IoT BASED SMART CROP-FIELD MONITORING AND AUTOMATION IRRIGATION SYSTEM

MINOR PROJECT-1 REPORT

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BONAFIDE CERTIFICATE

Certified that this Minor project-1 report entitled “IoT BASED SMART CROP-FIELD MONITORING AND AUTOMATION IRRIGATION SYSTEM” is the bonafide work of “CH.Priya reddy (21UEEC0369), G.Pranay Kumar Reddy(21UEEC0089) and T.Ramya (21UEEC0325)” who carried out the project work under my supervision.

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ABSTRACT

Agriculture is the most important and worshipped occupation in India. Agriculture is livelihood for the most of the Indian who has rural background. Smart Irrigation helps to the development of agricultural country. In India, agriculture contributes about 16percentage of total GDP and 10percentage of total exports. Water plays an important role in Agriculture. Water is main resource for Agriculture. Irrigation is one method to supply water. In this irrigation process people are wasting water more by missing the timings. So too save water and time we have a excellent method called Smart irrigation system using IoT. By the smart irrigation system we are using various equipments like temperature sensor, humidity sensor, and soil moisture sensor. These sensors will find the various situations of the soil and based on soil moisture percent, land gets automatically irrigated. It means when field needs water then automatically motor will get ON and it will get OFF when it's get enough. These sensed parameters and motor status will be displayed on user devices.

Countries are working into making agriculture more sustainable by integrating different technologies to enhance its operation. Implementing improvements in irrigation systems is crucial for the water-use efficiency and works as a contributor to Sustainable Development Goals (SDGs) under the United Nations specifically Goal 6 and Target 6.4. This paper aims to highlight the contribution of SMART irrigation using Internet of Things (IoT) and sensory systems in relation to the SDGs. The study is based on a qualitative design along with focusing on secondary data collection method. Automated irrigation systems are essential for conservation of water, this improvement could have a vital role in minimizing water usage.

Agriculture and farming techniques is also linked with IoT and automation, to make the whole processes much more effective and efficient. Sensory systems helped farmers better understand their crops and reduced the environmental impacts and conserve resources. Through these advanced systems effective soil and weather monitoring takes place along with efficient water management. Irrigation systems have been determined as positive contributor toward optimized irrigation systems that could enhance the use of continuous research and development which focus on enhancing the sustainable operations and cost reduction. Lastly, the challenges and benefits for the implementation of sensory based irrigation systems are discussed. This review will assist researchers and farmers to better understand irrigation techniques and provide an adequate approach would be sufficient to carry out irrigation related activities.

Internet Of Things (IoT)is a shared network of objects or things which can interact with each other provided the internet connection. IoT plays an important role in agriculture industry which can feed 9.6 billion people on the Earth by 2050. Smart Agriculture helps to reduce wastage, effective usage of fertilizer and thereby increase the crop yield. In this work, a system is developed to monitor crop-field using sensors (soil moisture, temperature, humidity, Light) and automate the irrigation system. The data from sensors are sent to web server database using wireless transmission. In server database the data are encoded in JSON format. The irrigation is automated if the moisture and temperature of the field falls below the brink. In greenhouses light intensity control can also be automated in addition to irrigation. The notifications are sent to farmers' mobile periodically. The farmers' can able to monitor the field conditions from anywhere. This system will be more useful in areas where water is in scarce. This system is 92 Percentage more efficient than the conventional approach.

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CHAPTER 1

INTRODUCTION

1.1 Smart crop-field monitoring

In the ever-evolving field of agriculture, the convergence of Internet of Things (IoT) technology has paved the way for groundbreaking solutions. Among these, the IoT-based smart crop-fieldmonitoring and automation irrigation system stand out as a transformative force, redefining traditional farming practices.

1.2 Precision Agriculture Unleashed

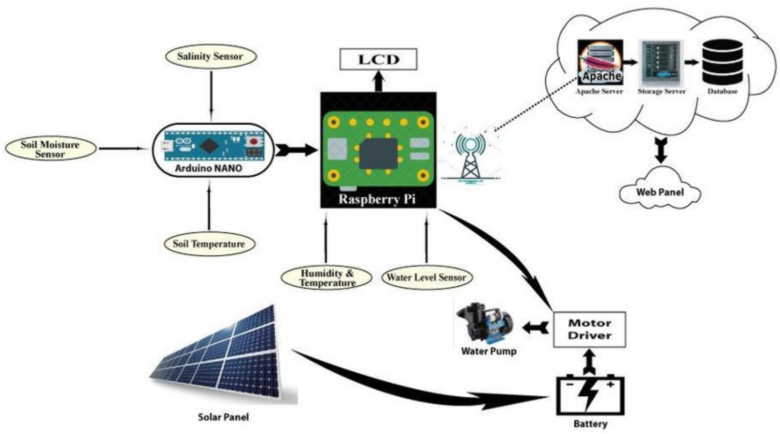

Figure 1.1: Precision Agriculture

Embracing the power of connectivity, this system seamlessly integrates sensors, actuators, and data analytics. The result is a real-time, data-driven approach to farming that empowers farmers with unparalleled insights into their crop fields One of the core functionalities of this system is the ability to monitor crop conditions in real time. Through sensor networks deployed across the field, crucial parameters such as soil moisture, temperature, and nutrient levels are continuously tracked, providing farmers with a comprehensive view of their crops.

