AN IOT – BASED PRECISION AGRICULTURE

Submitted in partial fulfillment of the requirements for the award of

Bachelor of Technology degree in

Information Technology

By

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DEPARTMENT OF INFORMATION TECHNOLOGY

SCHOOL OF COMPUTING

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with Grade "A" by NAAC | 12B Status by UGC | Approved by AICTE

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **VIJAY S(39120135) and VIGNESH S(39120134)** who carried out the Project Phase-2 entitled **" AN IOT – BASED PRECISION AGRICULTURE** " under my supervision from January 2023 to May 2023.

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DECLARATION

I, **VIJAY S (Reg. No- 39120135),** hereby declare that the Project Phase-2 Report entitled **“AN IOT BASED PRECISION AGRICULTURE”** done by me under the guidance of **Dr. V. NIRMALRANI, M.Tech., Ph.D.** is submitted in partial fulfillment of the requirements for the award Bachelor of Technology degree in Information Technology.

DATE:

PLACE: Chennai **SIGNATURE OF THE CANDIDATE**

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I am pleased to acknowledge my sincere thanks to the **Board of Management of SATHYABAMA for their kind encouragement in doing this project** and completing it successfully. I am grateful to them.

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ABSTRACT

IOT has the ability to transfer a data over a network without requiring human to human and human to machine interactions. Smart farming is an emerging concept, because IOT sensors capable of providing information about their fields .IOT in agriculture uses robots, drones, remote sensors, and computer imaging combined with continuously progressing machine learning Analytical tools is used for monitoring crops, surveying and mapping the fields .It provides data to farmers for rational farm management plans to save both time and money .The farming of agriculture has started past 12000 years back, Neolithic age gave birth of civilization, Farming and later being continued as traditional farming practices. India being an agrarian's country, Mostly Indian farming are dependent on rains, soil, dampness, and environment challenges. Our farmers upgraded to modern state of art technology in cultivation. Globally the IoT systems has contributed its application in many fields and proven to be successful. It is the time that Indian farmer need to introduce the Smart Agricultural systems for higher crop yield. The productivity with compilation of data from sensors, actuators and modern electronic gadgets the farmer can monitor agricultural fields. Smart Agriculture can forecast weather data, switching ON the pump motor acknowledging the dampness of soil terms of moisture levels with help of sensors which are interfaced to process module Arduino UNO. The Smart agriculture system can be operated from anywhere with help of networking technology. On joining process in research and development in Smart Agriculture & Artificial Intelligence can be cutting edge technology in data compiling and resource optimization. The pest & Insects controls that protects damaging the crop and also optimization resources utilization can be breakthrough. IOT and smart agriculture using automation. Monitoring environmental conditions is the major factor to improve yield of the efficient crops. The application developed for the same to the farmer's smartphone using internet like Mobile data or Wi-Fi/3G/4G.

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CHAPTER 1

INTRODUCTION

The identification of the techniques of smart farming that can give a boost to the deteriorating traditional agricultural sector. Use of smart techniques like Precision farming, efficient water management, Soil moisture and humidity monitoring are sureshot methods to increase yield per acre of land. Precision Agriculture avoids the improper and excess application of pesticides and fertilizers and enables the farmer to use land according to its quality and nature. Precision Farming is a potential salvager at a time when the water tables in India are diminishing at a rapid rate due to unprecedented demand by the agricultural and industrial sectors. Farmers still procrastinate or stubborn to traditional practices and delay in implementation may further decent the GDP in India. Recently skill acquired migrants all over the India who had returned to their natives during the Pandemic Covid-19 had chosen farming as their profession and are not interested go back. These migrants can now move closure to smart agriculture systems as it takes lesser time than traditional farmers to convince the adopt for the implementation of Smart agriculture system. Future agriculture will use sophisticated technologies such as robots, temperature and moisture sensors, aerial images, and GPS technology. These advanced devices and precision agriculture and robotic systems will allow farms to be more profitable, efficient, safe, and environmentally friendly. The purpose of SMART AGRICULTURE is to detect various problems of farmers and provide a solution by using 3 Ways Soil Meter sensor, soil moisture sensor and passive infrared sensor. Farming and agriculture is basis of human life and technology holds a tremendous role in increased production and decreased extra man power. IOT has opened a suitable solution for smart agriculture but remains a dream till the agriculture and farming situated in rural areas are not connected to the mainstream efficiently. The main aim of this project is to turn on and off bases and for water pump from anywhere using mobile phone. Now a days most of the farmers use water from the wells and underground water resources for their farms this they need water pumps. Using Arduino and GSM shield we can implement this project. The purpose of this system is to help the farmers for knowing the update of the field frequently. The India is an agricultural country. Nowadays, at regular intervals the lands are manually irrigated by the farmers. There is a chance that the water consumption will be higher or that the time it takes for the water to reach the destination will be longer, resulting in crop dryness. Real-time temperature and humidity monitoring is crucial in many agricultural disciplines. However, the old method of wired detection control is inflexible, resulting in several application limitations. This project achieves irrigation automation as a crucial answer to this problem. This is accomplished with the aid of a Raspberry Pi, which controls the moisture and temperature sensors based on the input provided. Moisture sensors are used in the construction of an automated plant watering system for this purpose. The main aim of our project is to reduce the complexity of supervision and to avoid the continuous monitoring. We can accomplish smart agriculture using our system. This system includes IoT-based agricultural monitoring. The Internet of Things (IOT) is transforming the agriculture business and addressing the enormous difficulties and huge obstacles that farmers confront today in the field. The soil moisture sensor is put into the soil to determine whether the soil is wet or dry, and if the moisture level in the soil is low, the relay unit attached to the motor switch must be monitored on a regular basis. When the soil is dry, it will turn on the motor, and when the soil is moist, it will turn off the engine. Agriculture is done in every country from ages. Agriculture is the science and art of cultivating plants. Agriculture was the key development in the rise of sedentary human civilization. Agriculture is done manually from ages. As the world is trending into new technologies and implementations it is a necessary goal to trend up with agriculture also. IOT plays a very important role in smart agriculture. IOT sensors can provide information about agriculture fields. we have proposed an IOT and smart agriculture system using automation. This IOT based Agriculture monitoring system makes use of wireless sensor networks that collects data from different sensors deployed at various nodes and sends it through the wireless protocol.

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CHAPTER 2

LITERATURE SURVEY

2.1. LITERATURE SURVEY:

A. A Model For Model Agriculture Using IoT.

In 2016 Prof. K. A. Patil and Prof. N. R. Kale have described Climate changes and rainfall have been erratic over the past decade. Due to this in the recent era, climate-smart methods called smart agriculture, is adopted by many Indian farmers. Smart agriculture is an automated and directed information system. technology implemented with the IOT (Internet of Things). IOT is developing rapidly and being widely applied in all wireless environments. In this paper, sensor technology and wireless Network integration of IOT technology have been studied and reviewed based on the actual situation of the agricultural system. A combined approach using the internet and wireless communications, A remote monitoring system (RMS) is proposed. The major objective is to collect real-time data on the agricultural production environment. That provides easy access to agricultural facilities such as alerts through Short Messaging Service (SMS) and advice on the weather pattern, crops, etc.

B. Internet of things for Agriculture Application

In 2018, Manishkumar Dholu, Mrs. K. A. Ghodinde have described about the Internet is experiencing very explosive growth. Nowadays, with so many devices connected to it, we had only personal computers (PCs) and mobile handsets with internet access earlier, but now, with the Internet of Things, i.e., the IoT concept of connecting things with the internet, millions of devices are connecting with it. This development of the IoT leads to the idea of machine-tomachine communication, which means that two machines can communicate with one another, as well as all the data that was previously on a private server can now be found on the internet, so the user can access it remotely. The application of IoT is feasible in almost all industries, particularly where speed of communication is not an issue. This paper proposes the application of cloud based IoT in the agriculture domain. Precision agriculture is basically a concept that insists on providing the right number of resources at the exact right time. These resources could include anything, such as water, light, pesticides, etc., to implement precision agriculture. In agriculture, the benefits of IOT have been utilized in the proposed paper. The fundamental idea is to sense all the required agricultural field parameters and take the required decision to control the actuator. These agriculture parameters are soil moisture, temperature, and relative humidity. Humidity around the plant, light intensity Based on the reading sensed by the sensor, suitable action is taken, i.e., opening the irrigation valve. is actuated based on soil moisture readings, the valve for the forger (for spraying water droplets) is actuated based on relative humidity (RH) readings, etc. This paper proposes the development of a sensor node capable of measuring all these parameters and creating the actuation signal for all the actuators. On top of that, sensor nodes are also capable of sending this data to the cloud. An Android application is also being developed in order to access all these agricultural parameters.

C. IOT Based Smart Agriculture Management System

In 2019, G. S. Nagaraja, Avinash B Soppimath, T. Soumya, Abhinith A has described This sector contributes to the Indian economy a great deal. It contributes over 17% of the total. Gross Domestic Product (GDP). With the introduction of newer seed varieties, new methods of agriculture, and the use of efficient fertilizers, crop production has increased. But without using smarter methods, the agricultural domain remains in the backlog. The conventional method involves a lot of human instincts, which at times fail. And as a result, a more intelligent approach to crop production is required. using the Internet of Things (IoT) and machine learning techniques. The proposed system is the smart agriculture management system (SAMS), which is automated to help farmers increase crop production. The system also helps reduce resource waste by adopting a technique called precision agriculture. The system uses different sensors for data acquisition to measure various environmental factors that are required for crop production. The data obtained from these sensors is visualized in the form of graphs.

D. Development of Prototype Smart Control System…

In 2022, Rudi Hartono, Rayhan Emillul Fata, Ridho Fata Ulwan has described The quality of agricultural products depends on the experience and instincts of farmers in understanding the land conditions and crops. Of course, when compared to the calculated calculations, these results are less. We are here to help farmers manage their agricultural land in the face of these problems. Ionic offers products in the form of IoT devices that can monitor and automate agricultural land. With the precision farming method, the monitoring data will be precise, and the execution of agricultural management will become more precise and automated thanks to the resulting data. The manufacture of the product starts by analyzing the device's production needs. These needs are in the form of hardware development needs in the form of IoT devices and software development needs in the form of applications. This analysis turns the device into a prototype product ready to be tested. These activities will produce IoT products and software to help farmers manage their agricultural land. To be able to produce these devices, production costs and the value of products and services are required, amounting to $24,998,200.00.

E. Sensor-based Smart Agriculture with IoT Technologies

In 2022, K.Nanthini, M.karthikeyan, V.Erajavignesh and G.Bala Ajith Kumar has described The Internet of Things (IoT) as a new technology trend that is being used in almost every area of life. When connected to the internet and to each other, your entire system becomes smarter. We have used IoT in all areas of our lives, including smart cities, smart homes, and smart retail. Much more. From 9.6 billion by 2050, agriculture needs to deliver even faster to meet this type of demand. This is possible with the latest technology, especially the IoT. The IoT enables labor-free farms. Not only can it be used for large-scale agriculture, but it can also be used for livestock management, greenhouse management, and agricultural land management. The most significant tool for the IoT is the sensor. A sensor is a device that collects important data that is interpreted to obtain the required analysis. The important objective of sensors is to determine the soil's physical qualities and the environment. The main applications of sensors are control and supervision, safety, alarms, diagnostics, and analytics. Sensors make innovative agriculture more effective and trouble-free. In agriculture, the sensor is mainly used for measuring NPK (nitrogen, phosphorus, and potassium) levels and detecting disease and soil moisture content. The main solution to this problem is smart farming, which modernizes traditional farming practices. This paper narrates the role of IoT applications in smart agriculture. Smart farming is also known as precision farming since it uses accurate information to draw outcomes. It demonstrates the different sensors, applications, challenges, strengths, and weaknesses that support the IoT and agriculture.

