

SentinelEye: ML-Based Wild Animal Intrusion Detection System Using Raspberry Pi – A Review

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Abstract: *The frequent intrusion of wild animals into farms, city outskirts, and public spaces often leads to crop destruction, property loss, and potential threats to human safety. Traditional preventive methods such as fencing, manual patrolling, and CCTV surveillance are often costly, inconsistent, or limited in range. To address these challenges, this project proposes an intelligent Farm Animal Intrusion Detection System built using Raspberry Pi, camera modules, and IoT-based alert mechanisms powered by machine learning. Unlike conventional video surveillance systems, this solution operates on image-based detection. The camera periodically captures still images and transmits them to a trained deep learning model—using YOLO or CNN architectures—for real-time identification and classification of animals. When an intrusion is detected, the system triggers animal-specific sound alarms to drive them away and immediately sends SMS alerts to farmers or forest officials, including details such as the animal type, location, and time. All captured images and detection records are securely stored either locally or in the cloud for future reference and analysis. This cost-efficient and scalable system is ideal for protecting agricultural lands, schools, highways, and residential zones located near forest areas. By integrating AI, ML, and IoT technologies, it effectively reduces false alerts, prevents human–wildlife conflicts, safeguards crops, and promotes sustainable smart farming practices.*

Keywords: Image-Based Detection, Deep Learning, YOLO, CNN, Raspberry Pi, IoT, Smart Farming, Intrusion Detection, Computer Vision, Public Safety

I. INTRODUCTION

Wildlife intrusion into human settlements has become an escalating issue worldwide, especially in agricultural zones and urban peripheries. Farmers frequently experience severe crop damage and economic setbacks when wild animals such as boars, elephants, or monkeys enter their fields. Likewise, people living near forested regions—along highways, schools, or residential areas—face increasing safety risks from unexpected animal encounters. Traditional prevention measures like fencing, watchtowers, and manual patrolling often prove expensive, labor-intensive, and unreliable in harsh conditions, limiting their long-term viability. Recent advancements in artificial intelligence (AI), computer vision, and Internet of Things (IoT) technologies have opened new possibilities for automated monitoring and intrusion detection. Using camera-based observation integrated with deep learning algorithms, it is now feasible to identify animal movements accurately and send instant alerts. When combined with compact computing platforms such as the Raspberry Pi, these AI-driven IoT systems provide a low-cost, energy-efficient edge solution capable of operating continuously without direct human supervision. This project introduces a Farm Animal Intrusion Detection System designed to recognize and respond to wildlife activity using machine learning models such as YOLO and CNN variants. The system captures images via a camera, processes them locally on the Raspberry Pi, and upon detecting an animal, activates sound-based deterrents while simultaneously sending SMS alerts with details like the time, location, and species detected to farmers or authorities. With its flexible and scalable architecture, the system can be effectively



deployed across farms, forest edges, highways, schools, and residential neighborhoods—enhancing agricultural protection, reducing human–wildlife conflicts, and strengthening overall public safety.

II. LITERATURE REVIEW

Several researchers have explored AI- and IoT-based solutions for automated animal intrusion detection in agricultural and wildlife environments. Saxena et al. [1] developed an AI-powered system employing convolutional neural networks (CNNs) to detect animal intrusions in real time, offering scalability and rapid response but limited by lighting and weather conditions. Mamat et al. [2] implemented a YOLOv5-based model on Raspberry Pi to classify multiple animal types efficiently, achieving 94% accuracy while maintaining low hardware cost, though facing challenges in low-light and multi-camera scenarios. Panda et al. [3] proposed an IoT-based system combining sensors and cameras to capture images upon motion detection, enabling cost-effective surveillance but limited by coverage range and vegetation interference. Similarly, Penchalaiah et al. [4] designed a YOLOv3-based intrusion detection model integrated with Arduino, PIR sensors, and GSM modules to deliver real-time alerts, though scalability and low-light performance remained issues. Patil et al. [6] introduced an enhanced AI-based system capable of distinguishing between harmless and harmful animals, significantly improving detection reliability under normal conditions; however, environmental variations such as illumination changes and partial visibility reduced system accuracy. Delwar et al. [7] advanced this concept by integrating IoT devices with YOLOv8 for high-speed, real-time monitoring and multi-camera support. Their system demonstrated strong scalability but depended heavily on stable internet and compatible hardware. Kumar et al. [8] applied AI-based monitoring for wildlife conservation, focusing on behavioral analysis and movement prediction across habitats. The study emphasized algorithm adaptability but noted difficulties in maintaining accuracy across diverse terrains. Naveen et al. [9] proposed a dual-purpose IoT system for both animal intrusion and early forest fire detection, enhancing forest management through sensor integration, though requiring frequent maintenance and complex configuration. Pringle and Vass [10] demonstrated AI applications in ecological research, using image recognition to track hedgehog populations in the UK. Their approach showcased environmental benefits and biodiversity monitoring potential, but scalability and image quality remained concerns.

