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# IoT-based Smart Agriculture System

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***Abstract*— The smart agriculture system designed in this paper utilizes sensors and cloud technologies to ease and track the execution of important activities in farming. It adds a PIR module that observes animal motion, DHT11 for monitoring temperature and humidity, and a soil moisture sensor for best irrigation practices. The system also employs an LDR which seeks the sunlight, a waterproof temperature probe specifically for water, and a manual or automatic switchable water pump. The processing of observer sensor data is through the ESP8266 microcontroller whereas control and observation are made in real-time by telephony applications through the Blynk IoT. This feedback is done instantaneously using I2C LCD. This system helps to reduce wastage of resources, enhance crop management, and advocates for environment-friendly agriculture techniques, hence solving contemporary issues in farming efficiently and relatively.**

***Index Terms*— ESP8266, NodeMCU, PIR Sensor, IoT-based Agriculture Systems, Blynk IoT, DHT11.**

## I. INTRODUCTION

Agriculture is an important area for food production globally, but it also comes with various challenges and problems like inefficient use of resources, farm diseases, unpredictable weather, and threats from animals. Conventional agricultural systems tend to use more water, fertilizers, and every other resource available unnecessarily and it is also very cumbersome.

Precision Agriculture is a smart farming approach that improves the accuracy of operations by giving each plant or animal precisely what it needs to grow in the best possible way, optimizing overall performance while reducing waste, inputs, and pollution.[1] With the Internet of Things (IoT), it becomes easier and possible to upgrade farming by making smart farms through control and improvement of farming operations IoT Based Smart Agriculture System Agricultural Management System Using Internet of Things Technology Now, more than ever, advances in agriculture are required to face the increasing food demand due to the fast-growing world population. This project, an IoT-based Smart Agriculture system, looks into these problems and offers a solution by combining all sorts of sensors and actuators for the management of the farm automatically. Such as temperature, humidity, soil moisture, and light as well as animal intrusion detection for crop protection. Data gathered through sensors is then processed by the ESP8266 microcontroller which also controls the operation of a relay switch controlling the water pump to effect automated irrigation in response to soil moisture content. The water pump can equally be activated/deactivated manually via a pushbutton. An I2C LCD is used to present the information and real-time data to the cowherds within instantaneous reach, IoT based Blynk application allows farmers to control their farms sitting in a different location.

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In order to upsurge the harvest, modern science and innovation must be applied in agriculture. [2] Such a system is both viable and inexpensive, thereby promoting smart farming where maintenance costs are minimized, productivity is enhanced and labour is lessened.

## II. Literature Survey

- M. Manoj Venkata Sai et al. [3] proposed an IoT Smart Agriculture Project that used temperature sensors, moisture sensors, humidity sensors, and pH sensors for monitoring crops. They used a feedback control mechanism having a centralized control unit that regulates water irrigation onto the field in real-time by using the instantaneous moisture, temperature, humidity, and pH values provided by the sensor unit as per the need of the crop, the controller decides to turn on or off the water irrigation using Arduino NodeMCU. Their project focused on providing the right amount of water which eventually increased the efficiency of the farm.
- Gilroy P. Pereira et al. [4] proposed an IoT-Enabled Smart Drip Irrigation System comprising an ESP8266, solenoid valve, soil moisture sensor, temperature sensor, air humidity sensor, and water flow sensor. This system used the Blynk IoT mobile app and web dashboard to collect irrigation data, have access to the automatic irrigation feature, manual access to the water valve if needed, and monitor the temperature, soil moisture as well and air humidity.

  In the system, the ESP8266 regularly checks the dryness of soil and temperature and if the results are appropriate for watering the ESP8266 opens the solenoid valve thereby watering the crops. ESP8266 reads the humidity sensor values and notifies the user. In both primary and field tests, the system was found to run well and was able to grow the crops.
- Miss. Bhagyashree A. Tapakire et al. [5] proposed a project in their paper of a smart irrigation system using various sensors, control valves, and pump motors and combined it with IoT, cloud computing, and optimization tools. This system uses various low-cost sensors to sense soil moisture and temperature. The project consists of a Raspberry Pi, soil moisture sensor, temperature sensor, camera, control valve, and a motor driver. The camera is used to keep watch on plant growth. The sensed data is stored in the Thing Speak cloud service for monitoring the data and its storage. This system regulates irrigation work without any manual intervention using IoT technology. The paper concluded at the point which said that this agriculture monitoring system served as a reliable and efficient solution for farmers' corrective action can be taken and we can achieve uniform irrigation with this proposed system.

## III. Project Overview

This report describes the design and an implementation of a smart agriculture system based on IoT for automating the critical farming processes to deal with issues like resource wastage changes in weather with no prior notice and loss of crops from pests and animals. The proposed solution integrates various sensors along with cloud technologies to monitor environmental and soil parameters. It automates the process of irrigation, detects animal intrusion, and gives real-time monitoring of geraniums via the esp8266 microcontroller and the blynk IoT platform.

The system minimizes resource wastage, enhances productivity, and promotes environmentally friendly agriculture.

