# AI-Based Precision Agriculture Monitoring and Control System

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**Abstract -** The AI-Based Precision Agriculture Monitoring and Control System is designed to support agricultural monitoring and weed-cutting operations using embedded control technology. The system employs ESP32 microcontrollers to collect environmental data through sensors and control vehicle movement using DC geared motors. An ultrasonic sensor assists in obstacle detection, while a relay-based switching arrangement controls the weed-cutting mechanism and water pump. An ESP32-CAM provides camera functionality, and an INA219 sensor monitors electrical parameters. Wireless communication and Firebase integration enable sensor-data storage and remote monitoring. Agricultural prediction capabilities can be incorporated to analyse collected data and support crop-related decisions. The proposed system integrates sensing, motor control, power monitoring, and wireless data access into a single agricultural platform.

## 1.INTRODUCTION

Agriculture plays an important role in food production and economic development. Conventional agricultural operations often require considerable manual effort for monitoring environmental conditions and controlling equipment. Technological developments in embedded systems, sensors, and wireless communication provide opportunities to improve agricultural monitoring and automation.

The proposed AI-Based Precision Agriculture Monitoring and Control System combines sensor-based environmental monitoring with vehicle movement and weed-cutting operations. The system uses an ESP32 DevKit V1 as its main controller and an ESP32-CAM for camera functionality. Sensors measure temperature, humidity, soil pH, and rain conditions. An ultrasonic sensor detects nearby obstacles, while a motor driver controls the movement of the vehicle. The system also incorporates a relay-controlled weed-cutting mechanism and water pump. An INA219 sensor monitors electrical parameters, and wireless communication enables sensor data to be stored in Firebase and accessed through a web interface. Agricultural prediction capabilities can be used to analyse collected data and support crop-related decisions.

## 2. Body of Paper

### 2.1 System Architecture

The system consists of ESP32 controllers, sensors, a motor driver, a relay module, a power supply, and a wireless monitoring interface. The ESP32 DevKit controls the vehicle, while the ESP32-CAM provides camera functionality. Firebase enables sensor-data storage and remote monitoring.

### 2.2 Hardware Components

The main components are ESP32 DevKit V1, ESP32-CAM, DHT11, soil pH sensor, rain sensor, MPU6050, INA219, ultrasonic sensor, motor driver, 12 V DC geared motors, weed-cutter motor, relay module, water pump, solar panel, battery, and voltage regulators.

### 2.3 Sensor Monitoring

Sensors measure temperature, humidity, soil pH, rain conditions, motion, distance, and electrical parameters. The ESP32 processes the readings for monitoring and control.

### 2.4 Vehicle Movement and Obstacle Detection

The ESP32 controls the DC geared motors through a motor driver. The ultrasonic sensor detects obstacles, and the controller executes programmed stopping and turning operations.

### 2.5 Weed-Cutting and Water-Spraying Mechanism

The relay module controls the weed-cutter motor and water pump according to programmed commands.

### 2.6 Camera and Wireless Monitoring

The ESP32-CAM captures images and communicates with the main controller. Wi-Fi and Firebase support remote sensor-data monitoring through a web interface.

### 2.7 AI-Based Agricultural Prediction

Collected agricultural data can support crop-related predictions. Vehicle navigation and obstacle detection use programmed control logic.

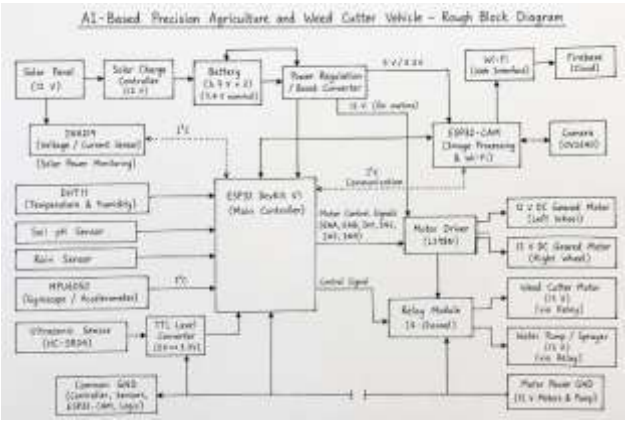
### 2.8 Power Supply System

The solar panel, charge controller, battery, and voltage regulators supply power to the system. The INA219 monitors electrical parameters.

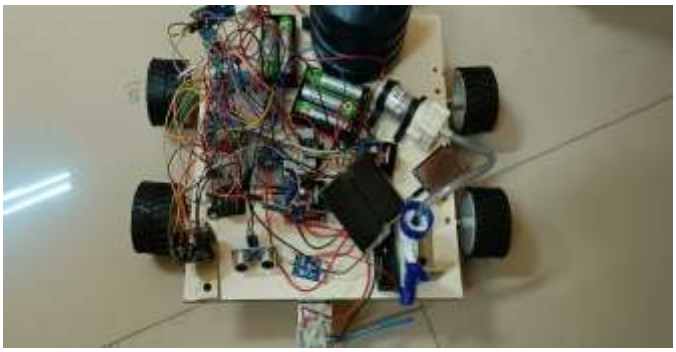
**OUTPUTS:**




**SYSTEM ARCHITECTURE**




**EXPERIMANTAL SETUP**



## 3. CONCLUSIONS

The AI-Based Precision Agriculture Monitoring and Control System integrates environmental sensing, vehicle movement, obstacle detection, weed-cutting control, and wireless monitoring. The ESP32 provides the main control functionality, while the ESP32-CAM supports camera operations. Sensors collect environmental and motion-related data, and the motor driver and relay module control the vehicle's actuators.

Firebase and Wi-Fi provide remote data storage and access. The system also incorporates solar electrical-parameter monitoring and provides a platform for agricultural prediction capabilities.

The project demonstrates an approach to combining embedded systems and agricultural monitoring in a single platform. Further testing is required to evaluate sensor accuracy, obstacle-handling performance, battery operation, and the reliability of agricultural predictions.

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**Biography:**



**Dr. Amit Kumar K** is an **Assistant Professor** in the **Department of Electrical and Electronics Engineering** at **PES Institute of Technology and Management, Shivamogga, Karnataka**. He is actively involved in teaching and guiding engineering students in their academic projects and research activities. He guided the project **titled "AI-Based Precision Agriculture Monitoring and Control System."** His guidance contributed to the development and implementation of the proposed system. He encourages students to explore innovative technologies and practical engineering solutions.