RESEARCH ARTICLE

RSP Science Hub

International Research Journal on Advanced Science Hub
2582-4376
www.rspsciencehub.com
Vol. 07, Issue 03 March

Check for updates

http://dx.doi.org/10.47392/IRJASH.2025.018

Bluetooth Controlled Agrisense for Agricultural Operations

Archana Devi S[1], Asath Sugaina A[2], AbinayaSaraswathi B[3], Ilakkiya M[4]
[1,2,3,4]Department of Computer science and Engineering, Kamaraj college of Engineering and Technology Virudhunagar, India
Emails: *archanadevicse@kamarajengg.edu.in[1], 21ucs081@kamarajengg.edu.in[2], 21ucs006@kamarajengg.edu.in[3], 21ucs118@kamarajengg.edu.in[4]*

Article history
Received: 01 February 2025
Accepted: 14 February 2025
Published: 15 March 2025

Keywords:
Smart Crop Water Management System, Bluetooth Enabled Control, Green Energy, Eco-Friendly Farming, Rob-Agriculture, Arduino, Remote Sensing, Solar Based Power, Water Saving. Engagement, Content Strategy

Abstract
Due to high demand for sustainable agricultural practice, this project presents Bluetooth operated mobile AgriSense for irrigation and grass cutting. Equipped with Arduino Uno, Bluetooth, DC motors, and solar lithium-ion batteries, AgriSense works via an Android application; the mobile application controls water dispensation and field upkeep. This is in combination with a servo- controlled sprinkler that offers the best control of water distribution hence efficiency in the supplied water for irrigation purposes. Also, these solar panels being efficient, produce light energy, corresponding to the environment conservation acts. For optimal functionality, the proposed AgriSense comprises of individual power, control, mobility and irrigation sections. Each of the modules improves its function and flexibility in response to agricultural requirements, which makes it possible to incorporate more features into the system if necessary. Even the AgriSense implements other strategies like LoRa-based communication coverage for larger range or track for rough surface, which further helps to customize the flexible and adaptive capability of AgriSense to fulfill the roles of various farming fields. This project represents a pioneering strategy to incorporate robotics into change in sustainable farming to cope with the coming issues in water and labor scarcity in the farming industry.

1. Introduction
In India, where 70% of the population relies on agriculture for their livelihoods, there exists a critical need for modernization efforts to sustainably enhance productivity and livelihoods. However, these efforts are hampered by the scarcity of skilled labor, especially prevalent in developing nations. The adoption of upgraded technology is thus imperative to overcome these challenges and propel agricultural growth. Specifically, tasks such as sowing and spraying require advanced technological solutions to optimize efficiency and ensure sustainable agricultural practices. Addressing these challenges through targeted modernization efforts is essential for unlocking the full potential of the agricultural sector and securing the livelihoods of millions who depend on it [1].

2. Related Works
In agricultural robotics, various studies have focused on automating seed sowing techniques. Anil Karwankar and Saurabh Umarkar introduced an Automated Seed Sowing AgriSense using Arduino and pneumatic systems [2]. However, practical use is hindered by unidirectional movement and automatic power cutoff when

encountering obstacles. Meanwhile, M.D. I. Sujon, R. Nasir, and Jayasree Baidya investigated oil seed rape treatments and seeding techniques, utilizing ultrasonic detection for navigation. Despite advancements, challenges like soil variability remain [3]. These studies collectively emphasize progress in agricultural automation while highlighting the overcome existing limitation in seed sowing technologies.

3. Proposed Work

The overall process of the Bluetooth Controlled Agri sense for Agricultural Operations was illustrated in this section. The System design was depicted in Figure 1.

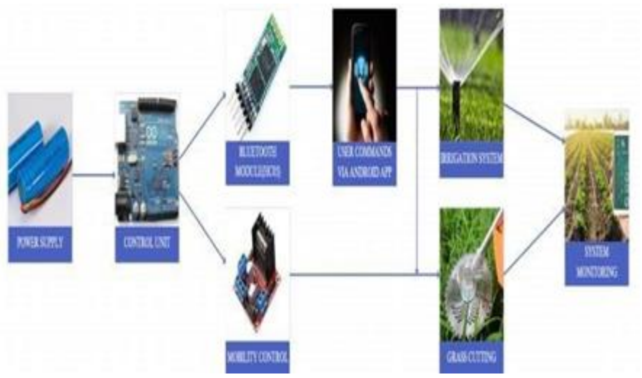

Figure 1 System Design

3.1. System Design and Architecture

The proposed work focuses on creating a modular framework comprising the following submodules:

- **Power Module:** This module will manage energy supply using solar-powered lithium-ion batteries to ensure sustainable and uninterrupted operation.
- **Control Module:** Equipped with an Arduino Uno and Bluetooth communication, this module will act as the brain of the system, coordinating all operations.
- **Mobility Module:** Incorporating DC motors, this module will enable the system to move across fields and adapt to various terrains.
- **Irrigation Module:** Using servo-controlled sprinklers, this module will provide precise and efficient water distribution, minimizing wastage.

