

Smart Agriculture System Using ESP32 For Motor Monitoring and Crop Health Management

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ABSTRACT

The Smart Agriculture System using ESP32 for Motor Monitoring and Crop Health Management is designed to improve farming efficiency through the integration of Internet of Things (IoT) and Artificial Intelligence (AI) technologies. The system continuously monitors important agricultural parameters such as temperature, humidity, motor voltage, and current in real time. The ESP32 microcontroller collects and processes sensor data and transmits it to the Smart Kissan mobile application, enabling farmers to monitor field conditions and control irrigation motors remotely. In addition, the system incorporates an AI-based crop disease detection module that analyzes leaf images uploaded by farmers and provides disease predictions along with treatment recommendations. This integrated approach helps reduce manual effort, improve motor safety, enable early disease detection, increase crop productivity, and support sustainable farming practices. The proposed system offers a cost-effective, user-friendly, and scalable solution for modern agriculture.

KEYWORDS

ESP32, Smart Agriculture, Internet of Things (IoT), Motor Monitoring, Crop Health Management, Artificial Intelligence, Crop Disease Detection, Smart Kissan App, Remote Monitoring, Precision Farming, Smart Irrigation, Sustainable Agriculture.

INTRODUCTION

Agriculture is one of the most important sectors contributing to food production and economic development. Traditional farming methods often depend on manual monitoring and operation of agricultural equipment, which can result in inefficient resource utilization, delayed decision-making, and reduced crop productivity. Recent advancements in IoT and AI technologies have enabled the development of smart farming systems that provide real-time monitoring, automation, and intelligent decision support.

The proposed Smart Agriculture System uses the ESP32 microcontroller for motor monitoring and crop health management. The system monitors environmental conditions and motor parameters while providing remote access through the Smart Kissan mobile application. Furthermore, AI-based image processing is used to detect crop diseases from leaf images and suggest suitable treatments. The integration of

IoT and AI technologies improves farming efficiency, reduces operational costs, and promotes sustainable agricultural practices.

A. Background: Agriculture plays a crucial role in supporting the growing global population. However, many farmers still rely on traditional methods for irrigation management and crop monitoring. These methods often lead to excessive resource consumption and reduced productivity. The emergence of IoT-based monitoring systems and AI-powered disease detection techniques has created opportunities to improve agricultural operations through automation, real-time data collection, and intelligent decision-making.

B. Problem statement: Farmers frequently face challenges such as manual motor operation, lack of real-time monitoring of agricultural equipment, delayed detection of crop diseases, and insufficient access to field information. These issues can lead to equipment failures, crop damage, lower productivity, and increased operational costs. Therefore, there is a need for a smart and efficient system that can monitor motor performance, provide remote control capabilities, and detect crop diseases at an early stage.

C. Objective: To develop an IoT-based smart agriculture system using ESP32.

To monitor motor voltage, current, temperature, and humidity in real time.

To provide remote motor monitoring and control through the Smart Kissan mobile application.

To implement AI-based crop disease detection using leaf image analysis.

To provide disease prediction results along with treatment recommendations.

To improve agricultural productivity and reduce manual effort through automation.

D. Significance: The proposed system contributes to modern agriculture by combining IoT and AI technologies into a single platform. It enables farmers to monitor motor performance remotely, reducing the risk of equipment damage and improving operational efficiency. The crop disease detection module helps identify diseases at an early stage, allowing timely treatment and reducing crop losses. The system supports data-driven decision-making, improves

productivity, reduces labor requirements, and promotes sustainable farming practices. Its low-cost and scalable design makes it suitable for adoption by small and medium-scale farmers

LITERATURE REVIEW

Literature survey				
Sr.no	Title/author/year	Technology used	Key Features	Limitations
1.	Smart Irrigation System Using IoT (Author: XYZ, 2019)	Arduino, Soil Moisture Sensor, GSM Module	Automated irrigation using soil moisture sensor	Limited sensor accuracy and network access
2.	IoT-Based Agriculture Monitoring System (Author: ABC, 2020)	NodeMCU, DHT11, Soil Sensor	Temperature and humidity monitoring, real-time data	No irrigation control or motor automation
3.	Wireless Sensor Based Farming (Author: PQR, 2021)	Arduino, Zigbee	Monitor crop conditions using sensors	Complex system, no mobile app
4.	ESP32-Based Smart Irrigation System (Author: LMN, 2022)	ESP32, Blynk App, Soil Moisture Sensor	Remote control via mobile app, basic automation	Limited to soil moisture, no motor feedback or crop health monitoring
5.	AI-Based Crop Disease Detection System (Author: STU, 2023)	ESP32, AI Model, Camera	Detects plant diseases from images	No motor control, no real-time monitoring
6.	Smart Agriculture System Using ESP32 With Mobile App (Proposed)	Smart Kissan App, ESP32, Sensors, AI model	Logic-based app, motor ON/OFF, shows temperature, voltage, current, humidity, crop disease prediction with image upload, gives disease name + confidence +	Requires internet, AI model accuracy depends on dataset

METHODOLOGY

The proposed Smart Agriculture System continuously monitors motor parameters and environmental conditions using ESP32, voltage sensor, current sensor, and DHT11 sensor. The collected data is transmitted to the Smart Kissan mobile application through Wi-Fi for real-time monitoring. The user can remotely monitor motor status and control the motor through the mobile application. For crop health management, the user uploads a leaf image through the application. The AI-based disease detection model analyzes the image and predicts the disease along with confidence percentage and treatment recommendations. This methodology enables efficient motor monitoring, remote operation, and early disease detection, thereby improving agricultural productivity and reducing manual effort.

