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Agriculture Automation System using Machine Learning and Internet of Things

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ABSTRACT

Agriculture balances both food requirement for mankind and supplies indispensable raw materials for many industries, and it is the most significant and fundamental occupation in India. The advancement in inventive farming techniques is gradually enhancing the crop yield making it more profitable and reduce irrigation wastages. This project aims at making use of evolving technology i.e., IOT and smart agriculture using automation. Monitoring environmental conditions is the major factor to improve yield of the efficient crops. The feature of this project includes development of a system which can monitor temperature, humidity and moisture content of the crops in agricultural field through sensors using Arduino board. Decision tree algorithm, an efficient machine learning algorithm is applied on the data sensed from the field in to predict results efficiently which helps in decision making regarding water supply in advance.

Keywords– Automation, Crop Management, Internet of Things, Machine Learning

I. INTRODUCTION

INDIA is an agricultural country. India ranks second worldwide in farm output. Nowadays, at regular intervals the lands are manually irrigated by the farmers. In this process there is possibility in which the water consumption may be more or time taken by the water to reach the time may also exceed which leads to dryness of the crops. To meet the growing demand of irrigation and due to uncertain climatic conditions, it is necessary to focus on sustainable irrigation approaches and improving the efficiency of such existing irrigation systems, we have come up with this system that is going to help the farmers to work in ease by adopting certain modern-day technologies.

In today's era, there has been a significant shift towards automation in agriculture to improve productivity, efficiency, and sustainability. One of the emerging trends in this field is the integration of Internet of Things (IoT) and Machine Learning (ML) into agricultural systems. IoT devices can be deployed in various forms such as sensors, drones, and actuators. These devices can monitor environmental conditions, soil moisture, crop growth, and livestock health, among other parameters. By collecting real time data from the farm, IoT enables farmers to make informed decisions and take timely actions. In agriculture, ML algorithms can analyze the vast amount of data collected by IoT devices and extract valuable insights. These insights can help farmers optimize irrigation schedules, predict crop diseases, detect pest infestations, and improve overall farm management. The integration of IoT and ML in agriculture automation systems offers several benefits such as farmers can access real-time data about their crops and livestock through mobile applications or web portals. This remote monitoring capability enables them to respond quickly to any issues, saving time and resources.

Furthermore, the integration of IoT and ML in agriculture automation systems holds tremendous potential for transforming the way farming is done. It enables farmers to monitor their operations remotely, make data-driven decisions, and adopt precision agriculture practices.

A. Existing System

Currently, there are numerous researches on Agriculture Automation System. Many authors have elaborated and proposed an irrigation system using internet of things, mainly considering the wastage of water in the certain regions. Using Wireless Sensor Network (WSN), IoT along with Constrained Application Protocol (CoAP) a smart irrigation system was developed which can be easily managed and tracked to make sure the water usage more effectively. This system is corroborated to be low cost and detailed and was importantly designed to manage the water supplying through internet.

They have also introduced IoT in order to detect the physical data and send it to the user. They also highlighted methodologies which can be utilized to provide solution to different problems like recognizing rodents, several risks to crops. IoT device is developed using python scripts, which can send a notification with no human interference.

B. Proposed System

Appropriate environmental conditions are necessary for optimum plant growth, improved crop yields, and efficient use of water and other resources. Automating the data acquisition process of the soil conditions and various climatic parameters that govern plant growth allows information to be collected with this system with less labor requirements. This IOT system will be able to monitor the variation in the temperature, humidity of the environment. This project is to promote convenience and ease of plant growth for small scale farmers and also enable small scale farmers to plant healthy crops all year round with little supervision. It helps to save time and effort of farmers and with efficient cost. Smart farming pairs SDI (Subsurface Drip Irrigation) which is the most prevalent irrigation method to control crop watering time and situation with IoT based smart agriculture sensor helps to continuously monitor moisture levels and plant health automatically.

C. Scope of the Project

This agriculture automation systems can optimize the process of planting and seeding by using many smart technologies that will ensure accurate seed placement, optimal spacing, and efficient use of seeds, leading to higher crop yields. It can monitor soil moisture levels and weather conditions in real time. Based on this data, automated irrigation systems can adjust water flow and distribution, ensuring that crops receive the right amount of water at the right time.

Such an automated system can analyze soil samples and apply fertilizers precisely, based on crop requirements and nutrient deficiencies. This enables farmers to optimize nutrient uptake, minimize waste, and improve overall soil health. This automation system utilizes remote sensing technologies to monitor crop health, growth rates, and productivity. This data can be analyzed to generate insights and recommendations for farmers, allowing them to make informed decisions regarding crop management, such as adjusting fertilization, irrigation, or harvesting schedules.

