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AgroSense: An IoT-Based Manual Crops Selection Farming

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Abstract

This paper introduces an Intelligent Irrigation System utilizing IoT technology to revolutionize agriculture. Employing the ESP32 microcontroller and an array of sensors for monitoring soil moisture, water levels, and environmental conditions, the system automates irrigation processes based on real-time data. Communication is facilitated through the Blynk platform, enabling remote monitoring via a mobile application. Additionally, a sophisticated algorithm for crop selection and irrigation control is implemented, accessible both through an LCD interface and the Blynk app. By integrating considerations of soil moisture and water availability, the system dynamically adjusts irrigation protocols to accommodate various crops such as rice, wheat, potato, and corn. Emphasizing sustainability, the project optimizes water utilization, fostering efficient crop growth while reducing waste. Furthermore, the inclusion of a manual crop count feature enhances decision-making processes by providing valuable field feedback. The culmination of these efforts presents a user-friendly and innovative solution for precision agriculture, showcasing the transformative potential of IoT and machine learning in modernizing farming practices. Through meticulous methodology and comprehensive testing, this project yields promising results, demonstrating flawless functionality and seamless integration of hardware and software components. Ultimately, this project contributes to advancing agricultural practices towards sustainability and efficiency, offering actionable insights for stakeholders in the agricultural sector..

Keywords: IoT Technology, Precision Farming, ESP32 WiFi Module, Blynk, Arduino IDE

I. Introduction

Farmer's main goal is to get good yield from his land. But it is seen that, due to not taking some steps, the crops of the land do not yield well and even the plants of the land die. To improve agriculture with fewer resources and labor efforts, substantial innovations have been made throughout human history. However, despite this, the high growth rate has prevented supply and demand from matching for all these years. On the flip side, it is anticipated that the momentum of urbanization will persist at an increased rate, projecting that approximately 70 percent of the global population will reside in urban areas by 2050, a notable rise from the current 49 percent. In addition, income levels will be many times higher than they currently are which will increase the need for food, particularly in emerging nations.

In particular, the existing 2.1 billion tons of annual cereal production needs to reach almost 3 billion tons, and to meet the 470 million tons of demand, the yearly meat production should rise by more than 200 million tons. Crop production is becoming crucial not only for food but also for industry; in fact, many countries'

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economies rely heavily on crops like cotton, rubber, and gum. Moreover, the market for bioenergy derived from food crops has experienced recent growth. Less than ten years ago, ethanol production alone consumed 110 million tons of coarse grains, accounting for around 10 percent of global production.

The escalating use of food crops for the production of biofuels, bioenergy, and various industrial purposes poses a threat to food security [1]. The strain on already limited agricultural resources is rising as a result of these demands. Regretfully, due to several factors, including topography, temperature, climate, and soil quality, only a small percentage of the earth's surface is appropriate for agricultural purposes, and even the majority of these areas are not uniform. The agricultural sector has been witnessing a transformative shift towards more efficient and sustainable practices.

In this context, the integration of Internet of Things (IoT) technologies in agriculture has shown significant promise. The concept of IoT, or the Internet of Things, encompasses the interconnected network of devices and the technology facilitating their communication with each other and with the cloud. IoT integration involves linking everyday objects with the internet, where an IoT application comprises software and services that consolidate data from diverse IoT devices. Utilizing machine learning or artificial intelligence, this data undergoes analysis to enable informed decision-making, with subsequent communication of decisions back to the devices for intelligent responses. Key technologies within IoT systems encompass edge computing, cloud computing, and machine learning. Edge computing enhances smart device capabilities at the periphery of IoT networks, reducing latency and improving response times. Cloud technology facilitates remote data storage and device management, ensuring accessibility across the network, while machine learning entails software and algorithms processing data for real-time decision-making, deployable either in the cloud or at the edge.