Precision agriculture (PA) is the science of improving crop yields and assisting management decisions using high technology sensor and analysis tools. PA is a new concept adopted throughout the world to increase production, reduce labor time, and ensure the effective management of fertilizers and irrigation processes.

1.2.1 Intelligent Irrigation Automation

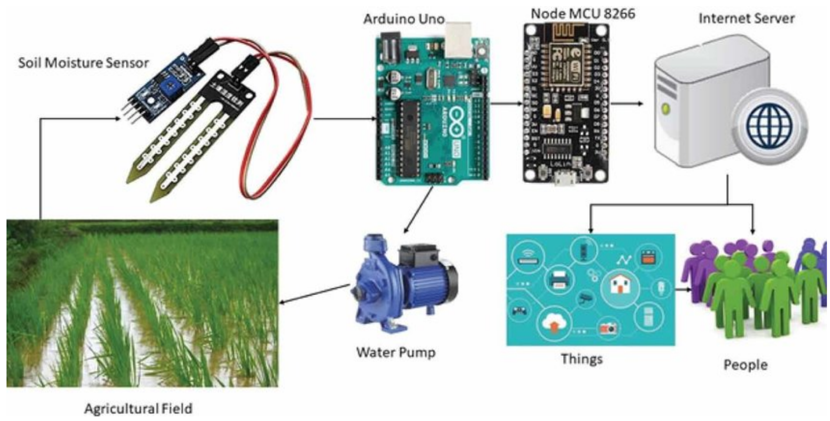

Figure 1.2: Intelligent Irrigation Automation

The heart of the system lies in its ability to automate irrigation processes intelligently. By leveraging the collected data, the system makes informed decisions on when and how much water to deliver to the crops, optimizing resource usage and promoting sustainable farming practices.

1.3 Yield Enhancement and Resource Conservation

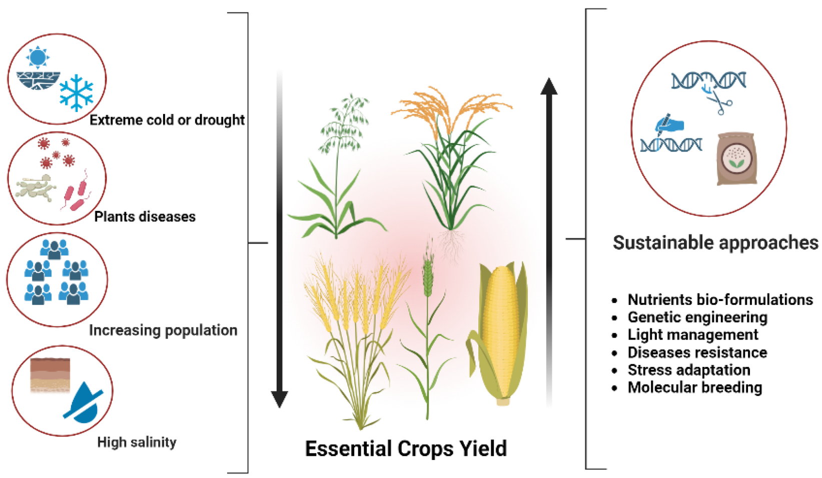

Figure 1.3: Yeild Enhancement and Resource Conservation

Beyond improving crop yield, the IoT-based system contributes to the conservation of vital resources. Efficient irrigation management not only boosts productivity but also addresses the critical need for water conservation in agriculture. Resource conservation means safeguarding precious resources such as minerals, wildlife, trees, water, and other natural resources. Resource conservation also involves judicious use of resources to avoid waste and allow the environment to rejuvenate. COR theory suggests that the loss of resources is more stressful than the gain of resources, which implies that individuals may be more motivated to prevent resource loss than to acquire new resources. COR theory has been widely applied in various domains, including occupational stress, burnout, health, and well-being.

