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Automatic Water Dispensing System for Plants

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Abstract: Agriculture can be transformed into smart agriculture due to the advanced wireless network and the Internet of Things (IoT). As the human population increases, so does the demand for crops. With real-time monitoring, a smart agriculture system's awareness of soil moisture measurement, humidity, and environmental temperature will increase food security. In addition, smart agriculture can increase crop yield, reduce water waste, and boost productivity. In light of this, this study proposes smart agriculture, which employs sensor-based monitoring in real-time without human intervention. Users have direct access to real-time data, and all sensor data is recorded and monitored at all times and from anywhere within the internet's coverage area. The development of a mobile application facilitates growth monitoring and user access to data. This research measures yield-affecting agricultural factors such as soil moisture, humidity, and temperature. Nonetheless, monitoring environmental factors is crucial to increasing crop yields. The experiment was conducted on two chili plants, one with an automation system and one without, which were manually watered once daily at 7:00 a.m. It is estimated that the plant with the system can maintain the optimal moisture level, whereas the other plant's moisture measurement continues to decrease. Compared to manual watering, automatic watering also results in accelerated plant growth. Consequently, a smart agriculture system is anticipated to improve plant growth and system efficiency.
Keywords: IOT Technology, Smart irrigation, Precision Farming, Soil moisture sensors, Real time monitoring, Water conservation

I. INTRODUCTION

Precision farming has become a vital tactic for raising agricultural production and sustainability in the face of rising global food demand and water shortages. Conventional irrigation techniques frequently lead to ineffective crop management and water waste, which makes resource conservation difficult. Smart irrigation systems use cutting-edge technologies like soil moisture sensors, the Internet of Things (IoT), and data analytics to optimise water use in order to solve these problems. Based on weather factors and soil moisture levels, these systems enable real-time monitoring and provide exact water application suited to the unique requirements of crops. Smart irrigation systems that automate water distribution not only increase crop yields but also support environmental sustainability by cutting down on water waste and boosting resource management effectiveness. In order to achieve sustainable agriculture and resilience in the face of climate variability, this study examines the design, implementation, and advantages of smart irrigation systems in precision farming.

II. LITERATURE REVIEW

From crude wooden implements to smart farming employing IoT, AI, and robotics, agriculture has changed in tandem with technology. These developments increase production, minimise labour costs, and maximise land utilisation. Plant growth depends on water, and irrigation maintains the right moisture content. An effective technique that saves water and stops soil erosion is drip irrigation, which applies water straight to plant roots. In arid areas, it works incredibly well, increasing agricultural output while cutting waste. An ESP32 microcontroller, soil moisture, temperature, humidity, and water flow sensors were used in this study to create an Internet of Things-enabled drip irrigation system. It is integrated with the Blynk app, which enables manual control, automates watering, and tracks data in real time. The technology maintains ideal soil conditions for robust plant growth while guaranteeing effective water utilisation.[1]

With 0.676 gallons of water per plant, spring onions thrived after a week of automatic irrigation. Consistent moisture levels were verified by sensor data, enhancing plant health and cutting down on labour and water waste. There are financial advantages to smart irrigation systems as well. Long-term water savings and higher agricultural yields, according to research, outweigh the initial investment expenses. Precision irrigation is now more widely available thanks to government incentives that encourage adoption. Widespread use is hampered by issues including expensive costs, specialised knowledge, and poor rural connectivity. Adoption can be increased by addressing these problems via infrastructure upgrades, training, and incentives. Smart irrigation will become crucial for efficient, productive, and sustainable farming around the world as costs come down and technology improves.[2]

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Poor rural connectivity, high expenses, and technical complexity are some of the issues facing smart irrigation. Small farmers need training and face financial challenges. IoT efficiency is decreased by restricted network access. Adoption can be accelerated by government grants, reasonably priced technology, and educational initiatives. Increased awareness and infrastructure will help scalability even further. Smart irrigation will become more affordable and available as technology develops. Increased use will save water, increase productivity, and have financial advantages. By removing these obstacles, sustainable farming is ensured, contributing to the future security of food production. Long-term improvements in productivity, resource management, and environmental sustainability will result from today's investments in smart agriculture.[3]

