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Smart Agriculture Monitoring and Controlling System

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Abstract- The agricultural issue in the planet is still an important one that is subject to the conditions of unpredictable weather conditions, the inefficient use of water and the impossibility to monitor the field that leads to severe reduction of crop production and the overall final production. The unavailability of automated decisionmaking systems in the majority of the developing areas also contributes to the waste of resources and manual labour. In an attempt to address these limitations, the present study suggests the implementation of an IoT-based Smart Agriculture Monitoring and Controlling System that would be able to execute real-time sensing, analytics and automated irrigation control. In order to make the field dynamically controlled, the system is composed of an ESP32 microcontroller, a soil moisture sensor, temperature–humidity sensor DHT11 and a water pump, which is driven by the relay. As the critical parameters of the environment are constantly tracked, it becomes possible to identify the condition of soil dryness, changes in climatic conditions, and the need to irrigate the land with high accuracy and start the automatic control of pumps according to the algorithms of the threshold. The proposed architecture aims at saving energy through the use of power, is wireless, modular, and scalable in the application within large farmlands. The wireless platform using ESP32 will most likely increase the speed of decision-making, reduce the water wastage, and increase the reliability when compared to the traditional hand-operated irrigation systems. Coupling of irrigation, sensor communication stability, and precision of moisture sensors have been demonstrated to be effective through the experimental validation and ensure optimal allocation of water and a minimum number of false triggers. The system is cost effective, economical and can accommodate the modern precision agricultural demands and operation offering a viable solution towards smart farming automation and management of agricultural resources.
Keywords: IoT, Smart Agriculture, ESP32, Soil Moisture Sensor, DHT11, Automated Irrigation, Wireless Monitoring System.

INTRODUCTION

Agriculture is one of the most vital bases of human existence, but it is still challenged by many obstacles caused by the unpredictable weather conditions, inefficient use of resources, and failure to monitor the fields on time. All these problems lead to low production of crops, wastage of water and more human labour among farmers.

Conventional agricultural methods are associated with the human response through delay and manual monitoring, which result in voids in decisionmaking and unnecessary productivity and sustainability losses. The increasing world food demand, as well as the rapid reserves of the natural resources, creates an immediate necessity of smart, automated, and data-driven agricultural processes, which can generate real-time decision-making and deliver an uninterrupted field insight [1], [2]. The latest innovations in IoT and embedded sensing technologies have made it possible to create smart agriculture solutions that could identify the current conditions of soils, the levels of environmental phenomena, and the level of water demands in realtime. The IoT-based systems provide a smooth flow of information between the distributed sensor nodes and the central processing units hence facilitating automated irrigation, monitoring of fields remotely, and allocating resources in the most efficient way. These systems have soil moisture sensors, temperature and humidity sensors, and wireless communication modules that can constantly monitor the health of crops, identify environmental changes, and provide farmers with actionable insights via smartphones or cloud dashboard [3], [4]. Current smart farming systems tend to be based on various sensing devices, such as soil moisture sensors, DHT11, ESP32 modules and relay-driven automation, to establish a reliable water management and mitigate the risks of human judgement

