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Smart Agriculture Using IOT

Rhea Pinto[1], Damayanti Patil[2], Nathan Joseph[3], Chryselle Barreto[4], Shamsuddin Khan[5]

[1,2,3,4]UG Student, Department of Computer Engineering, St. Francis Institute of Technology, Mumbai, India
[5]Assistant Professor, Department of Computer Engineering, St. Francis Institute of Technology, Mumbai, India

Abstract
The project focuses on physical components and sensors to leverage the Internet of Things (IoT) for smart agriculture, presenting a myriad of applications with the potential to revolutionize the agricultural sector. By connecting various physical objects, sensors, and machinery to the internet, IoT facilitates data collection and exchange for more effective agricultural management. The project introduces an in-house, user-friendly smart farming device designed to streamline farming operations, integrating essential information and communication technology with sensing technologies to provide efficient agricultural services. The goal is to acquire real-time data on temperature, humidity, water level, and soil moisture for environmental monitoring. Through the utilization of IoT technologies, farmers can enhance decision-making, increase output, and promote sustainable farming practices and effective agricultural systems.

Keywords: Sensors, IoT technology, Smart Farming, Sustainable farming practices

1. Introduction
In India, the importance of agriculture cannot be emphasized. It is the foundation of the economy and the source of nutrition for more than 58% of the people, making it the lifeblood of the country. However, this important industry confronts many obstacles, such as the requirement for resource efficiency and unpredictable weather patterns. Fortunately, a new era of smart farming is being ushered in by developing technologies, most notably the Internet of Things (IoT). IoT, which is sometimes regarded as the "next big thing" in agriculture, provides a range of solutions to help both large and small farmers. IoT serves as an attentive steward of the fields by continuously monitoring vital variables like temperature, humidity, and soil conditions in real-time. Accessible technology gives farmers the knowledge and resources they need to raise abundant harvests at a reasonable cost. Because of this, farming methods become more effective and environmentally beneficial by reducing the need for chemicals and conserving water. There is always a growing need for food in a world where population growth is continuous. Aiming to solve problems like water scarcity and climate change at the same time, IoT-driven smart farming is rising to the occasion. This is a critical step towards a time when agriculture benefits everyone by being both more environmentally friendly and more productive. India is well-positioned to enhance its economic prosperity and food security, ensuring a better future for its citizens, as technology and agriculture continue to combine.

2. Literature Review

Abhiram MSD, et al. (2022) addresses the challenges faced by Indian agriculture, which is the primary occupation for a significant portion of the population. Increased crop output and water availability are impacted by climate change, which calls for more effective irrigation methods. To keep an eye on important environmental variables including temperature, humidity, and soil moisture levels, the suggested system makes use of a Node MCU and several sensors. To detect rainfall, it also has a raindrop sensor built in. The technology uses this data to automate irrigation, making sure crops get the right quantity of moisture. Moreover, farmers may monitor and manage the system remotely using their smartphones thanks to the Blynk IoT platform. This creative method maximizes crop growth conditions while conserving water resources, boosting agricultural sustainability and productivity. The use of IoT technology facilitates informed decision-making for farmers and improves the productivity of farming methods in India [1].

Vippon Preet Kour, et al. (2020) propose a hybrid approach that combines wind and solar energy sources to reduce power consumption and represents a forward-thinking solution to the persistent challenges of power supply and consumption in various sectors. Power utilization and availability have frequently been limiting constraints in many systems, and integrating renewable energy sources, such as solar and wind power, offers a promising way to maximize power utilization. This strategy makes use of the complementary qualities of solar and wind energy. A more balanced and dependable power supply is produced by the abundance of solar power during the day while wind energy may be inconsistent. Using both sources helps the system become less dependent on grid electricity and fossil fuels, which lowers energy costs and promotes sustainability. Additionally, the interoperability of this hybrid system guarantees that it can easily integrate with current infrastructure, allowing it to be flexible enough to accommodate a wide range of applications and sectors [2].

Vijaya Saraswathi, et al. (2022) suggest an innovative approach involving real-time data collection and visualization, utilizing bar graphs to depict the crop’s efficiency, temperature, and soil moisture levels with remarkable precision. This approach relied less on external infrastructure than conventional methods because it didn't rely on broadcast communication through WiFi or cellular networks. Furthermore, they realized the value of comprehensive field management and changed their focus from plant-centric to field-centric circumstances. They addressed the larger environmental context in which crops develop in this way, enabling more complex and efficient decision-making. By using IoT technology to improve agriculture's efficiency and sustainability, this initiative looks forward and will make future farming techniques more precise, data-driven, and field-condition-adaptive [3].

