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An IoT-Based Smart Agriculture Monitoring and Advisory System

Samruddhi Avadhoot[1], Shravani Ghorpade[2], Suraj Rajguru[3], Dr. R. Rashmi[4]
[1, 2, 3]*Electronics and Telecommunications, PVPIT Bavdhan* ,Pune, India
[4]*Project Guide Dean Academics, PVPIT Bavdhan*,Pune,India

Abstract: This research work addresses key challenges in agriculture such as inefficient water usage, lack of real-time field monitoring, and limited access to timely advisory for farmers. To overcome these issues, this paper presents an IoT-based smart agriculture monitoring and advisory system that enables continuous tracking of environmental and soil conditions. The proposed system uses sensors such as soil moisture, temperature, and humidity to collect real-time data from the field using a microcontroller (ESP32). The collected data is transmitted to a cloud platform for storage and analysis. Based on the sensed parameters, the system provides automated irrigation control and generates useful advisories to farmers for better crop management. It also includes features like remote monitoring through a mobile application, alert notifications for abnormal conditions, and data visualization for easy understanding. The system is designed to be cost-effective, user-friendly, and scalable for both small and large farms. The experimental results demonstrate that the proposed system helps in optimizing water usage, reducing manual effort, and improving overall agricultural productivity, making it a practical solution for modern smart farming.

Keywords: Internet of Things (IoT), Smart Agriculture, Soil Moisture Monitoring, Automated Irrigati on, ESP32.

I. INTRODUCTION

The agricultural sector is an extremely important sector to the economy of India. A large part of the population relies on agriculture to earn a living and it provides a significant contribution to food production and employment and overall economic growth in general.

The agriculture industry provides food security for the nation. In addition, agri-business provides support to various other sectors of the economy such as textiles, food processing, and trade.One of the biggest challenges to traditional farming techniques is unpredictable weather, inefficient water usage, soil degradation, and a lack of timely information for farmers.

Through the use of modern agriculture, many of these challenges can now be overcome, and sustainable agriculture can be promoted. Modern agriculture leverages the use of technology such as the Internet of Things (IoT), automation, and data analytics to improve efficiencies within the agriculture sector. As a result, farmers can monitor field conditions on a real-time basis and reduce waste of resources and ultimately make more informed decisions.Sustainable farming methods are used to conserve water, preserve soil, and promote the production of crops through increased agricultural yields while minimizing the environmental impact from agriculture.

By utilizing smart agricultural practices, farmers can realize increased yields with less work and cost.

An Internet of Things (IoT)-based system can deliver information about continuous measurements made in a farm environment for both the farmer's immediate needs and long-term production planning. In addition to providing up-to-date data about all relevant environmental conditions in real time, this system will also provide the farmer an opportunity to take immediate action based on their own experience.

This project consists of an ESP32 microcontroller and a number of sensors developed to monitor a variety of parameters in a farm environment. The primary purpose of this system is to collect and process real-time information from multiple sensors installed in the field and use the information to provide a better understanding of the conditions affecting the growth of crops.

There will be multiple sensors used in this project, including a soil moisture sensor to determine the amount of water in the soil; a temperature sensor; a DHT11 sensor for measuring temperature and humidity in the environment. Each parameter is key to determining the current state of a crop and ensuring that it grows successfully.

The system will also include an automatic irrigation system that uses a relay module to turn on and off an electrically operated water pump based on the amount of moisture present in the soil. By using the automatic irrigation system, a farmer can reduce the amount of water wasted and know that their crops will be able to receive the appropriate amount of watering.

In addition to controlling irrigation, the system will include a motion detector in the form of a passive infrared (PIR) sensor. The collected data can be displayed and monitored remotely through an IoT platform, allowing farmers to access information anytime and from anywhere.