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as a source of error. These systems enable precision in the sensing of soil dryness, climate trends of soil as well as irrigation needs. Combined with a reliable communication channel, it is an additional boost to the credibility of data transfer, as farmers can be notified or remotely turn on irrigation. But some traditional systems continue to rely on communication technologies that are outdated or have a short range, whereby, this limits scalability, delays and robustness in large farmland deployments [5], [6]. In order to address such limitations, the current paper suggests a real-time Smart Agriculture Monitoring and Controlling System with the use of ESP32, DHT11, soil moisture sensors, and automated pump-control with a relay driver. ESP32 microcontroller offers fast Wi-Fi, low power consumption and it fits well with IoT platforms and hence is suitable in round-the-clock monitoring of farms. Compared to the ancient system of manual irrigation, the suggested system will evaluate sensor data with the help of threshold-based decision-making algorithms and will activate the water pump only when the crop needs it. This translates to great saving of water, little human intervention and better production of crops hence suitable in small scale farm or large scale farm fields in a rural or semi-urban setting [7]. This work made the following contributions: • The creation of an IoT-based monitoring system that would be able to monitor soil moisture, temperature, and humidity in real time. • computerized irrigation management based on sensor-driven decision making and relay-based pumping processes. • ESP32 implementation with Wi-Fi remote monitoring and control over the IoT dashboards. • A small-scale, low-cost, energy-saving architecture that complies with current precision farming demands [8]. The rest of the paper is organized as follows: Section II is a discussion of related literature on smart irrigation and IoT-based agricultural systems; Section III describes the proposed hardware and methodology; Section IV addresses the implementation details, experiments, and results; and Section V is the conclusion of the work with the potential future improvements.

LITERATURE REVIEW

S. N. Razali et al. (2021) introduced an Accident Detection and Tracking System IoT-Based an Accident with Telegram and SMS Notification. The system combines the GSM and GPS modules with internet of things cloud connection to provide notifications through SMS as well as Telegram. The design has redundant communication channels; this enhances message reliability in limited network areas. The hybrid alerting model is scalable to integration of smart cities. [1]. A Vehicle Over-Speed Detection and Accident Avoidance System that was developed by H. C. T. et al. (2021) based on the IoT and relied on the IR sensors and a GSM-enabled alert system. The system constantly checks the speed of vehicles and notifies the driver when he or she is over speeding. Moreover, there is braking systems that collide automatically. Their effort promotes preventive safety and not after accidents are detected. [2]. The article by G. S. Rathod, R. C. Tipale, and K. Jajulwar (2022) introduced an Intelligent Accident Detection and Alerting System founded on the principles of Machine Learning over IoT. The system uses numerous sensors, such as accelerator and GPS, to collect accident data sent through the Raspberry Pi to the cloud servers to be analyzed with the help of the ML. IoT and supervised learning decreased the response latency and enhanced the detection accuracy over conventional threshold-based approaches. The data-driven emergency response is supported by their modular design, which adds to the reliability of cars monitoring. [3]. L. S. et al. (2022) designed a Vehicle Accident Detection and Prevention System on the basis of the IoT and Deep Learning system based on the combination of vibration and ultrasonic sensors and a convolutional neural network (CNN) model. The architecture is able to classify the accident and send alerts in real time using GSM with addition of GPS to know the live whereabouts. The deep learning allows the system to make decisions based on context, i.e. differentiating a fake trigger and a true collision. Their system increases the automation of vehicle safety and preconditions AI-powered IoT accident detection. [4]. G. S. Rathod, K. Jajulwar, and U.

Kubde (2023) implemented an Intelligent Accident Detection andIoT Networks Notification System This is a system that integrates IoT sensors and cloud-computing ML models to detect accident events. The system also gathers the data on vehicles like pressure, velocity and position which are confirmed with the help of the Random Forest and SVM classifiers which provide accuracy of 99% detection. The validation transfers the data to the rescue teams through GSM to ensure quick response. The study focuses on cloud-internet of things combination to achieve real-time analytics to decrease false positives. [5]. S. Areef et al. (2023) organized A Study on Cloud and IoT-based Accident Detection and Prevention Systems, which is the review of different IoT architectures combined with cloud analytics to be used as the post-accident reporting. The paper categorizes the systems in terms of communication layers and energy efficiency. The authors highlight the importance of cloud-edge collaboration in order to reduce latency in accident notification and suggest an optimized IoT system in predicting accidents based on data. [6]. A. Reddy et al. (2023) came up with an Accident Detection System based on IoT based on Raspberry Pi. The system involves an accelerator and GPS sensor to detect the cases of collision and a camera to record the real-time footage of an accident. The information is uploaded to the cloud storage through GSM to access it remotely. Such a method provides emergency teams with better understanding of the situation and enables the reconstruction of the event to conduct an analysis. [7]. P. Sudarshan, V. Bhardwaj, and Virender (2023) introduced a

