International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 13 Issue: 06 | Jun 2026 www.irjet.net p-ISSN: 2395-0072

Animal Intrusion Alert System for Smart Farming

Anita A. J [1], Nisarga P. P [2], Vijayalaxmi H [3], Samrudhi V. K [4], R Sai Meghana [5]

[1 2 3 4] *B.Tech 2nd Year, Dept. of Electronics and Communication Engineering, Visvesvaraya Technological University, Belagavi, Karnataka, India.*

[5] *Junior Research Fellow, Dept. of Electronics and Communication Engineering, Visvesvaraya Technological University, Belagavi, Karnataka, India.*

Abstract - *Agriculture plays a vital role in ensuring food security and supporting the economy. One of the major challenges faced by farmers is crop damage caused by wild and domestic animals entering agricultural fields. Traditional methods such as fencing, scarecrows, and manual monitoring often require significant effort and are not always effective. To address this issue, the Animal Intrusion Alert System for Smart Farming has been developed as an automated solution for detecting animal movement and providing immediate alerts to farmers. The proposed system uses a PIR (Passive Infrared) sensor to detect motion within the monitored area. The detected signal is processed by the STM32 Blue Pill microcontroller, which acts as the central controller of the system. Whenever movement is detected, the system activates an LED indicator and a buzzer to generate visual and audible alerts. An ESP32 module is also incorporated to support future wireless communication and IoT-based monitoring applications. The system continuously monitors the agricultural environment and operates automatically without requiring constant human supervision. The proposed solution is cost-effective, reliable, and easy to implement. Experimental results demonstrate that the system successfully detects motion and generates timely alerts, helping farmers reduce crop losses and improve farm security. The project highlights the application of embedded systems and sensor technologies in modern smart farming and provides a foundation for future enhancements such as mobile notifications, cloud monitoring, and intelligent animal recognition.*

Key Words: Animal Intrusion Detection, Embedded Systems, ESP32, PIR Sensor, Smart Farming

1. INTRODUCTION

Agriculture is one of the most important sectors supporting the economy and food production worldwide. Farmers invest significant effort and resources in cultivating crops to meet the growing demand for food. However, agricultural fields are frequently threatened by the intrusion of wild and domestic animals such as boars, monkeys, deer, elephants, and stray cattle. These animals often enter farms in search of food and water, causing severe damage to crops and resulting in considerable financial losses for farmers. Traditional methods used to protect crops include fencing, scarecrows, manual patrolling, and guard animals. While these methods provide some level of protection, they are often ineffective, labor-intensive, and costly. Monitoring large agricultural areas continuously is difficult, especially during nighttime.

Therefore, there is a growing need for an automated and intelligent system capable of detecting animal intrusion and alerting farmers immediately. Recent developments in embedded systems, sensors, and wireless communication technologies have enabled the implementation of smart farming solutions. These technologies help farmers automate monitoring processes and improve farm security. The Animal Intrusion Alert System for Smart Farming is designed to detect animal movement near agricultural fields and generate alerts using embedded hardware components.

Animal intrusion into agricultural fields remains a major concern in rural farming communities. Farmers often suffer substantial crop losses due to the inability to detect intrusions at the right time. Existing protection methods require constant human supervision and may fail under adverse weather conditions or during nighttime operations. The main problem addressed in this project is the development of an automated system capable of detecting animal movement and generating immediate alerts. The system should operate continuously with minimal human intervention while providing reliable and timely notifications to prevent crop damage.

The main objectives of the Animal Intrusion Alert System for Smart Farming are:

1. To detect animal movement near agricultural fields using a PIR sensor.
2. To monitor farm boundaries continuously and automatically.
3. To process sensor signals using the STM32 Blue Pill microcontroller.
4. To generate visual alerts using LEDs when intrusion is detected.
5. To generate audible alerts using a buzzer for immediate farmer notification.
6. To enable future wireless communication through ESP32 integration.