1.3.1 Synergy of Agriculture and Technology:

Figure 1.4: Synergy of Agriculture and Technology

This innovative solution exemplifies the harmonious integration of agriculture and technology, offering a sustainable and intelligent approach to modern farming. As we delve into the details of this IoT-driven system, the future of agriculture unfolds with unprecedented potential for growth and efficiency. In recent years, the agricultural sector has witnessed a significant transformation due to advancements in technology, particularly the integration of the Internet of Things (IoT). One of the most impactful applications of IoT in agriculture is smart irrigation systems. These systems leverage IoT sensors, data analytics, and automation to optimize water usage and enhance crop yield. Moreover, smart irrigation systems offer farmers greater flexibility and convenience through remote monitoring and control capabilities. Farmers can access real-time data and adjust irrigation settings from anywhere using their smartphones or computers. This enables proactive management of irrigation operations, even when off-site, thereby improving overall farm efficiency and productivity.

1.3.2 Organic forming:

Organic farming is an agricultural approach that avoids synthetic pesticides, fertilizers, and genetically modified organisms (GMOs). It emphasizes natural methods such as crop rotation, composting, and biological pest control to promote soil fertility, biodiversity.Organic farming, also known as ecological farming or biological farming, is an agricultural system that uses fertilizers of organic

Figure 1.5: Organic Farming

origin such as compost manure, green manure, and bone meal and places emphasis on techniques such as crop rotation and companion planting.Non-organic farming typically relies on the use of synthetic fertilizers, pesticides, and herbicides to maximize crop yields and prevent damage from pests and diseases. In non-organic farming, genetically modified crops may also be used, as well as other methods such as monoculture and intensive farming.

1.3.3 Water Management

Figure 1.6: Water Management

IoT sensors monitor soil moisture levels, enabling efficient irrigation and reducing water wastage.Water management refers to the systematic planning, allocation, and utilization of water resources to ensure sustainable and efficient use. It involves the monitoring, conservation, distribution, and treatment of water for various purposes, such as agriculture, industry, domestic consumption, and environmental preservation. The goal is to optimize water usage, prevent wastage, and maintain a balance between supply and demand while considering ecological and social aspects. Management of water arises from the water cycle and water development use. The interactions between water cycle and water development use define the three management areas in water:resources management,service regulation and environment management.IWRM is based on the three principles: social equity, economic efficiency and environmental sustainability.

CHAPTER 2

LITERTAURE SURVEY

2.1 Overview

The agricultural sector faces challenges such as water scarcity, climate change, and the need for increased crop productivity. Smart irrigation systems leveraging the Internet of Things (IoT) offer innovative solutions to optimize water usage and enhance crop yields.An IoT-based smart crop-field monitoring and automation irrigation system combines technology and agriculture to create efficient, data-driven processes for managing crops and water use.

2.1.1 functionalities

-Real-Time Monitoring: The system provides real-time data on soil moisture, temperature, humidity, and other environmental factors. This allows farmers to make informed decisions about irrigation and crop management.

-Automated Irrigation: Based on sensor data and predefined thresholds, the system can automatically control irrigation, ensuring optimal water use. This helps in reducing water waste and maintaining consistent soil moisture levels.

-Alerts and Notifications: The system can send alerts to users when certain conditions are met, such as low soil moisture or adverse weather. This allows for quick responses to potential issues.

-Data Analytics and Reporting: The system can collect historical data for trend analysis, enabling farmers to understand seasonal patterns and optimize their practices accordingly.

-Integration with Other Systems: The IoT system can integrate with other agricultural technologies, such as drones or weather forecasting services, for enhanced functionality.

2.1.2 Benefits

-Resource Efficiency: Automated irrigation reduces water waste and optimizes resource use, leading to cost savings and environmental benefits.

-Improved Crop Health: Real-time monitoring helps maintain optimal growing conditions, promoting healthier crops and higher yields.

-Reduced Labor: Automation reduces the need for manual monitoring and irrigation, lowering labor costs and effort.

- Scalability and Flexibility: The system can be scaled to fit different farm sizes and adapted to various crop types, providing flexibility in agricultural practices.

2.1.3 Challenges and Considerations

-Initial Setup Costs: The initial investment in sensors, communication infrastructure, and automation equipment can be high.

-Technical Maintenance: Maintaining the system requires technical expertise and regular updates.

-Data Security and Privacy: As with any IoT system, data security and privacy must be considered to protect sensitive agricultural information.

2.2 Literature survey

Research on IoT-based smart crop-field monitoring and automated irrigation systems has gained momentum in recent years. Various studies have focused on integrating sensor networks, data analytics, and automation technologies to enhance agricultural practices. Some key literature includes:

1. "Smart irrigationsystem using IoTand machine learning methods" by Ahmed A Esmail,Manar A. Ibrahim,Sayed M. Abdallah, Ahmed E.