2.1 INFERENCES FROM LITERATURE SURVEY

From the above-mentioned literature works, there has been effective research on Smart Agriculture system and many models have been proposed. It is evident that the above-mentioned systems have their own pros and cons. While some of the recent works involve hybrid technologies and provide better accuracies, they are still far from what is needed. With higher accuracy, comes the need for low computational costs, high processing speed, and most of all, the convenience of use. Agriculture is essential to India's economy and people's survival. The purpose of this project is to create an embedded-based soil monitoring and irrigation system that will reduce manual field monitoring and provide information via a mobile app. The method is intended to help farmers increase their agricultural output. A pH sensor, a temperature sensor, and a humidity sensor are among the tools used to examine the soil. Based on the findings, farmers may plant the best crop for the land. The sensor data is sent to the field manager through Wi-Fi, and the crop advice is created with the help of the mobile app. When the soil temperature is high, an automatic watering system is used. The crop image is gathered and forwarded to the field manager for pesticide advice.

2.2 OPEN PROBLEMS IN THE EXISTING SYSTEM

The existing systems Presently, farmers rely on a sparsely distributed network of sensors to gather data on farm conditions. In addition to the physical constraints of these sensors, Dr. Chandra also explained that they are expensive. He cited the example of a limited set of sensors, which can cost up to 8,000 USD. As a result, farmers continue relying on less advanced farming technologies which limits their productivity. To overcome these costs, FarmBeats uses unmanned aerial vehicles (UAVs) to enhance spatial coverage and establish precise maps. In areas where there are constraints on the use of drones—including government regulations, low battery life, and high costs—Tethered Eye helium balloons are used instead. These aerial sensors generate a stream of continuous images of the farm conditions, which are used to refine the data collected by sensors on the ground. As a result, this approach helps reduce hardware costs while facilitating more precise data collection.

CHAPTER 3

REQUIREMENT ANALYSIS

3.1 FEASIBILITY STUDIES/RISK ANALYSIS OF THE PROJECT

The internet of things helps people live and work smarter, as well as gain complete control over their lives. In addition to offering smart devices to automate homes, IoT is essential to business.

- IoT provides businesses with a real-time look into how their systems really work, delivering insights into everything from the performance of machines to supply chain and logistics operations.
- Three different soil test meters in one device: It measures moisture content in soil, pH/Acidity/Alkalinity, and light intensity (sun rays).
  Water wasted through irrigation can be conserved by soil moisture sensor.
- PIR (Passive Infrared) Sensors can be used to prevent harm caused by predators by detecting the motion of animals and scars the animal away from the field by using buzzers and creating alarm.
- GSM: Keeps the farmer updated frequently about their field status, especially when an inconvenience occurs.
- Technologies Iot made possible:
- Access to low-cost, low-power sensor technology.
- Connectivity
- Cloud computing platforms

Hazard risks: The monitoring system may not detect all hazards present in the mine, or there may be equipment failures that cause the system to malfunction, resulting in serious safety incidents. The likelihood of this risk can be reduced by ensuring that the monitoring system is regularly maintained and tested, and by implementing redundancy measures to ensure that multiple systems are in place to detect hazards. The impact of this risk could be severe, including loss of life, injuries, and property damage.

Communication risks: There may be issues with communication between the monitoring system and miners or management, such as a failure to receive alerts or a lack of understanding of how to respond to alerts. To reduce this risk, clear communication protocols should be established and regularly reviewed, and training should be provided to ensure that all stakeholders understand how to use the system.

Technical risks: There may be technical challenges associated with the development and implementation of the monitoring system, such as compatibility issues between different sensors and software systems. To reduce this risk, a thorough evaluation of available technologies should be conducted prior to implementation, and technical experts should be consulted throughout the development and implementation process.

Environmental risks: There may be environmental factors, such as extreme temperatures or high humidity levels, that could impact the performance of the monitoring system. To reduce this risk, the system should be designed to withstand the environmental conditions present in the mine, and regular maintenance should be conducted to ensure that the system remains functional in all conditions.

Regulatory risks: There may be regulatory or legal requirements associated with the development and implementation of the monitoring system, such as compliance with safety standards or data privacy regulations. To reduce this risk, regulatory compliance should be carefully considered throughout the development and implementation process, and legal experts should be consulted as needed. Three key considerations involved in the feasibility analysis are

- Economical feasibility
- Technical feasibility
- Social feasibility

3.2 SOFTWARE REQUIREMENTS SPECIFICATION

Hardware specifications:

Arduino, 3 Way Soil meter, soil moisture sensor, passive infrared sensor, Relay, DC motor, GSM, Breadboard.

System Required:

Higher RAM of about 4GB

Software Requirements:

C

CHAPTER 4

DESCRIPTION OF PROPOSED SYSTEM

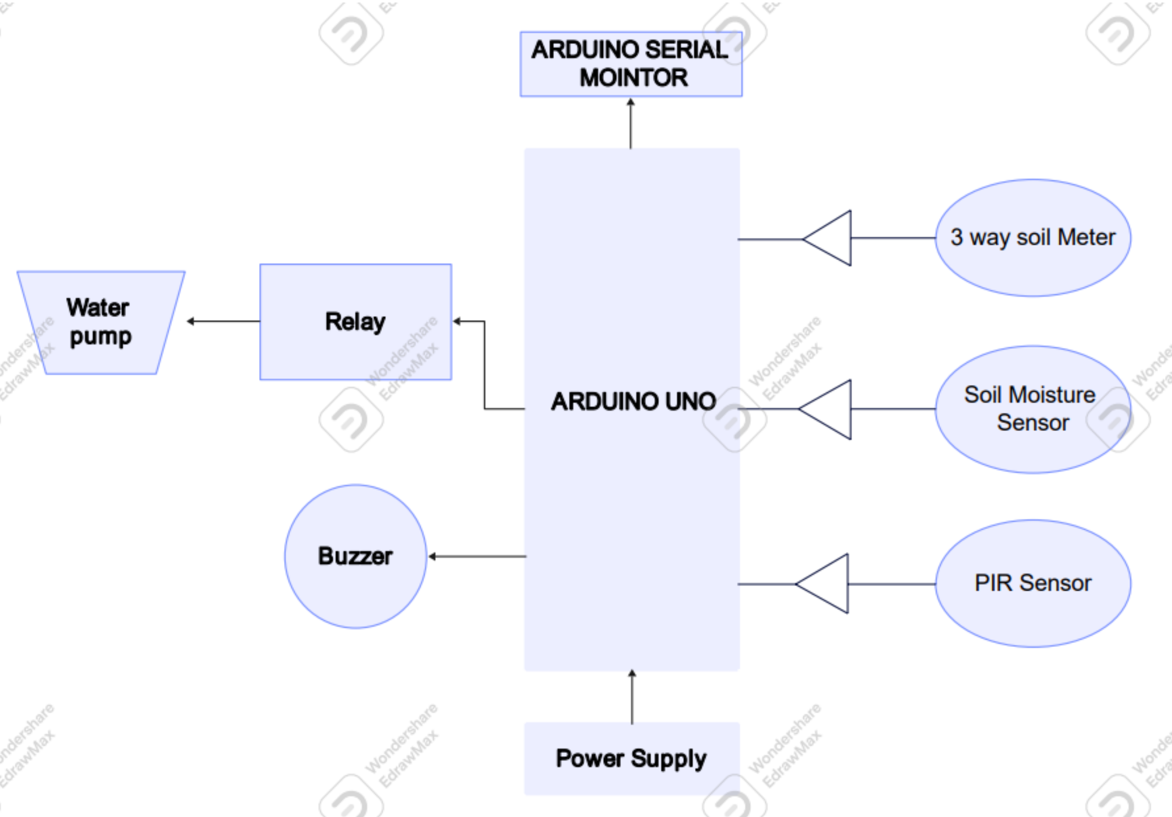
4.1 SELECTED METHODOLOGY OR PROCESS MODEL

As traditional farming is more labor intensive, Risky, and resulting to suicidal due low yield or Act of God. Small farmers unaware of the smart agriculture system big fishes and corporate community are enjoying the advantages of smart agriculture technology. Thanks to Pandemic Covid-19 which returned the migrants back to their respective villages and having no source of income are happily willing to come back to their original agriculture farming as their occupation. At this time when the Smart Irrigation System is an IoT based device which can automate the irrigation process by analyzing the moisture of soil and the climate condition (like raining) can be incorporated by small players in farming and enjoy high yield profit earning. IOT advancement helps in agrarian societal information on conditions like atmosphere, temperature and productivity soil, harvest web watching engages area of weed, level of water, bug acknowledgment, animal interference into the field, alter improvement, cultivation. The farmers can know get details of farm conditions with the help of remote sensor framework and WSN (Wireless Sensor Networking) systems sitting at home or any other place. The existing system for finding suitable crop is not available and if available then there is no android application for it. Some have websites while others don't have one and the work is done manually. The farmer's use their learned methods from over the years only. The famers don't have access to the necessary resources and also, they lack knowledge like the effect on soil if continuously sown with the same seed over a number of years. Since, there is lack of resources and knowledge, lots of efforts are invested with very less produce which is unprofitable. The proposed system seeks to tackle such problems by developing an android application which enables farmer to get availability of resources and suitable crops that are suitable for that area. This paper intends to propose a system which reduces the efforts of the farmer and increases the yield thereby saving time and money, also efficient utilization of resources and money. Along with this information, the system assists the farmer in finding the nearby marketplaces, pesticides shop, labors through contractors. Agriculture is done in every country from ages. Agriculture is the science and art of cultivating plants. Agriculture was the key development in the rise of sedentary human civilization. Agriculture is done manually from ages. As the world is trending into new technologies and implementations it is a necessary goal to trend up with agriculture also. IOT plays a very important role in smart agriculture. IOT sensors can provide information about agriculture fields. we have proposed an IOT and smart agriculture system using automation. This IOT based Agriculture monitoring system makes use of wireless sensor networks that collects data from different sensors deployed at various nodes and sends it through the wireless protocol. This smart agriculture using IOT system is powered by Arduino, it consists of Temperature sensor, Moisture sensor, water level sensor, DC motor and GPRS module. When the IOT based agriculture monitoring system starts it checks the water level, humidity, and moisture level. It sends SMS alert on the phone about the levels. Sensors sense the level of water if it goes down, it automatically starts the water pump. If the temperature goes above the level, fan starts. This all is displayed on the LCD display module. This all is also seen in IOT where it shows information of Humidity, Moisture and water level with date and time, based on per minute. Temperature can be set on a particular level; it is based on the type crops cultivated. If we want to close the water forcefully on IOT there is button given from where water pump can be forcefully stopped. The existing system for finding suitable crop is not available and if available then there is no android application for it.

Some have websites while others don't have one and the work is done manually. The farmer's use their learned methods from over the years only. The famers don't have access to the necessary resources and, they lack knowledge like the effect on soil if continuously sown with the same seed over a few years. Since, there is lack of resources and knowledge, lots of efforts are invested with very less produce which is unprofitable. The proposed system seeks to tackle such problems by developing an android application which enables farmer to get availability of resources and suitable crops that are suitable for that area. This paper intends to propose a system which reduces the efforts of the farmer and increases the yield thereby saving time and money, also efficient utilization of resources and money. Along with this information, the system assists the farmer in finding the nearby marketplaces, pesticides shop, labours through contractors. This smart agriculture using IOT system is powered by Arduino, it consists of Temperature sensor, Moisture sensor, water level sensor, DC motor and GPRS module. When the IOT based agriculture monitoring system starts it checks the water level, humidity, and moisture level. It sends SMS alert on the phone about the levels. Sensors sense the level of water if it goes down, it automatically starts the water pump. If the temperature goes above the level, fan starts. This all is displayed on the LCD display module. This all is also seen in IOT where it shows information of Humidity, Moisture and water level with date and time, based on per minute.

