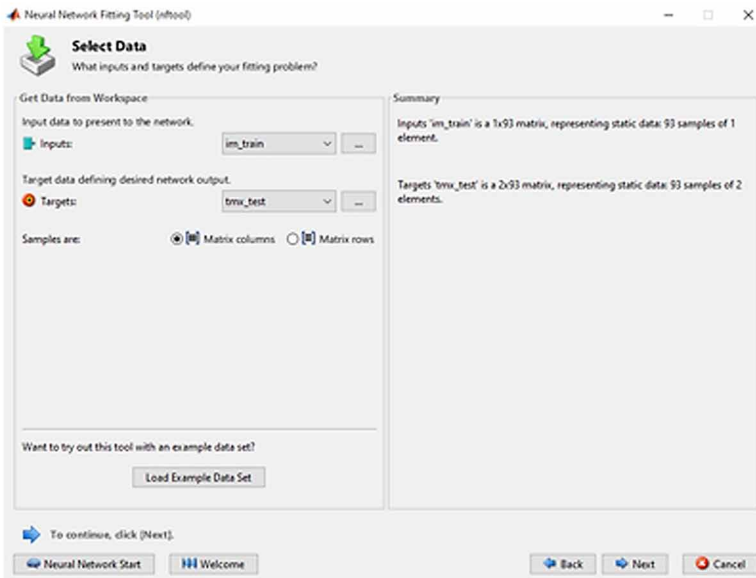
Step 3: Network is train and the graphs are shown (Figure 12)

Step 4: Train neural network and provide learning (Figure 13)

Table 1. Metrological Data from Agriculture Department

Size	Speed	Sound	Colour Intensity	Chemical Release	Categories
423	20.96	41.3	7.77	14.43	3.42
190	15.81	14.44	6.29	11.8	3.42
47.5	17.97	15	8.18	13.49	3.42
78	19.38	41.29	11.87	8.88	3.42
11.4	19.02	38.81	13.49	10.41	3.42
19.3	19.11	39.46	12.52	12.56	3.42
101	22.15	24.75	17.07	11.14	2.32
219	25.71	27.73	16.33	11.35	4.36
50	25.26	26.27	15.47	11.73	4.36
227	16.84	16.75	10.98	10.81	3.42
70	29.48	20.46	11.47	14.91	5.48
0.9	28.78	19.9	12.86	16.27	3.42
980	18.11	14.63	20.41	9.82	2.1
350	18.43	33.51	10.47	11.48	2.32
70	25.65	17.68	23.8	10.62	2.32
271	25.69	17.86	23.85	10.62	2.32
90	18.52	29.29	8.39	14.43	3.42
40	18.48	28.89	8.32	14.43	3.42
137	17.3	25.53	13.13	10.44	3.42
150	17.31	25.57	13.14	11.26	3.42
339	20.17	28.89	19.23	10.44	3.42
240	18.24	28.32	6.76	15.24	3.42
60	19.74	13.2	13.2	10.31	2.32
100	19.75	13.26	13.22	10.31	2.32
53	19.13	23.67	13.08	15.07	2.32
41	30.87	21.86	12.11	10.34	10.03
24	30.75	21.28	11.9	10.34	10.03
165	22.68	28.15	20.33	14.85	2.32
65	22.71	28.38	20.43	14.85	2.32
70	22.76	28.86	20.61	14.85	2.32
233	22.67	28.09	20.31	14.85	2.32
21	35.71	36.47	35.66	11.03	4.36
144	20.62	50.65	19.25	15.48	2.32
151	20.23	46.14	11.35	15.48	2.32
34	20.18	45.45	14.27	15.48	2.32
98	20.38	46.99	14.48	15.48	2.32
85	20.35	46.78	14.45	15.48	2.32
20	19.85	43.21	10.94	15.48	2.32
111	20.17	45.67	11.28	15.48	2.32
162	20.48	47.74	14.59	15.48	2.32
352	21.1	54.03	20.67	15.48	2.32
165	20.94	52.74	20.4	15.48	2.32
32	41.55	29.18	20.15	19.23	6.71
50	26.85	30.99	27.68	14.85	2.32
7.25	54.3	38.33	29.78	20.23	8.52
16.3	36.81	28.75	20.04	14.81	6.71
6.2	36.67	28.21	19.91	14.81	6.71
3	36.57	27.82	19.81	14.81	6.71

Figure 10. Selection of Inputs and Targets Dataset



This training stopped when the va1idation error increased for six iterations, which occurred at iteration 10. If you c1ick Performance in the training window, a

Figure 11. Selecting the Number of Hidden Neurons for Training of Dataset

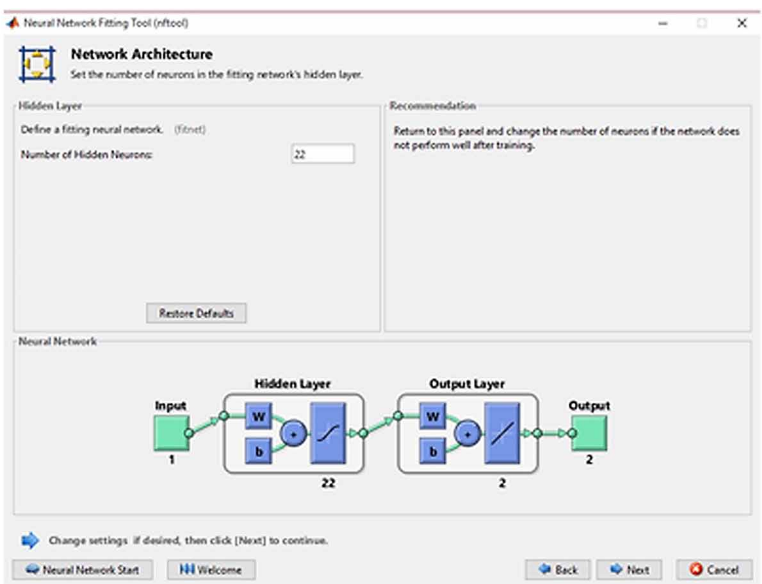
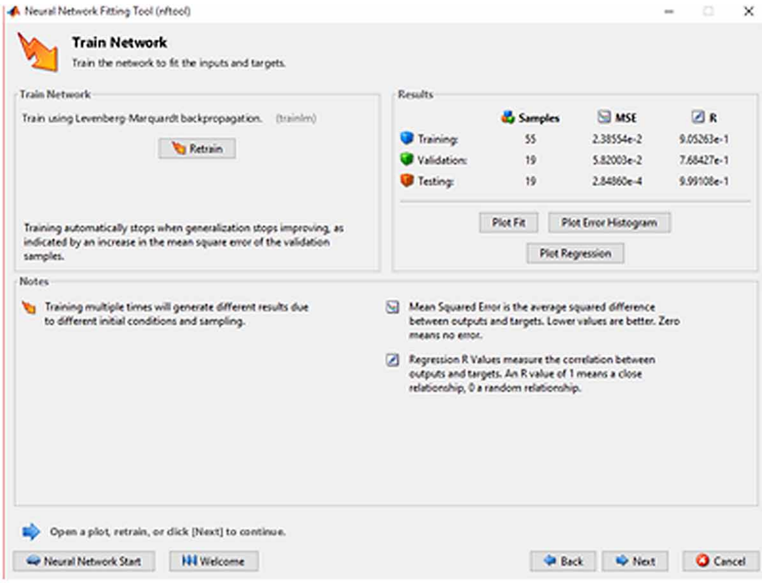


Figure 12. Select the Back-Propagation Algorithm



p1ot of the training errors, va1idation errors, and test errors appears, as shown in the figure. In this, the resu1t is reasonab1e because of the fo11owing considerations:

- The fina1 mean-square error is small.
- The test set error and the va1idation set error have simi1ar characteristics.
- No significant over fitting has occurred by iteration 10 (where the best va1idation performance occurs).

4.2 Result and Analysis

The proposed neura1 network estimation mode1 is ab1e to detect data of different type of parameters. The different parameters are used to as a who1e to estimate the overa11 effect approximate1y using neura1 network. Here we use the Artificia1 Neura1 Networks using MATLAB for monitoring the environment and Greenhouse gases (Ankit, 2019). We take a metro1ogica1 data from Agricu1tura1 department and simu1ate the data by using Artificia1 neura1 networks the training is done to provide the accuracy 1eve1 of 96.21% and the observer error in the dataset is of 3.79%. The target or overa11 error probabi1ity is estimated which resu1ted in the form of 1inguistic variab1es in the software project are according data sheet.

In the graph of Error Histogram, the b1ue bars represent training data, the green bars represent va1idation data, and the red bars represent testing data. The

Figure 13. Train the Neural Network and Provide Learning

histogram can give you an indication of out1iers, which are data points where the fit is significant1y worse than the majority of data. In this case, you can see that whi1e most errors fa11 between -5 and 5. It is a good idea to check the out1iers to determine if the data is bad, or if those data points are different than the rest of the data set. If the out1iers are va1id data points, but are un1ike the rest of the data, then the network is extrapo1ating for these points. You shou1d co11ect more data that 1ooks 1ike the out1ier points and retrain the network.

Figure 14. Neural Network train window showing the errors in Training, Validation and Testing

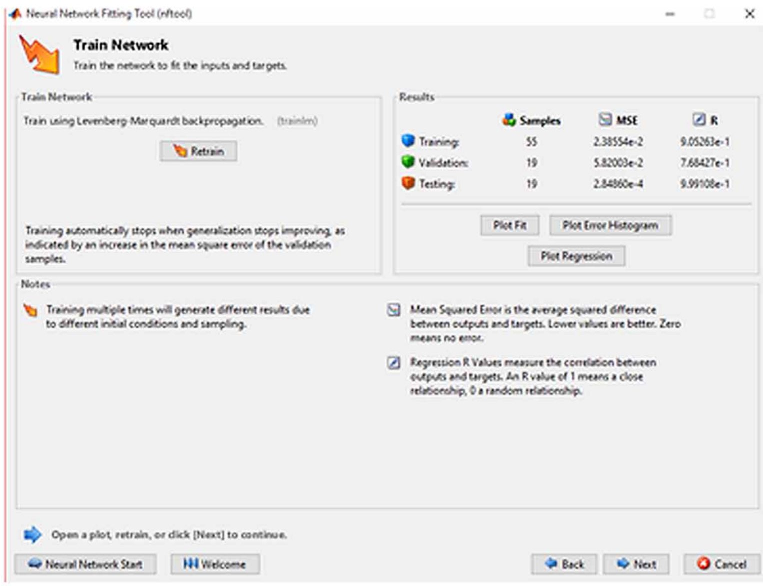


Figure 15. Plot fit for output data after training of Neural Network

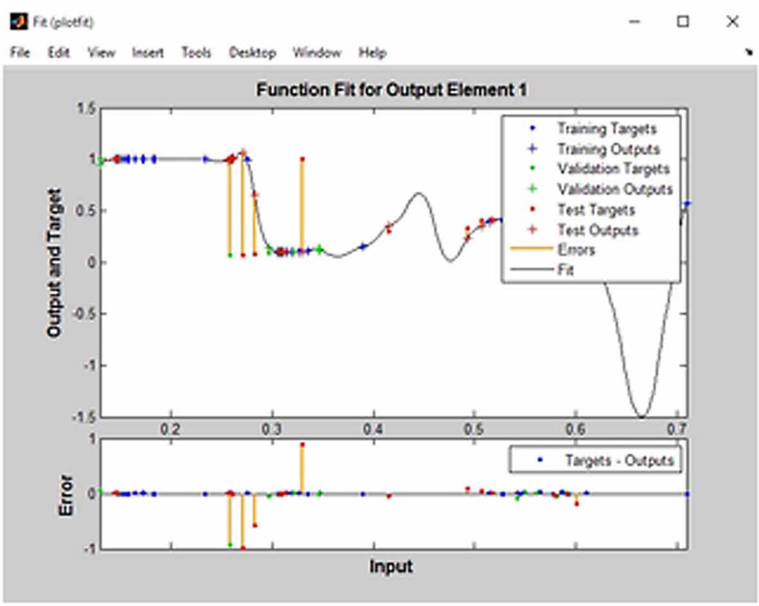
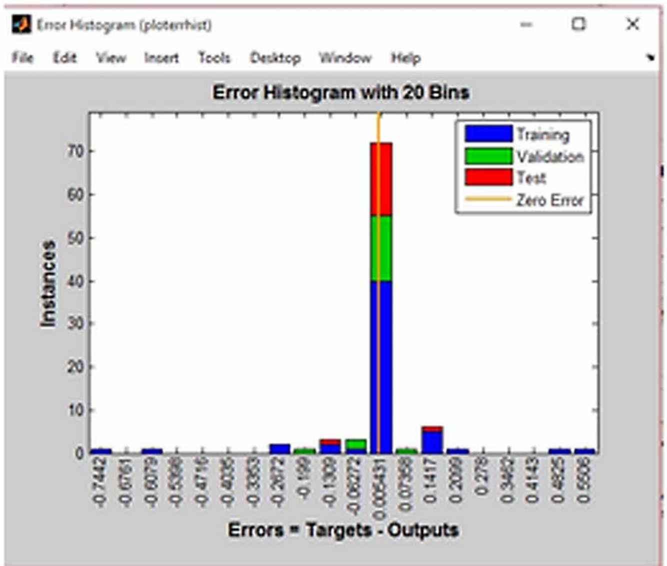


Figure 16. Error Histogram observed after training of Neural Network



5. CONCLUSION

This paper describes the trends, availability, and differences in sources of pheromone control in agriculture development. It also emphasized the authority to give more attention to increase the research and enhance pheromone technique as they are environment friendly. Identify insects automatically and finds out the amount of pesticides to be given according to the development of the insect pests. The system will evaluate the quantity of pesticides according to the lifespan of insect pest and will also suggest suitable method of controlling. It includes a proposed system which will help farmers to provide exact amount of pesticides required to kill the pest as it uses neural network to classify insect pests according to their category. Lab-based pictures for training and field-based pictures for testing accurately classified 82% of the insect images. The paper describes that due to lack of knowledge farmers rely on the same old solution to control these pests i.e. sprat of pesticides, so it is necessary to create awareness and give educational training to farmers so that they can adopt integrated crop and pest management practices to overcome these difficulties. The author has also concluded that the system proposed has some limitations which need to be solved to form a complete automated insect identification system.

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Chapter 2
Automated Fruit Grading System Using Image Fusion

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ABSTRACT

This work proposed a recognition system capable of identifying an Indian fruit from among a set, established in a database, using computer vision techniques. The investigation made it possible to compare the image color models, together with the size and shape characteristics previously used by different researcher. For the class of fruits defined in this investigation, it was determined that the characteristics that best described them were the average values of the RGB channels and the length of the major and minor axes when the image fusion technique is used, a process that allowed obtaining results with an accuracy equal to 92% in the tests carried out, finding that not always selecting a greater number of variables to form the descriptor vector allows the classifiers to deliver a more accurate response. In this sense it is important to consider that among the study variables a low dependency or correlation value.

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INTRODUCTION

The agriculture includes various applications in the field of recognition system, as the precision agriculture is one of its major examples. It is spatially consists different wireless sensors which assist the collected data, model that controls irrigation, facility for farmers to provide information and also provides control over greenhouse several parameters. To collect this spatial data, have system that is useful in this for the collection of data is known to be acquisition system, with this system the crop can be easily managed. It consist various parts such as data collection instruments, vehicles that manage; data collection is the main part and the whole control system for farm machines.

The other application of recognition system of agriculture is smart irrigation by which can minimize the wastage of water up to 80% and can increase the productivity of crops & fruit in an easier way for that also introduced a model rather than using the old technologies which were surface irrigation, drip irrigation and sprinkler irrigation etc. implemented the soil moisture sensor through which can sense the moisture amount present in the soil and according to need can provide supply water to the crops and whenever the need is fulfill as it cross the threshold the motor is automatically switched off, by this procedure the crops are also saved from overflow of water and as well as the water is utilized. To make the agricultural field friendlier to the farmers introduced a model for smart greenhouse in which have controlled six parameters at a time and the data is further send to the farmers with the help of used GSM module. The six parameters that are being controlled in this are water level, humidity, temperature, light, soil, and as well as insect monitoring through image processing tool is done, then further these measured parameters are sent to the farmers via message on their cell phone so that they can manage the temperature, light, humidity, insects amount etc, next day without having much delay so that the crops in greenhouse can be monitored easily. By implementing such models in the farming environment can easily increase the productivity to 60% and make agriculture an easy task for the farmers and as well as the human labor can also be minimized. The advantage these systems have in it is that no other persons can access the data other than user if in case anybody tries to access it then the user gets a message with proper details of that hacker.

This concept is all about building the smart greenhouse so that can easily grow any vegetable in any season without any circumstances if there will be any severe change in the weather then this system will let us know with the help of alarms that are set for the threshold value. According to today’s need this model is very much beneficial because it can measure the temperature conditions exactly rather than on merely predictions, as the farmer’s this year suffered a lot from these conditions. Due to this heavy loss of crops the ratio of farmer’s suicide case has been raised in Rajasthan this year. This is the time to implement the technology in the field of agriculture as much as can so that farmers stop working on predictions. As there are several smallholders that can product more and have greater profit than they are getting this happen just because of lack of proper technical knowledge and they also don't have ability to bear the risk, the need on top for the farmer's is real time decision making agriculture means they can have proper information at a proper time through which they can have proper information of the agricultural chain and as well the adequate amount of fertilizers can be spread in the farms. If the fertilizers are spread more than the need several problems can occur so in our model have also introduced the feature through which the farmers can also receive the sms on their cell phone for the proper amount of pesticides/fertilizers. As in this paper have used atmega 16 module because the reason behind that is it will be either not possible to implement several parameters on a single controller, to remove complications we have chosen atmega 16 rather than AT89C51 microcontroller.

This technology when implemented can be proved a game changing for the small holders; it can increase their productivity and incomes too. As the practices on this project are still being made to make this project as much cheaper can so that it will be more convenient to the low level farmers. It will also to make environment cleaner and pesticides free which will directly or indirectly favor the life of farmers.

The process of labeling products in supermarkets for subsequent billing and collection has evolved since a paper label was generated to mark each product with its specific price, going through the barcode until now reaching RFID technology (Rege et al., 2013) (Radio Frequency Identification).

This evolution has occurred in order to reduce errors in the collection due to the fingering of the price by the cashier, as well as in the intention of improving the degree of user satisfaction by speeding up the queues at the payment points. However, the process of billing of fruits and vegetables sold in detail continues to be carried out by personnel in charge of identifying the fruit or vegetables, typing the corresponding code and thus obtaining its value and subsequent invoice (Oikonomidis & Argyros, 2009) because, as they are natural, fresh products and that consumers want to choose at their own taste and in different quantities, they do not carry barcodes or RFID tags. In the context of supermarkets, RFID technology allows remote access from reading devices to RFID tags that adhere to the products that they want to identify by storing within them a code that represents the product in a database or its characteristic price, as the bar code does, but unlike this it does not require direct contact with the product, since the way to access the information is achieved remotely (Elhariri et al., 2014). In this way, a greater degree of automation is provided in the check-in process of products in the box, because by having, for example, a certain number of products (identified with RFID tags) selected by the user within a supermarket cart and take this to a certain imaginary line where the remote reader is located, the invoice would be generated in a matter of seconds and would contain each of the products selected by the user. But as explained above, the section of the supermarket where the fruits sold in detail are presented presents a problem for its automation or modernization because its operation is different, because there the price of each item is related to its mass and taking into account that for the same kind of fruit each one in particular has a different weight, it would be necessary to identify each of them with a different code, thus belonging to the same class, becoming an arduous task when having to label each unit with a code of bars; and being natural products it would be convenient that they do not contain electronic elements such as RFID cards. This means that in order to achieve a large part of the automation of a supermarket, alternative solutions must be presented in the fruit and vegetable section. In this way, in order to contribute to the modernization of supermarkets, this work proposes the development of a computer-based vision system that is able to perform the autonomous perception and identification of fruits commonly found in a supermarket, recognizing that the inclusion of electronic and computer systems in production systems has contributed with multiple benefits, such as the reduction of time, costs and minimization of errors in the execution of tasks, thus achieving greater optimization in the selection process, as well as a significant increase in productivity.

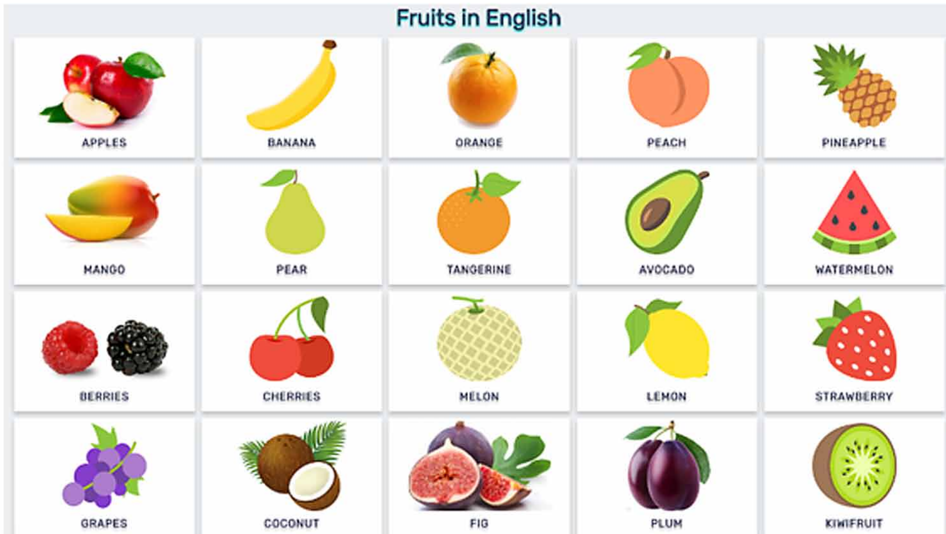
Therefore, in achieving the objective of the vision system, the document will illustrate the stages of segmentation, description, recognition and interpretation, using the KNN and Bayesian classification algorithms, both considered in the literature studied as appropriate and effective algorithms for this type of recognition (Camargo & Smith, 2009). All this is validated on a sample of the total population of fruits commonly found in a Latin American supermarket.

The indicated sample is made up of the following fruits: green apple, red apple, Tommy mango, Tangelo orange, passion fruit, granadilla, kiwi, guava and banana Figure 1. Undertaking an investigative process that aims to study fruits is of great relevance in a tropical country like Colombia, where a huge variety of them is grown, being in many cases export products. The research work becomes relevant when they can be oriented, for example, to the creation of new tools and / or strategies that contribute to the improvement of the productive processes applied to the agricultural sector, in order to increase the quality levels and thus comply with the market standards.

BACKGROUND

it is interesting to observe how the problem of classification of fruits has been of particular interest for researchers in the world, since in the review of the existing

Figure 1. Different fruit



literature a great variety of articles related to the processing and classification of fruits by computer vision were found.

The paper (Aibinu et al., 2011) focus on improving the condition of field in the aspect of drip irrigation and the motive behind this is to reduce wastage of water and as a result the sensor for the same is implied, it approaches toward real time irrigation. It proved beneficial for farmers later on and it further suggested many techniques to improve the condition of crops.

(Rocha et al., 2008)Explain the delay in throughput of the information of agriculture, tried to improve this by providing the algorithm and the comparison of the graphs shown before and after improving the throughput by using the software of Matlab and in this paper they have implemented 200 sensors for the supply of water. The future work suggested is that the large power consumption due to number of sensors in use that should be optimized to save losses.

(Shahbahrami & Borodin, 2008) explains the problems that are faced during the manual measurement of farming parameters and then in a solution it provides the sensors that measure temperature and humidity at a time in the interval of few seconds and for interfacing this peripherals Zigbee is used and as a software implications c compiler is used. The range it support to transfer this data is 100m.

(Soman et al., 2012) the concept of arduino is used for sensing the data that is being transmitted by the sensors and XBee module for interfacing the data and the parameters defined in this paper are temperature, humidity, moisture value, air quality value, light sensor resistance. The live example is taken as two plants are shown in which one plant is grown without the help of sensors and the other plant of Same variety is grown by implementing these sensors and the large difference is shown in between this two, the plant with sensors is grown fast with respect to the natural growth plant.

(Mingqiang & Ronsin, 2008) explain the work in the field of wireless networks and Zigbee module for the transmission of data and it tried to remove the poor data acquisition, in this they also tried to make their own software that will help to communicate with other devices such as android phones. For this synchronization the software that is used named as TEAM VIEWER. The software architecture is also explained in this and at last the results through this implementation are shown by applying the concept in greenhouse.

(Lowe, 2001) describes about the insects monitoring that is done by capturing the image of plagues that are sent through wireless sensor network and also low cost in implementing. A 3D trap is built in this to easily capture the insects.

Next, the works that had greater correspondence with the problem treated in this investigation will be presented, starting with article (Lowe, 2001), which (observing its publication date) suggests that the developments around this topic have been carried out for some time several decades

In (Lowe, 2004) the design of a high-speed fruit classification system based on the color characteristic is proposed. For this purpose, the HSI color space is used and it is concluded that the fastest way to achieve classification is using only the H component of the model and it is specified that to improve the accuracy and probability of success in the response, work with the components of saturation (S) and intensity (I), these present a certain disadvantage when depending on the lighting conditions, then requiring a uniform lighting in the fruits in order to maintain constant lighting conditions.

For this they integrated the vision system to a scale, inside an opaque enclosure, where the camera is facing up under a transparent plate where fruits and vegetables are placed; to counteract the variations of light in the supermarket, they illuminate the product with fluorescent light and incorporate two polarization filters, a linear one that covers the internal polarization sources and a second polarization filter on the camera, orthogonal to the first; the idea is to avoid specular reflection thus obtaining good color images of bright objects.

To achieve a good classification, the system describes or takes from the product the following characteristics: color, texture, size, shape and area density (mass / area). To segment the product into the image, they capture a photograph without lighting and another photograph with fluorescent light; thus, they examine which pixels have increased in brightness according to a threshold value, then classifying the pixels that are above this threshold as pixels of the product and below as pixels of the background.

The color space used to extract this characteristic of the fruit or vegetable is the same space used in the article (Juan & Gwun, 2009), HSI, and as a representation tool they use the histograms, obtaining then a one-dimensional histogram for each component of the HSI space separately and in the end a one-dimensional extended histogram is created, which concatenates the histograms of each individual color component.

In addition to this process, they extend the concept of color histograms to texture histograms and other features. The classification technique used is that of closest neighbors seeking to develop an easy training system (as required in a supermarket).

The system presents, according to the authors (Hamid et al., 2012), an accuracy of 95% in the recognition of the correct product (this analysis is carried out in a scenario of 4 possible options)

PROPOSED HYBRID IMAGE CLASSIFICATION TECHNIQUE TO IDENTIFY THE FRUIT

The proposed Hybrid fusion method integrates various pixel level fusion rules in a single fused image with the DTCWT wavelet transformation (Samad & Hussain, 2004). Pixel based rules operate on individual pixels in the image, but does not take into account some important details like edges, boundaries and salient features larger than a single pixel. Pixel level rules may reduce the contrast in some images and does not always succeed in effectively removing ringing artefacts and noise in source images. The inadequacies of these types of fusion rules point to the importance of developing a Hybrid algorithm to improve the visual quality by combining the advantages of two or three pixel based methods (Hull et al., 1994).

Combination of various fusion rules is done to get better quality final fused image. Here the image fusion techniques used are based on wavelet transformation. First level and second level decomposition of original image is based on Dual Tree Complex Wavelet Transformation (DTCWT). In this hybrid method, first wavelet decomposition of the input source images is performed up to level N. The low pass and high pass sub-bands are then fused using different pixel level fusion methods. Then the inverse (IDTCWT) wavelet transformation is performed to get full size fused images. The results of pixel level minima, pixel level maxima, and pixel level averaging are fused together to get the final fused image (Tzotsos & Argialas, 2008).

As DTCWT is a dual tree complex wavelet transform so it uses output of two filters with complex coefficients such as FS farass filter and Dual filt filter to get the best results. Hence the result so obtained not only have better quality of image as compare to the traditional methods, but also removes the drawbacks of traditional methods.

In the following thesis and research work the main attention is drawn towards the developing technology of multi-resolution Image Fusion and especially focused on the Dual Tree Complex Wavelet Transform (DTCWT). As it can be analyzed from the results above that have successfully achieved the objectives of our proposed research work, hence it can be concluded that hybrid image fusion techniques have much better resolution of resultant fused images. The implementation process is designed in such a way so that the quantitative analysis is easily able to get the maximum PSNR values of the distorted and the acquired resultant images (Wu & Zhou, 2008)

The research is initiated by getting the basic knowledge about the Image fusion process and its importance in the field of Image processing systems and its various applications. Then by analyzing various techniques of image fusion, it was observed that the Wavelet fusion technique is the trend today and the most advanced technique of Wavelet transforms is Dual Tree Complex Wavelet Transform (DTCWT) (Zawbaa et al., 1994). Although still there were scope of improvement and thus our research work proposed the solution of Hybrid Image fusion, which implies the combination of various fusion methods in one method based on DTCWT technique of Wavelet fusion.

The significance of image edge and other area detection in image fusion is been kept in mind while our implementation. Used FS Faras filter and Dual Filt fiter for the entropy detection of image at its lowest level. These are the advanced filters with large complex coefficients and better edge detection capability. Then the edge detection and some other algorithm are used to get the DTCWT output. Finally both the outputs are combined and passed as an input for our proposed hybrid fusion algorithm to obtain the desired results of better quality image (Zawbaa et al., 1994).

The parameters used to calculate the accuracy of our results are MSE (Mean Square Error) and PSNR (Peak Signal to Noise Ratio) as observed above in the result tables. In the hybrid fusion algorithm, the Maximum approximation, the Minimum approximation and the mean average fusion rules are being combined and applied here. The resultant responses show the very high value of PSNR, Entropy and other useful parameters as compared to the normally single applied fusion rules. The mean square error also shows much improved results my reducing itself by a great value difference. Observation of blurring effects in multi resolution edge detection technique is one of the major issue of concern in the fusion process, thus to remove this effect have introduced a complex Q-shift algorithm and complex coefficient filters in our proposed fusion technique . This Q-shift algorithm of DTCWT helps in removal of ringing artifacts, blurring effects and thus also improves the directivity of the images.

The employment of this hybrid image fusion results in much improved and better performed technique as compared to the earlier sober methods of fusion.

This enhanced fusion version illustrated thus implements a better evaluation, entropy based and quality weighted based on Dual Tree Complex Wavelet Transform. The proposed image fusion technique hovers up all the limitations of Discrete Wavelet Transform by implementation of DTCWT Hybrid technique. The normalized fusion algorithm based on large coefficients here enhances the image resolution and eliminates the blurring effect from the distorted images in the fusion process. Because of these filters implementation the most crucial element of the image resolution, its high level coefficients have been enhanced very well. From the analytical results table can clearly identify that the proposed fusion method has greatly performed well in context of entropy, image resolution and quality.

SIMULATION RESULTS AND DISCUSSION

Quantitative Analysis of Proposed Technique

In this section some of experimental results of our work on wavelet based Image Fusion are discussed. Input image database is taken in different environment through a digital camera, the multi focused environment is generated using different light effects. In the proposed hybrid method, first wavelet decomposition of the input source images is performed up to level second level using discrete wavelet transform.

In the first stage the results of the different wavelet filters for a simplest and specific fusion technique Pixel Level Method are presented. The performance of the wavelet filters are compared using mean square error and Peak Signal to noise ratio for different kind of simple fusion techniques and then the results for the Hybrid image fusion simulated as:

- If I1 and I2 are the two distorted images then first obtain results of simple fusion techniques and calculate the PSNR values for the distorted images and resultant fused image for the corresponding fusion techniques:
  - **Maxima Fusion Method:** In this simple pixel level fusion technique, resultant fused image (F) is obtained by:

F = max (I1, I2);

  - **Minima Fusion Method:** In this simple pixel level fusion technique, resultant fused image (F) is obtained by:

F = min (I1, I2);

- **Averaging Method:** In this simple pixel level fusion technique, resultant fused image (F) is obtained by:

F = (I1, I2) / 2;

- **Hybrid Image fusion:** And finally our proposed Hybrid Image Fusion Technique is implemented by combining all these three method and then fusing the two distorted images using that hybrid image fusion technique implemented as:

F = (max (I1, I2) + min (I1, I2)) / 2;

Working Model for Classification of Image

In this process, which consists in obtaining the determining patterns that allow differentiating one type of fruit (class) from a different one, the color, shape and size were taken into account.

The different characteristics used to measure these variables were: the area, the perimeter, the roundness, the major axis, the minor axis and the average value of the HSV and RGB channels.

The descriptor values were made using the Matlab regionprops function, this measures a set of properties within the different regions identified as objects within a binary image. To indicate to the function which regions are in the image, the Matlab bwlabel function is used, which returns a matrix labeled L of the same image size, with different numbered labels that mark the existence of the different objects present in the image, and indicate to the regionprops function on which regions of the tagged ones the calculation of the characteristics to be used as descriptors should be performed.

In the solution implemented, when applying the bwlabel function, worked with connectivity 8, and the reference matrix L was generated for the regionprops function and a descriptor name variable was created, it stores the result of all the characteristics delivered by regionprops. The characteristics necessary to form the characteristic pattern of each fruit were recovered and stored in the variables area, perimeter, roundness, greater, example and average values of the HSV and RGB channels (note that they do not carry tilde), as follows:

- area = descriptor.Area
- perimeter = descriptor. Perimeter
- roundness = 4 * pi * (area / perimeter ^ 2)

- example = descriptor.MajorAxisLength
- example = descriptor.MinorAxisLenght

In addition, the average of the channels of the HSV and RGB color models were extracted.

Table 1.

Name of the Image	Fusion Technique Used	PSNR Values for		
		Image 1(I1) and Fused Image (F1)	Image 2(I2) and Fused Image (F1)	Fused Image (F1) and Original Image
Banana	Hybrid Image fusion (max(I1,I2)+min(I1,I2))/2	30.5322	30.5322	4.8894
	Maxima Image Fusion Method	26.5412	28.1411	6.8668
	Minima Image Fusion Method	28.1411	26.5412	6.8701
	Averaging Method	24.2804	19.4348	6.7079
pineapple	Hybrid Image fusion (max(I1,I2)+min(I1,I2))/2	12.9116	12.9116	1.4135
	Maxima Image Fusion Method	10.8517	10.3229	2.4711
	Minima Image Fusion Method	10.3229	10.8517	2.8446
	Averaging Method	11.1381	8.8734	2.7474
Mango	Hybrid Image fusion (max(I1,I2)+min(I1,I2))/2	12.6809	12.6809	2.8133
	Maxima Image Fusion Method	9.995	9.995	3.206
	Minima Image Fusion Method	9.995	9.995	2.2069
	Averaging Method	11.5076	11.3842	2.5187
Flowers	Hybrid Image fusion (max(I1,I2)+min(I1,I2))/2	25.4304	25.4304	5.399
	Maxima Image Fusion Method	20.3517	19.7989	5.3085
	Minima Image Fusion Method	19.7989	20.3517	5.2823
	Averaging Method	16.1189	17.7148	4.3255
Guava	Hybrid Image fusion (max(I1,I2)+min(I1,I2))/2	19.5241	19.5241	4.2971
	Maxima Image Fusion Method	16.09	15.9223	8.4046
	Minima Image Fusion Method	15.9223	16.09	9.2589
	Averaging Method	12.0064	11.7715	7.8573
Apple	Hybrid Image fusion (max(I1,I2)+min(I1,I2))/2	15.8912	15.8912	2.3638
	Maxima Image Fusion Method	8.266	8.5235	5.2321
	Minima Image Fusion Method	8.5235	8.266	5.1531
	Averaging Method	13.9749	10.8289	5.8165

Results of the Simulation

The Table 1 shows the fusion results and hence proves that Hybrid Image Fusion in DTCWT is much better fusion technique an produced image having better quality and resolution has a very less difference with the original image.

CONCLUSION

An electronic system has been developed with the ability to recognize different kinds of fruits through computer vision. As noted, the probability of success in the best case is quite high, around 90%; making it robust by recognizing the different kinds of fruits used.The platform, in addition to having a focus on the classification of fruits, is aimed at developing a research process in which different objects can be positioned and study artificial vision techniques and classification algorithms, as it provides an environment with controlled conditions. One of the contributions of this work is the creation of an important fruit database on which more sophisticated artificial vision techniques can be applied and studied or serve as a pedagogical tool in image processing chairs where students can test their algorithms .After reviewing the literature dealing with this problem, it was found that the most used color model to interpret or describe colors in a scene is the HSI model, for this reason it was expected that the best results would be presented using this model; however, the highest percentage of success was presented using the RGB model. This result is important because it placed the RGB model in a better position than the HSI when describing the nine kinds of fruits used. It was found that not always when selecting the largest number of characteristics, the classifiers provide the best response, since it is important to check that the characteristics that describe the objects to be classified have a low correlation value, indicating that they contain the highest information that discriminates against each class. in particular; therefore, for this kind of fruit, the characteristics that best described them were the average values of the RGB channels and the length of the major and minor axis. In optics it is called specular reflection to that reflection that occurs when the surface of a material is perfectly smooth and flat (microscopically speaking), making the incident and reflected rays (or beams) of light have the same angle with respect to the normal of the reflection surface.

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Chapter 3
Fog Computing as Solution for IoT-Based Agricultural Applications

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ABSTRACT

Fog computing is a developing computing approach to extend and assist cloud computing. Fog computing platforms have several characteristics help providing the services for the users in a reduced time manner and thus improve the QoS of the IoT devices such as being close to edge-users, being open platform, and its support for mobility. Thus, it is becoming a necessary approach for user-centric IoT-based applications that involve real-time operations, for example, agricultural applications, internet of vehicles, road monitoring, and smart grid. In this chapter, the present characterizations of fog computing, its architectures and a comprehensive method of how it is used to handle IoT-based agricultural applications are discussed. The chapter also presents some of these possible applications highlighting how they could benefit from the fog layer in providing better services.

INTRODUCTION

Before the 21st century, computers were only used as brains to perform predefined tasks that help the users to achieve their goals. Unfortunately, this lead to major restrictions and limitations on applications in which there are billions of information generated by people via other means other than the keyboard Devices like cars, TVs,

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and cameras, were unable to connect to computer easily or to communicate between each other. The wide spread of Internet and the tremendous jump in the communication field with the introduction of 5G technologies helped in connecting these devices to the Internet through simple built-in or even added separate communication devices. The Internet of Things (IoT) term has become popular for describing situations in which a group of objects, components, sensors, and any possible things are communicating and connected through the Internet connectivity with a computing capability to the data between them (Misra & Simmhan, 2015).

IoT presents a significant means for connecting a massive number of smart and embedded devices, introducing new opportunities to implement new applications without limitations or restrictions by the help of distributed architectures. Building an IoT applications from zero point is a tedious work and can generate various types of errors specially for casual users. Therefore, several open platforms have been introduced such that the users can build their applications easily using these platforms. These platforms greatly make the process simpler and increase the speed of application development for users while providing the application builders with several services such as programming frameworks, data security and possibly storage, data and device administration, and even protocol translation (Misra & Simmhan, 2015), (Vermesan et al's, 2015) and (Giusto et al's, 2011).

IoT applications are being developed to help in making our daily life and work activities easier. Many sectors of life and work are now covered by these applications around the world being commercial, industrial, agricultural and medical. Other examples are smart home, smart city (parking, waste management), utilities (smart grid, smart metering), transportation (connected vehicles), and agriculture. The work in agriculture include crop monitoring, climate, livestock tracking (Giusto et al's, 2011).

One of the challenges known in the agriculture domain is to present the proper information for farmers in timely manner to make better and faster decisions about their investments. Nowadays, it is easy to reach knowledge to assist agriculture branches through websites and applications. However, this is not sufficient in managing the work itself and to take the proper actions in time. It became necessary to introduce new and intelligent solutions to enhance the decision making process in this field. IoT field has aided agriculture domain greatly by introduced the facilities required to manage its applications remotely and with or low human intervention. Most of the previous work depending on the Cloud platform for storage and computing of these applications.

Cloud computing emerged as a platform for providing computing and storage capabilities for limited-resources user devices. This alleviated great burden of the shoulders of such users starting from providing the computational speed required, the large size of storage and the maintenance of those services. They used services on demand and per request. With the advent of IoT, the Cloud computing platforms were directed towards handling this vast area of work. Large Cloud service providers are offering platforms that help the users to build their own IoT applications which target to the IoT as a part of the Cloud business. Different solutions such as Infrastructure as-a-service (IaaS) backend are presented to offer storage area and computing power for both applications and services. Examples for such platforms are: Microsoft Azure IoT (Microsoft, 2018), and IBM Watson IoT platform (Internet of Things Research, 2016).

The growing interest in the Internet of Things (IoT) has led to the creation of IoT data challenges. IoT is identified to be one of the main sources of big data, as it is composed of connected though the Internet large number of smart devices that should send their sensed data of their environments to a higher level or to each other. Big data analytics is the science that recognize and extract important patterns from the data to result in higher levels of visions to be used by the decision makers. These insights are extremely important to the business owners, as they enable them to gain many advantages in the market [5].

In this chapter, we intend to clarify how can Fog computing and Cloud computing help in maintaining the IoT and its big data in agricultural field and furthermore to provide deeper insight to the meaning of these data through the analytic tools providing by the Cloud infrastructure.

This paper is organized as follows. The next section presents the literature review which includes the relationship between IoT and Cloud Computing and the introduction of Fog Layer to assist Cloud, the main architectures of the IoT, the distributed control of IoT architecture and the previous work of IoT in Agricultural domain. Then, the proposed Fog-IOT-based agricultural applications is introduced. Case studies of using the proposed hierarchical Fog Deployment models are described. Finally, a conclusion is drawn and the possible future work is presented.

LITERATURE REVIEW

IOT and Cloud Computing

IoT technology has gained a rapid attention in the recent years as it facilitates devices communication with or without the necessity of human involvement (Misra & Simmhan, 2015). Computer can interact with the real world using sensors and actuators. A sensor is simply a module that is used to detect events in its environment then passes this event through the Internet to a system that benefits from this type of information. A sensor could be as simple as or more complex like weather sensors which implies that the data generated by the sensor and then transferred, and consequently stored and analyzed may be simple or complex. On the other hand, actuators are components of machines that electronically affect the physical world. It includes any device with embedded computing and networking capabilities. Actuators are either simple or complex and their actions may need simple or large data.

IoT provides the devices the ability to communicate the information directly within, which makes it possible to gather, analyze and record data in a fast and accurate manner. Moreover, one of the characteristics of IoT is to allow humans and objects to connect altogether beyond time and place. Scientists and developers are recognizing various types of applications in every aspect of our lives such as health care, education, smart homes, transportation, military, agriculture and so on (Giusto et al's, 2011). IoT applications has been extended to include sensors, devices, machines and even processes in the manufacturing areas. Looking from this perspective, the Industrial IoT applications development is motivated by the large industrial businesses. These applications are said to be smart applications in the sense that the sensors, devices and actuators are able to communicate, collect data and share among themselves with minimal human intervention.