Overall, the proposed system aims to make agriculture smarter, more efficient, and sustainable. It reduces manual effort, saves water, and improves crop productivity. Due to its cost-effectiveness and ease of use, the system can be easily adopted by farmers, making it a practical solution for modern agriculture

A. Components Used

- ESP32 Microcontroller
- Soil Moisture Sensor
- DHT11 (Temperature & Humidity Sensor)
- PIR Sensor
- Rain Sensor
- Relay Module
- Water Pump
- Buzzer
- LDR Sensor
- Power Supply
- Connecting Wires

1) Soil Moisture Sensor

Working:

This sensor measures the amount of water present in the soil. It has two probes that are inserted into the soil. When the soil is wet, it conducts electricity better; when dry, conductivity is low. Based on this, moisture level is detected.

Range:

0 (completely dry) to ~4095 (fully wet, depends on ADC of ESP32)

Output:

Analog output (continuous values) and sometimes digital output (wet/dry)

2) Temperature & Humidity Sensor (DHT11)

Working:

The DHT11 sensor measures temperature and humidity using an internal thermistor and humidity sensing component. It sends digital signals to the ESP32.

Range:

- Temperature: 0°C to 50°C
- Humidity: 20% to 90%

Output:

Digital output (temperature in °C and humidity in %)

3) PIR Sensor (Passive Infrared Sensor)

Working:

This sensor detects motion by sensing infrared radiation (heat) emitted by humans or animals. When motion is detected, it triggers a signal.

Range:

- Detection distance: ~3 to 7 meters
- Angle: ~120°

Output:

Digital output (HIGH when motion detected, LOW otherwise)

4) Rain Sensor Working

The rain sensor detects the presence of water droplets on its surface. When rain falls, the resistance changes, and the sensor detects rainfall.

Output:

Analog output (rain intensity level) and digital output

5) ESP32 Microcontroller

Working:

ESP32 is the main controller of the system. It collects data from all sensors, processes it, and sends it to the cloud using Wi-Fi.

Range:

- Operating voltage: 3.3V
- Wi-Fi range: ~50–100 meters

Output:

Digital processing, Wi-Fi data transmission

6) Relay Module

Working:

The relay acts like an electronic switch. It allows the ESP32 to control high-voltage devices like a water pump.

Range:

- Typically supports 5V control signal
- Can switch 220V AC devices

Output:

ON/OFF switching (digital control)

7) Water Pump (Actuator)

Working:

The pump is used for irrigation. It turns ON when soil is dry and OFF when soil is wet, based on relay control.

Output:

Physical water flow for irrigation

8) LDR Sensor (Light Dependent Resistor)

Working:

It measures light intensity. Resistance decreases when light increases.

Range:

Varies with light intensity

Output:

Analog output (light level)

9) BlynkIoT

The Blynk IoT is a cloud-based IoT platform used to connect the ESP32 microcontroller with a mobile application via Wi-Fi. It enables real-time transmission of sensor data such as soil moisture, temperature, and humidity to the cloud server. The processed data is displayed on a user-friendly dashboard for monitoring purposes. Additionally, the platform allows remote control of actuators like water pumps through the mobile interface. In the proposed system, Blynk IoT plays a crucial role in enabling automation, real-time monitoring, and alert notifications. Thus, it enhances the efficiency and usability of the smart agriculture system.

II. METHODOLOGY

The proposed work suggests an end-to-end intelligent system that collects real-time data using sensors like soil moisture, temperature, and humidity through ESP32. This data is sent to the cloud via IoT for monitoring and analysis. Based on the data, the system automatically controls irrigation and provides alerts to the user..

A. *Overall Architecture*

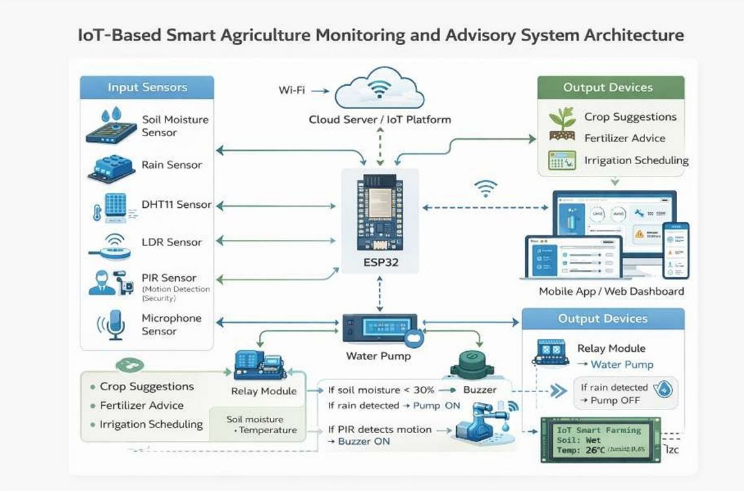


Fig.3.1 Architecture

Proposed framework consists of the following major components:

- Input Sensors
- ESP32 Microcontroller
- Cloud Server / IoT Platform
- Output Devices / Actuators
- User Interface
- Smart Advisory System

1) *System Architecture Design*

The system consists of three main layers:

- Sensing Layer: Comprising sensors such as DHT11 (temperature and humidity), soil moisture sensor, and PIR sensor to measure environmental and field conditions.
- Processing Layer: Using ESP32 microcontroller to collect sensor data, perform initial processing, and communicate with the cloud server.
- Application Layer: The processed data is transmitted to Blynk IoT cloud platform and displayed on a mobile application to provide real-time monitoring and advisory.

2) *Sensor Data Acquisition*

- The DHT11 sensor measures ambient temperature and humidity.
- The soil moisture sensor detects the volumetric water content of the soil.
- The PIR sensor monitors the presence of animals or unauthorized movement in the field.
- All sensors are interfaced with the ESP32 microcontroller using appropriate analog/digital pins.
- Sensor data is read periodically at a pre-defined interval of every 5 seconds to ensure timely monitoring.

3) *Microcontroller Processing*

- ESP32 receives data from all sensors and converts raw sensor outputs into meaningful values (e.g., soil moisture in %).
- Thresholds are defined for each parameter to generate advisories:
    - Soil moisture < 30% → Irrigation required.
    - Temperature > 35°C → Protective measures needed.
    - Humidity < 40% → High risk of crop dryness.

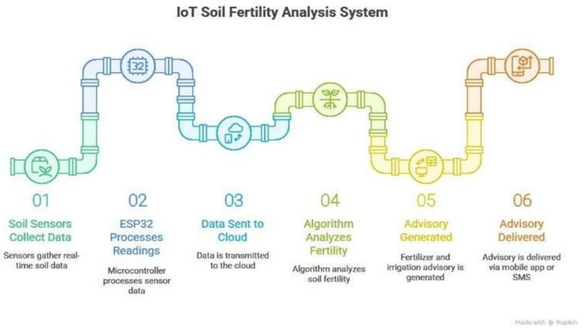
4) Cloud Integration

- The processed sensor data is uploaded to Blynk IoT cloud using Wi-Fi connectivity of ESP32.
- Blink IoT acts as the cloud interface, storing the data and providing an API for mobile application integration.

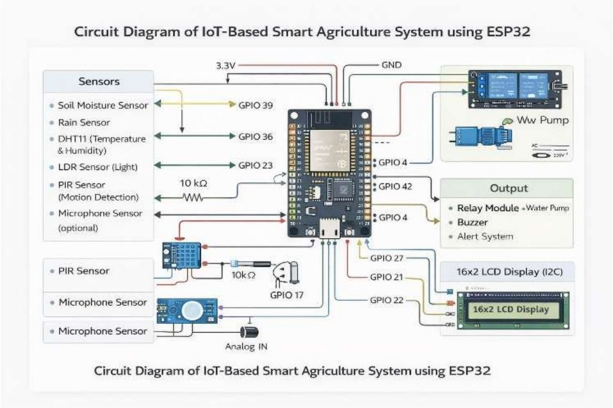
5) Advisory Generation

The system automatically generates advisories based on sensor readings:

- Alerts for low soil moisture or high temperature.
- Notifications for preventive measures such as irrigation, shading, or pesticide spraying.
- Advisory logic is embedded in the ESP32 firmware and synchronized with Blink IoT to trigger push notifications.



6) Circuit Diagram



The circuit diagram illustrates an IoT-based smart agriculture system centered around the ESP32 microcontroller, which acts as the main processing and control unit.