3.2. Hardware Implementation

The hardware implementation will bring together robust components for seamless functionality. The integration of solar-powered batteries ensures eco-friendly energy, while Bluetooth modules enable reliable communication and control.

3.3. Software Development

A user-friendly Android application will be developed to interface with the system. This application will allow farmers to remotely control irrigation and maintenance operations using need for further improvements to enhance efficiency and operations using Bluetooth connectivity, providing convenience and flexibility.

3.4. Smart Irrigation Mechanism

The irrigation module will focus on optimizing water usage through a servo-controlled sprinkler system, ensuring precise distribution sed on field requirements. This approach aims to significantly reduce water wastage.

3.5. Renewable Energy Integration

The power module will harness solar energy, reducing dependence on conventional energy sources and promoting sustainable agricultural practices.

3.6. Field Testing and Optimization

Field tests will be conducted to evaluate the system's performance in various agricultural conditions. Feedback will be used to refine the modules and ensure reliability and efficiency.

3.7. Components Required

- Arduino - ATMEGA328
- Relay (4 channel)
- Rechargeable Battery (12V 3A)
- Bluetooth Module (HC05)
- DC Motor
- Wheels
- Blades (Cutting grass)
- Motor Driver (L293D IC)
- Water Sprinkler (Pesticide Spraying)
- Frames (Wood, tools, clamps, screws)

3.8. Functional Decomposition

Breaking down the AgriSense into functional modules enhances understanding and facilitates efficient design. The power module includes the lithium-ion battery, ensuring a sustainable energy source. The control module, managed by Arduino Uno and the Bluetooth module, oversees the Agrisense operation. The mobility module, driven by DC motors and the L298N motor driver, governs the Agrisense movement. Lastly, the irrigation module, comprising the 5V DC pump and servo motor, handles the precise delivery of water to the field. A hierarchical diagram illustrates the interconnectedness and dependencies of these modules (Figure 2).

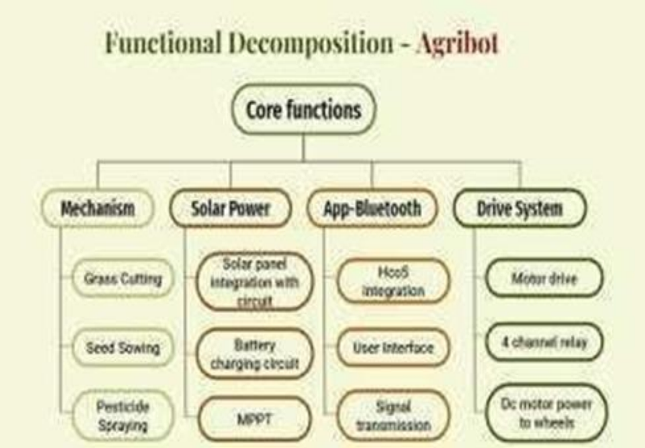

Figure 2 Functional Decomposition

4. Alternate Methods

Consideration of alternative methods is crucial to ensuring optimal design choices. Alternative motor drivers, sensors, and irrigation mechanisms were evaluated for their suitability in the Agrisense. Various motor drivers were assessed for efficiency, heat generation, and cost- effectiveness. Sensor options were compared based on accuracy and adaptability to agricultural conditions. Different irrigation mechanisms were explored, weighing factors such as water distribution accuracy and maintenance requirements. Ultimately, the selected components were chosen for their balance of performance, cost, and compatibility with the project's objectives.

4.1. Power Source

Figure 3 Renewable Energy

Alternative energy sources such as wind turbines or biomass generators can supplement or replace solar panels to provide continuous power (Figure 3).

Hybrid systems combining multiple renewable energy sources could offer more reliable power generation, especially in regions with inconsistent sunlight.

4.2. Control Unit

Utilizing more advanced microcontrollers like Raspberry Pi or BeagleBone could enhance computational capabilities and enable more complex functionalities (Figure 4). Implementing edge computing systems can distribute computing tasks closer to the sensors, reducing latency and improving real-time responsiveness.

Figure 4 Microcontroller

4.3. Communication System

Implementing LoRa (Long Range) or Zigbee communication protocols can provide longer-range and lower-power communication options compared to Bluetooth (Figure 5). Integrating cellular or satellite communication modules can enable remote monitoring and control capabilities even in areas without Wi-Fi coverage.