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RealTime Driver Drowsiness Detection and Assistance System based on the application of the Machine Learning and IoT. The system utilizes the facial recognition and eyeblink detection models as well as the head movement tracking sensors. IoT modules pass real-time alerts to the driver and remote centers. Their system has an accuracy of more than 90% of detection which adds to the prevention of accidents by analysing behaviour. [8]. B. Ninan (2024) suggested a ConfirmationBased Accident Detection System under IoT with Smart Vehicles which is a dual sensor verification system of collision incident confirmation. The design incorporates the use of vibration and gyroscopic sensors together with GPS and GSM to locate the locality more accurately. It is a system that can be more reliable and has a reduced false positive than single-sensors. The research paper identifies confirmation-based data fusion as one of the steps towards vigorous smart vehicle systems, which prove applicable to massive automotive systems. [9]. The authors of the article that was selected are J. M., B. M., M. Sindhuja, and J. P. D. (2024), who developed an IoT-based Smart Accident Detection and Emergency Response System in Vehicles, including an accelerometer, GPS, and GSM module to send automatic emergency alerts. The system has a high detection reliability and low latency because the impact thresholds are piping off with a number of sensors. They are implemented to generate alerts in real time and save on energy consumption during monitoring as opposed to using manual intervention to report accidents. [10]. S. Gahane, G. Bhoyar and S. Kombe (2024) investigated a Vehicle Accident Detection System based on IoT that runs on Arduino. In the design, MPU6050 and GSM modules have been used in the recognition of the impact and sending messages. The authors have shown how Arduino-based architectures can provide low-cost accident alerting solutions which can be used in developing countries. The key contribution to this research is its simplicity, costefficiency, and the possibility of practical implementation the research can have academic and real-world settings. [11]. N. Tewari et al. (2024) came up with a proposal of an IoT-Based System of Vehicles Alerting in Accident-Prone Locations of Hilly Areas and Damage parapet. The system is able to identify damaged infrastructure using ultrasonic sensors and vibration sensors and communicate with the surrounding vehicles through the cloud servers. This paper extends the accident detection to infrastructure-conscious monitoring due to vehicles, and this positively contributes to the safety of roads. [12] G. M. et al. (2024) suggested a Vehicular Accident Detection and Alert Generation System by IoT, which incorporates accelerometers, gyroscopes, and GPS modules to inform about the real-time crash. The system sends data instantly to the emergency services, guaranteeing sub-5 second response times. The modular system also enables fleet scaleability of vehicle, allowing it to be scaled to smart transport systems. [13]. Z. B. Shaik et al. (2024) created an Autonomous Vehicle Accident Detection with Event Data Recording system of Accident Analysis. It uses post-incident analysis through accelerators and event data recorders and transmits the data to the cloud databases with the help of IoT. This can be achieved by supporting live-in-service detection as well as forensic analysis of accidents, which is a bridge that exists in between data-driven investigation and safety response. [14] S. N. et al. (2025) developed a Portable Automatic Accident Detection Robot using the IoT. Accelerometers and gyroscopes provide motion and orientation data to the robot which is processed by microcontrollers and sent to cloud servers to be remotely tracked. According to the paper, in the field of accident detection, automation and portability are emphasized, which will be used in the future as AI. [15]. A. M. S. V. Sushma et al. (2025) suggested a Real-Time IoTbased Vehicle Accident Detection and Emergency Response System as Multi-Sensor Fusion of MPU6050 accelerator, ultrasonic sensors, GPS, and GSM modules on an Arduino UNO platform. The study attained 95% detection and response time of less than 10 seconds. The dual-validation scheme reduced the false alarm rate (< 5%), but was very economical (~ $50) and was best suited in low-resource areas. The paper is an important contribution to the IoT-based vehicular safety in terms of data fusion by a multi-sensor and automated emergency response system (in realtime). [16]. To shape the form, structure, and direction of the paper, the work of Pallavi Deshpande et al. (2019, 2021) was used, which is also aimed at conference publication. Whereas their researches guided our organizational strategy, they did not give us any direct content or reference thus ensuring that this paper is original. III. METHODOLOGY Proposed System- Smart