The implementation of IoT in precision farming is revolutionizing the global agricultural landscape, addressing concerns such as food scarcity, and enhancing productivity sustainably. By leveraging technologies like GPS, GIS, sensors, and aerial devices, IoT-based precision farming optimizes crop management processes, boosts production levels, and maximizes resource efficiency. The adoption of precision agriculture technology offers farmers a plethora of benefits, including enhanced monitoring, improved decision-making, centralized data management, and optimized resource utilization. Through real-time monitoring of environmental factors, soil conditions, and crop health, IoT-enabled farming enables timely responses to local changes, mitigating risks and ensuring optimal yields. Various IoT farming applications, such as crop monitoring, utilize devices and tools to collect data on crop health, water levels, and soil quality, empowering farmers to manage anomalies effectively and prevent potential issues. This report presents a comprehensive overview and design proposal for an IoT-based manual crop sectional smart agricultural system that incorporates soil moisture sensors, pump motors, and water level sensors.

II. BACKGROUND

The background of the work on "AgroSense: An IoT-Based Manual Crops Selection Firming" stems from the evolving landscape of agriculture, where technological advancements, particularly the Internet of Things (IoT), have revolutionized traditional farming practices. Agriculture faces challenges such as climate change, resource scarcity, population growth, and the need for sustainable food production [2]. In response, smart farming systems have emerged as a solution, leveraging IoT technologies to address these challenges and enhance agricultural efficiency IoT in Agriculture: The integration of IoT devices, sensors, and connectivity solutions has transformed agriculture by enabling real-time data collection and analysis. IoT technologies facilitate the monitoring of various parameters, such as soil moisture, temperature, humidity, crop health, and environmental conditions.

The selection of suitable crops significantly impacts agricultural productivity, resource utilization, and economic outcomes for farmers. Optimal crop selection involves considering factors such as soil type, climate conditions, market demand, and sustainability. The availability of accurate, timely data through IoT-based systems empowers farmers to make informed decisions regarding crop selection, irrigation, fertilization, and harvesting schedules. This data-driven approach helps optimize yields while minimizing resource waste.

Various smart farming systems have been developed and implemented globally, showcasing different approaches to utilizing the IoT for crop selection. These systems encompass a range of technologies, from precision agriculture tools to AI-driven predictive models and decision support systems [3]. Understanding the challenges and barriers to implementing IoT-based smart farming systems, including cost, infrastructure, data privacy, and technology literacy among farmers, is crucial. Identifying opportunities to overcome these challenges and maximize the benefits of IoT in agriculture is part of the background exploration.

III. Literature Review

Building on the work of Gilroy P. Pereira (2023), who pioneered an ESP32-based irrigation system with soil moisture sensors achieving 35 percent water savings, our project aims to further optimize water usage and crop selection through an intelligent IoT system. We leverage real-time data, machine learning algorithms, and a user-friendly interface to create a robust solution for precision agriculture, promoting sustainability and maximizing resource efficiency for farmers [4]. Inspired by the success of Sami Touil. (2022) in implementing machine learning for automated irrigation, which generated 20 percent water savings and 15 percent yield increase, our project delves deeper by incorporating additional data sources and advanced algorithms. We aim to surpass these achievements by optimizing both resource efficiency and crop productivity, contributing to a more sustainable future for agricultural [5].

Rakhi (2023) proposed an IoT system with multi-sensor capabilities, optimizing irrigation for various crops. Our project expands on this by incorporating a wider range of data and employing sophisticated optimization techniques to create dynamic irrigation schedules tailored to specific crop needs and environmental conditions [6]. Shakib (2023) Smart Greenhouse Monitoring System for remote monitoring paves the way for our project. We leverage Blynk's user-friendly interface and expand its capabilities, enabling real-time data visualization, remote adjustments, and comprehensive farm management from anywhere [7].

