International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 10 Issue: 04 | April - 2026 SJIF Rating: 8.659 ISSN: 2582-3930

FARM-GUARD PATROL ROBOT

B.Ramyasree banavathu.ramya@gmail.com
Assistant Professor, Department of ECE
Guru Nanak Institute Of Technology, Hyd

Thota Greeshma greeshmathota300@gmail.com
Department of ECE
Guru Nanak Institute Of Technology, Hyd

Shaik Salman shaiksalman5864@gmail.com
Department of ECE
Guru Nanak Institute Of Technology, Hyd

Uduthala Tejashwini
uduthalatejaswini@gmail.com
Department of ECE
Guru Nanak Institute OfTtechnology, Hyd

ABSTRACT

Farm Guard Patrol Robot is developed to provide an efficient and reliable solution for real-time monitoring and protection of agricultural fields. The system is designed to address critical challenges such as crop damage caused by animal intrusion and unauthorized human activities, particularly in scenarios where continuous manual surveillance is impractical and labor-intensive. The proposed model integrates an ESP8266 microcontroller with PIR and LDR sensors to enable accurate motion and ambient light detection, ensuring adaptive operation under varying environmental conditions, including both day and night. Autonomous navigation and patrolling are achieved using motor drivers and a servo-based directional control mechanism, allowing the robot to move efficiently across the field. Upon detection of any intrusion, the system activates an audible buzzer alert and transmits notifications through wireless communication for immediate attention. A delay mechanism is incorporated to minimize false triggering and improve detection reliability. Experimental observations indicate that the system effectively identifies intrusions, responds promptly, reduces human intervention, and significantly minimizes potential crop damage. The solution is energy-efficient, cost-effective, and easy to deploy, making it highly suitable for small- and medium-scale farmers. Overall, the system contributes to the advancement of smart agriculture by providing an automated, practical, and scalable approach to field security and monitoring.

INTRODUCTION

Ensuring the safety and security of agricultural fields has become a significant concern due to increasing instances of crop damage caused by animals and unauthorized human intrusion, which directly impact agricultural productivity and result in economic losses for farmers. Traditional protection methods such as physical fencing, scare devices, and manual monitoring are widely used; however, these approaches are often ineffective for continuous surveillance, labor-intensive, and unable to provide real-time response, especially in large-scale or remote farming areas. Moreover, existing modern solutions based on camera surveillance, Internet of Things (IoT), and artificial intelligence offer improved accuracy but are generally expensive, complex, and dependent on reliable internet connectivity, making them less accessible to small- and medium-scale farmers. These challenges highlight the need for a practical, affordable, and automated system that can ensure continuous monitoring and timely detection of potential threats.

In recent years, advancements in embedded systems and robotics have enabled the development of autonomous ground-based monitoring systems capable of operating with minimal human intervention. Such systems combine sensing technologies, control mechanisms, and communication modules to perform real-time detection and response. The Farm Guard Patrol Robot is developed based on this concept, aiming to provide an efficient and low-cost solution for agricultural field security. The system integrates motion detection using a Passive Infrared (PIR) sensor and environmental awareness using a Light Dependent Resistor (LDR), allowing adaptive operation under varying lighting conditions. An ESP8266 microcontroller is utilized as the core processing unit to handle sensor inputs, control movement through motor drivers, and coordinate the overall system operation. The inclusion of a servo-based mechanism enables directional control, ensuring effective coverage of the monitored area.

The robot is designed to patrol the field autonomously and respond to detected intrusions by activating an alert system and transmitting notifications through wireless communication, thereby enabling timely action. The overall system emphasizes energy efficiency, reduced operational complexity, and ease of deployment, making it suitable for practical agricultural applications. By minimizing human effort and enhancing the reliability of field monitoring, the proposed system contributes to improved crop protection and supports the transition toward smart and sustainable farming practices.

