iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 Issue: VI Month of publication: June 2025

DOI: https://doi.org/10.22214/ijraset.2025.72214

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue VI June 2025- Available at www.ijraset.com

Agrisense: Automated Irrigation and Smart Seeding With Crop Monitoring

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Abstract: This paper presents Agrisense , a smart farming robot designed to perform automated seeding, irrigation, and remote crop monitoring. The system integrates an Arduino Uno microcontroller with a soil moisture sensor, relay module, servo motors, water pump, buzzer, ESP32-CAM, and Bluetooth module. A mobile device connects via Bluetooth to manually drive the vehicle. A mechanical switch triggers the seeding mechanism, and soil conditions are checked every 2 seconds for automated irrigation. When the soil is dry, the pump activates automatically. The ESP32-CAM allows live crop image capture via IP access. Powered by two 9V batteries or an adaptor, this low-cost system is intended to simplify field work for farmers while promoting water conservation and labor efficiency.
Keywords: Arduino Uno, Bluetooth, ESP32-CAM, Soil Moisture Sensor, Relay Module, Motor Driver, Smart Irrigation, Autonomous Seeding, Farm Robot

I. INTRODUCTION

Agriculture has always been the cornerstone of human civilization, serving as the primary source of food and raw materials. However, with rapid global population growth, climate change, and increasing demands for food security, traditional farming techniques are proving insufficient. Modern farmers face significant challenges such as labor shortages, inefficient water usage, inconsistent crop monitoring, and the need for real-time data to make informed decisions. To address these challenges, the integration of automation and IoT (Internet of Things) technologies in agriculture is gaining momentum. Additionally, inconsistent watering can lead to over-irrigation or under-irrigation, both of which affect crop yield and soil health. Similarly, relying on manual observation for crop health monitoring is impractical for large or remote farms. To mitigate these issues, the concept of precision agriculture—which combines sensor technologies, automation, and intelligent systems—has emerged as a sustainable solution. In this context, we present Agrisense, a smart robotic farming assistant designed to automate seeding, monitor soil moisture levels, perform need-based irrigation, and enable live crop image monitoring remotely via an ESP32-CAM module. Agrisense is a mobile robot built on the Arduino Uno microcontroller and integrates various components including soil moisture sensors, servo motors, relay module, water pump, IR sensor, ESP32-CAM, and a motor driver module. It is manually navigated via a Bluetooth connection to a smartphone and powered by two 9V batteries or a direct adaptor supply.

II. BLOCK DIAGRAM

The block diagram of this system shows the Arduino Uno at the center, interfaced with the soil moisture sensor, IR sensor, relay module, water pump, buzzer, servo motors, motor driver, ESP32-CAM, and Bluetooth module. The power supply feeds the entire system, ensuring all components receive the required voltage.

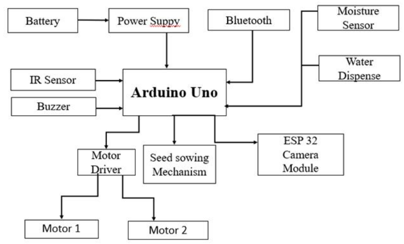
Agrisense is a smart agricultural robot designed to help farmers by automating soil moisture monitoring, irrigation, and crop monitoring using sensors and a camera module. It is controlled remotely via Bluetooth and can operate on batteries or an adapter.

A. Soil Moisture Monitoring and Irrigation Control

The soil moisture sensor is the core component used to monitor the moisture content of the agricultural field. This sensor is inserted into the soil and sends real-time data to the Arduino Uno every 2 seconds. When the moisture level falls below a predefined threshold, the Arduino triggers the relay module to turn on the water pump. This ensures automatic irrigation without any human intervention. A buzzer is also activated during this event to indicate that the system is actively irrigating the field.