III. PROPOSED METHODOLOGY

Smart irrigation deployment is fraught with challenges, such as costly installation, poor connectivity in rural locations, and complicated technology. Many small-scale farmers need training to effectively operate sophisticated irrigation systems, which they cannot pay. Weak network coverage in rural areas makes it difficult to collect data in real time, which lowers the efficacy of IoT-based farming. Widespread adoption is further deterred by the high cost of automation equipment like sensors and controllers. Additionally, many farmers lack the technical skills required for system maintenance and troubleshooting. Despite the long-term advantages of automated irrigation, these problems impede its adoption. Governments, academic institutions, and agricultural associations must collaborate to offer farmers financial aid, technical training, and awareness campaigns in order to increase adoption of smart irrigation. Support from the government, cost reductions based on research, and easier access to technology are all necessary to promote the use of smart irrigation. Small farms may find these systems cheaper with government grants and subsidies. Financial difficulties will be lessened with the development of affordable, effective irrigation technologies. To teach farmers how to operate and maintain automated irrigation, educational programs had to be implemented. Increasing mobile and internet connectivity in agricultural regions will boost system effectiveness and data accuracy. Policymakers, agricultural experts, and technology developers working together can make large-scale implementation easier. Adoption will be made easier by promoting smart irrigation systems that are easy to operate. A greater dependence on automation will increase crop yields, reduce overuse, and improve water efficiency. Smart irrigation will become a practical option for productive and sustainable farming with careful work.

Technological developments are revolutionising irrigation, optimising water use, boosting agricultural output, and reducing environmental damage. Automated solutions will become more accessible and reasonably priced as advancements continue. By examining plant requirements, soil conditions, and weather patterns, AI-driven solutions can enhance irrigation. Intelligent sensors and machine learning will be incorporated into future irrigation systems to maximise water delivery. This technology will support sustainable farming methods, guaranteeing that food supply stays steady in the face of climatic uncertainty. Progress will be accelerated by sustained government support and industry collaborations. Smart irrigation can become commonplace if current technological and financial obstacles are removed. Long-term agricultural sustainability will result from investing in these innovations now, making farming more resource-conscious, climate-resilient, and profitable.

IV. BLOCK DIAGRAM

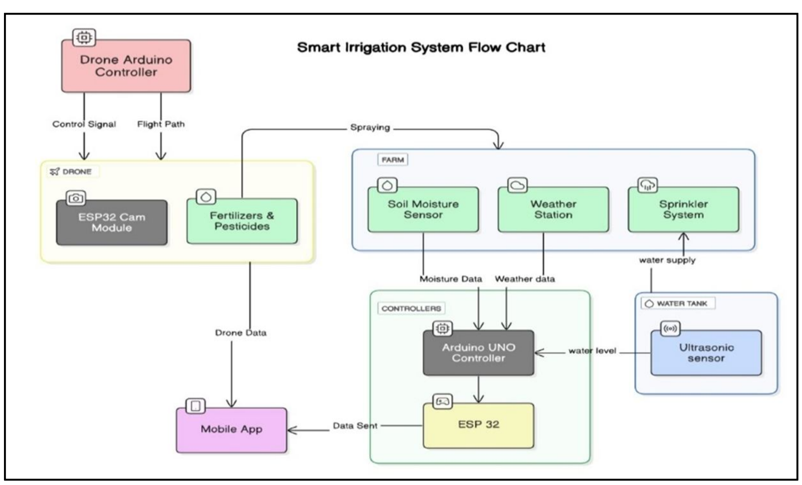

Fig 1. Block diagram of the system

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The overall working of the system is as follows:

A. ESP32 Dev Module

As a link between sensors and the Blynk cloud platform, the ESP32 is an essential component of the Smart Irrigation System. It uses I2C to gather data from soil moisture, temperature, and humidity sensors, interprets that data, and uses Wi-Fi to send real-time updates. The Blynk app allows farmers to remotely monitor farm conditions, guaranteeing effective water management. Additionally, the ESP32 logs data for well-informed decision-making and initiates warnings for anomalous readings. Precision farming is improved by its capacity to automate irrigation based on real-time sensor data. The ESP32 is essential for contemporary smart agriculture and remote farm management because of its cloud integration and effective processing, which maximise resource utilisation, save water, and enhance crop health.

B. Arduino UNO

The Smart Irrigation System's Arduino serves as its main controller, controlling both input and output functions. For effective irrigation, it analyses real-time data from temperature, humidity, and soil moisture sensors and turns on water pumps depending on predetermined thresholds. Arduino also acts as the drone's flight controller, regulating motor speeds for accurate navigation and stabilising movement by evaluating accelerometer and gyroscope data. Additionally, it automates spraying systems by using sensor readings to actuate actuators. Farm productivity is increased by this combined capability of drone stability and irrigation automation. In today's technologically advanced agriculture, Arduino is essential since it makes precision farming possible and minimises manual labour.

C. ESP32-CAM Module

Through the capture of high-resolution photos for plant health evaluation, the ESP32 camera module improves drones in smart irrigation.

Compared to conventional ground inspections, aerial imagery yields more insightful information. It is set up for multispectral imaging and may identify nutrient deficits, stress, and general health in plants. It wirelessly sends data to a central system for real-time analysis and decision-making thanks to integrated Wi-Fi and Bluetooth. By automating crop monitoring, the module reduces labour costs while effectively covering wide areas. It also permits comprehensive mapping by merging aerial photos, detecting regions needing irrigation. Because of its low cost, farmers can now afford enhanced monitoring, which enhances resource management, increases yields, and encourages sustainable farming methods through data-driven agricultural interventions and precision irrigation.

