IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 11, May 2025
Impact Factor: 7.67

Smart Farm Protection System with Animal Intrusion Detection and Frequency – Based Deterrents

V Veena[1], Bhutham Sudeeshna[2], Voggu Bharath Kalyan[3]
Assistant Professor, Department of IT[1]
UG Scholars, Department of CSB[2,3]
Mahatma Gandhi Institute of Technology, Hyderabad, Telangana, India
vveena_it@mgit.ac.in, sudeeshnapatel@gmail.com, bharathkalyan6363@gmail.com

Abstract: *Animal intrusions into agricultural fields and residential areas pose significant risks to crop safety, human well-being, and overall environmental security. This project introduces a vision-based, intelligent, real-time system for animal detection and repulsion. Instead of using traditional motion or infrared sensors, the system uses sophisticated image processing techniques to detect the presence of animals in either static or live visual input. The system uses GPIO-based actuation via a Raspberry Pi to automatically activate physical deterrents, such as an acoustic buzzer and a water spray mechanism, once an animal is detected. To guarantee that the user is aware of the intrusion right away, an SMS alert is sent to them simultaneously. PyQt was used to create an intuitive graphical user interface that allows users to upload images, stream live video, and monitor activity for detection. In addition to providing real-time feedback on detections and actions taken, a user-friendly graphical interface created with PyQt allows users to stream live video, upload images, and monitor activity. This solution supports more secure and effective farm or property management by providing a scalable, economical framework for protecting sensitive areas from animal encroachment through the use of multimodal deterrence and automated alerting.*

Keywords: Animal Intrusion, Computer Vision, Real-time Detection, Raspberry Pi, Automated Repellent, Smart Agriculture, GUI Monitoring

I. INTRODUCTION

Agriculture and rural communities often grapple with the significant issue of animal intrusion, which can lead to crop damage and conflicts between humans and wildlife. This challenge is particularly pronounced in areas near forests, like Tirupati in Andhra Pradesh, where wild animals such as elephants and wild boars frequently wander into farmland or residential areas. These intrusions not only cause agricultural losses but have also resulted in injuries and even fatalities, posing a serious threat to local residents. Traditional methods to combat this issue, such as fencing, manual patrols, or noise-based deterrents, often fall short and require a lot of effort. Therefore, there's a pressing need for a real-time, automated, and non-lethal solution to detect and deter animals before any harm is done. This project introduces a smart animal intrusion detection and repellent system that utilizes deep learning and embedded hardware to automatically monitor for animal activity and respond immediately. The system employs a object detection model running on a Raspberry Pi to identify animals through uploaded images or live video feeds. When a target animal is detected, the system activates a series of deterrents— specifically a water motor and sound buzzer—and sends real-time SMS alerts to the relevant user via Twilio. An interactive PyQt-based GUI enables users to operate the system smoothly, monitor intrusions, and observe the deterrent actions in real-time. This solution is particularly ideal for deployment in areas adjacent to forests like Tirupati, where it can not only safeguard crops but also alert residents and minimize the risk of dangerous encounters, making it a valuable asset for both agricultural safety and community protection.

Problem Statement

Each animal intrusion results in the damage of crops, economic losses, and increased safety problems for farmers and residents residing near forests or rural areas. The problem is made worse due to the intrusions being frequent and unpredictable. Traditional approaches like monitoring manually, employing fences, or using scare devices do little to mitigate the issue at hand. These methods are highly unreliable, labor-intensive, and costly. In this modern world of smart solutions for agriculture, there is a need for a real-time system that can actively identify animal presence and respond accordingly. This project fills the gap by using computer vision and automation technology to identify intrusions and activate measures to deter the animals without human engagement. A smart solution shifts the burden and helps reduce land loss while allowing people to live in the area and cohabitate with wildlife in a sustainable way.

II. LITERATURE SURVEY

Recent advancements in animal intrusion detection and repellent systems have leveraged various technologies such as ultrasonic frequency generators, deep learning, IoT, and computer vision to address challenges in agriculture and wildlife management. Awal et al. [1] designed a cost-effective variable ultrasonic frequency generator operating in the range of 20–125 kHz for rodent repellent applications, demonstrating high detection accuracy and minimal frequency generation error. However, the study lacked real-world testing on rodents and did not evaluate long-term durability or habituation effects.