Figure 5 LoRa (Long Range)

4.4. Mobility Mechanism

Employing tracked or wheeled robotic platforms instead of wheeled vehicles can offer better traction and stability, especially in rough terrains (Figure 6). Implementing legged or aerial drones can provide alternative methods for navigating challenging landscapes and reaching remote areas.

Figure 6 **Wheeled Vehicles**

4.5. Irrigation System

Adopting drip irrigation systems can offer more precise water delivery directly to plant roots, reducing water wastage and improving efficiency (Figure 7). Implementing smart irrigation algorithms based on soil moisture sensors and weather forecasts can optimize water usage and adapt to changing environmental conditions.

Figure 7 **Water Delivery Directly to Plant Roots**

5. Verification Matrix

Table 1 **Verification Matrix**

Requirement	Test Method	Acceptance Criteria
Uniform Pesticide Spray	Visual inspection during operation	Even distribution of pesticide
Blockage Prevention	Flow rate measurement	Consistent flow without blockages
Reliable Operation	Durability testing	Functionality after repeated use
Easy Maintenance	Disassembly and reassembly	Quick and hassle-free maintenance

This simplified verification matrix ensures that the pesticide sprinkler mechanism meets essential requirements, focusing solely on its functionality and usability (Table 1).

5.1. FMEA Analysis

Table 2 **FMEA Analysis**

Process Step	Potential Failure Mode	Potential Failure Effect	SEV Rating	Potential Causes	OCC Rating	Current Process Controls	DET Rating	RPN Rating	Action Recommended
Pesticide Sprinkling	Clogging of pesticide sprinkler mechanisms	Uneven application of pesticide	6	Blockage due to debris	4	Periodic cleaning schedule	5	120	Improve filtration system to prevent blockage
		Ineffective pest control	7	Nozzle malfunction	3	Sensor-based monitoring system	6	126	Install backup nozzle system to ensure continuous flow
User-friendly Application	Software glitch	Loss of control over App/IOT	8	Software bugs	6	Regular software updates	5	240	Implement thorough software testing before deployment
		Inaccurate data transmission	7	Connectivity issues	4	Error detection algorithms	6	168	Enhance error detection algorithms for data accuracy

Pesticide Sprinkling: Risks of clogging and nozzle malfunction may cause uneven application (Table 2). Regular cleaning and backup nozzles mitigate issues, while filtration and monitoring upgrades reduce risks.

User-friendly Application: Software glitches and data transmission errors risk control loss and inaccurate data. Regular updates and error detection help, but thorough testing and enhanced detection are crucial.

5.2. House of Quality

The House of Quality (HOQ) method streamlines Agrisense pesticide sprinkler design by aligning customer requirements with engineering features, prioritizing precise pesticide application and reliability (Figure 8). This ensures optimization for user expectations and operational efficiency.

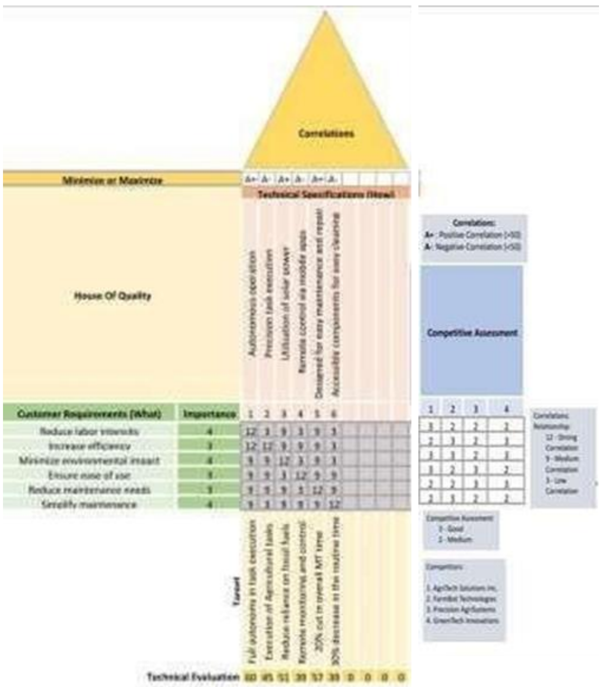

Figure 8 **House of Quality (HOQ)**

5.3. Patent Search

- The patented **Agricultural spraying machine (CN103444687A)** employs a truss structure to reduce weight and minimize crop damage, with precise control over spraying quantity.
- The patented **Backpack sprayer-duster (CN203424200U)** features a simplified tuning mechanism for connecting to the blower, enhancing assembly efficiency and reducing size.
- The patented **Ultra-wide insecticide sprayer frame (CN203505394U)** utilizes a balanced design with shock absorbers to maintain stability and improve efficiency during operation, particularly in uneven terrain.