   Water loss and improper scheduling are problems with traditional irrigation techniques, making it difficult to meet the growing demand for food production while also preserving precious water resources.Agriculture 4.0 or precision agriculture is a technology of agricultural supervision that detects, calculates, and reacts to inconsistencies within the same environment and other environmental yields. The main objective of the study of agriculture 4.0 is to provide a judgment support system to manage the whole field of agriculture to optimize the profits on the inputs as well as the conservation of the resources. . Predicting the pumping and effect of different fertilizers using remote sensing and crop health sensors are the first steps towards Agriculture.

2. "Real Time Automation of Agriculture Environment for Indian Agricultural System using IoT" by D. Sathish Kumar, Gopinath N,Kiruthika SB,Ezhilarasi D.

   Indian irrigation covers just a third of the nation's total land area; the country ranks second in global irrigated areas. Rains are inconsistent and there is a lack of water. Most of the regions need canals to be constructed for irrigation that does not rely on rainfall.The system proposes a soil moisture sensor at each place where the moisture has to be monitored. Once the moisture reaches a particular level, the system takes appropriate steps to regulate or even stop the water flow. The circuit also monitors the water in the water source so that if the water level becomes very low, it switches off the motor to prevent damage to the motor due to dry run. The system also consists of a GSM modem through which the farmer can easily be notified about the critical conditions occurring during irrigation process.

3. "Enhancing Crop Yields through IoT-Enabled Precision Agriculture" by Dr. Rashmi Sharma,Vishal Mishra,Suryansh, Srivastava.

   Agriculture has a significant impact on the development of agricultural nations. One-third of India's GDP, and over 70percentage of its population, are dependent on agriculture. The nation's development has frequently been impeded by agricultural problems.In , the authors carried out an irrigation control model by detecting soil moisture deficit in root zones (RZSMD) using the notion of real-time, and for this, the authors used a system of identification of the water balance data to obtain a linear time series model. In , the authors proposed a soil moisture prediction system for a lychee orchard using the Deep Long Short-Term Memory (LSTM) model, which is a linear time series model that uses sequential processing over time.

4. "Promoting Sustainable Agricultural Practices Through Incentives" by Raffaele Giaffreda,Fabio Antonelli,Paolo Spada.

   For a better and more sustainable use of irrigation water in this article we present a system that incentivises and rewards virtuous behaviour in agricultural practices in a given multi-actor ecosystem while maintaining yield and improving quality of crop.The rest of the paper will be presented as follows: The second part will be devoted to the definition of agriculture 4.0, artificial intelligence, and the mathematical resolution of linear model treatment. The third part will present the creation of the database, the approach, the results, and finally a conclusion and perspectives.

5. "IoT based smart crop-field monitoring and automation irrigation system" by Rao Sridhar.

   In the literature on IoT-based smart crop-field monitoring and automated irrigation systems, researchers emphasize the significance of real-time data collection for precision agriculture. Studies highlight the integration of various sensors such as soil moisture, temperature, and humidity devices to monitor crop conditions.Processing the collected data using many algorithms namely: KNN, neural networks, support vector machine, Naive Bayes, and Logistic Regression. The results showed that the KNN algorithm has a better decision-making rate compared to the others, with a rate of 98.3 percentage In recent years several researchers have used artificial intelligence systems and the internet of things to deal with irrigation problems precisely using linear models.

6. "IoT-Equipped and AI-Enabled Next Generation Smart Agriculture: A Critical Review, Current Challenges and Future Trends" by Sameer Qazi.

   Smart Agriculture Systems (SAS) are driven by several key factors, which include the adoption of IoT technologies for remote, unmanned monitoring of the agriculture fields and taking corrective actions to make the environment most conducive for crop growth.Artificial Intelligence for Agricultural Innovation (AI4AI) is a new principle that is beginning to gain the confidence of the scientific community. Agriculture is experiencing rapid adoption of artificial intelligence (AI) and machine learning (ML) in terms of both agricultural products and agricultural techniques in the field. Cognitive computing is becoming the most disruptive technology in agricultural services, as it can understand, learn, and respond to different situations (based on learning) to increase accuracy.

7. "Congestion Control in Cognitive IoT-Based WSN Network for Smart Agriculture" by Daniyal Alghazzawi.

   The primary need for a human being to survive on the planet earth is food, so it is critical to work on various aspects of the country's agricultural needs. Agricultural activities necessitate the expansion of land available for cultivation and irrigation. So that the crop does not become overburdened, it must be cultivated in such a way that it recovers the bare necessities of the country's people.Currently, Microsoft is working with 175 farmers in Andhra Pradesh, India, to provide advisory services for seedlings, land, fertilizer, etc. This initiative has already resulted in an average 30 higher yield per hectare compared to last year.

8. "A Systematic Review on Monitoring and Advanced Control Strategies in Smart Agriculture" by Syeda Iqra Hassan.