Faisal Karim Shaikh, et al. (2022) talk about the integration of sensors, data analytics, and IoT principles in agriculture as a profound shift from traditional farming practices. A wide range of sensors, including those for temperature, humidity, soil moisture, and aerial photography, actively gather data in real time. IoT platforms get this data after which it is analyzed to help with decision-making. There are many advantages to this method, such as accurate monitoring that saves resources and makes it easier to optimize fertilization, watering, and pest management. Farmers may monitor their fields remotely, increasing operational efficiency, from a distance. However, difficulties continue. IoT sensor system implementation involves significant upfront expenditures, such as sensor installation and purchase, in addition to continuous operational costs. In addition, issues like data security, network dependability, and maintenance complexity are major worries. All the same, the coming together of sensors, data analytics, and IoT concepts could transform agriculture, promoting sustainability and raising yields [4].

Faisal Muhammad Shoaib Farooq, et al. (2019) conducted a thorough analysis of existing literature, case studies, and IoT technologies applied in agriculture. The effects of IoT in smart farming were categorized, with an emphasis on the technologies' efficiency and insights. With the help of this survey study, decision-makers can make well-informed assessments of the function of IoT in agriculture. It provides a comprehensive overview of IoT applications in agriculture by utilizing both real-world experiences and literature studies. Along with showing the possibility for more developments in smart farming, it also showcases new trends. But it's important to recognize some limitations. Choosing sources based solely on what has already been written could lead to prejudice. This could limit the study's depth of understanding because it lacks practical experience. Furthermore, contextual gaps in coverage and the quick speed of technological advancement are significant factors to take into account when evaluating the results [5].
John Smith, et al. (2022) suggest an innovative system that aims to enhance agricultural efficiency through precise irrigation management, remote monitoring capabilities, and mobile app interventions. Through the use of real-time sensor data, this configuration facilitates data-driven decision-making, which eventually raises agricultural yields. One noteworthy aspect is the use of IoT-controlled irrigation, which improves growing conditions and overall productivity while preserving water resources by adjusting to soil moisture levels. There are, nevertheless, many crucial factors to take into account. Technical expertise for setup and upkeep is necessary for a successful deployment. Strong connectivity is necessary for the system to function, yet in some places, this connectivity may be restricted. In addition, possible security threats need to be handled, and continuous maintenance is necessary to guarantee continuous operation, especially in places with spotty network coverage [6].
Shamyla Riaz, et al. (2022) delves into a comprehensive exploration of IoT applications in greenhouse agriculture, encompassing a detailed examination of the sensors and devices employed, communication protocols utilized, and the underlying enabling technologies. By highlighting new trends, it provides insightful information on the ever-changing IoT technology landscape in the context of greenhouse agriculture. The comprehensive analysis in the study focuses on IoT-based greenhouse farming practices and how they can greatly improve crop management and operational effectiveness. This paper also adopts a comprehensive approach, examining established and conventional cultivation methods in addition to exploring contemporary IoT alternatives. When it comes to adopting IoT-based solutions, producers can make more informed decisions because of this all-encompassing viewpoint, which gives them a deeper grasp of the technological underpinnings of greenhouse agriculture [7].

3. Proposed Solution

The proposed solution revolutionizes traditional farming by introducing a user-friendly, in-house smart farming device. This innovative project seamlessly blends cutting-edge information communication technologies with advanced sensors, optimizing and modernizing agricultural processes. It empowers farmers to make data-driven decisions, ultimately enhancing the efficiency and productivity of farming practices. The goal is to get live data about temperature, soil moisture, and humidity to monitor the surrounding environment. By constantly monitoring these factors, it ensures that the farming environment is precisely controlled. To enhance accessibility and usability, the project also includes the development of a dedicated mobile application that is compatible with ESP technology. This application will provide a user-friendly interface for controlling and monitoring the smart farming system, making it an all-encompassing and efficient solution for modern agricultural needs.

The following are the components being used for the project:

1. Battery - 9V batteries are commonly made of six individual cells that are then enclosed in a singular wrapper to form a block
2. ESP32 - Microcontroller board with integrated Wi-Fi and dual-mode Bluetooth, used for programming and controlling various electronic devices, and sensors in compact form factors.
3. Relay Module - The relay module functions to switch electrical devices and systems on or off.
4. Electronic water pump - Electric water pumps are water pumps driven by electricity. Here we are using a 3 - 6V Operating Voltage and an 80 - 120 L/H Flow Rate
5. Soil Moisture Sensor - The soil moisture sensor is used to gauge the volumetric content of water within the soil.
6. Temperature and Humidity Sensor (DHT11) - The DHT11 is a basic, ultra-low-cost digital temperature and humidity sensor.
7. Fans and heating device - Fans will be used to reduce the temperature and the grow lights will be used to increase the temperature of the system gradually.
8. Motors - The motors will be used for movement in a singular direction to attain horizontal motion for plowing the field.