Various sensors such as the soil moisture sensor, rain sensor, DHT11 (temperature and humidity), LDR (light), PIR (motion), and an optional microphone sensor are interfaced with different GPIO pins of the ESP32.

These sensors continuously monitor environmental and field conditions, and the ESP32 processes this data to make intelligent decisions. All components are powered using the 3.3V supply and share a common ground, ensuring stable operation of the system. Based on the sensor data, the ESP32 controls output devices such as a relay module connected to a water pump, a buzzer, and an alert system. For instance, when low soil moisture is detected, the relay automatically activates the water pump for irrigation. Additionally, a 16×2 LCD display (connected via I2C pins GPIO 21 and GPIO 22) is used to show real-time sensor readings and system status.

III. RESULTS AND DISCUSSION

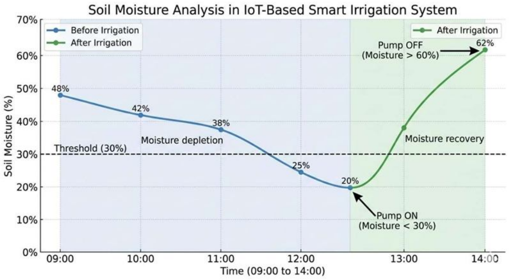
The proposed IoT-based smart agriculture monitoring system was tested under different environmental conditions to evaluate its performance and response accuracy.

The system continuously monitored parameters such as soil moisture, rainfall, temperature, humidity, and motion activity, and generated appropriate actions and alerts.

The results demonstrate that the system responds effectively to real-time changes and ensures efficient resource utilization. The graphical analysis of sensor outputs validates the reliability and automation capability of the proposed system.

A. Soil Moisture Sensor Analysis

The soil moisture analysis graph shows the variation of moisture levels before and after irrigation. Initially, the moisture level gradually decreases from 48% to 20%, indicating natural depletion due to environmental conditions. When the moisture level falls below the predefined threshold of 30%, the system automatically activates the water pump. This is clearly observed at the point where moisture reaches around 20%, triggering irrigation. After the pump is turned ON, the soil moisture level increases steadily from 20% to 62%, indicating effective water supply to the soil. Once the moisture level exceeds 60%, the system automatically turns OFF the pump, preventing over-irrigation. This result confirms that the system efficiently maintains optimal soil moisture levels and conserves water by automating irrigation.

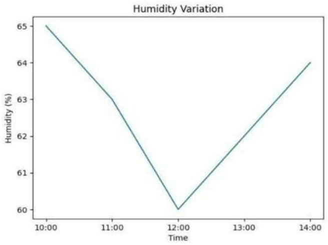


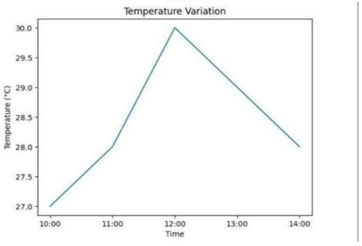
B. Temperature and Humidity Analysis

The temperature and humidity data obtained from the DHT11 sensor showed stable and consistent readings throughout the testing period. The system successfully monitored environmental conditions and provided real-time updates.

Based on predefined thresholds, advisories such as high temperature warnings and low humidity alerts were generated.

The observed values indicate that the system can effectively track environmental variations and assist in decision-making for crop management. The integration of these parameters with the advisory system enhances the overall intelligence of the solution.



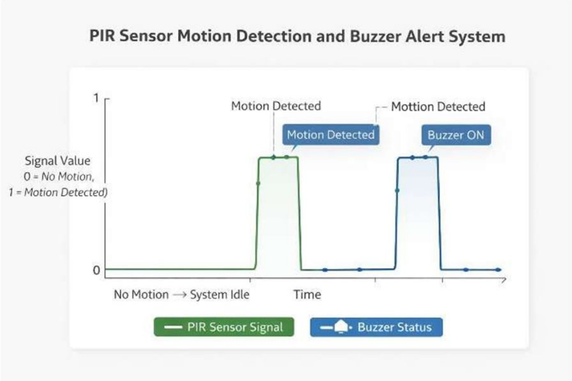


Time (hrs)	Soil Moisture (%)	Temperature (°C)	Humidity (%)	Pump Status
09:00	48	26	68	OFF
10:00	42	27	65	OFF
11:00	38	28	63	OFF
12:00	25	30	60	ON
13:00	20	29	62	ON
14:00	62	28	64	OFF