Varun and Nagarajan [2] proposed a hybrid convolutional neural network (CNN) approach combining thermal and regular cameras to achieve high accuracy (99.6%) in animal intrusion detection, supported by IoT-enabled real-time alerts and deterrents. Despite robustness under dynamic backgrounds and lighting, this model's reliance on thermal cameras presents scalability and cost challenges, and its generalizability to unseen species remains limited. Under consideration was the ultrasonic system that is IoT-based for wild animal detection, incorporating wireless data transmission and a method for real-time alerts to farmers, by Panda et al. [3]. It is an effective method to reduce crop damage, but scaling and adapting to various field conditions need improvement. Kommineni et al. [4] presented a computer vision approach that uses pre- trained MobileNet SSD models to detect wild animals, with real-time classification and alarm generation. On the contrary, however, their method depends highly on a stable internet connection and fails to see whether areas of dense vegetation are degrading classification accuracy. Ibraheam et al. [5] went for deep learning CNN models to recognize animal species, attaining very high levels of accuracy (up to 99.8%) in classifying several species from diverse sets of images. It could massively increase robustness, yet doing almost anything to tell humans apart from animals or to deal with dim lighting or occlusion would also limit its real-time applicability. Ravoor et al. [6] advertised MobileNetv2 SSD and ResNet50 to detect animal intrusions and to track the reidentification, with up to 99.6% reidentification accuracy on a Raspberry Pi prototype. However, such a problem with the limited/different variety of datasets and robustness of deployment emerges. Balakrishna et al. [7] present an IoT-based solution utilizing Raspberry Pi and ESP8266 Wi-Fi modules, machine learning algorithms (SSD and R-CNN) for animal intrusion detection, and alerting the concerned authority. SSD performed better, but due to limitations in dataset size and real-world deployment-related challenges, the scaling of the solution is hard. On the other hand, Sabeeian et al. [8] adopted CNNs for wild-animal detection, noting a 98% validation accuracy while also pointing out hardware limitations pertaining to memory and processing speed, which were, in turn, bottlenecks in the model functioning. Radhakrishnan et al. [9] treated animal detection through support vector machines employing Gabor features with up to 99.48% accuracy, again stressing the need for bigger datasets and robustness of the model under noisy and partially formed conditions.

Technically, these studies reflect promising directions for animal intrusion detection with AI, IoT, and ultrasonic. However, there are additional common gaps: dataset sizes are comparatively small, there is a heavy dependence on single sensor modalities, lack of real-world and long-term evaluations, and issues with scaling and robustness. Hence, future studies should target multimodal sensing, increase generalizability of models, and come up with cheap and scalable frameworks that can be varied and applied to agricultural and environmental setups.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 11, May 2025
Impact Factor: 7.67

III. SYSTEM DESIGN

3.1. Proposed System Overview:

The proposed animal intrusion detection and repellent system monitors agricultural areas for unauthorized animal entries and responds in real time using deterrents like a water motor and buzzer. It leverages deep learning-based object detection (YOLOv4-tiny) to identify animals from a video feed and sends SMS alerts to caretakers using Twilio.

Unlike traditional methods, this system offers automated and cost-effective monitoring with a Raspberry Pi. It features a PyQt5 GUI with image upload and live feed options, activating deterrents only upon detection to reduce false alerts and save power. This enhances farm security with minimal manual effort.

3.2. Software and Hardware Requirements:

The animal intrusion detection and repellent system is built on a Raspberry Pi 3 Model B+ with a Pi Camera for capturing real-time video. A 9V battery powers the water motor and buzzer, both controlled via a relay module connected to GPIO pins. For communication, SMS alerts are sent using the Twilio API, with optional GSM integration or internet connectivity.

Software components include Raspbian OS and Python 3.9, with OpenCV for video processing and YOLOv4-tiny for animal detection, executed via TensorFlow. A PyQt5-based GUI provides image upload and live feed monitoring options. GPIO control is handled through the RPi.GPIO library. The system has been successfully tested on both Raspberry Pi and a laptop, ensuring reliable, cross- platform performance.