The scope of this project includes the design and development of an embedded system capable of monitoring agricultural areas for animal intrusion. The system utilizes a PIR motion sensor to detect movement and an STM32 Blue

Pill microcontroller to process intrusion events. Whenever movement is detected, a buzzer and LED alert mechanism is activated to notify nearby farmers. The project focuses on developing a prototype suitable for agricultural applications. The ESP32 module provides opportunities for future expansion through IoT integration, cloud connectivity, and mobile notifications. The proposed system is suitable for farms, orchards, plantations, and crop fields where animal intrusion is a common problem.

2. LITERATURE SURVEY

Yang et al. (2021) presented a comprehensive survey on smart agriculture technologies, discussing the integration of IoT, wireless sensor networks, cloud computing, artificial intelligence, and embedded systems in modern farming. The authors highlighted that sensor-based monitoring and automated alert systems significantly improve agricultural productivity and reduce manual intervention. They concluded that real-time monitoring using embedded devices forms the foundation of smart farming applications, including animal intrusion detection and crop protection [1].

Abraham et al. (2023) conducted a detailed review of wild animal intrusion detection systems used in agriculture. The study analyzed various sensing technologies such as PIR sensors, infrared sensors, cameras, GSM modules, and IoT-based monitoring systems. The authors observed that embedded sensor networks combined with wireless communication provide reliable and cost-effective solutions for protecting crops from wild animal attacks. The review also suggested integrating intelligent image processing techniques to improve detection accuracy [2].

Miao et al. (2023) proposed a fog-based smart agriculture system capable of detecting animal intrusion before animals entered agricultural fields. The system combined PIR sensors, cameras, LoRa communication, and edge computing to detect, identify, and predict animal movement. Experimental results demonstrated low-latency detection and timely alert generation while reducing cloud communication overhead, making the proposed architecture suitable for rural farming environments [3].

Ashok Kumar et al. (2021) reviewed various animal intrusion detection and repellent systems developed for agricultural applications. The authors compared GSM-based alert systems, wireless sensor networks, image processing techniques, and machine learning methods used for wildlife monitoring. The study concluded that combining embedded microcontrollers with motion sensors and communication modules provides an effective and economical solution for minimizing crop damage caused by animal intrusion [4].

Ajayi and Olaifa (2023) reviewed existing farmland intrusion detection systems, ranging from traditional fencing methods to modern IoT-based monitoring systems. Their analysis showed that wireless sensor networks, embedded controllers, and smart surveillance technologies offer better reliability, reduced human effort, and improved farm security compared to conventional protection methods [5].

Liu et al. (2021) discussed the evolution of Agriculture 4.0 and emphasized the importance of IoT, sensor networks, automation, and intelligent monitoring in modern farming. The study explained that embedded systems enable real-time monitoring of environmental parameters and security events, providing the technological foundation for smart agricultural applications such as automated animal intrusion detection [6].

Khanna and Kaur (2019) investigated the role of the Internet of Things (IoT) in precision agriculture. The authors demonstrated that IoT devices equipped with sensors and wireless communication enable continuous monitoring of agricultural environments while improving resource utilization and crop protection. The study concluded that sensor-based automation can significantly enhance agricultural productivity and reduce labor requirements [7].

Ray (2017) presented a comprehensive review of IoT technologies applied to smart agriculture. The paper discussed sensor networks, embedded controllers, cloud computing, and wireless communication for agricultural automation. The study highlighted that low-cost embedded systems provide practical solutions for real-time field monitoring, making them suitable for applications such as animal intrusion detection and farm security [8].

Elijah et al. (2018) reviewed the application of IoT and data analytics in agriculture. The authors examined various sensing technologies, wireless communication methods, and cloud platforms used for intelligent farming. Their work concluded that integrating embedded systems with IoT significantly improves monitoring efficiency and enables rapid response to security threats and environmental changes in agricultural fields [9].

Rajesh et al. (2024) developed a smart wildlife intrusion detection and diversion system that combines infrared sensors, cameras, machine learning algorithms, LED lights, and sound-based repellent mechanisms. The proposed system accurately identified wild animals and activated visual and audible deterrents to protect crops. Experimental evaluation demonstrated improved detection accuracy and reduced crop damage, making the system highly suitable for modern smart farming applications [10].