The system was observed for a specific duration, and sensor readings were recorded at regular intervals.
Table I shows the collected values of soil moisture, temperature, humidity, and pump status. A predefined threshold value is set based on the crop type and soil characteristics. Typically, if the soil moisture level falls below 30%, the system identifies the soil as dry and automatically activates the irrigation pump via a relay module

C. PIR Sensor and Buzzer Response

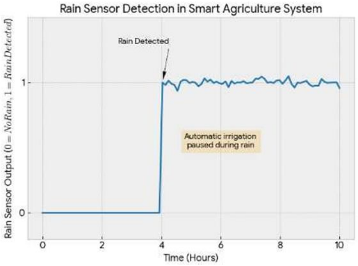
The PIR sensor graph shows how the sensor detects movement in the field of agriculture. The sensor output stays at 0 when there is no movement, and the system stays idle. When motion is detected, the output changes to show that something is moving, like animals or people who shouldn't be there.



The buzzer goes off as soon as it senses movement, sending out an alert signal. The graph shows that the buzzer status follows the PIR signal with a small delay. This makes sure that the alert goes off only after the proper detection. When the motion stops, both the PIR signal and the buzzer turn off. This proves that the intrusion detection and alert system works.

D. Rain Sensor Analysis

The rain sensor graph shows how the system reacts to rain. The sensor output starts at 0, which means there is no rain. Around the fourth hour, the sensor output suddenly goes up to 1, which means it has found rain.
The system automatically stops watering when it rains, even if the soil is dry. This behavior makes sure that water isn't wasted when it rains naturally. The steady high signal during the rain shows that the system can reliably detect things and work well in real-time environmental conditions.



E. Relay Module and Water Pump Control Analysis

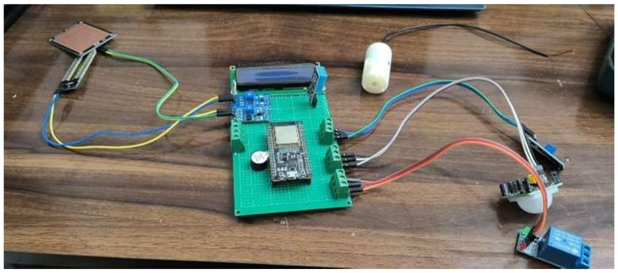
We looked at how the relay module and water pump worked based on the system logic and the moisture level in the soil. The relay is a switch that turns the water pump on and off based on the sensor's reading of the moisture level. The relay stays OFF and the pump stays off when the soil moisture level stays above the threshold value of 30%. This means that irrigation is not needed.
When the soil moisture level drops below the threshold (about 20%), the ESP32 sends a control signal to the relay module, which turns on the water pump. This is what the system does. This automatic activation makes sure that the irrigation happens on time without any work from the user.

The pump keeps running during the irrigation process until the soil moisture level reaches the desired upper limit, which is about 60%. The relay module turns off the pump when this level is reached. This stops overwatering and saves water. This ON–OFF control system uses threshold-based logic to make sure that water is managed well.

IV. HARDWARE IMPLEMENTATION

The hardware setup of the proposed IoT-based smart agriculture system consists of an ESP32 microcontroller interfaced with multiple sensors and output devices. Sensors such as soil moisture, DHT11 (temperature and humidity), rain sensor, LDR, and PIR are connected to monitor environmental and field conditions.

A relay module is used to control the water pump automatically based on soil moisture levels, while a buzzer provides alert notifications during motion detection. Additionally, a 16×2 LCD display is integrated to show real-time sensor data. The system operates using a 3.3V power supply and enables real-time monitoring and automation for efficient agricultural management.