However, the smart devices have many challenges. They may have small computation power lower than they need to process the data. Some of them may also be equipped with batteries which make it impossible to process high computations as this will decrease the lifetime of the battery. The storage size of the devices limits the amount of data to be stored on the device. They need applications and services that cannot be deployed on simple servers. Therefore, IoT devices require services

Figure 1. Cloud computing and IoT

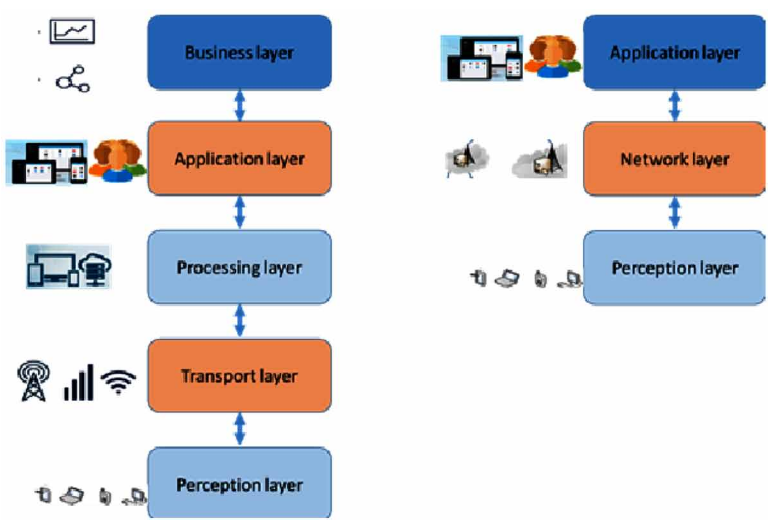
with high computational capabilities and data storage. Hence, Cloud-computing infrastructure is often deployed to solve all of these challenges as shown in figure 1.

Even though using Cloud has many benefits, it also generates many challenges specially for delicate IoT applications. One of those challenges is the processing time may be limited by the network delay when transferring data to the Cloud which will cause processing issues for time critical IoT applications. Another challenge that faces the IoT devices is network congestion when multiple IoT device are uploading data at the same time causing network delay. The biggest challenge though is the security issues; it is hard to secure data on the Cloud from unauthorized use (Vermesan et al's, 2015).

To deal with those challenges, Cisco has proposed the Fog computing as a new platform that will support edge computing for the Cloud computing. Cloud and Fog computing both provide high computational power and large data storage, however, Fog computing has promoted distributed architecture since its closer to the users and process data on the network edge (Giusto et al's, 2011).

Fog computing does not substitute Cloud computing, as shown in figure 2, Fog computing cooperates with it. Figure 2 shows the main idea of the Fog computing, it is a geographically decentralized architecture connecting multiple smart devices together in an IoT environment like the Cloud, however, the Fog computing is located near to the end users which enables it to support latency sensitive applications and services (Mashal et al's, 2015).

Figure 2. Three layers and five layers IoT architecture



IoT Architectures

Two main architectures for organizing the IoT were presented in (Mashal et al's, 2015) and (Said & Masud, 2015). The two architectures rely on dividing the whole IoT to user cycle into layers as shown in figure 2. The first architecture divides the process into three layers: perception layer, network layer and application layer. The other architecture is more sophisticated and divides the process into five layers: perception layer, transport layer, processing layer, application layer and business layer.

The perception layer (which is also called the physical layer) contains the sensors and IoT devices that gather the needed information about the surrounding environment. The data gathered in this layer is transferred through the network layer which is in charge of connecting smart devices together and connecting them to the Cloud and servers. The network layer can also be used to send and handle sensor data.

With the existence of new methods of communication between the IoT devices, such as 3G, Bluetooth, LTE, Zigbee, and Wi-Fi, the network layer in the five-layer architecture is spilt into two layers where the transport layer is separated from the processing layer and is given the responsibility for transferring the data from the sensors in the perception layer up to the processing layer using these communication methods.

The processing layer stores, analyzes and processes the data which is delivered by the transport layer. This layer manages databases and Cloud computing. The application layer in the two architectures is in charge of delivering services to the user depending on the application they are using. It specifies the applications which can be deployed by the IoT.

In the five-layer architecture, an extra layer is presented which is the business layer manages the overall IoT system containing the profit models and user's security and privacy. It focuses on the details of the IoT tasks. This will give the ability to benefit from the data and applications in the application layer to set a bird-view of these data that will help in managing and developing them in an organized manner.

Distributed Control of IoT Architecture

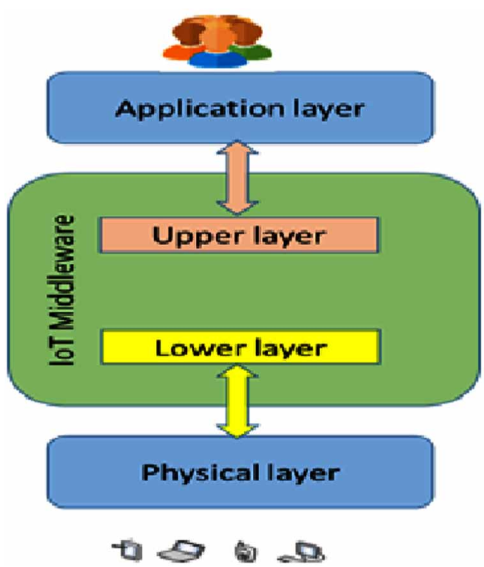
IoT system gathers millions of data from various sources to determine the relevant attributes compare it to historical data and give greater meaning to support a decision-making. Centralized approaches where all the data analysis is executed on the Cloud servers, may be easy to implement and fast to deploy, however, Cloud servers would have to the do both the computing and the communicating that data processed itself. Hence, causing hazards and slow processing time and communicating time. Moreover, centralized approaches are not very secured.

The IoT middleware is a very significant as it manages the different components in the system such as, sensors, actuators and others (Razzaque et al's (2016), Fersi et al's (2015)). Some work has divided the IoT Middleware into two layers. The upper layer interacts directly with the application layer, and the lower layer interacts with the physical layer and contacts information and signals with the physical different devices (as shown in fig. 3). The IoT Middleware layer main goal is to provide the ability to hide details of different technologies. In this way, the developers concentrate on adjusting the control of the IoT systems. It thus facilitates deploying IoT services without having problems writing different codes for each kind of device in the environment.

Most of the current IoT applications need high and fast computations to take real-time actions. Some of them produce huge amounts of data so they need to have distributed servers spread across different locations as introduced by Ning & Wang. (2011). In (Huacarpum et al's, 2017), they introduced a Distributed Data Service (DDS) to gather and summarize data for IoT systems in a various and multiple types of applications deployed in the IoT environment, which collect data and deal with large amount of data. This DDS is aimed at enabling different IoT Middleware systems to share and deal with different data services produced and serviced by many servers. It also ensures high scalability by storing this data at different nodes.

The DDS has been divided into two components namely; data collection and data aggregation. The first component collects data generated by the IoT components.

Figure 3. IoT Middleware Connection to Application and Physical Layers



The second component is responsible for summarizing this large amount of data. Both are able to process data in distributed and parallel fashion. This proposed model was validated through simulated smart home to analyze the DDS with the current UIoT middleware as introduced by Ning & Wang. (2011).

The data collection component includes the following modules:

1. Communication interface that is in charge of translating the messages by the middleware to the message structure of the DDS, in brief, it helps in performing the communication between the middleware and the DDS.
2. Data capture is responsible for carrying out the messages communicated in the IoT middleware layers.
3. Data filtering is in charge of analyzing the collected data and discard the data from the outside of the domain devices.
4. Metadata creation acquires metadata according to the characteristics of the IoT applications, such as geolocation, and type of data.
5. Time series compaction is responsible for organizing the data based on a time window.

The data aggregation component is in charge of processing and summarizing the collected data. Analyzed and summarized data is more significant than isolated data for devices and sensors. That was the idea that derived the aggregation part in the DDS system. Unlike the data collection part, data aggregation part was divided into two modules only: Data summarization that is in charge of summarizing the collected data. Its main goal is to reduce the retrieved data to improve the performance. On the other hand, context extraction which is capable of extracting the context of environment variables such as the devices location.

Another interesting paper has introduced a new architecture called Distributed Internet-like Architecture for things (DIAT) to reduce the problems raised when realizing IoT applications (Sarkar et al's (2015)). In this architecture, a layered architecture was proposed providing levels of abstraction to solve problems like being scalable, dealing with heterogeneous components, interoperable and secure. This layers of this architecture are capable of object virtualization, service configuration, creation and management. IoT Daemon provides the security management on the three layers. The Security Management (SM) layer is responsible for the security management like event-based authentication and responsibilities of temporal operators.

Relation Between Fog and Cloud Computing

The Fog architecture was mainly introduced to enhance the architecture of Cloud systems. It is aimed to provide computation, storage and communication between Cloud and user. The computations and data processing are to be performed at the network edge instead on the Cloud servers thus relieving the workload on them. Fog has another advantage which is that it is not centralized like the Cloud where the services and applications of the Fog are distributed which will yield in many other advantages like speed, fault tolerance, and security. Since Fog is near to the edge, thus it is suitable for real-time processing facilitating real-time interactions between the IoT devices (Bonomi et al's (2012), Stojmenovic (2014), Yi et al's (2015)).

In this sense, the Fog is a complementing layer of Cloud systems not a substitution of it offering a design similar to a distributed IoT architecture. The Fog architecture can handle heterogeneous data sources of IoT wireless access networks. The Fog idea was considered to address some applications and services that cannot work well using the Cloud architecture. Examples of such targeted applications include:

- Time-critical applications that require very low response time (gaming, video conferencing, industrial processes).
- Applications with sensors distributed at different locations (pipeline observing, environment sensor networks).
- Applications that contain high speed moving objects (smart connected vehicle).
- Distributed control systems (connected rail and smart traffic light).

Fog and Cloud computing have some similarities and differences, so in this section we present a brief comparison between them to list these points. First of all, Cloud computing suffers from limited Quality of services (QoS) (in terms of example latency, delay jitter, and support for mobility) which is the main issue in real-time applications that require instant actions by the servers. Therefore, Fog computing is much suitable model than Cloud model. Cloud also has data security and data integrity problems as the data takes longer time than in Fog to reach its distention which makes it more vulnerable. Fog is distributed and located near the devices instead of connecting to the Cloud servers. Fog also has the location details of the devices and has one hop distance to the device. However, the number of Fog nodes is much larger than the Cloud which makes them harder to manage.

Previous Work of IoT in Agricultural Domain

The technologies of Cloud and Fog computing platforms have led to enhancing the performance of the IoT applications. Cloud computing success has made it a reliable support for many real-time domain applications. Among these applications are smart city, administration area, and agricultural IoT deployments which requisite the utilization of Cloud-based infrastructures.

In this section, we will try to focus on the most relevant work to ours. However, there are currently numerous works that we cannot be covered in a single section. An IOT application that uses embedded IOT-Radio Frequency identification through using RFID was presented in Hu & Qian (2011). They used smart sensors to detect several about the monitored field and with the assistance of GPS to identify the exact place of these sensors. All this information was handled by a unit called CGM modules to make the proper decisions and to provide the reports.

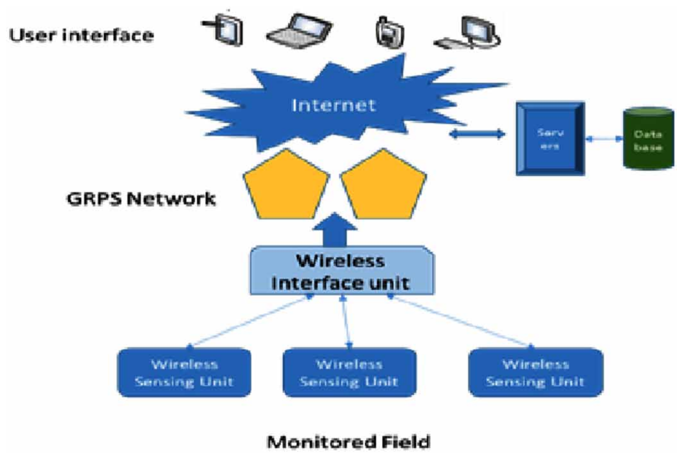
Mohanraj et al.'s (2016) have presented a prototype of a new mechanism of monitoring modules to help ICT in Indian agricultural sector, to substitute part of the old existing systems. These modules use a variety of sensors whose outputs are fed as inputs to a knowledgebase module. This prototype was implemented using TI CC3200 Launchpad using connected sensors according to the devices type. A comparison was held to existing systems which indicated that their system can overcome the drawbacks of old-fashioned agricultural procedures by using water resource in an efficient manner while minimizing work cost. Gondchawar and Kawitkar (2016) have presented solutions to agriculture automation using IoT technologies to improve the current agriculture methods.

Nandurkar et al.s (2014) have proposed the usage of temperature and moisture sensors to monitor the crop in India with the aim to regulate the flow of water to the crop field. This could save water and thus enhance the irrigation quality. This is achieved using an easy web application regarding the study level of the farmers that will use this application.

Similar work was by Gutiérrez et al's (2013) and Kim et al's (2008) who developed a microcontroller-based algorithm to adjust the water amount through a prespecified temperature and soil moisture thresholds. The system is provided by an Internet interface for the users to enable data montoring and irrigation scheduling as shown in fig. 4.

Fisher and Kebede (2010) have proposed a data acquisition system to monitor crop field conditions using many sensors (soil moisture, air, and canopy temperature). They only stored these data on a handheld computer connected using a serial port. They used this data for analysis to take the decision manually. Other work by Mirabella and Brischetto (2011) used hybrid architectures where wireless units are situated

Figure 4. Distributed Wireless Sensor Network for Irrigation System Remote Sensing and Control



in the greenhouse for flexibility, and wired units are implemented in the open area to control the actuators.

Chaudhary et al's (2015) and Mohanraj et al.'s (2016) have claimed that the large amount of data produced by agriculture monitoring devices such as weather data, soil condition data, cropping arrangement, location of crop diseases. These devices could be services, satellites, and sensors. According to this, they presented an agro advisory system to help the farmers to gain the advices from the agriculture experts. Their system was implemented in Gujarat – India dedicated to cotton farmers. It utilized web services and Mobile Application Development Advisory system with the aid of cotton ontology. The farmers are supplied with answers for their problems through an expert system. The proposed ago system architecture is composed of main components to hold the stationary data, to enclose cotton concepts data, geographic data that contains the mapping between the field and the Google earth, and handle and manage the other components.

Many advisory systems were introduced in the agriculture domain such as: eSagu that includes experts' advices to improve field production, Agrisnet that is a web portal which presents information about seeds and fertilizers through a scalable data bank, KKP which implements information on crop growing, its price and availability providing some important statistics, and mKrishi which is a mobile application that helps the farmers through multimedia tools to simplify the queries for farmers.

Mekala and Viswanathan (2019) have introduced a Cloud-enabled CLAY-MIST measurement (CMM) index that uses temperature and relative humidity to determine the proper situations of a crop. They used the amount of water vapor and air pressure to assess the proper temperature for plant growth. A variable called the comfort level is computed based on the relative humidity and the standard constant optimal temperature.

Comba et al.'s (2018) have introduced an unsupervised algorithm for vineyard detection and vine-rows features evaluation, based on 3D point-Cloud maps processing. They aimed to automatically detect the vineyards and evaluate the vine rows orientation and of inter-rows spacing. Their Cloud algorithm has three stages: (1) exact local land surface and height estimation of Cloud points, (2) point-Cloud investigation and scoring function based on a new vineyard probability value, and finally (3) vineyard areas detection and local features assessment. The obtained results were accurate even in the existence of dense inter-row grassing, absent plants and steep terrain slopes.

Foughali et al.'s (2018) have introduced a potato late blight disease prevention DSS. The DSS was used to estimate the applied fungicide quantity grounded by the weather condition late blight forecast model. They explored using IOT sensors positioned in farmlands in order to collect an exact weather information which is then passed to a Cloud IOT framework.

Adetunji and Joseph (2018) were interested in building a Cloud-based monitoring platform that is used to observe and control the agricultural resources. They built their own implemented Cloud platform on Heroku Cloud server and used 4duino and sensors to detect the environment parameters such as soil moisture, humidity, ambient temperature, dew point and soil temperature. The visualization service in their Cloud platform enables the users to view the received data from the sensors at different hours.

Davcev et al.'s (2018) have introduced a highly scalable IoT agricultural system using LoRaWAN network for optimized consumption data transmission between the sensor nodes and the Cloud services. The system was applied to a grape farm. They included many Cloud services in their system and utilized data stream for analytics purposes. Some of their system services are: remote control that is used to handle the executor nodes control, analytics service used to mine the collected sensors data, or to send a command via remote control service to the actuators connected on the network, and data collection service used to collect data from the service bus.

Raikar et al.'s (2018) have introduced a CloudIoT architecture for providing smart irrigation system. This system was implemented using the MQTT lightweight protocol which saves 22% energy and speeds up the process by 15% compared to the current protocols. They connected and managed the temperature and soil moisture data using Amazon Cloud. Weka (Waikato Environment for Knowledge Analysis) tool was used for data analysis.

Lomotey et al.'s (2014) have introduced a mobile architecture to offer farmers with on-time information. The farmers can benefit of such applications in deciding the appropriate pesticide amount and type. This architecture was built as a three layered architecture provided by Cloud middleware. The farmers can reach the information through Wi-Fi or 3G [2]. They had two scenarios the first when is an Internet connection and the second when the system is offline for any reasons to be able to cope with such a problem. Through the NoSQL storage style, the farmers can store previously searched results on a cache thus they will not require to connect to the Internet each time they need the same data. Moreover, instead of using Wi-Fi or 3.5/4G, the farmers can access the system through Bluetooth.

Given all the previous work, in this paper, three possible architectures utilizing the Fog network and the Cloud are presented. These models facilitate the organization and the control of the IoT devices and controllers in an efficient manner specifically for the real-time applications. Then, these three models are applied to three case studies in the field of agriculture. However, they can be used for any other similar fields of real-time applications.

PROPOSED FOG-IOT-BASED AGRICULTURAL APPLICATIONS

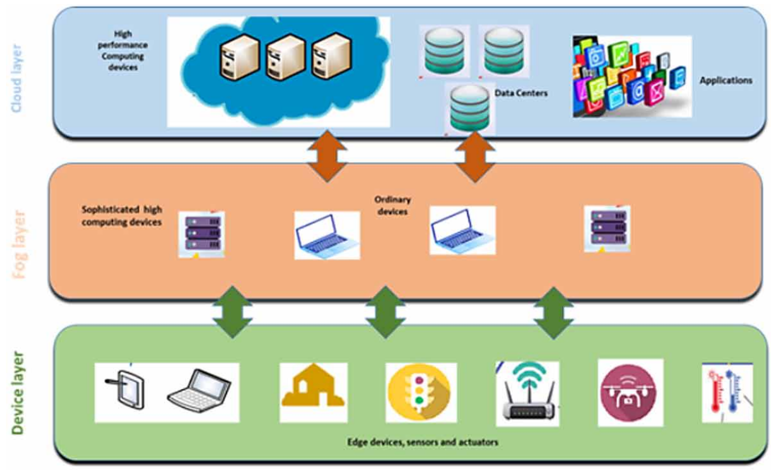
Fog computing is a distributed platform that offers execution, storage, and communication facilities between the IoT devices and the Cloud computing storage area. The Fog layer is now considered as an important extension of the Cloud as it provides many supporting and helpful characteristics such as edge position, position awareness, and small response delay. The idea of the Fog was proposed mainly to support the end-user devices with services, such as the real-time applications (e.g. online games, online conferences, and augmented reality).

In some applications, serval nodes are deployed because of the wide geo-distribution of the problem at hand, such as field monitoring in particular. Fog nodes can be diverse in their nature, and can be deployed in a widespread range of environments. For such reason, we need to find methods for efficient distribution of the models and tasks, distribution and aggregation of data streams on Fog nodes and different methods of results formation.

Due to the advantages and disadvantages of both Fog and Cloud, they can work together to help each other overcoming these disadvantages. So, they are seen as completing each other rather than competing each other. Fig. 5 represents an architecture connecting Cloud and Fog computing to IoT devices. The number of nodes of Fog computing varies according to the nature of the IoT application [12].

In this work, three possible architectures are introduced for using Fog network with the Cloud in controlling the IoT devices and controllers of the real-time applications as follows:

Figure 5. Fog Layered Architecture

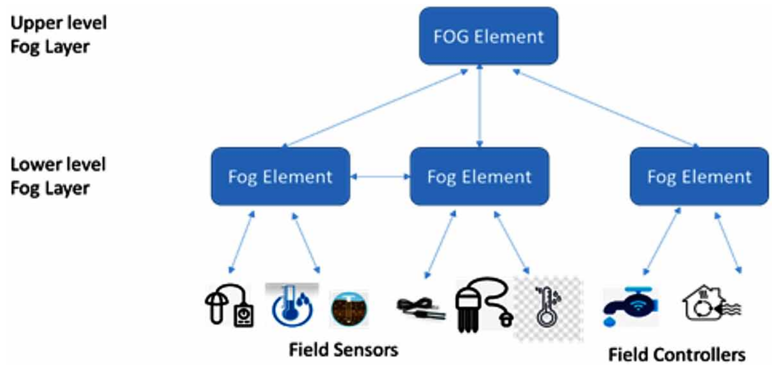


A Hierarchy of Fog Elements

In a subset of applications, Fog nodes can handle the IoT devices alone without the need of Cloud layer. The IoT devices connected directly to the Fog node may consist of simple sensors or actuators capable of communicating data via simple communication devices such as Bluetooth. These devices may be limited in power, processing and storage. These devices may send the data at high rates or low rates according to the application at hand. The IoT device responsibility is to gather the sensed data, and deliver it to the Fog layer for summarization and storage. The Fog node organizes the IoT devices communication and takes the appropriate real-time control signals. The Fog node can use a diversity of software according to the application at hand.

In these applications, a large number of Fog nodes may necessitate organizing these nodes into a hierarchy of Fog clusters (as shown in fig. 6). There is no need for the cooperation with the Cloud as the computing and storage power of the Fog nodes are sufficient to handle the system at hand. This organization could be used with applications which needs high privacy and security, or in places where the Internet connection is not found or unstable. Examples on this scenario could include fields monitoring, animals monitoring and tracking, ranching or poultry farming (or any type of domestics).

Figure 6. Fog Only Hierarchal Architecture

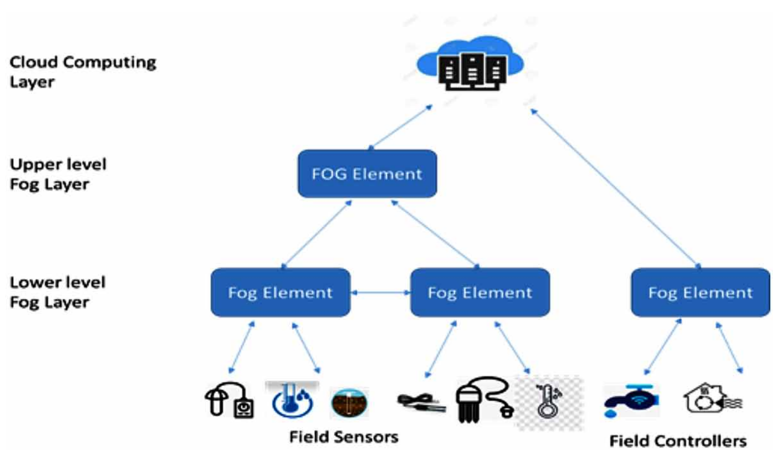


A Hierarchy of Fog Elements Connected to the Cloud

On the other hand, figure 7 shows the merge of Fog deployment with the Cloud. Cloud is used for high level and overall information processing and decision-making. The decision has a deeper concept than this taken by the Fog components layer. It could be delayed and can be based on accumulative data. In this organization, the Fog nodes are responsible of receiving the IoT devices real-time data and store them transiently and only deliver a data digest to the Cloud.

The Cloud platform role is to receive and merge Fog nodes data then perform analysis on this data. Finally, the data is sent back to the Fog nodes from the Cloud after this analysis either directly or a control signal based on this analysis. In this sense, the Cloud is considered as the administrator for the whole system and can

Figure 7. Hierarchal Fog and Cloud Architecture

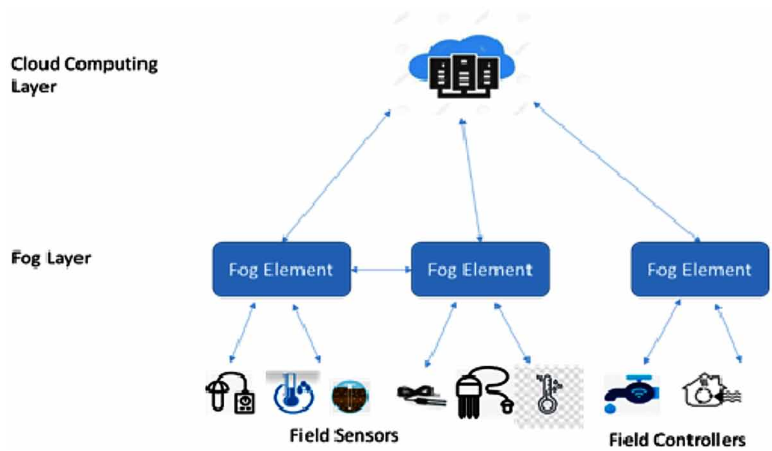


utilize the deep learning approaches and data analytics to get a bird view look. Examples on this Fog hierarchy could be commercial building management, field overall water consumption, power required for poultry, commercial solar panel monitoring, and choice of pesticides and fertilizers.

Fog Elements Connected Directly to the Cloud

Finally, in figure 8, the Fog here handles the time-sensitive processing while the Cloud handles the operating and business-related data processing. Examples on this scenario could include agriculture observing and mobile network speedup. However, the Fog nodes can be assigned some monitoring and control responsibility specially for protection control.

Figure 8. Fog and Cloud Architecture

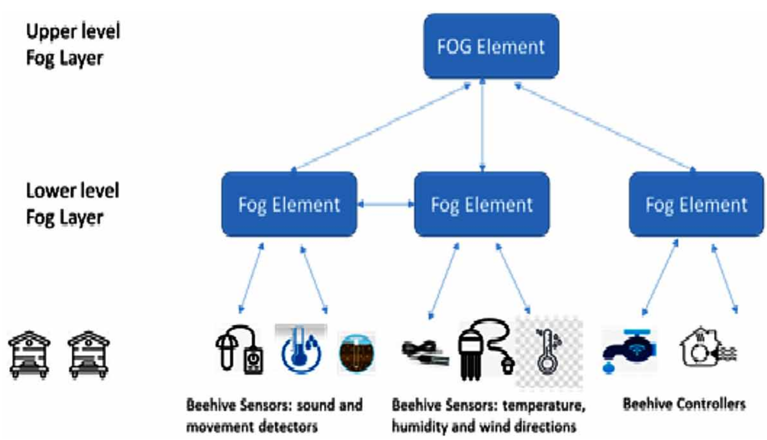


The Fog computing developers usually use Fog nodes to write IoT applications where they are near the network edge. According to the type of data, the Fog IoT application delivers the data to the proper layer for more analysis if required. For example, the highly time-sensitive data could be better analyzed on the Fog node neighboring to the IoT devices producing the fast and appropriate control data, while the noncritical data is better sent to the Cloud for more analysis and permanent storage.

CASE STUDIES OF FOG-IOT-BASED AGRICULTURAL APPLICATIONS

In this section, case studies of the above architectures are given. Three famous applications namely; Honey bee hives monitoring, irrigation monitoring and controlling and crop field monitoring, are used to illustrate how the proposed Fog architectures. can be used One of the main IoT applications in the agricultural domain is field monitoring and automation. Honey bee hives monitoring has been chosen in this section as a case study as its populations need to be maintained by monitoring its health and numbers. The weather condition affects greatly the growth and life of the bees. The result of monitoring allows in-field hive data to provide knowledge about the bee colony status and the external weather conditions. Various sensors are used in the monitoring process such as temperature, humidity, sound and movement detectors, and wind directions. These sensors can be distributed in various places which may be difficult to monitor by humans on regular basis. These sensors are connected to PCs, which makes them inappropriate for distant, large scale, or widespread distributions. In this case, Fog Only Hierarchal Architecture can be used without connecting to the Cloud as shown in fig. 9.

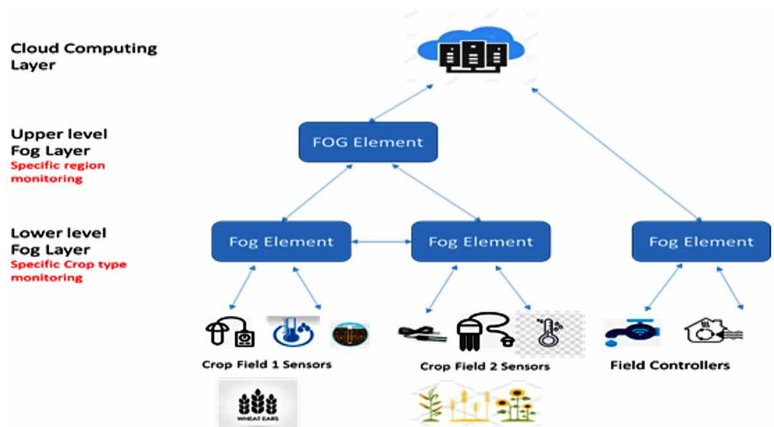
Figure 9. Fog Only Hierarchal Architecture Applied to Beehive Monitoring



Another case study is the irrigation monitoring and controlling system can follow the Hierarchal Fog and Cloud Architecture where each region is the responsibility of a Fog element. The various regions are then the responsibility of a higher Fog node which monitors these various regions. The whole system delivers its data for the Cloud to make higher decisions and for any reports that helps the country decision maker in taking its future decisions as shown in fig. 10. Example of sensors are temperature and humidity sensor, soil moisture senor, magnetic float sensor for water level indicator, and current level of water in the canals sensor.

The Cloud can make a full irrigation plan while the Fog upper level can make smaller decisions when monitoring various section of fields. The lower level Fog nodes have direct interaction with the sensors/actuators of a smaller area of the field planted with different type of crops which make its decision regarding this type of crop more accurate. Based on the estimation of the water required for the crop type, the speed and amount of water is adjusted to irrigate the field.

Figure 10. Hierarchal Fog and Cloud Architecture Applied to Irrigation Monitoring and Control



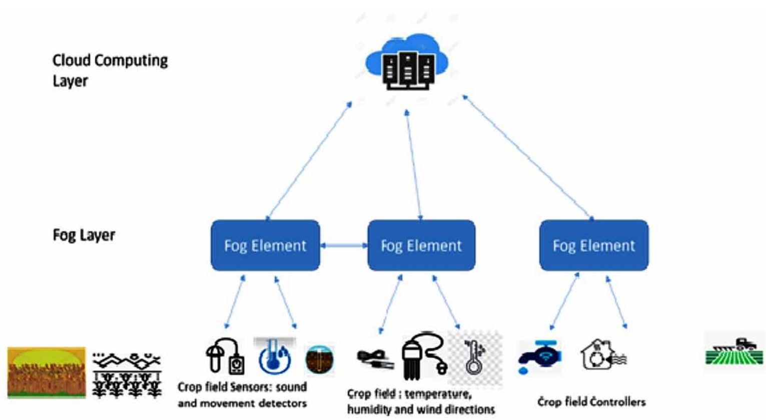
Finally, crop field monitoring where there is a need for the Cloud for data analysis to make conclusions for subsequent seasons. In this case, Fog elements are connected directly to the Cloud as shown in fig. 11. Many sensor nodes are required to measure, for example, light, humidity, soil moisture, temperature, and intensity. The Fog elements can introduce functions like plant growth monitoring, reminder for harvest gathering, fertilizer spraying, pesticides, and irrigation. Whereas the Cloud provides higher functions based on the year/season data and any other commercial data like predicting the possible crop profit giving the expected crop growth, country selling price, and shipping and handling costs. It can provide the Fog nodes with weather forecast which governs the irrigation plan set by the Fog node.

CONCLUSION AND FUTURE WORK

Fog computing has given the Cloud an excellent chance to handle the small and fast volume of data generated by the IoT devices. They are targeted to process data closer to its originator and to manage the issues of the large data volume, variety, and velocity. Fog computing moreover can greatly accelerate the response to the produced events by the time of travelling back and forth to the Cloud for analysis. Furthermore, it doesn't need a large bandwidth by unloading huge amount of network traffic to be sent. Finally, it also guards the sensitive IoT data by analyzing it near to its sources. Ultimately, administrations that embrace Fog computing can gain more knowledge about the data, leading to improved business, higher service levels, and enhanced security.

As a future work, more application of the agriculture can utilize these models. If large number of IoT devices are used, clustering algorithms can be used to find the optimal grouping of those devices to be controlled and monitored by which Fog device. Backup timing and placement of the IoT devices data and the analysis of these data can be a future work.

Figure 11. Fog and Cloud Architecture Applied to Crop Field Monitoring



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KEY TERMS AND DEFINITIONS

Agricultural Applications: IT systems that enables using the architectural systems either remotely or locally.

Cloud Computing: Cloud computing is a type of computing that works on shared remote computing resources to facilitate fast and secure applications. The services provided by the Cloud are delivered to the users as they need them.

Fog Computing: Fog computing is a decentralized computing architecture which is used to store data, compute processes, exchange data with and between lower layers of computers and upper level of Cloud computing.

IoT: The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, sensors and other connected to the application using them using Internet. They could include embedded sensors and actuators

IoT Architectures: They are the methods of connecting and organizing the IoT devices with each other or to the external world.

Chapter 4
Green Cloud

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ABSTRACT

Distributed computing is an incredible region of information and correspondence progressions, introducing current challenges for environmental security. These advances have a diversity of use spaces, since they offer flexibility, are trustworthy and dependable, and offer prevalent at tolerably negligible exertion. The conveyed figuring rebellion is updating current frameworks organization, and offering promising biological protection prospects, for example, money related and inventive field of premium. The developments can improve quality yield and to shrink carbon impressions and (e-)waste. The structures can change by dispersed processing into green circulated registering. Finally, future research headings and open issues with respect to green circulated registering are shown. This outline is intended to fill in as best in class bearing to investigate green distributed computing.

1. INTRODUCTION

Reasonability haves a lot of importance among programming and hardware designers and customers over the latest 2 decades, in view of the rapid improvement in imperativeness usage. The impact of data moreover, correspondence pushes (ICTs) on the earth all through the whole existence has been pondered, to drive green and

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moderate redesigns. They can give all things considered to the improvement of the current circumstance with nature by deteriorating the negative effects that had expanded during the most recent decades. The huge amount of weight on makers to drop into line with biological standards and to make things and associations that most extreme negative consequences for the common system. Contrasting with ICTs, the green characteristics of things and associations are found out with common sense related considerations, for example, green ICTs, ordinary informatics, ecological informatics, practical selecting, and green figuring. As appeared by Hilty et al. (Koomey, 2011), the choices that were made concerning be capable improvement of ICTs and the relationship between these two fields must think about the constructive and harmful impacts of ICTs on nature both in the present what's undeniably, later on. The appeal of the progressions has driven, if all else fails, to the rejection of trademark concerns by both the makers and the clients. Their level of progress, mutually with strain from general normal affiliations, has picked a move towards the exploitation of ICTs in consistence in the midst of trademark rules. It is besides certain that there is fervor for checking and ensuring about the normal structure. In any case, there are a few squares to making and executing certain conceivable structures in ICTs, for example, the related costs, a nonappearance of the time what's more, intrigue required to manage the system's difficulty, nonattendance of responsibility with respect to common effects, or bother between work environments inside affiliations (ICT affiliations and others)suppliers of cloud-type things and associations, there is expansive burden from regulatory relationship to invalidate negative consequences for the earth..

The improvement of green distributed computing is immovably associated to the advancement of green data centers, considering the way that server ranches are the focal point of the circulated processing. As showed by Koomey (Koomey, 2011), the imperativeness ate up by server cultivates in 2010 addressed 1.4% of the supreme usage. A report circulated by GeSI (GeSI, 2013), which is considered "one of the most careful and all around saw reviews of the Internet's imperativeness ultimatum at the overall level", surveys an extension in the part of outright carbon dioxide (CO_2) radiations from ICTs from 01.3% of overall releases in 2002 to 02.5% in 2020.

Considering circulated registering and imperativeness use, a social event of investigators at Lawrence Berkeley National Laboratory and Northwestern University made the showing instrument known as the Cloud Energy moreover, Emissions Research Model (CLEER). Their model Fig.5 the essentialness save assets from moving neighborhood arrange programming and enrolling into the server farms. The server farms build up the cloud(Buyya et al., 2009).

The consequences measure the basic essentialness productivity programming impression of email and Customer Relationship Management programming might be decreased by as much as 87% if all business customers in the US moved to appropriated processing (Masanet et al., 2013). Whether or not the model doesn't think about all the elements, it can show accommodating in inciting vivacious profitability in the server ranches which have a spot with Internet associations.It could guarantee an expansion in fiery straightforwardness and illuminate buyers to empower them to pick superlative offer. The profits of distributed computing are progressively huge for condition insurance if information focuses are based on the green processing guideline(Gai & Li, 2012).

The explanation behind this section is to contemplate the present composition on green conveyed registering and to recognize the crucial concerns that have been inspected and applied. The most critical responsibilities of circulated processing to regular security are recognized in the going with zones. This section doesn't present new responses for green disseminated registering. Or maybe, it includes the interest and tries of investigators and society in a noteworthy domain: viable imaginative progression. Academic composing is stressed over progression and reliably displays the latest disclosures and achievements in the examined arena. In any case, in the field of biological security, various on-screen characters in the open field, for instance, feature writers, bloggers, Non-Governmental Organizations (NGOs), human rights defenders and basic humans, accept a huge activity. Therefore, we choose to show both insightful composing moreover, non-academic assessments in turf of green conveyed dealing out at the moment.

2. RESEARCH METHOD

As showed by Webster and Watson (Webster & Watson, 2002), minding the composing is noteworthy for making a strong foundation for pushing data. In order to gain a sentiment of the existing state of green cloud preparing considers, we diagramed both the insightful composition and non-educational examinations. In the past case, we accumulated information from meeting papers, journal papers, particular reports, likewise, books from different sensible databases, including ISI Web of Science, Association for Computing Hardware (ACM) Digital Library, IEEE Computer Science, Scopus, and Science Direct. The data banks grant admission to driving programming designing journals and first rate peer-assessed PC science gathering circulations (El-Gazzar, 2014). The watchwords recycled was "green appropriated registering", "doable conveyed figuring" and "viable" in mix with "disseminated processing". Using these chases, recognized 1922 results(Heininger, 2012; Mell & Grance, 2009) (Table 1).

Aimed at the going with progresses, we used EndNote. The filtering criteria incorporated the shirking of dull articles, meeting reviews, and affirmations of social occasions or various events. For the remainder of the papers we read the title,

Table 1. Numbers of papers in international databases

Year	Database				
	Web of Science	ACM Digital Library	IEEE Computer Society	Scopus	Science Direct
2009	7	4	4	8	10
2010	3	4	12	17	19
2011	12	15	21	42	41
2012	22	12	37	70	73
2013	31	12	43	82	83
2014	61	12	51	84	142
2015	65	3	63	84	201
2016	48	16	48	94	266
Total	249	78	279	481	835

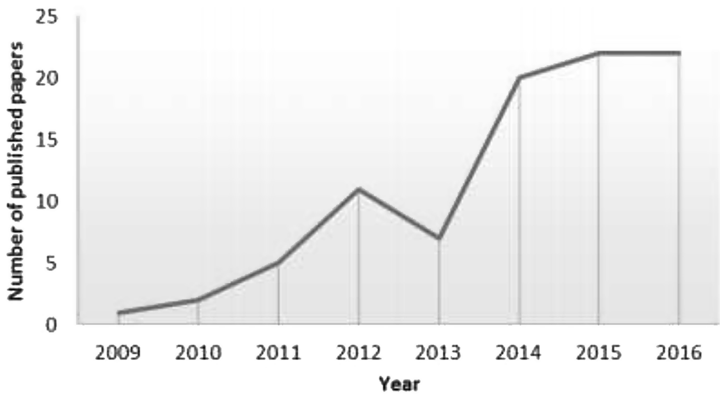
watchwords, and abstracts, and cleared out the papers irrelevant to the subject of this assessment. These dismissal criteria diminished the outcome to 90 articles that were viewed as pertinent and sensible for our assessment. The year 2009 was picked as starting stage, since green disseminated registering has pulled in the thought of investigators since that year.

For non-educational assessments, examined reports dispersed honestly by ICT relationship, by ICT advising associations, NGOs, and various sources. We explored these assessments and suppositions since they earnestly sway the aura towards green disseminated figuring for a wide variety of customers (organizations, legislative affiliations, and individuals). Sometimes, they could all the almost certain mirror the authentic impact of mechanical modify, as they can manage the market and, obviously, the new examples. Educational and non-academic explore supplement each other. The examination of the two sources offers an all out image of green conveyed processing, which is huge really and publicly.

3. GREEN CLOUD COMPUTING STATUS AND TRENDS

For the going with pushes, we utilized End-Note. The sifting criteria consolidated the avoidance of repetitive articles, meeting outlines, and statements of social events or different occasions. For the rest of the papers we read the title, watchwords, and abstracts, and got out the papers insignificant to the subject of this appraisal. These expulsion criteria decreased the outcomes to 90 articles that were seen as relevant and sensible for our evaluation. The year 2009 was picked as beginning stage, since green dispersed preparing has pulled in the idea of agents since that year. For non-scholarly evaluations, we investigated reports coursed truly by ICT relationship, by ICT controlling affiliations, NGOs, and different sources. We looked into these appraisals and suppositions since they emphatically manipulate the mentality towards green circled preparing for a broad gathering of clients (organizations, legislative affiliations, and people)(Armbrust et al., 2009). Now and then, they could even more plausible mirror the confirmed effect of mechanical change, as they can control the marketplace and, obviously, the new models. Instructive andnon-scholastic research supplement one another. The assessment of the two sources offers a hard and fast image of green passed on enrolling, which is vital truly and within society(Rasheed, 2014).

Figure 1. Distribution of surveys over years



We recognized five classifications of green distributed computing contemplates: models and techniques, structures, systems, calculations, and general issues. These investigations dissect and propose answers for the accompanying natural issues: humanizing vitality proficiency, effective administration of server farm assets (equipment and programming), lessening operational expenses, and diminishing carbon emanations. A few creators present their proposition and answers for at least two natural issues what's more, a few examinations could can be categorized as two of the classes referenced above, e.g., systems and calculations, models and additionally techniques and structures or models or potentially strategies and calculations(Youseff et al., 2008).

Table 2 shows assess papers by classification and as indicated by the natural issues tended to. For each paper, we recognized the principle classification and at least one ecological issues for which arrangements were proposed. Productive asset the board will improve distributed computing execution by lessening vitality utilization, e-waste, and expenses. In green distributed computing, asset the board implies utilizing heterogeneous and topographically appropriated assets to meet

Table 2. Classification of the papers reviewed

Category	Surveys	Survey Focus			
		Energy Efficiency	Resource Management	Operational Costs	CO_2 Emissions
Algorithms	[17–25]	√	√		
	[26,27]	√			√
	[28–38]	√			
	[39,40]	√		√	
	[41]	√	√	√	
	[42]	√	√	√	
Architectures	[11,43–45]	√	√		
	[12,46–50]	√			
	[51]	√		√	
Frameworks	[52]				√
	[53,54]	√	√		
	[55,56]	√		√	√
	[57]	√		√	
	[58,59]	√			
General Issues	[60–65]	√			
	[66–68]	√			√
	[69]	√	√		
	[70]	√	√		√
	[71]	√		√	
	[72]				√
	[73]	√		√	√
Models & Methods	[74,75]	√	√		√
	[76–80]	√			√
	[81–87]	√	√	√	
	[88]		√		
	[89–98]	√			
	[99–101]				√
	[102]	√		√	√
	[103]	√		√	
	[104]	√			√

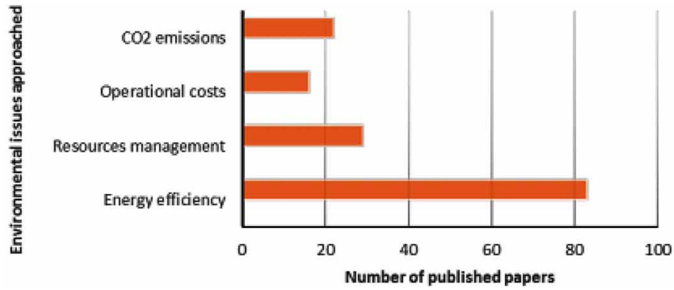
customers' solicitations with the base negative impact on the earth. Luckily, a few variables which advantage distributed computing suppliers additionally bring benefits for the earth. For instance, lessening vitality utilization will cut suppliers' expenses, however will likewise bring about decreased CO_2 discharges.

