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Animal Detection And Alert System in Farmlands

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ABSTRACT –

Human-wildlife conflict poses significant challenges, particularly in agricultural regions where wild animal intrusions lead to crop damage and economic loss. It mainly occurs in regions where agricultural fields are located near forest or wildlife-rich regions suffer from the problem of wild animal intrusions, which not only damage crops but also endanger farmers' livelihoods and food security. Traditional methods such as manual guarding, fencing are largely ineffective. Labor-intensives are not practical or ineffective for large-scale or remote farming operations. **This study proposes an IoT-integrated animal detection and alert system which** includes the use of ESP32-CAM for continuous image and video monitoring for the security of farmlands from the animals intrusion and deep learning models like YOLOv8 are trained to detect and classify different animal species that creates a threat to crops in real-time. Once an intrusion is detected then the **system automatically activates alerts via buzzer and SMS notifications via** GSM modules (e.g., SIM800L)**, enhancing the farm security. This proposed solution not only aims to offer cost-effective, efficient, and automated protection and but it also serves as a practical model for deploying intelligent field monitoring systems, ensuring enhanced security, sustainability and productivity in the agricultural sector against animal intrusions**

Keywords: IoT, Animal Detection, Deep Learning, Alert Systems, Agriculture Security, Wildlife Monitoring

INTRODUCTION

Agriculture forms the backbone of many developing economies, particularly in regions like India, where a significant portion of the population depends directly or indirectly on farming for their livelihood. However, one of the critical challenges faced by modern agriculture-especially in areas bordering forests or wildlife habitats or regions has the increasing frequency of animal intrusions into farmlands. Animals such as cow, elephants, wild boars or pigs, deer, tiger, monkey, bear etc… in agricultural fields, causing extensive damage to crops, endangering human safety, and resulting in substantial economic losses. Traditional methods for farm security include manual patrolling, building fences, or using scare factics like loud noises or fire are not only ineffective in the long term but also unsustainable and labour cost are very high. These methods lack real-time responsiveness and often fail during night-time or in larger field areas. Moreover, manual monitoring poses serious risks to farmers and does not allow for predictive or data-driven management of wildlife conflicts. Recent advancements in smart agriculture-particularly in the domains of the Internet of Things (IoT), machine learning (ML), and deep learning (DL)-present a transformative opportunity to automate and enhance farm surveillance and security. Several research works have shown the potential of combining IoT-enabled sensors, camera modules, and Al-based Image recognition models for real-time detection of animals. Devices such as ESP32-CAM, Raspberry Pi, and IR sensors, when Integrated with algorithms like YOLOV8, SSD (Single Shot Detector), and hybrid neural networks, offer high accuracy in identifying animal movement and classifying intrusions based on species or threat level. The integration of GSM modules like SIM800L allows these systems to instantly notify farmers via SMS providing timely alerts that can prevent damage. Additional alert mechanisms-like sirens will be activated automatically based on sensor inputs, reducing human involvement and ensuring 24/7 monitoring. These models analyze historical data to predict intrusion patterns. This shift from reactive to proactive monitoring which represents a significant leap toward sustainable and smart farming. This paper presents a comprehensive design using IoT in real-time providing a framework for solving the problem of animal intrusions in agriculture field.

LITERATURE REVIEW

Novel Animal Detection System Using YOLOv8 (@2024 IEEE): This paper proposes a cascaded YOLOv8 model with adaptive preprocessed and feature extraction techniques to improve the accuracy of animal detection in complex farm environments. The system processes the images in real-time, effectively distinguishing the animals species from the background under varying lighting and weather conditions. The adaptive preprocessing reduces noise and enhances key features by improving detection speed and precision. The proposed system is suitable for deployment on edge devices to enable faster response in farm security scenarios.

Alert Messages Based on Wild Animal Activity Detection Using Hybrid Deep Neural Networks (@2023 IEEE): This study uses a hybrid deep neural network which combine with convolutional and recurrent layers to detect wild animal movements and generate alert messages automatically. The network is trained on various animal behaviors patterns to minimize false positives. Alerts are transmitted in real time, enabling farmers to take preventive

actions against crop damage and livestock attacks. This hybrid approach balances detection accuracy and computational efficiency, making it suitable for real-world monitoring systems.

IoT-Based Object Detection System for Endangered Animal Protection (@2023 MDPI Future Internet): The authors developed an IoT-based animal detection system leveraging the low-power cameras and cloud processing to monitor endangered species in protected areas. The system integrates object detection models that classify animals and send notifications to conservation officers. The IoT framework facilitates continuous monitoring with minimal human intervention, improving wildlife protection and farm security simultaneously.

Real-Time Animal Detection Using IoT in Agricultural Fields (@2021 IJCRT): This paper presents an IoT solution employing cameras connected to microcontrollers for real-time detection of animals in agriculture fields. The system processes video feeds locally to detect the intrusions and sends instant alerts via SMS. The low-cost design allows deployment across large farms, helping farmers prevent crop losses caused by stray animals.