B. Crop Monitoring Using ESP32-CAM

The ESP32-CAM module is used to capture real-time images of the crops. This module connects to a WiFi network and streams or stores images that can be accessed through a mobile device using an IP address. The images help in remote visual monitoring of crop conditions, plant growth, and pest detection. It works in coordination with the Arduino Uno, which sends a signal to take pictures at desired intervals or based on specific triggers.



C. Robot Movement and Seeding Mechanism

The Agrisense robot uses a motor driver to control its wheels, allowing it to navigate through the farm. IR sensors help in obstacle detection or line-following to guide the robot's movement safely. The robot is equipped with servo motors that operate a mechanical seed-dispensing mechanism. A switch is provided to initiate the seeding process, allowing the robot to drop seeds at specific intervals as it moves across the field.

D. Bluetooth-Based Remote Control

The entire robot system can be manually controlled using a mobile phone via Bluetooth. A Bluetooth module (like HC-05) is connected to the Arduino Uno, enabling users to send commands for movement, seeding, irrigation, and camera capture. This feature adds flexibility, especially when farmers want to override automatic functions and control the robot manually.

E. Seeding Mechanism Using Servo Motor

The Agrisense robot is equipped with a smart seeding mechanism that uses servo motors for precise control over the seed dispensing unit. The servo motors are connected to a small hopper or seed container. A manual switch is provided to trigger the servo motor, which rotates a specific angle to release a fixed quantity of seeds into the soil as the robot moves across the field. This method ensures that seeds are sown at regular intervals and at consistent depth, increasing efficiency and reducing manual labor. The mechanism is designed in such a way that the robot can perform sowing and irrigation simultaneously, if required.

III. LITERATURE SURVEY

Title	Author	Implemented Method	Merits	Demerits
IoT-Based Smart Agriculture Monitoring System	Sharipah B. Daud, R. A. Rahman, M. H. A. Zainal (2025)	Sensors with ESP32, and auto-pump control	Real-time data, auto irrigation, remote access	Needs internet, limited by sensor quality
Agricultural Robot for Soil Monitoring	R. Verma et al. (2019)	Arduino-based rover with soil sensors and manual control	Mobile platform, remote sensing of soil conditions	No auto-irrigation, no image capture
IoT-based Farm Surveillance System	K. Kumar and V. Sharma (2020)	ESP32-CAM with WiFi for live video and surveillance	Remote monitoring via internet, low-cost camera	Requires stable internet, no irrigation or movement features
Bluetooth Controlled Farm Robot	S. Desai and A. Joshi (2021)	Arduino with Bluetooth and motor driver	Easy manual control via smartphone	No automation, lacks sensors for soil
Smart Agriculture Vehicle Using Arduino & IoT	T. Rane and D. Pawar (2022)	Soil sensor, pump, motor driver, servo seeder, ESP32-CAM	All-in-one: irrigation, seeding, and image capture	Battery limitation, no GPS or cloud integration

IV. METHODOLOGY

The Agri sense project is a smart farming robot based on Arduino Uno that automates irrigation, seeding, soil monitoring, and crop surveillance. It uses a soil moisture sensor to control a water pump via a relay, and a servo motor for seed dispensing. The robot is powered by batteries or an adaptor and is controlled through Bluetooth using a smartphone. An ESP32-CAM captures crop images and streams them over Wi-Fi. A motor driver enables movement, and a buzzer provides alerts. This system helps farmers save water, reduce labor, and monitor crops efficiently.

A. Soil Moisture-Based Irrigation Control

A soil moisture sensor is used to detect the current moisture content of the soil. The sensor checks soil conditions every 2 seconds. When the moisture level drops below a threshold, it signals the Arduino to activate a relay which powers the water pump. The pump irrigates the soil until optimal moisture is restored. This automatic irrigation system conserves water and ensures that crops receive water precisely when needed.

B. Smart Seeding Mechanism

The robot includes a servo motor connected to a seed container for precise seeding. The motor rotates when a switch is pressed, dropping seeds at regular intervals into the soil. This automation reduces labor and ensures uniform seed placement. Farmers can initiate the seeding function while controlling the robot using their smartphone via Bluetooth, ensuring ease of use and improved field efficiency.