The most referred topic is optimization of energy consumption, next is resource management (Figure 2).

Figure 3 shows that there are 5 parts of green cloud computing analysis (algorithms, general issues, models and methods, frameworks and architectures) acknowledged in the prose last one decade.

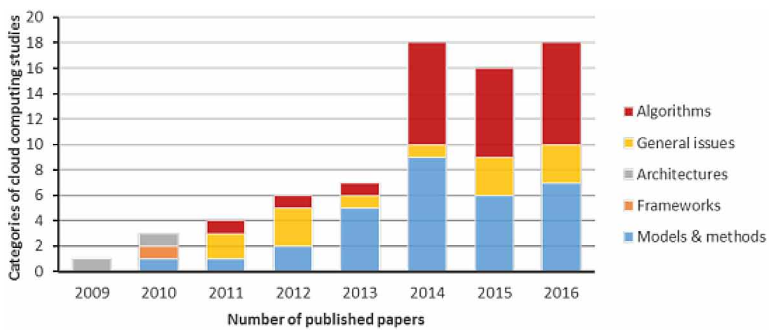
In the archives on green conveyed processing, the makers have foreseen new systems and models to upgrade resource the administrators or to diminish

Figure 2. Distribution of surveys on environmental issues between 2009 and 2016



imperativeness usage. Estimations are shown in a significant number of articles. Alternate points of view, for instance, estimations, general examinations of negative effects on nature, and the relationship of providers in biological affirmation are associated with the general issues order.

Figure 3. Distribution on categories of green cloud computing surveys



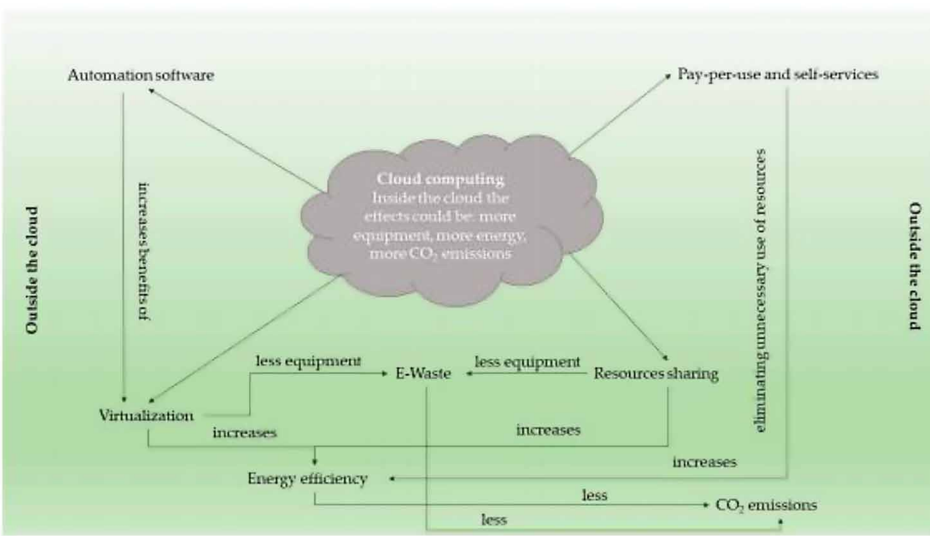
4. GREEN CLOUD COMPUTING IN NON-ACADEMIC STUDIES

In non-scholarly examinations, both the unhelpful and constructive outcomes of distributed computing on the biological system have been examined and featured in different minutes by a range of creators and associations. As indicated by Mines, distributed computing framework has two basic components with respect to effect on the earth: vitality proficiency and asset effectiveness. As indicated by a similar creator, distributed computing attributes carry advantages to ecological insurance even at the point when they don't have this degree expressly. Virtualization and computerization programming increment vitality proficiency and diminishing the physical impression and e-squander. Similar exercises will be performed with less hardware and less vitality utilization both for clients and green server farms, because of improved asset effectiveness. Pay-per-use and self-administration urges clients to restrain utilization to genuine requirements. Mutual asset get to permits clients (associations or people) to utilize a similar framework and administrations. This trademark will diminish the measure of hardware required. Interest for cloud figuring administrations is relied upon to keep on expanding. This will expand the vitality utilization furthermore, gear, without the selection of proper measures to ensure nature by cloud figuring suppliers that will compose the cloud greener. Fig.5 exhibits these impacts.

Right now, of the examinations focus on vitality utilization in distributed computing. In a statement from Accenture, it is asserted that, by vitality streamlining, CO_2 discharges in cloud registering may be decreased by in any event 30%. Another examination, attempted in 2011 by an autonomous organization on a few global organizations that had been utilizing distributed computing for in any event two a long time, evaluates that the vitality putting something aside of US organizations would be more than $12 billions every year.

The yearly carbon decrease is evaluated, in a similar report, at 85.7 million metric tons—likeness half of CO_2 outflows.

Figure 4. Cloud computing characteristics and their influences on the environment



The cut in vitality utilization and the necessary equipment is joined by diminished CO_2 outflows, just as decreased (e-)squander. A significant job is played by the significant cloud organizations—Apple, Facebook, Google, Amazon, Microsoft, IBM, Salesforce, and so forth.— which have resolved to utilize just sustainable power source in server farms, and are giving early indications of achieving this guarantee. The measure of clean vitality utilized by these organizations has expanded altogether in the most recent couple of days. Table 3 shows the information gathered by Greenpeace in 2012 and 2016 about the vitality sources utilized by a portion of the huge distributed computing suppliers.

Table 3. Comparison of significant cloud data centers in 2012 and 2016 [113,114]

Cloud Datacenters	Coal		Nuclear		Clean	
	2012	2016	2012	2016	2012	2016
Amazon	34%	30%	30%	26%	14%	17%
Apple	55%	5%	28%	5%	15%	83%
Facebook	39%	15%	13%	9%	36%	67%
Google	29%	15%	15%	10%	39%	56%
HP	50%	27%	14%	5%	19%	50%
IBM	50%	27%	12%	15%	12%	29%
Microsoft	39%	31%	26%	10%	14%	32%
Oracle	49%	36%	17%	25%	7%	8%
Salesforce	34%	16%	31%	15%	4%	43%

As indicated by Wheeland "the basic business basic of augmenting benefit and limiting expenses makes certain to drive cloud suppliers toward the most effective processing rehearses conceivable, and the side advantages of vitality effective processing in a universe of carbon points of confinement and atmosphere enactment makes green IT a need from a consistence point of view as much as a tasks stance". The intensity of the servers and their efficiencies are the most significant elements for decreasing vitality utilization. The business has distinguished better approaches to utilize servers' all out limit because of their virtualization. Hence, equipment prerequisites have had a much more slow development than anticipated.

5. CONCLUSION

Cloud computing is another model that incorporates effectively existing innovations so as to increment the proficiency of asset use. The consequences of utilizing these innovations are differed. The providers of such administrations and the creators of studies attempted by associations intrigued by natural insurance have featured both positive and ominous parts of the impacts of distributed computing on the biological system. Comprehensively, distributed computing is likely going to help a pleasing connection of the earth to how much the ICT equipment producers and the associations giving advantages in the period alter themselves to common systems and agree to the recommendation of non-managerial relationship concerning techniques for lessening the destructive effects of hardware likewise, programming. This paper inspects the responsibility of circulated figuring to environmental confirmation according to the assessments regarding this matter grasped up until this point. The most critical perspectives are according to the accompanying:

- The primary publicized advantages are those which allude to vitality productivity. So as to go along with guidelines on natural security, the organizations which offer cloud administrations ought to diminish to a base the utilization of vitality from non-inexhaustible sources and supplant it with sustainable power source utilization. The investigations embraced so far have featured that the record of clean vitality use is still very high, surpassing the vitality acquired from non-sustainable sources(Mingay, 2007).
- An expansion in the utilization of vitality from inexhaustible sources will prompt lesserCO_2. discharges, yet thinking about that the primary pointer isn't yet cultivated true to form, carbon outflow decreases are probably not going to meet the desires for natural associations.
- Minimizing e-waste is another questionable point of view inciting selective necessities. The usage of cloud enrolling may affect the lessening in the proportion of gear required by affiliations additionally, the speed of substitution. Eventually, this is a long stretch bit of leeway and it is difficult to measure in the occasion that appropriated processing will be a response for this current, questionable, and overall issue. Be that as it may, the cloud advertise is frequently emerging and, if the present preference proceeds, the impacts on the framework will be seen soon. Obviously, good impacts on the organic system will be checked whether distributed computing providers and customers convert entirely engaged with the issues, similar to the case for any approach or technique which features the consequence of the earth.

The information gathered right now help to acclimate perusers with the present condition of green distributed computing. Because of the examination attempted, we notice the accompanying perspectives, which ought to be considered by cloud providers just as clients if distributed computing is to have a good connection with nature. (1) Providers of distributed computing administrations ought to legitimize the advantages to associations as far as a legitimate money saving advantage proportion.

(2) Cloud advancements ought to be executed by green ICT standards, with the base conceivable negative impacts on nature. (3) Reducing vitality utilization, CO_2 outflows, and e-waste ought to be a need for the providers of cloud administrations, just as for buyers when they pick their providers. (4) Environmental associations should ensure that data is plainly accessible on the impact of cloud advances on nature. Explicit target examinations ought to be performed, pointed at giving information to associations keen on embracing these innovations. (5) Cloud administration providers ought to know about all the natural suggestions in each nation and adjust their exercises likewise.

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Chapter 5
Internet of Things:
A Conceptual Visualisation

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ABSTRACT

Internet of things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. It has three layers. First layer is data acquisition through sensors and actuators, data transferring using different devices and last is data analysis with different analytic techniques. In this chapter, a conceptual overview of internet of things is mentioned. Different sensors and actuators which are responsible for data acquiring are described with their specification. Networking devices which are responsible for transferring data from sensors to server are also described with their applications. Data analytics techniques like descriptive, predictive, and perspective are also explained. Internet of things is now proven as boon for agriculture development. In the last section, different techniques are explained that are used in information and communication technique-enabled agriculture practices.

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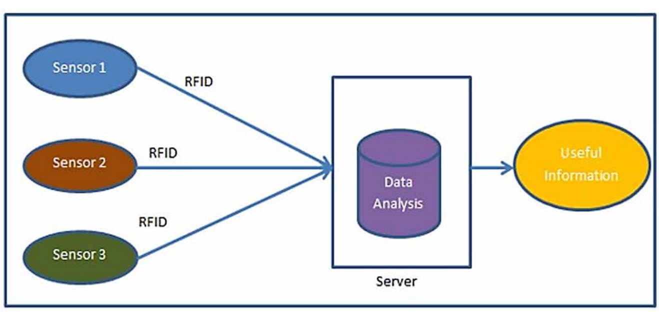
1. INTRODUCTION OF INTERNET OF THINGS (IoT)

The Internet of Things (Kamal, 2017) can be defined as a network of electronic objects using the Internet to control, coordinate and alter the environment. In other words, Internet of Things is a collection of many electronic gadgets such as appliances, lighting equipment, and other household gadgets, which are connected to each other over the Internet and can communicate with each other, making their control and coordination relatively easier than manually operating them. Internet of Things is a concept still in the development phase or beta phase, but various tech companies now offer IoT enabled appliances, such as Philips and other tech giants. These companies offer simple IoT functionality to the customer in their products, enabling the customer to interact with their environment more proactively than it did before, by giving them the power of customization. Work is progressing in the direction of further improve upon this functionality of the IoT framework, making users capable of controlling their home or any other environment with ease. Examples include Home Automation System which uses Wi-Fi or Bluetooth for exchange data between various devices of home. IoT refers to Things (IoT) Internet. Connecting any device inclusive of mobile phones, vehicles, home appliances and other wearable devices integrated with sensors and actuators to the Internet so that these objects can exchange data on a network is a reflection of IoT. Interestingly, there is a difference between IoT and the Internet, there is no human role. The IoT devices can create, analyze and act on the behavior of individuals. Because of IoT all these things are possible. Technology consulting company Gartner plans to use 6.4 billion connected items worldwide this year, up 30% from last year IoT Conceptual Framework

A conceptual IoT framework can be represented by the following simple equation and shown in Figure 1:

Figure 1. Conceptual overview of IoT



Physical Object added to Controller, Sensor and Actuators plus Internet = Internet of Things

As it can be seen, this environment consists of three major components, a physical object to be controlled, and an array of controllers, sensors and actuators, interacting with each other over the internet. Generally, IoT consists of a network of physical objects and devices in which a number of objects can gather data and communicate to organize, maintain, acquire and analyze data in order to use the same in products and services.

A more intricate IoT networking can be represented by the equation below (Kamal, 2017):

Gather + Enrich + Stream + Manage + Acquire + Organize and Analyze
= Internet of Things with connectivity to the data centre, enterprise or cloud server

2. FRAMEWORK FOR IOT

The following equation formulates a concept of IoT framework (Kamal, 2017).

Gather + Consolidate + Connect + Collect + Assemble + Manage and Analyze
= Internet of Things with connectivity to cloud servers.

The framework manages (Mahalle et al, 2010) the IoT services using the data from all the sensors and the network of devices and objects, cloud services and shows the flow of data from IoT devices and services using the cloud server. This equation shows a complex conceptual framework for using IoT. The steps are as follows:

- Levels 1 and 2 are used to gather and consolidate the raw data. It is made of a sensor network and gateways, which is used to consolidate the data at level 2.
- Level 2 and level 3 communicate with each other via data streams, where a communication management subsystem is in place.
- Levels 3 and 4 are made up of connection, assembly, collection and management subsystems; the services are rendered at level 4.
- Real-time analysis of data, series analysis and intelligence subsystems are also present at levels 4 and 5. A data store, database or cloud infrastructure is in place at level 5.

3. MAJOR COMPONENTS OF IoT

3.1. Sensors

Sensors are an array of diodes capable of sensing the physical parameters of the environment such as temperature, pressure, potential difference and so on (Vuppalapati, 2019). Sensor-actuator pairs are a useful tool in the robotic industry and other control systems. Sensors are used for measuring temperature, pressure, humidity, acceleration, magnetic field intensity, and GPS signals and so on. Sensors are of two types based on the type of input they provide to the control unit and hence are called analogue and digital sensors. Analogue sensors include a thermistor, pressure gauge, and Hall sensor and so on. The digital sensors include a touch sensor, metal sensor, rotator encoder, ambient light sensor and so on.

On/Off Switch

On the sensor board, the switches are connected to two points in a circuit. Two wires, red and black connect with two long vertical rows providing access to the 5 volt supply. A third wire connects Digital PIN 2 to one leg of the pushbutton and the same leg connects through a pull-down resistor to ground. While another leg connects 5 volt supply. On the pushbutton not being pressed i.e open, there is no connection between pushbuttons and the pin is connected to ground to be read as LOW. In case the above doesn't happen, the indicator reads HIGH.

PC817 Power Sensor (Digital)

This digital is made up of an internal LED that an Arduino output can drive. Mainly if the series has a resistor higher than approximately 220 ohms. The module has a phototransistor output and no electrical connection, only light can cross the barrier inside. This module is very good for connecting devices of no common ground connection and operates on different voltages. The module has these PINs: **VCC external** - 5V; **GND external** – G round; **DO** - Digital PIN -> 220R resistor -> pin1 optocoupler -> GND. Power Sensor is shown in Figure 2

Reed Sensor (Digital)

Reed switches are magnetically-actuated electrical switches exposed to a magnetic field either of a magnet or a strong electrical current. At this magnetic exposure, two ferrous materials inside the sensors pull together with the connection closing so that the current can flow. The sensor consists of two PINs GND external (LEFT) and

Figure 2. Power Sensor

DO digital output interface (RIGHT). The electrical circuit closes when a magnet is near the switch and opens when it is far.

PIR Sensor

PIR sensors (Sahoo et al, 2017) small and inexpensive, sense motion to detect whether a human moved in/out of the sensors range. And since they do not wear out and are quite easy to, they are commonly found in appliances and gadgets that are used in houses and businesses. Often referred to as Passive Infrared or Pyroelectric or IR motion sensors, they are basically made of a pyroelectric sensor which can detect levels of infrared radiation emitted by everything at some level. In fact, hotter the object, more the radiation. The detector is split into two halves that cancel each other out. They have a sensitivity range up to 6 meters. The module depends upon a 5V-12V input voltage with a data pulse of 3V to detect no activity. The PINs are **VCC external** - 3.3V-5V, **GND external** - GND, **OUT** Digital input interface. The PIR acts as a digital input so all that needs to be done is wait for the pin to flip high (detected) or low (not detected).

Potentiometer Sensor

Potentiometers (Vimal & Shivaprakasha, 2017) are resistors that function to alter resistance via a knob or dial with their large range of resistance attuned from zero to whatever maximum resistance specific to it. Potentiometers have three pins. The outer pins are used for connecting power source - Vref (external +5V) and GND (external). The middle pin (analogue output interface A0) to give the variable of a resistance value. Mostly traditional volume knobs employ a potentiometer.

4 Digit 7 Segment LED (Digital)

4 digit 7 segment displays have no need for Ground, 5V, or 3.3V connection. They have 12 breakout pins that can connect either directly to the Arduino or through a resistor. 8 out of the 12 pins that are displayed for the 7 segments used to form any digit while one controls the decimal point. The rest 4 pins control each of the 4 digits on the display. It contains a 7-segment LED on four numeric displays where the digits are independent that use their own common cathode or common anode connection point.

Sound Sensor

Sound Sensor (Saha et al, 2018) is a part that gets sound waves and changes over them into electrical signs. It recognizes the sound force in the surrounding condition as a microphone does. VCC outside (3.3V), GND outer (GND), AO simple yield interface (A0). The Sound Detector is a little board that joins a microphone and some preparing hardware. It gives an audio yield yet, in addition, a double sign of the nearness of sound, and a simple portrayal of its amplitude. The Sound Detector has 3 separate output.

SD Card (SPI)

An SD card is a perfect answer for capacity necessities because of its little size, low power, effortlessness, and minimal effort. The similarity of the SD card with most gadgets makes it simpler to get to and recover information from the card utilizing any PC for further handling as indicated by the application. The LC Studio SD Card module enables you to include information stockpiling capacity. Correspondence with the SD card in SPI transport mode is a basic order reaction a convention that is started by the ace gadget (microcontroller) by sending a direction outline (Kapoor et al, 2016). At the point when the SD card gets the direction outline, the card reacts by sending a reaction outline or a mistake outline contingent upon the order that was sent by the host microcontroller.

Relay (Digital)

A relay is an electrically operated switch i,e. it can be turned on or off, letting the current going through to flow or stop. This module comes with two relays COM and

NO that don't have any contact between them. When triggered, the relay connects to the COM (common) pin and power is provided to the load. When there is contact between the COM (Common Pin) and NC (Normally Closed) pin which is always (even when the relay is turned off) a triggered relay in such a situation opes the circuit with no power supply. The PINs are **GND** - Ground, **IN1** - controlling the first relay, **IN2** - controlling the second relay, **VCC** - 5V.

Accelerometer Sensor GY-61 with ADXL335 Chip (Analog)

These sensors measure acceleration on the movement of the device (Bisio et al, 2016) and without movement, there is only acceleration due to gravity. With this module, one can measure:

- Acceleration in three directions
- Rotation or angles in three directions
- Orientation

The pin definition is as follows:

- VIN/VCC external
- GND external
- X analog output interface
- Y analog output interface
- Z analog output interface

The calibration is an easy process too, as Earth has a stable gravitational field and the variations are too little and insignificant for the sensor to be affected.

Flex Sensor

It is a sensor which is capable of varying its resistance on the basis of the bend, or 'flex' of the sensor. When the substrate bends, the sensor generates a resistance output which is related to the bend radius, which in turn is inversely proportional to the amount of bend. That means the smaller the bend radius the larger the resistance. A voltage divider can be created by connecting the flex sensor with a static resistor, which then can produce a variable voltage which is readable by the ADC on the microcontroller. The pin definition is as follows:

- VCC extension
- A0 analog output interface

Working principle: On one of the two sides of the sensor, there is a polymer ink which is embedded with conducting particles. When sensor position is straight, the particles offer the resistance of 30k ohms. When the sensor is bent the resistance get increases. This is true for bend in both directions and a maximum of 70k ohms can be achieved by bending through 90 degrees.

PC817 Digital Power Sensor

This IC has an embedded LED which can be operated on an Arduino output, with a series resistor of around 200 ohms. It is usually used for connected devices which don't have a common ground connection to be driven at different voltages. The specs sheet of this sensor is as follows:

- Output: Phototransistor
- Isolation Voltage: 5 kV
- Input current: 20 mA
- Output voltage: 80 V
- Opto Case Type: DIP
- Number of pins: 4
- Number of channels: 1

The pin definition of this sensor is as follows:

- VCC external
- D0 digital output interface
- GND external

Digital Capacitive Touch Sensor

This is a touch sensor (Chui et al, 2010) which can be added to a project to improve the interface. When a capacitive load such as a stylus or a hand is in proximity of the sense-pad, a change in capacitance is registered by the sensor and the switch is activated. The pin definition is as follows:

- VCC external
- SIG digital input interface
- GND external

Capacitive touch sensor uses the human skin as the part of the circuit, as the sensor detects the changes in capacitance on the sense-pad and generates output thereafter.

LDR Light Sensor

This is a sensor which works on the principle of Light Dependent Resistor. This sensor is a photo-sensitive device therefore it can be called photocell as well. This sensor has a wide variety of application, primarily in light automation, whether it is home or outdoors. The pin specifications of the sensor are as follows:

- Vref external
- A0 analog output interface

Since the resistance of the sensor is inversely proportional to the square of the intensity of EM radiation, the R-I curve is parabolic in nature. The resistance of LDR can vary drastically; from 5k ohms in daylight to 20 million ohms during night.

Digital 4x4 Keypad Sensor

This is a simple 4x4 key array capable of reading numerical or alphanumeric input from the user. It is a 4x4 matrix with sensors (Okafor et al, 2017) to detect the pressure applied by the user to input data and transduce the pressure to electronic input to the processor. The process of identifying a key is summarized as follows: Starting from the first row, the microcontroller grounds it by providing a low to it. If data read is all 1s, that implies no keys are pressed and the process moves on. Ground comes to R2 and process repeats. This process is repeated until a zero is detected. After the detection of zero the key is easily identified at the value of the input determined. Pin wiring of the keypad to the Arduino Uno is a simple task as shown in Table 1 and Figure 3.

Digital Reed Sensor

Reed switches are the switches, which are magnetically-actuated, that is, when the device is exposed to magnetic field, the ferrous material inside pull together and the current can flow. The pin definition is as follows:

- D0 digital output interface
- GND external

This switch sometimes appears to be magically-actuated, as exposure to magnetic field closes the switch and makes the current flow.

Figure 3. Keypad Sensor

DHT11/DHT22 Humidity Sensor

It is a humidity and temperature sensor (Tianlong, 2010) which produces calibrated

Table 1. Arduino Connectivity Keypad Sensor

Pins	Wiring to Arduino Uno
R1	D10
R1	D11
R3	D12
R4	D13
C1	D6
C2	D7
C3	D8
C4	D9

output. It is a low-cost sensor with a high degree of reliability and stability. It also comes in two forms, a sensor alone or a complete module. This sensor measures relative humidity. The calibration is done in laboratory conditions and the results are stored in memory as reference points. The specs sheet of the sensor is as follows:

- Temperature range: 0-50 °C
- Temperature accuracy: ± 2% °C
- Humidity range: 20-90% RH
- Humidity accuracy: ± 5% RH
- Operating Voltage: 3 V to 5.5 V

These sensors consist of a thermistor or an NTC temperature sensor, a humidity sensor component and an IC on the backside of the sensor. The whole module acts individually and operates as if there are three separate sensors. The sensors are not dependent on one another.

MQ2 Gas Sensor

It is a sensor which contains a small heater with an electro-chemical sensor, capable of detecting many gasses as per the calibration. It is used to detect flammable gases such as LPG, Butane, Propane, Methane, Alcohol, Hydrogen. One of the key features of the MQ2 gas sensor is that the user can define the sensitivity of the sensor; it can detect concentrations from 300 ppm to 10,000 ppm, which can be important for various sensitive applications. Gas Sensor is shown in Figure 4. The pin definition of the sensor is as follows:

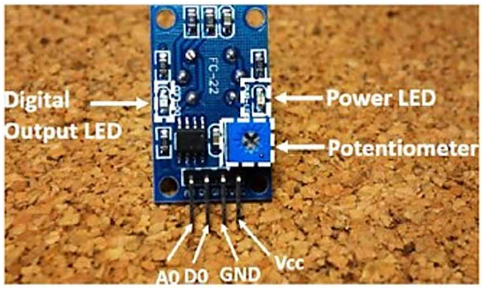
- GND external
- VSS external
- D0 digital output interface
- A0 analog output interface

Joystick Sensor

The 2-axis joystick sensor is a simple method to add X-Y control to a system. Usually a joystick is spring loaded so that it can return to its default position. A tactile switch is added to the stick which is turned on when it is depressed. There are 5 pins in the module, which are as follows:

- VCC external

Figure 4. Gas Sensor



- GND external
- VRx Analog output interface
- VRy Analog output interface
- SW Digital output interface

The joystick consists of a combination of 2 analog potentiometers and a digital switch. It is shown in Figure 5.

Figure 5. JoyStick Sensor

Piezo Buzzer

It is a sensor which is used to generate a certain sound when current passes through it. It is capable of making the sound due to the presence of a crystal which vibrates as an application of the piezoelectric effect. The higher the voltage the higher the frequency of the sound. There are two pins in the sensor, one goes to GND, the other goes to digital pins of Arduino, it is shown in Figure 6.

Figure 6. Piezo Buzzer

YL-69 Soil Moisture Sensor

This sensor measures the moisture (water content) in the soil (Rehman et al, 2017). It finds wide usage in agriculture, irrigation and botanical gardens and other laboratory applications which require precise measurements of water levels in the soil. It is made up of two parts – an electronic board which houses the circuitry and the probe which measure the soil humidity. The specifications of the sensor are as follows:

- Voltage: 5V
- Current: <20mA
- temperature: 10°C-30°C

- Interface type: Analog

The definitions of the pins

- VCC external 3.3V-5V
- GND external
- D0 digital output interface (0 and 1)
- A0 analog output interface (0-4.2 A)

The sensor works by creating a potential difference which is directly proportional to the dielectric permittivity of water. The changes in voltage can be interpreted as changes in dielectric permittivity and hence the changes in water levels.

3.2. Control Units

A custom chip or a Micro-controller Unit (MCU) is used as a control unit. Some examples of the same are ATMega 328, ATMega 32u4, ARM Cortex and ARM LPC. A micro-controller is basically a chip or core in a VLSI or SoC.An MCU is made up of a processor, a memory and several other hardware units which are integrated together. An MCU also includes firmware, timers, and functional IO units and interrupt controllers. An MCU also has various application-specific modifications available as well, such as the presence of an ADC or a PWM integrated on the chip itself.

Popular IoT Development Boards are as follows:

Arduino Uno

This board (Arduino Store, 2015) uses MCU ATMega 32u4 that has Arduino support and also includes Wi-Fi, Ethernet, USB port, Micro-SD card slot and three reset buttons in the module. The board can also combine with Atheros AR9331 to run Linux.

Microduino

This board is a small one compatible with Arduino. It can be stacked with other boards compatible with Arduino and all the hardware designs of the same can be found in the open source.

Intel Galileo

It is a line of Arduino-certified boards. Based on the x86 structure, Intel Galileo is open-source hardware that includes the Intel SOC X1000 Quark-based SoC. Since Galileo is pin-compatible with Arduino, it is also compatible with boards certified by Arduino. It features 20 digital I/O, supports PoE and contains 12-bit PWM for accurate control. Galileo also features 6 analogue inputs along with all the digital inputs.

Intel Edison

It is a computer module, which enables creating prototypes and faster development of prototyping projects and is capable of producing IoT and wearable computing devices rapidly. Intel Edison also enables seamless device-to-cloud communication and device internetworking. Edison also includes foundational tools which are capable of collecting, storing and processing data in the cloud and processing rules on the data stream between cloud and devices. It is also capable of generating triggers and alerts based on its advanced analytical capabilities.

Beagle Board

It is a low power board – a card like a device capable of running Android or Linux. The software and the hardware for IoT devices based on Beagle Board are in the open source.

Raspberry Pi Wireless Inventors Kit (RasWIK)

This enables Raspberry Pi Wi-Fi connected devices (raspberrypi, 2015). Although a fee has to be paid by the user for the hardware, all of the code is in the open source. A user can come up with a new idea or use one of the 29 different projects whose documentation comes with the device. It can also be used to produce IoT devices commercially.

3.3. Communication Module

This consists of a message queue and cache and protocol handlers. A device-message queue inserts and deletes a message at once from the queue on a first in, first out basis and the cache stores the incoming messages. The architectural style used for HTTP access by GET, POST, PUT and DELETE methods for resources and building web services is REST (Representational State Transfer).

In a model, the physical cum data-link layer is made up of a local area network or a personal area network. A local network of M2M or IoT devices uses either wired communication technology or wireless communication technology. This connectivity can be established by RF, Bluetooth, ZigBee IP, and ZigBee NAN, mobile, 6LoWPAN or NFC.

Near Field Communication

NFC (Haselsteiner & Breitfuß, 2006) is an enhancement of ISO/IEC 14443 standard for contact-less proximity-card. It is a short distance (around 20 cm) wireless communication technology. It is a way to exchange data amongst IoT devices in proximity of each other. NFC is gaining momentum especially in creating more secure payments method – as there is no need of swiping the card, there is almost zero chance of Skimmer related card frauds. Examples of other applications are electronic keys for cars, house, office entry keys and biometric passport readers. NFC devices simultaneously exchange data both ways and the setup time is around 0.1 seconds. The device/reader generates RF fields for the nearby passive devices such as passive RFID. Features of an NFC device are:

- Range is within 10-20 cm.
- Device can also "piggyback" Bluetooth or Wi-Fi signals to extend the range from 10 cm to 30 m or higher.
- The data transfer can happen at speeds of 106 kbps, 212 kbps, 424 kbps and 848 kbps.

There are three modes of communication:

- Point-to-point (P2P) mode: Both devices generate alternative RF which is used by devices to communicate.
- Card-emulation mode: This mode is used in smart cards and smart card readers, as this mode allows uninterrupted to read/write. FeliCaTM and MifareTM standards are protocols which allow the read/write by the card and card reader, and then the reader can transfer the information to the server via Bluetooth or Wi-Fi.
- Reader mode: Using NFC the device can read passive RFID devices as described previously.

RFID

RFID (Want, 2006) stands for Radio Frequency Identification, which is an automatic identification method which uses the internet. An RFID device finds its usual application as a tag/label, which enables the object on which the RFID device is placed to be tracked and its movement monitored. The object can be a parcel or it can be a bird, the applications are many in tracking movements. Most IoT application of RFID devices is in businesses, where it can be used to track parcels, inventory control and tracking, supply chain management and sales log-ins.

Bluetooth BR/EDR and Bluetooth Low Energy

For establishing physical cum data link layer, Bluetooth devices follow the IEEE 802.15.1 standard protocol. BT devices communicate via forming a WPAN devices network (Collotta & Pau, 2015). There are two modes for the devices are Bluetooth BR/EDR (Basic Rate 1 Mbps/Enhanced Data Rate 2 Mbps and 3 Mbps) and Bluetooth low energy (BT LE 1 Mbps). As of now, there are two newer, more advanced Bluetooth versions in place. The v4.2, also known as Bluetooth Smart, was released in 2014. It had features like BT LE data packet length extension, secure connections and link layer privacy, extended scanner and filter link layer policies and IPSP. Other features included a range of up to 150 meters, a transfer speed of 1 Mbps and a setup time of fewer than 6 seconds. The Bluetooth v5, which came out in June 2016, increased the broadcast capacity by 8 times, increased the range by 4 times and also doubled the speed, taking it to a maximum of 2 Mbps.

The features of Bluetooth BR/EDR and Bluetooth Low Energy are:

- Support to NFC pairing, to enable lower latency in pairing BT devices.
- AES-CCM 128 authenticated encrypted algorithm is used for highly secure authentication and maintenance of high levels of confidentiality.
- Option is available for BT Smart to connect with IPSP via an IPv6 connection.
- Auto-synchronization between various devices. BT network uses features such as self-discovery, self-healing and self-configuration.
- Two modes – dual or single mode devices used for IoT/M2M devices LAN.
- Radio range depending on classes or radio: Class 1 or 2, used in BT implementation.
- Operation can be done in two modes – secured as well as unsecured, the option of which lies with the device.
- Smaller packets in LE mode.

ZigBee

These devices follow the IEEE 802.15.4 standard (Zigbee.org, 2010) which forms a WPAN device network. ZigBee end-point devices create a WPAN of sensors, actuators, appliances, medical data systems or controllers, which are embedded within systems and are connected to the internet via the IEEE 802.15.4 standard and related protocols for IoT applications in services and medical and business processes. ZigBee NAN (Neighborhood Area Network) is a version of WPAN to form a smart grid. The features are:

- Used for low-power, short-range WPAN
- L1 layer PDU = 127 B.
- Multicast forwarding to support mDNS (multicast Domain Name System) based SD (serial discovery).
- A self-configuring and self-healing dynamic pairing mesh network and has options for unicast or multicast capabilities.
- The device can operate in six different modes – end-point, ZigBee-IP router, IP host, ZigBee network coordinator, ZigBee-ZigBee device router and ZigBee-IP coordinator.
- Support is available to develop discovery mechanism with full application confirmation.
- Support is also available to pair coordinator with end-point devices and routers in a star topology.
- Support also available for sensor nodes network integration, application devices and sensors configured as either end-point devices or routers.
- RFD is integrated with ZigBee SE 2.0.
- Low latency link layer connection.
- It can create a larger network using many star topologies and inter-PAN communications.
- The IP enhancement in ZigBee provisions the IPv6 connectivity over IPv4. A ZigBee IP device is an RFD (Reduced Function Device). ZigBee IP supports IPv6 network coupled with the 6LoWPAN header compression, for the objectives of internet connectivity and control of low power. RFD also means that one device is 'sleepy', that is, a device which has infrequent data transmission patterns (waking up, sending data and going back to sleep on unequal intervals of time). TCP/UDP transport layer and TI. Sv1.2 public key and PSK cypher suite to ensure an end to end security via the protocols.
- The ZigBee router also uses a reactive and proactive protocol in routing modes, which allows applications on large-scale automation and remote sensing.

- Range is to a maximum of 200 meters with a transfer rate of 250 kbps at low power.
- ISM band frequencies use a direct sequence of spread spectrum, 16-channel radio, and help ensure link level security using the AES-CCM-128 standard. ZigBee NAN is used in devices used for distribution automation devices, smart-metering and creating a smart grid communication profile. The features of a ZigBee network are:
- A router is placed in a star configuration establishes a connection to 6LoWPAN, which connects devices with IEEE 802.15.4 enabled to an IPv6 network.
- Communication between the IoT web objects and the network layer happens at a high rate – thousands of bytes are exchanged per second.
- 127 B communications at a single data transfer happen between the adaptation layer IEEE 802.15.4 devices.
- IETF Neighbor Discovery, Routing Over Low Power Less Network (ROLL), IPv4/IPv6 network, TCP/UDP/ICMP transport, RPL routing, SSL/TLS security layer protocols for the communication between web objects/applications and the ZigBee devices.

Wireless Fidelity

This is an interface technology using the IEEE 802.11 protocol and facilitates the creation of WLANs (Reed et al, 2005). Wi-Fi devices, through home AP/public hotspots, connect enterprises, businesses and offices. Wi-Fi interface is a very popular one, varied across devices such as automobiles, instruments, sensors, actuators, computers, tablets, mobile phones, printers and many other devices. Wi-Fi interfaces connect within themselves using Wi-Fi, or they can choose to connect to an AP or wireless router using Wi-Fi PCMCIA or built-in circuit cards, via the following process: The features of Wi-Fi interface, APs and router are listed as follows:

- Wi-Fi offers great mobility and roaming.
- Flexible antenna frequencies are available, that is, either 2.4 GHz or 5 GHz frequencies can be used in the interface.
- The setups generally used are the 2.4 GHz IEEE 802.11b adapters or 5 GHz (802.11a or 802.11g) adapters. In addition to these, many other 802.11 protocols can be used.
- · The installation is easy and the operation is simple and flexible.
- Wi-Fi gives security, reliability and integrity.

- It gives a dynamic environment to expand and scale network. Scalability refers to a system can have a huge number of smaller interfaces, routers and APs.
- It uses WPA (Wireless Protected Areas) and WEP (Wireless Equivalent Privacy) security measures.
- Wi-Fi uses the 802.11g protocol for speeds as high as 54 Mbps and 802.11n protocol for very high speed, up to 600 Mbps, making use of multiple antennas to increase the speed.
- The range of Wi-Fi is between 30 meters to 150 meters.
- Wi-Fi is compatible with both wired and wireless infrastructure, ensuring compatibility and with that an easier access to data services.

RF Transceivers and RF Modules

The simplest of RF circuits are RF transmitters and transceivers. The transceiver is a device capable of both receiving and transmitting data from opposite ends, requiring an additional circuit within the device to separate input and output. RF oscillators are used in such circuits to generate RF frequencies to be used by the devices. Although ZigBee, BT and Wi-Fi use similar technology, that is, ISM band transceivers, but their circuits are comparatively complex. The IoT/M2M applications use ISM band RF with either transceivers or pairs of transmitters and receivers. The applications of RF across industries are security, telemetry, fleet management, GPS, automation, healthcare, automobiles, and back-up cameras and so on.

GPRS/GSM Cellular Network – Mobile Internet

An IoT/M2M gateway of communication can access a WWAN (Wireless Wide Area Network) (Agustina el al, 2003). This network access may require the use of a GPRS, or a newer generation of networks, such as LTE, to access the internet. In a mobile phone, there are provisions for BT, Wi-Fi and USB wired port (usually either a micro USB port or USB Type C port) connectivity. Wireless connectivity also uses networks such as GPRS, GSM, UMTS/LTE and WiMAX services using a modem. In a modern-day smartphone, there are many embedded sensors too, like accelerometer, GPS, proximity sensor and so on.

Wireless USB

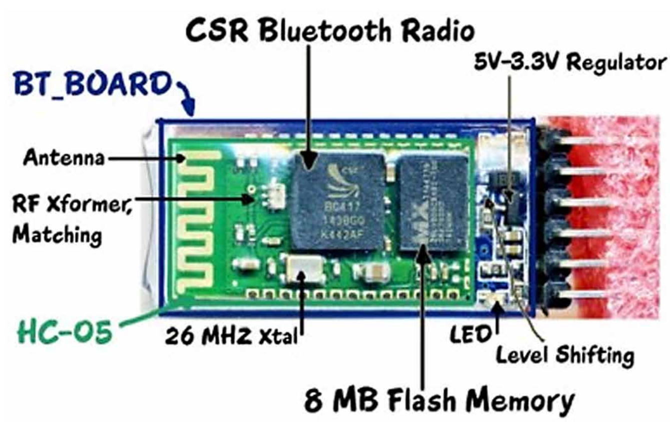
It is an extension of the wired USB 2.0, operating at ultra-wideband from 5.1 GHz to 10.6 GHz. It is generally used in short range PAN, with a very high speed of up to 480 Mbps, at a 3-meter channel. A device can become a USB as well as limited capability host to wireless channels as well.

Some Arduino supported connectivity sensors are discussed below

HC05 Bluetooth

HC-05 module (Jayantilal, 2014) is a Bluetooth SPP (Serial Port Protocol) module which is designed to set up a transparent wireless serial connection. It has a fully qualified Bluetooth V2.0 Enhanced Data Rate and 3Mbps Modulation. A CSR Bluecore 04 chip with CMOS technology and with Adaptive Frequency Hopping Feature, it has a small footprint of 12.7 x 27 mm to simplify design/development cycle. Its PIN WIRING is Bluetooth VCC supply +5.0v, Bluetooth GND, Bluetooth Tx D10 Pin and Bluetooth Rx. D11 Pin. It has a typical sensitivity of -80dBm with integrated antenna and an edge connector, it is shown in Figure 7.

Figure 7. Bluetooth Chip



NRF24L01 (SPI)

Arduino NRF24L01 USING RF transceiver model is commonly used in wireless communications to lower power consumption. It has a 2.4GHz frequency operational on also giving us an advantage of low power. The nRF24L01 has quite a number of pins available and these pins are majorly required. The pins are: GND (Ground) -GND; MISO - 3.3V-5V tolerant; SPI slave output, 12 Wiring; MOSI - 3.3V-5V tolerant SPI slave input 11 Wiring; SCK - 3.3V-5V tolerant SPI clock, 13 Wiring; CS - chip select, 8 Wiring; CE - chip enable, toggling between TX and RX, 7

Wiring; VCC - VRAW, being regulated on voltage range of 3.3V-7V. To program this structure, the program is first informed of the libraries that are to be used. The radio (an object) is then created. The program is then connected to various PINs. The global array though is ‘rxDDAR’. It can be modified according to the demands. The default address is 00001 which can be changed to any 5 digit array. The modem is then to be activated and the program should have a string of loop to be sent using a modem.

SIM800 GSM (Serial)

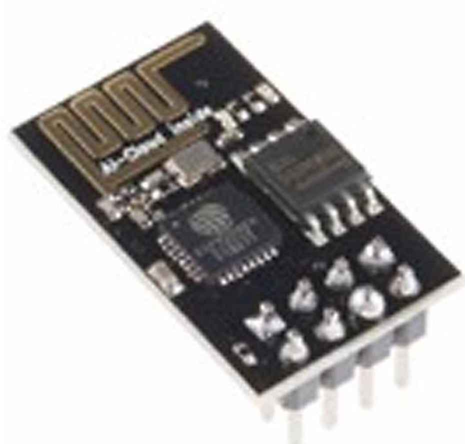
GSM stands for Global Systems for Mobile. This sensor allows sending messages, MMS, GPS and audio, all via AT commands from UART. The sensor had in-built features for audio calls and microprocessors. It can work in all countries that are provided with GSM controls. The module has 12 pins to the interface. They are NET Helical Antenna; VCC 3.4 - 4.4 V; RST Reset; RxD Reciever; TxD Transmitter; GND Ground Pin; RING Ring Indicator; DTR deactivate/activate sleep mode; MIC± Microphone; SPK± Speaker, it is shown 8.