   Agriculture and forestry plays a vital role for food security and property development.Agriculture is one amongst the fundamental sources of keep for folks and plays a key role within the development of the agricultural economy.Smart Agriculture is becoming very important essence for farmers now a days and it will become more important in upcoming era for proper growth of the fields and increase in the productivity of yieldsn recent years several researchers have used artificial intelligence systems and the internet of things to deal with irrigation problems precisely using linear models.

9. "Energy-Efficient Edge-Fog-Cloud Architecture for IoT-Based Smart Agriculture Environment" by Hatem A.Alharbi.

   The current agriculture systems compete to take advantage of industry advanced technologies, including the internet of things (IoT), cloud/fog/edge computing, artificial intelligence, and agricultural robots to monitor, track, analyze and process various functions and services in real-time.However, these models allow better control of irrigation but combining it with data analysis techniques makes their sampling very slow and limited to the region where it is calibrated In this paper, we aim to propose an irrigation prediction approach to efficiently manage intelligent automatic irrigation.

10. "Towards Paddy Rice Smart Farming: A Review on Big Data, Machine Learning, and Rice Production Tasks" by Rayner Alfred.

    Big Data (BD), Machine Learning (ML) and Internet of Things (IoT) are expected to have a large impact on Smart Farming and involve the whole supply chain, particularly for rice production. The increasing amount and variety of data captured and obtained by these emerging technologies in IoT offer the rice smart farming strategy new abilities to predict changes and identify opportunities.Installing the sensors (soil moisture, temperature, and rain) Linking the set of sensors to an acquisition system, Using the Node-RED platform whose objective is to facilitate supervision, storage, and notification, and processing the collected data using many algorithms namely: KNN, neural networks, support vector machine, Naive Bayes, and Logistic Regression. The results showed that the KNN algorithm has a better decision-making rate compared to the others, with a rate of 98.3.

11. "Development of the Internet of Smart Orchard Things Based on Multi-Sensors and LoRa Technology" by Pingchuan Zhang.

    he spectrum of applications for Internet of Things (IoT) technology in production and life has grown as the technology has matured. Using the IoT technology to intelligently monitor and scientifically manage the agricultural environment has become an unavoidable trend and a critical component of current agricultural development.Agricultural IoT technology is a new type of agriculture that combines the IoT with agricultural production, and is a new trend in global agricultural development.Traditional agriculture has been the pillar of development on the planet for centuries. But with exponential population growth and increasing demand, farmers will need water to irrigate the land to meet this demand. Because of the scarcity of this resource, farmers need a solution that changes the way they operate.

12. "Artificial Intelligence Technology in the Agricultural Sector: A Systematic Literature Review" by Ersin Elbasi.

    Due to the increasing global population and the growing demand for food worldwide as well as changes in weather conditions and the availability of water, artificial intelligence (AI) such as expert systems, natural language processing, speech recognition, and machine vision have changed not only the quantity but also the quality of work in the agricultural sector.This paper proposes an intelligent and flexible irrigation approach with low consumption and cost that can be deployed in different contexts. This approach is based on machine learning algorithms for smart agriculture. For this, we used a set of sensors (soil humidity, temperature, and rain) in an environment that ensures better plant growth for months, from which we collected data based on an acquisition map using the Node-RED platform and MongoDB.

13. "Internet-of-Things (IoT)-Based Smart Agriculture: Toward Making the Fields Talk" by Muhammad Ayaz.

    Despite the perception people may have regarding the agricultural process, the reality is that today's agriculture industry is data-centered, precise, and smarter than ever. The rapid emergence of the Internet-of-Things (IoT) based technologies redesigned almost every industry including "smart agriculture" which moved the industry from statistical to quantitative approaches. Such revolutionary changes are shaking the existing agriculture methods and creating new opportunities along a range of challenges.the advent of new technologies, the notion of Agriculture 4.0 has become a reality to keep up with and meet the demand. With the addition of artificial intelligence and IoT through the collection and processing of agricultural data, decisions have become more and more precise to facilitate decision-making.

14. "Context Aware Evapotranspiration (ETs) for Saline Soils Reclamation" by Arfat Ahmad Khan.

    Accurate Evapotranspiration for saline soils (ETs) is important as well as challenging for the reclamation of saline soils through an effective leaching process. Evapotranspiration (ET) by FAO-56 Penman-Monteith standard method is complex, especially for saline soils. Moreover, existing studies focus on the use of the Internet of Things (IoT) and machine learning-enabled smart and precision irrigation water recommendation systems along with the ET estimation by limited parameters.This paper proposes an intelligent and flexible irrigation approach with low consumption and cost that can be deployed in different contexts. This approach is based on machine learning algorithms for smart agriculture.

15. "AoI-Aware Energy-Efficient SFC in UAV-Aided Smart Agriculture Using Asynchronous Federated Learning" by Mohammad Akbari.