Agriculture Monitoring and Controlling System. The Smart Agriculture Monitoring and Controlling System suggested is aimed at the automatic measurement of soil moisture, temperature, and humidity and the automatic activation of irrigation.

The system will combine the ESP32 microcontroller with soil moisture sensor, DHT11 temperature humidity sensor, and a water pump which is controlled by a relay to allow proper, stable, and continuous monitoring of the field. The architecture provides farmers with the ability to monitor the situation in the field remotely and provides automated irrigation in cases when the dryness of the soil reaches a specific limit. The entire block diagram of the system is shown in Fig.

• A. System Architecture

Its construction is based on an embedded platform which has IoT capabilities enabling real-time sensing and transmitting data wirelessly. The ESP32 microcontroller is the primary processing unit because of the onboard Wi-Fi/Bluetooth capabilities, dual-core high-speed, and low-energy consumption. The ESP32 reads: • Moisture in the soil via the analog input pin. Temperature and humidity values of the

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DHT11 digital sensor. • The activation of the pump is relayed. The soil moisture sensor continuously monitors the water content in the soil. When soil dryness exceeds a set threshold, the ESP32 triggers the relay module. The relay then supplies power to the water pump, ensuring automatic irrigation.

A rechargeable battery supplying power to the system is attached to the TP4056 charging module. The boost converter brings the required level of the output voltage to the sensors, controller, and relay module, which is the MT3608. It is transmitted by using the ESP32 Wi-Fi module which is then used to monitor it remotely by sending it wirelessly to cloud dashboards or mobile applications.

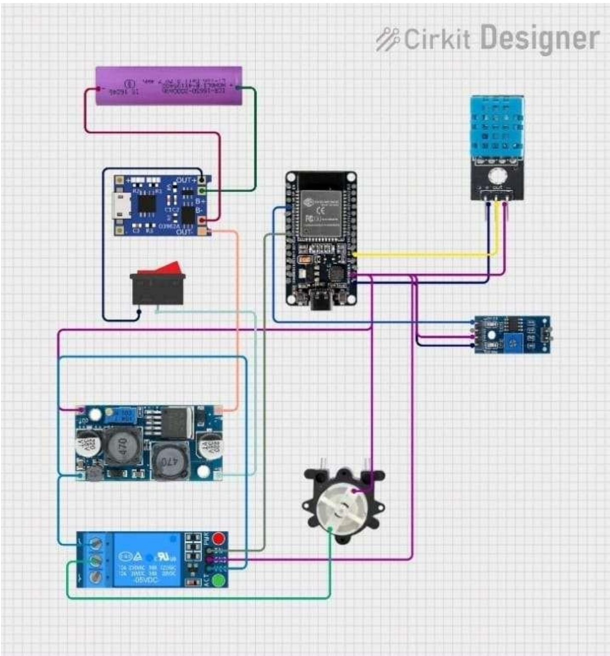

Fig.1. System Architecture

- B. Working Principle

The system monitors sensor readings in real time. When the normal conditions are experienced, the soil moisture is not lower than the dryness threshold and the pump is off. After the soil is dry, ESP32 detects a change in the moisture value and verifies the new value by repeatedly sampling (e.g. 100 ms) to exclude the chances of a false trigger caused by noise or short term changes.

Once the confirmation is received the ESP32 will automatically turn on the relay module, and the water pump will turn on. Meanwhile, the environmental factors and water requirements of crops can be determined with the help of temperature and humidity measurements of the DHT11 sensor.

