

Research Paper

# REAL-TIME ANIMAL INTRUSION DETECTION AND ALERT SYSTEM FOR AGRICULTURAL FIELDS USING SENSORS AND CONTROLLER

KALERU LAXMI PRASANNA, HARSHITHA U NAIR, KOLUKURI KRISHNA, ADLA AKHIL

BURRI NARENDAR REDDY, Assistant Professor

PALLAVI ENGINEERING COLLEGE, Hyderabad, Telangana 501505.

**Abstract:** Human–animal conflict in agricultural regions has become a critical issue, leading to significant crop damage and economic loss for farmers. This paper presents the design and implementation of an IoT-based animal intrusion detection and alert system aimed at enhancing farm security. The proposed system utilizes a NodeMCU microcontroller integrated with infrared (IR) sensors, a GSM communication module, an LCD display, and a buzzer to detect and respond to animal movements in real time.

Multiple IR sensors are strategically deployed around the farm boundary to continuously monitor intrusion activity. When an animal crosses the sensing region, the system detects the interruption and triggers immediate responses. A buzzer is activated to deter the animal, while the GSM module sends an instant SMS alert to the farmer, enabling quick intervention. Additionally, the NodeMCU hosts a web-based interface through its built-in Wi-Fi capability, allowing remote monitoring of system status and sensor activity.

The proposed system is cost-effective, energy-efficient, and easy to deploy, making it highly suitable for rural and remote agricultural environments. Unlike traditional methods such as manual guarding or electric fencing, the system provides automated monitoring, real-time alerts, and remote accessibility. The integration of IoT technology with communication modules enhances reliability and scalability. This work demonstrates a practical approach toward smart agriculture by reducing crop losses and improving farm security through intelligent monitoring systems.

**Keywords:** Internet of Things (IoT), Animal Intrusion Detection, Smart Agriculture, NodeMCU (ESP8266), GSM Communication, IR Sensors, Farm Security System.

## I. INTRODUCTION

Agriculture is one of the most important sectors contributing to the economic growth of many countries, particularly in rural regions where it serves as the primary source of livelihood. However, farmers face numerous challenges that directly affect crop productivity and income. Among these challenges, animal intrusion into agricultural fields has emerged as a serious and persistent problem. Wild animals such as boars, deer, monkeys, elephants, and stray cattle frequently enter farmlands in search of food, leading to severe crop damage, economic loss, and increased human–animal conflict.

Traditionally, farmers have relied on manual and conventional methods to protect their crops from animal attacks. These methods include physical fencing, human surveillance during night hours, scarecrows, fire torches, and electric fencing systems. While these techniques have been used for

decades, they suffer from several limitations such as inefficiency, high labor requirements, lack of real-time monitoring, and potential risks to both humans and animals. Manual guarding is physically exhausting and impractical for large agricultural areas, while electric fencing can be expensive and harmful to wildlife. Moreover, animals often adapt to scare tactics over time, reducing their effectiveness.

With the rapid advancement of technology, the Internet of Things (IoT) has opened new opportunities for smart agriculture solutions. IoT enables seamless communication between sensors, microcontrollers, and communication devices through the internet, allowing real-time monitoring, automation, and remote access. By integrating IoT with embedded systems, it becomes possible to design intelligent systems capable of detecting animal movement and providing immediate alerts to farmers.

The proposed system, titled “Animal Detection with SMS and IoT,” aims to develop an automated and efficient solution to detect animal intrusion in agricultural fields and notify farmers instantly. The system is built around a NodeMCU (ESP8266) microcontroller, which is widely used in IoT applications due to its low cost, compact size, and built-in Wi-Fi capability. Multiple Infrared (IR) sensors are strategically placed along the boundaries of the farmland to continuously monitor movement. When an animal interrupts the IR beam, the sensor detects the presence of an object and sends a signal to the microcontroller for processing.

Upon detection of intrusion, the system performs multiple actions simultaneously to ensure immediate response. A buzzer is activated to generate a loud sound, which acts as a deterrent to scare away animals from entering deeper into the field. At the same time, a GSM module is used to send an SMS alert to the farmer’s mobile phone, providing real-time notification about the intrusion. This enables the farmer to take prompt action, even if they are not physically present at the farm.

In addition to alert mechanisms, the system incorporates a web-based monitoring interface hosted by the NodeMCU. This interface allows farmers to remotely monitor the status of the sensors and the overall system through a smartphone or computer connected to the network. The integration of IoT technology enhances accessibility, enabling farmers to supervise their fields from any location.