3. METHODOLOGY

The Animal Intrusion Alert System for Smart Farming is designed to provide an automated solution for protecting agricultural fields from animal attacks. The system continuously monitors the farm area using a PIR (Passive

Infrared) sensor and detects motion whenever an animal enters the protected region. Upon detection, the system generates immediate alerts through an LED indicator and buzzer, allowing farmers to take preventive action before significant crop damage occurs.

The proposed system consists of five major components: STM32 Blue Pill microcontroller, PIR sensor, ESP32 module, LED, and buzzer. The PIR sensor acts as the sensing unit, while the STM32 Blue Pill serves as the central processing unit responsible for analyzing sensor signals and controlling output devices. The LED provides visual indication, whereas the buzzer generates an audible warning signal. The ESP32

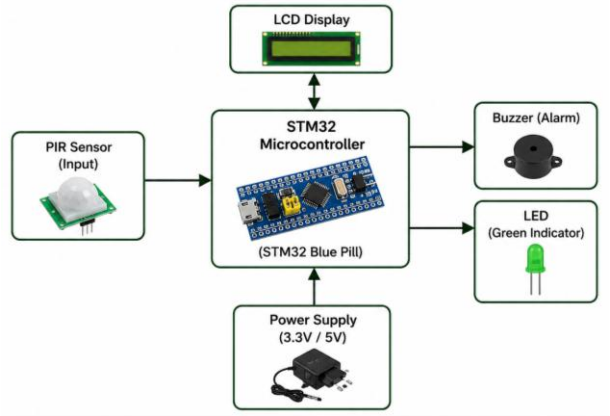

Fig -1: Block Diagram of Animal Intrusion Alert System

module can be used for future IoT-based communication and remote monitoring applications. The system operates continuously and automatically. When no movement is detected, the PIR sensor remains inactive, and the system stays in monitoring mode. Once an animal enters the detection zone, the PIR sensor detects changes in infrared radiation and sends a signal to the STM32 Blue Pill microcontroller. The controller processes the signal and activates the LED and buzzer.

The block diagram in Fig.1 illustrates the overall operation of the Animal Intrusion Alert System. The PIR sensor continuously monitors the farm environment and detects animal movement. The detected signal is transmitted to the STM32 Blue Pill microcontroller for processing. The STM32 Blue Pill acts as the brain of the system and determines whether an intrusion event has occurred. If motion is confirmed, the controller immediately activates the LED and buzzer to alert the farmer. The ESP32 module can additionally transmit alert information through wireless communication technologies such as Wi-Fi and cloud platforms. This architecture ensures real-time detection and rapid alert generation, making it suitable for agricultural field protection.

4. IMPLEMENTATION

The development of the Animal Intrusion Alert System for Smart Farming was carried out through a systematic approach involving hardware design, software development, integration, and testing. The objective was to create a reliable and cost-effective system capable of detecting animal movement and generating immediate alerts for farmers.

The first stage involved selecting suitable hardware components including the STM32 Blue Pill microcontroller, PIR sensor, ESP32 module, LED, and buzzer. These components were chosen because of their low cost, reliability, and ease of integration. The STM32 Blue Pill was selected as the main controller due to its processing capability and multiple GPIO interfaces.

After hardware selection, the circuit connections were designed. The PIR sensor was connected to the STM32 Blue Pill to provide motion detection signals. The LED and buzzer were connected as output devices to generate visual and audible alerts. The ESP32 module was included to support future wireless communication and IoT-based monitoring.

The software development phase involved programming the STM32 Blue Pill using Embedded C. The program continuously monitors the PIR sensor and checks for motion detection events. Whenever movement is detected, the controller activates the LED and buzzer. The system then returns to monitoring mode once the movement disappears.

After integrating the hardware and software components, testing was performed under different conditions. The system was evaluated for motion detection accuracy, response time, and alert generation performance. Experimental results confirmed that the system successfully detects animal movement and generates alerts effectively.