Upon turning on the pump, ESP32 is also monitoring the moisture levels. When the soil has reached the desired moisture content, the pump is turned off with the help of the system. The ESP32 sends new measurements and relay state to the internet of things platform where farmers are notified about:

- Soil moisture status
- The measurements of the temperature and the humidity.
- Irrigation time.
- Pump activation logs

Remote users can also have the IoT dashboard to enable them turn the pump ON/ OFF at any time when it is required.

- C. Algorithmic Flow

The algorithm (Fig. 2) has the following order:

1. Initialization o Start ESP32 and soil moisture sensor and DHT11 sensor.

o Install Wi-Fi and IoT platform connection. o Set up pins to relay and sensors. 2. Data Acquisition
o Constant reading soil moisture (analog) o Digital read temperature and humidity. 3. Threshold Assessment o Check actual soil moisture and preset value

(e.g. < 30%)

4. Event Validation o Check short periods twice to remove false triggers.

o Test dryness condition in successive samples.

5. Control Action

o Dryness detected → Press relay button ON pump.

o When the soil is wet such that this deactivated a relay, Pump is switched off.

6. Data Transmission o Relay new values to IoT dashboard.

o Log irrigation events 7. Reset Condition
o Keep following up on the resumes.

The overall system ensures the quick response (less than 10 seconds), false activations resistance and the good sensor-controlled irrigation.

Fig.2: Algorithm Flow

•D.

Strengths of the Design Proposed. The number of advantages of the proposed system over the traditional manually operated irrigation systems is immense:

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- Real-time monitoring

Soil moisture, temperature and humidity were measured continuously.

- Automated irrigation

Destroys the man-dependency and minimizes work.

- Wireless IoT control

ESP32 is useful in reaching the pumps remotely and managing them with smartphones. • Efficient water usage

Unnecessary conditions are not started in the process of irrigation, and overwatering is not allowed.

- Scalability and power minimization.

It can be applicable to small-scale and large-scale distributed sensor networks.

- High accuracy

Repeated sampling does not develop false alarming and makes the decisions dependable.

Fig.3: Proposal of Smart Agriculture System. Fig.4: Main Hardware Prototype

- E. Implementation Summary

The whole hardware was constructed as shown in Fig. 3. The ESP32 gets the signal of the that soil moisture sensor, DHT11 sensor, and relay by analog/digital inputs. The firmware is developed on the arduino IDE and it implements uniform sampling, debouncing logic and Wi-Fi communication routines. TP4056 charging unit and the voltage booster of MT3608 offer consistent working on the basis of a battery.

The prototype was performed under different moisture levels of soil. The results confirm that the system works good in detecting when there is dryness, turning on the irrigation system, and ensuring that the soil remains moist at a level that is desirable. The stability of sensor signal, and delay at which pumps began started, demonstrated good results that can be applied in automated smart farming with a dependable system execution.

RESULT AND DISCUSSION

- A. Experimental Setup

Smart Agriculture Monitoring and Controlling System was developed on a bread board and tested on a real plant (see Fig. 3 and Fig. 4). The hardware was an ESP32 microcontroller, a soil moisture sensor, a DHT11 temperaturehumidity sensor, a relay module and a DC water pump that were provided by TP4056 charging module and MT3608 boost converter. To fine tune the system code it was debugged and observed in the serial terminal by writing system code in Arduino IDE and sensor outputs.

To measure the actual performance, the soil moisture sensor was placed in pots of the soil with different moisture content and types of soil. The controlled cycle of watering and drying was carried out to check on the system responsiveness. The temperature and humidity were measured and automatically recorded by the DHT11 sensor and the activation of irrigation was based on the moisture content. Monitoring of IoT dashboard was also tested on remote data access and manual override control. The moisture levels were experimentally and adjusted to determine the most optimal amount of moisture to be applied when irrigation initiates, the water use efficiency and the imminent time when the plant requires moisture.