Figure 8. GSM Module

ESP8266 WiFi (Serial)

The ESP8266 WiFi Module is a self-contained integrated protocol of TCP/IP that can give access to any Wi-Fi over a microprocessor. The module is self-sustaining and complete allowing the host application to connect over external flash and keep the cache content. This also decreases the load on a memory application. The Pin Wiring is GND - Ground; Tx - D7; Rx - D8; CH_PD - 3.3 V'; VCC - 3.3 V, it is shown in Figure 9.

Figure 9. ESP8266 Module



3.4. Software

Some examples of M2M software and development box are:

Mongo

Mongo open-source M2M web-based software. It has built-in support for multiple platforms, protocols, databases, user-defined points, metadata and import/export (Banker, 2011).

DeviceHive

DeviceHive is one of the M2M communication frameworks. An M2M platform and integration tool, it enables connecting devices to IoT. It also contains web-based management software that creates security-rules-based e-networks and helps create better monitoring devices. The web software integration in DeviceHive enables one to create prototypes and test them online to test their functionality.

Open M2M Protocols, Tools and Frameworks

Some of the open protocols, tools and frameworks for M2M are as follows:

- XMPP, MQIT-OASIS standards group and OMA LWM2M-OMA standard group for protocol
- 3GPPP study group for the security of M2M equipment.
- ITU-T Focus Group M2M in a global standardization program for a common M2M service layer.
- Various projects of Eclipse M2M industry working groups are Koneki, Eclipse, and SCADA for open standards for communications protocols, tools and frameworks.

Mainspring

Mainspring a development tool and a source framework by M2MLabs, to develop M2M applications. Its features are:

- Flexible modelling of devices and their configurations,
- Connection among different applications and devices,
- Usage of SQL database,
- Persistence of data also easy retrieval
- Programming in Java and Apache Cassandra, and
- Validation and normalization of data.

4. ANALYTICS IN IoT

The organized data can be used for many purposes after it has been collected from devices. There are two ways in which the applications can used this data – for reporting, monitoring and rule-based actions. An enterprise usually creates sections and unit-wise analytics. The analytics allow fact-based decision-making in place of intuition-driven decision-making, which is essential to provide business intelligence and are a key to the success of a business. One key requirement of analytics is that the data needs to be accessible and available. It uses data mining, arithmetic, statistical and other advanced methods, such as machine learning to find new information which is used to add value to data. Analytics can be helpful to make business models helpful in service and processes. There are three phases to analytics before deriving any facts and providing business intelligence, which is as follows:

4.1. Descriptive Analytics

These analytics answer questions regarding the past (Abbasi, 2014). Descriptive analytics means finding aggregates, frequencies, means, variances or groupings using selected properties. Descriptive analytics allow the following:

- Actions such as OLAP (Online Analytical Processing) for the analytics.
- Visualizations or dashboard displays of analyzed results.
- Reporting or generating spreadsheets.
- Creating indicators which are called key performance indicators.

Descriptive Analytics Methods

- **Spreadsheet-based reports and data visualizations**: results of the analytics can be presented in a spreadsheet before creating data visuals for the user. Spread-sheet allows the user to visualize the "what if". Since a spreadsheet is basically a table, the values are in the cells in the rows and columns. Values can have a predefined relationship to other values. The values can be related to one another cell or set of cells via formula or Boolean algebra.
- **Descriptive statistics-based reports and data visualizations**: Descriptive analysis can also make the use of descriptive statistics, which means finding a peak, minima, maxima, variance, and other statistical parameters. Formulae are used to allow data showing variance a bit understandable.
- **Data mining and machine learning methods in analytics**: Data mining means the use of algorithms to "mine" hidden information in large amounts of data. Machine learning is the modelling of the same data to specific tasks.
- **Online analytical processing (OLAP) in analytics**: OLAP allows viewing of data up to desired resolution, or granularity (Berson & Smith, 1997). It enables roll up or drills down view of data. OLAP allows summarized information and automated reports from a large database. The results of these queries are made of metadata, which is a data which describes the actual data. OLAP uses analysis functions which aren't possible to code in SQL,

therefore the data structure is designed from the perspective of the user, using formulae as in spreadsheets. OLAP is a step up from normal query systems. OLAP is a system, which is interactive and shows different summaries of a multidimensional data by selecting the attributes in a multidimensional data cube. OLAP also allows analyzing data in a multidimensional structure called a data cube, in which each dimension is a hierarchy, which has a dimension attribute, which further defines the dimension, and summary of the measure attribute.

A 'slice' of data-cube could be viewed when values of multiple dimensions are rigid. A 'dice' of data-cube is to be viewed with variable values in multiple dimensions. 'Slicing and dicing functionalities' mean that the specific values of these attributes are selected then put on display on top of cross-tables. A slice is a data relationship in the analyzed multidimensional data. A slice of data relationship between two attributes can be visualized individually. A cubical dice contains six faces, in which each face is marked distinctly. Face 1 has one dot, Face 2 has two and so on. Similarly, an n-dimensional structure will have 2n faces and the same number of tables which are then cross-referenced. OLAP can be of three types, which are multidimensional OLAP, relational OLAP and hybrid OLAP, acronymic names of which are MOLAP, ROLAP and HOLAP, respectively.

4.2. Predictive Analytics

Predictive analytics answer the question of the future, that is "what will happen?". It is an advanced type of analytics, in which the user interprets the outputs from analytics using descriptive analytics methods, such as data visualizations. Visualizing can display the effects to increase competition for a product and take decisions years ahead of time, such as the need to change product mix and other improvements necessary. This uses algorithms such as regression, correlation, optimization and multivariate statistics and techniques such as modelling, simulation, neural networks and machine learning (Shmueli, Koppius, 2011). There are many applications of predictive analytics, which are as follows:

- Undertaking of preventive measures to avoid failures of products and other product-related issues
- Prediction of trends
- Managing the campaign with market strategy integrated from earlier studies regarding various parameters affecting sales
- Prediction of anomalous characteristics and detection of anomalies

- Prediction of trends by studying patterns and identifying clusters with similar behaviors
- The results of predictions do need verification, however, from domain knowledge

4.3. Prescriptive Analytics

Prescriptive Analytics answers the questions regarding not only the future but the reason behind the happenings of the future based on the input from descriptive analytics and business rules. The ultimate phase, in addition to the prediction also gives suggestions as to what actions to take for optimum benefits. Prescriptive analytics also suggest best course of actions in the current state of input and rules.

5. IoT IN AGRICULTURE

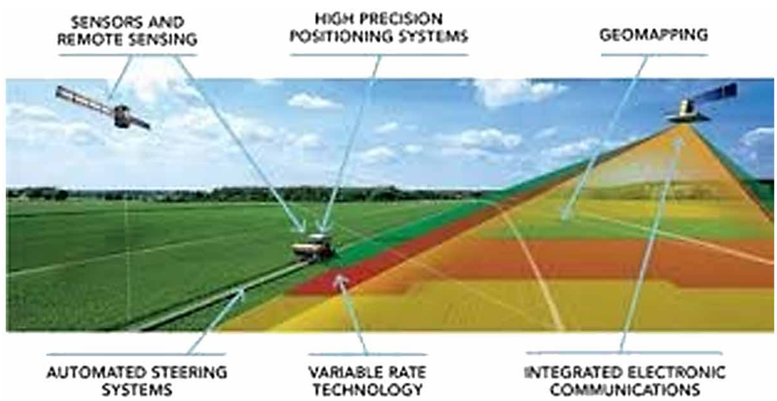
Internet of Thing is now becoming the emerging field of research. It has variety of applications such as smart cities, healthcare, aids for physically challenged people and of course agriculture. Using IoT the level of agriculture can be increased. Process of agriculture can be performed effectivity and efficiently with the help of IoT. IoT based sensors such as humidity and temperature sensor DHT11, soil moisture sensor (YL-69), different ion selective electrodes (Nitrogen, Potassium, calcium), pH and Electronic Conductivity can be used to monitor the different physical and chemical properties of soil. With the help of predictive analysis, a crop yield production can be ascertained by capturing image from Geographical Information System (GIS) or by with the help of supervised machine learning. Some advanced sensors such as leaf and stem sensor can be used to identify the water requirement in a specific crop. IoT based simple rain gauge system are also now developed to ascertain the rainfall that help farmer to identify the net water to irrigate. These vital parameters can be stored on a server using RFID and Wi-Fi technology or farmer can direct monitor these values into his smart phone using OTG device, using Bluetooth transmitter and ESP module. Animal husbandry is also the part of agriculture. GPS modules can be embedded in the body of cattle to identify their location.

5.1. Precision Agriculture

It provides new parameters to help the farmers for better crop production and monitoring. It covers the entire agriculture process with the help of ICT enabled services. Precision Agriculture encompasses different ICT enabled services in the process of agriculture. It includes Global Positing System, RS & Geographical

Information System, Image Processing, Sensors Technologies and Smart Phones Application Development that will help for building the Decision Support Systems for crop production and management. Since Precision Agriculture is not bounded with a single technology, it is hard to say when the concept of Precision Agriculture is exactly born. Precision Agriculture is the key element of the third agriculture revolution. However, the concept of GIS was introduced in 1968 by Roger Tomlinson, GPS was introduced in 1973 and Image Processing was introduced in 1960. So, it can be assumed that the concept of Precision Agriculture born in between of 1960 to 1970. The stakeholders of Precision Agriculture are Agriculture Scientist, Information Technology Scholars and farmers. Livestock monitoring, agriculture drone and smart green house are the major applications of precision agriculture.

Figure 10. Precision Farming



5.2. Agriculture Drones

Technology has changed in the course of time and agricultural drones are an excellent example. Today, agriculture is one of the major drone - based industries (Puri et al, 2017). Drones are used in agriculture to improve diverse agricultural practices. Ground and aerial drones are used in agriculture to evaluate crop health, irrigate, monitor crops, spray crops, plant and analyze soil and soil. Drone data allows us to gain insights into plant health indices, plant counting and yield forecasting, plant height measurement, canopy cover mapping, field mapping, scouting reports, stockpile measurement, chlorophyll measurement, wheat nitrogen content, drainage maps, weed pressure mapping, etc. Agriculture drone is shown in Figure 11.

Figure 11. Agriculture Drone

6. CONCLUSION

Internet of Things is now becoming emerging field of research and its applications are now becoming a boon for agriculture. In this chapter, basic concepts along with its framework of IoT are discussed. In IoT, capturing input is important which is done with the help of sensors and actuators. Different analog and digital sensors are discussed which can be implemented in real time scenario. Communication devices which are responsible for transferring data sensed by the sensors such as Bluetooth, Wi-fi, GSM are also discussed. Further, categories of data analytics are also explained. As future work, this chapter can be enhanced with practical implementation.

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Chapter 6
Internet of Things and the Role of Wireless Sensor Networks in IoT

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ABSTRACT

Internet of things (IoT) is a network of connected devices that work together and exchange information. In IoT, things or devices means any object with its own IP address that is able to connect to a network and can send and receive using internet. Examples of IoT devices are computers, laptops, smart phones, and objects that are operational with chips to collect and correspond data over a network. The range of internet of things devices is huge. Consumers use smart phones to correspond with IoT devices.

INTRODUCTION

The Internet of Things (IoT) is a collection of interrelated and interconnected computing devices, machines, objects and people. These things have a unique identifiers and transfer data over a network, without requiring human-to-human or human-to-computer interaction. Internet of things is an aggregation of things, physical objects, and more particularly Smart things.

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To transform electrical and electronic component into smarter one, IoT act as a user interface and it is integrated into these electrical and electronic devices. It is expected that in next 2 years approximately, 50 billion of things will be connected to internet. WSN is connecting things to the internet with the help of gateways.

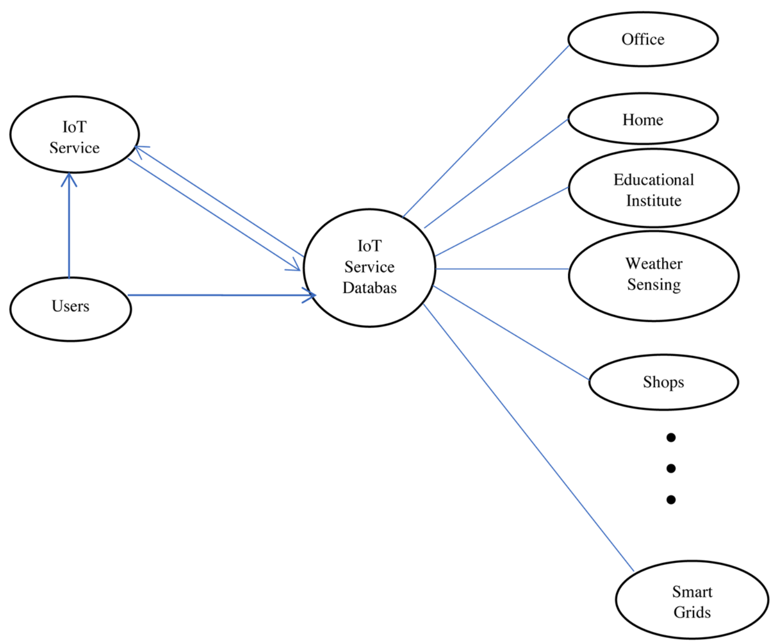
The major components of Internet of things are: Things or Objects, Sensors, Actuators and Storage Component. Things are Smart Things. Smart things are the objects or entities or devices which are equipped with electronics, computing capabilities, and a communication interface. Smart things can be discovered, controlled and managed remotely using communication interfaces and computing capabilities, on the internet.

A sensor forms an essential interface for the IoT implementation and therefore referred as the front end of the IoT environment. Sensor data collection acts as a stimulating event to perform any of the task offered by any IoT implementation.

Micro-electro-mechanical systems (MEMS) are computer chips that are the unavoidable integral part of an IoT implementation. These contain both sensors and actuators. A sensor transforms the functional energy into electrical signals while, an actuator transforms electrical signals into functional and useful energy.

IoT is a collection of a large number of devices, applications and services which are communicating with each other. So a large amount of data is produced. The

Figure 1. Interaction between user and environment in IoT



data must be stored in storage devices, for processing and analysis.B ulk of data is generated by some IoT applications like smart home, real-time financial analysis, smart banking etc. The data is large and heterogeneous. So cloud based storage with big data analytics is used for data storage in IoT.

Thus WSN is becoming the key technology of IoT. In future the interaction between user and environment will be like as shown below in figure 1.

It can be said that the most important application of WSN is in Internet of Things (IoT). Sensor nodes are integrated with IoT, connects with internet dynamically to achieve designated task. An IoT architecture is consist of sensing units and a cloud based layer. This layer is used to monitor these sensing units remotely by the user in real time. There are many issues, challenges and different methods when WSN is integrated with IoT for taking data from anywhere, WSN are integrated into network as a part of IoT. IoT needs sensors, actuators, RFID tags, mobile phones and internet connectivity to work properly.

Some enabling technologies of IoT are Near-Field Communication (NFC) and Radio frequency identification (RFID), Optical Codes (OC) and Quick Response Codes (QRC), ZigBee, 6LOwPAN, LTE-Advanced (LTE- A), Z-Wave etc. Some of the IOT Platforms used are AllJoyn, Xively, IoTivity, 2lemetry, HomeKit, EVRYTHNG etc.

1. APPLICATIONS

IoT applications look more capable in the coming years. IoT will possibly be used within other technologies like Artificial Intelligence (AI) and automation. The future of IoT is more attractive where billions of things will be talking with each other least or no human intervention.

IoT has many applications. Some applications are explored below.

1.1 Wearables

Wearable's are built using IOT applications. It is earliest application deployed the IoT at its service. Examples of wearables are smart watches and guardian glucose monitoring device.

1.2 Health Care System

IoT has many applications in the healthcare. It provides high-quality medical services using internet of medical things (IoMT). Real-time monitoring of patients remotely can also be done using IoT medical devices. An emergency situation like an asthma attack, heart failure etc., can be reported immediately to a physician and thus lives of many individuals can be saved.

1.3 Smart City

The smart city is a very big modernization. It uses a variety of use cases like environmental monitoring, waste management etc. It tries to remove the uneasiness and troubles of people living in cities. Many city-related problems are also solved in smart cities. Smart cities using IoT is shown below in figure 2.

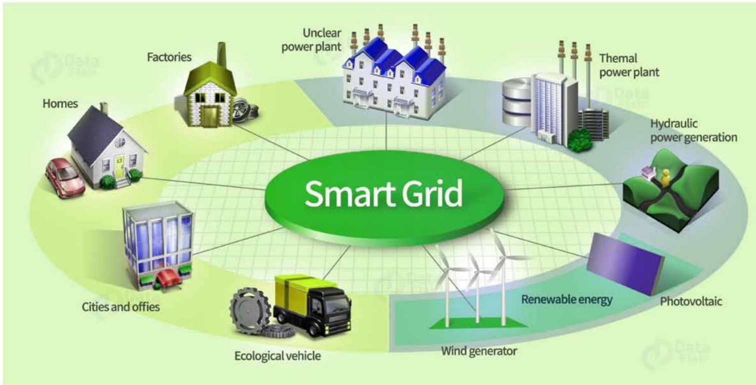
Figure 2. Smart City using IoT

IoT is used in smart homes also. In smart home, deviations from the normal behavior means an anomalous activity and it causes alert message or alarm for inhabitant. Smart home is the most important and efficient application of IoT. The number of people searching for smart homes increases every month with about 60,000 people and it is increasing further.

1.4 Smart Grids

A smart grid also uses IoT. In smart grid information of the behaviors of clients and electricity suppliers is extracted in an automated way to develop the economics, efficiency and reliability of electricity distribution as shown below in figure 3.

Figure 3. Smart Grid



1.5 Smart Supply Chain

Solutions of the problems like tracking of goods when they are on the road, or helping suppliers to exchange inventory information are some offerings of the smart supply chain. Factory equipment containing embedded sensors communicate data concerning different parameters like pressure, temperature with an IoT enabled system. Smart Supply chain is shown below in figure 4.

1.6 Smart Farming

It is the main IoT applications that should be overemphasized. In India, to feed a large population, we need to combine agriculture with technology to obtain best results. Smart Farming is an efficient method of farming. It implements connected devices and novel technologies collectively into agriculture. As Smart Farming mainly depends on IoT, it eliminates the physical work of farmers and increases the productivity. Smart farming uses IoT.

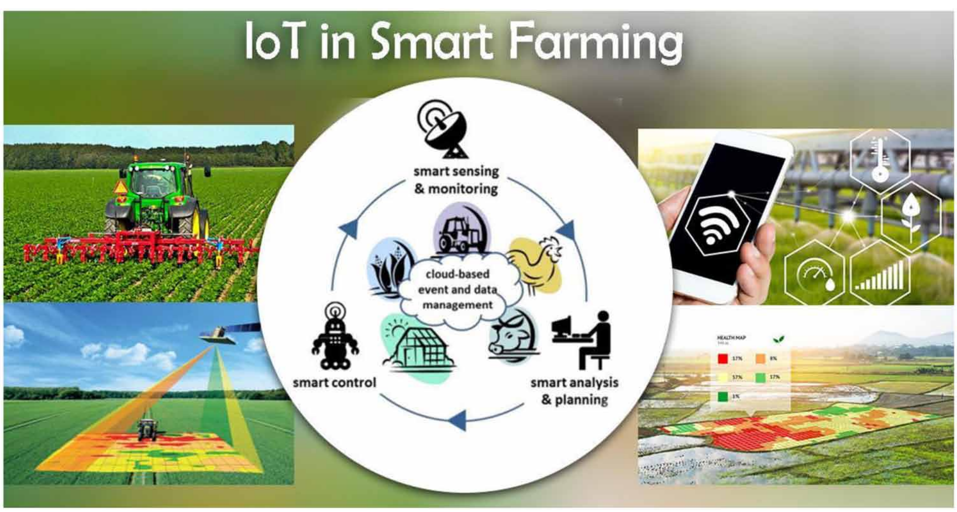
The aim of using IoT in agriculture is to initiate the newest technology in agriculture and to produce better crop by collecting real-time status of crops. We can expect IoT will forever change the way the food is grown. Many technologies available presently with farmers for smart agriculture and farming. Some of them are like Sensors, Software, Connectivity, Location etc. Many types of sensors are available for measuring different properties related to agriculture like types of soil, moisture, temperature, light, water, humidity, pressure etc. Similarly many dedicated software solutions are available that aims precise farm types or use case atheist. Different types of connectivity like cellular, LoRa, etc. are available for proper data monitoring and analysis. GPS, and Satellites are used for location related

Figure 4. Smart Supply Chain

information. Robotics is used for self-directed tractors and processing facilities etc in smart farming. Data analytics is used in individual analytics solutions and data pipelines for downstream solutions.

One of the best ways is the use of Smart Greenhouse as below in figure 5. Using greenhouse farming, yield of crops can be enhanced by controlling environmental parameters.

Figure 5. IoT in smart farming



2. CHALLENGES

There are many challenges in the IoT. Some of them are explained below.

2.1 Security

Security is a main concern of the Internet. As the connected devices increases, the chance to use security vulnerabilities also increases. In future, IoT will become more ingrained in our lives. So security becomes more concern. Significant city infrastructure can also be a target.

2.2 Scalability Challenge

Scalability issues also the main challenge in the IoT products. IoT devices commonly not have enough computational power, storage capacity and even proper operating system.

2.3 Privacy Challenges

The IoT creates unique challenges to privacy. All this information exposes legal and regulatory challenges causing data protection and privacy law. Some data that IoT devices collect are very sensitive and necessary precautions aren't taken when storing and sharing the data with other service providers.

2.4 Standards and Regulation Challenges

Some main challenges facing the adoptions of standards within IoT are standard for handling unstructured data and technical skills to leverage newer aggregation tools.Regulatory standards for data markets are not followed for data brokers, who sells data collected from various sources. Clear guidelines should be there on the retention, use, and security of the data including metadata

3. IoT PRODUCTS

IoT devices are included in our daily life, Some of which are given below.

3.1 Google Home Voice Controller

It have features like control the volume, media, thermostats, lights and many more functions as shown below in figure 6. It remotely handles the home lights and helps in planning their things automatically. Timers and alarms are also manageable using this.

Figure 6. Google Home Voice Controller

3.2 Footbot Air Quality Monitor

It is used to measure indoor pollution and improve air quality and it is shown below in figure 7. It often gives accurate results.

3.3 WeMo Insight Smart Plug

It is a good IoT product as shown below in figure 8. It helps to turn on and off lights and appliances and to monitor them from remotely.

Figure 7. Footbot Air Quality Monitor

4. WSN IN IoT

Entire physical infrastructure of a building or a bridge or anything is coupled with information and communication technology. IoT is a step towards computing, controlling, cost saving and automation. Intelligent monitoring of the system is achieved through the use of sensors and embedded devices. Thus WSN is becoming the key technology of IoT.

4.1 Wireless Sensor Networks

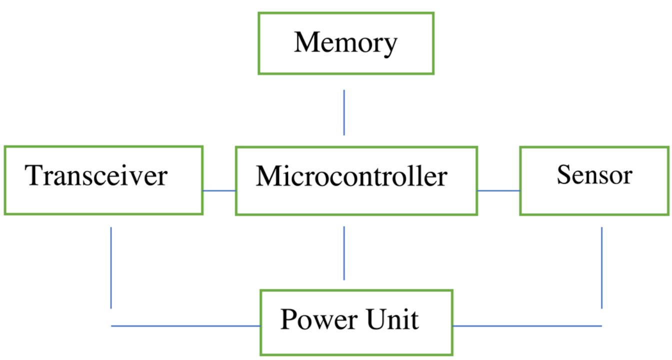
A wireless sensor network is a wireless network of sensors; consist of spatially distributed independent devices used to observe environmental conditions like pressure, humidity, temperature, pollution etc. Earlier it was used for civilian application scenarios. But now it is used in several applications including building automation, environment and health monitoring and controlling of traffic etc. A model of WSN is given below in figure 9.

Every node in a WSN is equipped with a sensor, a small microcontroller, a radio transceiver device, and an energy source generally in the form of a battery) (Akyildiz et al.,2002). An extra power harvester can be present to converts the energy from

Figure 8. WeMo Insight Smart Plug

an external source (Like kinetic, solar and wind energy) into electrical energy and recharges the traditional power storage element.

Figure 9. Model of Wireless Sensor Node



Wireless Sensor Networks is consist of a large number of low-cost, small-power and multi-functional sensing devices called sensor nodes. Each sensor node is equipped with sensing, data processing and communication capabilities. The sensor nodes form a connected network and work collectively to accomplish the assigned tasks such as surveillance, environment monitoring and data gathering. Since sensors are low-cost devices, a large amount of sensors could be densely deployed inside or surrounding the interested phenomenon to provide the measurements with satisfactory accuracy.

Further, each low-cost sensor node has only limited resources such as power, computational ability, bandwidth and memory. Once a sensor node consumes all its battery energy, it will die or disappear in the network. The network may cease to work when the remaining sensor nodes are not sufficient to accomplish the assigned tasks. Energy efficiency is an important factor for maintaining sensor network functionalities and increasing the system lifetime. So, an extra power harvester can be present to converts the energy from an external source (Like kinetic, solar and wind energy) into electrical energy and recharges the traditional power storage element.

4.2 Applications of WSN

There is a broad range of applications of WSN like health, military, and security. The applications for WSNs are many, but mostly applications involve a kind of monitoring, tracking, and controlling. WSNs can monitor a wide variety of conditions such as temperature, humidity, pressure, levels of noise, lightning conditions, etc.. Even though WSNs were initially designed for military applications, they are used in many civilian and industrial applications. Specific applications for WSNs are fire detection, nuclear reactor control and traffic monitoring. Some other important applications are

- In Indoor/Outdoor environment monitoring like Forest fire detection, Flood detection, Precision agriculture and Bio complexity mapping of the environment.
- In Inventory locations awareness.
- In Bio medical applications like in cancer hyperthermia.
- In Future consumer applications including smart home like Home automation, Smart environment.
- In Industrial automation like in expanding existing industrial plants and production processes,
- In Structural monitoring like to detect and localize damage in buildings, bridges, ships, and aircraft. These systems consist of a device that collects and stores vibration measurements from a small number of sensors.

- In Health and wellness monitoring like Tele monitoring of human physiological data, Tracking and monitoring patients and doctors inside a hospital, Drug administration in hospitals etc.
- In Physical security for military operations like Monitoring friendly forces, equipment and ammunition, Battlefield surveillance, Reconnaissance of opposing forces and terrain, Battle damage assessment, Nuclear, biological and chemical attack detection and reconnaissance.

4.3 Challenges

Along with advantages of WSN, there are many challenges for Wireless Sensor Network. The main challenges in Wireless Sensor Network are given below.

- Wireless Sensor Network is consist of many unreliable nodes.
- Each node in Wireless Sensor Network has very limited storage power and computational capacity.
- Communication range of nodes is very limited in Wireless Sensor Network.
- Nodes in Wireless Sensor Network have deeply distributed architecture and autonomous operation.
- Energy conservation is the main challenge as they are battery powered and battery cannot be recharged again. Thus increasing the network lifetime of Wireless Sensor Network is the main challenge.
- In Wireless Sensor Network, a malicious node is to be identified for security purpose. This protection is given by powerful gateways. Wireless Sensor Network should also be able to manage network configuration for new nodes joining in the network, elimination of faulty nodes, scalability, self healing capability etc.

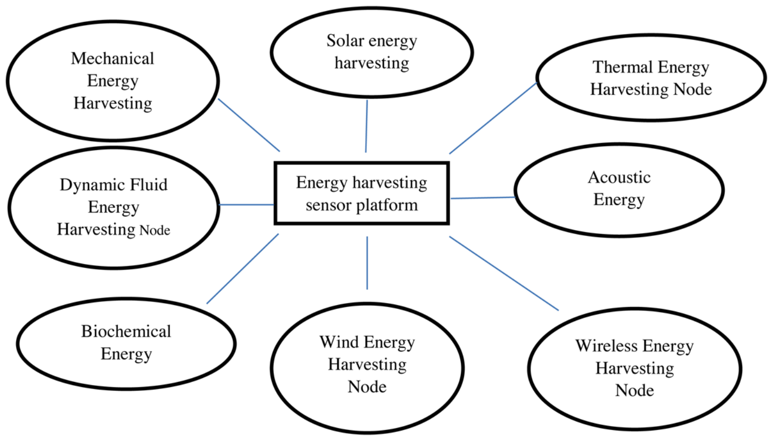
4.4 Energy Problems in WSN and Solutions

The amount of time for which the given WSN is active and provide sufficient information is called lifetime of WSN. Sensor network is expected to last several months without recharging (K. S. et al.2004 & W. K et.al. 2005) . Wireless communication consumption more power rather than sensing and data processing (Yong et al. 2006). Different energy efficient target issues are discussed in (Gupta & Roy 2011). Comparison of different energy minimization techniques in WSN is given in (Gupta & Roy 2013). Comparative analysis of energy consumption using different node scheduling heuristics is given in (Gupta & Roy 2019) . Comparison of sensor node scheduling heuristic for WSN & energy harvesting WSN is given in (Gupta & Gupta 2019).

4.5 Energy Harvesting Techniques

EH-WSNs consume energy from EH-WSN sources. Various sources of energy harvesting are Mechanical energy harvesting, Photovoltaic energy, Thermal energy harvesting, RF energy harvesting, Wind energy harvesting, Biochemical energy harvesting, Acoustic energy harvesting and Dynamic fluid energy harvesting etc (Lu & Yang 2010) (Wang & Ko 2010) (Reinisch et al. 2011) as shown below in figure 10.

Figure 10. Energy harvesting methods



Solar energy is simple, cheap, efficient, renewable energy resource, pollution free, noiseless process and has limitless availability. In RF energy harvesting technique no mechanical parts required. In Biochemical energy harvesting it is easy to use of steady fuel source and it gives continuous energy output and implantable applications for human being. Acoustic energy harvesting works very well in remote or isolated locations. Thermal energy harvesting have no moving parts and long lifetime for human worn applications. It is Easy and simple

CONCLUSION AND FUTURE

IoT have never-ending options for businesses. The business scenery is gradually shifting with IoT. This chapter demonstrates the background and applications of IoT.

Some examples of IoT-based solutions are also given in this chapter. It also have ideas how a businesses can benefit from emerging technologies. Next decade competition will be largely defined by how companies influence from new technologies. It is expected that in next 2 years approximate 50 billion of things will be connected to internet. WSN is connecting things to the internet with the help of gateways. In future almost all devices will be connected to the internet and it will be vital part of our lives.

WSN is becoming the key technology of IoT. IoT devices are computers, laptops, smart phones and objects, which are operational with chips to collect and correspond data over a network. These devices sense and collect data using sensors. The range of Internet of Things devices is huge. Consumers use smart phones to correspond with IoT devices.

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Chapter 7
IoT-Based Agri-Safety Model:
Mechanised Agricultural Fencing

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ABSTRACT

There are many problems in the agricultural sector. One of the major issues is the safety of crops from the animals. The crop land near forest or any reserved wildlife get affected by the animals, decreasing production. The result is the conflict between animals and farmers. This chapter proposes an inexpensive and effective way to alert the farmer of animal intrusion in the farm by employing a pressure load sensor deployed in the ground wired with a vertical mounted unit with the actuators. The vertically mounted unit produces a loud sound and LED light strobes to deter the animal and also alert the farmer.

INTRODUCTION

Farming is one of the most hazardous occupations in India. The risk of farming injuries and illness can be reduced when working with mud, animals, within an extreme climate in the open field by evaluating the risk factors and minimizing them. Accidents can be prevented through better farming education, making sure equipment is well maintained and has adequate safety features, having safety procedures in place, and training to every worker and family member about potential dangers. But the most important way of reducing risk is by using protective and modified accessories and protecting themselves from hazards. Indian farmers are not economically sound as they are unable to protect their land, animals, crops, and themselves. Due

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to continuously working in unhealthy and extreme climate the Indian farmers are suffering in many types of diseases and Muskulateral disorder(MSD).So extensive researches are essential towards the safety of farmers from occupational hazards by focusing on new smart materials that can help them not only to work in sunlight, rain, mud, and contamination but also help them to increase the productivity and provide a better and ergonomically safe place with pleasing working atmosphere. So evaluating the working conditions and Occupational hazards of Indian farmers and substituting research on modified materials in terms of farming accessories and validating it through test, review, and survey can full fill the research concept. Still, some problems of farmers remain unsolved that is human-animal conflict in farming. Farmers across the country and abroad face significant threats from pests, damages done by animals, and other types of crop losses which result in lower yields. Most often, none of the steps taken to counter the problems are adequate. Agriculture is a vital part of the Indian economy. More than 70% of the people in rural households depend on agriculture. The contribution of agriculture is about 17 percent of the total Gross Domestic Product (GDP) and gives employment to over 60 per-cent of the total population of the country. So, the easier we make for our farmers to produce the better our economy will be in the coming time. That's why it is very important to develop our agricultural sector. There are many problems in the agricultural sector. Nowadays one of the major issues is the safety of crops from the animals. The cropland near the forest or any reserved wildlife gets affected by the animals for which the production gets decreased. After the result is that the conflict between animals and farmers. This project proposes an inexpensive and effective way to alert the farmer of animal intrusion in the farm by employing a pressure load sensor deployed in the ground wired with a vertically mounted unit with the actuators. The vertically mounted unit produces loud sound and LED light strobes to deter the animal and also alert the farmer.

Humans have cleared the vast areas of land for crop cultivation and their needs increase pressure on wildland animals. So, this causes the migration of animals to a nearby village and rural area to fulfill their requirements and thus resulting in human-animal conflict (HAC). The cropland near a forest or any reserved wildlife gets affected by the animals for which the production gets decreased. The most common way to prevent such interactions, which is in wide use nowadays is to make a barrier, also known as fencing.

The problems created by the wild animal over the crop cultivation has become a very common occurrence across the world. Some of the issues that can be solved by fencing are-

1. Crops can be protected resulting in an increment in the production.
2. The conflict between animals and farmers.

3. Establish a boundary to mark one's property, etc.

Types of fencing used nowadays:

- **Wood fence**: Most Popular type of fencing used. They are inexpensive and lightweight. But they are not suitable for long time use due to the effect of environmental factors on wood.
- **Barbed wire fence**: Consists of steel wires. They are the most popular fencing solution for farms, agricultural lands, residential apartments & commercial premises.
- **Woven wire fence**: Primarily used for agricultural fencing. More effective than barbed wire fencing for containing small animals.
- **High tensile wire fence**: Made from carbon steel. Outlasts and outperforms woven wire fence,
- **Electric fence**: Consists of live steel wires. They are very effective but at the same time very dangerous.
- **Synthetic fence**: Made of PVC or vinyl. They are inexpensive but very durable.

With the advancement in technology, various methods have been implemented to mitigate human animal conflict.

Electric wire fences are employed in forest areas to contain wild animals. Satellite imaging is used to monitor the movement of animals. GPS sensor-based collars are used to detect the existence of elephants in many parts of the world.

The design of such systems is generally small and rugged. They are a good long-term investment and are everlasting. An e-Fence made with quality materials can serve up to 40 years. However, these systems require good maintenance and the initial set up cost is high if old fencing needs to be removed before installation.

BACKGROUND

Over the years, increased anthropogenic pressure coupled with the expansion of agriculture lead to the depletion of the territory and prey base of wildlife species residing in these environments (Mills and Hofer, 1998; Alam et al., 2015). As a result, animals such as hyenas are forced to venture into human settlements in search of food and water for survival. Most often. they prey on domestic animals and livestock. Wildlife is accountable for the loss of 3% of livestock per year (Jackson and Nowell, 1996). A number of different wild animals are involved in such conflicts, but, it is aggravated when large carnivores are involved (Dickman, 2008). Man wildlife conflict primarily involves interspecific competition for resources which automatically jeopardizes the lives of the local people and leads to economic losses as well (SilleroZubiri and Laurenson, 200I). These conflicts mainly occur at the forest edges and in those areas where the predators have easy access to the livestock without getting noticed (Woodroffe and Ginsberg, 1998). The occurrence of conflicts has increased in recent decades. Anthropogenic activities have escalated in almost every eco-zone owing to gradual elevation in need of daily subsistence(Vitouseket aI., 1997). In fact, it is this unrestricted desire for space and subsistence that have initiated fragmentation of forests and habitats and augmented conflicts over available resources even at the national level (Laurance and Bierregaard, 1997; Mishra, J 997). Carnivores mostly attack livestock that is grazed in forest lands and in human settlements which also poses a risk to human lives. The damage inflicted on humans or on their livelihood often infuriates the herd owners who resort to measures to avenge the loss (Conforti and de Azevedo, 2003). The striped hyena *(Hyaena hyaena* L. 1758) is a near-threatened large carnivore with a wider distribution range than other hyena species. Hyaenidae family consists of four species around the globe such as striped hyena, spotted hyena, brown hyena, and Aardwolf (Mills and Hofer, 1998). They are mostly a scavenger by habit (prater 1971). Some hyena species are considered as proficient hunters. They seek their food by scent (Prater 1971, Kruuk 1976). These carnivores are playing an important role in maintaining the forest and grassland ecosystems (Millls and Hofer, 1998; Abi-said and Abi-said, 2007). Of the four extant hyena species, only the striped hyena is found in India. The striped hyena is categorized as Near Threatened by the ruCN (Arumugam et al. 2008) and placed in schedule-III. The total Indian population estimate is around 1000 to 3000 individuals representing around 18-20 percent of the total world population (Mills and Hofer, 1998). The populations are generally declining throughout their geographical range due to persecution, poisoning and hunting for meat or medicinal purpose, besides depletion of prey populations and wildlife diseases (Singh et al., 2010; Akay et al., 2011; Jnawali et al., 2011; Dejene et al., 2016). Other environmental factors such as scarcity of food and shelter may also be contributing to the decline, including diminishing food stocks and competition with other carnivores over shelter (Alam, 2011, Akay et al., 2011, Khorozyan et al., 2011). Assessment of the status and distribution of animals to monitor population trends in case of rare or endangered species is a key ecological parameter for understanding the ecology and conservation status of a species (Williams et at, 2002). Keeping view of this, the conflict between humans and the hyena was studied in and around the Agra district of Uttar Pradesh, India to support the conservation strategies and record the fact involved in the human-hyena conflict. Mukhtar(2015) has explained the developments of advanced electronics have brought revolutionary changes in these fields. Equipment theft is a severe problem in many industries including transportation and construction, especially for more significant businesses. Damani et al.(2015) have explained the Global Positioning System (GPS) is a system based on Global Navigation Satellite System (GNSS) that provides reliable location and time information at all times in any weather condition on earth .Reclus and Drouard(2009) have explored about Geo-fencing enabled remote monitoring of geographic areas surrounded by a virtual fence (geo-fence), and automatic detections when it tracked mobile objects that entered or exited these areas. Cardone et al. Have explored that Geo-fence apps and tools monitored the devices or other physical objects that entered or exited the established geo-fenced area and provided administrators with alerts when there was a change in the status of the device. Ramaprasad and Narayanan(2019) have developed Vehicles tracking and navigation are becoming the most important requirements of the people. A hybrid model for tracking and tracing by used GPS and wireless sensor networks to get the vehicle and cargo positions. This system architecture consisted from three components: Firstly, a Hybrid Network Infrastructure integrated technologies GPS, Wi-Fi, RFID and ZigBee to perform the entities tracking, while GSM/3G, Wi-Fi and ZigBee were used for communication between the components. Secondly, Intelligent Monitoring Devices to motion detection, RFIDs and communication through ZigBee networks. Lastly, the Central Server provided services so that different logistics applications are developed proposed by Yang et al,(2010).

METHODOLOGY

The proposed system provides a smart and inexpensive method for the farmers to control animal intrusion in farms. The system uses a load sensor that is connected to a centrally mounted unit that has the sound and LED strobe light mechanism.

The Arduino platform is used for this mechanism. Once the load sensor is activated it gives output to the Arduino through a load cell amplifier HX711. Programming is installed in Arduino in such a way that when a threshold weight value is reached LED light as well as an alarm system is activated which keeps the animals away from the field.

This system does not require the older fencings to be removed as the sensor can be placed outside the old fence.

It is the main component used in the system. It is a form of a strain gauge that uses a transducer to vary the current due to deformation: Three wire load cell

We have used the HX711 load cell Amplifier. The output from the load cell is very low and the amplifier is used to boost this output so that it can be used with Arduino. By using these highly accurate weight measurements can be done.

Arduino Uno is a microcontroller with 14 digital pins, 6 analog pins powered by USB cable. It is paired with a load cell amplifier and output as LED light strobe and sound through the speaker. It stores the program for using the circuit. Some of the technical specifications are:

- Op. Voltage: 5V
- Analog Input Pin: 6
- SRAM: 2KB
- Digital I/O Pins: 20mA
- EEPROM: 1KB
- Flash Memory: 32 KB of which 0.5KB used by bootloader

For producing sound ISD 1820 Voice Recording and Playback module is used. It is paired with Arduino output and the speaker is connected with it to produce loud sounds to keep animals away from the field.

RESULT AND DISCUSSION

Arduino Software v1.8.8 was used for coding prototype board. Following code was used for weight sensor:

```
#include "HX711.h"
HX711 scale(5, 6);
float calibration_factor = 48100; // this calibration factor is
adjusted according to my load cell
float units;
float ounces;
#define LED_BUILTIN  13
void setup() {
  pinMode(LED_BUILTIN, OUTPUT);
  Serial.begin(9600);
  Serial.println("HX711 calibration sketch");
  Serial.println("Remove all weight from scale");
  Serial.println("After readings begin, place known weight on
scale");
  Serial.println("Press + or a to increase calibration
factor");
  Serial.println("Press - or z to decrease calibration
factor");

  scale.set_scale();
  scale.tare();  //Reset the scale to 0
```

```
  long zero_factor = scale.read_average(); //Get a baseline
reading
  Serial.print("Zero factor: "); //This can be used to remove
the need to tare the scale. Useful in permanent scale projects.
  Serial.println(zero_factor);
}
void loop() {

  scale.set_scale(calibration_factor); //Adjust to this
calibration factor
  Serial.print("Reading: ");
  units = scale.get_units(), 10;
  if (units < 0)
  {
    units = 0.00;
  }
  ounces = units * 0.035274;
  Serial.print(units);
  Serial.print(" kg");
  Serial.print(" calibration_factor: ");
  Serial.print(calibration_factor);
  Serial.println();
  if(Serial.available())
  {
    char temp = Serial.read();
    if(temp == '+' || temp == 'a')
      calibration_factor += 1;
    else if(temp == '-' || temp == 'z')
      calibration_factor -= 1;
  }
    scale.tare();  //Reset the scale to 0
    if(units>=5)
    {

    }
    else
    {
      Serial.println(" no weight");
    }
}
```

About 70 percent of people living in rural households in India depend on the agricultural economy as their main source of income. But many of them face problems due to human-animal conflict, especially near forest lands. Damaged crops by wild animals is a major part of the losses faced by them which enhanced us to think about how to reduce such damages and increase their productivity. Till date, only primitive fencing is being used which is not that effective enough to keep animals away from farmlands. So, we needed something more advanced and economical technique developed in these areas. Traditional wire or wooden fencing used by farmers comes at a higher cost of setting up and not suitable for every kind of animal intrusion. We needed something which is user-friendly, easily accessible, and easily installable in farming areas by the farmers with less effort without much knowledge required. So, we thought of developing a system of fencing which would meet the requirements and provide a solution to the problems of these farmers. The method used in animal detection with smart electric fencing for agricultural land only gives the position from where the animal has entered the field via SMS to the farmer, but it does not provide any means to drive away from the animal. The initial setup of these systems that were studied was higher than that which is proposed by us as some require the old fencing to be removed. Electrical fencing poses a danger of electrocution to the farmer as well as other workers on the farm and is not very feasible. Many of the systems have exposed wires for fencing which are subjected to environmental conditions like storms, snow, etc. Heavy wiring is required to cover all areas of the farm, whereas the borders of the forest are the main entry point considered in our system, thus reducing the amount of wiring required. The proposed system tries to overcome these shortcomings and that too in a smart and inexpensive way. So An effort is given to incorporate traditional methods like shouting, drum beats, and huge spotlights that scare away the animal through the use of mechanical devices and LEDs.

