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Smart Agriculture System

Mohammad Maaz
Bachelor's of Technology in Electronics and Communication Engineering
University of Engineering and Management
Kolkata, India
maazshamsi2004@gmail.com

Harsh Agarwal
Bachelor's of Technology in Electronics and Communication Engineering
University of Engineering and Management
Kolkata, India
agarwalh156@gmail.com

Devraj Chauhan
Bachelor's of Technology in Electronics and Communication Engineering
University of Engineering and Management
Kolkata, India
devrc007@gmaill.com

Pratip Bera
Bachelor's of Technology in Electronics and Communication Engineering
University of Engineering and Management
Kolkata, India
pratipbera790@gmail.com

Kaifuddin Sanpui
Bachelor's of Technology in Electronics and Communication Engineering
University of Engineering and Management
Kolkata, India
kaifuddinsanpui@gmail.com

Ujjwal Raj
Bachelor's of Technology in Electronics and Communication Engineering
University of Engineering and Management
Kolkata, India
ujjwalraj578@gmail.com

Maumita Das
Assistant Professor
Department of Electronics and Communication Engineering
University of Engineering and Management
Kolkata, India
maumita.das@uem.edu.in

Sudipta Ghosh
Associate Professor
Department of Electronics and Communication Engineering
University of Engineering and Management
Kolkata, India
sudipta.ghosh@uem.edu.in

***Abstract*—This research paper presents a smart agriculture system that optimizes irrigation using soil moisture sensors, relay-controlled water pumps, and rainfall detectors controlled via a Raspberry Pi. The system automates water application based on soil moisture levels and adapts to rainfall, promoting efficient water use and sustainable farming practices.**

***Keywords*—Smart Agriculture, Embedded Systems, IOT, Sustainable Farming, Irrigation Optimization, Raspberry Pi**

INTRODUCTION

The growing global population is putting a lot of stress on the world's food systems and natural resources. To feed everyone, we need to increase food production, but this requires a lot of water. In fact, most of the world's freshwater is used for farming, which is a big concern because water is a limited resource. We need to find new ways to use water more efficiently in agriculture and reduce the environmental impact of farming.

One promising approach is to use technology to make irrigation systems more efficient. By using real-time data and automation, these "smart" systems can ensure that crops get exactly the right amount of water, reducing waste and conserving water. This study aims to design and implement a state-of-the-art irrigation management system that uses technology to make farming more sustainable and productive.

PROBLEM STATEMENT

Traditional agricultural practices struggle with inefficiency, resource overuse, and vulnerability to climate change, leading to suboptimal crop yields and environmental degradation. There is an urgent need for innovative solutions to enhance productivity and sustainability in farming.

PROPOSED SOLUTION

The Smart Agriculture System is a novel approach to optimize water usage in agriculture, reducing waste and promoting sustainable farming practices. This system integrates a moisture sensor, a relay-controlled water pump, and a rainfall sensor, controlled via a Raspberry Pi to ensure that crops receive the exact amount of water required, minimizing waste and conserving water.

KEY COMPONENTS

1. SOIL MOISTURE SENSOR:

The soil moisture sensor shown in figure 1 is a crucial component in the system that measures the moisture level in the soil. It works on the principle of electrical conductivity, where two electrodes are inserted into the soil to detect the moisture level. When the soil is moist, the electrodes conduct electricity, and when the soil is dry, the electrodes do not conduct electricity. The sensor converts the electrical conductivity into a digital signal, which is then sent to the Raspberry Pi 3B+ which interprets the signal and determines the moisture level in the soil. If the moisture level falls below a certain threshold, the Raspberry Pi 3B+ sends a signal to the relay module to activate the water pump, ensuring the soil receives the necessary amount of water.

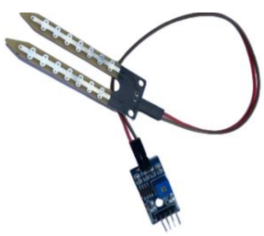

Fig 1. Soil Moisture Sensor

2. RAINFALL SENSOR:

The rainfall sensor shown in figure 2 is another essential component in the system that detects rainfall and sends a signal to the Raspberry Pi 3B+ to control the water pump. This sensor works on the principle of electrical conductivity, where a series of electrodes are exposed to the atmosphere to detect rainfall. When rain falls on the electrodes, it creates a conductive path, allowing electricity to flow. The sensor converts the electrical conductivity into a digital signal, which is then sent to the Raspberry Pi 3B+ which interprets the signal and determines if it is raining. If it is raining, the Raspberry Pi 3B+ sends a signal to the relay module to deactivate the water pump, preventing unnecessary water usage.