D. Soil Moisture sensor

The Smart Irrigation System's soil moisture sensor, which measures the soil's water content in real time, is essential. By activating water pumps or valves when moisture falls below a predetermined level, it guarantees that crops receive the best possible irrigation. It stops irrigation when enough moisture is found, avoiding overwatering and saving resources. This accuracy reduces water waste, guards against waterlogging-induced root damage, and encourages more robust plant growth. The sensor reduces manual labour by enabling automated, effective watering through the provision of precise data. By ensuring that crops receive the proper amount of water for optimal growth and enhancing overall resource management in agriculture, its integration into smart farming improves sustainability.

E. Ultrasonic Sensor

For keeping an eye on the water levels in irrigation storage tanks, the ultrasonic sensor is essential. In order to determine the water volume, it generates ultrasonic waves and measures how long it takes for them to reflect off the water's surface. By maintaining ideal levels, this real-time data helps guarantee continuous watering. To avoid shortages, the device can initiate automated replenishment if the water level falls below a predetermined threshold. Furthermore, it finds unexpected level drops to discover leaks.

The sensor improves water management through resource allocation and irrigation schedule optimisation. Smart irrigation systems become more dependable and resource-efficient as a result of its integration, which also reduces water waste and promotes sustainable farming methods.

F. Sprinkler System

Precision farming requires the sprinkler system, particularly when combined with drone-based plant health monitoring. By modifying output in response to real-time data from soil moisture sensors and drones equipped with ESP32 cameras, it guarantees that crops receive the proper amount of water. By avoiding overwatering or underwatering, this adaptive method maximises resource use and enhances crop health. It can also plan irrigation according to weather predictions, saving water by preventing needless watering prior to precipitation. The system adapts to shifting soil conditions through ongoing monitoring and feedback loops, increasing efficiency. The sprinkler system promotes smart irrigation innovations and sustainable farming methods by optimising yields and decreasing water waste.

G. Weather Monitoring Station

The weather station, which provides real-time information on temperature, humidity, wind speed, and rainfall, is essential to smart irrigation. By using this data to forecast weather patterns, irrigation can be optimised by postponing watering when rain is predicted. It guarantees that irrigation takes place in the best possible conditions, minimising water loss due to wind or evaporation. Furthermore, monitoring long-term climate trends helps farmers efficiently plan their irrigation plans. The system adjusts to weather variations by evaluating both previous and current data, guaranteeing accurate water use. This proactive strategy promotes sustainable farming, reduces over-irrigation, and increases crop resilience. Incorporating a weather station into modern agriculture enhances production, climate adaption, and resource efficiency.

H. Drone

By facilitating effective crop monitoring, health evaluation, and targeted interventions like fertiliser or pesticide spraying, drones are revolutionising precision farming. With their sophisticated sensors, cameras, and GPS, they eliminate the need for manual inspections by capturing aerial photos and real-time data to identify illnesses, pests, and water stress. Even in difficult-to-reach places, their accurate and controlled spraying capabilities guarantee equal coverage, reducing chemical waste and environmental effect. Preventive interventions are also made possible by multispectral and thermal sensors, which assess crop development, detect nutrient deficiencies, and forecast stress. Drones optimise resource use, boost production, and lower operating costs in modern agriculture by integrating with IoT-based weather stations and controlled irrigation to create a data-driven, sustainable farming ecosystem.

I. Blynk IOT App

The Blynk IoT platform provides farmers with an easy-to-use interface for effectively monitoring real-time farm data. It allows for well-informed irrigation decisions by displaying real-time sensor values, such as soil moisture, temperature, and humidity. Furthermore, it incorporates drone-gathered information, including environmental data and field photos, enabling focused crop health management treatments. In order to optimise irrigation schedules, Blynk also takes weather forecasts into account, giving updates on temperature, humidity, and rainfall. Blynk makes smart farming more accessible and efficient by combining key farm insights into a single platform and providing farmers with data-driven methods to increase productivity, save resources, and boost crop yields.