Temperature can be set on a particular level; it is based on the type crops cultivated. If we want to close the water forcefully on IOT there is button given from where water pump can be forcefully stopped. he objective of this project is to offer assistance to farmers in getting Live Data (Temperature, Humidity, Soil Moisture, Soil Temperature) for efficient environment monitoring which will enable them to increase their overall yield and quality of products. This smart agriculture using IoT system powered by Node MCU consists of a DHT11 sensor, Moisture sensor, DS18B20 Sensor Probe, LDR, Water Pump, and 12V led strip. When the IoT-based agriculture monitoring system starts, it checks the Soil moisture, temperature, humidity, and soil temperature. It then sends this data to the IoT cloud for live monitoring. If the soil moisture goes below a certain level, it automatically starts the water pump. We previously build Automatic Plant Irrigation System which sends alerts on mobile but doesn’t monitor other parameters. Apart from this, Rain alarm and soil moisture detector circuit can also be helpful in building Smart Agriculture Monitoring System.

4.2 SYSTEM ARCHITECTURE DIAGRAM



4.3 DESCRIPTION OF SOFTWARE FOR IMPLEMENTATION AND TESTING PLAN OF THE PROPOSED MODEL/SYSTEM

4.3.1. IOT (Internet of Things)

IoT stands for Internet of Things, which means accessing and controlling daily usable equipment and devices using Internet.

Our IoT tutorial includes all topics of IoT such as introduction, features, advantage and disadvantage, ecosystem, decision framework, architecture and domains, biometric, security camera and door unlock system, devices, etc.

4.3.1.1. What is an Internet of Things (IoT)

Let's look closely at our mobile device which contains GPS Tracking, Mobile Gyroscope, Adaptive brightness, Voice detection, Face detection etc. These components have their own individual features, but what about if these all communicate with each other to provide a better environment? For example, the phone brightness is adjusted based on my GPS location or my direction. Connecting everyday things embedded with electronics, software, and sensors to internet enabling to collect and exchange data without human interaction called as the Internet of Things (IoT).

The term "Things" in the Internet of Things refers to anything and everything in day to day life which is accessed or connected through the internet.

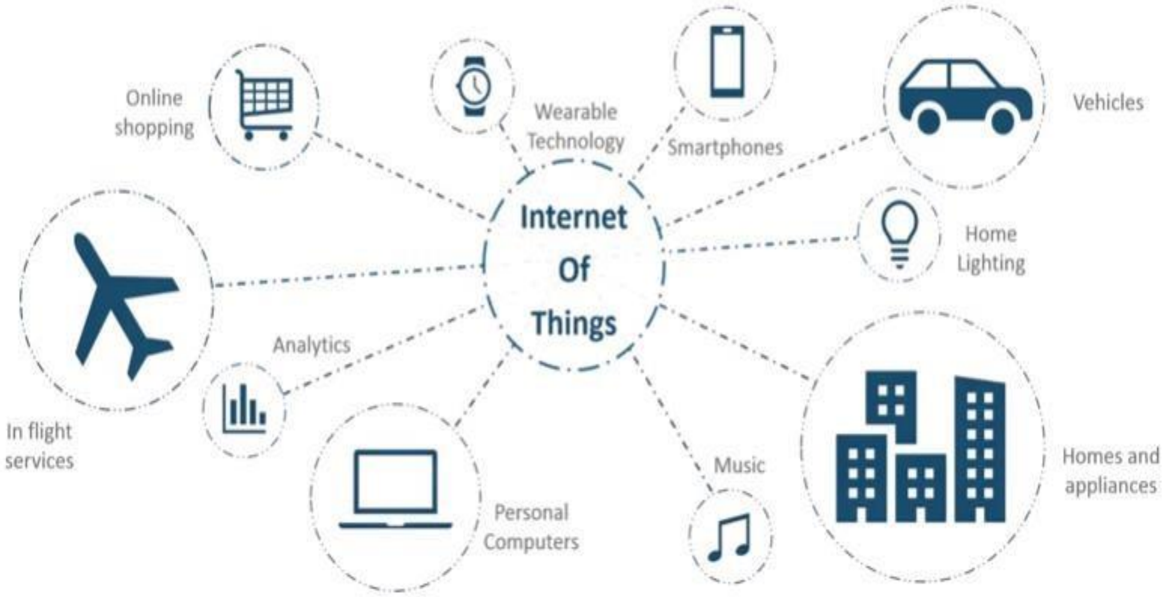


Fig.4.3.1.1. Internet Of Things

IoT is an advanced automation and analytics system which deals with artificial intelligence, sensor, networking, electronic, cloud messaging etc. to deliver complete systems for the product or services. The system created by IoT has greater transparency, control, and performance.

As we have a platform such as a cloud that contains all the data through which we connect all the things around us. For example, a house, where we can connect our home appliances such as air conditioner, light, etc. through each other and all these things are managed at the same platform.

If there is a common platform where all these things can connect to each other would be great because based on my preference, I can set the room temperature. For example, if I love the room temperature to to be set at 25 or 26-degree Celsius when I reach back home from my office, then according to my car location, my AC would start before 10 minutes I arrive at home. This can be done through the Internet of Things (IoT).

4.3.1.2. How does Internet of Thing (IoT) Work?

The working of IoT is different for different IoT eco system architecture. However, the key concept of there working are similar. The entire working process of IoT starts with the device themselves, such as smartphones, digital watches, electronic appliances, which securely communicate with the IoT platform. The platforms collect and analyze the data from all multiple devices and platforms and transfer the most valuable data with applications to devices.

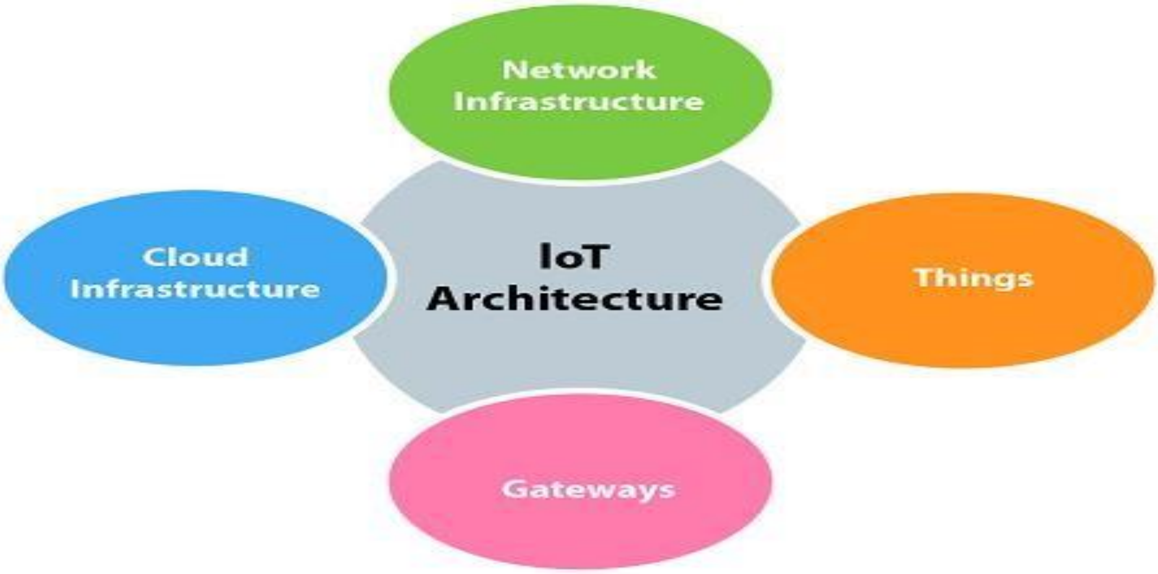


Fig.4.3.1.2. Working of IOT

4.3.1.3. FEATURES OF IOT

The most important features of IoT on which it works are connectivity, analyzing, integrating, active engagement, and many more. Some of them are listed below:

i. *Connectivity:* Connectivity refers to establish a proper connection between all the things of IoT to IoT platform it may be server or cloud. After connecting the IoT devices, it needs a high speed messaging between the devices and the cloud to enable reliable, secure and bi-directional communication.

ii. *Analyzing:* After connecting all the relevant things, it comes to real-time analyzing the data collected and use them to build effective business intelligence. If we have a good insight into data gathered from all these things, then we call our system has a smart system.

iii. *Integrating:* IoT integrating the various models to improve the user experience as well.

iv. *Artificial Intelligence:* IoT makes things smart and enhances life through the use of data. For example, if we have a coffee machine whose beans have going to end, then the coffee machine itself order the coffee beans of your choice from the retailer.

v. *Sensing:* The sensor devices used in IoT technologies detect and measure any change in the environment and report on their status. IoT technology brings passive networks to active networks. Without sensors, there could not hold an effective or true IoT environment.

vi. *Active Engagement:* IoT makes the connected technology, product, or services to active engagement between each other.

vii. *Endpoint Management:* It is important to be the endpoint management of all the IoT system otherwise, it makes the complete failure of the system. For example, if a coffee machine itself order the coffee beans when it goes to end but what happens when it orders the beans from a retailer and we are not present at home for a few days, it leads to the failure of the IoT system. So, there must be a need for endpoint management.

4.3.1.4. ADVANTAGES AND DISADVANTAGES OF IOT

Any technology available today has not reached to its 100 % capability. It always has a gap to go. So, we can say that Internet of Things has a significant technology in a world that can help other technologies to reach its accurate and complete 100 % capability as well.

4.3.1.4.1. Advantages of IoT

Internet of things facilitates the several advantages in day-to-day life in the business sector. Some of its benefits are given below:

- *Efficient resource utilization:* If we know the functionality and the way that how each device work we definitely increase the efficient resource utilization as well as monitor natural resources.

- *Minimize human effort:* As the devices of IoT interact and communicate with each other and do lot of task for us, then they minimize the human effort.
- *Save tim*e: As it reduces human effort then it definitely saves out time. Time is the primary factor which can save through IoT platform.
- *Improve security:* Now, if we have a system that all these things are interconnected then we can make the system more secure and efficient.

4.3.1.4.2. Disadvantages of IoT

As the Internet of things facilitates a set of benefits, it also creates a significant set of challenges.

4.3.1.5. EMBEDDED DEVICES SYSTEM IN IOT

It is essential to know about the embedded devices while learning the IoT or building the projects on IoT. The embedded devices are the objects that build the unique computing system. These systems may or may not connect to the Internet. An embedded device system generally runs as a single application. However, these devices can connect through the internet connection, and able communicate through other network devices.