3.3. System Design:

The proposed animal intrusion detection and repellent system adopts a modular architecture to ensure real-time processing, effective deterrent control, and easy maintenance. Each module is designed for a specific function, enabling accurate animal detection and responsive action in field environments. The modular design also supports future enhancements and scalability.

3.3.1. Camera Module:

The Camera Module, using a Pi Camera, captures continuous video footage of the surveillance area. This real-time video feed is the primary input for animal detection and initiates the subsequent decision-making process.

3.3.2. Object Detection Module:

This core module processes the video frames using a lightweight deep learning model—YOLOv4-tiny or YOLOv8. It uses OpenCV for preprocessing and employs PyTorch or TensorFlow for model inference. Detected objects are filtered based on predefined animal classes to ensure accurate targeting.

3.3.3. Deterrent Activation Module:

Once an animal is detected, this module activates the repellent mechanisms: a buzzer and a water motor. Controlled via GPIO pins and a relay module, the system ensures safe and timely activation to scare away intruding animals. The deterrents are triggered only upon valid detections to minimize power usage and false alarms.

3.3.4. Alert Communication Module:

This module is responsible for notifying the landowner or caretaker. Upon detection, it uses the Twilio API to send an SMS alert with relevant information. The system supports both internet-based messaging and optional GSM integration for remote areas.

3.3.5. Graphical User Interface Module:

A PyQt5-based GUI provides users with two operational modes: image upload and live video feed. The GUI displays detection results and activated deterrents only when an animal is present, offering intuitive and clutter- free interaction.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 11, May 2025
Impact Factor: 7.67

3.3.6. GPIO Control Module:

This module handles low-level hardware control, interfacing the Raspberry Pi GPIO pins with external components such as the relay, motor, and buzzer. It ensures safe voltage switching and isolates the Pi from high-power circuits.

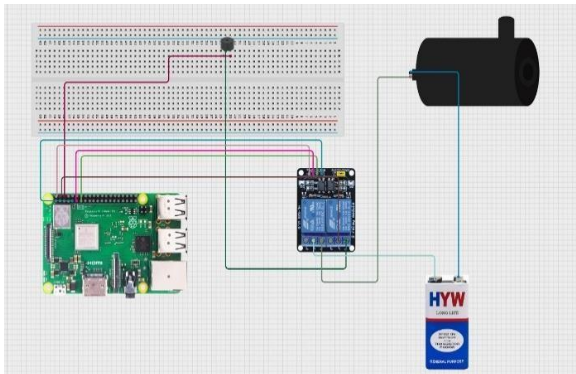

Fig 3.1: System Architecture

The Figure 3.1 illustrates the hardware architecture of the animal intrusion detection and repellent system using Raspberry Pi. It comprises several key components: the Raspberry Pi 3 Model B+, a Pi Camera, a relay module, a water motor, a buzzer, and a 9V battery power supply. The integration ensures real-time animal detection, GPIO-based deterrent activation, and SMS alerting via the Twilio API.

IV. RESULTS AND DISCUSSION

The proposed Animal Intrusion Detection and Repellent System was successfully designed, developed, and deployed using a Raspberry Pi 3 Model B+, Pi Camera, YOLOv4-tiny object detection, PyQt5 GUI, and Twilio-based SMS alert services. GPIO-controlled deterrents including a buzzer and water motor were integrated to provide real-time, automated responses to detected animal intrusions.

Animal Detection

The system effectively detected animals like lions and elephants in both uploaded images and live video using the YOLOv4-tiny model on a Raspberry Pi 3 Model B+ with a Pi Camera. Detection was consistent and accurate, with an average response time of under two seconds. The system maintained reliable performance under normal lighting conditions, with minimal false detections.

Activation of Deterrents

Upon detection, the system automatically triggered appropriate deterrents via GPIO—using specific sound frequencies for each animal along with a water motor. The deterrents were activated without delay, showing smooth coordination between detection and response, ensuring immediate action to repel intruding animals.

SMS Alert System

SMS alerts were successfully sent using Twilio whenever an animal was detected. Each message included the animal type and the deterrents used. The alerts were delivered within seconds, ensuring quick notification to the user and confirming the system's reliability in remote communication.