V. RESULT

Fig 2. Farm prototype

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Fig 3. Agricultural Drone

VI. CONCLUSION

By automating procedures and improving real-time decision-making, the combination of a smart irrigation system, drone technology, and a Flutter-based smartphone app revolutionises contemporary farming. By using sensors to track temperature, humidity, and soil moisture, the system ensures accurate irrigation based on field conditions. High-resolution camera-equipped drones eliminate the need for manual inspections by providing airborne imagery to identify crop health problems, fertiliser shortages, and water stress. Farmers may receive weather forecasts, drone data, and real-time sensor readings using the mobile app, which acts as a central platform. Crop yields are increased, water waste is avoided, and improved farm management is made possible by this smooth integration. Additionally, the technique reduces the need for excessive pesticides and fertilisers, increasing the sustainability of agriculture. The Smart Irrigation System dramatically lowers agricultural costs while boosting output by allocating resources and water efficiently. Through the app, farmers can create automatic watering schedules that change in response to real-time data and weather forecasts. Drones help with targeted pesticide and fertiliser spraying, which lowers chemical use and its negative effects on the environment. Analysis of historical data also aids farmers in making long-term, well-informed choices on irrigation schedules and crop rotation. Scalability can be improved by expanding this system to handle larger farms and more crops. Future developments like machine learning and AI-based predictive analytics may further increase productivity. This system ensures food security for future generations by combining state-of-the-art technologies, giving farmers the tools they need to maximise yields, adjust to climatic fluctuations, and support sustainable farming practices.

VII. AKNOWLEDGEMENT

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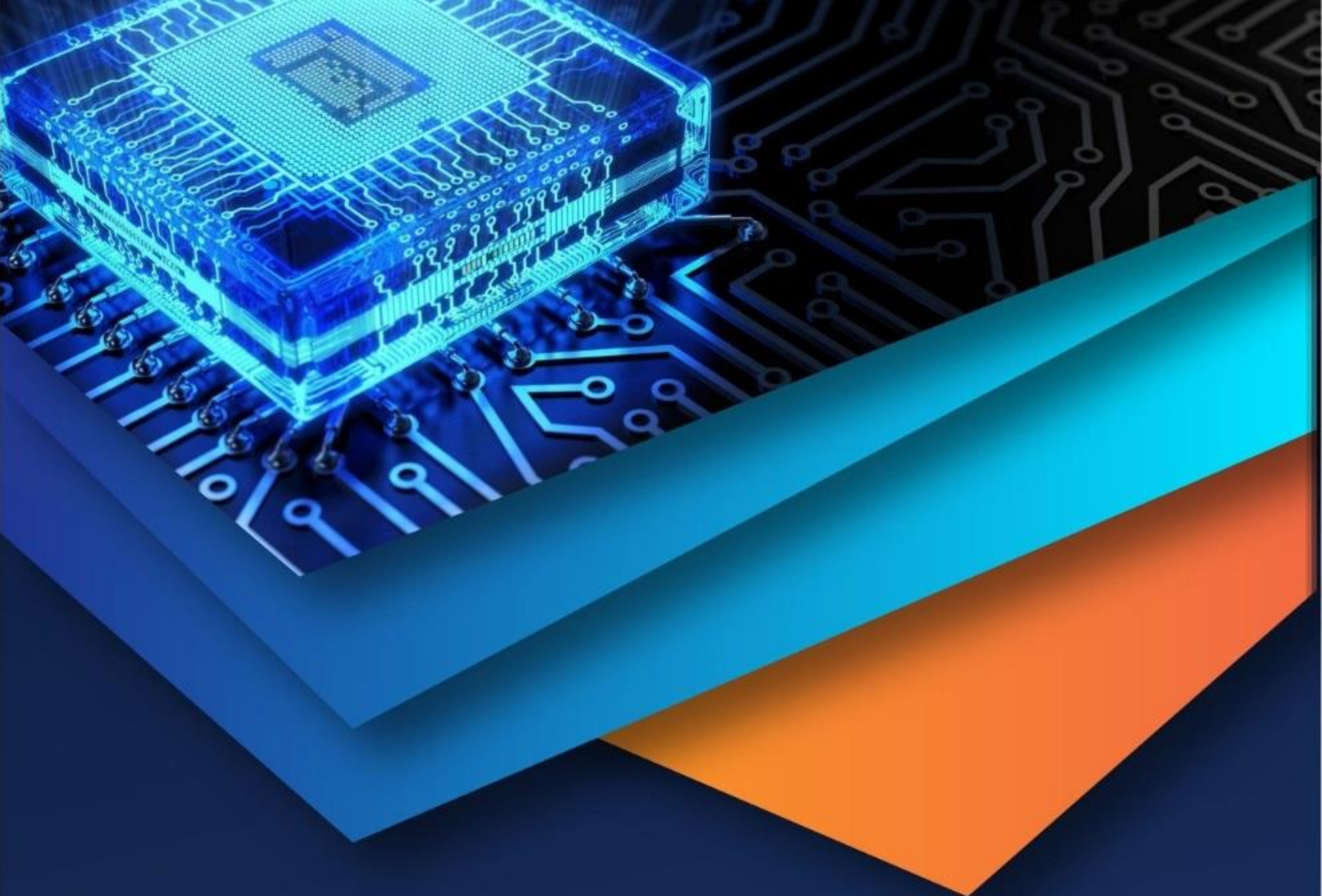

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