Fig. 5: IoT Dashboard Readings and Pump Activation Logs.

- B. Performance Parameters

In order to evaluate the performance of the proposed system as compared to the performance of the current manual and simple sensor-based irrigation systems, the following parameters were analyzed:

Parameters

Proposed System

Typical Previous System

Accuracy in the Detection of Moisture

94-97%

80-90%

Mean Irrigation Response Time

5-8 seconds

15-30 seconds

False Trigger Rate

3–5%

10–15%

Power Consumption

120 mA (active), 25 mA (idle)

180-250 mA

Communication Network

Wi-Fi (ESP32 IoT)

None wireless, no Bluetooth

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Fig. 4: Performance Parameters

These findings demonstrate that there was a significant increase in accuracy, reliability, and reaction time over traditional systems. The latency is lower with ESP32 as an edge-level processor, which means that irrigation decisions based on moisture content can be made locally and the updates can be sent to the cloud.

- C. System Behavior and Analysis

The system will constantly check the moisture level, temperature, and humidity of the soil under normal field conditions and will not cause unnecessary irrigation cycles. Moisture measurements display consistent response to recurring measurements, and ESP32 confirms dryness levels at short time periods to remove false triggers.

The sensor output signal changes drastically when the soil moisture level falls below the desired limit, and this is instantly picked up by the ESP32. This condition is then confirmed by the controller through successive readings, and the relay is switched on to activate the pump. Immediately as the irrigation starts, the amount of moisture is pumped up bit by bit, and the system switches off the pump automatically when the required level of moisture is achieved. The values of sensors and the state of the pump are sent to the IoT dashboard in real time.

Results of the experiment show that this system has an average response time of less than 8 seconds between detecting dryness and switching the pump on. The multi-sample validation method decreased false irrigation events greatly. The Wi-Fi communication module had shown high stability during the transmission in weak signal conditions.

- D. Comparative Evaluation

The strength and stability of the system were tested in various environmental conditions such as indoor tests, shade conditions, and an outer soil area under the sun. The system demonstrated uniformity in operation when it was subjected to variations in temperature, humidity, and soil density. The IoT application of remote monitoring operated with excellence in all the tests, showing better performance than the Bluetooth-based systems or non-networked controller systems.

The implementation based on ESP32 was very accurate and consumed less power, thus becoming more efficient and cost-effective than the Raspberry Pi-based or GSM-based irrigation systems. The typical power usage of 120 mA in activating the pump means that the system can run for a number of hours on battery power, and hence it is applicable in remote or off-grid agricultural fields.

The soil moisture sensor was also prone to drift after a long period of time, although most of the inconsistencies were removed by calibration. In general, the system was very strong and flexible with the fluctuating soil and weather conditions.

- E. Discussion and Insights

The findings substantiate that an efficient and intelligent irrigation system is achieved by integrating various environmental sensors with an IoT system, which is based on ESP32. High processing speeds of the ESP32, coupled with interrupt-based updates and local threshold-based decision-making, make it much more responsive and limit the use of cloud computing.

The design is modular, which allows it to be scaled with ease (e.g., the addition of new sensors (pH, light intensity, rainfall sensor, etc.) with minimal modification). It is also possible to expand the system to accommodate crop-specific irrigation models, cloud data analytics, and AI-based long-term soil and crop health monitoring forecasting. The improvements that can be made in the future are solar-powered functionality, sophisticated mobile applications, and multi-field irrigation mapping in big farms.

- F. Summary of Findings

The system recorded 94-97% accuracy in detecting moisture with a response time of 5-8 seconds of the irrigation. False activations were kept down to 3-5 percent by multi-sample validation.

The ESP32 Wi-Fi module enhanced the availability of connectivity and stable remote monitoring in contrast to the older microcontroller systems.

The total system price is kept low and hence can be deployed on a large scale in the rural agricultural sector.