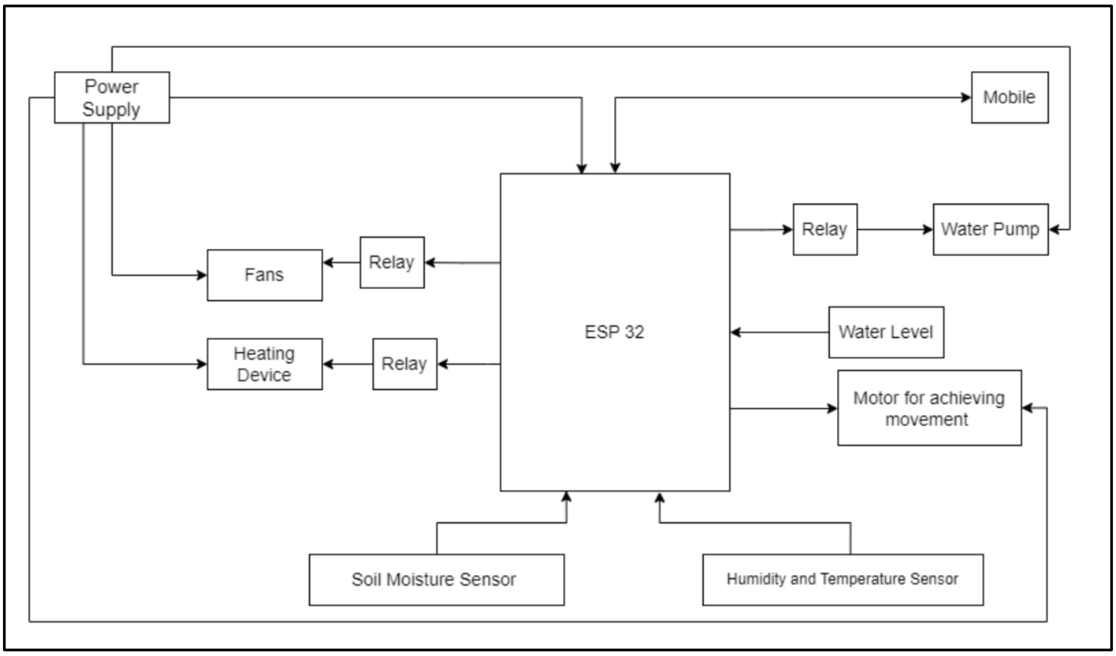

Fig. 1: Workflow of System

ESP32 checks the soil condition and performs ploughing after which the user performs sowing of seeds. After which the irrigation is performed. Then ESP32 checks the humidity and temperature for the system. Based on the result generated by the sensors, it will send a signal to the fans and heating devices. It also sends a signal to the water pump based on the water level sensor resulting in irrigation. All the information generated by the system will be displayed on the application. All these devices are connected to an external power supply.

4. Results

The results part shows how we have implemented our project as well as the monitoring of the crop's growth.

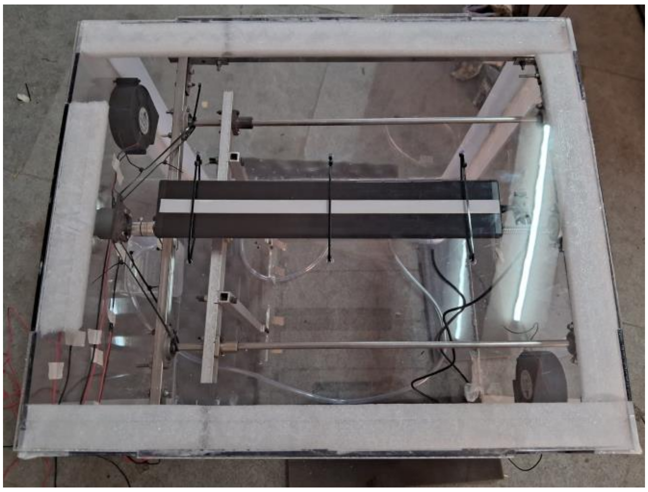

Fig. 2: System - Top View

Fig. 2 shows the initial phase system where all IoT components are connected to the model and are in the testing phase, which includes a plowing system, irrigation system, cooling and heating device along with sensors.