II. RELATED WORK

IoT based Smart Agriculture using Machine Learning by Kasara Sai Pratyush Reddy and others [1], was highly motivated by the realization of future water scarcity that is going to create a great havoc. The main components of this system architecture are temperature, soil moisture, humidity sensors and raspberry pi. The authors were able to understand the central role played by raspberry pi in the system for providing storage to the datasets and they implemented the use of decision tree algorithm to predict the accurate results in case of crop quality and yield. The result was then sent to the farmer through an email regarding the water supply. They have trained the model using supervised machine learning algorithms, on the real time data, it processes and generates an output yes/no and sends the decision to the farmer through an email [1].

IoT based smart agriculture system was proposed by Sushanth and Sujatha [2]. This uses the concept of IOT, WSN and cloud computing to help farmer plan an irrigation schedule for his farm through an agriculture profile which can be then edited as per his/her requirements. A customized Global System for mobile communication module is designed here for wireless radiation monitoring SMS.

This module was able to receive serial data from radiation monitoring devices such as the smart irrigator here that will transmit data as text SMS to a host server. The system’s usage in data analysis for better decision support in this GSM based smart agriculture system was analyzed [2].

An IOT based Agriculture Monitoring System proposed by Boobalan. J and others [3], consists of Raspberry Pi, various sensors camera and motor driver. Using high end sensors some of the environmental parameters such as temperature rise, oxygen is sensed and are transmitted to the mobile phone through IOT. In smart supervising system the pi camera captures the video and transfer it to cloud through Raspberry Pi. Here an insight on how the PIR sensor senses the entry of obstacles in the restricted area and updates it to cloud was observed. According to changing conditions of moisture, temperature and humidity farmers will be able to schedule the proper timing for water supply and all the necessary things that required for proper growth of plants [3].

Automation in Agriculture proposed by Subham Patra and others [5], explores the utilization of IoT within the agriculture sector. This model aims at increasing the crop yield by helping in predicting better crop sequence for a selected soil. With the help of IBM IoT platform, real time sampling of the soil and the information acquired is further used for analyzing the crop. Many readings of the soil moisture, temperature, and humidity of the environment for various days at different times of the day are also taken. This paper varies from the above because of the use of IBM IoT platform. IoT data together with IBM cloud can help us to improve our work, extract valuable insights to improve operations and enable innovative models [5].

The paper, Embedded System Design for Irrigating Field with Different Crops Using Soil Moisture Sensor proposed by Sathiyabama and others [8], has been designed keeping in mind the potential hazards faced by farmers in agriculture, water shortage becoming one of the major among them. An efficient method is provided here by implementing the smart irrigation scheme, in which the farmer can monitor the status of the field from a remote location. They identified that the system can be further enhanced by using fuzzy logic controller. The fuzzy logic scheme is used to increase the accuracy of the measured value and assists in decision making [8].

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The aim of this paper was to compare machine learning algorithms and linear multivariate algorithms on basis of their performance of prediction. As soil moisture is frequently associated with variability in yield, the authors here have estimated the moisture content of soil using auto regressive error function along with machine learning algorithms. Also, they have developed a new model by employing Self-adaptive evolutionary agent in extreme machine learning architecture [9].

III. OBJECTIVES

The following are the objectives that brief out the aims of our project:

- Increased Efficiency
- Optimal Resource Utilization
- Enhanced Crop Quality and Yield
- Sustainable Farming Practices
- Remote Monitoring and Control
- Data-Driven Insights
- Cost Reduction and Increased Profitability