A. Materials:

1. ESP32 Microcontroller: Acts as the main controller for data processing, Wi-Fi communication, and system control.

2. DHT11 Sensor: Measures temperature and humidity of the agricultural environment.

3. Voltage Sensor: Measures motor supply voltage and monitors electrical performance.

4. Current Sensor: Measures motor current consumption and helps identify abnormal conditions.

5. Relay Module: Controls motor switching operation (ON/OFF).

6. Motor: Represents the agricultural motor used for irrigation or pumping applications.

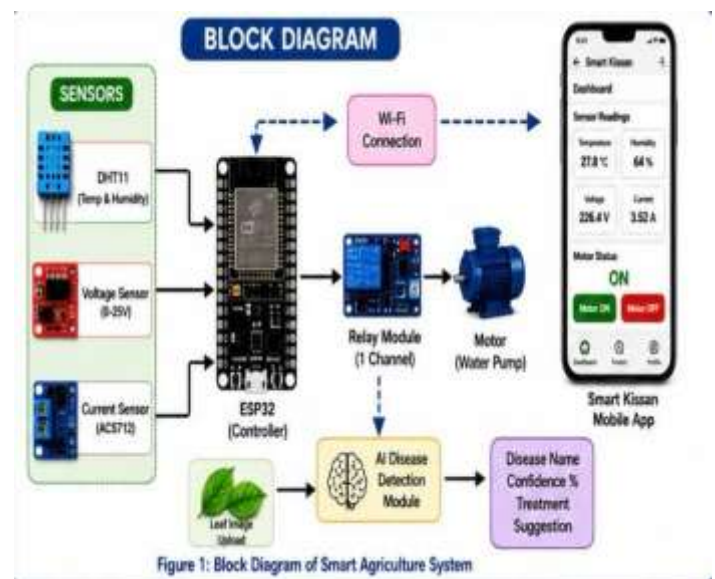
7. Connecting Wires and Breadboard: Used for hardware connections and circuit implementation.

8. Wi-Fi Communication: Provides wireless communication between ESP32 and Smart Kissan App.

9. Smart Kissan Mobile Application: Displays real-time monitoring data, motor status, and disease prediction results.

10. AI Disease Detection Model: Analyzes leaf images and predicts crop diseases with treatment recommendations.

B. Detailed procedures / Block diagram:



1. Preparation of Components: Gather ESP32, DHT11 sensor, voltage sensor, current sensor, relay module, motor, connecting wires, and power supply.

2. Circuit Design and Connections: Connect DHT11, voltage sensor, and current sensor to ESP32 input pins. Connect relay module to ESP32 output pin and connect motor through relay.

3. Programming the ESP32: Develop the program using Arduino IDE. Configure sensor reading, Wi-Fi communication, motor control, and cloud data transmission.

4. Wi-Fi and IoT Setup: Configure ESP32 to connect with Wi-Fi and communicate with the Smart Kissan mobile application.

5. Motor Monitoring and Control: Monitor voltage, current, temperature, and humidity data in real time. Allow users to remotely switch the motor ON/OFF through the application.

6. AI-Based Disease Detection: Upload crop leaf images through the application. The AI model processes the image and predicts crop diseases with confidence percentage.

7. Testing and Validation: Verify sensor readings, motor operation, app communication, and disease prediction accuracy.

8. Final Deployment: Deploy the system in agricultural environments for real-time monitoring and crop health management.

B. Data flow and processing:



Explanation :

Step 1: Sensors collect temperature, humidity, voltage, and current data.

Step 2: ESP32 processes the sensor readings.

Step 3: Data is transmitted to the Smart Kissan mobile application via Wi-Fi.

Step 4: User monitors motor status and environmental conditions.

Step 5: User uploads crop leaf image.

Step 6: AI model analyze image and predicts disease.

Step 7: Disease name, confidence percentage, and treatment recommendation are displayed.

Step 8: User takes corrective actions and remotely controls motor if required.

Decision (Predict?)

- Yes** → System predicts crop disease, shows name, confidence %, and treatment.
- No** → System do not predicts exact disease, low confidence and wrong treatment.

Display Output → Shows disease details or motor status

Loop Back → System returns to start and repeats process

RESULT



A .Presentation of finding: The findings are presented using real-time data displayed on a mobile app or LCD, including soil moisture, temperature, humidity, and motor status. Graphs and charts from the IoT platform (like Thing Speak/Blynk) show changes in conditions over time. The system also displays crop disease predictions with confidence percentage and suggested treatment. Overall, the results highlight improved water management, efficient motor control, and better crop health monitoring.

B. Analysis: The sensor data (soil moisture, temperature, humidity, and water level) is analyzed to determine when irrigation is needed and how efficiently water is used. Motor operation data is checked to ensure proper functioning and detect faults. The system also analyzes crop images to identify diseases and suggest treatments. Overall, the analysis helps in improving decision-making, increasing crop yield, and ensuring efficient resource management.

C. Interpretation of results: The results show that the system successfully monitors soil and environmental conditions and automatically controls the motor for efficient irrigation. It helps in reducing water wastage and ensures proper crop growth. The disease detection feature provides useful insights for early treatment. Overall, the system proves to be effective in improving productivity and supporting smart farming practices.

CONCLUSION

A. Summery of finding: The smart agriculture system using ESP32 effectively monitors soil moisture, temperature, and humidity in real time. It automatically controls the irrigation motor, reducing water wastage and manual effort. The system also helps in early detection of crop diseases and provides useful insights for better decision-making. Overall, it improves efficiency, saves resources, and supports sustainable farming.

B. Implication: This system shows that using smart technology in agriculture can improve efficiency and reduce water wastage. It helps farmers make better decisions through real-time data and automation. The project also supports sustainable farming and reduces manual effort. Overall, it highlights the importance of adopting IoT-based solutions in modern agriculture.

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