A. IoT Dashboard Interface

The IoT Blynk home page acts as the interface used for real-time monitoring and management of the smart agriculture system. The interface shows the relevant variables like soil moisture content, temperature, and humidity, among others. Furthermore, there is an indication of the state of motion detection and the alarm status. The sensors' information is updated in real-time, hence enabling the user to view the environmental status from remote areas. In addition, there are visualizations that show the status of system operations, including the operation of pumps and alarms.

B. Advisory System

The proposed system generates simple and effective advisories based on real-time sensor data to assist in better decision-making for agricultural practices.

These advisories are based on predefined threshold values of soil moisture, temperature, and humidity.

1) Soil Moisture-Based Advisories
  - If soil moisture < 30% → “Irrigation required immediately.”
  - If soil moisture is between 30%–60% → “Soil moisture is optimal.”
  - If soil moisture > 60% → “No irrigation needed (risk of overwatering).”

2) Temperature-Based Advisories
  - If temperature > 35°C → “High temperature detected, provide shading or increase watering.”
  - If temperature < 15°C → “Low temperature detected, protect crops from cold conditions.”

3) Humidity-Based Advisories
  - If humidity < 40% → “Low humidity, risk of dryness—consider irrigation or misting.”
  - If humidity is between 40%–70% → “Humidity level is optimal.”
  - If humidity > 70% → “High humidity detected, risk of fungal diseases.”

V. CONCLUSION

In conclusion, the IoT-Based Smart Agriculture Monitoring and Advisory System serves as a demonstration of how contemporary sensors can be integrated with data processing techniques to increase efficiency in agriculture. In particular, the system takes advantage of an ESP32 microcontroller to capture data from various sensors that measure different parameters such as soil moisture, temperature, humidity, precipitation, illumination, and motion detection sensors.

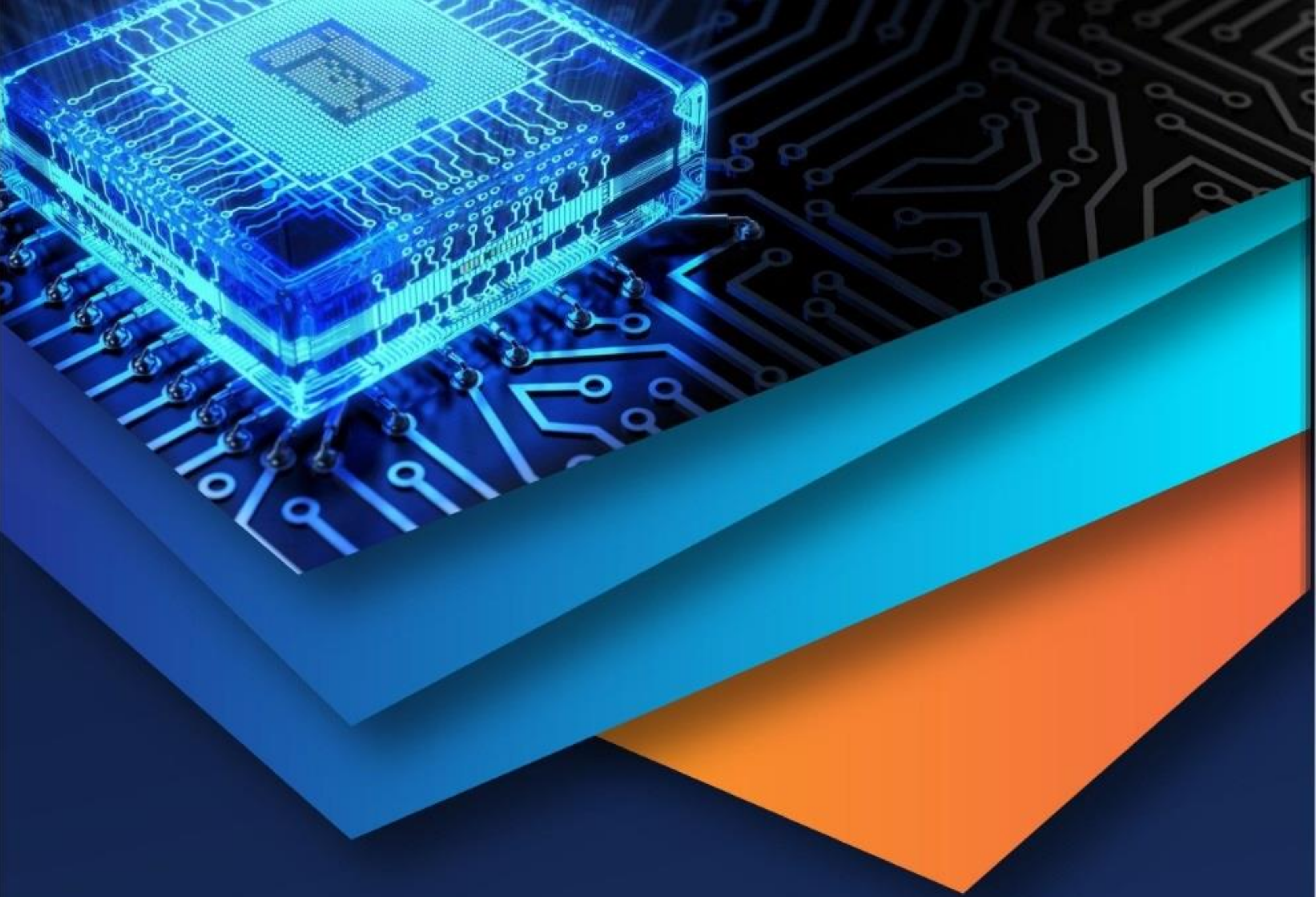
Based on the collected data, intelligent control of irrigation with a help of the relay-powered water pump is achieved. Moreover, the use of a rain sensor makes sure that irrigation will be suspended during the rainfall and thus water will not be wasted, while a motion detection sensor will improve safety as it will detect any unwanted movements in the field and send notifications through a buzzer.