C. Remote Crop Surveillance with ESP32-CAM

An ESP32-CAM module is mounted on the robot to monitor the condition of crops in real-time. This module captures images and streams them over Wi-Fi, which can be accessed through a specific IP address on a connected device. This feature allows farmers to visually inspect field conditions without being physically present, enabling early detection of crop issues or pests.

D. Robot Navigation and Control

The vehicle’s movement is driven by DC motors, which are controlled via a motor driver module. Directional input is received from a Bluetooth module, which connects to the user's smartphone. This setup allows the farmer to steer the robot easily across the field, reaching targeted areas for seeding or irrigation. A buzzer is also used to give audio feedback during operations like pump activation or seed dropping.

E. Power Supply and Dual Mode Operation

The Agrisense robot can be powered by two 9V batteries or an external DC power adaptor, making it flexible for field or lab use. The dual-mode power setup ensures uninterrupted operation and allows testing without battery consumption.

F. Overall System Operation

The Agrisense system begins operation when powered, initializing all components such as the soil sensor, servo motor, ESP32-CAM, Bluetooth, and motor driver. It continuously checks soil moisture and irrigates only when needed. The farmer can control the movement and initiate seeding using a mobile phone. Meanwhile, the ESP32-CAM captures crop images and streams them to the user’s device. This combination of sensors, wireless communication, and motor automation provides a complete smart farming solution that reduces manual labor, saves water, and enables remote monitoring.

V. SYSTEM WORKING (DATA FLOW)

The Agrisense system integrates various sensors, communication modules, and actuators to perform automated seeding, soil moisture monitoring, irrigation, and remote crop monitoring. The system is designed to operate in real-time, with constant data acquisition, decision-making, and monitoring. The workflow of the system is divided into the following stages

A. Initialization and Monitoring

The system is powered by either two 9V batteries or an external DC power adaptor. Once powered on, the Arduino Uno initializes all connected components, including the soil moisture sensor, motor driver, servo motors, ESP32-CAM, Bluetooth module, and water pump.

Upon initialization, the system continuously checks the soil moisture levels every 2 seconds using the soil moisture sensor. If the soil is dry, the water pump is activated to irrigate the crops. The farmer can control the vehicle and initiate seeding via a mobile app connected via Bluetooth. Meanwhile, the ESP32-CAM captures and streams crop images in real-time for remote monitoring.

B. Dual-Mode Operation

The system operates in parallel across two primary modes: seeding/irrigation and remote monitoring.

Seeding and Irrigation Mode:

- The mechanical switch activates the seeding mechanism.
- The robot moves and distributes seeds at intervals, based on preset conditions.
- The system checks soil moisture levels every 2 seconds and triggers irrigation when needed.
- The water pump operates via relay, and servo motors control the distribution of water to specific areas of the field.

Remote Monitoring Mode:

- The ESP32-CAM module captures live crop images every time the system is accessed through the mobile app via its IP address.
- This mode allows users to monitor crop health in real-time, ensuring that proper irrigation and seeding have been done

C. Event Trigger and Response

- The relay turns ON the water pump when moisture levels fall below the defined threshold.
- The servo motors direct water flow to specific regions of the field based on the robot's movement and position.
- The switch is activated by the farmer to begin seeding. The robot dispenses seeds in predefined intervals as it moves across the field.
- The ESP32-CAM transmits real-time crop images accessible through the app, providing remote crop monitoring for the user.

D. Cloud Data Visualization

To enable remote monitoring and data analysis, the system periodically uploads soil moisture data and other environmental parameters to a cloud platform. The cloud service (e.g., ThingSpeak) processes the data and presents it through dynamic visualizations. This allows farmers to track real-time irrigation status, soil moisture levels, and crop health, offering insights into the system's performance and the field's condition.