    In the midst of rising global population and environmental challenges, smart agriculture emerges as a vital solution by integrating advanced technologies to optimize agricultural practices. Through data-driven insights and automation, it tackles the necessity for sustainable resource management, enhancing productivity and resilience in the face of complex food security and ecological concerns. The prospects of utilizing the Internet of Things (IoT) for smart agriculture are tremendous, where many IoT devices can be deployed for local environment monitoring, precision farming, autonomous irrigation, and, soil management.Optimal management of available water resources at the farm level is necessary due to increasing demands and limited resources. It is important to increase crop yields under limited water sources for optimal crop production to meet future food production needs.

CHAPTER 3

PROPOSED MODEL

3.1 Proposed model

Creating an IoT-based smart crop-field monitoring and automated irrigation system involves integrating various sensors, communication protocols, and automation technology to manage crop health and water usage efficiently. Here's a comprehensive model that includes components, architecture, and operation.

3.1.1 Components

Sensors

- Soil Moisture Sensors: Monitor soil moisture levels to determine irrigation needs.When electric current passes through these electrodes, they form an electromagnetic field in the soil. The probe measures the permittivity of a soil medium by measuring the charge time of a capacitor made with that medium and thus the soil water content.

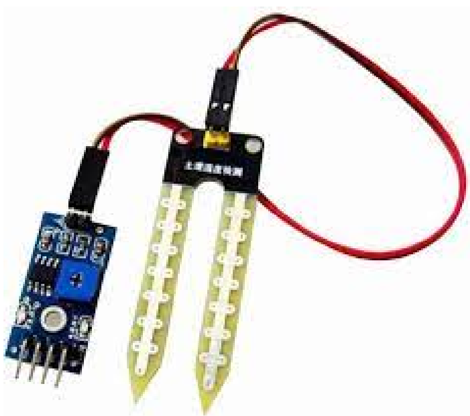

Figure 3.1: Soil Moisture Sensor

- Temperature and Humidity Sensors: Track environmental conditions affecting crop growth.Temperature and humidity sensor (or rh temp sensor) is devices that can convert temperature and humidity into electrical signals that can easily measure temperature and humidity.A temperature and humidity sensor are low cost-sensitive electronic devices that detects, measures and reports both dampness and air temperature. The proportion of moisture noticeable all around to the highest amount of moisture at a specific air temperature.

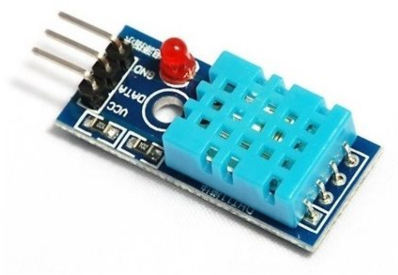

Figure 3.2: Temperature and Humidity Sensor

- Rain Sensors: Detect rainfall to adjust irrigation.A raindrop sensor has a board on which nickel is coated in the form of lines. It works on the principle of resistance. The principle is that when there is no rain drop on board, the resistance is high so we get high voltage according to V=IR.

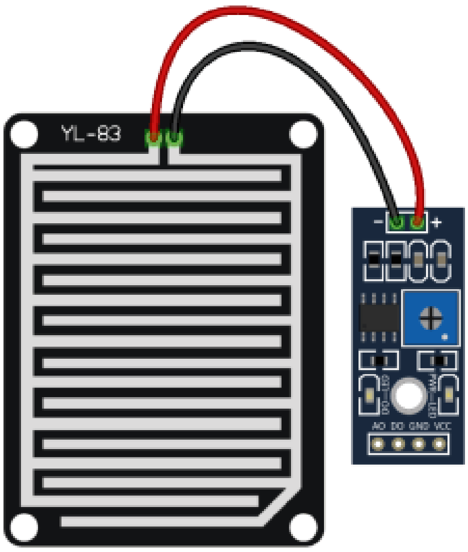

Figure 3.3: Rain sensor

- Light Sensors: Measure light intensity for optimal plant growth.Light sensors work by the photoelectric effect. Light can behave as a particle, referred to as a photon. When a photon hits the metal surface of the light sensor, the energy of the light is absorbed by the electrons, increasing their kinetic energy and allowing them to be emitted from the material.There are typically 2 main sensor types currently used in lighting. They are passive infrared (PIR) and microwave. (Other sensor types are used however are more expensive and less common such as ultrasonic instead of microwave and dual sensors with a combination of ultrasonic and PIR).