Graphical User Interface Experience

The PyQt5 GUI provided a clean and intuitive interface for both image uploads and live monitoring. It displayed detection results, triggered deterrents, and SMS alert confirmations effectively. The layout and responsiveness made the system user-friendly and easy to operate.

IJARSCT

International Journal of Advanced Research in Science, Communication and Technology

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

ISSN: 2581-9429

Volume 5, Issue 11, May 2025

Impact Factor: 7.67

Discussion

The results confirm that the system is practical for real-time animal intrusion detection and response in outdoor settings. With its ability to detect, deter, and alert autonomously, it serves as a promising solution for protecting crops or property. Future enhancements could focus on nighttime detection, multi-camera support, and secure communication to improve scalability and robustness.

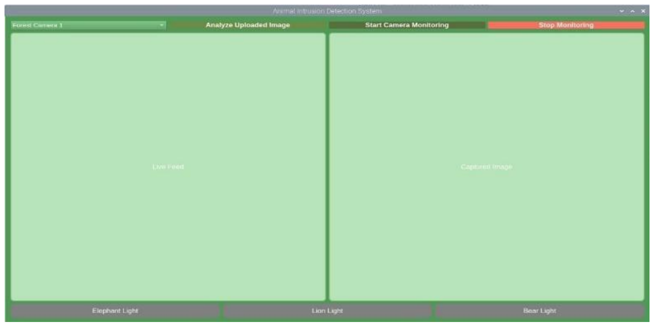

Figure 4.1 : Initial Interface of the Monitoring Systeme

The Figure 4.1 illustrates the real-time monitoring interface, showing the live camera feed on the left and the captured detection snapshot on the right, confirming successful identification of an animal.

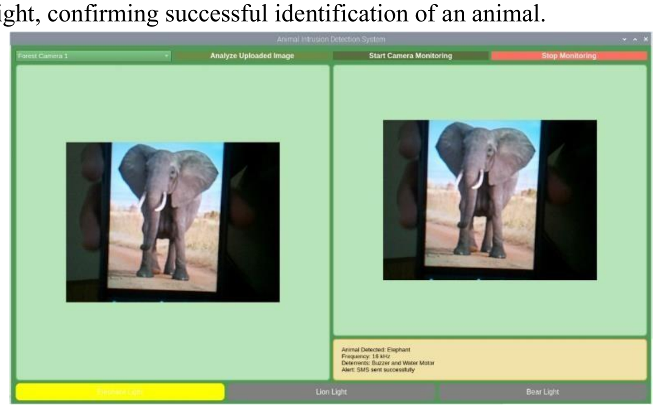

Figure 4.2: Live Animal Detection Interface Figure 4.2 demonstrates the active alert frame generated after animal detection, highlighting the detected species, frequency used for repulsion, triggered deterrents, and SMS notification status.

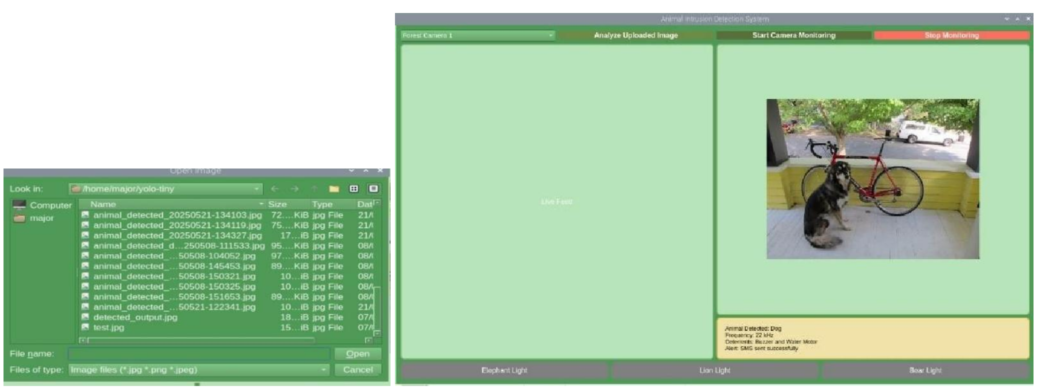

Figure 4.3: Image Upload and Detection Result Figure 4.3 displays the detection output for an uploaded static image, where the system correctly recognizes the animal and initiates the deterrent actions, alongside an alert summary.