Application of IoT and Machine Learning in Crop Protection Against Animal Intrusion (@2021 KeAi Global Transitions Proceedings): This research explores the integration of machine learning algorithms with IoT devices to identify and detect the animal intrusion in crop fields. The study emphasizes the importance of precise detection and timely alerts to minimize the crop damages. The proposed system uses sensors and cameras for continuous surveillance and automated response which promotes sustainable agricultural practices.

Building upon these contributions, this present project utilizes the YOLOv8 model for enhanced animal detection accuracy with the help of ESP32-CAM for cost-effective edge processing, and the SIM800L module for sending real-time SMS alerts to the farmers or to the landlords. This combination results in a practical and scalable solution for farm security and offer timely animal detection and notification.

PROBLEMSTATEMENT

Farmers in rural, forest-adjacent areas face severe crop damage and personal risk due to frequent wild animal intrusions. Traditional methods are largely ineffective mainly in night time or larger spread out farms and need of human presence and often fail to detect determined animals. The result not only decreases the production level and income of the farmers but also significantly increase the stress and reduced quality of life for farming communities. As well as existing tech solutions are costly, unreliable, or lack of intelligent or scope in classification and real-time alerts. There is a critical need for a smart, affordable, and scalable animal detection system using IoT that can accurately identify threats and send timely alerts through offline-capable communication like SMS to the farmers mobile number provided.

OBJECTIVES

- To develop a smart surveillance system for agricultural fields using integrated hardware components such as ESP32-CAM for continuous monitoring of farm boundaries and perimeters.
- To apply deep learning models for accurate animal detection and classification, using object recognition frameworks such as YOLOv8.
- These models will enable the system to distinguish between different types of animals and reduce false positives from human or harmless object movements.
- To implement an automated alert mechanism that triggers the buzzers and simultaneously sends real-time notifications to farmers via GSM (e.g., SIM800L module).
- This ensures timely response without requiring manual monitoring.
- To evaluate the performance of the system under real-world conditions, such as detection accuracy, false alarm rate, alert response time, power consumption, and communication.
- To empower farmers with data-driven insights, logs of intrusion events, frequency patterns, at the time of detection and it will help in decrease the long-term strategies and improving farm management practices.

METHODOLOGY

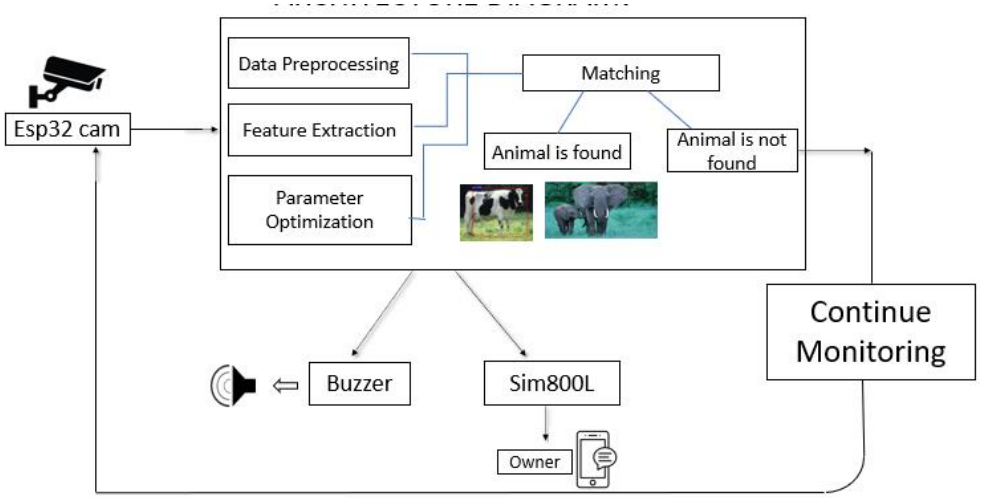
The methodology for developing the proposed animal detection and alert system involves the integration of hardware, software, and Intelligent algorithms to achieve real-time surveillance and automated response. The system is designed with a modular architecture that combines edge-based processing, deep learning models, and loT-enabled communication technologies to monitor agricultural fields effectively.

The proposed animal detection and alert system employs a modular architecture integrating ESP32-CAM for real-time image capture and motion detection. Image processing is handled locally using deep learning models such as YOLOv8 optimized for edge devices to ensure fast and accurate animal classification without any loss of time to secure the farmlands or crops from animal intrusion and safeguard the landlords ’s properties.

A custom dataset of common farm-invading animals was compiled and used to train the models to analyse and classify the different animals and enhance the performance of the trained dataset model for classification. The system distinguishes between actual threats and irrelevant motion and reduces false alarms. Once a threat is confirmed with high confidence, deterrents like sirens are activated, and alerts the landlords via GSM (SIM800L). The system supports Wi-Fi, GSM, powered by batteries and energy-saving modes and as well as support, proving the system's real-world applicability and efficiency.