In contrast, our project takes a different approach, leveraging alternative structural configurations and control mechanisms to enhance agricultural spraying efficiency. This innovative design offers distinct advantages and greater adaptability in various agricultural settings. (Refer Figures 9 to 12).

6. The Final Prototype

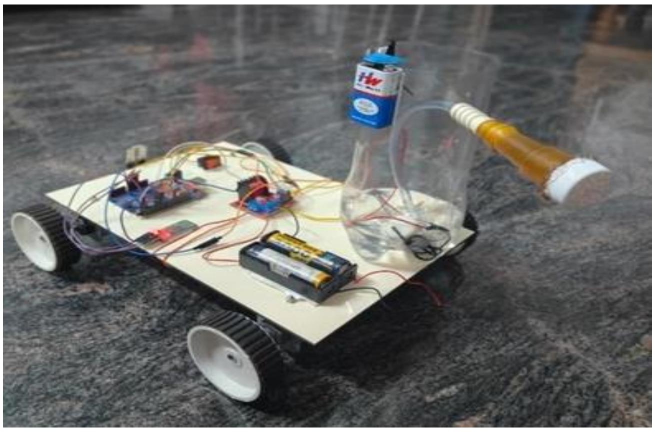

Figure 9 Prototype

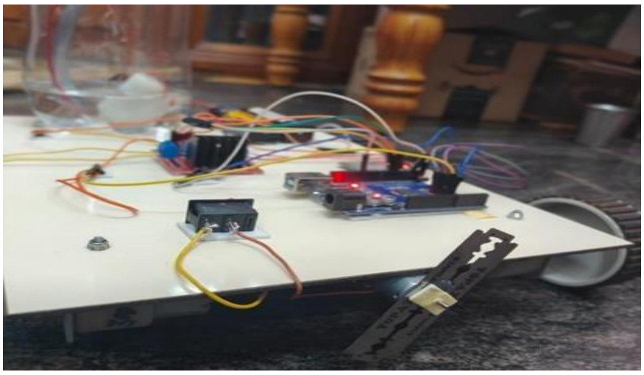

Figure 10 Grass Cutter

Figure 11 Top View

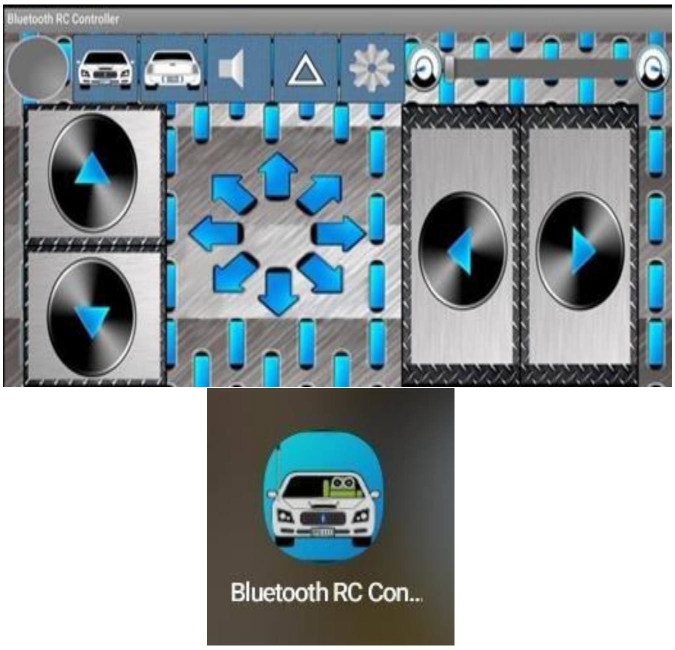

Figure 12 App Used to Move the Agri Sense Around

Conclusion

The Bluetooth-controlled Agrisense system modernizes agriculture by integrating renewable energy, precise water management, and automation to address resource scarcity and labor shortages. Its modular design ensures adaptability across terrains, while features like servo-controlled irrigation and Bluetooth-enabled control highlight its potential to merge robotics and green technology. This project promotes sustainability and offers scalable solutions for future agricultural challenges.

References

[1]. S. Umarkar and A. Karwankar , "Automated Seed Sowing Agribot using Arduino," in IEEE Conference on Communication and Signal Processing, April 2016, pp. 1379-1383.

[2]. M.D.I. Sujon, R. Nasir, M.M.I. Habib, M.I. Nomaan J. Baidya and M.R. Islam "Agribot: Arduino Controlled Autonomous Multipurpose Farm Machinery Robot for Small to medium scale cultivation," in IEEE conference Proceedings of the Third International Conference on Electronics Communication and Aerospace Technology.

[3]. H. Pota, R. Eaton, J. Katapriya and S. D. Pathirana, "Agricultural robotics: A streamlined approach to realization autonomous farming," in IEEE conferenceon industrial and information systems, 2007, pp. 85-90.