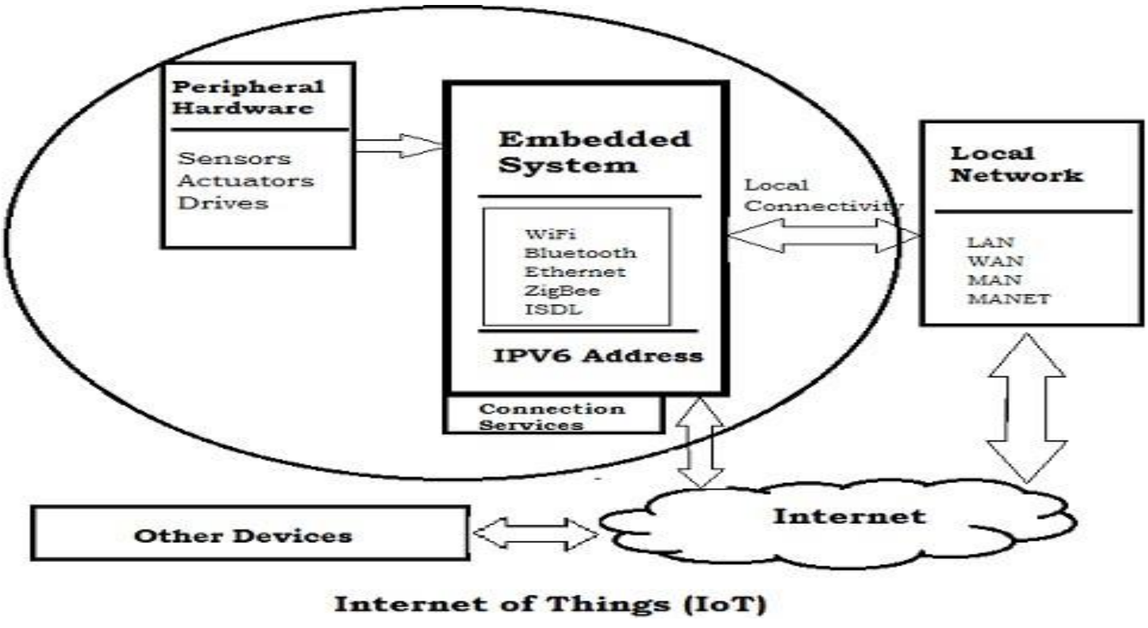


Fig.4.3.1.3. Embedded System in IOT

4.3.2. METER SENSOR:

In simple terms, a soil meter or sensor is a device you can use to measure and monitor the various aspects of soil like its pH, moisture content, temperature, and the environmental light present. What these soil meters do is provide the stakeholders a susceptible way to monitor the above-mentioned soil aspects in real-time i.e., directly on their fields. As a result, the entire process which was earlier used to make farmers wait for days or weeks for the lab reports can now be completed in a matter of a few minutes. Whether you’re an amateur gardener, a flower enthusiast, or someone who grows fruits or veggies at home, a soil meter is suitable for all. Besides being cost and time effective, a soil meter is also a budget-friendly option where you can rely on the results obtained which are more accurate than the lab results. In the below sections, I’m going to discuss the various aspects of an ideal soil like pH, temperature, moisture, and how each of these affects the plant’s growth.

Fig.4.3.2.1 Soil meter sensor

4.3.3. SOIL MOISTURE SENSOR:

Soil moisture sensors measure the volumetric water content in soil. Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighing of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content.

The relation between the measured property and soil moisture must be calibrated and may vary depending on environmental factors such as soil type, temperature, or electric conductivity. Reflected microwave radiation is affected by the soil moisture and is used for remote sensing in hydrology and agriculture. Portable probe instruments can be used by farmers or gardeners. Soil moisture sensors typically refer to sensors that estimate volumetric water content. Another class of sensors measure another property of moisture in soils called water potential; these sensors are usually referred to as soil water potential sensors and include tensiometers and gypsum blocks.

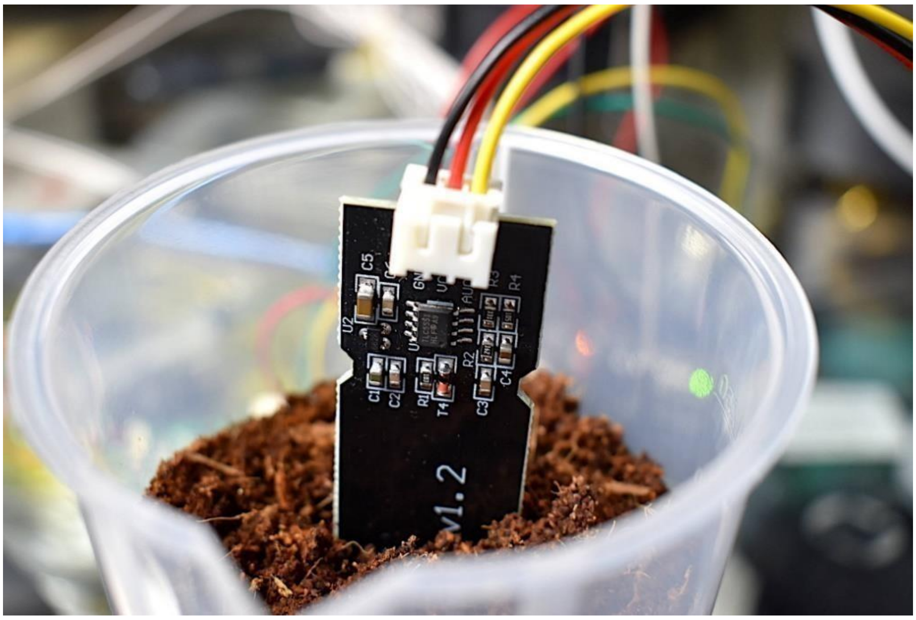


Fig.4.3.2.2 Soil Moisture Sensor

4.3.4. PASSIVE INFRARED SENSOR:

A passive infrared sensor (PIR sensor) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. They are most often used in PIR-based motion detectors. PIR sensors are commonly used in security alarms and automatic lighting applications. PIR sensors detect general movement, but do not give information on who or what moved. For that purpose, an imaging IR sensor is required. PIR sensors are commonly called simply "PIR", or sometimes "PID", for "passive infrared detector". The term *passive* refers to the fact that PIR devices do not radiate energy for detection purposes. They work entirely by detecting infrared radiation (radiant heat) emitted by or reflected from objects.

Fig.4.3.2.3 PIR Sensor

4.3.5. TEMPERATURE & HUMIDITY SENSOR:

The humidity sensing device DHT11 is a moisture holding substrate with the electrodes applied to the surface. The change in resistance between the two electrodes is proportional to the relative humidity. Humidity sensors work by detecting changes that alter electrical currents or temperature in the air.

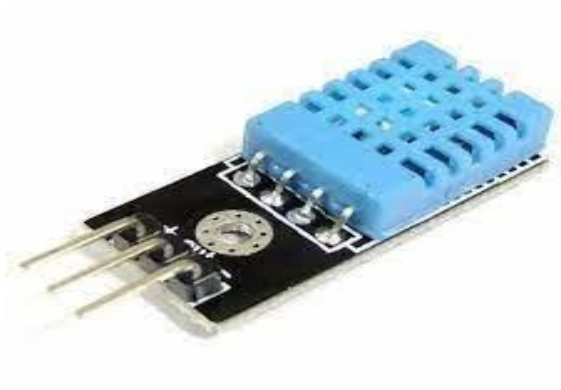


Fig.4.3.2.4 Temperature and Humidity Sensor

4.3.6 Arduino UNO:

Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analogy inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. You can tinker with your Uno without worrying too much about doing something wrong, worst-case scenario you can replace the chip for a few dollars and start over again. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

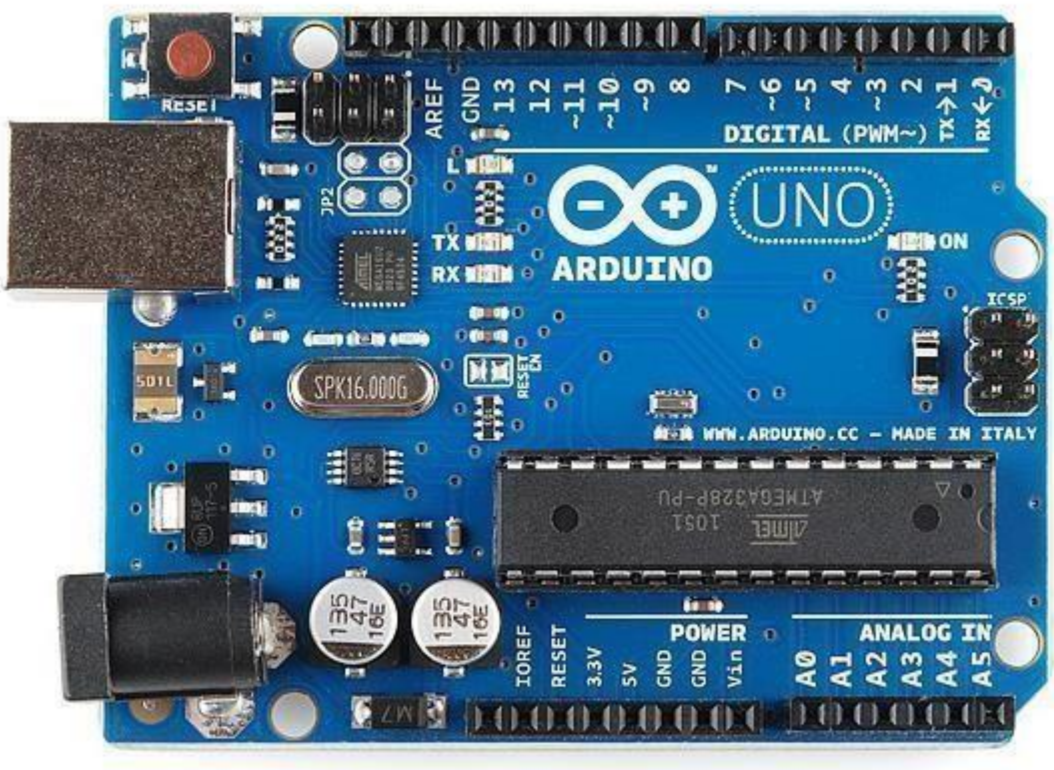


Fig 4.3.2.5 Arduino

4.3.7 LCD Display:

Liquid crystal displays (LCDs) have materials which combine the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered form similar to a crystal.

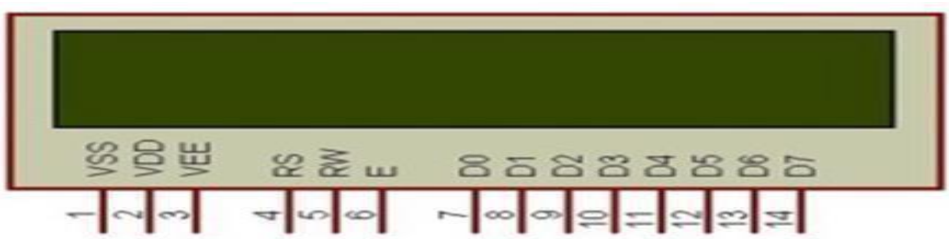


Fig 4.3.2.6 LCD Display

An LCD consists of two glass panels, with the liquid crystal material sand witched in between them. The inner surface of the glass plates are coated with transparent electrodes which define the character, symbols or patterns to be displayed polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle.

4.3.8 DC Motor:

A DC motor is any of a class of rotary electrical motors that converts direct current (DC) electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor.

Fig 4.3.2.7 DC Motors

DC motors were the first form of motor widely used, as they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight brushed motor used for portable power tools and appliances. Larger DC motors are currently used in propulsion of electric vehicles, elevator, and hoists, and in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.

4.3.9 Buzzer:

An audio signaling device like a beeper or buzzer may be electromechanical or piezoelectric or mechanical type. The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc. Based on the various designs, it can generate different sounds like alarm, music, bell & siren. The pin configuration of the buzzer is shown below. It includes two pins namely positive and negative. The positive terminal of this is represented with the '+' symbol or a longer terminal. This terminal is powered through 6Volts whereas the negative terminal is represented with the ''symbol or short terminal and it is connected to the GND terminal.

Fig 4.3.2.8 Buzzer

4.3.10. Relay:

A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals.