I EXISTING SYSTEM

Existing agricultural field monitoring systems primarily rely on traditional methods and advanced technological solutions, each with its own limitations. Conventional approaches such as fencing, manual surveillance, and scare devices are widely used but lack real-time detection capabilities and require continuous human effort. These methods are often ineffective in preventing sudden intrusions, especially during night-time or in large agricultural areas.

Modern systems incorporate technologies such as Internet of Things (IoT), camera-based surveillance, and artificial intelligence for improved monitoring and detection. While these systems provide higher accuracy and remote accessibility, they involve significant implementation costs and require stable internet connectivity for proper functioning. Camera-based solutions may also experience reduced performance in low-light conditions and adverse weather environments. Additionally, many existing robotic systems focus on specific applications like pest detection or aerial monitoring and may not offer a complete, ground-based autonomous solution for field security. These challenges highlight the need for a more practical, cost-effective, and self-sufficient monitoring system.

II METHODOLOGY

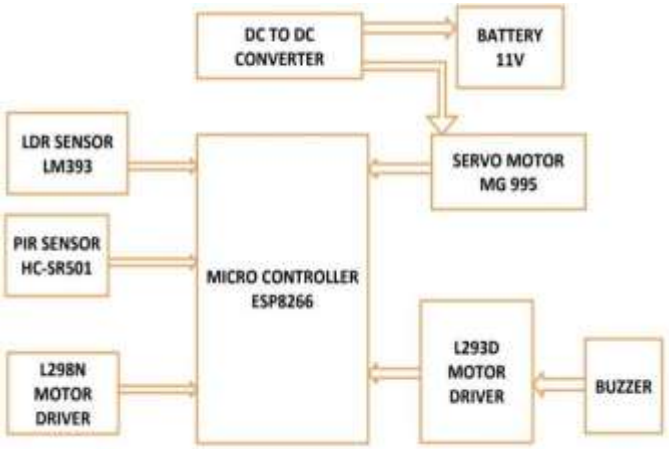
An autonomous Farm Guard Patrol Robot is designed using a microcontroller-based architecture that integrates sensing, control, actuation, and communication modules for effective agricultural field monitoring. The system is powered by an 11V battery, and a DC-to-DC converter is utilized to regulate and supply appropriate voltage levels to all components, ensuring stable and reliable operation. The ESP8266 microcontroller functions as the central control unit, interfacing with all input and output devices. A Passive Infrared (PIR) sensor is connected to the microcontroller to detect motion caused by humans or animals. When motion is detected, the sensor generates a digital signal that is processed by the controller to initiate appropriate actions. In addition, a Light Dependent Resistor (LDR) module is interfaced to monitor ambient light intensity, enabling the system to adapt its behavior based on day and night conditions.

Motor drivers such as L293D or L298N are connected between the microcontroller and DC motors to control the robot's movement. These drivers receive control signals from the ESP8266 and regulate motor direction and speed, allowing the robot to move forward, backward, and turn during patrolling. A servo motor (MG995) is also interfaced with the controller to provide directional movement, improving the coverage area and enabling rotational adjustments.

A buzzer is connected as an alert mechanism and is activated immediately when an intrusion is detected. The ESP8266 utilizes its built-in Wi-Fi capability to transmit notifications, enabling real-time monitoring and remote alerts. Proper control logic, including delay mechanisms, is implemented within the microcontroller to minimize false triggering and ensure stable system performance.

During operation, the robot continuously patrols the agricultural field while monitoring sensor inputs. Upon detecting any abnormal activity, it generates alerts and adjusts its movement accordingly. The integration of these components ensures efficient surveillance, reduced human effort, and reliable performance, making the system suitable for practical deployment in agricultural environments.

Fig.1 - Block Diagram



Applications:

- **Agricultural Field Monitoring**: Used to continuously patrol farmlands and detect animal intrusion, helping to prevent crop damage.
- **Large Farm Surveillance:** Suitable for monitoring large agricultural areas where manual supervision is difficult and time-consuming.
- **Plantations and Orchards:** Helps in protecting fruit gardens and plantation crops from animals and unauthorized entry.