SYSTEM DESIGN

The proposed animal detection and alert system is built on a modular framework trained for real-time operation in remote wildlife-prone farmlands. It integrates four key subsystems and they are sensing, image processing, alert communication, and power management. ESP32-CAM is equipped with cameras and placed at strategic points, continuously monitor all the areas of the farm.



The system shown in the image represents an *automated animal detection and alert system* designed for farmland protection. It uses an ESP32-CAM module to continuously monitor the environment. The camera captures real-time images or video streams and sends this data for analysis to detect the presence of any potentially harmful animals near the farmland.Captured visuals are processed locally using deep learning models like YOLOv8, known for their speed and accuracy on edge devices and used to analyze temporal patterns in animal movements, enhancing detection accuracy over time.

In the *processing phase*, the captured data undergoes three main stages: data preprocessing, feature extraction, and parameter optimization. Data preprocessing involves cleaning and resizing the input image to improve the accuracy of detection. Then, relevant features such as shape, color, or patterns are extracted from the image using computer vision techniques or pre-trained models like YOLOv8. Parameter optimization fine-tunes the detection algorithm for faster and more accurate results.

After feature extraction, the system performs *image matching* to compare the extracted features with a preloaded database or dataset of animals (e.g., cows, elephants, boars(pig), tiger, monkey, deer, bear etc…) which have a serious threat to farmlands. If a match is found, the system identifies that an animal is present; otherwise, it concludes that no animal is found. This decision-making block ensures efficient filtering and recognition based on known threats using the previous databases.

If an *animal is detected*, then the system immediately triggers two alert mechanisms. One is, *buzzer* is activated to scare the animal away or alert nearby people. At the same time, simultaneously, the *SIM800L module* sends an SMS to the farm owner or responsible personnel, providing real-time notifications about the detected intrusion. This dual alert system ensures quick action can be taken to prevent damage in the agricultural field.

If *no animal is detected*, then the system simply continues monitoring the area. This loop ensures the system remains active and vigilantly. It constantly analyze incoming data from the ESP32-CAM without interruptions unless a threat is detected.

This *automated monitoring and alerting system* is low-cost, efficient, and highly suitable for remote farmlands. It reduces the need for manual surveillance and ensures a quick response to potential animal threats, protecting both crops and property effectively.

VII.RESULT AND DISCUSSIONS

The proposed animal detection and alert system was thoroughly tested in both controlled and real agricultural field. It was specifically deployed in forest-adjacent farmlands where wildlife intrusions are common. These comprehensive scenarios helped evaluate the system's effectiveness, reliability, and adaptability in real-world environments for the farm security.

In terms of detection accuracy, YOLOv8 out performed by achieving 80–95% accuracy. The system reliably identified common animals like wild boars(pig), cows, monkeys, elephant, tiger and dogs. Tuning detection thresholds and dataset augmentation minimized false positives caused by shadows or human activity.

Alert responsiveness was quick, with an average reaction time of 1.5 to 3 seconds for deterrents and sending alerts via SIM800L (GSM). While GSM network delays were noted in some rural zones, Wi-Fi offered faster communication where available. Farmers found the alerts very useful for taking immediate action.

System robustness was demonstrated using different animal species with stable performance from ESP32-CAM. Powered battery backups ensured continuous operation, even during. Energy-efficient programming allowed sensor nodes to operate up to 2 -3 days without recharging.

The solution proved to be highly cost-effective and making it easy to accessible by small-scale farmers. It leverages open-source hardware and software for affordability and customization. Minimal training was needed, and even farmers with little technical knowledge were able to use the system efficiently.

Some limitations were observed, such as occasional connectivity issues in remote areas, difficulty detecting camouflaged or small animals in dense vegetation, and the energy demands of continuous video processing. Future improvements may included for better speed, accuracy, and pattern recognition. Overall, the system shows strong potential to support rural farm security and reduce human-wildlife conflict.

VIII.CONCLUSION

Many farmers face big problems when wild animals enter their farms, especially near forests. These animals can damage crops, cause money loss, and even put farmers in danger and become a significant challenge for farmers to handle these issues everyday. Traditional methods of monitoring and deterrence are no longer sufficient to handle this growing threat in agricultural fields. To address this issue a smart system was made using low-cost devices like ESP32-CAM and tools with the help of AI models like YOLOv8, which can easily able to quickly spot animals and provide datas where and what(species) they are and send alerts using buzzers and through text messages(SMS). The smart animal detection system helps protect farms from wild animal attacks using cameras, sensors, and AI. It sends alerts and triggers buzzer to scares animals away automatically. The system is affordable and it is easy for farmers to use. It makes farming safer, reduces crop loss, and supports modern, eco-friendly farming.

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