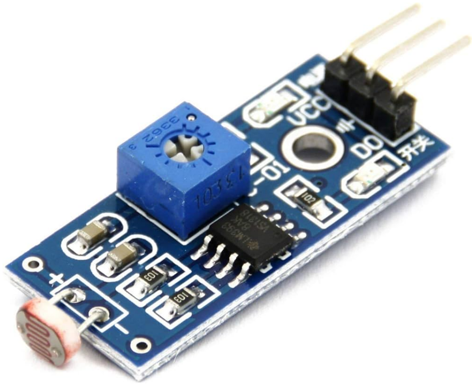

Figure 3.4: Light Sensor

- Water Level Sensors: Ensure sufficient water in storage tanks or reservoirs.The Submersible level sensor works by measuring the hydrostatic pressure emitted by a liquid in the tank. Since hydrostatic pressure is a measure of two variables, one being the density of the fluid and the other being the height of the fluid.

Figure 3.5: Water Level Sensors

- CO2 Sensors: Monitor CO2 levels to understand photosynthesis efficiency.An NDIR CO2 sensor works on either a diffusion or flow principle; the gas either diffuses or is pumped into the sample tube. The IR light will pass through the length of the tube and any CO2 gas molecules will absorb the waveband of 4.2 µm but allow other wavelengths to pass through.The Arduino IO expansion shield is the best match for this CO2 sensor connecting to your Arduino microcontroller. This is an electrochemical Arduino-based CO2 sensor, it is suitable for qualitative analysis.

Figure 3.6: CO2 Sensors

Communication Technology:

- Wireless Protocols: LoRa, Zigbee, Wi-Fi, or cellular networks for long-distance communication.Each node in the system acts as both a wireless data source and a repeater. Information from a single sensor node passes from node to node until it reaches the transmission gateway. It uses the IEEE 802.15. 4 low speed personal area network protocol for the unified physical layer in Zigbee technology.

- Gateways: Devices to collect data from sensors and transmit it to the cloud or a central server.It usually works as a safety guard to the local networks and links the local network to the public network system. It is a security firewall build with the principle of NAT. It activates the machine with local IP to enable the internet via the comprehensive address of the gateway.

Controllers and Actuators:

- Microcontrollers: Arduino, Raspberry Pi, or other similar platforms to process sensor data and control actuators.The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller (MCU) and developed by Arduino.cc and initially released in 2010.

- Solenoid Valves: Control irrigation based on sensor data.Solenoid valves are control units which, when electrically energized or de-energized, either shut off or allow fluid flow. The actuator takes the form of an electromagnet. When energized, a magnetic field builds up which pulls a plunger or pivoted armature against the action of a spring.

- Pumps: Manage water flow from reservoirs to fields.It is a switch which is connected to the water pump and Genuino 101. The relay will control the flow of water from the pump based on actions given to Genuino 101. The water pump will be inside the water pump connected with a pipe. When the pump is turned on it will supply water from the pot through the connected pipe.

- Motors/Actuators: Control the position of irrigation systems, such as sprinklers or drippers.A mechanical actuator functions to execute movement by converting one kind of motion, such as rotary motion, into another kind, such as linear motion. An example is a rack and pinion. The operation of mechanical actuators is based on combinations of structural components, such as gears and rails, or pulleys and chains.

- *Data Storage and Analytics*:

- Cloud Storage: For remote data storage and access.Cloud Storage is a mode of computer data storage in which digital data is stored on servers in off-site locations. The servers are maintained by a third-party provider who is responsible for hosting, managing, and securing data stored on its infrastructure.

- Analytics Platforms: Analyze data to derive insights on irrigation patterns and crop health.It is a software solution or tool suite where organizations can contextualize information and gather insights by integrating multiple data sources. This allows users to consolidate their systems in one place where they can clean and transform their data.

- *User Interface*:

- Mobile or Web Application: Allow farmers to monitor field conditions, receive alerts, and control irrigation systems remotely.Mobile applications are specifically created to be operated from mobile. In contrast, web applications are created with the purpose of the content and services being browsed by the user from any device via browsers.

3.1.2 Architecture

- *Sensor Network*:

- Install sensors throughout the crop field. Soil moisture sensors can be placed at different depths and locations to capture a complete picture. Other sensors (temperature, humidity, light, rain) are placed strategically around the field.Most common architecture for WSN follows the OSI Model. Basically in sensor network we need five layers: application layer, transport layer, network layer, data link layer and physical layer. Added to the five layers are the three cross layers.

- *Communication Layer*:

- Sensors communicate with a central gateway via wireless protocols. The gateway can be located in a central part of the field or near the farm's main infrastructure.The communication layer handles the connectivity, message routing among remote devices, and routing between devices and the cloud. The communication layer lets you establish how IoT messages are sent and received by devices, and how devices represent and store their physical state in the cloud.

- *Data Processing and Automation*:

- The gateway processes sensor data and sends it to the cloud for storage and further analysis.

- The gateway or cloud-based system processes sensor data to make irrigation decisions.