4.1 System Working

The working of the Animal Intrusion Alert System begins when power is supplied to the circuit. The PIR sensor continuously monitors the protected agricultural area and detects changes in infrared radiation caused by animal movement. When an animal enters the sensing range, the PIR sensor generates a signal that is transmitted to the STM32 Blue Pill microcontroller. The controller processes the signal and determines whether motion has occurred. If motion is detected, the controller immediately activates the LED and buzzer. The LED provides a visual warning, while the buzzer generates an audible alert to inform farmers about the intrusion event. The system continues monitoring until the animal leaves the detection area. Once no motion is detected, the controller switches off the LED and buzzer and returns to normal monitoring mode. The ESP32 module can

additionally be used for future wireless communication and IoT-based monitoring applications.

4.2 Software and Hardware Implementation

The implementation of the Animal Intrusion Alert System for Smart Farming consists of both hardware and software components that work together to provide real-time animal intrusion detection and alert generation. The hardware is centered around the STM32 Blue Pill (STM32F103C8T6) microcontroller, which acts as the main processing unit. A PIR (Passive Infrared) sensor is used as the input device to detect animal movement by sensing changes in infrared radiation. Whenever motion is detected, the PIR sensor sends a digital signal to the STM32 microcontroller for processing.

Based on the received signal, the microcontroller activates the output devices, namely the LED and the buzzer. The LED provides a visual indication of intrusion, while the buzzer generates an audible alarm to alert nearby farmers. An ESP32 module is also interfaced with the STM32 Blue Pill to

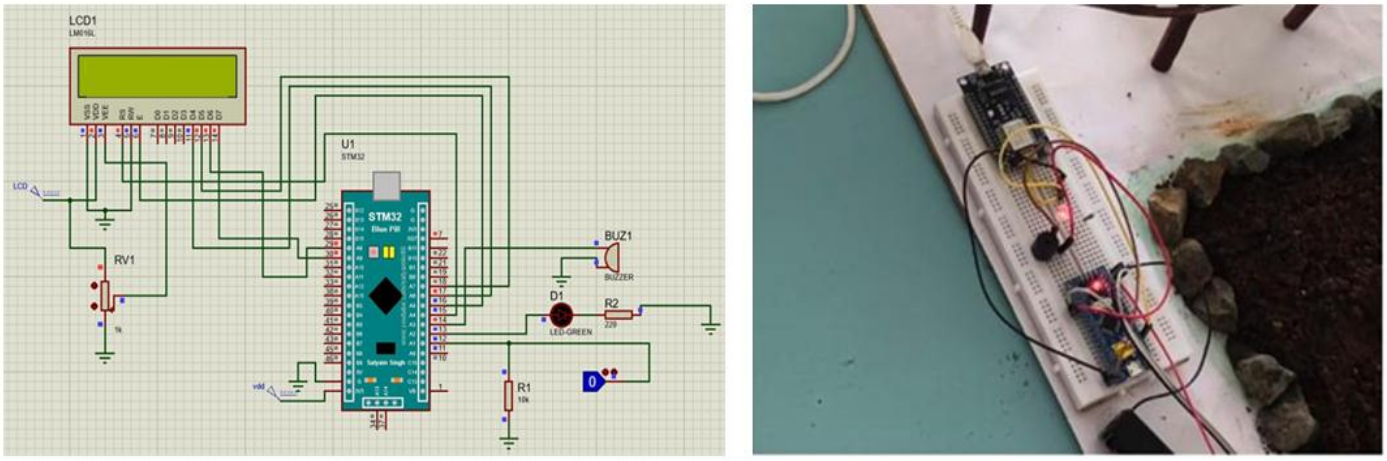

Fig -2: Implementation of Animal Intrusion Alert System for Smart Farming: (a) Software and (b) Hardware