- **Rural and Remote Area Security**: Can be deployed in areas with limited access to advanced security systems, providing a simple and effective solution.
- **Industrial and Construction Site Security:** Useful for safeguarding equipment and materials in restricted zones.

III HARDWARE DETAILS:

ESP8266 Microcontroller

The ESP8266 serves as the central processing unit of the system, responsible for controlling all operations. It receives input signals from sensors such as the PIR and LDR modules and processes them to make decisions. Based on the programmed logic, it controls the motor drivers, servo motor, and buzzer. Additionally, it enables wireless communication for sending alerts, making the system intelligent and connected.

PIR Sensor (HC-SR501)

The Passive Infrared (PIR) sensor is used for motion detection. It detects infrared radiation emitted by humans or animals and generates a digital output signal when motion is identified. This signal is sent to the ESP8266, which triggers further actions such as alert generation and robot movement.

LDR Sensor (LM393 Module)

The Light Dependent Resistor (LDR) is used to measure ambient light intensity. It helps the system differentiate between day and night conditions. Based on the light levels, the microcontroller adjusts the system behavior, enabling efficient operation under varying environmental conditions.

L298N Motor Driver

The L298N motor driver is used to control the DC motors that drive the robot. It receives control signals from the ESP8266 and regulates the direction and speed of the motors. This allows the robot to move forward, backward, and turn while patrolling the field.

L293D Motor Driver

The L293D motor driver acts as an interface between the microcontroller and output devices. In this system, it is used to assist in controlling additional components such as actuators or alert mechanisms. It ensures proper current supply and protects the microcontroller from high-power loads.

Servo Motor (MG995)

The servo motor provides precise angular movement and is used for directional control. It allows the system to rotate specific components, such as sensors or reflective elements, improving the monitoring coverage of the robot. The servo is controlled by PWM signals from the ESP8266.

Buzzer

The buzzer functions as an alert system to indicate intrusion detection. When triggered by the microcontroller, it produces an audible sound to warn nearby individuals and deter animals or intruders from entering the field.

DC-to-DC Converter

The DC-to-DC converter regulates the voltage supplied from the battery to different components. Since various components require different voltage levels, the converter ensures stable and safe operation by providing appropriate voltage outputs.

Battery (11V)

The battery acts as the primary power source for the system. It supplies electrical energy to all components, enabling the robot to operate autonomously in agricultural fields without dependence on external power sources.

IV SOFTWARE DETAILS

Robot programming is the development of a control scheme for how a machine interacts with its environment and achieves its goals. A Robot Operating System is a middleware, a collection of software frameworks for robot software development. A robot control software is a program for controlling robots.
A robot control software is a program for controlling robots. Popular programming languages in robotics include C / C++, Python, JAVA, C# /.NET, MATLAB, Embedded C, etc. Robot programming is fast becoming a big deal as more companies show interest and invest in robots.

Arduino IDE

The Arduino Integrated Development Environment – or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions, and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them. Programs written using Arduino Software (IDE) are called sketches.

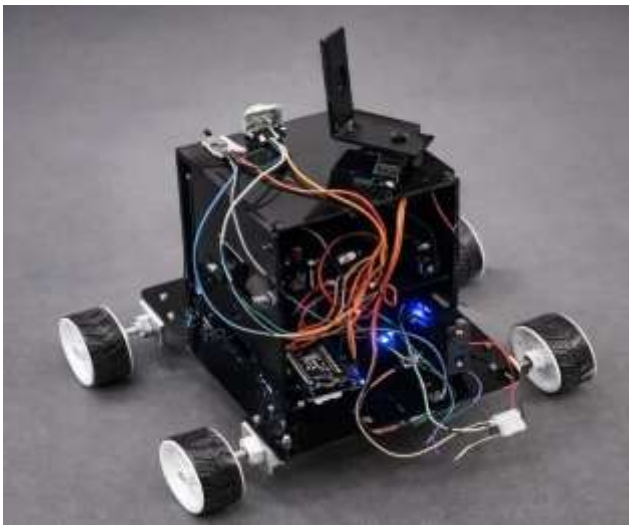


FIG 2. PROTOTYPE OF FARM GUARD PATROL ROBOT.