Compared to traditional methods, the proposed system offers several advantages such as automation, real-time communication, cost-effectiveness, and ease of installation. It eliminates the need for continuous human monitoring and reduces dependency on unreliable conventional techniques. Furthermore, the system is designed to be scalable and can be enhanced by integrating advanced technologies such as camera-based detection, machine learning algorithms for animal classification, cloud storage, and renewable energy sources.

Another significant benefit of this system is its contribution to reducing human–animal conflict. Instead of harming animals through electric shocks or traps, the system focuses on early detection and non-invasive deterrence methods such as sound alerts. This promotes a safer and more sustainable coexistence between agriculture and wildlife.

Overall, the Animal Detection with SMS and IoT system represents a practical implementation of smart agriculture using embedded systems and wireless communication technologies. It provides an efficient, reliable, and affordable solution for protecting crops from animal intrusion. The adoption of such intelligent systems can significantly improve agricultural productivity, reduce financial losses, and support the transition toward modern precision farming practices.

## II. LITERATURE SURVEY

Human–animal conflict in agricultural areas has become a critical issue due to habitat loss, urban expansion, and increasing agricultural activities near forest regions. Researchers have proposed various technological solutions using IoT, sensors, image processing, and machine learning to detect animal intrusion and alert farmers in real time.

Several studies focus on sensor-based animal detection systems. In one approach, systems using PIR sensors, ultrasonic sensors, and infrared sensors are deployed around farmland boundaries to detect motion. When an animal enters the detection zone, the sensors send signals to a microcontroller, which activates alarms and sends alerts via GSM modules. These systems are simple, cost-effective, and suitable for rural environments.

Another research direction involves GSM-based alert systems integrated with embedded controllers. These systems automatically send SMS notifications to farmers when an intrusion is detected, ensuring quick response and minimizing crop damage. In addition, buzzers or sound devices are used as deterrents to scare animals away. Such systems provide real-time communication but are limited in terms of detection accuracy and range.

Researchers have also developed camera-based and image processing systems for improved detection accuracy. These systems use cameras connected to microcontrollers or embedded platforms like Raspberry Pi to capture images of intruding animals. Machine learning algorithms, such as YOLO (You Only Look Once), are used to identify and classify animals. Once detected, alerts are sent to farmers via GSM or internet-based applications. These systems provide higher accuracy but require more computational resources and power.

In recent years, IoT-based smart agriculture systems have been widely explored. These systems integrate multiple sensors, cloud platforms, and wireless communication technologies such as Wi-Fi, LoRa, and GSM. They enable continuous monitoring, real-time data analysis, and remote access through mobile or web applications. Advanced systems also include predictive models that can forecast animal movement and provide early warnings.

Some studies have proposed multi-sensor fusion systems that combine different types of sensors such as vibration sensors, gas sensors, laser sensors, and motion detectors. These systems improve detection accuracy and reduce false alarms by analyzing data from multiple sources. However, they increase system complexity and cost, making them less suitable for small-scale farmers.

Machine learning and deep learning techniques are also being used for intelligent animal detection and classification. Algorithms such as Convolutional Neural Networks (CNN), Support Vector Machines (SVM), and K-Nearest Neighbors (KNN) are applied to classify animal images and improve detection reliability. Although these methods achieve higher accuracy, they require large datasets, high processing power, and are not always feasible in low-resource rural environments.

Despite significant advancements, existing systems still face several challenges. Many solutions are either too complex, expensive, or require high computational resources. Additionally, some systems depend heavily on internet connectivity or cloud infrastructure, which may not be reliable in rural areas.

Therefore, there is a need for a simple, cost-effective, and reliable system that can provide real-time detection and alerts without requiring complex infrastructure. The proposed system addresses this gap by using NodeMCU, IR sensors, GSM communication, and a buzzer to create an efficient and affordable solution for farmers.

### III. PROPOSED METHOD

The proposed system aims to develop an IoT-based intelligent animal detection and alert mechanism to protect agricultural fields from animal intrusion. The system integrates sensor technology, wireless communication, and embedded systems to provide real-time monitoring and instant alerts to farmers.

#### 1. System Overview

The proposed system consists of the following main components:

- NodeMCU (ESP8266) microcontroller
- Infrared (IR) sensors (multiple directions)
- GSM module for SMS communication
- Buzzer for local alert
- LCD display for system status
- Web-based monitoring interface (Wi-Fi)

The system is designed to continuously monitor the farm boundary and respond immediately when an intrusion is detected.