### *A. Importance of IOT-based Smart Agriculture System*

IoT-based smart agricultural systems transform farming in terms of efficiency, sustainability, and productivity. They optimize water, energy, and other resources, maintain highly mechanized irrigation and monitoring of crops, and offer real-time data to facilitate decision-making on the part of farmers. This not only cuts labour costs but also minimizes environmental impacts, together with adapting to unpredictable weather patterns. They thus complement each other in assuring sustainable food production as well as world food security.

### *B. Key Components*

*Sensors and Actuators*

- PIR Sensor: Detects animal movement near crops and alerts farmers.
- DHT11: Monitors temperature and humidity.
- Soil Moisture Sensor: Triggers irrigation based on moisture levels.
- LDR: Monitors light intensity.
- Relay Module and Water Pump: Automates and controls irrigation.

*Processing and Control*

- ➢ The ESP8266 microcontroller processes data from sensors and manages actuators.
- ➢ Data is displayed locally on an I2C LCD and transmitted to the cloud for remote access.

*IoT Integration*

- ➢ The Blynk IoT platform allows farmers to monitor real-time data, receive alerts, and control irrigation systems remotely.

*Power Source*

- ➢ A rechargeable battery ensures continuous operation, making the system suitable for remote locations.

### *C. Other Recommendations*

Use either SI (MKS) or CGS as primary units. (SI units are encouraged.) If your native language is not English, try to get a native English-speaking colleague to proofread your paper. Do not add page numbers.

## III. METHODOLOGY

This built system aims to apply the Internet of Things to agricultural processes and expects to mechanize and improve farming by use of coherence sensors and actuators controlled by an esp8266 chip it is real-time fruit of generation obtaining soil and environmental measures and quantitative processing inputting into the system and maintaining the devices from anywhere around the world through Blynk IoT.
The idea of integrating IoT in the field of agriculture offers a plethora of benefits. A few of them are listed below:

- ➢ IoT enables automation and remote monitoring of agricultural practices.
- ➢ IoT provides real-time updates of data on various parameters which allow farmers to make data driven decisions.
- ➢ IoT can boost the efficiency of farming activities by automating tasks such as pest control, irrigation, and fertilization.
- ➢ Sustainability and resource management are also possible with the help of IoT-based smart farming. [6].

### *A. Work Flow*

Data Collection: Sensors gather environment and soil data.
Processing and Decision Making: The ESP8266 processes sensor data and decides on actions, such as irrigation.
User Interaction and Remote Access: The Blynk platform allows remote monitoring and control, while the I2C LCD provides local data display.

### *B. Sensors and Components Used*

*PIR Sensor (Passive Infrared Sensor)*
Function: the PIR sensor will detect movement specifically animal activity near the crop area it senses infrared radiation emitted by nearby objects, particularly animals or humans this capability has therefore allowed an alert to be sent to the farmer through the Blynk app once movement is detected.
Usages: Protects crops by notifying the farmer of any potential threats from animals, reducing crop damage.

*DHT11 Sensor (Temperature and Humidity Sensor)*
Function: The DHT11 is a digital sensor that measures temperature and humidity in the environment. It outputs both values as digital signals to the ESP8266.
Technical Specifications:
Temperature Range: -40°C to 80°C with ±0.5°C accuracy.
Humidity Range: 0 to 100% with ±2-5% accuracy.
Usage: Helps in monitoring environmental conditions for optimal crop growth. The data can be used to adjust irrigation levels or send notifications to the farmer if conditions deviate from optimal ranges.

*Soil Moisture Sensor*
Function: It gives the volumetric water content in the soil, thereby indicating whether the soil is too dry or sufficiently moist. It functions by determining the dielectric constant of the soil, changing with moisture content.
Usage: The sensor automates irrigation through real-time acquisition of soil moisture data. If such value falls below a given threshold, the water pump is activated through a relay in irrigation of the crops according to signals from the ESP8266.

*C. Actuators and Output Components*

*Relay Module*

Function: A relay is an electrically operated switch used to control the water pump the relay allows the esp8266 to turn the pump on or off based on soil moisture levels.

Usage: Automates the irrigation process by controlling the water pump it can be manually overridden by a button that allows the farmer to start the water pump whenever needed.

*Water Pump*

Function: The water pump delivers water to the crops it can be turned on or off either automatically based on soil moisture data or manually via a button.

Usage: The automated irrigation system ensures greater efficiency for crop irrigation because irrigation is scheduled according to real-time soil moisture conditions greatly reducing the chances of over and under-application while providing adequate water for crops consider it a diligent caretaker of work in the field water whenever required promote sustainable agriculture and office farming practices.

*Manual Access Button*

Function: This button provides manual control of the water pump allowing the farmer to start or stop the pump when necessary.

Usage: Gives farmers the flexibility to water their crops manually if they want to override the automated system.

*D. Control Unit and Data processing*

*ESP8266 Microcontroller*

Function: The ESP8266 is the main processing unit that collects data from the sensors and controls the actuators it's a powerful microcontroller with built-in wi-fi and Bluetooth making it ideal for IOT applications.