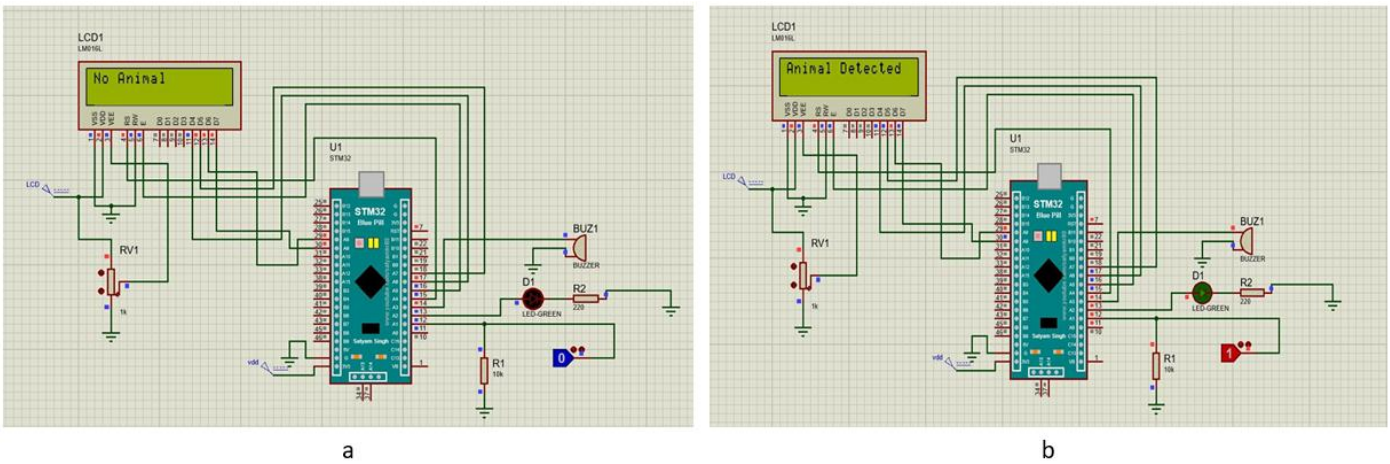

Fig -3: Proteus Result of Animal Intrusion Alert System for Smart Farming: (a) No Animal and (b) Animal Detected

facilitate future IoT-based applications such as wireless monitoring, cloud connectivity, and mobile notifications. The entire system is powered using a regulated 3.3 V/5 V power supply to ensure reliable operation of all connected components.

The software was developed using Embedded C and programmed into the STM32 Blue Pill microcontroller. During system initialization, all GPIO pins are configured, with the PIR sensor set as the input and the LED, buzzer, and ESP32 communication pins configured as outputs. The program continuously monitors the PIR sensor in an infinite loop. When the sensor detects motion, the controller immediately switches ON the LED and buzzer to generate alerts. Once the motion ceases, the controller turns OFF the output devices and returns to monitoring mode. The software is designed to provide quick response, reliable performance, and low power consumption while allowing future expansion through ESP32-based wireless communication.

Fig.2(a) and Fig.2(b) illustrates the overall software and hardware implementation of the Animal Intrusion Alert System respectively. The PIR sensor continuously monitors the protected area and sends motion detection signals to the STM32 Blue Pill microcontroller. The microcontroller processes the input signal and controls the LED and buzzer to generate visual and audible alerts. The ESP32 module is connected for future IoT-based communication, enabling remote monitoring and notification capabilities, while the regulated power supply provides stable operating voltage to all system components.

5. RESULTS

The Animal Intrusion Alert System for Smart Farming was successfully designed, implemented, and tested. The developed system effectively detected motion using the PIR sensor and generated alerts whenever movement was identified within the monitored area. The STM32 Blue Pill microcontroller successfully processed the sensor signals and controlled the output devices. The Hardware Result of Animal Intrusion Alert System for Smart Farming is shown in Fig.4.

Fig -4: Hardware Result of Animal Intrusion Alert System for Smart Farming

During testing, the system operated continuously and monitored the surroundings without requiring human intervention. Whenever the PIR sensor detected motion, the LED indicator and buzzer were activated immediately, providing visual and audible alerts. This allowed rapid identification of intrusion events and demonstrated the effectiveness of the proposed solution. Proteus Result of Animal Intrusion Alert System for Smart Farming is shown in Fig. 3(a) No Animal and Fig. 3(b) Animal Detected.