IV. ARCHITECTURE

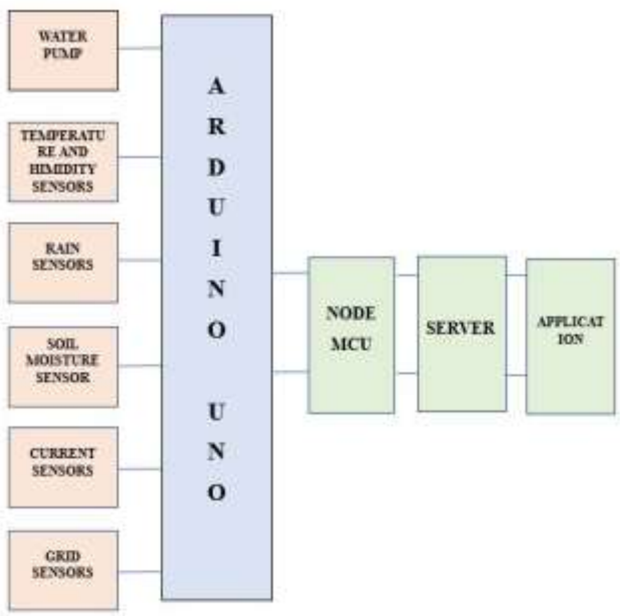

Figure 4.1: Block Diagram

The fig 1 shows the circuit connection of system where the microcontroller is connected to sensors (soil moisture sensors, rain sensors, temperature and humidity sensors and Current sensor and Grid Sensor) where these sensors sense the amount of water in the soil, temperature, rain etc. The microcontroller (Arduino) is embedded with software code, the NodeMCU acts as the network interface for the server and the Arduino, which helps in sending the data to the server through http protocol. The water pump can be operated with the help of relays, the voltage and current sensors are used to detect the current for the pump. The water is controlled by solenoid valve. The user can operate these sensors and the motor through the application. Finally, the collected data is processed and analyzed using machine learning. Then the results from the predictions are carried out to achieve maximum efficiency and reliability of the system and give the best advice for the farmers to achieve maximum crop yield with limited environmental resources.

V. METHODOLOGY

The design here is proposed to manage agriculture automation system based on Internet of Things and Machine Learning. Connect the DHT11 Temperature and Humidity Sensor, ZMPT101B AC Single Phase grid sensor, ACS712 Current Sensor, Rain Sensor, and Soil Moisture Sensor to the Arduino UNO using appropriate wiring.

Connect the NodeMCU (ESP8266) to the Arduino UNO using serial communication or other compatible interfaces. Connect the Relay Module to the Arduino UNO to control devices or components. Program the Arduino UNO to read data from each sensor (DHT11, ZMPT101B, ACS712, Rain Sensor, Soil Moisture Sensor) at regular intervals. Use appropriate libraries or code snippets to interface with each sensor and retrieve temperature, humidity, grid voltage, current, rainfall, and soil moisture data.

Process the sensor data obtained by the Arduino UNO, including converting raw values into meaningful units or parameters. Utilize the NodeMCU (ESP8266) to establish a wireless connection (e.g., Wi-Fi) to transmit the processed sensor data to a server or cloud platform.

Implement appropriate communication protocols (e.g., MQTT) for data transfer between the NodeMCU and the server/cloud platform. Set up a server or cloud platform to receive and store the transmitted sensor data. Configure the server/cloud platform to handle incoming data and store it in a database for further analysis and visualization. Develop control algorithms or logic based on the received sensor data to automate various agricultural processes. Program the Arduino UNO to actuate the Relay Module based on specific conditions or thresholds to control devices or components such as water pumps, irrigation systems, or ventilation systems.

Create a user interface or dashboard that allows users to monitor the real-time sensor data and control the system remotely. Implement visualizations, charts, or graphs to display temperature, humidity, grid voltage, current, rainfall, and soil moisture data in a user-friendly manner. Implement alerts or notifications based on predefined thresholds to inform users about critical conditions or anomalies detected by the sensors.

Develop decision support features that provide insights or recommendations to farmers based on the collected sensor data, such as irrigation scheduling, pest control measures, or energy optimization strategies. Regularly maintain and calibrate the sensors and

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components to ensure accurate and reliable data collection. Perform periodic checks and updates to the software and firmware running on the Arduino UNO and NodeMCU to ensure system stability and functionality.