E. Logging and Storage

Each event is logged in local or cloud-based storage, containing timestamps, images, sensor readings, and action data (e.g., seeding, irrigation). This archival data provides valuable insights into crop health, system performance, and future predictions for land management.

VI. IMPLEMENTATION & RESULTS

The proposed accident detection and alert system was implemented using a Raspberry Pi 4 Model B as the central processing unit.

A. Hardware Implementation

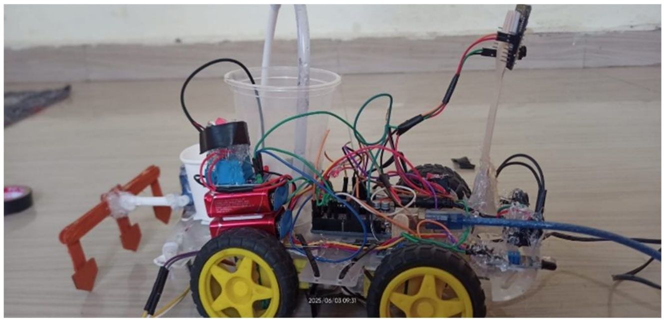
The following components were connected and configured:

1) Arduino Uno: Serves as the main controller, processing sensor data and coordinating actuator responses for seeding and irrigation.
2) Soil Moisture Sensor: Continuously checks the moisture level of the soil. If the value drops below a defined threshold, the irrigation system is activated.
3) Servo Motors: Used for seed dispensing and mechanical control of outlets or arms for planting.
4) Relay Module: Acts as a switch to control the DC water pump based on soil moisture sensor readings.
5) Water Pump: Provides the required irrigation to the soil when dryness is detected by the sensor.
6) Bluetooth Module (HC-05/06): Facilitates manual control of the robot using a smartphone app via Bluetooth communication.
7) Motor Driver (L298N): Drives the robot's movement motors, allowing forward, reverse, left, and right motion based on user input.
8) ESP32-CAM: Captures real-time images of crops and streams them through a local IP address, allowing remote monitoring.

9) Buzzer: Provides audible feedback when the pump is running, indicating that irrigation is in progress.
10) Power Supply: Dual 9V batteries for portability or an external 12V DC adaptor for longer use in the field.
11) B.Software Implementation
12) Arduino IDE: Used to develop and upload the firmware that controls the robot's logic, sensor inputs, and actuator outputs.
13) ESP32-CAM Web Server: Configured to host a lightweight web page for streaming live images accessible through a browser via IP.

B. Result Analysis

- The system was tested under actual farming conditions in a controlled outdoor test field.
- The robot responded accurately to Bluetooth commands and could navigate efficiently over tilled soil.
- The soil moisture sensor triggered irrigation accurately within 1–2 seconds of dryness detection.
- The ESP32-CAM delivered clear images over a Wi-Fi network, allowing farmers to visually inspect crop growth remotely.



VII. CONCLUSION

The Agrisense robotic farming system is a smart, low-cost, and practical solution designed to automate essential agricultural operations such as seeding, soil moisture monitoring, irrigation, and crop image capturing. By integrating widely available components like the Arduino Uno, soil moisture sensor, relay, servo motors, water pump, motor driver, Bluetooth module, and ESP32-CAM, the system demonstrates how small-scale farmers can adopt automation without the need for expensive commercial solutions.

The robot simplifies fieldwork through a Bluetooth-based manual control system that allows it to be driven using a mobile phone. A mechanical switch triggers the seeding mechanism, while the soil moisture sensor takes readings every two seconds to monitor dryness. When the soil moisture level drops below a preset threshold, the relay module activates the water pump automatically, ensuring timely and efficient irrigation. The integrated ESP32-CAM provides real-time visuals of the field by streaming crop images over Wi-Fi using a dedicated IP address, enabling farmers to monitor plant conditions remotely.