The use of a cloud platform allows transmitting the obtained data in real time and monitoring the data remotely via the internet either with a computer or smartphone.

In addition, the system offers some important suggestions regarding selecting the crops, fertilizers application, and irrigation schedule.

REFERENCES

[1] S. R. Nandurkar, V. R. Thool, and R. C. Thool, “Design and Development of Precision Agriculture System Using Wireless Sensor Network,” IEEE International Conference on Automation, Control, Energy and Systems (ACES), 2014.
[2] K. Lakshmisudha, S. Hegde, N. Kale, and S. Iyer, “Smart Precision Based Agriculture Using Sensors,” International Journal of Computer Applications, vol. 146, no. 11, pp. 36–38, 2016.
[3] N. Suma, S. R. Samson, S. Saranya, G. Shanmugapriya, and R. Subhashri, “IoT Based Smart Agriculture Monitoring System,” International Journal on Recent and Innovation Trends in Computing and Communication, vol. 5, no. 2, pp. 177–181, 2017.
[4] J. Burrell, T. Brooke, and R. Beckwith, “Vineyard Computing: Sensor Networks in Agricultural Production,” IEEE Pervasive Computing, vol. 3, no. 1, pp. 38–45, Jan.–Mar. 2004.
[5] Espressif Systems, “ESP32 Technical Reference Manual,” [Online]. Available: https://docs.espressif.com
[6] Arduino, “Arduino Official Documentation,” [Online]. Available: https://www.arduino.cc
[7] Random Nerd Tutorials, “ESP32 IoT Projects and Sensor Interfacing,” [Online]. Available: https://randomnerdtutorials.com
[8] MathWorks, “ThingSpeak IoT Analytics Platform,” [Online]. Available: https://thingspeak.com
[9] Aosong Electronics, “DHT11 Temperature and Humidity Sensor Datasheet,” [Online].
[10] SparkFun Electronics, “Soil Moisture Sensor Hookup Guide,” [Online].
[11] Adafruit Industries, “PIR Motion Sensor Guide (HC-SR501),” [Online].
[12] Electronics Tutorials, “Light Dependent Resistor (LDR) – Working Principle,” [Online].



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