VI. RESULTS

Figure 6.1: Internal Setup

Figure 6.2: Final model

Android Application Photos

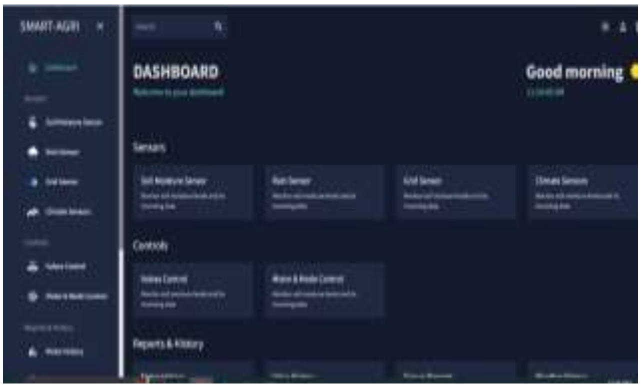

Figure 6.3: Application Dashboard

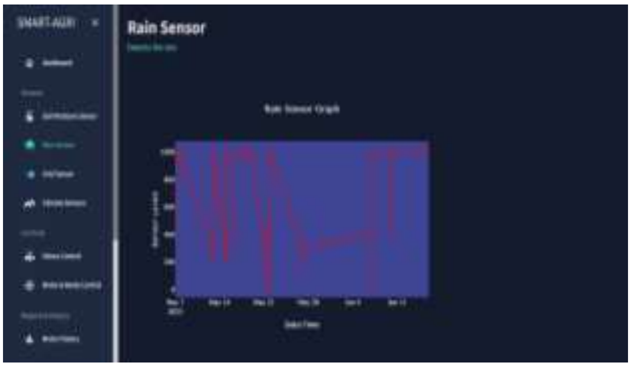

Figure 6.4: Rain Sensor Graph

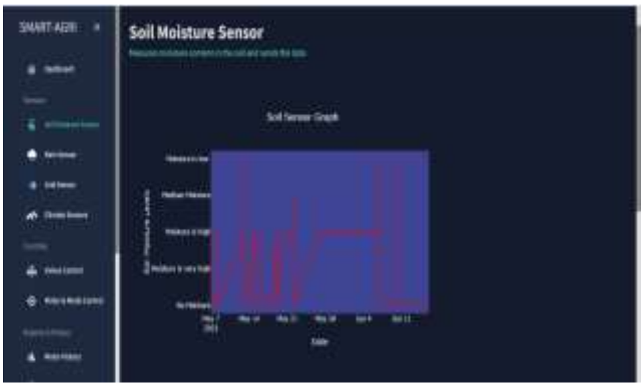

Figure 6.5: Soil Moisture Sensor Graph

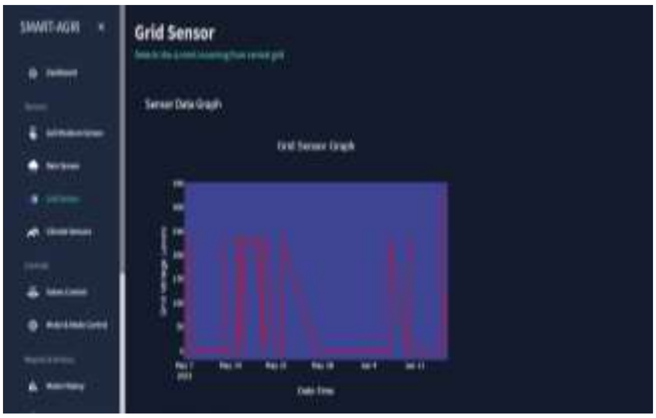

Figure 6.6: Grid Sensor Graph

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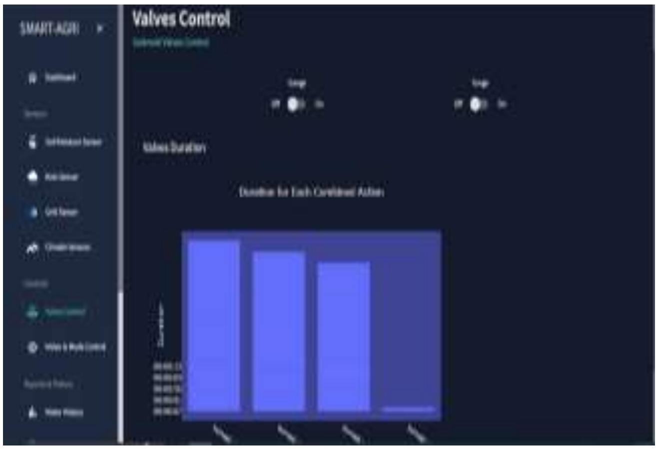

Figure 6.7: Valves Control

VII. CONCLUSION AND FUTURE ENHANCEMENT

The integration of IoT (Internet of Things) and ML (Machine Learning) in agriculture automation systems has the potential to revolutionize the farming industry. The combination of real-time data collection through IoT devices and intelligent analysis through ML algorithms enables farmers to make data-driven decisions, optimize resource utilization, increase productivity, and reduce costs. By automating various agricultural processes, such as irrigation, pest control, and crop monitoring, IoT and ML empower farmers to improve crop yields, enhance quality, and minimize environmental impact. For future work, the development of more advanced and specialized sensors can provide more accurate and detailed data on soil moisture, nutrient levels, plant health, and weather conditions. Integrating satellite imaging technologies with IoT and ML can provide a broader perspective on agricultural landscapes with combination of drones and other remote sensing technology. Combining IoT and ML with swarm robotics can bring further advancements to agriculture automation. It could also include the usage of blockchain technology in agriculture (in the near future) in order to increase optimization and efficiency. Overall, the future of agriculture automation using IoT and ML holds immense potential. Continued research and development in these areas, along with collaboration between technology providers and farmers, will drive innovation and lead to more sustainable and efficient farming practices.

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