- Automated irrigation controls (valves, pumps, etc.) are triggered based on the processed data. This might involve a set schedule or real-time adaptation to sensor readings.

-Data processing automation in the context of the Internet of Things (IoT) refers to the implementation of automated workflows and algorithms that handle the collection, analysis, transformation, and utilisation of data generated by IoT devices.

- *Monitoring and Control Interface*:

- A mobile or web application provides farmers with real-time data on crop field conditions.

- The interface also allows manual control of irrigation systems, adjusting thresholds for automation, and setting alerts for abnormal conditions.

-monitoring is the process of discovering, monitoring, and managing your connected devices. IoT monitoring analyzes data, provides insights, informs you of any issues affecting the business, and provides actionable answers for all your connected devices.

3.1.3 Operation

- *Automated Irrigation*:

- The system checks soil moisture levels at predefined intervals.

- If soil moisture is below a certain threshold, the system activates the irrigation system. It can be adjusted based on weather forecasts, rain sensors, or predefined schedules.

-Automatic irrigation is the use of a device to operate irrigation structures, so the change of flow of water from bays can occur in the absence of the irrigator. Automation can be used in a number of ways: to start and stop irrigation through supply channel outlets.

- *Data Analytics and Decision Support*:

- Collect and analyze data over time to identify trends and optimize irrigation schedules.

- Use analytics to detect issues like over-irrigation, plant diseases, or sensor malfunctions.

-The integration of IoT and data analytics enables organizations to extract valuable insights from the massive amounts of data generated by connected devices. This, in turn, supports more informed decision-making, improved efficiency, and the development of innovative solutions across various industries.

- *Alert System*:

- Notify farmers via mobile or web app of critical events, such as excessive soil dryness, equipment malfunctions, or unusual weather patterns.

-IoT alert systems play a crucial role in enhancing safety and security across various domains. By continuously monitoring sensors, devices, and systems, potential hazards can be identified promptly, allowing for immediate actions to mitigate risks and prevent accidents or security breaches.

- *Integration with Other Farm Systems*:

- The system can be extended to include other functionalities like fertilizer automation, pest detection, or integration with external data sources (e.g., weather forecasts, satellite imagery).

-This model is scalable and adaptable, allowing farmers to integrate more sensors, implement more advanced analytics, or incorporate additional automation over time.

-Smart irrigation system using IoT have revolutionized agriculture offering unprecedented control and efficiency. These systems utilize Internet of Things (IoT) technology to enhance traditional irrigation methods providing real time data and automation for optimized water usage.

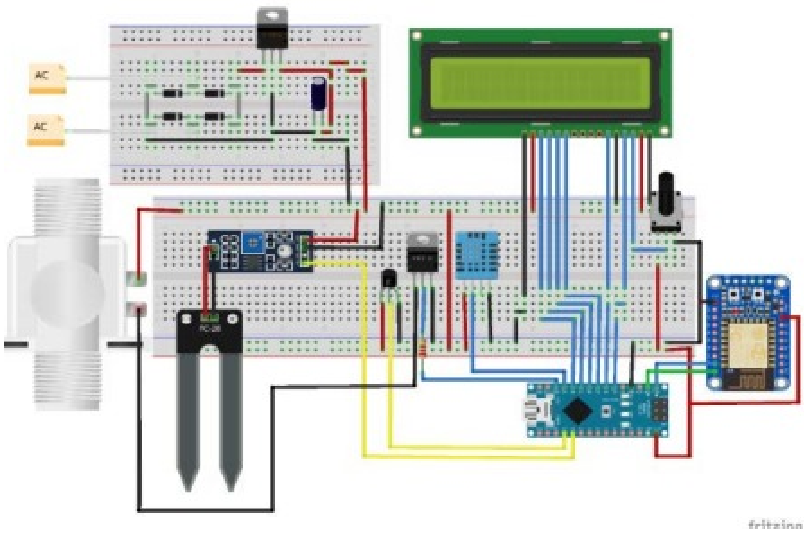

Figure 3.7: integration of the full circuit

CHAPTER 4

conclusion

The system designed is capable of monitoring, reading and storing data using sensors and also generates some actions according to the data. Storing data in database allow for future research and also ensure that any abnormality in future can be studied and corrected helping to avoid future discomfort. Web and mobile application with a user friendly interface make the system easy to understand without requiring any special skills. The system takes decision of automating the irrigation when the need arises according to the instruction received, that is, when the soil moisture falls below the brink without any human intervention. This system is cost effective which makes it affordable for farmers. Due to non-availability of internet connection in some remote farms, this work can be reconfigure to incorporate GSM module for sending SMS to farmers. The intelligence or decision making component of the system can also include some artificial intelligence modules so that the farmer's interaction with the system will be minimized this will lead to less human efforts for the monitoring.

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