Building on V.Sravani.'s (2022) An IoT Approach for Crop Health and Growth for remote irrigation control and data visualization, our project enhances user experience. We prioritize intuitive interfaces, empowering farmers with accessible tools to manage their farms remotely with ease and efficiency [1]. Inspired by Gloaguen's (2021) decision support system for crop selection considering soil, climate, and market factors, our project delves deeper. We integrate advanced algorithms and real-time data, providing farmers with dynamic and data-driven recommendations for optimal crop selection, maximizing profitability and sustainability [8]. Erion Bwambale, Felix K. Abagale & Geophrey K. Anornu (2021) proposed Smart irrigation monitoring and control system adapting to crop water needs and weather forecasts. Our project builds upon this concept, expanding data sources and employing advanced AI techniques to create a truly dynamic system that optimizes irrigation based on real-time crop-specific water requirements and environmental conditions [9]. Recognizing the importance of Mulcahy’s (2021) emphasis on IoT's role in sustainable agriculture, our project champions precision farming practices. We aim to minimize water waste, optimize resource utilization, and promote environmental responsibility, contributing to a greener and more sustainable agricultural future [10].

IV. Method

Methodology for implementing the AgroSense project:

1) Project Setup: To set up the irrigation system, gather the necessary hardware components, including the ESP32 WiFi Module, Soil Moisture Sensor, Water Leveling Sensor, Relay Modules, Pump Motors, Button, and LCD Display Module. Then, follow the provided schematics and wiring diagrams to connect the components appropriately.

2) Programming the ESP32: Develop firmware using C++ programming for the ESP32 to handle manual crop selection, sensor data acquisition, relay control, and implement a user-friendly interface for the button-based crop selection process.

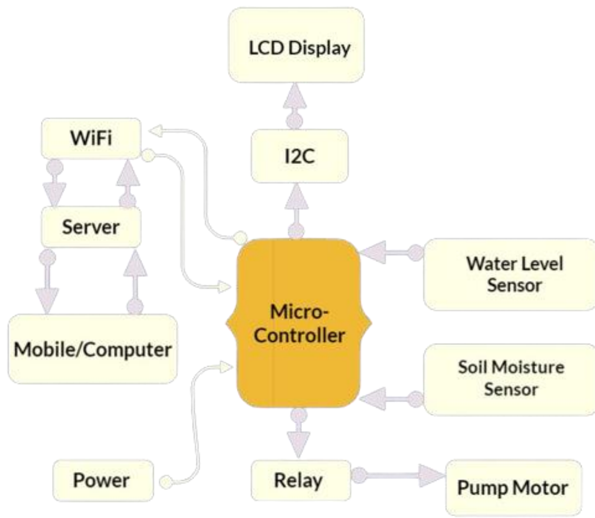


Fig.1. Block Diagram of IoT-Based Manual Crops Selection Firming.

3) Sensor Integration: Configure the ESP32 to read data from the Soil Moisture Sensor and Water Leveling Sensor.

4) Web Server Integration: Set up a web server to facilitate remote monitoring and control of the AgroSence system and develop the necessary web pages to display real-time sensor data, crop selection status, and manual control options.

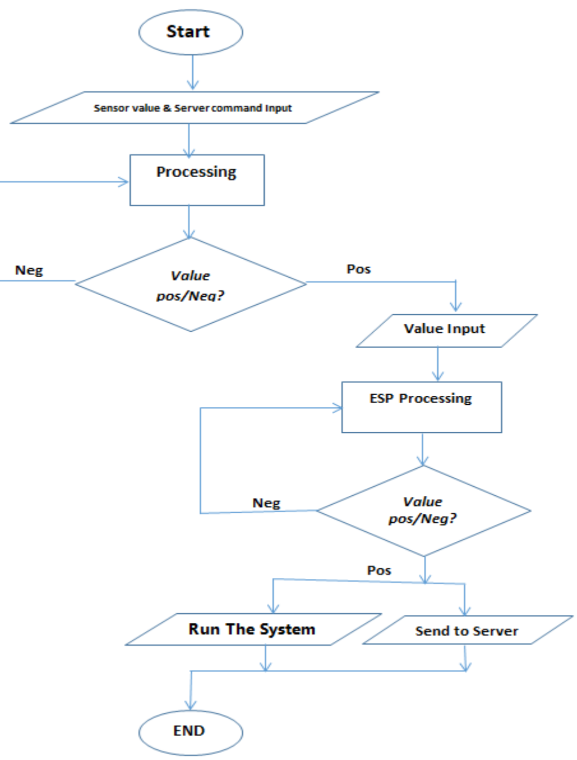


Fig.2. Data Flow Diagram of IoT-Based Manual Crops Selection Firming.