Fig 2. Rainfall Sensor

3. 5V RELAY:

The 5V relay module shown in figure 3 is a crucial component in the system that acts as a switch to control the water pump. This relay module works on the principle of electromagnetic induction, where an electric current flowing through a coil creates a magnetic field that attracts a metal contact, closing the circuit and allowing electricity to flow to the water pump. The relay module is controlled by the Raspberry Pi 3B+, which sends a signal to the relay module to activate or deactivate the water pump. When the Raspberry Pi 3B+ sends a signal to the relay module, it closes the circuit, allowing electricity to flow to the water pump, and the pump is activated. Conversely, when the Raspberry Pi 3B+ sends a signal to the relay module to deactivate the pump, it opens the circuit, cutting off electricity to the pump, and the pump is deactivated.

Fig 3. 5V Relay

4. MICRO SUBMERGIBLE WATER PUMP:

The micro submersible water pump shown in figure 4 is a compact and efficient pump that is designed to pump water from a reservoir to the soil. This pump works on the principle of electromagnetic induction, where an electric current flowing through a coil creates a magnetic field that interacts with a magnet, causing the pump to rotate. The rotation creates suction, drawing water into the pump and pushing it out through the outlet. The pump is controlled by the Raspberry Pi 3B+, which sends a signal to the relay module to activate or deactivate the pump based on the moisture level in the soil and the presence of rainfall.

Fig 4. Water Pump

5. RASPBERRY PI 3B+:

The Raspberry Pi 3B+ shown in figure 5 is a small, single-board computer that serves as the brain of the system. It is responsible for controlling the entire system, reading data from the soil moisture sensor and rainfall sensor, and controlling the relay module to activate or deactivate the water pump. The Raspberry Pi 3B+ is programmed to interpret the data from the sensors and make decisions based on the moisture level in the soil and the presence of rainfall. It sends signals to the relay module to control the water pump, ensuring that the soil receives the necessary amount of water while preventing unnecessary water usage. The Raspberry Pi 3B+ is a powerful and efficient computer that enables the system to operate autonomously and efficiently.

Fig 5. Raspberry Pi 3B+

METHODOLOGY

This study employed a mixed-methods approach, combining both qualitative and quantitative methods to design, develop, and test the Smart Agriculture System.

The Smart Agriculture System consisted of several hardware components, including a soil moisture sensor, rainfall sensor, micro submersible water pump, 5V relay module, and a Raspberry Pi 3B+. The assembled circuit can be seen in figure 6. These components were selected based on their compatibility, accuracy, and reliability. The soil moisture sensor and rainfall sensor were chosen for their ability to provide accurate readings of soil moisture levels and rainfall, respectively. The micro submersible water pump was selected for its compact size and efficient water pumping capabilities. The 5V relay module was used to control the water pump, and the Raspberry Pi 3B+ was chosen as the central processing unit due to its ease of use, flexibility, and affordability.

The moisture sensor senses the moisture level, and if found below the threshold, the relay is triggered, hence turning the pump on. On the other hand, if the rainfall sensor senses raindrops, it will not turn the relay on.

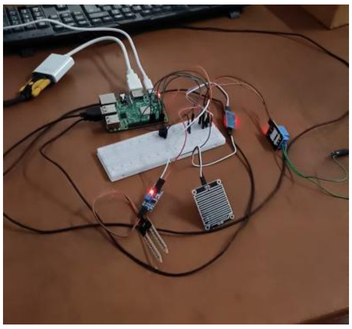

Fig 6. A working image of the project

RESULT

The system was tested in a controlled environment, and the results show that the system can accurately detect the water level in the soil and automatically irrigate the soil when necessary. The same can be observed in figures 6 and 7. The system successfully reduces manual labor and optimizes water usage, making it a viable solution for smart agriculture.

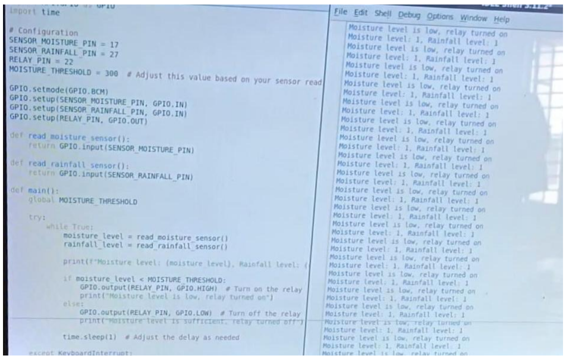

Fig 7. The final results obtained on a display

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CONCLUSION

In conclusion, this Smart Agriculture System project has successfully demonstrated the potential of sensor technologies in improving crop monitoring and automating irrigation procedures. By leveraging the capabilities of moisture sensors, rainfall sensors, and microcontrollers, this system has shown promise in optimizing water usage and enhancing crop yields. The project's innovative approach and technical solutions have significant implications for the future of sustainable agriculture.

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