#### 2. Working Principle

The system operates based on motion detection using IR sensors. These sensors are placed at different locations (North, South, East, and West) to ensure full coverage of the agricultural field.

- IR sensors emit infrared radiation and detect reflected signals.
- When an animal crosses the sensor path, the IR signal is interrupted.
- This change is detected and sent as a digital signal to the NodeMCU.

#### 3. Mathematical Representation

The detection logic of the system can be expressed as:

$$D = IR_1 + IR_2 + IR_3 + IR_4 \quad D = IR\_1 + IR\_2 + IR\_3 + IR\_4$$

Where:

- D = Detection status

Decision condition:

#### 4. System Operation

The operation of the system can be explained step-by-step:

##### Step 1: Initialization

- The NodeMCU initializes all peripherals including IR sensors, GSM module, LCD, buzzer, and Wi-Fi.
- A Wi-Fi access point is created for remote monitoring.

##### Step 2: Continuous Monitoring

- IR sensors continuously monitor the surroundings.
- Sensor outputs are read by the NodeMCU in real time.

##### Step 3: Intrusion Detection

- If any IR sensor detects movement (LOW signal), it indicates intrusion.
- The microcontroller processes this signal immediately.

##### Step 4: Alert Generation

Once an animal is detected:

- The buzzer is activated to scare away the animal.
- An SMS alert is sent to the farmer using the GSM module.
- The LCD displays “Animal Detected”.
- The web page updates the status to alert mode.

#### Step 5: Normal Condition

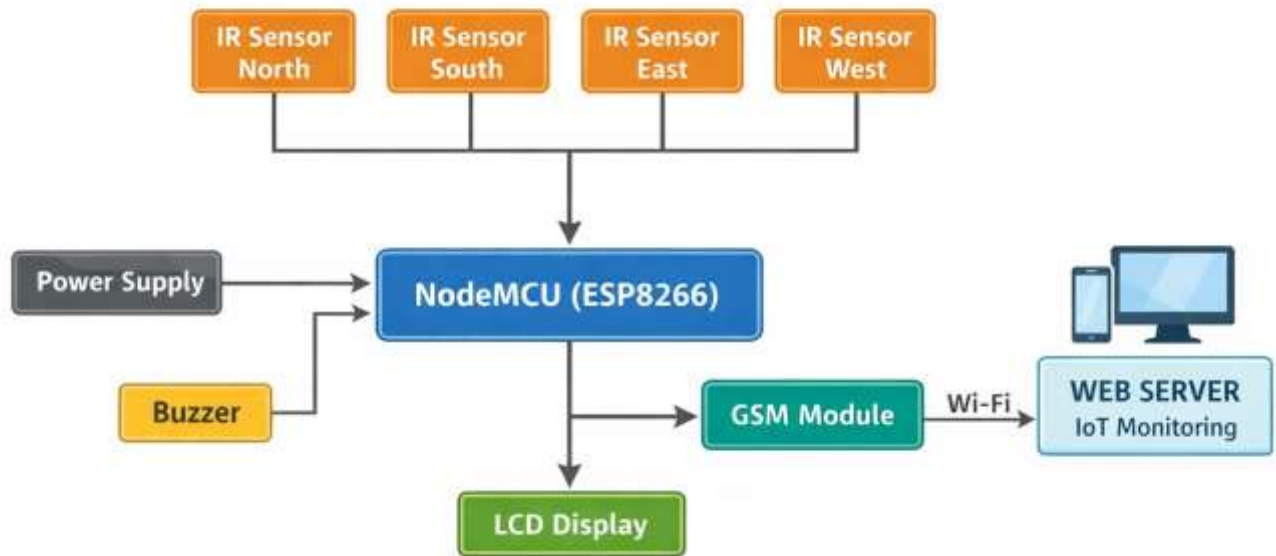
- If no sensor detects movement:
  - The buzzer remains OFF
  - LCD displays “Area Safe”
  - Web interface shows safe status

### 5. System Architecture

The block diagram represents the overall architecture of the proposed animal detection system.

- **IR Sensors (North, South, East, West):**  
These sensors are placed around the farm boundary to detect animal movement from all directions.
- **NodeMCU (ESP8266):**  
It acts as the central controller. It processes signals from sensors and controls all output devices. It also provides Wi-Fi connectivity for IoT monitoring.
- **GSM Module:**  
Sends SMS alerts to the farmer when an animal is detected.
- **Buzzer:**  
Produces a loud sound to scare away animals immediately.
- **LCD Display:**  
Displays system status such as “*Animal Detected*” or “*Area Safe*”.
- **Power Supply:**  
Provides regulated power to all components.
- **Web Server (IoT Interface):**  
Allows remote monitoring of the system through Wi-Fi using a mobile or computer.