5) Relay Control Mechanism: Program the Relay Modules to manage power distribution to the sensors and pumps. Ensure the Relay Modules control the sensors during manual crops selection and activate the relay for sensor data transmission to the website.

6) Automatic Irrigation System: Design an algorithm to determine when to activate the Water Providing Pump and Water Exit Pump based on the soil moisture and water level readings also integrate the algorithm with the Relay Modules to automate the irrigation process.

7) Fail-Safe Implementation: Develop a fail-safe mechanism to handle potential failures in the automatic system. Implement a manual override feature through the button on the website to control the pump motors in case of system malfunctions.

8) Battery-Powered Operation: To configure the system to operate on battery power and implement power-saving measures on the ESP32 to extend battery life.

9) User Interface Refinement: To continuously refine the user interface (UI) on the website for a better user experience and ensure real-time updates on soil conditions while allowing effortless interaction with the system.

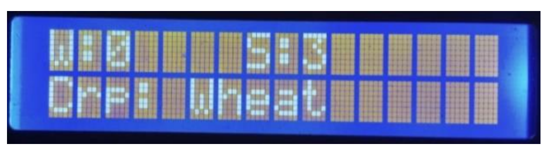
Here we see the microcontroller, which is an ESP32. It is a WiFi module. Since this system is automated, it must be connected to the internet. Here in the system, there are two sensors Soil moisture sensor and water level sensor. These are analog sensors. The LED monitor helps to see the condition of soil and water on the land. Since the microcontroller is connected to the internet, we can see the sensor data on the website or mobile. Based on the data conditions of the sensor, the pump motor will be turned on and off through the microcontroller with the help of a relay module. The microcontroller can be operated through a website or mobile.

V. RESULTS

The project underwent thorough testing, demonstrating flawless functionality. Crop identification was successfully achieved with separate conditions, and the project responded accurately to the values from the water level sensor and soil moisture sensor. All sensor data was effectively transmitted to the Blink server, and key values were accurately displayed. Calibration of the pump motors from the server was essential for maintaining the correct water level on the land. Additionally, the drainage system operated seamlessly, effectively managing excess water accumulation.

Selecting Crops:

(a) Selecting Crop- Rice.



(b) Selecting Crop- Wheat.

(c) Selecting Crop- Potato.

(d) Selecting Crop- Corn.

Fig.3. Selecting Crop.

Blynk Dashboard: Blynk is a platform that enables you to easily build IoT applications for your projects. It provides a Blynk server, a mobile app, and a library for various hardware platforms like the ESP32 to connect and exchange data between the hardware and the app. To show the values of a water level sensor and a soil moisture sensor using Blynk and an ESP32.