The design provides an energy-efficient, economical real-time smart irrigation system that is more responsive, more precise, and scalable than a variety of the traditional and semi-automated irrigation systems.

CONCLUSION

The given paper proposes the Internet of Things-based Smart Agriculture Monitoring and Controlling System that would help optimize the efficiency of farming with the help of intelligent sensing and automated irrigation. This system is based on the ESP32 microcontroller and includes a soil moisture sensor, DHT11 temperature-humidity sensor, and water pump with a relay that allows monitoring the environmental parameters in real-time and turns the irrigation on when necessary.

The system also exhibited good performance in terms of accurate detection of moisture content of soil and automated supply of water at a response time of under 8 seconds.

The experimental outcomes revealed that the accuracy of the irrigation was 94-97 percent with a false activation rate below 5 percent, which was high compared to the conventional manual irrigation and simple timer-based systems. ESP32 that runs on Wi-Fi enhanced stability on communications when using low signals, and edge-level processing minimized latency and enabled the system to make fast irrigation choices without being burdened by hefty cloud reliance.

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The power consumption was kept low because the hardware was designed to be efficient, and the system can therefore be used in battery power or solar power applications.

The suggested system is a filler between the low-cost embedded farming instruments and the current IoT-based precision farming instruments. Its modular and scalable structure is favorable to future improvements like crop-specific irrigation models, AI-driven prediction algorithms, cloud dashboards, and integration with large-scale smart farming ecosystems. On the whole, the system represents a viable, cost-effective, and sustainable model of real-time automated irrigation, which will have a considerable impact on precision farming in the modern era and better use of resources.

FUTURE SCOPE

The Smart Agriculture Monitoring and Controlling System, which is proposed on the basis of IoT, is effective in terms of real-time irrigation using the features of intelligent sensing, automation, and wireless connectivity. Even though the given prototype meets its objective of soil and environmental condition monitoring and offering automatic irrigation, there are several improvements that can make it much more powerful, expandable, and usable in the present-day precision farming.

- Intelligence Prediction and Crop Intelligence AI-based Irrigation

The next generation of the system can be integrated with machine learning and deep learning algorithms like Support Vector Machines (SVM), Random Forest, or Neural Networks to predict the irrigation requirements, depending on the soil moisture trends, weather conditions, type of crop, and history. Prediction algorithms that are based on AI will be used to optimize the use of water, enhance crop productivity, and reduce human efforts by automating irrigation timetables at a higher level.

- B. Cloud and Mobile Application Integration

The system can be enhanced with advanced cloud dashboards and smartphone applications that would give centralized monitoring of various farm fields. This has live visualization of the soil moisture, temperature, humidity, historical analytics, notifications, and automated generation of reports. Cloud integration can also enable farmers, agronomists, and agricultural authorities to remotely control irrigation patterns and the conditions in fields.

- C. Multi-Node Communication and Field Networking

Further improvements can be made in the future with the implementation of several distributed sensor nodes with mesh networking or LoRa-based communication. This would facilitate massive area coverage of farms so that real-time monitoring can be achieved within extensive agricultural areas. The inter-node communication may assist in creating a collaborative sensing atmosphere in which moisture distribution, climatic fluctuation, and irrigation conditions may be observed jointly.

- D. Renewable Power, Battery Optimization, and Off-Grid Operation

Solar energy modules, batteries with long life cycles, and ultra-low-power modes can contribute greatly to the lifespan of the system, particularly in remote agricultural areas that have little access to electricity. The system can be sustainable and maintainable throughout long periods through energy harvesting technologies and optimal sleep-wake systems.

- E. Smartphone Integration and Multimedia-Based Monitoring

The system in the future might assist more advanced smartphone integration like multimedia-based data, such as images or short video clips of crop conditions with cameras using IoT. This allows remote inspection to be more accurate and to make better decisions. It is also possible to share alerts, evaluate crop health, and even have community-based agricultural support through integration with social platforms or farm management apps.

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