The main objective of the project is to provide the farmer with an inexpensive and smart way to keep animals off the farm. The system is less sophisticated and employs a load sensor and actuator pair. To provide an easy setup at a low cost which best suits the Indian farmer even for a small land area. The proposed system is specially focused on elephant intrusion in agricultural areas near the forest regions to save the crop.

CONCLUSION

The main purpose of the project is to save the crop at a less cost for the Indian farmers as we know that most of the Indian economy depends on the agriculture industry. The present study and project will help reduce the problem of the destruction of crops from animals. Addition of solar panels to make the system self-sufficient. Testing with different loads so that different animal detection can be incorporated. Agriculture is a vital part of the Indian economy. More than 70% of the people in rural households depend on agriculture. The contribution of agriculture is about 17 percent of the total Gross Domestic Product (GDP) and gives employment to over 60 per-cent of the total population of the country. So, the easier we make for our farmers to produce the better our economy will be in the coming time. That's why it is very important to develop our agricultural sector.

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Chapter 8
Plant Diseases Concept in Smart Agriculture Using Deep Learning

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ABSTRACT

In the agricultural sector, plant leaf diseases and harmful insects represent a major challenge. Faster and more reliable prediction of leaf diseases in crops may help develop an early treatment technique while reducing economic losses considerably. Current technological advances in deep learning have made it possible for researchers to improve the performance and accuracy of object detection and recognition systems significantly. In this chapter, using images of plant leaves, the authors introduced a deep-learning method with different datasets for detecting leaf diseases in different plants and concerned with a novel approach to plant disease recognition model, based on the classification of the leaf image, by the use of deep convolutional networks. Ultimately, the approach of developing deep learning methods on increasingly large and accessible to the public image datasets provides a viable path towards massive global diagnosis of smartphone-assisted crop disease.

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1. INTRODUCTION

Agriculture performs a vital role within the global economy. Pressurize to the agriculture system (Coakley et al. 1999) will enhance with the continuing growth of the human population. Agriculture is the backbone of the Indian economy. The enormous substantial commercialization of the agricultural system impacts our climate quite severely (Solomon et al., 2007). The use of chemicals has contributed to tremendous amounts of chemical building up in water, food, soil, animals and also in our inner bodies. Synthetic fertilizers have a small-term effect on production, however a longer-term detrimental impact on ecosystem. Another adverse impact of this development has been at the circumstances of the worldwide agricultural communities (Cerri et al., 2007).Despite the matter of expanded productivity, farmers have undergone a decline agricultural fortunes in almost every country across the world. It is here that organic farming begins. Organic farming has the potential to deal with every of those problems and its main practice depends on fertilization, control of pests and diseases. Especially in throughout agricultural sector, where crop types are influenced by output productive patterns and management of resources, disinfestation levels (Mahlein et al. 2013), irrigation, productivity attention and efficient improvements (Ngugi et al., 2020) are coveted; maintaining these production rhythms without the use of any automatic controlling is likely to lead in resource loss, rotting and wasted crops polluted with impoverished soils. Agri-technology and precision farming, also called digital farming, have emerged as modern scientific disciplines that use data-intensive approaches of maximizing agricultural productivity while reducing its environmental effects. Data produced in modern farming procedures are provided by a number of different sensors (Reddy et al. 2015) that allow a clearer understanding of the operating environment (an interface of complex crop, soil, and climate conditions) and the process itself (machine data), resulting in more precise and quick decision making.

The challenge of effective protection of plant diseases is similarly linked to sustainable agriculture and environmental change issue factors. Detection of plant disease (Jadhav et al., 2020) by examining the effects on plant leaves with a naked eye, integrates increasingly growing constraints (Karthik et al., 2020). Deep learning one of the new, modern technique that used for processing images and analyzing featured data with precise outcomes and great potentiality. Considering that deep learning implemented significantly in related disciplines and recently penetrated to agricultural realm (Boulent et al., 2019).

1.1. Common Deep Learning Algorithms

The most widely used deep learning algorithms include GAN, RNN, and CNN explained briefly by Alex G, and Schmidhuber J. (2005). There are several other deep learning algorithms that are sub-categories as VGGNet, LSTM, ConvNets and DCGAN. These techniques derived directly or indirectly from the three popular deep learning algorithms.

1.1.1. Feed Forward Neural Network and Back Propagation (BP)

Based on neural BP or feed forward neural network back propagation network. This is one the supervised learning used algorithm consisting of several hidden layers of neurons in complete contact using back propagation error (Li et al. 2012).This implies each neuron layer is linked to upper neuron layer and every layer also has an activation feature to minimize neuron amplitude output through linear or nonlinear neuron input transformation. Hidden neurons are able to learn about the distinctive features regarding continuous forward propagation training data.

The back propagation neural network algorithm (Rajput et al. 2014) is also a supervised multi - layer learning technique for feed-forward networks from the artificial neural network (ANN) field. Neural feed-forward networks, called a neuron, are driven by one or more neural cells which process information. A neuron receives input signals which transmit their electrical signal through its dendrites to the cell body. The neuron passes out the signaling to synapses which are the ties between the dendrites of a cell and the dendrites of another cell. The back propagation process theory is just to model a defined function by altering the intrinsic weighting input signals to generate expected output. The system has always been equipped with a supervised approach of learning, where the system displays the inaccuracy between both the output of the system as well as a defined expected output which used to change its internal state. The back propagation algorithm (Zhang et al. 2019) is technically a form of weight training in a network of multilayer neural feed-forwards. As such, it involves identifying one or more layers of a network structure in which each layer is completely connected to next one. A typical structure of network consists of one layer of input, one another hidden layer with layer of output.

1.1.2. Recurrent Neural Network (RNN)

Much as CNN nets models often used for hyper spectral image detection, RNN nets models also used for HIS. The RNN is a kind of neural network (Diao et al. 2019), where the output from the previous step is fed as input into the current step. As output from the preceding step fed into the current step as input. In case of traditional neural networks, almost everything i.e. inputs and outputs indeed independent of one another but to predict the upcoming word of a message, it always be necessary to remember the prior words. Consequently, RNN originated with aid of a hidden layer that solved above mentioned problem. The key aspect of RNN is hidden state, which commemorates certain information of a list. RNN has a "memory" that contains all of the calculated data. To generate the output on all inputs or hidden layers, it employs the similar parameters for and input to perform the same function. Like all other neural networks this eliminates parameter complexity (Yu et al. 2019). In the field of plant disease detection, some researchers used Hyper Spectral Imaging (HSI) alongside deep learning models to examine improved vision for symptoms of plant diseases that generally made up of DCNN, PCA, and LR and hybrid approach for classifying hyper spectral images that suggested the better outcomes than existing classification tasks approaches. RNN (Luo et al. 2019) is capable of retrieving functional facts and semantic knowledge, and has produced breakthroughs for time series analysis, understanding of speech, and language modeling.

1.1.3. Generative Adversarial Nets (GAN)

A hyper spectral proximal sensing approach particularly depend on the current deep learning technique called Generative Adversarial Network (GAN) was introduced for detecting plant disease. The GAN architecture (Wang et al. 2017) fairly straightforward though the issue of one dimension GAN loss functions that remains difficult for beginners. The key explanation for that; the design requires teaching two models simultaneously: the generator and the discriminator. As every other deep learning neural network, the discriminator model modify information, but system requires the discriminator just a loss functional which implies that the generator loss functional is implied and learned throughout training. The GAN framework always defined with min-max of GAN loss although it is typically performed using the non-saturating loss function. Useful alternative loss features in current GANs have the least squares and functions for loss of Wasserstein. Large-scale evaluation of GAN loss functions shows no difference while other considerations are kept constant, such as computational budget and model hyper parameters.

GAN's creativity lies in their architecture. Technically it is variation of BP's latest algorithms. GAN (Z. et al. 2019) useful for learning of how to spread the real data and produce new data using a noise collection. This network's structure is composed of two framework models, a data generation model for capturing real actual data distribution as well as a related discrimination framework to the binary classifier.

1.2. Deep Learning Frameworks

A deep learning framework is an architecture, library, or resource that allows us to more easily and quickly construct deep learning models without going into the specifics of the underlying algorithms. We provide a simple and descriptive way to describe models using pre-constructed and configured part sets. Below, briefly introduce the most common TensorFlow, Caffe, Keras, and PyTorch frameworks (Shatnawi et al. 2018).

1.2.1. TensorFlow

TensorFlow was created by the Google Brain team of researchers and engineers. This is by far the most used app library in the area of deep learning. One of major reasons that TensorFlow is so prominent towards its utility for building deep learning algorithms like Python, C++ and R for multiple languages. TensorFlow is the Google's open source (Nguyen et al. 2019) computing system that continues to support deep learning algorithms like GAN, RNN, CNN and several other variants of the platform, including Mac, Linux, and Windows. TensorFlow also contains strengths, which include high flexibility, multi-language support, true portability, excellent documentation and a large algorithm library. TensorFlow demands dataflow plots that represent computation, operations of mutating state and shared status that traces a dataflow network node across numerous computation units, including general purpose GPUS, multi-core CPUS, and custom designed of ASICs, recognized as Tensor Processing Units (TPUS). TensorFlow provides broad variety of optimization interfaces (APIs) for implementation of deep learning applications, including basic calculations of vector matrix, convolutionary neural networks, visual aids, optimization algorithms, and recurrent neural networks.

1.2.2. Caffe

Caffe is another common deep learning application, based on the field of image processing. This was developed at the University of Claifornia, Berkeley by Yangqing Jia, during his Ph.D. And yes it's still open source. Caffe can process more than 60 million images per day with a single NVIDIA K40 GPU i.e. 1ms / inference image, and 4ms / learning image. In addition, Caffe can also be versatile, and expand quickly to new latest responsible tasks (Nguyen et al. 2019). Users may describe their own template of models using the forms of neuron layers contribute by Caffe. Convolution architecture for feature extraction (Caffe) was first deep learning system which commonly used in many organizations as a free open source. The Caffe framework and its associated techniques of optimization are offered as texts rather than codes.

(Shatnawi et al. 2018) defined that caffe gives model definition, optimal optimization settings, and pre-training weights with deep learnings high-speed, massive data. The framework of caffe always BSD certified C++ library with dependencies of Python including MATLAB to train and execute convolutionary neural nets and many different deep learning applications in a variety of architectures efficiently. Caffe offers a secure and modifiable framework for state-of - the-art profound learning algorithms and a reference set in Caffe includes the new state-of the-art deep learning algorithms and the collection of interactive comparison systems for scientists and practitioners.

1.2.3. Keras

Keras is developed in Python and can run TensorFlow on top of it. The TensorFlow interface can be a bit more challenging as it is a low-level library and it may be difficult for new users to understand several implementations. But at the other hand, Keras is an API of high quality, designed with a focus to allow for easy experimentation. So if you want quick results, Keras will take care of the core tasks automatically, and generate the output. Keras supports both Convolutionary Neural Networks, and Recurrent Neural Networks (Nguyen et al. 2019). It functions seamlessly on both CPUs and GPUs. In Keras the model layers are described in sequential fashion that ensures the layers are applied sequentially during the training of deep learning model. In general, Keras functional API is used to describe complex models, such as multi-output models or shared-layered models.

1.2.4. PyTorch

It is a connection to the deep learning system of Torch which used to construct deep neural networks and perform tensor computations. Torch is a platform based on Lua programming language while PyTorch runs on Python. PyTorch (Shatnawi et al. 2018) is a Python package providing Tensor computations. Tensors are multidimensional arrays, just like the nd-arrays of numpy which can also run on GPU. PyTorch uses graphs for complex computation. PyTorch's autograd software constructs computation graphs from tensors and computes gradients automatically. Instead of predefined graphs with different functionalities, PyTorch provides us with a structure to construct and even modify computational graphs during runtime (Nguyen et al. 2019). This is useful in circumstances where we don't know how much memory will be needed to create a neural network.

2. RELATED WORK

Smith et al. (2020) concentrated on annotation duration, as time criteria for annotation rather than the quantity of images readily accessible to become more important to the needs of the majority of groups of plant data analyzers wishing to use profound learning to analyze images. The results, particularly for appropriate remedial training, confirm the first hypothesis in addition to demonstrating that any deep learning prototype can be trained with high accuracy with less than two hours for annotation also for three corresponding datasets of contrasting target items, context and image reliability and illustrate the feasibility by training a specific model using short-term training questioning arguments that scores to around thousands of data image or significant marking data required for using CNNs.

Zhong et al. (2019) the author aimed to build a deep, learning-based, time series classification system for remote sensing. The analysis was done in Yolo County, California, where a highly complex irrigated farming method has now overtaken productive crops. In order to identify summer crops using Landsat Enhanced Vegetation Index time series, two types of deep learning architectures were built for the difficult task: one based on Long Short-Term Memory (LSTM), while the other centered on dimensional convolutional layers.

Chakraborty et al. (2000) showed that in order to detect and identify plant diseases, popular digital image analysis techniques were used, including the color analysis of threshold. Deep learning one of the new, modern technique that used for processing images and analyzing featured data, with accurate results and a wide potential. A subset of machine learning is deep learning, capable of the drawing conclusions from different collective sets of source data. Algorithms of Deep learning will take a couple of years of raw data— insights into how crops have grown and inherited those properties in various environments— and use this information to construct a prediction model.

Waldchen et al. (2018) reviewed the technical status of image processing based recognition methods for plant diseases. Major research barriers that need to be addressed in providing appropriate resources. Authors envisage systems of identification which allow users to obtain images of field experiments using a handheld camera device App, that many are then managed through an automated taxon classification system or, at least, by obtaining a number of selected taxa. This method is easy, as identifying involves no user work except taking an image and browsing the best matching species.

Garrett et al. (2006) reviewed the challenge of effective protection of plant diseases is similarly linked to sustainable agriculture and environmental change issue factors was. Detection of plant disease by examining the effects on plant leaves with a naked eye, integrates increasingly growing complexity. Because of this difficulty and the significant number of crops grown and their current phyto-pathological issues, even professional agricultural experts and plant pathologists can sometimes struggle to diagnose infectious diseases successfully; and therefore, false assumptions are drawn and remedies fear.

3. PROPOSED WORK

Plant diseases tend to be a severe obstacle to agriculture around the world. The objectives of this research are:

- Deep learning based approach for the detection of plant disease and its applicability.
- To implement a convolutional neural network model for classifying the plant leaf diseases among ten classes (Tomato_Target_Spot, Potato_Early_blight, Apple_Black_rot Orange_Haunglongbing_(Citrus_greening), Tomato_ Bacterial_spot, Gray_leaf_spot, Strawberry_Leaf_scorch,Pepper_bell_ Bacterial_spot, Peach_Bacterial_spot, Corn_ (maize) _Cercospora_leaf_ spot, Grape_Black_rot,).
- Utilization the concept of data argumentation, dropout and normalization.
- Accuracy curve and loss curve based analysis.

A Convolutional Neural Network (ConvNet) is indeed a Deep learning framework technique designed to capture a source input image, attributing significance (learnable biases and weights) to various different aspects / objects throughout the image, while being able to discriminate between them. Pre-processing is considerably lower than most other classification strategically algorithms needed for the use of a ConvNet. A ConvNet's architecture is close to that of the human brain contact pattern of Neurons, influenced by the Visual Cortex organization. In a restricted region of the visual field known as the Receptive Area that is individual neurons only respond to stimuli. A variety behind these fields coincides overlap to complete the whole viewing space. A model is acquired through CNN training–a set between weights or prejudices– that then responds mostly to the particular task for which it was developed. One of CNNs ' main strengths is its generalization capability that's also, the potential to interpret data that has not been seen before. This offers cognitive heterogeneity with around certain specific robustness, conditions for Image formation processing and variation in the intra class. Apart from that, studying these visual representations requires data on a large-scale study. Due to their large number of parameters, their ability to over fit the training data is one common problem with DNNs, meaning they cannot generalize. Other issues surrounding CNNs are the selection of an architecture suitable to a particular issue and performance interpretability of the training (effect of black box). CNNs for automated image detection of crop diseases and assessment of their potential for operating instruments.

The proposed layered architecture of CNN model is shown in fig. 1.

4. RESULT AND DISCUSSION

This work is implemented with a Intel(R) Core(TM) i5 6200UCPU @ 2.30GHz, 2401Mhz, x64-bit-based operating system, 8 GB RAM and 2 GB of AMD Radeon R5 M330 graphics engine running on the Windows 10 operating system was used. We used a dataset with 18,520 images for the training and 2,664 images for the validation. The sample images of dataset are shown in fig. 2 and parameters used during the training and validation for the experiment are given in Table 1.

Accuracy and Logloss is calculated using the equation 1 and equation 2 respectively.

$$Accuracy = \left(TP + TN \,/\, \left(TP + TN + FP + FN\right)\right) \tag{1}$$

$$\log loss = 1 \,/\, N \sum_{i}^{N} \sum_{j}^{M} y_{ij} \log\left(p_{ij}\right) \tag{2}$$

Our experiment recorded 99.64% accuracy with logloss score 0.01 for training set and 99.21% accuracy with 0.03 logloss for validation set in just 50 epochs. Accuracy and logloss curve are shown in fig. 3 and 4. Although our proposed research does have satisfactory performance, the number of experiments with larger dataset can be increased for better analysis.

5. CONCLUSION

In sustainable agriculture, crop protection is truly a trivial matter. It is expected to improve productivity and make better understanding of the relationship established between economic and environmental factors, reduce production costs for peasants and increase the intensity and accuracy of action. Deep learning technologies in smart agriculture have many possibilities there are many techniques in the detection and classification process of automatic or computer vision plant disease. In our framework, we established extensive deep learning models for plant disease detection

Figure 1. Layered architecture of CNN model

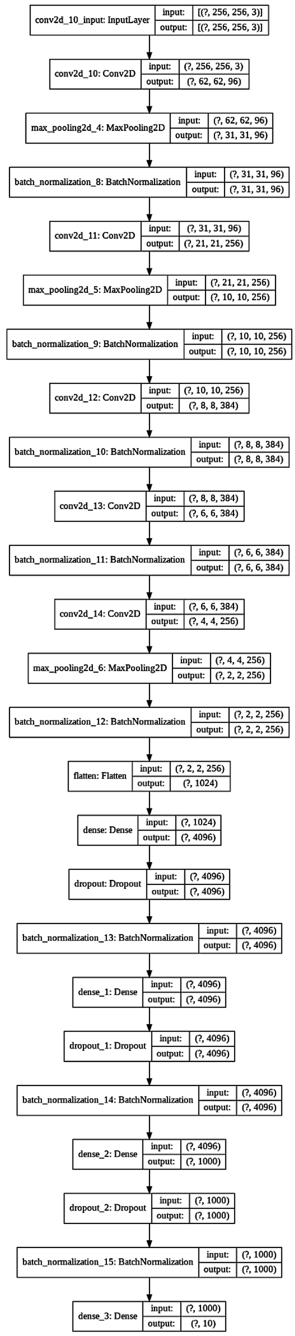


Figure 2. Sample Images of Dataset

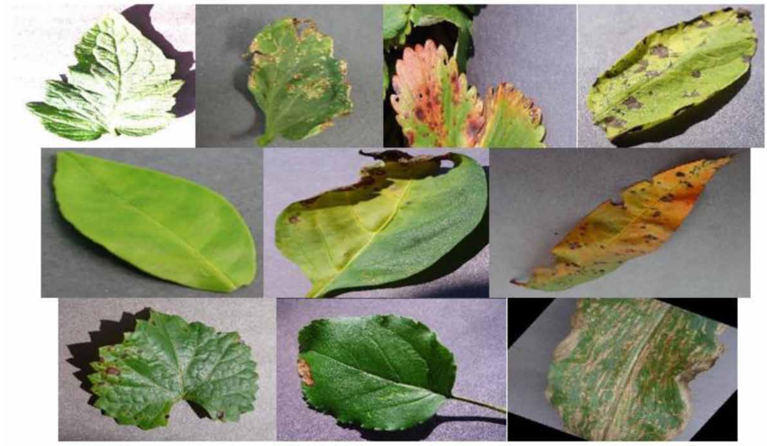


Table 1. Parameters Specifications

Parameter Name	Parameter Value
Input Size	256*256*3
Batch Size	32
Epochs	50
Logloss	Categorical cross entropy
Activation function	Softmax and ReLU
Optimizer	Adam
Tool	Anaconda 3.0 with Tensorflow in backend

Figure 3. Accuracy Curve

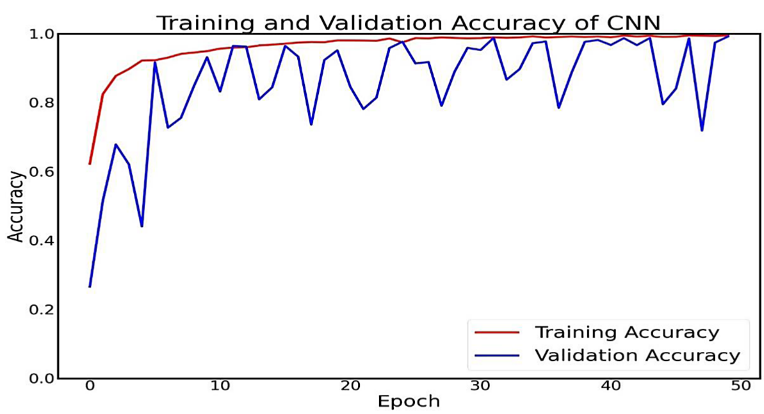
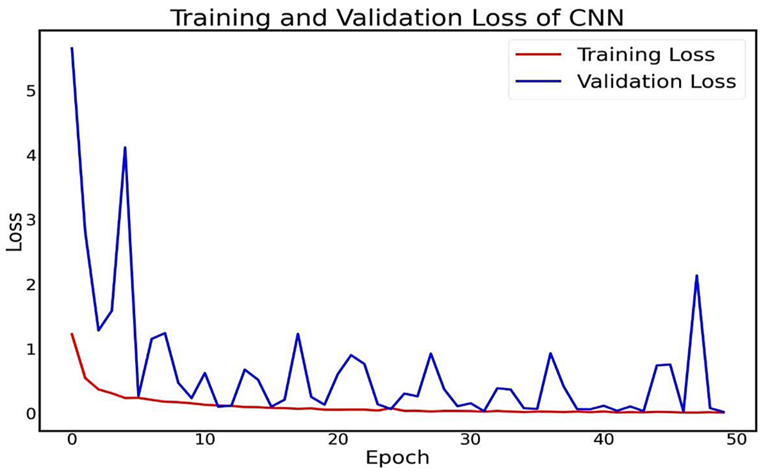


Figure 4. Logloss Curve



through leaf images based on CNN. The training epochs, dropout and batch size further influenced the corresponding results. Our research findings demonstrated how the deep-learning approach is capable of consistently detecting plant diseases with approximately 99.21 percent accuracy and 0.03 logarithm loss within only 50 epochs throughout 10 classes. Yet the works studied indicate the probable perspective of the deep learning techniques to identify diseases in crop. The discovery is certainly favorable for growth of new and latest agricultural tools which could lead to most efficient and secure production of food.

Moreover, future work include; extending the use of model by teaching it to identify plant disease onto the broader land areas, integrating aerial images of drone-captured orchards and the vineyards with neural convolutional networks for object detection.

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Chapter 9
Smart Agriculture and Farming Services Using IoT

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ABSTRACT

IoT technology is used in many areas like the smart wearables, connected devices, automated machines, and driverless cars. However, in agriculture, the IoT has brought the greatest impact. The industrial IoT is a driving force behind increased agricultural production at a lower cost. In the next several years, the use of smart solutions powered by IoT will increase in the agriculture operations. The number of connected devices in agriculture will grow from 13 million in 2014 to 225 million by 2024. The applications of IoT in the agriculture industry have helped the farmers to monitor the water tank levels in real-time, which make the irrigation process more efficient. The advancement of IoT technology in agriculture operations has brought the use of sensors in every step of the farming process like how much time and resources a seed takes to become a fully grown vegetable. Internet of things in agriculture has come up as a second wave of the green revolution.

INTRODUCTION

A wireless sensor network (WSN) is used to observe environment situations like pressure, humidity, temperature, pollution etc. Earlier it was used for civilian application scenarios. But now it is used in several applications including environment

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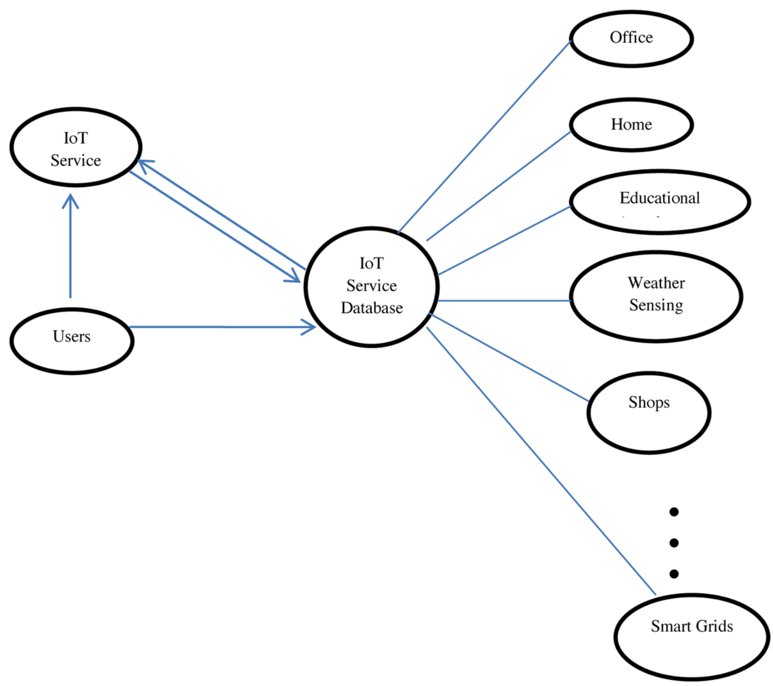
monitoring, home automation, traffic control etc. WSN is becoming the key technology of Internet of Things (IoT). WSN is main part used in IoT. Energy constraint is the main problem in WSN. Wake-Up Radio (WUR) can are connected to the pin headers (Fuqaha et al., 2015), to decrease the consumption of energy of the nodes further.

IoT is internetworking for internet of devices. IoT have many applications in smart homes, smart cities, agriculture, traffic management, transport, industrial automation, healthcare services and smart farming etc (Gondchawar and Kawitkar, 2016). In future the interaction between user and environment will be like as given below in figure 1.

Figure 1. Interaction between user and environment in IoT



Use of IoT in agriculture is important as it plays a fundamental role in the development of our countries economy. The IoT technology is used in many areas like the smart wearable's, automated machines etc. But, the IoT has brought the greatest impact in agriculture. The Industrial IoT has improved the agricultural production at a lesser price. The no. of devices in agriculture will raise from 13 million in 2014 to 225 million by 2024.

1. SMART FARM

Smart Farming is an efficient method of farming. It implements connected devices and novel technologies collectively into agriculture. As Smart Farming mainly depends on IoT, it eliminates the physical work of farmers and increases the productivity.

The IoT in agriculture production have helped the farmers to observe the water tank levels in real-time. The irrigation process becomes more proficient. Sensors are used in each step like calculating the time and resources a seed requires to become a fully-grown. Internet of Things is like a green revolution. IoT helps farmers to decrease costs and increase yields by improving farmer's conclusion based on precise data. Smart farming decrease the costs of production and increase yields .

Smart Farming is a hi-tech and effective system of doing agriculture and growing food in a sustainable way. It is an application of implementing connected devices and innovative technologies together into agriculture. Smart Farming majorly depends on IoT thus eliminating the need of physical work of farmers and growers and thus increasing the productivity in every possible manner.

With the recent agriculture trends dependent on agriculture, Internet of Things has brought huge benefits like efficient use of water, optimization of inputs and many more. What made difference were the huge benefits and which has become a revolutionized agriculture in the recent days. But due to lack of constant and reliable communication network infrastructure, the solution p-rovider of IoT well as the business owners are facing implementation challenges in remote or less developed regions. But, many network providers are making it possible by introducing satellite connectivity and expending cellular networks.

Smart Farming is a hi-tech and efficient method for doing farming. It implements connected devices and novel technologies collectively into agriculture. As Smart Farming mainly depends on IoT, it eliminates the physical work of farmers and increases the productivity in the field.

In Smart Farming farms are managed using Information and Communication Technologies like IoT and, Big data, to raise the quantity and quality of crop and reduce the human labour required. IoT has the impending to create a world where everything is connected by means of internet. Internet of Things in agriculture incorporates internet based advanced agriculture technologies and solutions. The field data are collected using sensors, cameras, micro controllers, and actuators and then send using internet farmer or operator. IoT is anticipated to have a significant role in: enhancing agricultural productivity; real-time field monitoring; increase in operational efficiency, yield enhancement, agriculture wastage minimization; precision farming to surmount natural calamities.

The benefits that the farmers are getting by adapting IoT are twofold. It has helped farmers to decrease their costs and increase yields at the same time by improving farmer's decision making with accurate data.

Smart agriculture using automation and IoT technologies is proposed by Prathibha et al (2017), in which smart remote controlled robot performs moisture sensing, weeding and spraying etc. The aim of using IoT in agriculture is to initiate the newest technology in agriculture and to produce better crop by collecting real-time status of crops. We can expect IoT will forever change the way the food is grown .Cooperation of private, state-owned and government enterprises with agro processing and food manufacturers are expected to. Smart agriculture mostly use IoT applications solutions. Even though smart agriculture IoT and industrial IoT are not accepted so as other consumer connected devices, still the market is very active. The use of IoT solutions in agriculture is growing continually.

Many technologies available presently with farmers for smart agriculture and farming. Some of them are given below:

- **Sensors:** Many types of sensors are available for measuring different properties related to agriculture like types of soil, moisture, temperature, light, water, humidity, pressure etc.
- **Software:** Many dedicated software solutions are available that aims precise farm types or use case atheist.
- **Connectivity:** Different types of connectivity like cellular, LoRa, etc. are available for proper data monitoring and analysis
- **Location:** GPS, Satellite, etc are used for location related information.
- **Robotics:** Robotics is used for self-directed tractors and processing facilities etc.
- **Data analytics:** data analytics is used in individual analytics solutions and data pipelines for downstream solutions.

1.1 Smart Farming Cycle Based on IoT

Data is the core of IoT and it can be taken from connected things and pass on over the internet for optimizing farming. All devices based on IoT are installed and they gather the data and then process it in a recurring way. Farmers react rapidly to up-and-coming issues and changes in the conditions. It should follow a cycle mainly consist of 4 phases as given below.

1.1.1. Observation

First phase is consisting of observation of data. Sensors trace data from the atmosphere, crops, soil and livestock etc.

1.1.2 Diagnostics

The data taken from sensors are feed to the cloud-based IoT platform, which has predefined regulations and models called “business logic”.

1.1.3. Decisions

Issues are discovered and the user as well as apparatus decide whether precise action is essential or not. If act is necessary then which type of action is required?

1.1.4. Action

After completion of these four phases, end-user evaluates and actions are taken. This cycle is repeated from the beginning.

1.2 IoT and Use of IoT in Agriculture

IoT applications look more capable in the coming years. IoT will possibly be used within other technologies like Artificial Intelligence (AI) and automation. The future of IoT is more attractive where billions of things will be talking with each other least or no human intervention. IoT has many applications like smart home, smart city, smart grid, smart supply chain, farming, smart wearables, health care system etc. Some challenges arise in IoT along with benefits like security privacy and scalability. IoT have never-ending options for businesses. The business scenery is gradually shifting with IoT.

Wireless Sensor network is becoming the key technology of IoT. A wireless sensor network is a wireless network of sensors. It is consist of spatially distributed autonomous and independent devices used to observe environmental conditions like pressure, humidity, temperature, pollution etc. Earlier it was used for civilian application scenarios. But now it is used in many applications including building automation, environment and health monitoring and controlling of traffic etc.

A sensor is the main component of a Wireless Sensor Node. In addition to a sensor, each node of a Wireless Sensor Network is typically equipped with some main components like Microcontroller, Transceiver, Sensors / Actuators, Memory, Power unit etc.

The sensor node senses the environment, collects the relevant data, process the information collected, store it in a buffer and forward this information to other nodes or base station in a wireless manner. An energy source (Power unit) supplies energy to the memory, sensing unit and transceiver. The processing unit is used to process incoming data and assemble them into packets to be transmitted using the wireless transceiver.

There are different types of sensors like seismic sensor, thermal sensor, acoustic sensor, visual sensor infrared sensor and magnetic sensor. A sensor can be passive or active. It may be directional or Omni-Directional. A wireless sensor node can include multiple sensors providing complimentary data. After sensing of physical quantity, a sensor causes the production of a continuous analogue signal. That's why; a sensing unit is typically composed of a number of sensors and an analog to digital convertor (ADC) which digitizes the signal.

Since many years, sensors were introduced and used in the agriculture operations. Sensors collect data and log in the memory and live data from the sensors are not received. This was the main difficulty in using conventional method of using sensors in agriculture.

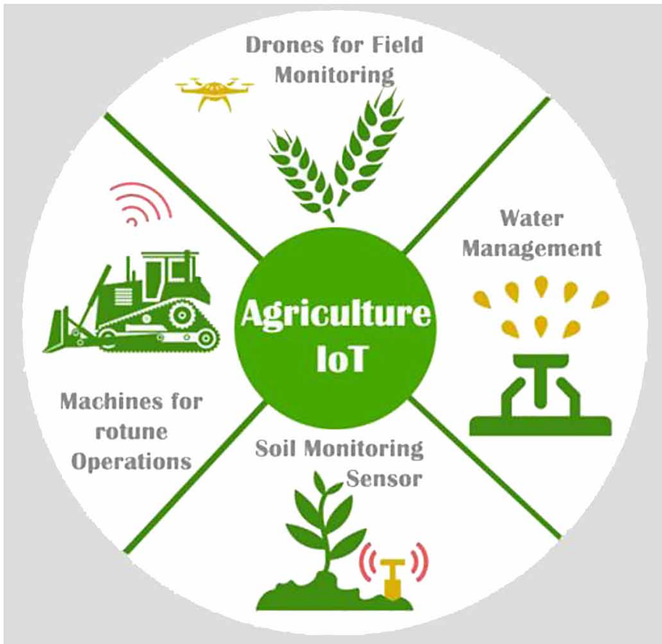
Advanced sensors are used in industrial IoT in Agriculture and are connected to the cloud through network. Obtained Real-time data makes decision making more effective. Farmers can monitor water level in the tank of water in real-time and thus irrigation becomes more proficient. Sensors are used in each step like time and resources calculation for fully-grown crop. A method of monitoring crop-field using temperature, soil, moisture, humidity and automatic irrigation system is given by by Rajalakshmi & Mahalakshmi (2016) .

1.3 Smart Farming and Its Applications

There are many applications of smart farming like Crop and farm animals management. Real time monitoring of farm animals updates the current status of farm animals and thus earns an enormous amount of profit. Farm animal's wearable's allows the farmer to monitor closely of their respiratory rate, heart rate, blood pressure, temperature and reproductory cycles etc. If any farm animal is found to be ill in the livestock, then that animal is segregated from the herd and its treatment for recovery is started. Real time geo fencing is a fortunate thing for farmers. Many parents have hypo-allergic children. For them, it is must to know the contents of any meal they are eating and this ensures that this will not result in bad situation.

Intellia IoT is a soil moisture sensor that gives detailed insight of soil moisture content and nutrients. It has a tailored dashboard to displays alerts messages and notifications, geo location, and gives information of all installed devices and their current state. Intellia IoT is deployed with a personalized dashboard and customized white marked app. IoT gives many benefits and applications, when used in agriculture. Some of them are shown in the figure 2 and are described below.

Figure 2. Applications of IoT in agriculture



1.3.1 Predicting Climate

Climate has a significant character in farming and unacceptable awareness of it can damage the quantity as well as the quality of the crops. Using IoT solutions, the real-time weather conditions are known and suitable action can be taken. Sensors are positioned within and outer surface of the agriculture fields. Sensors collect the data and farmer can decide the precise crops to grows and continue for the particular climatic. There are many numbers of sensors to sense these different parameters and organize consequently for smart farming. Sensors also monitor the crops condition and the weather close to them. An alert is post for any upsetting weather conditions. Thus the physical presence need is eliminated in disturbing climatic conditions and it finally increases the yield.

1.3.2 Precision Farming

Precision Farming, the most famous application, makes the farming preparation more exact and guarded using livestock monitoring and vehicle tracking. The main goal is to observe the data of sensors and then to act according to it. Many precision farming techniques like irrigation management, vehicle tracking, and livestock management. McBratney & Pringle (1999), measures properties of soil and optimize soil sample and management schemes. Kjellby et. al. (2019), gives the prototype design and testing of a long-range, self-powered IoT devices for precision agriculture.

1.3.3 Smart Greenhouse

Many weather stations that are IoT enabled are used to make our greenhouses smart. These stations automatically amend the climate conditions as per instructions. The process is cost-effective and more accurate. Sensors gather the data, pass it and monitor the greenhouse very accurately. Emails or SMS alerts are also used to monitor the water consumption and greenhouse state.

1.3.4 Data Analytics

The data is sensed, analyzed and transformed to using data analytics tools. Using data analytics weather conditions, farm animal's conditions and crop conditions can be analyzed. Using IoT devices, the real-time status of the crops can be known. Predictive analytics is used for better decisions.

1.3.5 Agricultural Drones

Beginning of agricultural drones has revolutionized the agricultural operations. Drone technology gives a very high rise to the agriculture industry. Sensors show groth of crops, their health and compute vegetation index.

1.3.6 Crop Water Management

Farmer pumps the water for cultivating the land. This causes wastages or insufficiency of water to the crops. In smart farming an alert message is send to the farmer when moisture level increases or decreases.

1.3.7 Pest Management and Control

A great loss of crops occurs due to predators or pests. Smart farming has a system that detects the motion of predators using PIR sensors. Thus farmers can use this data and prevent the damage. A project (Baranwal et. al. 2016), focuses on attacks of rodents and insects on agriculture products and security and protection mechanism for this.

1.4 Shaping Agriculture Using IoT

IoT have increased the production in the farms to a great extent. Below given are some benefits of IoT that has shaped the agriculture.

1.4.1 Large Amount of Data Collection by Agriculture Sensors

Data related to weather, progress of crops growth, quality of soil, cattle health etc are collected by smart agricultural sensors. Sensors can also be used to keep track and monitor the condition of the business, efficiency of equipments, staff performance etc.

1.4.2 Low Production Risk and Better Control Over Internal Process

We can plan for better product distributions by forecasting the output of production and quantity of crops going to harvest and are being able to make sure that product won’t lie about unsold.

1.4.3 Cost Management and Waste Reduction

By knowing any defects in the crops or health of livestock, it is likely to diminish the risks of losing the yield.

1.4.4 Increase Business Efficiency Through Process Automation

By using smart devices and multiple processes, the manufacture cycles are automated like irrigation and pest control.

1.4.5 Enhanced Quality and Volumes of Product

Best control and high standards of crop is achieved over the production through automation.

1.5 Requirements for Developing Smart Farming Solution

There are many use cases for IoT in agriculture. Farm's performance and profits can be increased by many ways. Before investing in smart farming, there are many challenges that needs to be consider.

1.5.1 Hardware

An IoT solution for agriculture is build by choosing the sensors for the device. The choice of sensor depends on the kind of data in order to be collect and the reason of the solution. In any case, success of the product depends on the quality of the sensors as it will decide the precision of the collected data and its consistency.

1.5.2 The Brain

Data analytics must be and is at the centre of every smart agriculture solution. The data collected is of no use if its sense cannot be made. Thus, there is a need of great data analytics capabilities with predictive algorithms to get actionable insights on the data.

1.5.3 Maintenance

Preservation of the hardware is a big challenge and is of primary importance. Thus, it desires to make sure that hardware is robust and maintainable. Else, it needs to be replace the sensors. Ultimately the maintenance cost and time will be increased

1.5.4 Mobility

Smart farming must be customized and accessible remotely using smart phone or desktop computer.

1.5.5 Infrastructure

A solid internal infrastructure is needed to make sure that the smart farming performs fine and to make sure that it can handle the data load. The internal infrastructure should be secure. Failing of security of the system will increases the likeliness of thieving the data.

CONCLUSION

This chapter demonstrates the background and applications of IoT and how IoT have changed the farming and agriculture process . IoT, Smart farming and its applications like precision farming, agricultural drones, crop water management etc are demonstrated. IoT enabled agriculture has helped to bridge the gap among the production, quality and quantity yield. The future is moving towards the smart ideas with improving the technologies, instruments and replacing with smart applications (Automation) with the invention of Internet of Things. Farming is the major source for the survival in this world. The Farming is also wearing foots towards these smarter technologies with newer improvements to increase the productivity with in short time.

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Chapter 10
Smart Agriculture Services Using Deep Learning, Big Data, and IoT (Internet of Things)

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ABSTRACT

The internet of things is believed to have long-lasting effects in both technology and modern society. In a modern information society, IoT can be seen as a global infrastructure that enables more advanced services by connecting physical and virtual devices and things to currently existing and even upcoming information and communication technologies. IoT takes advantage of identification, data capture, processing, and communication capabilities of modern technology to allow regular machines to provide new data sources to applications, which in turn can offer more advanced services. In terms of ICT technologies, IoT adds any thing communication to any time and any place. An increase in technology also leads to the development of smart agriculture. This chapter deals with the different electronic sensors used for the smart agriculture like soil moisture sensor, node MCU, water flow sensor, relay, water pump, solar system. The next section deals with big data in smart agriculture.

INTRODUCTION

Computer and internet have advanced from huge corridors and government disconnected structures first to average citizens' family units and during the most recent 10 years even to people's pockets[1]. This degree of access to innovation in technology allows individuals to share and interact whatever, at every point and

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nearly any place they are. The following phase of this innovative technological progression and innovation is known as the Internet of things (IoT) and it tends to be seen beginning to show up wherever in infrastructure from family units and corporate workplaces offices to even vehicles and open, public regions[2]. The Internet of Things is believed to have long lasting effects in both technology and modern society. In a cutting edge data information society, IoT can be viewed as a worldwide foundation infrastructure that empowers further developed administrations by interfacing physical and virtual electronic devices and things to as of now existing and in any event in communication technologies, up and coming data and correspondence advancements in the ongoing presence, truly outstanding and natural advances scaling imaginative innovative heights statures and making a standard scale is the Internet of Things (IoT)[3].It is certainly the chance of advanced digital communication that has modified things of valid mankind into more intelligent, smarter electronics devices. In India, unfortunately, farmers despite everything utilize ordinary conventional techniques of farming supervision prompting inputs wastages and close to the ground production due to loose kinds and measurements of water use to the field which relies on soil examination and plant give in. Water system forms are as old as people since agriculture is the most exceptional control of non-military personnel mankind and need to change water system innovation[4, 5].