Collectively, these studies highlight that while AI- and IoT-driven intrusion detection systems show promise for smart agriculture and wildlife safety, common challenges persist in terms of environmental adaptability, hardware limitations, and system scalability.

III. PROBLEM DEFINITION

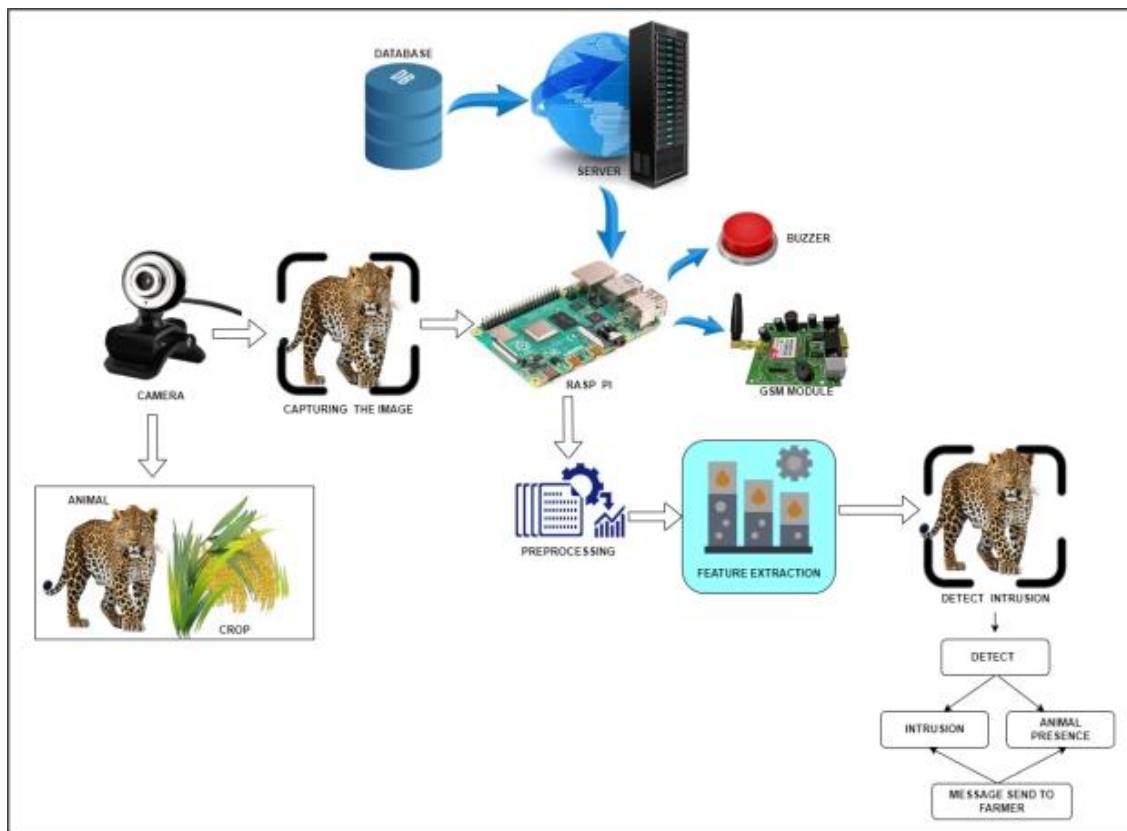
In recent years, wild animal intrusions into farmlands, villages near forest borders, highways, and public institutions have emerged as a pressing concern. Farmers often incur significant crop damage from animals such as wild boars, elephants, and monkeys, while residents in semi-urban and rural areas face the risk of accidents, injuries, and property loss. Traditional preventive methods—including fencing, manual patrolling, and CCTV monitoring—tend to be costly, labor-intensive, and often ineffective under challenging conditions such as poor lighting, dense vegetation, or expansive open fields. The absence of an affordable, automated, and reliable detection mechanism continues to exacerbate economic losses and escalate human–wildlife conflicts. This underscores the critical need for a real-time intelligent intrusion detection system that leverages machine learning, computer vision, and IoT technologies to enable precise animal identification, prompt alerts, and efficient deterrent measures.