CONCLUSION

An autonomous Farm Guard Patrol Robot has been designed and implemented to provide an effective solution for agricultural field monitoring and security. The system integrates key components such as motion and light sensors, motor drivers, a servo mechanism, and a microcontroller to achieve continuous surveillance with minimal human intervention. By enabling real-time detection of animal and human intrusion, along with immediate alert generation, the system enhances the overall protection of crops and reduces potential losses. The incorporation of wireless communication further improves monitoring efficiency by allowing remote awareness. The developed model demonstrates reliable performance under varying environmental conditions while maintaining low cost and energy consumption, making it suitable for practical deployment in small- and medium-scale farming environments.

The project highlights the potential of automation in transforming traditional agricultural practices into more efficient and secure systems. The modular design and simple architecture ensure ease of implementation and scalability for future improvements. Although the current system provides satisfactory performance, it can be further enhanced by integrating advanced technologies such as image processing, artificial intelligence, and GPS-based tracking to improve accuracy and functionality. Overall, the system contributes to the advancement of smart agriculture by offering a practical, economical, and adaptable solution for field security and monitoring.

ACKNOWLEDGEMENT

This project stands as a testament to the unwavering support and invaluable contributions of numerous individuals, without whom its fruition would not have been possible. We extend our heartfelt gratitude to the mentors, educators, and technical experts whose guidance and assistance have been instrumental in transforming our vision into reality.

First and foremost, we express our profound appreciation to **Mrs. B. Ramyasree**, Assistant Professor Department of Electronics and Communication Engineering, whose unwavering guidance has been pivotal throughout the course of this dissertation.

We are immensely grateful to **Mrs.G. Praveena Reddy**, Project Coordinator, and our entire faculty for their ceaseless encouragement and unwavering support, which have served as the driving force behind the completion of this project.

Our sincere thanks extend to **Dr. Anitha Swamidas**, Head of the Department of Electronics and Communication Engineering, whose invaluable suggestions have greatly contributed to the success of this endeavor, serving as a constant source of inspiration.

We also extend our gratitude to **Dr. B. Venkata Ramana Reddy**, Principal, for his continuous support and valuable guidance throughout this journey.

We acknowledge with deep appreciation the support and encouragement received from **Dr. H.S. Saini**, Managing Director of Guru Nanak Group of Institutions, whose unwavering belief in our abilities has been a source of motivation.

Additionally, we express our gratitude to our parents, friends, and all those who have provided encouragement and support along the way. . Their belief in us has been a driving force behind our efforts.

Lastly, we extend our thanks to all other staff members, both teaching and non-teaching, for their timely assistance and contributions, which have facilitated the progress of this project.

REFERENCES

1. Al Reshan et al., "AI-Powered Smart Agribot for Detecting Locusts in Farmlands," Scientific Reports, vol. 15, pp. 1–12, 2025.

2. T. Temesgen et al., "Geofenced Unmanned Aerial Robotic Defender for Deer Detection and Deterrence (GUARD)," Robotics and Autonomous Systems, vol. 180, pp. 104–115, 2025.

3. A. Adam et al., "Probabilistic Modelling and Safety Assurance of an Agricultural Robot," Reliability Engineering & System Safety, vol. 250, pp. 109–120, 2025.

4. S. Mukhopadhyay et al., "IoT-Based Real-Time Object Detection System for Crop Protection and Agriculture Field Security," Journal of Real-Time Image Processing, vol. 21, no. 4, pp. 567–580, 2024.

5. Y. Miao et al., "Fog-Based Smart Agriculture System for Animal Intrusion Detection," IEEE Access, vol. 11, pp. 45000–45012, 2023.