The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations thereof. Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal. Relays were first used in long-distance telegraph circuits as signal repeaters: they refresh the signal coming in from one circuit by transmitting it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

Fig 4.3.2.9 Relay

The traditional form of a relay uses an electromagnet to close or open the contacts, but relays using other operating principles have also been invented, such as in solid-state relays which use semiconductor properties for control without relying on moving parts. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called protective relays. Latching relays require only a single pulse of control power to operate the switch persistently. Another pulse applied to a second set of control terminals, or a pulse with opposite polarity, resets the switch, while repeated pulses of the same kind have no effects. Magnetic latching relays are useful in applications when interrupted power should not affect the circuits that the relay is controlling.

4.3.11 Water Pump:

The design and fabrication process of a mini water pump. All water pumps are motorized pumps that suck water from one end and push it out with force from the other end. We start with the fabrication of the fan with water suction blades. Now the system uses a frame with suction and out flow pipe connected to the inner frame. The inner frame consists of the fan arrangement. We now use a motor with a custom designed shaft arrangement to connect the motor to the fan arrangement. Now as soon as we power the motor it rotates the fan and thus drives the system which pulls water from one pipe and pushes it out with force through another pipe.

Fig 4.3.2.10 Water pump

4.3.2.12 ZIGBEE

ZigBee Physical Layer

ZigBee is a wireless technology developed as an open global standard to address the unique needs of low-cost, low-power wireless M2M networks. The ZigBee standard operates on the IEEE 802.15.4 physical radio specification and operates in unlicensed bands including 2.4 GHz, 900 MHz and 868 MHz. The 802.15.4 specification upon which the ZigBee stack operates gained ratification by the Institute of Electrical and Electronics Engineers (IEEE) in 2003. The specification is a packet-based radio protocol intended for low-cost, batteryoperated devices. The protocol allows devices to communicate in a variety of network topologies and can have battery life lasting several years.

The ZigBee Protocol

The ZigBee protocol has been created and ratified by member companies of the ZigBee Alliance . Over 300 leading semiconductor manufacturers, technology firms, OEMs and service companies comprise the ZigBee Alliance membership. The ZigBee protocol was designed to provide an easy-to-use wireless data solution characterized by secure, reliable wireless network architectures.

The ZigBee Advantage

The ZigBee protocol is designed to communicate data through hostile RF environments that are common in commercial and industrial applications.

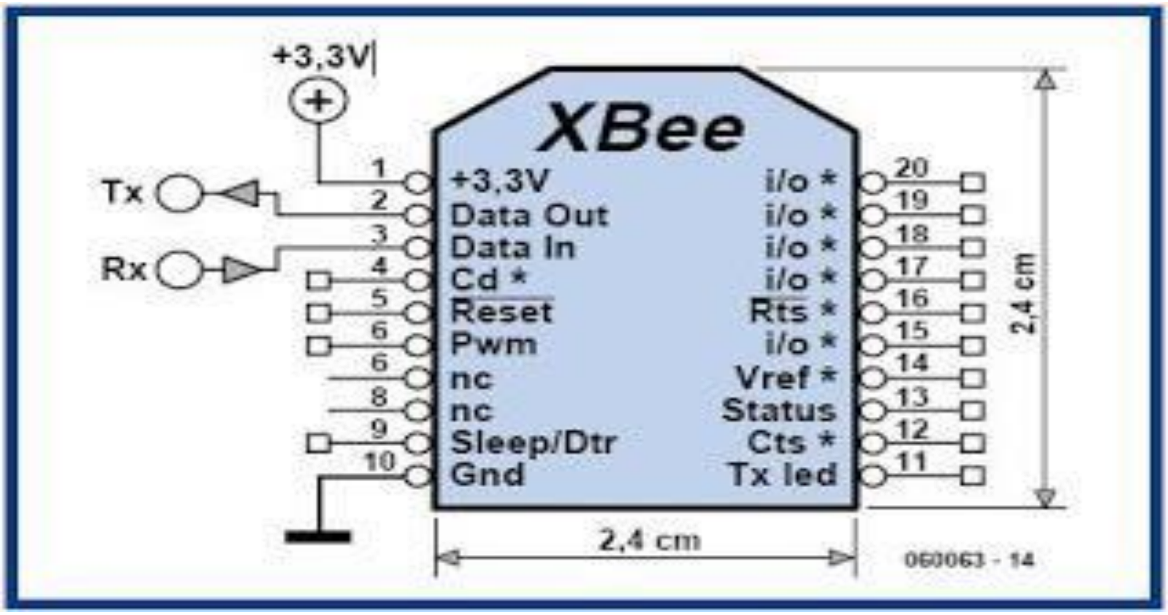


Fig.4.3.2.12 ZigBee Pin Diagram

ZigBee is a specification for a suite of high-level communication protocols used to create personal area networks built from small, low-power digital radios. ZigBee is based on an IEEE 802.15.4 standard. Though its low power consumption limits transmission distances to 10–100 meters line-of-sight, depending on power output and environmental characteristics,[1] ZigBee devices can transmit data over long distances by passing data through a mesh network of intermediate devices to reach more distant ones. ZigBee is typically used in low data rate applications that require long battery life and secure networking (ZigBee networks are secured by 128 bit symmetric encryptionkeys.) ZigBee has a defined rate of 250 kbit/s, best suited for intermittent data transmissions from a sensor or input device. Applications include wireless light switches, electrical meters with in-home-displays, traffic management systems, and other consumer and industrial equipment that requires short-range low-rate wireless data transfer. The technology defined by the ZigBee specification is intended to be simpler and less expensive than other wireless personal area networks (WPANs), such as Bluetooth or Wi-Fi.

ZigBee enables broad-based deployment of wireless networks with low-cost, lowpower solutions. It provides the ability to run for years on inexpensive batteries for a host of monitoring and control applications. Smart energy/smart grid, AMR (Automatic Meter Reading), lighting controls, building automation systems, tank monitoring, HVAC control, medical devices and fleet applications are just some of the many spaces where ZigBee technology is making significant advancements.

4.4 PROJECT MANAGEMENT PLAN

Introduction:	**September 1-30**
Literature Survey:	**October 1-31**
System Design:	**November 1-30**
System Implementation:	**December 1-31**
Testing:	**January 1-30**
Working model	**APRIL-MAY 3**

Fig 4.5 Project management plan

The project management plan for IoT Based Precision Agriculture system should include the following aspects:

- *Project Scope:* Define the scope of the project, including the key features and functionalities of the software.
- *Project Objectives:* Define the project objectives and the expected outcomes, including the benefits of the alerting and monitoring system for the farmers.
- *Project Timeline:* Develop a detailed timeline for the project, including the milestones and deadlines for each phase of the project.
- *Resource Planning:* Identify the required resources for the project, including the team members, hardware, software, and other resources.
- *Risk Management:* Identify potential risks that may affect the project's success, such as technical challenges, budget constraints, and timeline delays. Develop a risk management plan to mitigate these risks.
- *Quality Management:* Develop a quality management plan to ensure that the software meets the required quality standards and meets the project objectives.
- *Communication Plan:* Develop a communication plan to ensure effective communication between the project team, stakeholders, and other parties.
- *Project Budget:* Develop a detailed project budget that includes all the necessary costs, such as salaries, hardware, software, and other expenses.
- *Project Monitoring and Control:* Develop a plan for monitoring and controlling the project, including regular progress reviews and updates to ensure that the project is on track.
- *Project Closure:* Develop a plan for closing the project, including the handover of the software to the bus company, final project documentation, and a post-project evaluation to identify any lessons learned and areas for improvement.

In summary, the project management plan for IoT Based Precision Agriculture system for the farmers should include a detailed plan for managing the project from start to finish, including scope, objectives, timeline, resource planning, risk management, quality management, communication plan, budget, monitoring and control, and project closure.

4.5 TRANSITION/ SOFTWARE TO OPERATIONS PLAN

- Economic feasibility- The SMART AGRICULTURE being developed is economic because it conserves water by using soil moisture sensor.
- The sunlight, moisture, pH of the soil is measured by using 3 Way Soil Meter.
- The destruction of crops by predators are prevented by using Passive Infrared sensor (PIR).
- Global System for Mobile Communication (GSM) keeps them updated about their field either through image or voice note.
- Technical feasibility- The technical requirement for the system is economic and it does not use any other additional Hardware and software.
- Behavioral feasibility- The system working is quite easy to use and learn due to its simple but attractive interface. Users require no special training for operating the system.
- Sensors do not measure water in the soil directly. Instead, they measure changes in some other soil property that is related to water content in a predictable way, so it is easy to detect the moisture content in the soil and helpful for the farmers to get updates about their field easily.

CHAPTER 5

IMPLEMENTATION DETAILS

5.1 Development and Deployment Details

To develop and deploy the IoT Based Precision Agriculture, the following steps need to be taken:

1. ***Define Project Requirements:*** The first step is to define the project requirements through detailed project discussions with stakeholders. The discussions will focus on the system's features and functions, hardware and software requirements, communication protocols and the system's integrations.

2. ***Develop a System Architecture:*** A system architecture will have to be developed, highlighting important components of the system, including hardware and software equipment, data communication protocols, data security, and visualization interfaces.

3. ***Select Necessary Hardware and Software:*** Up-to-date hardware and software systems that are compatible with the system's architecture will be selected. This includes the sensors for data collection, communication hardware, control room equipment and interfaces, and backup systems for maintenance.

4. ***Integrating and Testing the System:*** Once the hardware and software equipment are selected, it will be integrated into the system architecture, followed by data testing to ensure errors are eliminated.

5. ***Deploying the System:*** Deployment will involve the setting up of a centralized control room, integration of alerting and communication systems, and training on the use of the system.

6. ***Performance Monitoring:*** The system's performance will be continuously monitored to mitigate risks through alerts and adjust systems where necessary.

7. ***Maintenance and Upgrades****:* Maintenance will be carried out using the backup system for minimal downtime while the flexibility of the system's architecture will allow for software upgrades for improved functionality.

5.2 ALGORITHMS

- Passive Infrared (PIR)sensor detects infrared light radiated by a warm object.
- The moisture in the soil is measured by using soil moisture sensor.
- The sensor measures the moisture content and based on the moisture content, it turns on or off the motor.
- 3 Way Soil Meter: Lets you know that soil is dry or not. It controls pH level in soil, acidic or alkaline is suitable for your plants.
- Tests whether plants are getting adequate sunlight or not. IOT connects all the sensors and sends their values and messages to the system for display.
- Principle of moisture meter: Moisture meters use the principle of electrical resistance to measure the conductivity of the soil. Soil moisture sensors measure the water content in the soil and can be used to estimate the amount o stored water in the soil horizon. Soil moisture sensors do not measure water in the soil directly. Instead, they measure changes in some other soil property that is related to water content in a predictable way.
- These sensors can be stationary or portables such as handheld probes. Stationary sensors are placed at predetermined locations and depths in the field, whereas portable soil moisture probes can measure soil moisture at several locations.

5.3 TESTING

The testing of an IoT based Precision Agriculture is essential to ensure that it meets its project objectives, mitigates project risks and guarantees the safety of Farmers. The testing process includes:

1. ***Functional Testing:*** This involves checking the system's hardware and software against the specified requirements. This stage is meant to ensure that the system's features and functions perform as expected.

2. ***Performance Testing:*** This involves testing the system's performance in different scenarios to ensure reliability and efficient detection of potential hazards. The system should be able to identify hazardous situations accurately and at the right time.

3. ***Integration Testing:*** This involves testing the communication channels between hardware and software systems, verifying that data collection and integration onto the system are efficient and accurate.

4. ***User Acceptance Testing:*** This involves testing the system with end-users to ensure the system's users can operate it with ease and achieve the project's intended objectives.