The fundamental objective of this book part is to overcome the recently referenced tribulations by arranging, planning an automated water system framework structure grounded on the possibility of IoT and to give a brilliant and reasonable answer for a rancher for keeping up their harvest wellbeing other than yield. We have considered the grain crop like rice since water is fundamental for the development and advancement of rice plants. Improvement of the idea of IoT with sensor technology and the close solar planetary system is an inventive and future pattern in the agriculture documented fields. Watering enormous areas of plants is a troublesome difficult task and necessities of an automated system framework to decrease human exertion in irrigation. So as to overcome this issue, numerous water system arranging strategies have been created dependent on soil, yield and climate checking. Irrigation system planning relies upon how much water is utilized during a water irrigation system [6]. The water system control and monitor the route toward modifying the capacity of Hydrogen (pH), temperature and dampness of the earth soil. The keen, smart and computerized automated water system is a farming procedure and flows cultivating strategy that has been extensively developed in made countries to assemble the troubles of the growing interest in nourishment food supply. In this book chapter comprise the utilization the idea of a dashboard, it works by means of HTTP convention and by utilizing this idea we can turn ON/OFF water motor pump farmland[7]. Here author has discussed some of the importance of Big Data and Deep Learning in Smart farming . Later in the below section you will came to know about the application and different Deep Learning architecture are available for the smart farming in agriculture, big data section describe the application and tools, characteristics of big data in agriculture .

SMART AGRICULTURE

Agriculture from the earliest starting point, agriculture is a pivotal piece of human society because of the truth that man and agribusiness are legitimately identified with one another. This reality leads towards the headway advancement and upgraded enhancement of the ordinary, improper and tedious time-consuming systems methodologies, utilized for agriculture-based agribusiness. The fast-moving world, new patterns and innovative progression has changed the way of life of individuals. Developing new advances are turning into a significant piece of schedule. Smart homes and grids planned urban areas, smart campus and smart farming is a portion of the entire progressed and redesigned, data and correspondence advancements that are helping people to spare time and get quicker and aureate results[8]. Smart agriculture can be composed of these main paradigms;

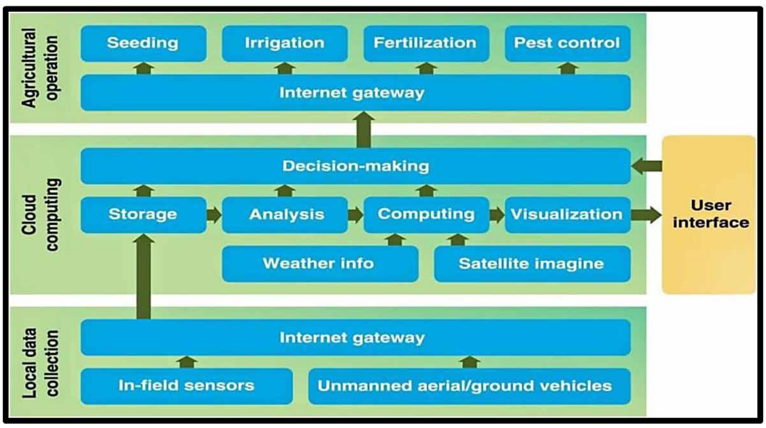
1. Smart Consumer
2. Smart Farmer
3. Smart farms

The smart consumer keeps an eye on the online access, for any end client to get data identified with the profitability, productivity, especially from the consumer electronics from the farms. This includes web-based interfaces like, web site, mobile application and information bases in the form of databases and online storage of information, etc. The opposite side of the smart customer is the smart farm side for the production and growth of the food. It is the fundamental hub from where the farmers can straightforwardly connect with open market, with no additional costs and contribution of outsider third party. Any homestead farm-based agriculture management framework can be utilized to deal with these outside exercises. This central hub is then associated with the smart land farms, which suggests and deployed sensor for the dampness, humidity, climate, water system management, data warehouse management for the data obtained in the sensors, animals in the farms, checking the requirement and recognition of pesticides[9, 10].

Agriculture is backbone of countries economy. Crop, tree and plant-based agriculture growth is imbalance due to lack of proper climate as per farming schedule as per myth. But where proper climate as per farming schedule, there is also growth imbalance. This is due to improper monitoring of farmland where farming is done.

Many scientific methods are deployed to solve and overcome this problem, but not fruitful results. Because scientific method is limited to solve the health of crop, tree and plant via providing fertilizers depend upon the testing of soil health parameters of that particular farmland. But we are not getting the updates on regular basis or at instant. Using the deployment of technology like sensor and embedded system and concept of IoT (Internet of things), gaps could be bridged among farming problems. The paper introduces the concept of IoT and summarizes applications in the modern crop growth, quality, breeding and health status of farmland monitoring with using IoT to focus on irrigation control system using Internet of Things. The IoT innovations can be grouped into three classes: information assortment or data collection, cloud-side data analysis, and decision making and IoT-based agriculture assisted operations(Mottaleb et al., 2016).

Figure 1. Architecture of IoT in Agriculture

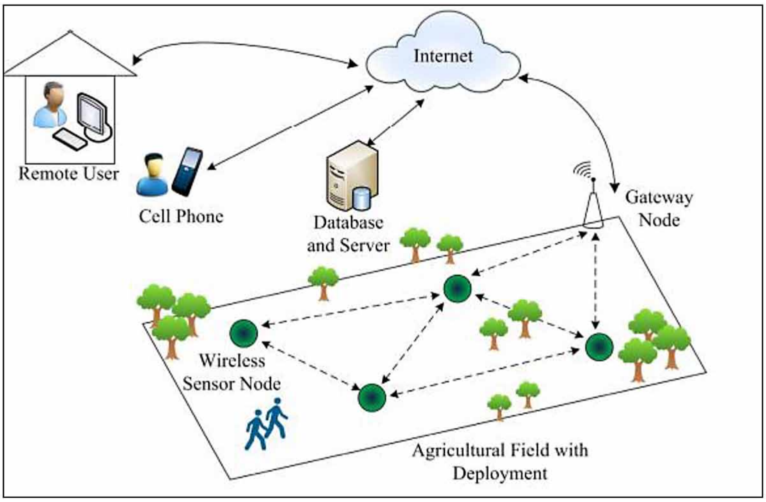


The Irrigation is one of the major issues find in agriculture mostly in developing countries. Like, in India, and the economy is for the most part contingent on the agribusiness yet because of isotropic state of the atmosphere, the farmers are not able to make full use of the agriculture resources. The main reason is the lack of rainfall and the discharge of the reservoir water. Continuous extraction of ground water causes the degradation of water level, so soil land comes in slowly in the un-irrigated areas(Burrough, 1986; Burrough, 2015; Vlotman et al., 2020). A significant explanation behind this is the sudden utilization of water that causes noteworthy water utilization. The most significant bit of advantage of current dribble/drip water system frameworks is that water is moving toward the root zone of plants, which assists with sparing to loss of water. In any case, right now, are utilizing water irrigation system conspires physically to irrigate their farm's lands at normal intervals of time. This process sometimes consumes more water or sometimes delays water supply that might be damage the crop. Water deficiencies can be destructive to crop before the noticeable shrivelling occurs. Moderate development rate, lightweight fruitfulness has been seen because of the absence of water. This problem can be totally dispensed with if the farmers utilize an automated programmed water system framework utilizing a remote sensor deployed with the help of a wireless sensor network(Burrough, 2015).

With the emergence of the Internet of Things (IoT), billions of electronics devices will be connected and managed by wireless networks powered by some specific energy sources. A large portion of IoT-based applications in agribusiness is intended for various applications across the different part of the world. For an example, IoT are utilized to screen the condition of nature through soil sustenance nutrition information data to predict plant wellbeing and item quality. IoT measures the water system arranging through soil Hydrogen (pH), temperature, dampness, moisture and climate weather checking and engineering of IoT based Automated Irrigation System utilizing the idea of a dashboard s are utilized to screen the condition of nature through soil sustenance nutrition information data to predict plant wellbeing and item quality. IoT measures the water system arranging through soil Hydrogen (pH), temperature, dampness, moisture and climate weather checking and engineering of IoT based Automated Irrigation System utilizing the idea of a dashboard is shown in figure(Singh et al., 2014). Cutting edge innovations can carry advantages to most of the individuals. In the ongoing years, the IoTs has started to assume a significant job in everyday lives, stretching out our observations and capacity to change the earth around us. Especially the agro-modern and natural fields apply IoTs in both diagnostics and control. Also, it can give data to the last client/shopper about the root and properties of the item. Along these lines, this examination intends to apply IoTs for PC supported the improvement of the water system in the farming field and major focus for paddy crop.

The water system of paddy crops is one of the significant issues found in farming for the most part in developing nations across the world. There are varieties of conventional paddy crop irrigation systems that have been followed from the ancient times. For illustration, in flow-based irrigation system the water resources like tanks or reservoirs are positioned at great heights. The flow of water is automatically downward when it is connected to the tank or reservoir. These categories of irrigation are regularly used and beneficial in plain areas. The other class of water system is a lift-water system where the harvested crop fields are arranged at a more elevated level than the water resources. The harvested crop field is flooded by lifting water from wells, tanks, waterways, water rivers utilizing the electrical water system pumps. At the present time the underground water is also pumped to irrigate the crop field using electrical

Figure 2. Real time implementation of IoT in Agriculture



water pumps. To improve conventional irrigation methods, there has been a lot of water system frameworks created utilizing progressed and intelligent innovations that help to decrease crop squanders, forestall exorbitant, crop waste, and rare/excess watering to crops and in this manner increment the harvest yield. This issue can be totally dispensed with if the farmers utilize a programmed and automatic intelligent water system framework utilizing sensors based IoT correspondence framework for the communication. For an example, IoT correspondence system is utilized to screen the condition of nature through soil nourishment data to anticipate plant wellbeing and item quality. IoT gauges water system arranging through soil Hydrogen (pH), temperature, dampness, and climate observing and design of IoT based Automated Irrigation System utilizing the idea of a dashboard based system. Above figure 1 illustrates the application of IoT communication system for agriculture. The quantity of sensor node signified by green circles is conveyed in the horticulture documented fields. This node sends the signals and communicates with one another through remote connections. The client at the remote place can control the conveyed sensor nodes through the utilization of cell phone, PC\laptop and so forth for a model, in the event that when the water level surpasses as far as possible then the client can turn OFF the water motor pump through a mobile phone or any other mobile device.. Basically, the designed IIS experimented on the paddy crop (rice) because sufficient supply of water is essential for growth and development of rice plants.

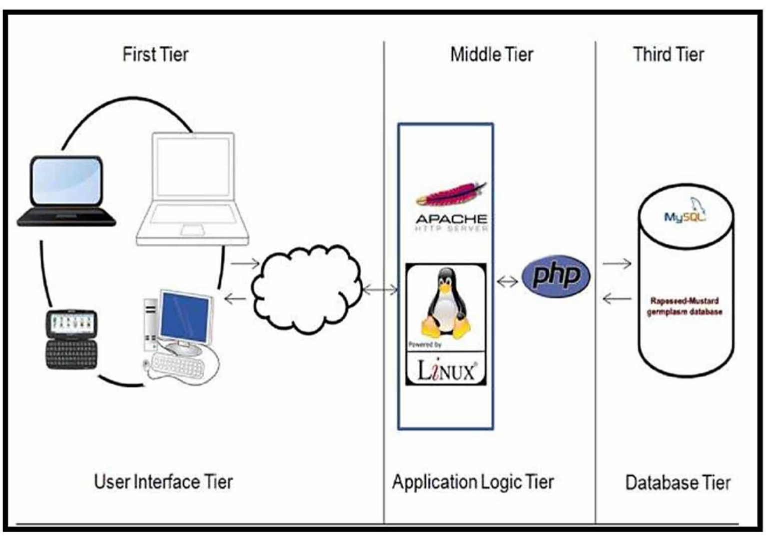
IMPORTANCE OF IOT IN AGRICULTURE

Some advantages of using IoT in agriculture are given below:

- Water Conservation.
- Increased Production.
- Increased Quality of Production.
- Lowered operating Costs.
- Improved Livestock Farming.
- Reduced Environmental Footprint.
- Real-Time Data and Production Insight.
- Remote Monitoring.
- Remote Controlling Sustainability.
- Food safety.
- Increased crop and food quality

The IoT innovations can be grouped into three classes: information assortment\ collection, cloud-side information investigation, and dynamic and IoT- assisted agriculture operations(Welbourne et al., 2009).The coming time of the IT prepared world will supplant conventional techniques with brilliant, effective and feasible agribusiness systems(Welbourne et al., 2009).

Figure 3. The Three tier Smart Agriculture distribution
(Kumar, 2013)

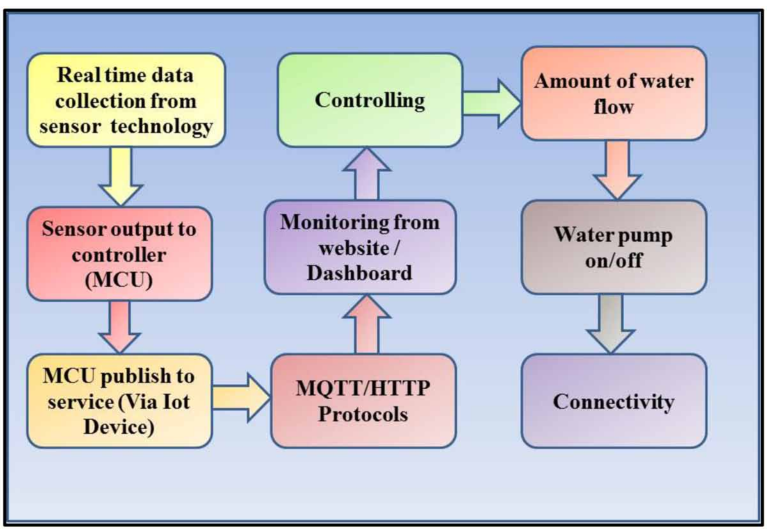


MATERIAL AND METHOD USED FOR THE IMPLEMENTATION OF SMART AGRICULTURE BASED IOT SYSTEM IN FARMS:

For the smart farming some material system, application software like Operating System Windows/Linux is used. Front end development was done through the HTML (Hyper Text Mark-up Language) and for the data parsing is done thought the PHP (Pre-Process Hypertext). For the physical implementation of the smart agriculture based system is done with the help of Node MCU (Micro Control Unit), ESP8266 Wi-Fi, Soil Moisture Sensor FC-28, Water Flow Sensor YF-S201, Relay electromagnetic switch, Solar panel unit.

For the development of deep learning based method in smart agriculture various steps were followed to reach the conclusion. For each step, a research plan was created, that customized to our needs and these steps involved Problem Formulation, Collection of data, Selection of sensors, and Development of framework system structure for monitoring and implementation of structure for real time monitor and control and notification about abnormality in the environment for smart agriculture based system.

Figure 4. Flow chart for the smart agriculture based system



In controlling part, first off the client can turn ON or OFF water-pump from anyplace (all-inclusive). In farmland, where the framework/system is introduced, there ought to be access of the Internet through a hotspot or Wi-Fi network. Besides, client can screen measure of stream of water, as indicated by that he/she can turn on/off the engine of farmland. Third, the client can likewise screen dampness substance of soil, it will assist the farmer with taking a legitimate choice according to his cultivating experience and dependent on sort of harvests/plant. Some plant/crop need extreme soil implies low water substance and some need free soil implies more water content. These kinds of parameters rely upon crop/plant classifications and the structure circuit chart of the proposed model is yielded figur4.

Hardware:

To execute this model, we are going to utilize the idea of software programming and electronic gadgets equipment/hardware which is following:

- Real Time Data Collection
- Soil moisture sensor
- Node MCU
- Water flow sensor
- Relay Water pump
- Solar System

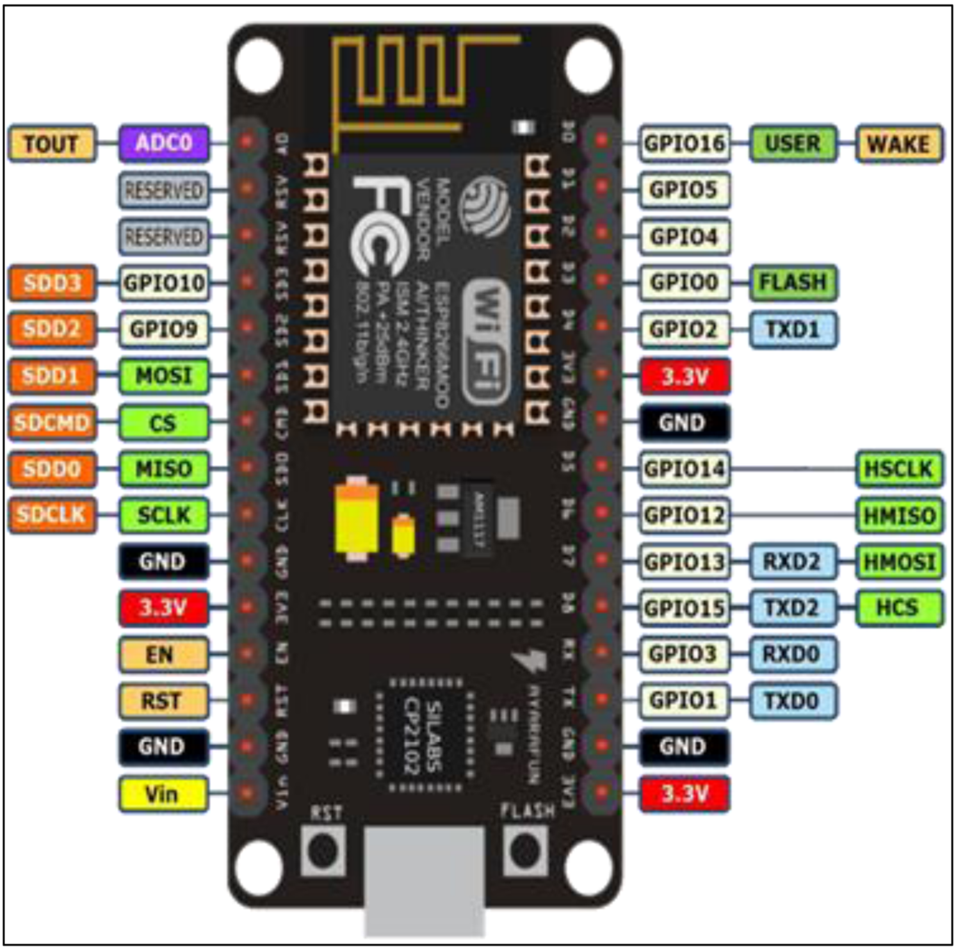
Node MCU

Node MCU is an open source-based firmware created for ESP8266 Wi-Fi chip. By investigating usefulness with ESP8266 chip, Node MCU firmware accompanies ESP8266 Development board/pack, for example, NodeMCU Development board. Since Node MCU is an open-source stage, their equipment configuration is open for edit/modify/build.. Incorporating Sensors and Peripherals with Microcontrollers is known as Node MCU and it is utilized to get information from sensor or to offer signals to control water pump. It contains Wi-Fi shield itself to impart remote through RF wave, it needs a hotspot to network connectivity. The figure of Node MCU is shown in the figure 5.

Soil Moisture Sensor

Soil moisture sensor gauges the volumetric substance of water inside the dirt and gives us the dampness level as yield. The sensor is outfitted with both simple and advanced yield, so it tends to be utilized in both simple and computerized mode. Figure6 shows the diagrams of Moisture Sensor.

Figure 5. Node MCU

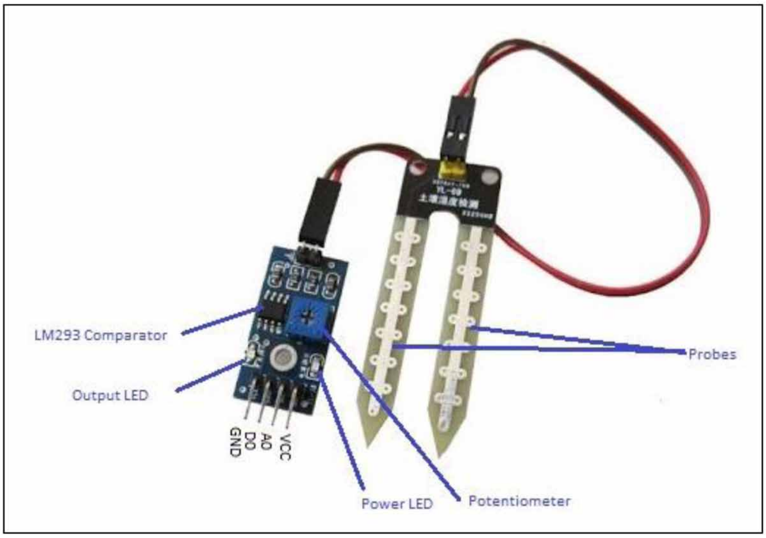


Working of Sensor

The soil sensor moisture comprises of two tests which are utilized to quantify the volumetric substance of water with in the field. The two tests permit the current to go through the dirt and afterward it gets the opposition incentive to measure the moisture value within the soil.

When there is more water, the soil will coordinate more prominent force which suggests that there will be less obstruction. Thusly, the soil moisture level will be higher. Dry soil conducts power incapably, so when there will be less water, by then the earth will coordinate less power which infers that there will be more impediment. Therefore, the moisture level will be lower. This sensor can be related in two modes;

Figure 6. Soil Moisture Sensor



Analog mode and automated mode. In the first place, we will interface it in Analog mode and a short time later, we will use it in Digital mode.

Specification

The specifications of the soil moisture sensor FC-28 are as follows:

- Input Voltage: 3.3 – 5V
- Output Voltage: 0 – 4.2V
- Input Current: 35mA
- Output Signal both Analog and Digital
- Pin Out – Soil Moisture Sensor

The soil moisture sensor FC-28 has four pins:

- VCC: For power
- A0: Analog output
- D0: Digital output
- GND: Ground

The Module additionally contains a potentiometer that will set the limit worth and afterward this edge worth will be looked at by the LM393 comparator. The yield LED will illuminate and down as indicated by this edge esteem threshold value.

Water Flow Sensor

Viable water the executives includes providing water as indicated by the genuine necessity, and along these lines estimating water is a fundamental advance in water the executive's management system. There are many water stream estimation strategies just as various kinds of water flow meters used to measure the volume of water stream in pipelines however these all are excessively expensive and cannot be used as a domestic scale. This article portrays thoughts for structure and improvement of ease programmed water stream meters, with the assistance of promptly accessible and minimal low-cost effort water flow sensors.

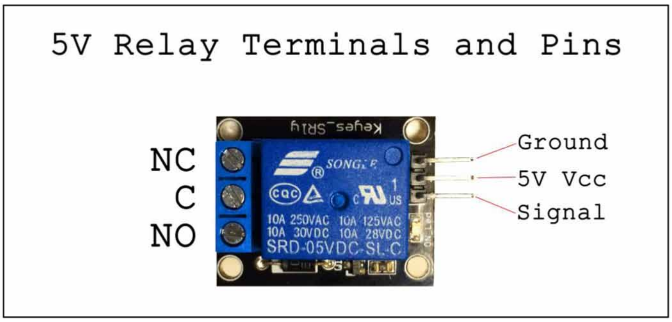
Figure 7. YF-S201 Hall-Effect Water Flow Sensor

Exact stream estimation is an essential development both in the arrangements of the provision in emotional subjective and money related points of view. Stream meters have exhibited heavenly contraptions for evaluating water stream, and now it is definitely not hard to build water the official's system using the celebrated water stream sensor YF-S201. This sensor sits as per the waterline and contains a pinwheel sensor to measure how much water has gone through it. There is a coordinated attractive Hall-Effect sensor that yields an electrical heartbeat with each revolution. The "YFS201 Hall Effect Water Flow Sensor" comes with three wires: Red/VCC (5-24V DC Input), Black/GND (0V) and Yellow/OUT (Pulse Output). By tallying the beats from the yield of the sensor, we can without much of a stretch compute the water stream rate (in liter/hour – L/hr) utilizing an appropriate change formula. Figure7 shows the complete layout of water flow sensor.

Relay Electromagnetic Switch

A relay is an electrically operated switch that can be turned on or off, letting the current go through or not, and can be controlled with low voltages, like the 3.3v/5v provided by the Node MCU pins.

Figure 8. Electromagnetic Relay Switch



The relay will do on-off to water siphon when hand-off will get signal from hub MCU from the dashboard by means of web-internet availability. The figure of the relay is given in figure 8. A relay transfer is an electrically worked switch that can be turned on or off, discharging the flow through or not, and can be controlled with low voltages, similar to the 3.3v/5v gave by the Node MCU pins.

Solar Panel for Electricity

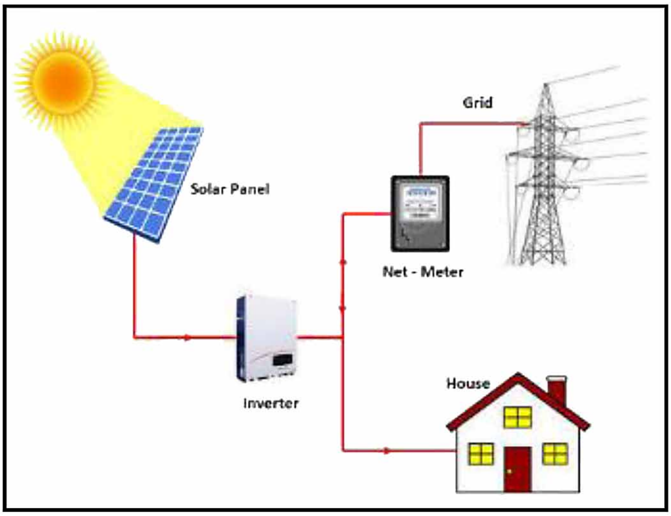
Sunlight based solar board utilizes the sun oriented light to create DC power and produced power relies on a rating of sun oriented solar plates. Figure9 speaks to the close planetary system and created DC power is put away in the battery by means of charging circuit or coordinated to the inverter. The inverter converts DC supply to air conditioning supply since the old water pumps are comfortable and working with AC supply. To implement this system, we need hardware that is following: -

- Solar plates
- Charging kit
- Battery

- Inverter

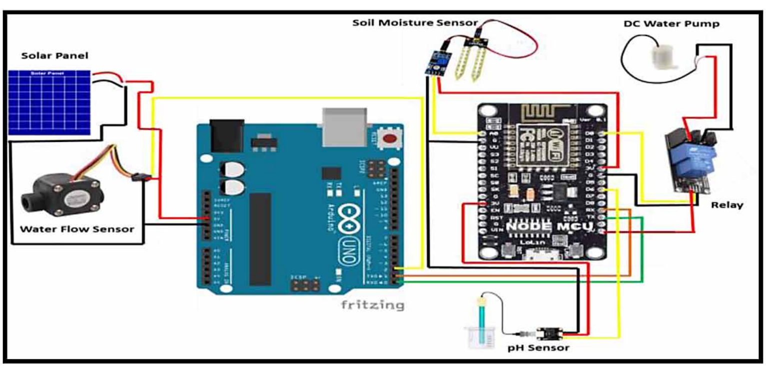
These sorts of parameter rely up upon crop/plant classes and the structure circuit outline of proposed model is given in figure 9.

Figure 9. Working of Solar Panel System



Above figure speaks to the circuit outline of the proposed model and the portrayal of circuit diagram are given as:

Figure 10. Circuit Diagram of Smart Agriculture based system



- For the smart agriculture-based monitoring system are using IoT technology through which we can measure the flow of fluid in ml and moisture content of soil.
- The information pin of the water stream sensor is associated with Arduino (pin no 2). This pin peruses the information of the sensor and transmits the information to Node MCU utilizing Serial correspondence by means of Rx-Tx.
- The information pin (analog) of the soil moisture sensor is associated with Node MCU (A0 pin) and the DC water pump by means of transfer is additionally associated with the D0 pin of Node MCU. The Node MCU peruses the information from all the associated gadgets and transmits all the information on the server via wired or wireless transmission.
- PH sensor is providing pH value and passing to node MCU.
- As we know, with the assistance of Node MCU we can send or/and get information on the server. As fluid streams from the stream flow sensor, we are sending a determined fluid stream say (1000 ml) to the server. We are likewise sending the soil moisture content to say (0%) to the server.
- As a result, we receive the moisture content of soil as well as the status of motor (ON/OFF).
- When the water stream rate is inside the range that is 1000, the water motor will turns 'On' and past the scope of stream rate that is more noteworthy than 1000, the water motor will be turned 'Off' consequently depending upon the soil moisture.
- The solar system utilizes the sunlight-based light to create DC power; power relies on the rating of sun oriented solar system plates. What's more, DC power is put away in battery through charging circuit or coordinated to inverter. The inverter converts DC supply to air conditioning supply since the old water pump is alright with air conditioning supply.

Phase 1: Connection Establishment and Data Reading in Smart Agriculture

- All sensor nodes are deployed and connect with main node of network.
- If the association is accessible, the main central hub sends data packets to every sensor node contain the ID of sensor node.
- The sensors start estimating the qualities in the wake of accepting the data parcels, the deliberate soil parameters esteems like: Soil moisture value (%) Acidic or alkaline value (pH value).
- The sensors measured the values, these values stored in the hardware memory (MCU).

- Depending on these put away qualities the MCU reacts with explicit activity as indicated by the conditions expressed beneath states.
- At that point, the MCU sensor node transmits the data packets remotely to the fundamental hub with the idea of IoT.

Phase 2: IoT Application

- The main node gets ID and data from each sensor node and sends the information packets to the server via dashboard concept.
- The server stores the information packets in it's a database.
- Finally, the data is shown on the information site and associated electronic devices.

BIG DATA IN IOT BASED SMART FARMING

The smart agriculture farming were structured this for water management in paddy crop. Water is essential for the advancement, growth, and improvement of rice plants(Verma, 2020). Be that as it may, consistent flooding brings about a lot of inefficient water surges through dissipation, drainage, and permeation. Developing proof demonstrates that persistent flooding is pointless for the rice to accomplish significant returns, which, in any case, depends on transient preliminaries. Long term field water conditions would create significant changes in soil properties, which may additionally influence soil water protection and harvest yield. Nonetheless, barely any examinations have been directed on long term field preliminary. In this way, there is little data on water utilization, crop yield, and water profitability after long haul appropriation of the water-sparing water system. The used dashboard of proposed model is given in the figure9 s represents the water requirement of smart agriculture at different growth stages and different pH of soil(Delgado et al., 2019).

Smart farming highlights the use of the IT (Information Technology) and communication for the betterment of farm management cycle. In computer science development of new technologies like cloud computing and internet of things has strengthen and use of artificial intelligence and robotics in the smart farming(Verma, 2020). This can lead to the arise of the concept of big data in the agriculture. The huge measure of information with a wide variety can captured through the sensor deployed in the field and used for the decision making analysis. The machines used in the smart agriculture are equipped with the sensors for the measurement of the data in the environment and for the machine behaviour. e.g. thermostat regulatory mechanism for temperature control to deep learning algorithm for the crop protection strategies, linkage of device to weather, market data to external big data resources(Delgado et al., 2019).

Big data requires diverse arrangement of techniques and technologies to reveal out the insight form the dataset that are diverse complex and massive in scale(Hashem et al., 2015). Information assets like volume, variety, velocity, veracity, are the key factors in the big data and require the big data analytical method for the transformation of data into the value(De Mauro et al., 2016).

Use of Big Data in Smart Agriculture

As smart machines and sensors crop up on farms and farm data grow in quantity and scope, farming processes will become increasingly data driven and data-enabled. Rapid developments in the Internet of Things and Cloud Computing are propelling the phenomenon of what is called Smart Farming Smart Farming is a development that emphasizes the use of information and communication technology in the cyber-physical farm management cycle. Innovation in technology like, the Internet of Things and Cloud Computing are relied upon to use this turn of events and present more robots and artificial intelligence in cultivating agriculture farming. This is enveloped by the phenomena of Big Data, gigantic volumes of information with a wide variety that can be captured, analysed and utilized for dynamic decision making(Wolfert et al., 2017).

Big Data technologies are playing an essential, reciprocal role in this development: machines are equipped with all kind of sensors that measure data in their environment that is used for the machines' behaviour. This varies from relatively simple feedback mechanisms (e.g. a thermostat regulating temperature) to deep learning algorithms (e.g. to implement the right crop protection strategy). This is leveraged by combining with other, external Big Data sources such as weather or market data or benchmarks with other farms. Due to rapid developments in this area, a unifying definition of Big Data is difficult to give, but generally it is a term for data sets that are so large or complex that traditional data processing applications are inadequate. Big data requires a set of techniques and technologies with new forms of integration to reveal insights from datasets that are diverse, complex, and of a massive scale. Big Data represents the information assets characterized by such a high volume, velocity and variety to require specific technology and analytical methods for its transformation into value figure11. The Data FAIRport initiative emphasizes the more operational dimension of Big Data by providing the FAIR principle meaning that data should be Findable, Accessible, Interoperable and Reusable. This also implies the importance of metadata i.e. 'data about the data' (e.g. time, location, standards used, etc.). Both Big Data and Smart Farming are generally new ideas, so it is normal that information about their applications and their suggestions for innovative work in research isn't broadly spread. A few creators refers to the appearance of Big Data and related innovation in technology as another innovation publicity that may neglect or failed to materialize, others consider Big Data applications may have passed the 'peak of inflated expectation' in Gartner's Hype Cycle(Delgado et al., 2019; Verma, 2020) .

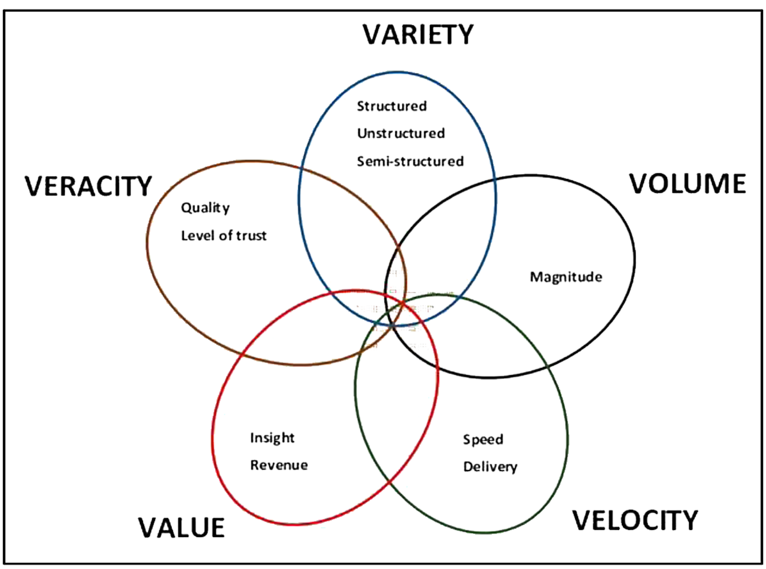
Here in this section of Big Data in smart farming provide insight into the cutting edge of Big Data applications in relation to Smart Farming and to identify the most important research and development challenges to be addressed in the future. However, technology is changing rapidly in this area and a state-of-the-art of that will probably be outdated soon after this book chapter is published. Therefore the analysis primarily focuses on the socio-economic impact Big Data will have on farm management executives and the whole network around it because it is expected that this will have a longer lasting effect(Alexander et al., 2017).

Big data requires a set of techniques and technologies with new forms of integration to reveal insights from datasets that are diverse, complex, and of a massive scale. Big Data represents the information assets characterized by such a high volume, velocity and variety to require specific technology and analytical methods for its transformation into value.

Factors on which big data analytics are changing the way of smart farming:

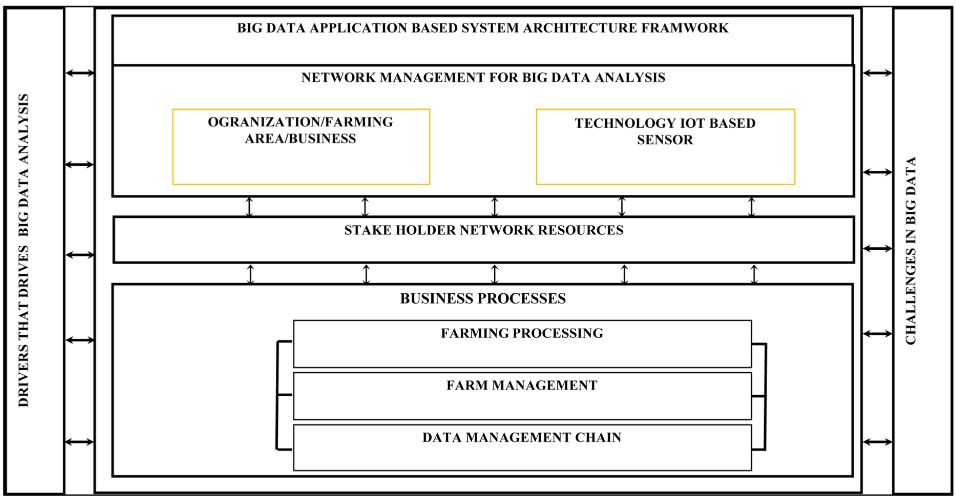
- Increase in the productivity and innovation in case of smart farming.
- To check and keep eye on managing environmental changes.

Figure 11. 5v's of Big data diagram
(Anuradha, 2015)



- To provide the cost saving opportunity and business development for the smart farming.
- Big data for the better supply and management of crops.

Figure 12. Big Data Supply Management System
(Lazzarini et al., 2001; Ngo et al., 2019)



Application of Big Data in Smart Agriculture:

- Yield prediction
- Risk management
- Food safety and spoilage prevention
- Sensing and monitoring
- Analysis and decision making
- Intervention
- Precision Farming
- Operation equipment management

Yield Prediction

The use of the mathematical model to analyze the data from chemical supplied in the farms, weather, leaf, biomass index in the environment and other feature associated with the farming are took into the consideration for the yield prediction. Technologies like machine learning/deep learning is used for the automated prediction form these data sets. By using some these methods we can allows farmers that what to plant, where and when to plant the crops. This use the sensor for the data collection and a little manual work is required for the best return from the farmer's crops. Yield prediction can improve the production of the crops in the countries like India China, Russia where the population increase is a measure concern(Bhosale, 2018).

Risk Management

Risk management is one of the areas which need more concern and influenced by the connected electronic devices and algorithms. Due to abnormal weather condition and some other condition risk management needs to be done. With the help of big data technologies it is possible for the farmers to evaluate or avoid the chance or crop failure and to improve the chance feed efficiency with in the production of stocks(Keating et al., 2010; Wu et al., 2014). e.g. In 2014 the data scientist of International Centre for Tropical Agriculture(CIAT) and Columbian rice growers saves million by predicting not to grow rice in the season with the help of risk management model for the weather pattern change(Vermeulen et al., 2012).

Food Safety and Spoilage Prevention

In modern days food safety is also a major concern, in modern- day farming instinct detection of microbes and incident of contamination is important. The instant food which is infected with the microbes need to be identified(Nukala, 2015). In farms the collection of data points for the crops like humidity and temperature and some chemical changes for the prevention and it makes a good picture of health in the smart agriculture farming business. Early detection will lower the repair bills and can be used to reduce some of the wastage of crops (Aung & Chang, 2014; Nychas et al., 2016).

Operation Equipment Management

For the better and more production in the farms various equipment were used. So it is important that the equipment are working properly. As the technologies grows the companies provide the more robust solution for the equipment management and some supply chain operations thus in a not so distant future, we can expect the much smoother conveyance of harvests crops in the market. e.g. Companies like John Deere are start using the sensors in their vehicles for the capturing of the data. With the help of web portals farmers can login and they can check the current position of soil and some maintenance of equipment so that the downtime is reduced and everything is productive(Mauser, 2015).

Smart Sensing and Monitoring

Remote Sensing (Drones or Satellite), Sensor, Global position system units, Hand held tools and weather stations are capturing the real time data from the surrounding environment for the crops and farms . Captured data is being analyzed by the Big data engines which provide the information to the stakeholders and further action is taken around the agriculture ecosystem. Via doing the optimization of crop seasons, bottleneck elimination of market and farmers, intervention in the crops at real time data analysis, identification of needs for the crops and done through the big data and can be solved with the help of smart sensing and monitoring tools.

Smart Analysis and Planning

Big Data tools embed with the artificial intelligence base algorithm enables all the associates to influence the smart analysis and planning to make and data-driven decisions. The data is collected from the different data point which could be the real-time farm data as well the off time farm data is available due to advances in Big data and AI. E.g. with the help of image processing techniques we can identify the plant or soil and with the help of machine learning technique we can improve the supply chain data so the products are reaching faster to the consumer. Via using GPS we can do the transit of better planning of logistics form storage to facility area and analysis of historical data reduce the losses and helps in the smooth cash flow so that the best type of crops to be planted.

Smart Control and Automation

Big data enables the real time basis of smart control and automation is facilitation. Use of big data technique with the help of the drones, farms-bots (chat bots for information) and use of intelligent sprinklers is done through the smart control and automation. E.g. spray of crop protection chemical and nutrients with the help of drones at the precise or needed area in the crops. To remove weeds with the help of lasers and automated weeders on the farms with the help of robots. In irrigation system provide more food per drop of water, and the use of self driving or moving of heavy machinery in the farms.

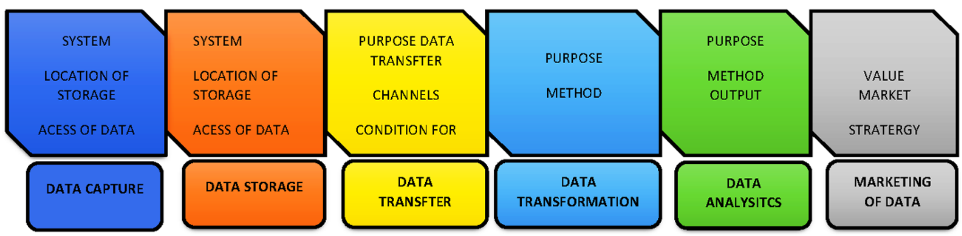
Precision Farming

The earth population is approaching 8 billion and it is estimated the global food production is increased by 60% till 2050. So in order to provide the food for the population scientist were working on the concept of precision farming in which the use of big data combination with the machine learning and deep learning based algorithm provide the solution for the specific crops. Sensors were capturing the data and the tools convert the hyper spectral data into some information which further analyzed with AI and hybrid cloud solution. With this solution farmers can optimize the land use, and increase the agriculture efficiency which could be termed as the precision farming(Bendre et al., 2015; Carolan, 2017). e.g.: plant genomics enables the agriculture scientist to use the big data to make the plant grow faster, stronger and more resistant to disease in different environment. NRGene, a cloud base genomics data solution which provide the application for the plant(Monat et al., 2019).

Issues Related to the Big Data Application in Smart Farming

As there is the advancement technology many corporate house engaged with the big data and smart farming, different start up were grown and start providing the solution to value chain supply and form the infrastructure, lay down of IoT based sensors and software's which manages all the data streams in all the agriculture farms .

Figure 13. The Big Data Application chain management system for smart farming based systems
(Chen et al., 2014)



There are different issues that are faced during the smart farming and agriculture are as follows(. & Chintala, 2020; Coble et al., 2018) see figure 13 and figure 12 describes the details of Supply Management Chain in Smart Farming:

1. **Data Capturing:** The availability of data, quality and data format is one of the key problem that comes when deployed sensors stream the data in different format. The alternative solution like Biometric sensing, open data platforms, data captured by multiple devices.
2. **Data Storage:** As the devices release the data of different plants in the farms we need some solution to quick storage and safe, cryptographic access to the

data. Cloud based platform like Hadoop distributed file system (HDFS), cloud based storage and hybrid storage system are available.