The Proteus simulation results verified the proper functioning of the system before hardware implementation. The simulation confirmed that the controller correctly responded to sensor inputs and activated the output devices as expected. The hardware prototype also produced similar results, indicating consistency between simulation and practical implementation. The PIR sensor demonstrated reliable motion detection within its specified operating range. The STM32 Blue Pill processed sensor signals efficiently and activated alerts with minimal delay. The LED and buzzer responded immediately whenever motion was detected, ensuring timely notification. The system maintained stable performance during continuous operation and consumed relatively low power, making it suitable for agricultural applications. Table.1 illustrates the observation table of animal intrusion alert system for smart farming.

Table -1: Project Observation Table

Test Condition	PIR Detection	LED Status	Buzzer Status
No Motion	Not Detected	OFF	OFF
Motion Detected	Detected	ON	ON
Motion Removed	Not Detected	OFF	OFF

6. CONCLUSION

The Animal Intrusion Alert System for Smart Farming was successfully developed to address the problem of crop damage caused by animal intrusion. The system utilizes a PIR sensor to detect animal movement and an STM32 Blue Pill microcontroller to process the detected signals. Whenever motion is identified, the system immediately activates a buzzer and LED, providing both audible and visual alerts to farmers. The project demonstrated that embedded systems can be effectively used in agricultural applications to improve security and reduce crop losses.

The developed system operated reliably during testing and successfully detected movement within the monitored area. The use of low-cost components such as the STM32 Blue Pill, PIR sensor, LED, buzzer, and ESP32 module makes the system affordable and suitable for small and medium-scale farmers.

The Proteus simulation and hardware implementation confirmed the proper functioning of the system. The results showed that the system can continuously monitor the farm environment, detect animal intrusion in real time, and generate immediate alerts. The ESP32 module also provides opportunities for future expansion through wireless communication and IoT-based monitoring. Overall, the project demonstrates a practical, economical, and efficient solution for protecting agricultural fields from animal intrusion and supporting the adoption of smart farming technologies.

REFERENCES

[1] X. Yang et al., "A Survey on Smart Agriculture: Development Modes, Technologies, and Security and Privacy Challenges," IEEE/CAA Journal of Automatica Sinica, vol. 8, no. 2, pp. 273–302, 2021.

[2] A. Abraham et al., "Literature Review on Detection Systems for Wild Animal Intrusions," Journal of Soft Computing Paradigm, vol. 5, no. 1, pp. 50–59, 2023.

[3] J. Miao et al., "A Fog-based Smart Agriculture System to Detect Animal Intrusion," arXiv, 2023.

[4] L. Ashok Kumar et al., "A Literature Research Review on Animal Intrusion Detection and Repellent Systems," Proceedings of ICCAP 2021, EAI, 2021.

[5] O. Ajayi and O. Olaifa, "A Review of Existing Farmland Intrusion Detection Systems," International Journal of Computer Applications, 2023.

[6] Y. Liu et al., "From Industry 4.0 to Agriculture 4.0: Current Status, Enabling Technologies, and Research Challenges," IEEE Transactions on Industrial Informatics, vol. 17, no. 6, pp. 4322–4334, 2021.

[7] A. Khanna and S. Kaur, "Evolution of Internet of Things (IoT) and its Significant Impact in the Field of Precision Agriculture," Computers and Electronics in Agriculture, vol. 157, pp. 218–231, 2019.

[8] P. P. Ray, "Internet of Things for Smart Agriculture: Technologies, Practices and Future Direction," Journal of Ambient Intelligence and Smart Environments, vol. 9, no. 4, pp. 395–420, 2017.

[9] O. Elijah et al., "An Overview of Internet of Things (IoT) and Data Analytics in Agriculture: Benefits and Challenges," IEEE Internet of Things Journal, vol. 5, no. 5, pp. 3758–3773, 2018.

[10] K. Rajesh et al., "Design and Development of Smart System for the Identification and Diversion of Wild Animal in Agricultural Field," Proceedings of the International Conference on Advances in Computing, Communication and Systems (ICACCS), IEEE, 2024.