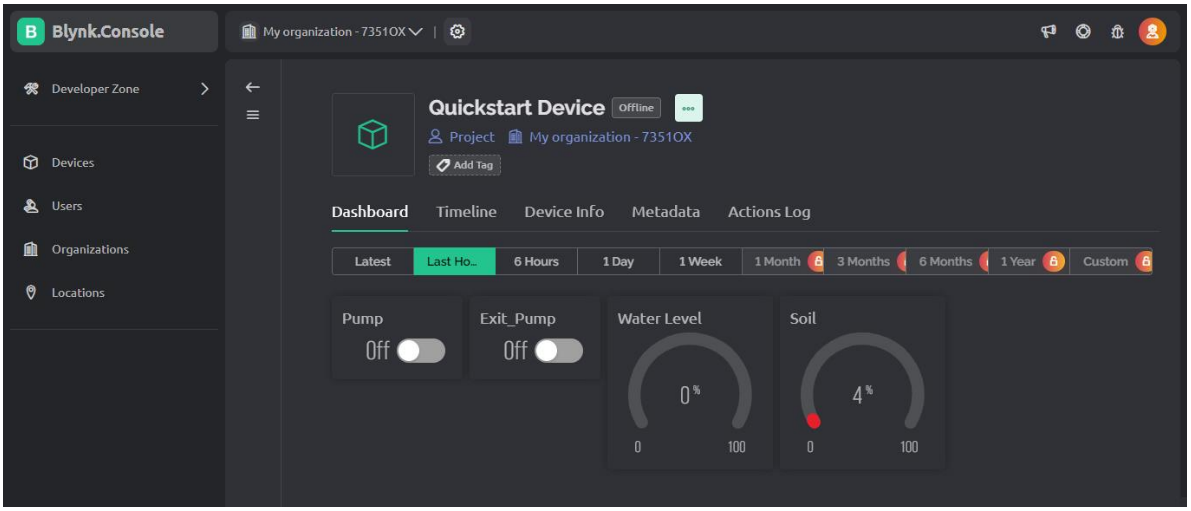


Fig.7. Blynk Dashboard Interface.

Hardware Setup: Connect the water level sensor and the soil moisture sensor to the ESP32. Ensure you have the appropriate connections, power supply, and resistors if needed. Install the Blynk library for ESP32 using the Arduino IDE or Platform IO.

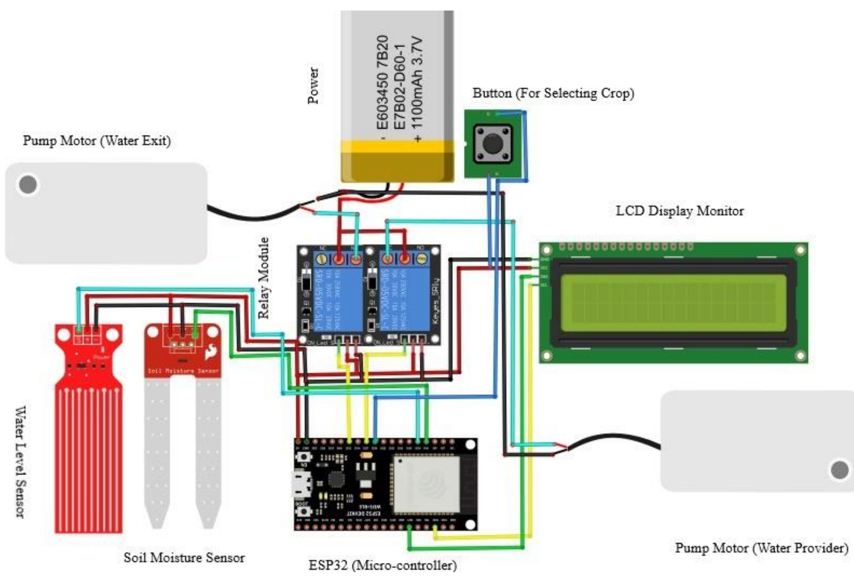


Fig.8. Circuit Diagram.

Create a Blynk Account or Download the Blynk app from the App Store (for iOS) or Google Play Store (for Android). Create an account and log in. Create a New Project. Create a new project in the Blynk app. Select the ESP32 board in the app. Add widgets to the Blynk app dashboard for displaying sensor values. For example, use the value display or Gauge widgets to represent the water level and soil moisture. Upload the code to your ESP32 using the Arduino IDE or Platform IO. Open the Blynk app, navigate to your project, and you should see the sensor values updating in real time on the widgets you added. This setup allows you to monitor and display the values of the water level sensor and soil moisture sensor on the Blynk app using an ESP32 microcontroller. Adjust pin numbers, sensor configurations, and Blynk widget settings as per your specific hardware and requirements.