3. **Data Transfer:** Due to heterogenicity/diversity of the data generated from the plants it become difficult to transfer, automation and data preparation and cleansing. We need to develop some of the machine learning algorithm to normalize the data, visualize and anonymize the heterogeneous data from farms.
4. **Data Analytics:** We have heterogenicity of data obtained from the sensors thus Semantic heterogenicity and real time analysis is important in case of smart farming like over watering or overexposure of plant in light or manures thus Real-time analysis along with the scalability is major issue, thus yield models, and concept of cognitive computing comes into play.
5. **Data Marketing:** Once the crop is developed next comes the concept of marketing and selling out this crops into the market at the appropriate price in order to get the profit. Thus development of such kind of solution is needed and for that we need the tools for the visualization of the data for analysis and other decision support system algorithms

DEEP LEARNING IN AGRICULTURE

Smart farming is significant for handling different difficulties and challenges of horticultural/agriculture for production, for example, efficiency, natural environment effect, food security, manageability and sustainability(Tyagi, 2016). As the global population is growing continuously, a large increase of food production must be achieved. This must be gone with the assurance of natural biological ecosystems by methods for utilizing manageable farming techniques. Food needs to keep up a high nutritional dietary benefit while its security must be guaranteed the world over. In agriculture farming has seen various number innovative changes in the most recent decade, getting more industrialized and innovative technology driven. To address these challenges, complex, multivariate and unpredictable agricultural ecosystems need to be better understood. This would be accomplished by checking, estimating, investigating, analysing, and measuring different physical perspectives and phenomena, consistently. The deployment of new information and communication technologies (ICT) for small-scale crop/farm management and larger scale ecosystem observation will facilitate this task, enhancing management and decision-/policy-making by context, situation and location awareness. This means use of Internet of Things (IoT), Cloud Computing (CC), Big Data (BD) and automation to gain better control over the process of farming. As the utilization of these advancements in technology in farms has developed exponentially with gigantic data in information production, there is have to create and utilize best in class tools/software so as to acquire understanding from the information gathered from the crop within the reasonable time period. The term Deep learning (DL) constitutes a modern technique for image processing, with large potential. Deep Learning/Machine Learning computer algorithm have been successfully applied in various areas, it has recently also entered the domain of agriculture(Kamilaris & Prenafeta-Boldú, 2018a).

In this section of book chapter we are going to discuss and learn about the initial understanding of various machines learning algorithm like Artificial Neural Network (ANN), Convolution Neural Network (CNN), the recent architectures of state of-the-art CNN and their underlying complexities. Other than the previously mentioned strategies, deep learning is a cutting edge approach with much potential and accomplishment in different areas where it has been utilized. It belongs to the research area of machine learning and it is similar to ANN. However, DL constitutes a 'deeper' neural network that provides a hierarchical representation of the data by means of various convolutions(Kamilaris & Prenafeta-Boldú, 2018b). This permits better learning abilities as far as catching the full complexity of the real-time assignment task under study, and in this way the prepared and train a model that can accomplish higher grouping classification accuracy. The current overview looks at the issues that utilize a specific class of DL named convolution neural systems (CNN), characterized as deep, feed-forward ANN. Convolution Neural systems extend the old style ANN by including more 'profundity depth in terms of layers' into the system, just as different convolutions that permit data representation in a progressive hierarchal manner and they have been applied effectively in different visual image related issues(Zhu et al., 2018). The inspiration for setting up this study originates from the way that CNN have been utilized as of late in horticulture and agriculture, with developing growing ubiquity and success, and the way that today in excess of 20+ research effort is going on that utilizing CNN exist for tending to different farming issues in smart farming. As CNN comprise presumably the most well known and generally used algorithm in agriculture research today, in issues identified with image analysis, the current study centres around this particular sub-set of DL models and strategies. Here we introduce the technique of CNN, as a promising and high-potential approach for addressing various challenges in agriculture related to computer vision. Besides analysing the state of the art work at the field, a practical example of CNN applied in identifying missing vegetation based on aerial images is presented in order to further illustrate the benefits and shortcomings of this technique(Gikunda & Jouandeau, 2019).

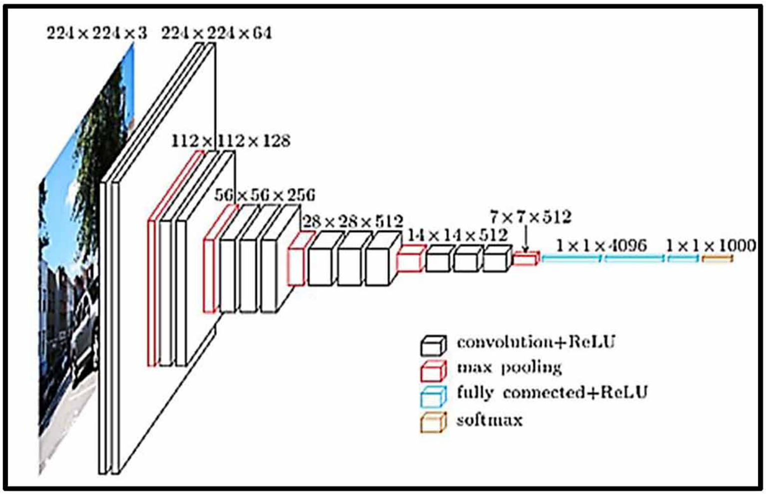
In machine learning, CNN constitutes a class of deep, feed-forward ANN that has been applied successfully to computer vision applications .In contrast to ANN, whose training requirements in terms of time are impractical in some large-scale problems, CNN can learn complex problems particularly fast because of weight sharing and more complex models used, which allow massive parallelisation(Christiansen et al., 2016) . Convolutional neural networks can increase their probability of correct classifications, provided there are adequately large data sets (i.e. hundreds up to thousands of measurements, depending on the complexity of the problem under study) available for describing the problem. They comprise of different convolutional, pooling and fully connected layers. The convolutional layers go about and act as feature extractors from the input pictures/image data whose dimensionality is then decreased by the pooling layers, while the fully connected layers go about as classifiers. For the most part, at the last layer, the FCC layers takes the mid level feature and exploits the high level image features learned, so as to classify the input pictures features into predefined classes(Bu & Wang, 2019). The profoundly hierarchical structure and large learning limit of CNN models permit them to perform classification and expectations especially well, being flexible and versatile in a wide assortment of complex difficulties and challenges(Zheng et al., 2019).

Convolutional neural networks can receive any form of data as input, such as audio, video, images, speech and natural language, and have been applied successfully by numerous organisations in various domains, such as the web (i.e. personalisation systems, online chat robots), health (i.e. identification of diseases from MRI scans), disaster management (i.e. identifications of disasters by remote-sensing images), post services (i.e. automatic reading of addresses), car industry (i.e. autonomous self-driving cars), etc(Coulibaly et al., 2019).

An example of CNN architecture displayed in As the figure14 shows, various convolutions are applied at some layers of the network, creating different representations of the learning data set, beginning from more general ones at the primary, first layers and getting more explicit at the more deeper layers. A blend of convolution layers and dense layers will in general present great precision results(Magomadov, 2019).

There exists different 'successful' popular designs architecture which scientists and scientist may use to begin constructing their models as opposed to beginning without any scratch. These include AlexNet, the Visual Geometry Group VGG Google Net and Inception-ResNet. Each architecture has different advantages and scenarios where it is used more appropriately It is also worth noting that almost all the aforementioned architectures come with their weights pre-trained, i.e. their network has already been trained by some data set and has thus learned to provide accurate recognition for some particular problem domain. Common data sets used for pre-training DL architectures include ImageNet and PASCAL VOC(Zheng et al., 2019).Table1: describes the CNN based different architecture used in the smart farming and agriculture . Table2: gives the information of where the deep learning based architecture used in agriculture for more details follows the table2.

Figure 14. CNN based framework for classification
(Gikunda & Jouandeau, 2019)



Moreover, there are various tools and platforms that allow researchers to experiment with DL The most popular ones are Theano, TensorFlow, Keras (which is an Application Programming Interface (API) on top of Theano and TensorFlow), Caffe, PyTorch, TF Learn, Pylearn2 and the Deep Learning MATLAB Toolbox. Some of these tools (i.e. Theano, Caffe) incorporate popular architectures such as the ones mentioned above (i.e. AlexNet, VGG, Google Net), either as libraries or classes(Gikunda & Jouandeau, 2019; Zheng et al., 2019).

CLASSIFICATION AGRICULTURE ISSUES IN THE PLANT (FIGURE15):

There are many deep learning solutions are developing for the agriculture and depending upon the different agriculture, smart farming. The current figure shows that how CNN is used in the smart farming in the various domains. In general CNN based some of the smart farming problem was solved there are as follows:

- In case of plant management includes the production of crops and their welfare like plant species classification, detection of disease or pest on crop, and the concept of yield production.
- CNN based solution for the livestock management, animal welfare like identification, detection, pest control and disease

Table 1. Different type of Deep Learning (DL) Frame work used in different Agriculture Purpose for classification via training DL model

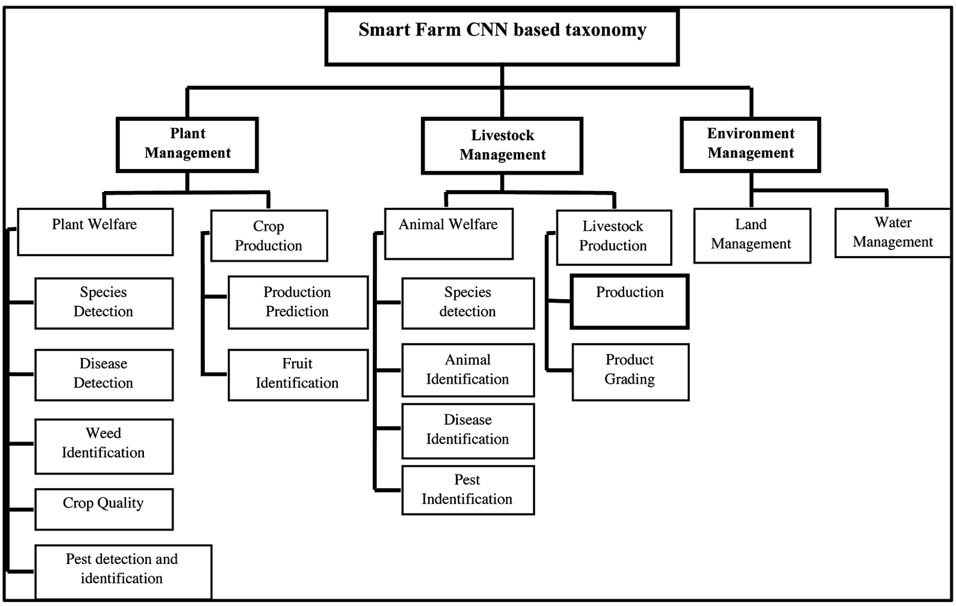
Sr. No	Deep Learning Architecture	Summary
1	**LeNet**	LeNet-5 is a seven layered architecture proposed by LeCunn. This architecture is used to classify the handwritten digit postal numbers address and each image is composed of 32*32 grey scale images.
2	**AlexNet**	AlexNet is similar to the LeNet-5 based architecture which includes the more filters. Instead of using Tanh (Hyperbolic Tangent) Function, AlexNet use the Rectified Linear Unit (Relu) function. AlexNet performs best are compare to LeNet in LSVRC challenge and reduce the error rate from 26.2% to 15.3%. It used the overlap pooling to reduce the size of network and error up to 0.4% top-1 and 0.3% top-5 error.
3	**NIN**	Network in Network is based on the GOOGLENET. NIN use the nonlinear multilinear perceptron instead of linear filters, as a result they obtain better feature extraction and accuracy. FCC (Fully Connected Layer) were replaced by the activation maps and use the concept of average pooling as a result parameter and network complicity is reduced.
4	**ENet**	Efficient Neural Network was given by Paszke and it is used for the running on low power devices like mobile phone. It is based on the ResNets architectures.
5	**ZFNet**	ZFNet was created by the Zeiler and Fefgus and this network won the 2013 ILSVRC image classification challenge. It reduced the top-5 rate up to 14.8% and uses the concept of MaxPooling for the down sampling.
6	**GoogleNet**	GoogleNet is 2014 ILSVRC challenge winner and inspired form the LeNet and based on the novel inception module, which calls and performs a series of convolutions and simultaneously collects the results also. It uses the different kind of filters like (1*1,3*3,5*5) and performs the max pooling .
7	**VGG 16, VGG13, VGG11,**	VGG16 were created by the Zisserman and Simonyan and took place second after the GoogLeNet in the competition. It is composed of 16 Layers of convolution with many filter layers. Thus it has many different architectures like VGG13 (13 layer), VGG11 (11 layer) . VGG16 get up 8.8% of error rate.
8	**ResNet**	Residual Neural Network was developed by the Kaiming, and it introduces a novel model to add the shortcut connections which gives the network a residual vision. Thus residual function is an refinement which tells us that how a network learn and adjust the input features for the high quality of feature within the image. it has 152 layers and having a low complex city than VGGnet and achieve an error rate of 3.57%.
9	**DenseNet**	This network is the logical extension of the ResNet and is the improved version of the network. In this network for the input the feature maps of the previous layer were used and reduce the gradient problem among all the networks.

(Gikunda & Jouandeau, 2019)

- Solution like environment management in greenhouses, land, water management in the crop field of greenhouses.

DISCUSSION

Figure 15. The proposed taxonomy for the use of CNN algorithm in various domains in smart farming
(Gikunda & Jouandeau, 2019)



Internet of things is an emerging technology used world-wide in the various domains. Integration of information technology with other fields makes it easier to understand and we got the more information regarding the domains. Computers and the internet have made their way from large halls and government secluded buildings first to common people households and during the last 10 years even to people's pockets. This level of access to technology lets people share and interact whatever, whenever and almost where-ever they are. The next stage of this technological advancement is called the Internet of things (IoT) and it can be seen starting to appear everywhere in infrastructure from households and corporate offices to even cars and public areas. The Internet of Things is believed to have long lasting effects in both technology and modern society. In modern information society, IoT can be seen as a global

Table 2. Application of Deep Learning algorithm CNN in Smart Farming

Sr. No	Problem Description	CNN Framework Used for Classification	Accuracy Obtained on the Data Set	Data Set Used for Classification
1	Automated Plant Disease Detection and diagnosis based on early symptoms	Deep ResNet	0.78% – 0.87%	Image data set of 8178 images
2	Fruit Counting and sorting	Inception-ResNet	0.91%	Image Data of Fruits 24,000
3	Detection and categorizing the criticalness of Fusarium wilt of radish based thresholding colour features.	GoogleNet		image data set 1500 images
4	Classify weed form the crop species	VGGNet	0.8620%	Image data set of 104013 images
5	To identify Pig Face	VGGNet	0.9607%	1553 image data set
6	Banana disease classification	LeNet	0.9600%	3700
7	To predict no of tomato in an image	GoogleNet + ResNet	0.91% - 0.93%	24,000 images
8	To identify the winter wheat and barley images from the dataset	DenseNet	0.9700%	4500 image data set
9	Leaf Disease Detection	CaffeNet	0.9630%	4483
10	To detect and identify the crop species and disease in crop	AlexNet + GoogleNet	0.9935%	54 306 images
11	Identifying obstacles in row crops and grass	AlexNet	0.999%	437 images
12	To identify different plants	AlexNet	0.4860%	91579 image data set
13	Recognize different plants species from the data set	AlexNet	0.9960%	Data set of 44 different classes
14	Detection of sweet Pepper and rock melon fruits	VGGNet	0.838%	122 images
15	Fruit Detection	VGG Net	0.904	

(Kamilaris & Prenafeta-Boldú, 2018a)

infrastructure that enables more advanced services by connecting physical and virtual devices and things to currently existing and even upcoming information and communication technologies. IoT takes advantage of identification, data capture, processing and communication capabilities of modern technology to allow regular machines to provide new data sources to applications, which in turn can offer more advanced services. In terms of ICT technologies, IoT adds Any Thing communication to Any Time and Any Place.

The procedure used to implement an automatic irrigation in India is done in a customary way which is financially luxurious and loose bringing about minor profitability and misfortunes in manures. In this paper, an automated irrigation system for agriculture monitoring using IoT communication is proposed. We have analysed our implemented model is effective and accurate and having a very fast response time. Due to this advantage, the proposed model becomes a better model than existing model based on the IoT. We use the concept of a dashboard, which is operates based on the http protocol and by using this concept we can turn on/ off water pump of farmland and monitor parameter like moisture and water flow amount using the IoT.

This research work involves the use of the IoT in the field of irrigation system in which there is a development of the fully automated system for water irrigation and monitoring system for the crops in the farms. The research work comprises of the two phases one phase involve the development of the front end for the turning OFF and ON for the water pump situated remotely via mobile device and the second phase involve the development and deployment of the custom hardware for the monitoring of water level, moisture level, and pH in the farm. In custom hardware is assembled in house and further after coding the microcontroller unit, pH sensor, for the general and specific crop is done. In the current has been done into the consideration for the general specification of crop further it is extended to the specific crop like rice or wheat. We have gained a good result while testing the model in the real time fields. The proposed model work accordingly and when the water level is low it sends the notification to the applicant mobile phone and then give the button to turn on and off the water pump motor.

Big data is one of the emerging field of computer science and this technology is widely used in almost all the domains . Thus in agriculture is has its own importance in smart farming. As the IoT Devices sends the data to the mainframe system we need such a solution to store, sort and analyse this data to get the meaning full information, thus Big data technology like HADOOP comes into play and we can get the result more faster than the other methods. Thus big data has a huge impact in the domains of smart farming.

Today world everything get smart and intelligent also, this has been done with the use of artificial intelligence in the systems . Due availability of data and computing power we can train the model based on the problem and use these models to predict the future of that problems, thus in case of smart farming lot of work has been done by the deep learning, here in the book chapter we have seen many application which use the deep learning algorithm like CNN for the prediction of various disease thus in future we see new agriculture problems which were solved by the use of deep learning algorithms.

FUTURE RESEARCH DIRECTIONS/ SUMMARY AND CONCLUSION

The present study entitled “Smart Agriculture Services Using Deep Learning, Big Data and IoT (Internet of Things)” was carried out at Jaypee University of Information Technology Solan Himachal Pradesh. The summary of the findings is as under:

- India is a developing country on which more than 70% of the village population is depend upon the irrigation system. Framing is one the main resource of the earning. Use of internet of things is getting popular day by day in the agriculture industry.
- Lot of research work is going on this area and lot of software; tools are developed for the irrigation-based system monitoring. Although the developed tools and software are working properly but there is no such tool available for the specific crops and integration of the solar panel in the microcontroller unit is done first time.
- Via using the internet of things in the irrigation we got the following observation like water conservation. The developed method will reduce the wastage of water in the farms. There is increase in the production rate of crop.
- There is an improvement in the production of livestock for the farmers. Using such kind of the technology in the fields of farming may reduce the carbon foot print on the earth and helps in the environment to reduce environment foot print.
- The current IoT based system can be handled remotely one can check the current status of the water level, moisture level and the available pH in the farm remotely. So, this can reduce the time and effort of the farmers.
- The IoT based system for the smart farming can increase the productivity of the farmers and helps to understand the betterment of crops, at what time what the plant needs, thus better understanding and crop yield increase.
- As the IoT sensor deployed they streams the data to the central nodes and then the data is transmitted to the central based servers there the big data analytics take place which helps the farmers, scientist, researchers to get the information about the plants and how to manage the crops .Thus big data analytics provide the better decision support system to different stakeholders who are involved with the crop management system . Hence there is increase in the crop chain management system.
- Deep learning is used in every field in which we predict the future of the problem based on the previous data sets via using some learning algorithms. Thus, in the case of smart farming we can use deep learning in various domains, we can increase the accuracy of prediction via adding new data set

of that problem, or we can develop new models that predict the disease more accuracy. With the help of deep learning helps to take the better decision in case of smart farming, thus near future we see a lot use of DL in agriculture.

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KEY TERMS AND DEFINITIONS

Big Data: It is a term widely used for the unstructured data. People generally confused that what is big data, in simple term when we have lot of data of different kind of some particular problem we can say that its big data for example: crop data of rice plant it include all the aspect of rice like amount of water needed, time period, fertilizer requirement, height, width, etc.

Deep Learning: A sub branch of Artificial intelligence in which we built the DL model and we don't need to specify any feature to the learning model . In case of DL the model will classify the data based on the input data.

IoT: Internet of things. It is an interdisciplinary field who is associated with the electronics and computer science. Electronics deals with the development of new sensors or hardware for IoT device and computer science deals with the development of software, protocols and cloud based solution to store the data generated form these IoT devices.

Machine Learning: It is again a sub set of AI in which we classify the data with the help of input data set, ANN, SVM, Random Forest are some of the algorithm used in this case.

Chapter 11
An Analysis of Big Data Analytics

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ABSTRACT

In the development of the advanced world, information has been created each second in numerous regions like astronomy, social locales, medical fields, transportation, web-based business, logical research, horticulture, video, and sound download. As per an overview, in 60 seconds, 600+ new clients on YouTube and 7 billion queries are executed on Google. In this way, we can say that the immense measure of organized, unstructured, and semi-organized information are produced each second around the cyber world, which should be managed efficiently. Big data conveys properties such as unpredictability, 'V' factor, multivariable information, and it must be put away, recovered, and dispersed. Logical arranged data may work as information in the field of digital world. In the past century, the sources of data as to size were very limited and could be managed using pen and paper. The next generation of data generation tools include Microsoft Excel, Access, and database tools like SQL, MySQL, and DB2.

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1. INTRODUCTION

In the development of advanced world, information has been creating each second in numerous regions like Astronomy, Social locales, Medical fields, transportation, web based business, logical research, horticulture, video and sound download. As per an overview, in 60 second, 600+ new client on YouTube and 7 billions of queries are executed on Google. In this way, we can say that the immense measure of organized, unstructured and semi organized information are produced each second around the cyber world which should be managed efficiently. Big Data conveys properties such as unpredictability, 'V' factor, multivariable information and it must be put away, recovered and dispersed the data.

Logical arranged data may works as information in the field of digital world. In past century the source of data so as to size are very limited which could be managed using pen paper. The next generation of data generation tools includes Microsoft Excel, Access and database tools like SQL, MySQL, and DB2 etc.

Now a day's, Advancement in Telecommunication and computation Technology are led on exponential growth and availability of data. When the data are increasing exponentially, parallel to it emerges many relative issues e.g. security, management, timeliness, incompleteness, Human collaboration, data Analysis skill.

2. LITERATURE REVIEWS

2.1 Need of Literature Review

The need of literature review is to overview the concepts, relations, cases and understanding the subjects to micro and macro level. Our chapter has been allowed to explore and review more literature part by part. Literature has been divided into different domains as (i) Big Data Analytics, (ii) Smart City, (iii) Water Management and (iv) Combinations of domains.

2.2 Literature Review

2.2.1 Big Data and Applications

Manish Kumar Kakhani, Sweetie Kakhani (2013) spoke about the basic concept of big data. The number of data is increasing continually in what percentage and area. What's the current & future research area expected in big data. They also spoke about big data in other fields of analytics. They're also mentioned about the tools and techniques the big data industry uses. The diverse possibilities of big data applications and how to manage, store, process and analyze big data were also discussed .

GuJifa, Zhang Lingling(2014) explained about the DATA, DIKW, Big Data, and Data Science relationship. The authors explained how information can be derived from small / big data, and it can be translated into knowledge and used with wisdom. It has gathered various meanings of big data and data science identified by different users.

Sampada Lovalekar (2014) defined Big Data definition, and how it varies from conventional data. They highlighted the problems and opportunities associated with big data. How various tools such as NOSQL, HADOOB and other HADOOB based projects are useful in big data research and management.

Amir Gangoti, Murtaza Haider (2015) identified academics and practitioners ‘ concepts & characteristics of big data. The paper also commented on analytical techniques (text, audio, video, social media & predictive analytics), statistical methods used for structured and unstructured data and characteristics, i.e. quantity, velocity and variety etc. The real-world data processing is not feasible for big data on a wide scale.

Justin Grimmer (2015) has clarified how machine learning and Big Data techniques operate on social media data. They defined data-generated behaviour, parameters by commenting on social media by users, watching, status, like, and these huge information can be used by Big Data and Machine Learning Technique, and useful information derived from it .

Cheikh Kacfah Emani, Nadine Cullot, Christophe Nicolle (2015) highlighted the concept of big data, tools and techniques such as Hadoop, Map reduces their problems and challenges in many fields such as business management, IT sector etc. 5 Vs of big data is defined in Hadoop feature and other tools handle high volume & data variety and produce useful information. Big Data tackled every aspect of its management to allow major changes.

2.2.2 Healthcare

Mentioned by Aisling O’Driscoll, Jurate Daugelaite etc (2013), there was a lot of difficulty in analyzing and processing Geomantic Data in large quantities. As in the beginning, it was very difficult to store and process significant quantities of signal (Peta Byte) and digital data in one place. They also identified cloud computing and big data technology, such as Infrastructure as a Service (IaaS), Software as a Service (SaaS), and Platform as a Service (PaaS) technologies.

J.Archenaa, E.A.Mary Anita (2015) talked about how healthcare & govt sector impacts on BDA, and how healthcare treatment improvements. In the government sector, big data often need to show consumer quality education. They also proposed

DFS architecture for stable BDA enabling Linux environment where the device itself provided access control.

Rashid Mehmood, Gary Graham (2015) discussed Big Data approach to the issue of care in the medical industry. They suggested a model that could have data load balancing capability that could solve the question of demand and supply in smart city. They worked on the technique of network planning and time shearing control, using Markov process, operational management technique to share Smart City's Ambulance-related problem. They also discussed the potential reach of the same model in the sector of Bike Shearing, Manufacturing Industry and Waste management.

2.2.3 Information Security

Nir Kshetri (2015) described the use of big data as having an impact on the business associated costs, benefits and externalities. Author explained the characteristics of big data and business welfare and data collection, storage, sharing and accessibility relationships. It should have made it possible for consumers to be known about the concept of providing merchant with their information than it might be misused. Yet most organizations have not developed a good practice to safeguard consumer data privacy. It is also described in social & economic prediction about the cost of benefits and the external side of big data.

Gang Chen, Sai Wu, Yuan Wang Explained about the Netease system for information security. Developed a real-time analytical system to support spam detection, game log analysis and Netease social mining. Initially, it explained about offline Hadoop system that was useful when the burst of complaints arrived from the customer in a specific time and secondary, online streaming system for Netease is described. They highlighted the number of big data issues such as increasing data size, more complex user requirements to handle, new hardware requirements, performance issues, failure recovery issues, etc., so that new processing system for big data management is required and analyzed with security.

B.Saraladevi, N.Pazhaniraja etc. (2016) described the problems of big data and security. They suggested some security and algorithm-related approach that could enhance Big Data security. On Hadoop's distributed file system, security approaches were applied, first user was able to access the correct data block, secondary blue eye algorithm providing node-to-node security and checking team attack. Name node approach reduced coaches for future references on the server. They cherished resolving certain issues in HDFS on the name node and data node.

By using QC, GA and pair hand protocol, Vijey Thayananthan, Aiiad Albeshri(2014) proposed a method & security technique and key management in mobile data centers. This paper also described how data center & users are transmitting mobile data. It is also proposed that symmetric key and cipher should be used to secure and protect privacy. They explained the quantity cryptography used in the proposed model for big data security, authentication handover and pair hand authentication protocol. The overall paper description was to achieve security & privacy and deal with data traffic in mobile data centers with the help of QA, GA and pair hand authentication.

Raissa Uskenbayeva, Abu Kuandykov (2015) illustrated data integration model using new technology that supports data storage, data integrity, query executing operation, machine data from different sources. These new tools & techniques are more potential and account for timely statistics compared with traditional ones. The author combined' R' with steaming system, Rhive and RHadoop for data set processing. For best results such as ROBDC, RJBDC and Rhive, it has suggested combining other data analytics techniques & Hadoop Project.

A, Vinay s. Shekhar (2015) described different fields of Face Recognition. The methodology proposed was based on techniques from the cloud and ANN. Method used network traffic between user interface and cloud over multi-level security solutions. By applying highly patented extreme learning machine technology, the FR Framework was designed for the task of Face tapering in social networking system like Facebook. This technology could also relatively easily give Face chrome authentication and access control.

2.2.4 Social Media

Gemma bello Orgaz, Jason jung (2016) has described big data's challenging role in social media. They talked with Big Data.sa author about uses of Hadoop, Mahout, and other tools, and proposed a method that helps to store, access, and retrieve information from real-data .

Peter O'Donovan, Kevin Leahy, Ken Bruton (2016) explained the use of Big Data Technology in smart technology in manufacturing. They also used Internet of Things (IOT), machine learning techniques to build new smart production without wasting extra time and money. This paper also contained some questioner that could solve some of the problems that occurred in the manufacturing industry during research.

Azza abouzeid, described by Kamil bajda (2015), Hadoop DB, whose parallel database system was capable of achieving similar sources of fault tolerance and the ability to operate in a heterogeneous setting. Author explored both parallel database and map technology to reduce system for fault tolerance & parallel database and performance & efficiency.

2.2.5 Smart City

M.Mazhar Rathore, Anand Paul, Awais Ahmad, Suengmin Rho (2015) used IoT-based system and Big Data Analytics to illustrate the scope of smart city development. A complete system, consisting of various sensors and systems such as smart home, vehicle networking, weather & water sensors, etc. as an object, is proposed and a4-tier architecture in which each tier performs a specific task is proposed. Tier 1 was responsible for data generation and collection, Tier 2 was responsible for communication between sensors and base station, Tier 3 was responsible for data management and processing using Hadoop & shark and last Tier 4 was responsible for data analytics and this type of system generation is more useful for future enhancement of smart city decision making and development .

Rob Kichen(2013) illustrated how cities, using digital devices and infrastructure, would become smart cities by generating huge amounts of big data. These data allow to analyze city life in real time, new phase of governance etc. This paper was on the implications of big data on smart urbanization help in city planning .

A. Merchanta, and M.S. Kumarb Mohan, P.N. Ravindrac, and P. Vyasa, and U. Manohard (2013) used analytical approach to attempt and things real time case study of Bangalore city water problem. To solve the problem they used SCADA, GSM, Flow Meter, Pressure Meter and SQL Database Software. This was a theoretical approach in which ultrasonic flow meters were established at every critical point in the city and at the time measured water flow rate, and showed differentiation between present reading and previous reading. GSM Modem transmitted this data and it was stored on SCADA system in SQL Database. The current reading will be sent to the applicant after analysis and calculation, and will also be stored on server for future use. For this architecture security is identified as a major problem, without proper security data being misused .

A. Candelli1 & F. Archetti (2014) proposed an approach based on the analysis of urban water data in time series and implemented support vector machine for urban water demand forecast. The author had identified typical day-to-day urban water demand, seasonal demand and area-wise urban demand that helped to forecast urban water demand. They collected individual customer smart meter data and tackled big data analytics techniques on them. In smart city this approach may have helped save water and costs. The proposed approach was runnable in a distributed and parallel system .

Jason Shueh (2014) illustrated the impact of Big Data on government sectors with different authors ‘ approaches in the article. Author describes that Big Data Analytics is a technique that is very useful in future citizen demand prediction and other things .

Steve French, Camille Barchers and Wenwen Zhang (2015) outlined how big data might be used in urban planning and decision-making. This paper discussed the suitability of big data for short-term management applications and identified the factors whose use for longer-range planning had been limited. Data Visualization, Data Analysis techniques were described to represent a graph, table, map showing a better solution to the problem of urban utility requirements .

Mark Leinmiller and Melissa O'Mara (2016) spoke about smart water needs in smart cities. The big problem that smart city has faced was demand, and supply is not equal. Smart meter and other sources generated data are not properly stored and maintained for future use. Incorporating smart water technologies enabled water suppliers to minimize Non-Revenue Water (NRW) by quickly and even predicatively finding leaks using real-time SCADA data and comparing that to model network simulations.so, the main aim of this article was to reduce energy load by shaving, maintaining machines and other things in smart cities .

2.2.6 Water Management

This article discussed the scope of big data which can solve problems related to water. Smart water meters generate huge amount of data. High resolution, domestic water consumption data, could help predict daily user water demand in different household sections such as shower, toilet, kitchen etc and predict or predict water wastage, leakage and other things in artificial intelligence system . Piyushimita Thakur, Nebiyou Y. Tilahun etc. (2016) presented a survey on large data applications in urban system fields.it is an urban problem generated by poor data management for rich data management and attempts to solve problems. Commenting on challenges that are likely to arise in varying degrees when using Big Data for Urban Informatics in technological, methodological, theoretical and emerging political economy, the paper concludes .

2.2.7 Demand Prediction

R. J. Sousa, A. Gomes. (2013) addressed how District Metered Areas (DMA) influences nodal demand in different daily water demand patterns, and how it benefits pressure management. Their aim was to relate total cost investment to the given nodal demand and maximum benefits from leakage reductions. They identified demand and total cost of the condition of DMA design pressure, by managing pressure for two phases like before pressure reduction and then after pressure reduction. The author discussed a real case study and used the pressure simulation model to predict hydraulic behavior with different scenarios for the next 10 years and identified variation in total daily water production and reduction using DMA .

K. Thompsona, and R. Kadiyalab (2014) explained the application of M2M technology, Sensor and BDA are in government and private sector. They have described M2M technology such as sensors, smart meters etc. and how they collect and evaluate them to provide better problem solving . Tomasz Jacha, Ewa Magieraa etc. (2015) illustrated a comparative study assessing the performance of the Water Database Hadoop and MySQL. A real-time prototype project was used by the author to optimize water management system and reduce urban water usage. They collected various types of water related data such as user I d, type of record, average daytime temperature etc. They compared Hadoop and MySQL at various levels, such as maximum flow value in the entire data set, maximum pressure in a day, etc., and identified that Hadoop will deliver the best performance in water-related data set and also worked on distributed environment .

Cy Cheung en Martijn Nuijten (2015) showed that Big Data could potentially change the future of the water management system. It showed that not only could big data short analyze water management, it could also have implemented problems in real time. SCADA collects big data, predicting future demands and correcting man-made problems. Results showed that big data in the water industry could be archiving a great future and encouraging lower overall water levels .

John Quality (2015) suggested that the urban water demand (UWD) system requires a task to manage demand and response fluctuations properly at dynamic scale & time, ensuring rational, strategic water system management. A multi-scale approach is proposed-Boot Stack-Extreme Learning Machine (MBELM) approach which addresses issues related to supply system and water resource management. This model was Wavelet refinement-Bootstrap-Artificial Neural Network (WBANN) refinement. They used historical recording of urban water demand and split into temporal scale using DWT, then predicted using ELM technique, and also used bootstrap technique for assessing uncertainty. After forecasting results & intervals for the plot. It showed weekly and monthly quarterly forecasts of water reveling in a London .

DHI Solution (2016) presented Regional Water Distribution System (WDS) functioning. WDS has outdated or static water data information on assets: the biggest problems were slow and wrong emergency response and system maintenance. An online water distribution model with EPANET online water software is adopted, SCADA on monitoring system. Online system, based on data and information, could forecast system-user behavior .

2.2.8 Leakage Management

Archetti, Candelieri & E. Messina (2013) explained innovation approach to improve the process of leakage management through the technique of data analytics and the software for hydraulic simulation. The paper's aim was to reduce the time and costs of managing and intervening assets. They use tools such as SCADA, Customer Information System (CIS), Geographic Information System (GIS) and Hydraulic Simulation tools for an appropriate solution based on the web. The author has worked on case study of Brazil and has demonstrated that the sectoral water distribution system improves the management of leakage in the urban water industry .

Candelieri, D. Conti, F. Archetti (2013) discussed the need for water and the management of infrastructural assets through clustering. They collected data point sets of transformation and consisted of a scenario of leakage and represented them on graph to identify location of leakage on network. Open source R Software is used for algorithm clustering and partition algorithm used in it to identify network leakage. This approach to spectrum was very effective and gave better performance in analyzing the network of leakage localisation. It cuts down on system time and cost .

In. J. Habib, P. N. Marimuthu, S. Kim, Y. Pan (2013) presented Kuwait City's case study for solving water pipeline and management problems. Author worked on 3 different section & where they did statistical analysis of water production, water consumption and water distribution network status in town. They describe discovery of WPN computer network and original WPN network. They were using a smart device such as mobile robots to determine and authorize WPN layout. This integrated proposal has been discovered to help with manual inspection economically, long-term organization and scheduling assistances .

3. BIG DATA

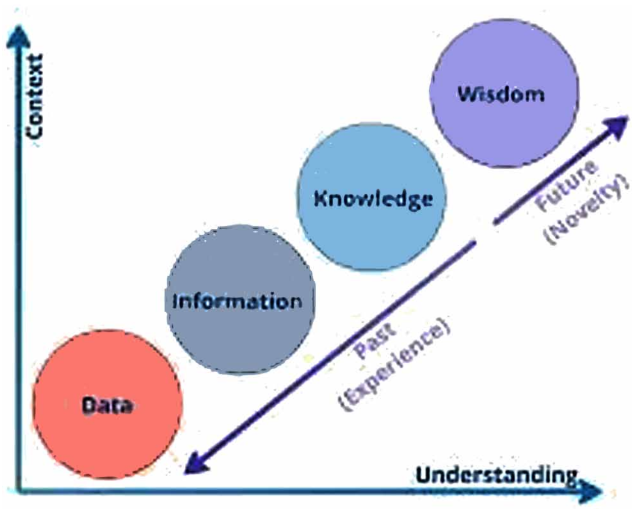
3.1 Data, Information and Big Data

Data is a value & variable those are defining in one sense and uses for other purpose. Data after collection and analysis is known as Information which is used for making a decision.

Figure 1. Data to Conclusion Conversion

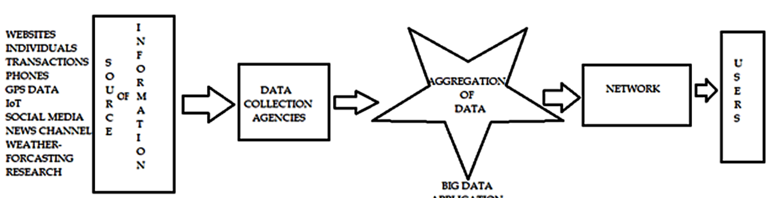
Need of database are to provide a rich set of information to manage, access and update of all available data and it is gradually increasing wrt to data. Now days, organization have released the importance of data for supporting business and decision making, so they keep maintaining data via different sources. Data hierarchy helps us to identify the problem, understand who, what, how and why should do use data for condition.

Figure 2. Journey of Data Hierarchy



In the era of digital technology, every second, many users have been uploading photos on social sites, lots of people search videos on YouTube and many queries run on Google.as data size are increasing like GB to ZB, information retrieving may become comparatively challenging. This void opens the opportunities for new technologies. 'Big Data' is one of the technology among them. It is now a focus point

Figure 3. Supply chain of Data



for researcher and all service manufacturing industries. It needs tools and technique to efficiently process large volume of data within limited run times.

It may divide big data generated sources in to two categories Internal Source and External Source. Internal sources are some activity those are in under control of business like transaction, log data and email etc. These are stored on company own computer and use to managed organizations. External data may currently have owned by organization and generated publicly, and it may have in unstructured and semi structured format. Social media, audio, photo and video are examples of external data sources. According IBM Survey Report Source of Data has been divided in Internal and External Sources. They are following.

Table 1. Data sources

Internal		External	
1.	Search Engine (88%)	1.	Social Browsing (43%)
2.	Log File (73%)	2.	Audio (33%)
3.	Mails (57%)	3.	Multimedia (34%)

Internal data is used in own decision making of organization and it does not mean that is it only generated in organization, but it may be generated by outsiders also. External data are very useful in decision making and forecasting of organization to predict customer behavior, demand and other things. So we can say that both data should play an important role in a organization.

3.2 Properties and Characteristics of Big Data

3.2.1 'V' Factor

Big data is represented by several 'V', whose have been increasing day by day. In 2001, 'Doug lance' present a paper on data management, introduce 3 V's in data, after that according to Nir Kshetri, Mark Lei miller and Melissa O'Mara, Piyushimita, Nebiyou, R. Gomes, J. Sousa, A.sa.Marques, Cy Cheungen (2014) there are many new **'V'** added i.e. 5 V's,6 V's, 8 V's,10 V's, 42 V's and now 100 V's also have introduced in data sets that describe Big data qualities.

1. **Volume:** Volume deals with size or vast amount of data. It can refer as data in rest or Magnitude. The term volume refers to the size. When the data size increases, every time, there are problem from the traditional data base because

the size of data is become double in every 2 sec. So, the big data pool has high volume of data.

2. **Variety:** It refers designed hierarchy of data sets. Data can be in any form i.e. structured, semi structured and unstructured. Variety refers that how many different forms of data is in structure, semi structure and in un-structure format.
3. **Velocity:** It deals with speed of data, the rate at which data are generated, analyzed and action taken on them. The term velocity means the rate at which big data is generated and the speed at which it is manipulated. The term velocity describes the customer last purchase rate, market condition, the customer behavior etc.
4. **Veracity:** Uncertainty in data due to incompleteness and inconsistency, introduce veracity in data. It refers data in drought. Veracity refers to accuracy of data that means, it represents uncertainty of data. For example, an organization needs to ensure that the data is correct as well as the analysis performed on data are also correct.
5. **Variability:** It refers variation in data flow rates.
6. **Value:** It refers to worth of data being extracted. There is huge amount of data, extract valuable information from data based on conditions. The sixth V of Big Data is value, that is all about quality of data and stored them and use in future perspective. For example, a large quantity of data has stored in telecommunication system, so that useful information can extract from all this information.
7. **Visualization:** present data in graphical view which help developer to understand data.
8. **Viscosity:** It is related to velocity that measures resistance to flow in the volume of data.
9. **Virality:** It refers how quickly data spreads in between node to node or people to people network.
10. **Vulnerability:** When size of people personal data increase, they have started feeling that it is being used to pry into their behavior to sell them things by different commercial websites.

3.2.2 Data Classification

There are three types of data in big data technologies.

1. **Structured data:** Structure data are most traditionally data sources. To manage the structure data, we use relational data. It represents only 5 to 10% of all informatics data. E.g. text data excel file etc. Structure data are most

traditionally data sources. To manage the structure data, we use relational data. In RDBMS table to manage the generated data.

2. **Unstructured Data:** Now, the data are in different formats like audio, video, text PDF etc. All those data are considered as unstructured because it doesn't reside in a traditional database or not in tabular or delimiter format. It represents around 80% of data. e.g. satellite image, scientific data, social media data etc.
3. **Semi Structured:** data whose doesn't reside in a relational database but have some organizational properties that make it easier to analyze is known as semi structured data. e.g. XML and JSON are semi structure data. The file is in XML format is considered in semi structure data. big data carries many sources of semi structure data.

3.2.3 Inherent Features

1. **Heterogeneity:** Big data are heterogeneous in nature because it is obtained from different sources and represent information from different sub populations. It requires sophisticated statistical techniques for model creation.
2. **Noise accumulation:** Noise in variables have true effects within the model. Noise for dissimilar parameters could control magnitudes of variables that have true properties in model.
3. **Spurious correlation:** Unrelated variables being found falsely, due to correlation in massive datasets, it generates result of high dimensionality.
4. **Incidental endogeneity:** Independent variables and statistical method used in regression analysis depends on assumptions. It is present in big data.