Figure 4.4 shows the SMS alert received when an Animal was detected, confirming activation of the buzzer and water motor deterrents.

DOI: 10.48175/IJARSCT-27209

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 11, May 2025
Impact Factor: 7.67

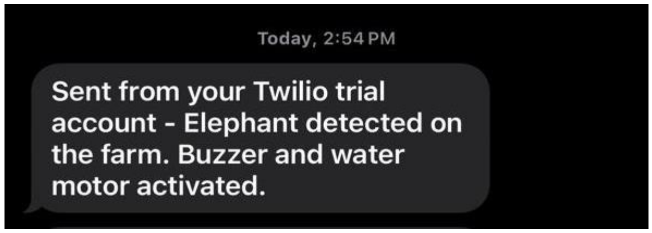

Figure 4.4: SMS Alert

V. CONCLUSION

This project presents a real-time, vision-based animal intrusion detection and repellent system that addresses the growing need for intelligent surveillance in both agricultural and residential settings. By utilizing advanced image processing and the YOLOv4-tiny object detection model, the system effectively identifies animals from live camera feeds or uploaded images without relying on traditional sensors. Upon detection, deterrents such as a buzzer and water spray are automatically triggered via Raspberry Pi GPIO controls, and immediate SMS alerts are sent to notify users of the intrusion. A PyQt-based graphical user interface enhances usability, offering intuitive options for image upload, live feed monitoring, and real-time status updates. The system's modular and scalable design ensures adaptability for diverse environments—from farmlands and gardens to residential compounds and wildlife-sensitive zones. Its cost-effective implementation, combining computer vision with automated deterrence and alerting, offers a practical and efficient solution for securing open areas against unwanted animal presence. This work demonstrates the potential of integrating AI and IoT technologies for smarter, safer, and more responsive environmental management.

REFERENCES

[1] Awal, M.A., Partha, P.K.P. and Islam, M.R., 2024. Design and development of a variable ultrasonic frequency generator for rodents repellent. Smart Agricultural Technology, 7, p.100414.

[2] Sajithra Varun, S. and Nagarajan, G., 2023. DeepAID: a design of smart animal intrusion detection and classification using deep hybrid neural networks. Soft Computing, pp.1–12

[3] Panda, P.K., Kumar, C.S., Vivek, B.S., Balachandra, M. and Dargar, S.K., 2022, February. Implementation of a wild animal intrusion detection model based on internet of things. In 2022 Second International Conference on Artificial Intelligence and Smart Energy (ICAIS) (pp. 1256–1261). IEEE.

[4] Kommineni, M., Lavanya, M. and Vardhan, V.H., 2022. Agricultural farms utilizing computer vision (AI) and machine learning techniques for animal detection and alarm systems. Journal of Pharmaceutical Negative Results, pp.3292–3300.

[5] Ibraheam, M., Gebali, F., Li, K.F. and Sielecki, L., 2020. Animal species recognition using deep learning. In Advanced Information Networking and Applications (pp. 523–532). Springer.

[6] Ravoor, P.C., Sudarshan, T.S.B. and Rangarajan, K., 2020, December. Digital Borders: Design of an Animal Intrusion Detection System Based on Deep Learning. In International Conference on Computer Vision and Image Processing (pp. 186–200). Springer Singapore.

[7] Balakrishna, K., Mohammed, F., Ullas, C.R., Hema, C.M. and Sonakshi, S.K., 2021. Application of IoT and machine learning in crop protection against animal intrusion. Global Transitions Proceedings, 2(2), pp.169–174.

[8] Sabeenian, R.S., Deivanai, N. and Mythili, B., 2020. Wild animals intrusion detection using deep learning techniques. International Journal of Pharmaceutical Research, 12(4), pp.1053–1058.

[9] Radhakrishnan, S. and Ramanathan, R., 2018. A support vector machine with Gabor features for animal intrusion detection in agriculture fields. Procedia Computer Science, 143, pp.493–501.

[10] Kathir, M., Balaji, V. and Ashwini, K., 2024, March. Animal Intrusion Detection Using YOLOv8. In 2024 10th International Conference on Advanced Computing and Communication Systems (ICACCS) (Vol. 1, pp. 206–211). IEEE.