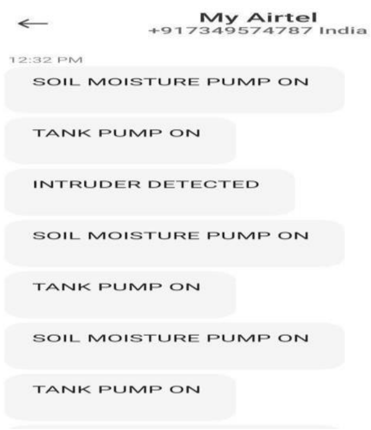
5. ***Regression Testing:*** This involves testing a previously tested software feature for regression. This ensures that any changes made to the system or any upgrades did not break other features.

6. ***Security Testing:*** This test ensures that the system data is safe and secure from potential cyber-attacks.

7. ***Stress Testing:*** This test aims to determine the system's performance during high demand periods or in extreme scenarios.

CHAPTER 6
RESULTS AND DISCUSSION

LCD will display message “Intruder detected” when PIR Sensor detects the motion in the farm. Intruder can be either human or animals. “Temperature value in °C” displayed simultaneously by the use of temperature sensor, “Moisture low and tank pump on” will be displayed when soil moisture sensor measured moisture is low. “Water level in tank in inches” measured by Ultrasonic sensor will be displayed in the LCD display. SMS (i.e. DRIP IRRIGARTION PUMP ON) will send to registered mobile number when moisture content is low in the soil. SMS (i.e. TANK PUMP ON) will send to registered mobile number when water level in tank is low. The goal of smart agriculture research is to ground a decision-making support system for farm management. A system that optimizes and examines how high-tech farming can aid the production output as well as focuses on the preservation of resources. Smart farming can make agriculture more profitable for the farmer. Decreasing resource inputs will have the farmer money and labor, and increased reliability of spatially data will reduce risks. The use of Arduino helped me to build an embedded system. In general, the project was successful and worked properly and succeeded in delivering the prototype on due time.



CHAPTER 7

CONCLUSION

7.1 Conclusion

Thus, the smart farming will revolutionize the world of farming and it will increase the productivity as well as improve the quality and can save lives of farmer. There is an urgent need for a system that makes the agricultural process easier and burden free from the farmer’s side. With the recent advancement of technology, it has become necessary to increase the annual crop production output of our country India, an entirely Acrocentric economy. The ability to conserve the natural resources as well as giving a splendid boost to the production of the crops in one of the main aims of incorporating such technology into the agricultural domain of the country. To save farmer’s effort, water and time has been the most important consideration. Hence, a smart farming IoT based agriculture stick for live monitoring of temperature, humidity, soil moisture, pH, sunshine, smoke detection, wind speed and rainfall conditions has been proposed using NodeMCU and Cloud computing. The stick has high efficiency and accuracy in fetching these live data. The agriculture stick being proposed in this project will assist farmers in increasing the agriculture yield and take efficient care of food production as the stick will always provide helping hand to farmers for getting accurate live feed of environmental results. This will also enable farmers to use IoT technology and they will be able to implement other smart farming techniques in their land to increase Yield. This capstone project gave me the chance to learn new technologies and work with new tools, this was a real proof that AUI has taught us to be long-life learners and to master self-learning before teaching us other class materials. Of course, this project is a combination of what I learned from all my computer science classes, the programming languages, the database systems and the engineering process that is important in any engineering project, all together with what I learned from other disciplines and by myself about IoT and the use of Arduino helped me to build an embedded system. In general, the project was successful and worked properly and succeeded in delivering the prototype on due time. I am proud and happy for this achievement especially that this is my first real big theoretical and practical project. It enabled me to get concrete results and to realize that I can indeed build products that would be beneficial in real life and that I can customize upon demand as future projects.

7.2 Future Work:

The existing solutions have incorporated IoT based smarter applications for solving several challenges in the agricultural and farming domain. I discuss the various prospects of these applications to improve the existing solutions as below, whereas the following sections shall show the path to improve the current situation point-wise.

Cost-effectiveness: Researchers around the world are mainly focusing at the reduction of hardware and software costs in IoT deployments, while maximizing the system output. Developing country men seek cost effective equipment's so that extra cost needed due to the use of foreign imported devices to build the systems get minimized. Though, international farms are developing cutting edge technologies in this regard, the challenge still exists how to bring down the cost further. Presented works do lack in cost effectiveness. Hence, such point is deliberately the need of the time.

Standardization: Current works in do not confirm to the standardized format of representation of data as well as the process. Standardization is another clot which may precisely be operated for growth of IoT. Standardization in IoT signifies to lower down the initial barriers for the service providers and active users, improvising the interoperability issues between different applications or systems and to perceive better competition among the developed products or services in the application level. Security standards, communication standards and identification standards need to be evolved with the spread of IoT technologies while designing emerging technologies at a horizontal equivalence. In addition, fellow researchers shall document industry specific guidelines and specify required standards for efficient implementation of IoT. Agriculture-related standardization while employing IoT should strictly be followed.

Heterogeneity: IoT is a very complicated heterogeneous network platform. But the mentioned works in agriculture are unable to interact with heterogeneous modules or communication technologies. This, in turn enhances the complexity among various types devices through various communication technologies showing the rude behaviour of network to be fraudulent, and delayed as clearly mentioned that the management of connected objects by facilitating through collaborative work between different things (hardware components or software services) and the administering them after providing addressing, identification, and optimization at the architectural and protocol levels is a serious research issue. However, to succeed at the agriculture domain, IoT need to be reassessed to sort out the depletion of the common platform.

Context awareness: When billions of sensor enabled things are connected to the Internet, it may not be feasible for the user group to handle all the data collected by the sensors. Context-awareness computing techniques need to be used in better way to help decide what data needs to be processed. Discussed Agri-tasks are void of context awareness. This seems to ascertain the negation of information validation in form of continuous disrupted process. Surrounding environmental parameters and self assessment may transfer the localized context to others while making a well connected self cum periphery aware IoT ecosystem.

7.3 Implementation issues:

Autonomy: The future applications need to be fully autonomous to get leveraged with the specific needs.

Cost: Low-cost solutions are desirable for growth and usage of IoT based solutions.

User control panel: Mostly, non-technical people use IoT-agri based solutions in the field. Hence, it would be better to design a user-friendly interface in form of a control panel for efficient applications.

Energy: Green computing techniques need to be disseminated with the present IoT based agriculture where IoT devices shall consume very less amount of energy that may in tern increase their life expectancy and make them less faulty, hence highly productive.

Interoperability: Interoperability issues are the most common in IoT devices. Devices should be capable enough to communicate with others from different genre so as the overall system be work as a live ecological setup.

Artificial Intelligence: Machine learning, and artificial intelligence techniques to be implemented together to cope up with predictive and behavioral analysis functionalities through employments of advanced decision support system and real-time assessments.

Maintenance: IoT systems shall be designed in such way that maintenance time and cost, both are reduced up to a descent level of acceptance towards the naive users.

System Portability: The probability of current system architectures need to be enhanced to make them solicited enough with particular aspects agricultural requirements.

7.4 Research Issues:

In recent times, with the advent of sensor-cloud, bigdata analytics and ubiquitous computing, new ground breaking applications are being envisioned. I briefly describe the concepts as below.

Sensor-cloud enabled computing: It is a recent concept that refers to the on-field IoT applications empowered with cloud computing and finding the meaningful information from large volume of data with various data types generated in high velocity. Moreover, the sensor cloud improves the data management, data access, and device management related tasks, while making agriculture smart in nature. Few applications may be based on below. A cloud-enabled storage system for measuring spatial variation of soil cum other environmental parameters depending

upon various seasons. A mobile sensor-cloud service may be designed for crop health monitoring. A cloud based infrastructure may be developed to predict the futuristic yield in crop productivity. Smart irrigation system for large fields may be developed which shall be controlled by the autonomous sensor-cloud. A cloud controlled green house system may be developed to monitor the production of offseason fruits and vegetables under a predefined environmental model. Remote operated field crops planting system need to be developed so as farmer less field may be plated by autonomous planting equipment. Cloud based horticulture management system may be developed to produce fruits in any season during the year. Cloud enabled smart floriculture environments need to be developed so as the flowers be kept fresh and fragrant for a long period of time.

Real-time livestock monitoring system may be empowered by the cloud services to uplift the economic status of the farmer in automatic way. Fish farming is an crucial area when cloud enabled services could monitor and control the process staring with breeding up to selling in the market. Cloud enabled agro-logistics system shall leverage high profit margin to the farmer by dispatching the vegetables, and other agri-products to the market in time. Big data analytics: According to big data analytics can be applied to find the inner sight of large volume of data that is generated at very high speed and belong to different genre. Many aspects can be discovered using big data analytics such as finding futuristic business trends, unknown structural patterns, customer preferences, prediction of disasters, systematic correlation between many components of fact etc. I hereby list a few agricultural applications suitable to be attached with big data.

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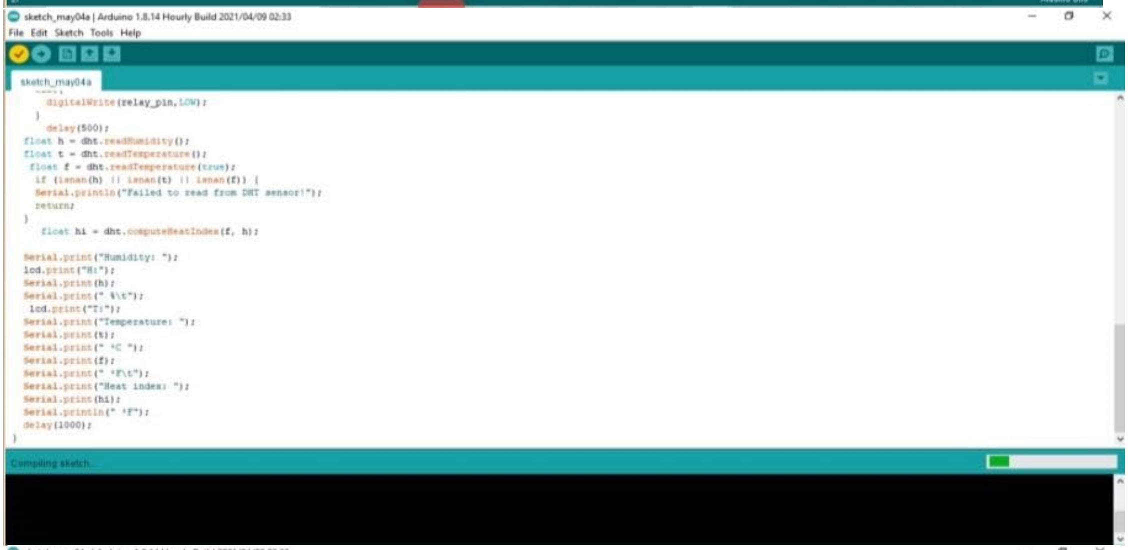
APPENDICES