## Animal Detection with SMS & IoT System



Proposed Block Diagram

### 6. Algorithm

1. Start
2. Initialize NodeMCU and peripherals
3. Read IR sensor values
4. If any sensor = LOW
  - o Activate buzzer
  - o Send SMS alert
  - o Update LCD and web page
5. Else
  - o Keep system in safe state
6. Repeat continuously

### 7. Advantages of Proposed Method

- Real-time detection and alert system
- Low cost and easy implementation
- Suitable for rural areas
- Remote monitoring using IoT
- Reduced human effort
- Non-harmful to animals

### 8. Future Enhancements

- Integration of camera and AI-based animal classification
- Solar-powered system for energy efficiency
- Cloud data storage and analytics
- Mobile application for monitoring

#### IV. CONCLUSION

The proposed Animal Detection with SMS and IoT system provides an efficient, reliable, and cost-effective solution for protecting agricultural fields from animal intrusion. Farmers often face significant crop losses due to wild animals entering their farms, especially during nighttime when monitoring becomes difficult. Traditional methods such as manual guarding, fencing, and scare techniques are either labor-intensive, expensive, or ineffective over time.

The developed system utilizes a NodeMCU (ESP8266) microcontroller, IR sensors, GSM communication, buzzer alerts, and a web-based interface to ensure real-time monitoring and quick response. The IR sensors continuously monitor the farm boundaries, and upon detecting an intrusion, the system immediately triggers a buzzer to scare away animals and sends an SMS alert to the farmer. Additionally, the IoT-based web interface allows remote monitoring, making the system more convenient and accessible.

One of the major advantages of this system is its automation and real-time alert capability, which significantly reduces human effort and response time. The system is also low-cost, easy to install, and suitable for rural environments, where advanced infrastructure may not be available. Furthermore, it provides a non-harmful approach to animal deterrence, helping to reduce human–animal conflict while ensuring crop safety.

The system can be further enhanced by integrating advanced technologies such as camera-based monitoring, machine learning algorithms for animal classification, cloud storage, and solar-powered energy systems. These improvements can make the system more intelligent, sustainable, and efficient.

In conclusion, the proposed system demonstrates how IoT and embedded systems can be effectively applied in agriculture to improve farm security, reduce crop damage, and support the development of smart farming practices. It represents a significant step toward modern precision agriculture and sustainable farming solutions.

#### REFERENCES

1. Kumar, "IoT Based Smart Agriculture Monitoring System," *International Journal of Engineering Research*, 2020.
2. S. Patel and R. Shah, "Wild Animal Detection System using IoT," *International Journal of Computer Applications*, 2019.
3. M. Sharma et al., "Sensor-Based Animal Intrusion Detection System," *IEEE Conference on Smart Agriculture*, 2021.
4. R. Kumar and P. Singh, "IoT Applications in Agriculture," *International Journal of Advanced Research in Computer Science*, 2018.
5. Verma, "Wildlife Detection Using IoT and Sensors," *International Journal of Scientific Research*, 2021.
6. Ramesh, "GSM Based Agricultural Monitoring System," *International Journal of Electronics Engineering*, 2017.
7. S. Karthik, "Smart Farming using IoT," *IEEE International Conference on IoT Technologies*, 2020.
8. N. Gupta and R. Jain, "IoT Based Field Monitoring System," *International Journal of Innovative Technology*, 2019.
9. T. Rao, "Embedded Systems in Agriculture," *Journal of Embedded Technology*, 2018.

10. Das, “Animal Intrusion Alert System using Sensors,” *International Journal of Computer Science and Engineering*, 2020.
11. P. Singh and K. Yadav, “Wireless Sensor Networks for Smart Agriculture,” *IEEE Transactions on IoT*, 2021.
12. R. Patel, “Low-Cost IoT Solutions for Farm Monitoring,” *International Journal of Smart Agriculture*, 2019.
13. M. Khan, “GSM Based Alert System for Farm Security,” *International Journal of Engineering Science*, 2018.
14. S. Gupta, “Smart Surveillance System for Agriculture,” *International Journal of Research in Engineering*, 2020.
15. K. Reddy, “IoT Based Smart Security System,” *International Journal of Electronics and Communication*, 2019.