Table 2. Inherent properties of big data

Features	Big Data	Required Methods
Heterogeneity	Highly Present	Sophisticated statistical methods
Noise accumulation	Some Variable present	Estimating Predictive model
Spurious correlation	Some unrelated independent variable	Simulation
Incidental endogeneity	Highly Present	Regression Analysis

3.3 Difference Between Traditional Data and Big Data

Big Data has become a Big Game Changer in Today's world. The major difference between Traditional data and Big Data are discussed in table 3.

Table 3. Difference between traditional data and big data

Parameter	Big Data	Traditional Data
Queries	Largely SQL	Traditional SQL
Data Type	Structured, Semi-Structured, Unstructured	Structured
Architecture	Distributed	Centralized
Data Modal	Distributed	Fixed Scheme
Data Traffic	More	Less
Data Volume	Petabyte	Terabyte
Data Relation	Unknown	Known relation
Data Integrity	Low	High

3.4 Big Data, Big Data Management and Big Data Analytics

3.4.1 Big Data

"Big Data is a term that describe large volume, complex and multivariable data that requires advanced techniques and technology to store, retrieve, analysis and distribute the information". According to Wikipedia "Big data is a collection of large and complex data sets that become difficult to process using on hand database management tools."

3.4.2 Big Data Management

According to Gu-jifa,zhang lingline in 2014 big data management involves people, policies and technologies in a place to ensure the accuracy, quality, security, maintenance and reliability of huge amount of data sets. It servers data for Analytics and reporting, by applying processes on data i.e. data cleaning, migration, integration and so on. It is a responsibly of Data Chief Officer, Data Manager, Data Administrator, Data Scientist, Developer and so on, to identify policy and approaches in organization to decide which and where information should be stored and placed in organization. Big data management can have categorized in 4 A's i.e. Acquisition, Assembly, Analyze, Action which shown in table 1.4.

3.4.3 Big Data Analytics (BDA)

Big data analytics is a holistic approach that allows to improve data driven decision making. It manages, process and analyze dimension of big data. Gang Chen, Sai Wu, Yuan Wang in 2015 BDA uncover hidden patterns, unknown correlations,

Table 4. 4 A'S in big data management

S.No	A	Process	Output
1.	Acquisition	Filtering Data	Store useful data and raw data
2.	Assembly (organization)	Cleaning Data	Extract actual information from useful data
3.	Analyze	Running Queried Building Algorithm (Data ware house)	Find new insights, improve quality of data, understand semantics
4.	Action (decision)	Efficiently Interpret result from analysis	Given valuable decision to user

trends and other useful information with the help of programing skills, Statistics and machine learning approaches. David Gorbet explains, "Increases in data introduce complexity as biggest challenge, Business across industries have to not only store data but also be able to influence it quickly and effectively to grow business value". It helps organization to harness their data and used it to identify new opportunities. BDA is applicable in every field of life i.e. web & e-trading, telecommunication, government, healthcare, financial and banking and retails.

3.4.4 Big Data Analytics (BDA) Steps

BDA follows basically six steps in decision making. It starts with Problem Identification, identify problem which we want to solve then Designing Data Requirement, why and which type data is useful for problem, followed by Preprocessing Data, it includes data cleaning (remove unwanted data) techniques, then Performing Analytics Over Data, apply machine learning and statistics on data and last Visualizing Data, visualization can be done by any software like R, Tableau etc.

3.4.5 Considerations for Big Data Analytics

Scale, scope and nature provide interesting insight into design and architecture whose impact on hardware and software system.

1. **Hardware Considerations:** According to Raissausken bayeva, Abukuandykov, Young Imcho in 2015big data analytics is performed on huge amount, specifically called as 'hot data' (initially measured or collected), 'cold data' (archival data), 'periodical data' (season, celebrity headlines), 'single file with different versions' (language, format) data. These data access patterns (frequency of how data accessed) can process future memory hierarchy optimizations. Hardware

platform consider compatible storage, process, networking and energy as shown in table 4 for big data analytics applications.

2. **Software Stack:** software system in big data technology are used to optimized (a) scale and accommodate large data set (b) efficiently leverage the hardware platform and (c) Bridge the increasing gap between the growth of the data and computing power. Distributed software system should have the tolerance to become robust after sudden hardware failure. There is problem occur with existing software are consistency, availability and partition tolerance on huge data. To reduce these problems, there are some parameters which help advanced hardware and software solutions in distributed environments.
3. **Big Data Platform:** big data platform is a solution that combines features and capabilities of several big data application and functions within a single result. It contains storage, servers, database, management and other big data management functions.it should be able to accommodate new platforms and tool based on business condition. It should support linear scale-out. table 1.6 shows number of hardware platform that support big data applications.
4. **Data base:** Harsh, R., Acharya, G., & Chaudhary, S. in 2018 Databases whose used in Big Data Applications, depend upon operation and output of data analysis. Database supported by big data are MongoDB, Hive, oracle NoSQL, Apache HBase etc.
5. **Programming Language** J.Archenaa and E.A maryanita in 2015 provides a way to user to connect with software. Sometimes high-level data science platform is not sufficient for a specific analytics task, then need of lower level programming language emerged. table 1.7 shows most popular programming language in big data.

3.4.6 Applications of Big Data in Different Domain

Big Data is used in every field of life. It solves real world problems through many different software like Hadoop, map reduce and other tools. Internet-use and M2M connections are main reasons for data growth. Big data technologies are applicable on various areas as below.

1. **Health care:** In health care, the big data uses patient experience and overall population health record for reducing cost and improve services. It may detect diseases at earlier stages when they can have treated more easily and effectively. It accesses patient information and define type of cause in it and solve problem online. Rashid Mehmood, Gary grahamin in 2015 reduce the Ambulance Transportation problem. Massive amount of data are collected using many sources which help to improving medical facilities.

2. **Market and Business:** Big Data is the biggest game changing opportunities for the marketing and business. The growth of internet can improve market and business of an organization. People can buy and sale the products anywhere and everywhere in the world. It can also define the customer behavior, their choices those are helpful for marketing growth. Many companies are become on top through online sailing. According to a survey, in last 20 years the growth of market is develop 25% extra through online marketing. They collect data, manipulate them and use their information for future purpose like a person purchase a product from online site then their whole information is captured by merchant.
3. **Education System:** Big Data gives a remarkable result in education system. It provides lots of facilities to students for their studies. Suppose a student can't understand a topic in a classroom than will check the topic on internet and clear his queries. Students can also attend online classes for their study. It will provide accuracy of answer. The analysis of data can also clarify about which type of data i.e. text, audio, video a student wants to use. As the result Instructor can guide choosing the future path efficiently.
4. **Sports:** In sports, data is collecting via Fan experience, data from wearable technologies (google glass, GPS tracker, fitness tracker etc.). it may have pulled out difference in scoring touchdowns, signing contracts or preventing injuries. It improves efficiency, accuracy and profitability in sports.
5. **Telecommunication:** Telecommunication plays a big role in today's digital life. In telecom industry, many different varieties of data are generating. Big data Technology creates scope for crowd-based antenna optimization, optimizing services with equipment monitoring, capacity planning and preventative maintenance (Dropped calls, Lack of network coverage, resulting in poor customer experience, Bandwidth issues, Poor download times, Inordinate service wait times, Switching, frequency utilization, capacity use etc.)
6. **Agriculture:** In the agriculture big data is play import role for check soil composition, water level, growth, output generation sequence of the plant. It can also helpful for future prediction of plant, growth of plant through the desire input.
7. **Smart Phone:** Smart Phones are current trends in 20th century. In Smart Phone there are lots of apps, finger print, facial reorganization patters etc, all are generating huge amount of data. those data identified the behavior of the person. A picture can define likes and dislikes of person and emotions at a time.
8. **Social Media:** face detection in social site with help of big data analytics and ANN Techniques are helpful in social media applications.45% of big data are generate through social media. People shares through information, chatting

with each other, posted on Facebook, twitter, exchange picture share their emotion etc. All these data are helpful in business and marketing.

9. **Scientific Research:** The role of big data for scientific research is becoming increasingly apparent, the massive data processing has become valuable for scientific research. Big data has contribution in many scientific discoveries like Digital earth and Global change etc. Huge dataset will serve as important input for current scientific problem thus leading for a new finding. The massive amount of data provides an endless source of new knowledge without modeling the scientific phenomena. There is no dough that Big Data will extensively change the way of scientific Research.
10. **Economic Survey:** Big data is transforming how business leaders make decisions. Vast amount of data helps to researcher for manage and recognize the economic and statistical challenges of our time e.g. Population study, literacy, food security and related policy making, statistical study for policy and decision making.
11. **Water Management:** In Government all sectors like Electricity, Transportation, Water management, Food Industry are generating a huge quantity of data. This stored huge data helps for user demand prediction. In water industry it helps to improve Leakage Deduction, Non-Revenue Water (NRW) identification, Proper Water Utilities and help in Management between Man- Machine work etc. Big Data Analysis can also predict future water demand of user by their previous data record. It is also very useful in water management to forecast an equal ration between demand and supply of water.

Big data have application in many others field like Banking, Data Mining, Fraud Detection, Call Center analysis, IT Log Analytics, Airlines, Tourism, in Human Resource Management, Product Development and Manufacturing and Smart Grid etc.

3.5 Challenges of Big Data

Opportunities never comes alone, it always followed by challenges. The biggest challenges for big data is the protection and security of personal identification Information. Data and their aim is to centralize storage and analysis them for whole system design. Challenges for big data is the protection of end user's privacy such as system frequently contain a team orders amount of personal identification information.

1. **Data Capture:** Capturing of Data is biggest challenge in big data. Big Data Captures Web Based Content and Transforming it into Search application.

Figure 4. Possibility Places of Challenges in Big Data

2. **Data Storage:** Big Data has a storage infrastructure that can store, retrieve and manage massive amount of data. It enables the storage and Sorting of data in a way that can easily accessed, used and processed by Application.
3. **Data Searching:** There is a huge amount of data is stored in big data tool. To identify correct data search is biggest challenge in Big Data.
4. **Data Shearing:** Data shearing is a process in which your original data is in controlled way. Only authorized person in organization can only see part of the whole data. Data shearing is a growing challenge for many organizations.
5. **Data Analysis and Visualization**: Data analysis is a process in which identified and examine a valid data, uncover hidden pattern and other useful information that is more helpful in organization to take more decision.

3.6 Big Data Issues

More data often means more issues. So, Big Data have many issues arising during its Management, Storage etc. Each issue has its own task as following below-

1. **Management Issue:** Manage a Huge Quantity of data is Biggest issue for Big data Engineers. The source of data is different by Size, Format of collection, Different Documents, Drawing, Pictures etc. There is not yet proper solution for them.
2. **Storage Issue:** The volume of user generated data has increases continuously. It is very hard to manage. User uploaded every second photos, video, text on social site that increased amount of data continuously. So, we required a parallel and Distributed architecture to store those huge data and process them.
3. **Processing Issue:** How to process petabyte, Zeta byte (ZB) form of data is an issue in Big Data. for effective processing of ZB of data will require broad parallel processing and new analytics algorithms to provide timely and illegal information.
4. **Security Issue:** Security is a biggest issue for huge amount of data. From security point of view the protection of user's privacy is one of big challenge. Big data have contained huge amounts of personal information and therefore privacy of users is a huge concern. So, to solve this issue first understand what

the weaknesses is are, then you have taken proper precautions to protect those weaknesses.

3.7 Big Data Analytics Tools and Techniques

With the help of data analysis, we uncover hidden pattern and correlation between data and pattern. As per growth of data it is not easy to identify correlation between huge amounts of data so that we use Big Data Analytics tools.

3.7.1 HADOOP

When it is used:

1. Data Size & Data Diversity
2. Life time data availability because it is scalable
3. For parallel data processing with Map reduce

Why it is used:

1. It is integrated with multiple frameworks (Mahout, R, spark, Mongo DB)

How it is used:
Core components

1. HDFS
2. Hadoop Map reduce
3. Hadoop yarn

Where it is used

1. In Genomics for Parallelized and distributed data processing & Analysis with bioinformatics community
2. Information security application (Hadoop based system)
3. In Healthcare (Real time Analysis & Store huge data & Predictive Analysis)
4. Social Big Data visualization and analysis
5. Real time retrieval of image in distributed memory system
6. Future prediction in water management

(Linux, window supported)

3.7.2 Map Reduce

When is used

1. To solve web-based search index creating problems
2. Presence of semi structured and unstructured data format

Why is used

1. It creates cluster of large number of data & manage thousands of Hadoop cluster
2. Reduce Network traffic

How is used

1. Map job
2. Reduce Job

Where is used

1. Geospatial query processing (google map)
2. Gap identification
3. URL Access frequency count
4. Reverse web link graph
5. Clinical big data applications

OS Support: Linux (Red Hat Enterprise Linux),Cent OS,SLES, Ubuntu/Debian

3.7.3 STORM

When it is used

1. Real time computing system,
2. It analyses, clean & resolve large amount of non-unique data point.

Why it is used

1. It processes vast amount of data in fault tolerance& distributed
2. It works on stream processing data
3. If super visor dies & we restart it, it will work from last point, no data loss

How it is used
Zookeeper

1. It works on cluster
2. State less system

Where it is used

1. Weather channel
2. Yahoo & twitter use it
3. Meta Market

Linux & Unix must have Ambari

3.7.4 HPCC

When it is used

1. Deep data analytics
2. Parallel batch processing support & also work on online query processing by indexed data file.

Why it is used

1. While working on Web service protocol

How it is used

1. Cluster processing using commodity hardware & high- speed networking
2. It have Throe & Roxie

Where it is used

1. Web service application,
2. HTTP,REST & JSO N, XML data
3. Infosys (360°customer view) Supported by Linux OS

3.8 Big Data Analytics Programming Languages

3.8.1 Apache Pig (Pig Latin)

Supported Operating System

- Window, OSX, Linux

Work For

1. Data Analytics
2. Data Manipulation with Hadoop

Features

1. It handle very large data set with Hadoop
2. Ease of Program
3. Optimization opportunities
4. User create their own function according requirement

When

1. It is generally used with Hadoop
2. To perform map reduce task without Java code
3. It is fit in pipeline paradigm
4. It handles structured, unstructured & semi structured data.

Developed by

- Yahoo

3.8.2 R

Supported Operating System

- Windows, Linux, Mac

Work For

1. Statistical Computing

2. Data Analytics
3. Scientific Research
4. Graphics representation
5. GNU is very easy for new user

Features

1. R code have cross platform inter operativity
2. It is freely available with GNU license
3. Data handling & storage facility
4. Simple & effective programming includes array, loop, vector & list

When

1. It is used for retrieve, clean, analyze, visualization the data.
2. For business, market & other Research work data analytics & scientist used it.
3. It work on time series analysis & classification & clustering

Developed by

- Ross lhaka at University of Auckland, New Zealand (1993)

3.8.3 ECL (Enterprise Control Language)

Supported Operating System

- Linux

Work For

1. it is Query Language
2. Optimization Features

Features

1. It has high level Primitives such as join, transform, Short, Project etc.
2. It Perform Loading, Extraction of data.
3. Backup and Recovery of Production

When

1. when we required more Security of Data because it has security, recovery, audit and compliance layer.
2. Entrepreneur data and government data.

Developed by

- HPCC System

4. CONCLUSION

Variety of literature has been surveyed to explaine the big data. Based on data collection, data had segregated to fulfill the properties of Big Data and segregated into their various defined 'V's for confirmation of Big Data existence. There have been attempted a sample data study (due to limitation) to complement Big Data Analytics. Water demand prediction has been taken as a sample problem and solved by steps of Big Data Analytics using Linear Regression and ANN model.

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Chapter 12
Towards Intelligent Agriculture Using Smart IoT Sensors

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ABSTRACT

The word "smart" is quite commonly associated with different types of products of IoT sensors and its contemporary technology. The frequent progress in the contemporary technology includes convention and the progressive integration of microprocessor. This gives the smart sensors application to a wide range of applications. Smart sensors when associated with agriculture are known as smart agriculture. With the help of smart sensors, technology of internet of things has helped agriculture in facilitating its efficiency, which further helps in decreasing the impact of environment on the production of the crops and deprecate the expenses. This is done by a few methods like calculating the condition of the environment, which affects the production of the crops, keeping a check on the cattle health and indicating when some problem occurs. The author discussed about sensors, their nature and evolution, generations of smarts sensors, and how they became better with the course of time in terms of smart agriculture.

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1. INTRODUCTION

A smart sensor is a type of device, which fetches data as input from the outside environment, processes that data, and gives the output in the human understandable and useful form. This process begins with the detection of a particular input and consequently built-in resources are adopted to operate functions, which are pre-defined. Not only it processes the input data, smart sensors also help in the automatic assembling of the data from physical environment, which is free from deceptive data, amidst the information, which is recorded in accurate manner (Kwaaitaal, 1993). The application area for smart sensors is quite wide like medical field, defence area and other various number of applications of science. Smart sensor also constitutes as an imperative and indispensable principle in other vital technologies like Internet of Things (IoT), the progressively contemporary platform with which anything plausible can be embedded with the help of a unique identifier i.e. UID (Amico et al., 2001; Chong et al., 2003).

The working of smart sensors is based on the idea of sensor nodes, which are substantially arrange either very close to the sensation or within it. Although it is not necessary to know the location of the sensor nodes in advance. Due to this factor, it becomes appropriate in unpredictable disaster relief process or distant terrains. Therefore, it states the idea that network protocols and algorithms related to sensors can process autonomous constructing and creating capabilities. This capability of sensor networks is surfaced only because of the cumulative application of sensor nodes (Schmalzel et al., 2005). A smart sensor node comprises of three vital and fundamental elements namely a memory core, a physical device that converts the energy from one form to another or physical transducer and a network interface. This transducer fetches or senses the data from physical environment and thus converts it in the form of electrical signal. This electrical signal is taken by an A/D converter as an input and converted into a digital based value, which can be further used by the processor. Here the processor, which is usually a type of a microcontroller, percolates the processing of the signals on the data fetched and forwards the output to the network in the form of the data. Hence, one can say that the processor, which is included in the network of smart sensors, can be considered as a type of a distributed parallel computer (Henry et al., 1993; Henry, 2001; Ho et al., 2005). Conventionally, sensor systems imbibe only single resource in which data is centrally processed. The advantage with this is that due to the local processing of the data at the node, the chosen data can be forwarded unrivalled to the network. With the help of this, the bandwidth which is necessary to sustain a single node is cut down adequately and hence larger number of nodes can endure the network (Kassal et al., 2018). Thus, we can say that sensor nodes are multifunctional, nominal and low-power consuming nodes, which are very peculiar in its size and can communicate sharply at short interval of distances. These minuscular, multifunctional sensor nodes can sense the data, process it and its components broadcast the data as well. Sensor nodes are equipped with a processor, which is on-board and rather than disseminating raw data, which is subject to the fusion, these nodes sustain its simple calculations by using processing competency. Through this, sensor nodes just transmit the necessary data that is moderately processed, for further communication instead of sending the entire loop of data. This collective effort of number of sensor nodes pushes the concept of sensor networks (Abbasi et al., 2014; Lee et al., 2010).

A smart sensor is the amalgamation of any kind of technology required for communication, a microprocessor and a sensor. It is a nominal power mobile microprocessor, which provides the resources for communication. The resources, which are required for computing constitutes an integral part of the physical design. When a sensor is only forwarding the data for remote processing, then it is not considered as a smart sensor. A smart sensor must comprise of other components such as amplifiers, control for excitation, transducers, compensation and analog filters. For example, ICM-20648 by Inven Sense is its chief smart sensor, which means it IS having an embedded DMP (Roozeboom et al., 2013). A smart sensor is the one that also imbibes elements, which are defined by software needed for processes such as conversion of data, digital processing and connection to foreign devices. So, one can say that any sensor associated with an interfacing circuit is a smart sensor, making it adequate for bidirectional communication, functions for logic and making decisions. Smart sensor is the amalgamation of actuator and a sensor, which directly gets physical, chemical or biological data and apprehends it in the digital format (Depari et al., 2012).

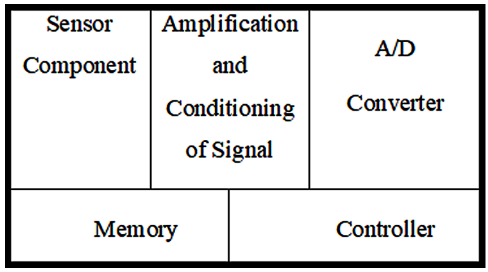
These days smart sensors are imbibed into various fields to take out the best of both the areas. One such are where smarts sensor technology has been successfully applied and is quite progressive is agriculture. *Smart agriculture* or *precision agriculture* is the name given when smart sensor technology is amalgamated with agriculture (Pang et al., 2012). In this work, further we will discuss thoroughly about the various types of smart sensors used into the agriculture. And what are the various types of technologies which are used differently for small scale and large sized fields.

2. NATURE AND EVOLUTION OF SMART SENSORS

As studied from various sources, models of smart sensor have six definite components associated with analog sensors. The basic smart sensor is described diagrammatically as shown in Figure 1.

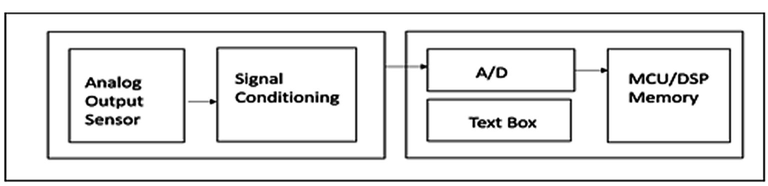
From figure 1, we can say that smart sensor requires a memory; a controller associated with logical control an A/D converter besides one sensor component,

Figure 1. Smart Sensor Components



which is required for amplification and conditioning of a signal. Various protocols accustomed with communication comes into an active state, once a signal is converted into a digital format. All this system can be taken into account only when uninterrupted and well-coordinated power supply is provided for the same. Thus, an uninterrupted power supply has come up as a concern, as problems accompanied with power supply management are labelled in the design of the system. In any system as the quantity of the components are reduced, various other factors like cost of the components cost of the accumulation of those components as well and cost of the interconnections is also reduced. The standard competence of the integrator lies in the fact that how the different choices of the integration are carried out in the entire system. It is with the help of integration only, that one can achieve the conditioning of the signal simultaneously with the fabrication or manufacturing of the signal. The way integration and partitioning are performed plays an important role in the working of the entire system of the sensors (Lee et al., 2010; Mainetti et al., 2011). The various ways of doing the same are expressed diagrammatically as shown in Figure 2.

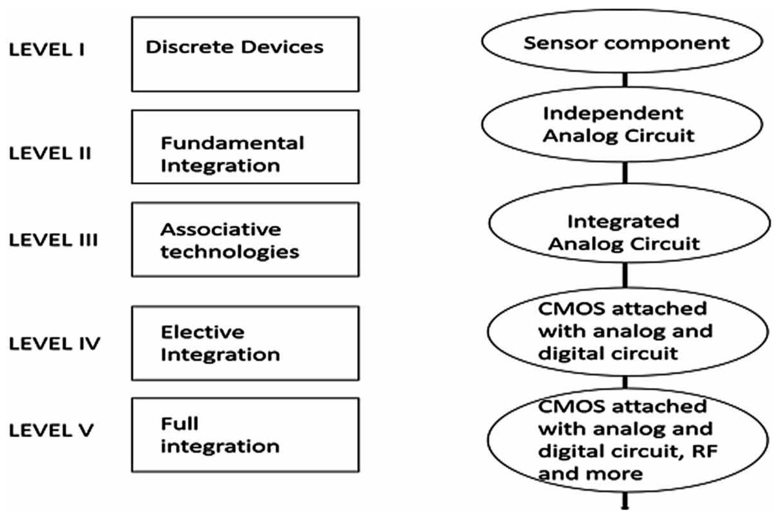
Figure 2. Different Ways of System Integration and Partitioning



The above are the description of the various ways in which the system of the sensors can be integrated. Although the entire procedure of the integration is quite tedious, for performing a specific application, sensor can be integrated with the amalgamation of analog output sensor, signal conditioning, A/D converter and optimised memory. The processing approach is the vital component of all the variations, which are represented above.

The migration path of the smart sensor technology has shown that from the computing part which is performed by the micro-controllers to the different circuits according to the level with which it is associated, it involves massive amount of integration (Al-Fuqaha et al., 2015).

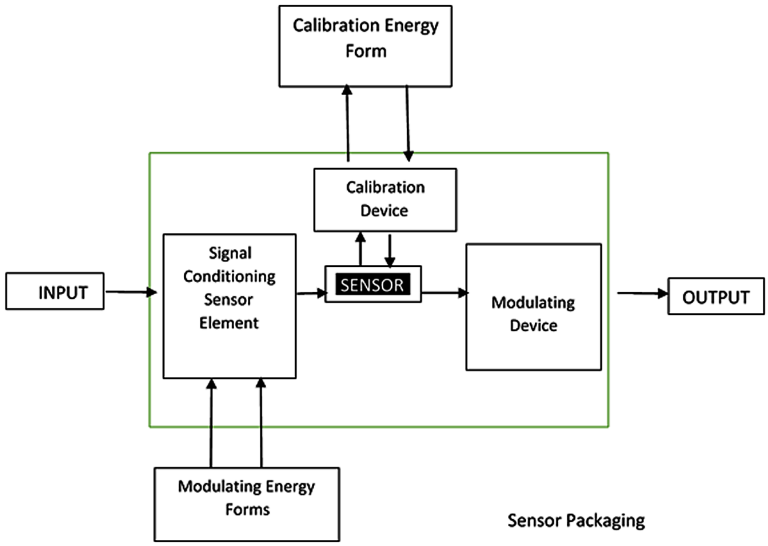
Figure 3. Migration of Sensor Technology



3. GENERAL ARCHITECTURE OF SMART SENSORS

Smart sensors are considered to be constituted as an element/s of IoT, which measures the physical or real-world data into the form of a digital data for further transposal to the microprocessor (Xu et al., 2014). The figure below displays the functioning of the smart sensor system. The microprocessors, which are built-in component of the smart sensor system, performs vital roles like application algorithm and conditioning of the signals. MPUs can help in the further functioning of course-oriented conditioning operations related with the transmission of the signals such as compensation, filtering etc.

Figure 4. General Architecture of Smart Sensor



3.1 Working of Smart Sensors

Microprocessors play a vital role in the functioning of smart sensors. From performing functions like digital processing to converting codes from analog to digital or converting digital to frequency signals, these microprocessors perform ample amount of functions. Important decisions like deletion or storage of any fragment of data corresponding to the input provided are also taken by microprocessors (Borgia, 2014). Apart from making decisions, other vital factors like managing resources are also taken care by them. At regular operating hours, microprocessors function automatically to downgrade the consumption of power. The microprocessors also contribute to the small size of the smart sensors than the standard sensors (Yan et al., 2014). There are various technologies, which are operating behind the function of smart sensors, which are making *"smart"* to work. Some of the technologies are discussed as below:

- **Micro Electro Mechanical Systems (MEMS):** MEMS is a class of systems, which are quite minute in its size. This structure is the amalgamation of both mechanical and electrical elements. A computer chip or an advanced integrated chip is been used in this technology for the formation and fabrication of these minute mechanical elements. These days, quite a few techniques and material are available which fit to the contemporary needs. Extensive data can be managed within a fraction of time with the support of this technology. The data, which is usually collected repeatedly by the sensors, are grinded with microprocessors. The data is stored or cleared accordingly with the advanced computation of microprocessors. Thus, making the sensors quite adaptable and increasing the capability of self-calibration. The primary concept of the epoch of smart sensors stays in the system of monitoring, which are also the foundations of technologies used for computations and accustomated instruments. Due to the amalgamation of all of these concepts only, a robust technology like *Smart Sensors* can be surfaced out (El Khaddar et al., 2017; Maras et al., 2015).

- **Very Large Scale Integration Technology (VLSI):** All the components that are associated with Micro Electro Mechanical System are expanded with the support of Very Large Scale Integration Technology (VLSI). Thus making all the parts capable to achieve all the electrical and mechanical functions. Not only the various devices of the MEMS can be implemented in every situation, this concept figures out the chemical process necessary for sensing the data which is used in converting the data, which is recorded from physical environment, to different electrical frequency. These frequencies can be deployed to process, record, transmit and displayed. The outlier provided by this technology to the devices, which are sensed smartly, is its small size and minute shape (El Khaddar et al., 2017; Maras et al., 2015).

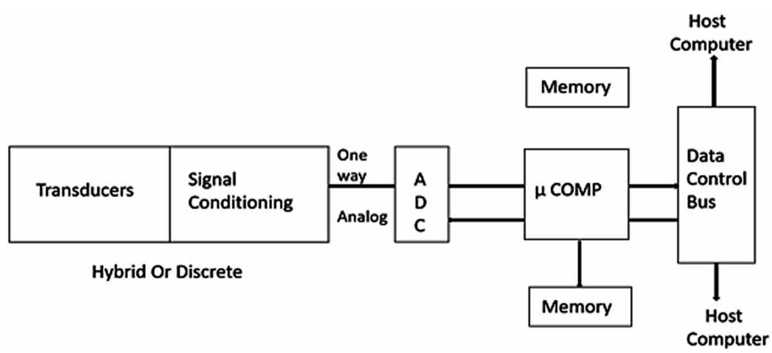
4. GENERATIONS OF SENSORS

It has been observed that there exist various generations of sensors while studying the literature [22]. These are described as below:

- **First Generation Sensors:** The electronic part accompanied with the device until now was minimal if not null. This device had MEMS element, which was associated with sensor, present within it. It was focused on a silicon-based schema. Very few times this structure was incorporated with analog amplification based upon a microchip.
- **Second Generation Sensors:** This generation was totally based on analog systems and all the electronics, which are the components in this structure of the sensors, are associated remotely with it. This generation also had MEMS element in amalgamation with analog amplification and addition to this it had converter, which is required for converting digital-to-analog signals embedded on the microchip. After being converted into a frequency, it is then transmitted to the circuit for further processing (Clark et al., 1998).

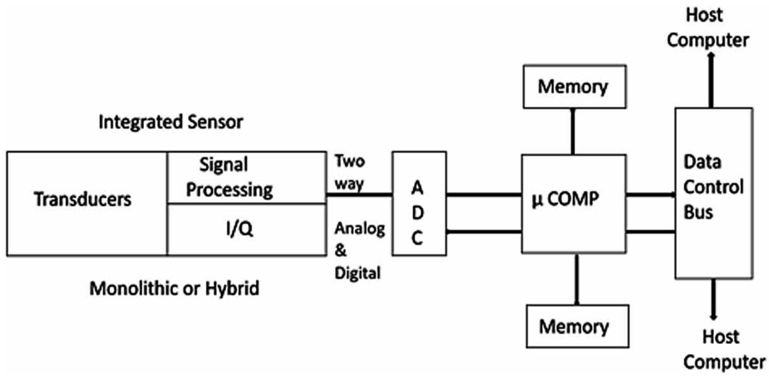
- **Third Generation Sensors:** It is the third generation where the greater number of the systems are accompanied. This generation had a major turning point as it was the first time that the primary phase of the amplification was happening on the sensor module or on the chip of the sensor itself. This resulted as the high level of analog signals as an output which was either encoded as an amplitude of voltage or a pulse rate which was variable in nature. The signal fetched from this is computed as a by-product and then further operated through a microcomputer (Wichmann, 2000). So briefly, it can conclude that, in this, there consists integration of various sensor components with an analog amplification, and thus converting analog signals to digital ones. These digital signals, which are converted through microprocessors, are used for the linearization as well as compensation of the temperature is done simultaneously on the same microchip. There are various number of automatic sensing systems are adequate for this kind of group.

Figure 5. Third Generation Smart Sensor Architecture



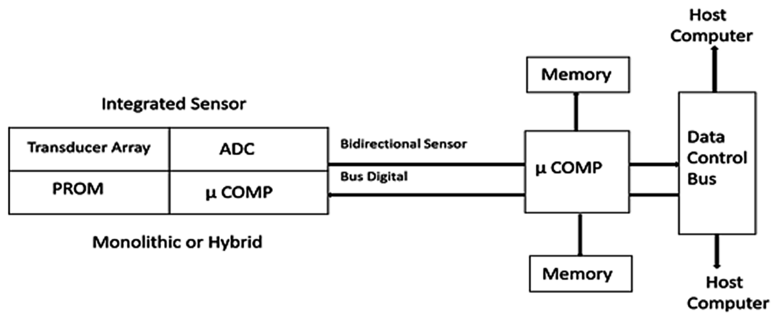
- **Fourth Generation Sensors:** As we evolved to the fourth generation, it could be seen that a greater number of electronic components related to digital and analog circuit are present on the chip itself. This makes a sensor capable of features like self-addressable, self-testing in some cases. This is achieved by a bi-directional connection between the microcomputer, which is hosting the transmission, and the sensor. Best examples for this are extensive area detectable devices used for imaging (IEC, 2002/2003).

Figure 6. Fourth Generation Smart Sensor Architecture



- **Fifth Generation Sensors:** The next perspective for sensors is fifth-generation sensors, in which, to make the two-way transmission between the microcomputer as digital, the process of converting the data is done on the senor itself or at least on the module of the sensor. In this generation, PROMS i.e. field-programmable read only memories are used to make these devices more compensated digitally (IEC, 2001). One of the major drawbacks of the fifth-generation sensors is that still this generation lacks formats and similarity of protocols needed for transmission, from the point of view of the system. Based on the evolution of the two technology of the sensor as well as the different electronic components, it becomes quite distinct that sensors, which are based on solid-state, will keep on consolidating electronic components bases circuits, which are further, experienced. The amalgamation of sensors, which are based on solid-state and are quite productive in terms of performance, refined form of signal processing and a control circuitry into a module of a smart sensor delivers a bi-fold contemplate (Goble et al., Oct 2001). This makes the sensor much more capable of in the scope of sensing function and verity as well as smart sensor becomes well competent and complete in itself to be called as an 'sensing system'. However, the limitation associated with these systems are that only after these systems are advanced and authenticated to competent enough to outperform the most common contemporary sensors, the sensors that are based on solid-state will not be properly exercised in account of their respective proficiency and different parameters. The progression of these systems will be necessary for the further progression of basic elements and other blocks of circuit, which builds the entire system (Goble et al., Aug 2001).

Figure 7. Fifth Generation Smart Sensor Architecture



Now, in the subsequent Table 1, we have summarized the aforementioned generations of sensors on the basis of various parameters such as Type of Network, Mode of Communication, Integration Level and Component/s Used.

Table 1. Comparative study of Generations of Sensors

	Type of Network	Mode of Communication	Integration Level	Component/s Used
First Generation	Sensing Only	Minimal electronic component incorporated	Discrete devices	Sensor Component
Second Generation	'Intelligences' to perform Computation	Analog Amplification	Fundamental Integration	Independent Analog Circuit
Third Generation	Smart Sensor Network	One way Analog	Associative Technologies	Integrated Analog Circuit
Fourth Generation	Self-addressable, self-testing Smart sensor Network	Two way Analog and Digital	Elective Integration	CMOS attached with Analog and Digital Circuit
Fifth Generation	Smart Sensor Network using PROMS	Bi-directional Sensor Bus Digital	Full Integration	CMOS attached with Analog and Digital Circuit, RF and more

5. ADVANTAGES OF SMART SENSORS

Whenever we refer to apprehension of fundamental distinguishing intelligence through mechanised components, smart sensors play a quite crucial role. In the below section, we are going to discuss about the advantages and disadvantages of smart sensors. Some of the advantages of smart sensors are as follows:

- Optimization: Different processes for mechanisms, which need alterations, can be readily optimised using smart sensors. Not only it optimizes this, it can save ample number of profiles and data of different organizations (ADQL, 2000).
- Accuracy: The quality of accuracy one can achieve from categorical digital control is impossible from the control systems, which are achieved from analog methods and other dominant alterations (Nesa et al., 2017)
- Speed: The burden of the central control organisation is reduced, as the conduction and conditioning done by it, is taken care by smart sensors now. Hence, this helps in maintaining and increasing the speed of the signals of the sensors (Nayyar et al. 2016).

However, their reliability is one of the main issues of smart sensors. If they are damaged or stolen, they can affect many systems badly. As, agriculture finds an enormous scope of using the smart sensors to benefit exponentially (Khan et al., 2017; Patil et al., 2017; Lee et al., 2013). Thus, we have outlined the association of smart sensors with agriculture in the next section.

6. SMART SENSORS AND AGRICULTURE

Now, we are going to discuss an area in which smart sensors or sensing technologies has been utilised and woven in such a manner that its progressive way has not only pushed the local farms to a great extent but also the global market has also been quite positively affected by it. The deployment of sensing technologies and mapping fields in the agriculture aids the farmers to help better understand their fields and thus yields good results (Patil et. al., 2012). When smart sensors technologies are used with agriculture it can be termed as *precision agriculture* or *smart agriculture*. This technology able the farmers to make use of resources like fertilizer, water, seeds etc. in minimal possible way and can capitulate maximum results (Suakanto et al., 2016; Gondchwar et al., 2016). With the help of this technology farmers can recognize their respective crops at the elementary level, can preserve their supplies and thus deduce its effect on the outside world. The concept of smart agriculture is not new, as its idea incepted back in 1980s, when GPS (Global Positioning System) became quite available for the common man (Dwarkani et al., 2015). Once farmer becomes adequate enough to portray their respective fields for crops, they are in the position to supervise and administer the treatments concerned with weeds and fertiliser only to the specific parameters which actually need it. With time, precision agriculture kept on improving itself with new technologies and concepts, like it was in 1990s, farmers endorsed methods for crop generating to yield suggestions for the manure and pH corrections. As wider number of variables could be amplified and incorporated into the model of a crop, good number of précised suggestions for the application of fertilizer, watering of the fields and even culminative harvesting, could be decide from this (Putjaika et al., 2016). In addition, number of technologies related to sensors are being used in precision agriculture, which gives a worthy insight to the farmers about their crops, fields and by adopting what measures they can actually upgrade the production of their respective fields (Bangera et al., 2016; Shenoy, 2016). This all can be possible just by providing the data to the farmers so that they can take decisions accordingly. Consequently, the various types of smart sensors that are being useful for the advancement of the field of agriculture have been delineated as below:

- **Location Sensors:** In this technology, GPS satellites are used to fetch the signals so that the latitude, longitude and the altitude can be determined. So therefore, in this minimum three number of satellites are needed so that the location can be triangulated. The key element of this sensing technology is precise positioning in the area of smart agriculture. NJR NJG1157PCD-TE1are some of the best examples of GPS integrated circuits used in location sensing technology (Rajalakshmi et al., n.d.).
- **Optical Sensors:** Optical Sensors estimate the properties of the soil by using light as an input. With the help of this sensing technologies, various frequencies of light can be estimated, light which are reflected in near and mid-range of infra-red lights and different types of spectrums which are polarised in nature. These sensors have been successfully installed on various platforms like drones or even satellites also. Though there are number of variables which can be fetched from optical sensors, colour data of the plants and soil reflectance are two of the major factors which are refined and accumulated. In addition to this, this sensing technology is developed mainly to calculate factors which are quite vital for the crop production like organic matter, clay and amount of moisture in the soil. Vishay is a perfect example of optical sensor being used for smart agriculture. It does its work by providing number of photodiodes and photodetectors, which are basically the fundamental segment for building these types of sensors (Abdullah et al., 2016).
- **Electrochemical Sensors:** This is the most vital type of sensor used in precision agriculture as it gives the significant information regarding the nutrient levels of the soil and pH value. This works on the basis of sensor electrodes which perform by distinguishing particular ions which are present on the soil. These days, sensing technologies which are escalated to

specifically construct "sleds" support in collecting, refining and also mapping of soil synthetic data (Mubarak et al., 2015).

- **Mechanical Sensors:** These sensors specifically measure compression of soil or "mechanical resistance". It works on the mechanism according to which the sensing technology in this use a research method which that bore the soil and also keeps account of repellent strength with the utilization of load cells. Infact, a same kind of technology has been exercised on big sized tractors so that necessities for pulling can be anticipated in advance for the purpose of ground enticing machinery. Here the perfect example can be taken as Honeywell FSG15N1A tensiometers, which helps in fetching the force taken due to the absorption of water by the roots and hence proves to very effective for irrigation interference (Zhao et al., 2015).
- **Dielectric Soil Moisture Sensors:** It helps in measuring the level of moisture by accessing the dielectric constant which is present in the soil. Dielectric constant is an electrical parameter that variates with time based on the content of level of moisture which is present in the soil (Sensor Survey, 2018).
- **Airflow Sensors:** Airflow sensors access the permissibility of soil air concoction. The best part about this sensing technology is that the calculations associated with these can be done at unique areas or dynamically during the locomotion. In this, the expected outcome is the amount of pressure that is needed to blow already known quantity of air into the field at well specified depth. With this technology, it is followed that different kinds of parameters of soil, which includes compaction, type of the soil, organisation of the soil and the level of the moisture, generates exclusive classifying signatures (Singh, 2000).
- **Agricultural Weather Stations:** These are self-enclosed sections which are located at different positions all over the producing grounds. The different locations have sensing systems associated with them according to the local climate and the crops of that particular station (Dobbing et al., 1998). There are some already specified intervals according to which different and all sorts of information is recorded like the temperature of the air, direction of the wind, humidity relatively prevalent at a particular location, rainfall, wetness parameter of the leaf, chlorophyll, speed of the wind, temperature at dew point and the pressure of the atmosphere. This entire data with all the parameters discussed is assembled and is forwarded wirelessly to a basic data logger at specified set of intervals. The fact that this technology provides portability and prices which are far less, makes the locations of weather captivating for the fields of all capacities (Houtermans, 2000; Patra, 2000).

Hence, all of the above sensing technologies are the ones which are mostly used in smart agriculture or precision agriculture. Apart from these sensors which are actually based on large scale and needs good amount of capital, there are some small scale based smart agriculture tools which are profoundly known as Smartphone Tools (Mekala et al., 2017). Below given is a Table 2 in which we can see how different smartphone tools are applicable to different parameters of the fields and thus helping farmers to increase their production (Grattan et al., 2000; Shen et al., 2013).

Table 2. Types of Smart Tools

S.No.	Tool Based on Smartphone	Farming Application/s
1.	Camera	Fetches photographs of the health of the leaf, chlorophyll content, level of ripeness. Calculates Leaf Area Index (LAI), organic soil and quantity of carbon in the soil.
2.	GPS	Gives position for mapping of the crops, location alerts for pests or disease, predictions based on solar radiations and fertilising.
3.	Microphone	Provides the estimate for the maintenance of the machinery used in the fields.
4.	Gyroscope	It identifies the equipment rollover.
5.	Accelerometer	Adopted as an alarm for equipment rollover. Calculates LAI (Leaf Area Index)

7. CONCLUSION

Smart agriculture or precision agriculture has grown to match the worldwide needs for food by utilising those innovative systems which mould it in cost effective as well as quite simple to accumulate and administer the data, habituate to the dynamic outside conditions, and thus utilise the supplies or reserves quite effectively. Though earlier it was only large fields to which these technologies were applied, now small farms or fields are also able to imply all the benefits of these technologies and thus have increased its production. Precisely for small farms, tools like smartphone tools are put into the place with its compatible applications.

Future work in this area is most probably to comprise an elevated level of usage of self-governing vehicles used in the farms. An increased level of wireless based transmission of data is also expected in the coming times. Apart from just crop monitoring and checking the condition of the soil, the small size-based vehicles can also calculate the state of the equipment of the farm thus permitting farmers to correct the servicing of the machinery and maintenance. In general, improvements made on the processes around industrial manufacturing will progressively fetch its path into the agriculture.

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