A. SOURCE CODE

```
#include <SPI.h>

#include <Adafruit_GFX.h>

#include <Adafruit_PCD8544.h>

#include <DHT.h>

float t, h, m1,  m2;

Adafruit_PCD8544 display = Adafruit_PCD8544(6, 5, 4, 3, 2);

#define DHTPIN 12
#define DHTTYPE DHT22

DHT dht (DHTPIN, DHTTYPE);

void setup()

{

  Serial.begin(9600); while (!Serial) continue;



  display.begin();            display.setContrast(35); display.clearDisplay();

          display.setTextSize(1); display.setTextColor(BLACK); display.setCursor(0,

  0); display.println(" IoT Based"); display.println("Smart

  Farming"); display.display(); delay(2000);

  display.clearDisplay(); display.display(); pinMode(13,

  OUTPUT); pinMode(11, INPUT); digitalWrite(13, LOW);

  dht.begin();

}

void loop() {
```

```
float h = dht.readHumidity(); float t = dht.readTemperature(); float m =
abs(100-
(analogRead(A0)/10.23)); if (isnan(h) || isnan(t)) {
  Serial.println("Failed to read from DHT sensor!"); return;
}
int it = t*100; int ih = h*100; int im = m; bool
pc = digitalRead(11); digitalWrite(13, pc);
display.clearDisplay();  display.setCursor(0,
0); display.println("Smart Farming");
display.print("Temp: "); display.println(t,1);
display.print("Hum: "); display.println(h,1);
display.print("Soil: "); display.println(m,0); if
(pc == 1) display.print("Pump on");
display.display();


// Send Data to Cloud StaticJsonDocument<200> doc;
doc["it"] = it;
doc["ih"] = ih;
doc["im"] = im;
doc["pc"] = pc; serializeJson(doc, Serial); delay(500);
}
```

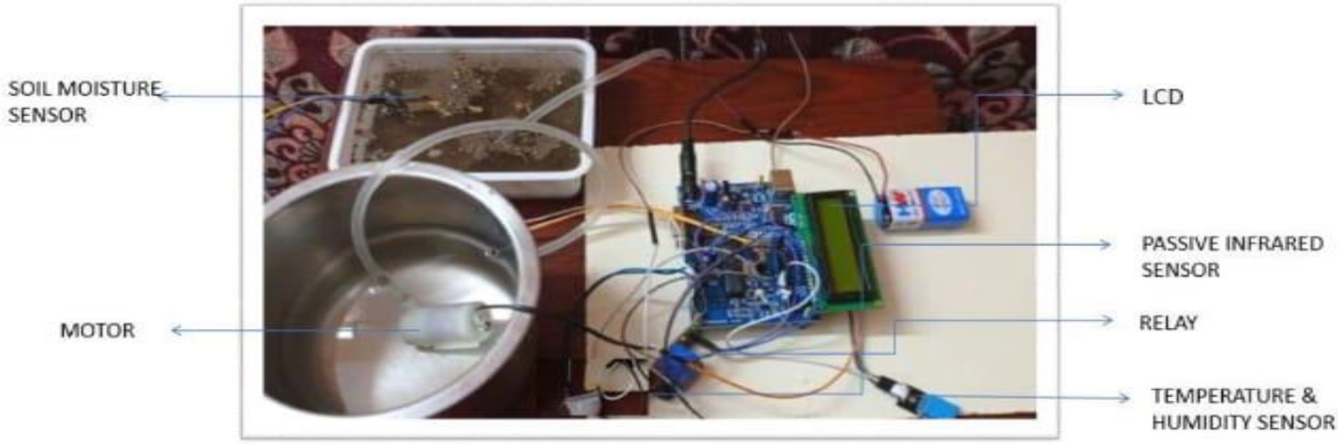
```
sketch_may04a | Arduino 1.8.14 Hourly Build 2021/04/09 02:33
File Edit Sketch Tools Help
sketch_may04a
#include "DHT.h"
#include <LiquidCrystal.h>
LiquidCrystal lcd(13,12,11,10,9,8);
#define DHTPIN A1
#define DHTTYPE DHT11
const int sensor_pin = A0;  /* Soil moisture sensor O/P pin */
pir_pin = A2;
buzzer = 5;
int relay_pin = 8;
DHT dht(DHTPIN, DHTTYPE);

void setup() {
  // put your setup code here, to run once:
  Serial.begin(9600); /* Define baud rate for serial communication */
  lcd.begin(16,2);
  pinMode(relay_pin,OUTPUT);
  pinMode(pir_pin,OUTPUT);
  pinMode(sensor_pin,OUTPUT);
  pinMode(buzzer,OUTPUT);
    dht.begin();
    lcd.print("AGRICULTURE MONITORING SYSTEM");

}

void loop() {
  // put your main code here, to run repeatedly:
  float moisture_percentage;
Compiling sketch...
27
Arduino Uno
```



```
sketch_may04a | Arduino 1.8.14 Hourly Build 2021/04/09 02:33
File Edit Sketch Tools Help
sketch_may04a
     digitalWrite(relay_pin,LOW);
   }
     delay(500);
  float h = dht.readHumidity();
  float t = dht.readTemperature();
   float f = dht.readTemperature(true);
    if (isnan(h) || isnan(t) || isnan(f)) {
    Serial.println("Failed to read from DHT sensor!");
    return;
  }
     float hi = dht.computeHeatIndex(f, h);

  Serial.print("Humidity: ");
  lcd.print("H:");
  Serial.print(h);
  Serial.print(" %\t");
   lcd.print("T:");
  Serial.print("Temperature: ");
  Serial.print(t);
  Serial.print(" *C ");
  Serial.print(f);
  Serial.print(" *F\t");
  Serial.print("Heat index: ");
  Serial.print(hi);
  Serial.println(" *F");
  delay(1000);
}
Compiling sketch...
```

```
sketch_may04a | Arduino 1.8.14 Hourly Build 2021/04/09 02:33
File Edit Sketch Tools Help
sketch_may04a
void loop() {
  // put your main code here, to run repeatedly:
  float moisture_percentage;
  int sensor_analog;
  sensor_analog = analogRead(sensor_pin);
  moisture_percentage = ( 100 - ( (sensor_analog/1023.00) * 100 ) );
  Serial.print("Moisture Percentage = ");
   lcd.print("M:");
  Serial.print(moisture_percentage);
  Serial.print("%\n\n");
  digitalWrite(relay_pin,HIGH);
  delay(5000);
  digitalWrite(relay_pin,LOW);
  delay(5000);

  pir = analogRead(pir_pin);

  if(pir>250)
  {
    digitalWrite(buzzer,HIGH);
    Serial.print("PIR:");
     lcd.print("P:");
      lcd.print(pir);
    delay(3000);
    digitalWrite(buzzer,LOW);
  }
Compiling sketch...
7
Arduino Uno
```

B. SCREENSHOTS



C. RESEARCH PAPER

AN IOT-BASED PRECISION AGRICULTURE

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Abstract

"Smart farming is an emerging concept because IOT sensors are capable of providing information about their fields." Agriculture is the largest provider of livelihood in rural India. The growth in agricultural production has been stagnant for the past several years. With the help of IoT devices, you can know the real-time status of the crops by capturing the data from sensors. Using predictive analysis, you can get insight to make better decisions related to harvesting. The trend analysis helps farmers predict upcoming weather conditions and the harvesting of crops. IOT can transfer data over a network without requiring human-to-human or human-to-machine interactions. IOT in agriculture uses robots, drones, remote sensors, and computer imaging combined with continuously progressing machine learning. Analytical tools are used for monitoring crops, surveying, and mapping the fields. It provides farmers with data for rational farm management plans to save both time and money.

Keywords *– Computer imaging, Remote sensors, Analytical tools, Data transfer, Temperature sensor.*

I. Introduction

Smart farming or precision agriculture is the use of technology to monitor and optimize agricultural practices. It involves using sensors, drones, robots, and other technologies to collect data on crop yields, soil moisture, temperature, humidity, and other factors that affect crop growth. This data is then analysed to make better decisions about irrigation, fertilization, and pest control. Smart farming can help farmers increase yields, reduce costs, and conserve resources.

Some of the techniques used in smart farming include precision agriculture, efficient water management, and soil moisture and humidity monitoring. Precision agriculture helps farmers use land according to its quality and nature, avoiding the improper and excessive application of pesticides and fertilizers. Efficient water management is essential, especially in areas where water tables are diminishing rapidly. Soil moisture and humidity monitoring can help farmers optimize irrigation, fertilizer application, and pest control.

Smart farming also involves the use of IoT devices, such as sensors and wireless networks, to collect and transmit data in real time. This data can be used to make informed decisions about crop management, reducing waste, and conserving resources. For example, an IoT-based agricultural monitoring system can use a soil moisture sensor to determine whether the soil is wet or dry, and if the moisture level in the soil is low, turn on a motor switch to activate a water pump.

Overall, smart farming is essential for the future of agriculture. With the use of advanced technologies such as robots, temperature and moisture sensors, aerial images, and GPS technology, farms can become more efficient, profitable, safe, and environmentally friendly. It is crucial to encourage the adoption of these technologies and provide training and support to farmers, especially those in rural areas.

II. Literature survey:

In 2016 Prof. K. A. Patil and Prof. N. R. Kale has been described Climate changes and rainfall have been erratic over the past decade. Due to this in the recent era, climate-smart methods called smart agriculture, is adopted by many Indian farmers. Smart agriculture is an automated and directed information system. technology implemented with the IOT (Internet of Things). IOT is developing rapidly and being widely applied in all wireless environments. In this paper, sensor technology and wireless Network integration of IOT technology have been studied and reviewed based on the actual situation of the agricultural system. A combined approach using the internet and wireless communications, A remote monitoring system (RMS) is proposed. The major objective is to collect real-time data on the agricultural production environment. That provides easy access to agricultural facilities such as alerts through Short Messaging Service (SMS) and advice on the weather pattern, crops, etc.

In 2018, Manishkumar Dholu, Mrs. K. A. Ghodinde has described about the Internet is experiencing very explosive growth. Nowadays, with so many devices connected to it, we had only personal computers (PCs) and mobile handsets with internet access earlier, but now, with the Internet of Things, i.e., the IoT concept of connecting things with the internet, millions of devices are connecting with it. This development of the IoT leads to the idea of machine-to-machine communication, which means that two machines can communicate with one another, as well as all the data that was previously on a private server can now be found on the internet, so the user can access it remotely. The application of IoT is feasible in almost all industries, particularly where speed of communication is not an issue. This paper proposes the application of cloud based IoT in the agriculture domain. Precision agriculture is basically a concept that insists on providing the right number of resources at the exact right time. These resources could include anything, such as water, light, pesticides, etc., to implement precision agriculture. In agriculture, the benefits of IOT have been utilized in the proposed paper. The fundamental idea is to sense all the required agricultural field parameters and take the required decision to control the actuator. These agriculture parameters are soil moisture, temperature, and relative humidity. Humidity around the plant, light intensity Based on the reading sensed by the sensor, suitable action is taken, i.e., opening the irrigation valve. is actuated based on soil moisture readings, the valve for the forger (for spraying water droplets) is actuated based on relative humidity (RH) readings, etc. This paper proposes the development of a sensor node capable of measuring all these parameters and creating the actuation signal for all the actuators. On top of that, sensor nodes are also capable of sending this data to the cloud. An Android application is also being developed in order to access all these agricultural parameters.

In 2019, G. S. Nagaraja, Avinash B Soppimath, T. Soumya, Abhinith A has described This sector contributes to the Indian economy a great deal. It contributes over 17% of the total. Gross Domestic Product (GDP). With the introduction of newer seed varieties, new methods of agriculture, and the use of efficient fertilizers, crop production has increased. But without using smarter methods, the agricultural domain remains in the backlog. The conventional method involves a lot of human instincts, which at times fail. And as a result, a more intelligent approach to crop production is required. using the Internet of Things (IoT) and machine learning techniques. The proposed system is the smart agriculture management system (SAMS), which is automated to help farmers increase crop production. The system also helps reduce resource waste by adopting a technique called precision agriculture. The system uses different sensors for data acquisition to measure various environmental factors that are required for crop production. The data obtained from these sensors is visualized in the form of graphs.