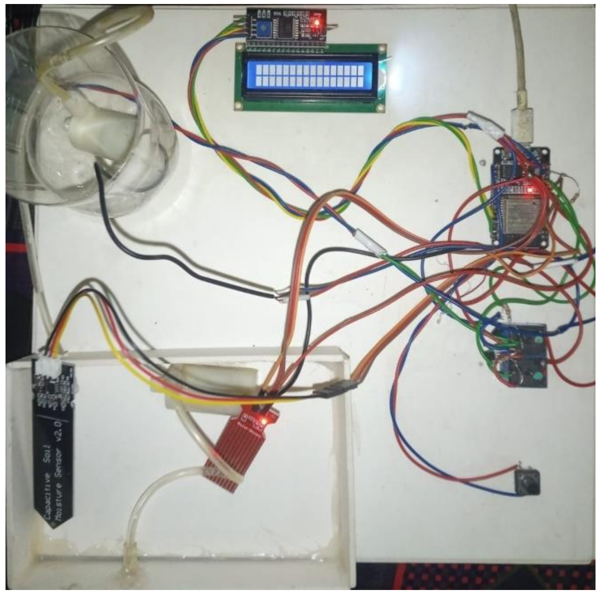


Fig.8. Circuit Model.

This is the System Model. Here we can see 2 sensors, 1 button, 2 motors, 2 relay modules, 1 microcontroller (ESP32), and an LED display. Here we can select crop manually very easily through the button. The crop we will select on the LED display, our system will work for that crop.

VI. CONCLUSION

Smart monitoring of soil moisture, water levels, and environmental conditions allows for precise and efficient water usage in agriculture. This leads to reduced water waste and improved resource management. By accurately monitoring and controlling irrigation based on crop-specific needs, the system facilitates enhanced crop growth, better yields, and improved quality of produce. Utilizing IoT sensors, the Blynk platform provides real-time data insights accessible via a user-friendly interface. Farmers gain actionable information about soil health, water availability, and crop conditions, aiding in informed decision-making [11]. Incorporating rainwater harvesting systems helps conserve water resources, promoting sustainable agricultural practices. The system encourages environmental stewardship by optimizing water usage. The Blynk platform enables remote monitoring and control, allowing farmers to manage irrigation schedules, check sensor readings, and adjust settings conveniently through their smartphones.

Implementing such a system requires an initial investment in IoT hardware, sensors, and cloud infrastructure. Maintenance, calibration, and ensuring robust connectivity in remote areas remain challenges. Additionally, educating and training farmers to utilize the technology effectively is crucial for successful adoption. The system has the potential for scalability and future enhancements. Integration with advanced technologies like AI for predictive analytics and continuous collaboration with experts can further refine the system's capabilities [12]. Overall, a smart irrigating and crop selection system powered by IoT technology and the Blynk platform offers a holistic approach to modernizing agriculture. By harnessing real-time data and smart decision-making, it aims to revolutionize farming practices, making them more sustainable, efficient, and productive. The system empowers farmers with valuable insights, enabling them to optimize resources and improve agricultural outcomes while contributing to environmental conservation.

Future Scope: Incorporate machine learning algorithms or AI models to further optimize crop selection, irrigation scheduling, and water management based on historical and real-time data [13]. Explore the integration of edge computing to enable faster and real-time decision-making, reducing reliance on continuous cloud connectivity [14]. Conduct workshops and educational programs to increase awareness and train farmers in utilizing advanced IoT technologies effectively for improved agricultural practices. Collaborate with agricultural research institutions and experts to continually refine the system, incorporating the latest advancements in smart farming technologies [15]. By addressing limitations, implementing recommended improvements, and exploring future enhancements, the button-based smart irrigating and crop selection system can evolve into a more robust, adaptable, and efficient solution for modern agriculture, contributing to sustainable farming practices and increased productivity.

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