IV. PROPOSED WORKING

The proposed system employs a camera module to capture images of the monitored area at regular intervals. These images are processed by a Raspberry Pi, which serves as the central computing unit. Using a machine learning model such as YOLO or CNN, each image is analyzed to accurately detect and identify wild animals. Upon detection, the system instantly activates a sound or alarm to drive the animal away and simultaneously sends an SMS alert to nearby residents, farmers, and authorities, providing details like the detection time and GPS location. The integrated GPS module ensures precise location tagging for every intrusion event. All detection data—including images, logs, and alert records—are stored locally or on the cloud for future reference and analysis. With IoT connectivity, users can remotely



monitor the system through mobile or web applications, enabling quick responses and enhancing safety for farms, residential areas, and other regions near wildlife habitats



V. RESULT

The proposed AI-based animal intrusion detection system offers effective real-time monitoring of farm areas, accurately identifying animals that enter protected zones. By leveraging deep learning models like YOLOv5 and YOLOv8, the system achieves high detection accuracy, typically between 80% and 99% for common farm animals and potential intruders. The use of IoT devices and cameras enables continuous, automated surveillance, reducing reliance on manual monitoring and minimizing human error. When an intruding animal is detected, the system immediately sends alerts via SMS, email, or a mobile app, allowing farmers to respond promptly. It also supports multiple camera feeds simultaneously, ensuring comprehensive coverage of the farm. All detection events are recorded in a database, facilitating analysis of intrusion patterns to further improve security measures. Performance is optimal under good lighting and favorable weather, though accuracy may decrease slightly in low-light or adverse conditions. Overall, the system provides a scalable, reliable, and efficient solution for safeguarding farms, reducing human intervention, and minimizing potential losses from animal intrusions.



Animal Image Classifier

Choose File No file chosen

Predict

Prediction: lion

Confidence: 99.69%



Animal Image Classifier

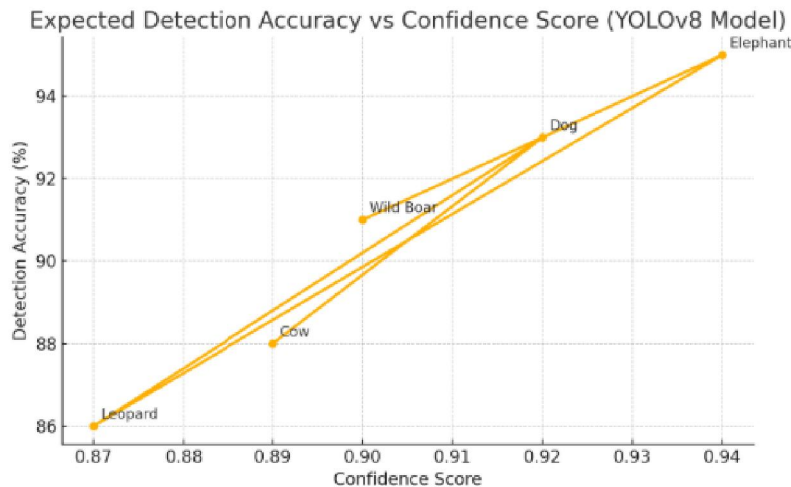
Choose File No file chosen

Predict

Prediction: leopard

Confidence: 87.67%





Above graph shows the expected comparison graph between Detection Accuracy and Confidence Score for different animals.

VI. CONCLUSION

The proposed camera-based smart animal intrusion detection and alert system provides an affordable, automated, and scalable solution to reduce human-wildlife conflicts. By integrating machine learning, IoT, and Raspberry Pi technology, the system delivers real-time detection, instant alerts, and detailed event logging. It safeguards crops and property while supporting safe coexistence between humans and wildlife. With its flexible design and potential for future upgrades, this system represents a promising approach for modern agriculture and effective wildlife management.

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