The system not only reduces manual labor but also promotes water conservation by delivering irrigation only when necessary. Its flexible power setup—via dual 9V batteries or an external adaptor—makes it suitable for both lab testing and real field deployment. Moreover, its modular design allows individual features (such as seeding, irrigation, and monitoring) to be used or upgraded independently, which adds to the system’s adaptability and scalability.

Overall, Agrisense brings together mobility, automation, sensing, and remote monitoring into a compact farming robot that supports precision agriculture in a meaningful way. It is especially valuable for small and medium-scale farms, where automation is still limited due to high costs and technical barriers. This project shows how open-source hardware and simple programming can be used to modernize farming practices. In future work, the system can be enhanced by integrating GPS for autonomous navigation, solar power for energy independence, and machine learning algorithms to analyze crop health based on captured images. A dedicated mobile app for controlling the robot and visualizing data could further improve usability and decision-making for farmers. Thus, Agrisense lays a strong foundation for developing more intelligent, sustainable, and connected agricultural systems.

REFERENCES

[1] Kumar and H. Rajagopal, “Automated Seeding and Irrigation System using Arduino,” Journal of Robotics, Networking and Artificial Life, vol. 8, no. 4, pp.259–262, Mar.2022.[Online].Available:https://doi.org/10.2991/jrnal.k.211108.006
[2] S. M. Malode, S. Telang, S. Gangane, A. Randai, and H. Meshram, “Automatic Seed Sowing System,” International Research Journal of Modernization in Engineering, Technology and Science (IRJMETS), vol. 5, no. 12, pp. 1127–1129, Dec. 2023. [Online]. Available: https://doi.org/10.56726/IRJMETS47289
[3] S. Thawali, B. Yadav, H. Rumde, and R. S. Sewane, “Design and Manufacturing of Robot for Digging and Seeding in Agriculture,” Proc. of International Conference on Ideas, Impact and Innovation in Mechanical Engineering (ICIIIME), vol. 5, pp. 1637–1644, 2017.

[4] M. Aravind Kumar, A. S. Reddy, and K. Sagadevan, "Automatic Seed Sowing & Irrigation Agribot using Arduino," International Journal of Pure and Applied Mathematics, vol. 119, pp. 1089–1092, 2018.
[5] D. S. Rahul, S. K. Sudarshan, K. Meghana, K. N. Nandan, R. Kirthana, and P. Sure, "IoT Based Solar Powered Agribot for Irrigation and Farm Monitoring," 2nd International Conference on Inventive Systems and Control, 2018, pp. 826–830.
[6] A. Joshi, M. Kale, and S. Patil, "Smart Agriculture Robot for Precision Farming," International Journal of Engineering Science and Computing, vol. 10, no. 6, pp. 19843–19847, Jun. 2020.
[7] V. Thorat, M. Kasturi, G. Patil, and R. Patil, "Design and Fabrication of Seed Sowing Machine," International Research Journal of Engineering and Technology (IRJET), vol. 4, no. 9, pp. 704–707, Sep. 2017.
[8] Arduino, "Arduino Uno Rev3," [Online]. Available: https://docs.arduino.cc/hardware/uno-rev3
[9] Espressif Systems, "ESP32-CAM Video Streaming Web Server,"[Online].Available: https://randomnerdtutorials.com/esp32-cam-video-streaming-web-server-camera-home-surveillance/
[10] TowerPro, "SG90 Micro Servo Motor Datasheet," [Online].Available: https://www.towerpro.com.tw/product/sg90-2/
[11] STMicroelectronics, "L298N Dual Full-Bridge Driver,"[Online].Available: https://www.st.com/resource/en/datasheet/l298.pdf
[12] N. Patel and M. Joshi, "Bluetooth Controlled Agricultural Robot using Arduino," International Journal of Scientific Research in Engineering and Management (IJSREM), vol. 4, no. 2, pp. 90–95, Feb. 2021.
[13] D. Singh and V. Sharma, "Soil Moisture Based Smart Irrigation System using IoT," International Journal of Engineering Research & Technology (IJERT), vol. 9, no. 6, pp.234–238,Jun.