*Key Features:*

240 MHz dual-core processor.

Wi-Fi and Bluetooth connectivity.

GPIO pins for sensor and actuator interfacing.

Usage: The ESP8266 collects information from all connected sensors.

Then it processes the data based on preprogrammed thresholds to control the water pump.

Finally, data is sent to the Blynk IoT platform for cloud storage and monitoring purposes.

*I2C LCD Display*

Function: The I2C LCD displays real-time sensor readings like temperature humidity and soil moisture levels providing the farmer with on-site immediate feedback on the system status.

Usage: Allows local monitoring without needing to check the Blynk app improving convenience for farmers physically in the field.

*E. IoT Integration*

*Blynk IoT Platform*

Function: Blynk is a cloud-based platform that allows full monitoring and control of an agricultural system through mobile apps or web dashboards. The farmers can remotely access sensor data, receive alerts, and control their water pump from anywhere.

Usage: The ESP8266 sends data to the Blynk platform allowing remote users to view real-time conditions like soil moisture temperature and humidity the platform also enables farmers to manually control the water pump and receive notifications about critical events like low soil moisture or animal activity.

*F. Power Source*

*Battery*

Function: The system operates on a rechargeable battery ensuring continuous functionality even in remote locations where a stable power supply may not be available this design provides reliable and uninterrupted service making it an ideal solution for areas with limited access to electricity.

Usage: Provides uninterrupted power to the esp8266 sensors and actuators ensuring reliable operation of the system.

*G. Operational Flow*

Data Collection: The sensors continuously monitor vital environmental parameters, including temperature, humidity, soil moisture, and sunlight. This constant vigilance ensures that optimal conditions are maintained for crop growth.

Processing: The ESP8266 processes the sensor data if the soil moisture level is low it activates the relay to turn on the water pump if animal movement is detected it sends an alert to the farmer through Blynk.
Remote Monitoring and Alerts: The Blynk platform updates the farmer with real-time data on the mobile app allowing them to monitor the farm from anywhere notifications are sent for critical events such as low soil moisture or animal activity.
Manual Control: Farmers can also control the water pump manually either through the on-site button or via the Blynk app.

## IV. RESULTS AND DISCUSSION

The system developed for this project emphasizes the automation of monitoring and controlling environmental factors affecting plant health through the Internet of Things-based smart agriculture system. Hardware components include: the ESP8266 microcontroller, soil moisture sensor, DHT11 temperature and humidity sensor, relay module, water pump, and a battery for portability. The Blynk IoT platform can be accessed from a mobile device for real-time data visualization and control.

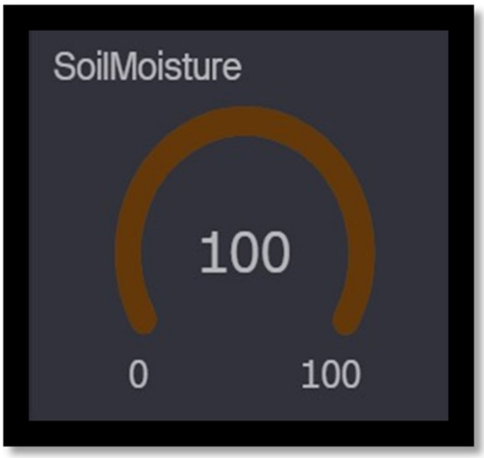


Fig [1] Soil Moisture Reading


Fig [2] Humidity Reading


Fig [3] Temperature Reading

The system architecture has a simple but effective IoT structure. The ESP8266 reads sensor values, processes them, and sends the data to the Blynk server via Wi-Fi. The mobile device connected to the same Blynk platform retrieves real-time data and displays it on its dashboard. The sensor readings can be monitored on the app, and the user can send control commands like turning on the water pump manually.
The system is self-sufficient wherein there is no extending detection of soil moisture to possibly colonize irrigation. Once soil moisture indicates dryness, the relay is activated by ESP8266, sending a pump operation command. Irrigation now occurs until the desired soil moisture level is achieved, ensuring precision in irrigation operation.

## V. CONCLUSION AND FUTURE SCOPE

The IoT-based Smart Agriculture system effectively automates important farming processes with key efficiency improvements and a decrease in the intake of manual labor. The sensor-based temperature, humidity, soil moisture monitoring, as well as animal activity detections forms real-time information to improve decision-making. The ESP8266 microcontroller processes these data to control water by sending signals to irrigate with a relay-water pump. The system using the Blynk IoT platform allows for remote monitoring and control of the fields, which enables farmers to control their field systems anywhere. This leads to resource conservation, which is also minimal in its human inputs thus leading to an improvement in the productivity of the crops and also a manner of increasing efficiency operationally. IoT can help farmers in numerous ways. With the deployed sensors/actuators across farms and machinery, farmers can gain as an abundance of insightful data such as temperature, fertilizer used, water used, etc. Once an IoT-enabled smart system is in place, farmers can easily monitor a variety of environmental parameters and do analytics. [7]

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