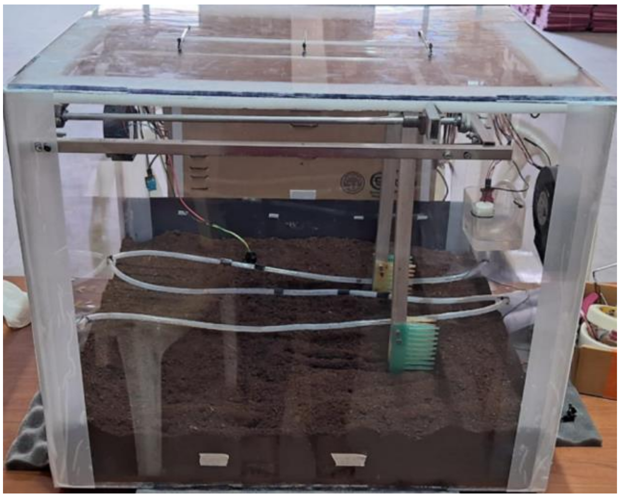

Fig. 3: System with soil - Side View

Fig. 3 shows a side view of all the working components with the soil placed in the box.

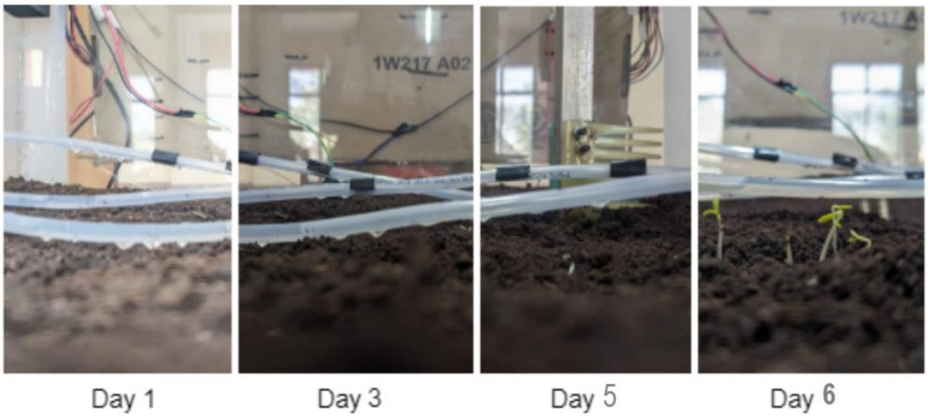

Fig. 4: Plant Growth

Fig. 4 shows the growth of plants in the system over a period of time.

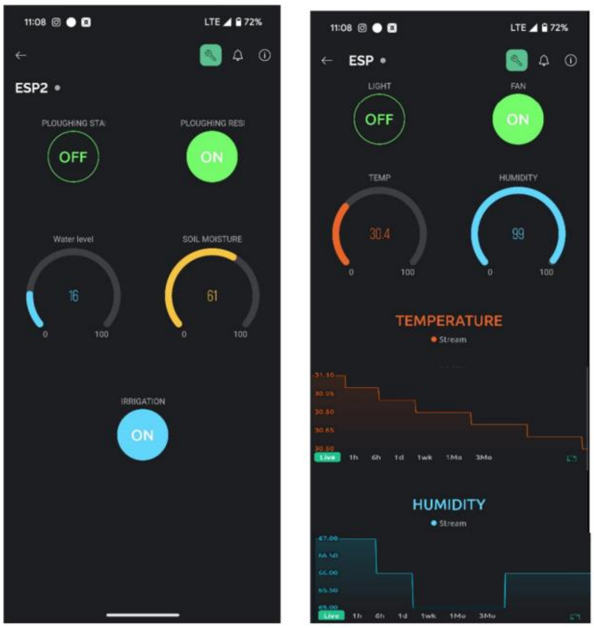

Fig. 5: Blynk Application

Fig. 5 shows a Blynk application that is connected with the system which allows users to operate the system remotely where the reading of sensors is visible along with the switch for plowing and irrigation mechanism.

5. Conclusion

Smart Agriculture represents a modern and highly efficient approach to farming, fostering a significant transformation in food production. It focuses on the crucial optimization of crop growth and soil health, with an added benefit that allows customers to closely monitor the development of their crops, significantly lowering the risk of food adulteration and guaranteeing the safety and quality of produce. In a time when self-sufficiency and sustainability are critical, smart agriculture correlates perfectly with the growing desire for productive, technologically advanced farming. It provides a wide range of advantages, including increased food safety, increased output, and more effective use of resources, finally following the course for a more cutting-edge and sustainable agricultural future.

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