In 2022, Rudi Hartono, Rayhan Emillul Fata, Ridho Fata Ulwan has described The quality of agricultural products depends on the experience and instincts of farmers in understanding the land conditions and crops. Of course, when compared to the calculated calculations, these results are less. We are here to help farmers manage their agricultural land in the face of these problems. Ionic offers products in the form of IoT devices that can monitor and automate agricultural land. With the precision farming method, the monitoring data will be precise, and the execution of agricultural management will become more precise and automated thanks to the resulting data. The manufacture of the product starts by analyzing the device's production needs. These needs are in the form of hardware development needs in the form of IoT devices and software development needs in the form of applications. This analysis turns the device into a prototype product ready to be tested. These activities will produce IoT products and software to help farmers manage their agricultural land. To be able to produce these devices, production costs and the value of products and services are required, amounting to $24,998,200.00.

In 2022, K.Nanthini, M.karthikeyan, V.Erajavignesh and G.Bala Ajith Kumar has described The Internet of Things (IoT) as a new technology trend that is being used in almost every area of life. When connected to the internet and to each other, your entire system becomes smarter. We have used IoT in all areas of our lives, including smart cities, smart homes, and smart retail. Much more. From 9.6 billion by 2050, agriculture needs to deliver even faster to meet this type of demand. This is possible with the latest technology, especially the IoT. The IoT enables labor-free farms. Not only can it be used for large-scale agriculture, but it can also be used for livestock management, greenhouse management, and agricultural land management. The most significant tool for the IoT is the sensor. A sensor is a device that collects important data that is interpreted to obtain the required analysis. The important objective of sensors is to determine the soil's physical qualities and the environment. The main applications of sensors are control and supervision, safety, alarms, diagnostics, and analytics. Sensors make innovative agriculture more effective and trouble-free. In agriculture, the sensor is mainly used for measuring NPK (nitrogen, phosphorus, and potassium) levels and detecting disease and soil moisture content. The main solution to this problem is smart farming, which modernizes traditional farming practices. This paper narrates the role of IoT applications in smart agriculture. Smart farming is also known as precision farming since it uses accurate information to draw outcomes. It demonstrates the different sensors, applications, challenges, strengths, and weaknesses that support the IoT and agriculture.

III. Existing System:

• The destruction of crops by predators is prevented by using passive infrared sensors (PIR).

• The Global System for Mobile Communication (GSM) keeps them updated about their field either through an image or voice note.

• Technical feasibility: The technical requirement for the system is economic, and it does not use any other additional hardware or software.

• Behavioural feasibility the system is quite easy to use and learn due to its simple but attractive interface; users require no special training to operate the system.

• Sensors do not measure water in the well directly. Instead, they measure changes in Some other solubility property is predictable in relation to water content, making it easy to predict. to detect soil moisture content and to easily provide farmers with information about their field.

There is no system in place for finding acceptable crops, and even if there were, there wouldn't be an Android app for it. Some of them use websites, whilst others don't, and the job is done by hand. The farmers simply apply the techniques they have mastered through time. The farmers lack awareness about issues like the impact of repeatedly sowing the same seed over a period of years and lack access to essential resources. Lack of resources and understanding results in a lot of work being put in with little payoff, which is unprofitable.

IV. Proposed System:

In our venture traditional farming requires more labour, is dangerous, and increases the chance of suicide because of poor crops or a natural calamity. The benefits of smart agriculture technology are being reaped by big fish and the corporate world, while small farmers are oblivious of it. They are eager to resume their former career of farming because Pandemic COVID-19 forced them to return to their various villages without any means of support. Currently, small participants in farming can implement the Smart Irrigation System and benefit from high yields and profit margins by automating the irrigation process by assessing the moisture of the soil and the climate circumstances (like rain). IOT development provides information about conditions to rural societies. such as the climate, soil productivity, and atmosphere. The areas of weed, water level, bug recognition, animal interference in the field, improvement of the alteration, and cultivation are all monitored during harvest. With the use of a remote sensor framework and WSN (wireless sensor networking) devices, farmers can obtain information on farm conditions while seated anywhere. There is no system in place for finding acceptable crops, and even if there were, there wouldn't be an Android app for it. Some of the work is done manually, while others don't have websites. The farmers only apply the techniques they have mastered through time. The farmers lack understanding about the impact of farming practices on the land, as well as access to essential resources. Over several years, the same seed is continuously sowed. Lack of resources and understanding results in a lot of work being put in with little payoff, which is unprofitable. By developing an Android application that enables farmers to learn about the availability of resources and crops suitable for their region, the proposed solution addresses such problems. In order to save time and money through the effective use of resources and money, this paper will provide a system that lessens the farmer's labour while increasing the yield. In addition to providing this knowledge, the system aids the farmer in locating neighbouring markets, pesticide stores, and labour via contractors. Every nation has practiced agriculture for many years. Agribusiness is both a science and an art of growing plants. The main innovation in the rise of sedentary human civilisation was agriculture. Hand labour has been used in agriculture for ages. The goal of advancing agriculture is essential given the global trend towards new technologies and applications. The Internet of Things is crucial to smart agriculture. IOT sensors have the ability to provide data regarding agricultural lands. We have suggested an automated IOT and smart agriculture system. The wireless sensor networks used by this IOT-based farm monitoring system gather data from various sensors placed at various nodes and transmit it via wireless protocol. This Arduino-powered Internet of Things (IoT) system for smart agriculture includes a temperature sensor, moisture sensor, water level sensor, DC motor, and GPRS module. The water level, humidity, and moisture level are all checked when the IOT-based farm monitoring system first turns on. It notifies the phone through SMS of the levels. When the water level drops, sensors monitor it and begin the water pump immediately. The fan turns on if the temperature rises over the set point. The LCD display module shows all of this. This may be observed in IOT as well, where data on humidity, moisture, and water level are shown together with date and time, based on per-minute measurements. Depending on the type of crop being grown, the temperature can be controlled at a certain level. There is a button that allows us to stop the water pump on the IOT if we wish to violently turn it off. By developing an Android application that enables farmers to learn about the availability of resources and crops suited for their location, the suggested solution tackles such problems. Through the effective use of resources and money, the method proposed in this article would save time and money by reducing the farmer's labour requirements while increasing production. In addition to providing this knowledge, the system aids the farmer in locating neighboring markets, pesticide stores, and labour via contracts. This Arduino-powered Internet of Things (IoT) system for smart agriculture includes a temperature sensor, moisture sensor, water level sensor, DC motor, and GPRS module. The water level, humidity, and moisture level are all checked when the IOT-based farm monitoring system first turns on. It notifies users through SMS about the levels over the phone. When the water level drops, sensors monitor it and begin the water pump immediately. The fan turns on if the temperature rises over the set point. The LCD display module shows all of this. This may be observed in IOT as well, where data on humidity, moisture, and water level are shown together with date and time, based on per-minute measurements. Depending on the kinds of crops that are grown, the temperature can be controlled at a given level. There is a button that lets us stop the water pump if we want to violently shut off the water on IOT. This project's goal is to assist farmers in obtaining real-time information (temperature, humidity, soil moisture, and soil temperature) for effective monitoring the environment will help them improve the overall production and product quality. A DHT11 sensor, a moisture sensor, a DS18B20 sensor probe, an LDR, a water pump, and a 12V LED strip are all components of an IoT-powered smart agricultural system. The soil moisture, temperature, humidity, and soil temperature are all checked when the IoT-based farm monitoring system starts up. For real-time monitoring, it subsequently transmits this data to the IoT cloud. The water pump is automatically started whenever the soil moisture falls below a predetermined threshold. Previously, we created an automated plant watering system that monitored certain parameters but did not send notifications to mobile devices. In addition, a circuit for detecting soil moisture and an alert for rain can be useful in creating a smart agricultural monitoring system.

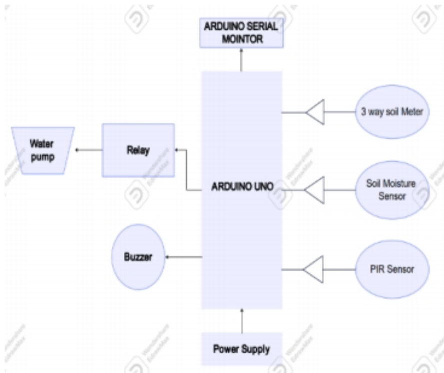

Fig 4.1: System Architecture model for the proposed work.

1. Soil Moisture Sensor:

Sensors for measuring soil moisture quantify the volumetric water content of the soil. Soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons as a proxy for the moisture content, because the direct gravimetric measurement of free-soil moisture requires removing, drying, and weighing of a sample. It is necessary to calibrate the relationship between the measured property and soil moisture since it can change based on the environment, including the soil type, temperature, and electric conductivity. The soil moisture has an impact on the reflected microwave radiation, which is employed for remote sensing in agriculture and hydrology. Farmers and gardeners can both employ portable probing tools.

2. Temperature and Humidity Sensor:

The electrodes on the surface of a moisture-holding substrate make up the DHT11 humidity sensor. The relative humidity has an impact on how much the resistance between the two electrodes changes. In order to function, humidity sensors must be able to detect changes in electrical currents or air temperature.

3. PIR Sensor:

An electronic sensor that measures the infrared (IR) light emitted by objects in its field of vision is known as a passive infrared sensor (PIR sensor). Most frequently, they are utilized in PIR-based motion detectors. PIR sensors are frequently utilised in autonomous lighting and security alarm systems.

Fig 4.2 Implementation of Sensors.

V. Results and Discussion:

When a motion is detected in the farm by a PIR Sensor, the LCD will show the message "Intruder detected." Animals or people can be intruders. The temperature sensor concurrently displays "Temperature value in °C" and "Moisture low and tank pump on" when the moisture level sensed by the soil moisture sensor is low. The LCD display will show the "Water level in tank in inches" as determined by the ultrasonic sensor. When the soil's moisture level is low, an SMS (i.e., DRIP IRRIGATION PUMP ON) will be sent to the registered cell phone number. When the water level in the tank is low, an SMS (i.e., TANK PUMP ON) will be sent to the registered mobile phone.

VI. Conclusion:

In conclusion, the purpose of smart agriculture research is to establish a foundation for a farm management decision-support system. a system that maximizes crop output, considers how high-tech farming may help, and focuses on resource protection. Agriculture may be more profitable for farmers with smart farming. Farmers will save money and labour by reducing the input of resources, and hazards will be decreased by improved spatial data dependability. As a result, smart farming will revolutionize the agricultural industry and enhance output while also enhancing the quality and having the potential to save farmers' lives. A method that simplifies and removes burdens from the farmer's side of the agricultural process is urgently needed. Recent technological advancements have made it possible for become vital to boost our nation's India's wholly acrocentric economy's output of annual crop production. One of the key goals of integrating such technology into the agricultural sector of the nation is the capacity to save natural resources while also providing a fantastic boost to the output of crops. Water and time conservation have always been top priorities for farmers. Therefore, a smart farming IoT-based agricultural stick employing NodeMCU and Cloud computing has been proposed for real-time monitoring of temperature, humidity, soil moisture, pH, sunlight, smoke detection, wind speed, and rainfall conditions. When retrieving this real-time data, the stick is highly effective and precise. The suggested agricultural stick in this project would help farmers increase will always receive assistance from the agricultural yield and efficient care of food production as the stick to acquire an accurate live feed of environmental outcomes. Additionally, this will allow farmers to deploy IoT technology and other smart agricultural practices on their property to boost yield. AUI has taught us to be lifelong learners and to master self-learning before teaching us additional course content, and this capstone project allowed me the opportunity to learn new technologies and work with new tools. Of course, this project combines everything I've studied in all of my computer science subjects, including programming languages, database systems, and the crucial engineering process.

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