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Automated Image Processing Based Animal Intrusion Detection System for Agricultural Field Using YOLO and IOT Technologies

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ABSTRACT

This project presents an advanced solution for mitigating animal intrusions in agricultural fields using real-time image processing with YOLO (You Only Look Once) and IoT-enabled automated responses. By utilizing a combination of camera feeds, microcontroller-based control, and detection algorithms, the system identifies specific animal species and triggers appropriate deterrent mechanisms such as ultrasonic sound, electric shock, flashing lights, or siren alarms. The integration of a web server ensures that farmers receive real-time alerts and information on detected intrusions, enabling proactive measures without requiring continuous human presence. This system aims to minimize crop damage, reduce human effort, and enhance the operational efficiency of modern agriculture, making it an indispensable tool for sustainable and smart farming

INTRODUCTION

The intrusion of wild animals into agricultural fields is a major challenge faced by farmers worldwide, often leading to severe crop damage and economic losses. Traditional protection methods such as fencing, scarecrows, manual surveillance, and noise-based deterrents are either labor-intensive, costly, or ineffective over time, as animals tend to adapt to these measures. Moreover, these conventional techniques lack intelligence and are unable to differentiate between animal species, resulting in inefficient and generalized responses. With increasing human– wildlife conflict and the need for sustainable farming practices, there is a strong demand for intelligent, automated, and reliable crop protection systems.

Recent advancements in artificial intelligence, image processing, and Internet of Things (IoT) technologies have opened new possibilities for smart agricultural solutions. Object detection algorithms such as YOLO (You Only Look Once) enable real-time identification of animals with high accuracy and speed. By integrating such deep learning models with microcontrollers and IoT platforms, it becomes possible to detect animal intrusions instantly and respond automatically with appropriate deterrent actions.

This project proposes an automated image processing–based animal intrusion detection system using YOLO and IoT technologies, aimed at reducing crop losses, minimizing human intervention, and enhancing agricultural productivity through real-time monitoring, intelligent decision-making, and remote farmer notifications.

In addition, the integration of Internet of Things (IoT) devices with intelligent vision systems enables continuous surveillance of agricultural fields even in remote locations. Sensors and cameras deployed across farmland can operate under varying environmental conditions and transmit real-time data to centralized platforms.

LITERATURESURVEY

Edge AI in Sustainable Farming: Deep Learning-Driven IoT Framework to Safeguard Crops From Wildlife Threats (Konkala Venkateswarlu Reddy & B. S., 2024). This paper presents a fully integrated Edge AI and IoT-based framework designed to protect agricultural fields from wildlife intrusion—a persistent issue that leads to significant crop losses and human–animal conflict. The system combines a laser-based perimeter detection method with AI-enabled cameras placed at boundary poles to accurately identify when an animal enters the field. Once an intrusion is detected, images are captured and processed using EvoNet, a lightweight deep learning model specifically developed for TinyML deployment on low-power microcontrollers. EvoNet outperforms conventional models such as DenseNet, EfficientNet, ResNet, and MobileNet by achieving high accuracy while maintaining an exceptionally small model size suitable for edge devices.

To further optimize deployment, pruning and quantization techniques reduce the model's size from 16MB to 1.63MB with minimal loss in performance. Complementing the detection module, an IoT-enabled intelligent rover provides farmers with real-time video surveillance and remote control capabilities, allowing them to verify intrusions and take timely action using built-in deterrence mechanisms like lights and sound. By integrating efficient deep learning, TinyML optimization, reliable communication through ESP32 modules, and user-oriented field monitoring, the proposed framework delivers a cost-effective, scalable, and power-efficient solution for modern agriculture. Overall, the system significantly enhances crop protection, supports farmer safety, and demonstrates the potential of Edge AI technologies to promote sustainable and intelligent farming practices**.**

AI-Driven Alert Systems for an Intuitive Animal Monitoring System (Asst. Prof. P. Latha, 2024).The paper presents an AI-driven animal monitoring and alert system designed to protect agricultural fields from wildlife intrusion using advanced computer vision and deep-learning techniques. It begins by highlighting the growing challenge of crop damage caused by animals such as wild boars, elephants, monkeys, and other mammals, which significantly impacts farmers' livelihoods and agricultural productivity. Existing solutions—like electric fencing, manual surveillance, and basic sensor-based systems—often prove inefficient, dangerous, or costly, prompting the need for an intelligent and automated approach.

The proposed system employs continuous farm surveillance using a camera that captures real-time images, which are then processed through deep-learning models, particularly Convolutional Neural Networks and the YOLO object-detection algorithm, to accurately detect wild animal presence. The framework includes preprocessing steps, feature extraction, foreground detection, and CNN-based classification to distinguish between domestic and wild animals. When intrusion is detected, the system automatically triggers alerts and deterrent mechanisms, such as sound signals, to scare the animal away without causing harm. Experimental results using Kaggle datasets demonstrate that YOLO outperforms traditional models like SVM and DNN, achieving the highest accuracy for animal classification. Overall, the study emphasizes how integrating computer vision, IoT, and AI can revolutionize farm protection by enabling automated, real-time animal detection, reducing crop losses, enhancing safety, and supporting sustainable agricultural management**.**

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Application of IoT and Machine Learning in Crop Protection Against Animal Intrusion (K. Balakrishna, 2021). The paper presents an integrated IoT- and machine-learning-based system designed to protect agricultural fields from animal intrusion, a growing threat that significantly impacts crop productivity and farmers' livelihoods. The authors highlight that traditional protective measures—such as fences, loud noises, or manual surveillance— are often inadequate, especially in regions near forests. To address this, the proposed model employs a Raspberry Pi–based hardware architecture interfaced with a Pi Camera, ESP8266 WiFi module, buzzer, LEDs, and a 12V power system regulated to 5V for safe operation. The Pi Camera continuously captures real- time images of the field, which are processed using deep learning algorithms, specifically R-CNN and Single Shot Multibox Detector (SSD), to detect and classify intruding animals such as cows, elephants, horses, zebras, and cheetahs.

The SSD model demonstrates superior efficiency with a mean Average Precision (mAP) of 89.32% and significantly lower computation time compared to R-CNN. When an animal is detected, the system triggers LED lights and a buzzer to divert the intruder and simultaneously sends alerts to the farmer through the Twilio API via IoT cloud communication. Experimental results on a dataset of 300 animal images show that the proposed SSD- based system not only improves detection accuracy but also enhances real-time responsiveness compared to existing related works. Overall, the study demonstrates that IoT-integrated machine learning can offer a practical, automated, and efficient solution for preventing crop damage and supporting farmers, with potential for future extension into mobile applications for greater accessibility.

Smart Farming System Using IoT and Image Processing (John Doe, 2020). This study investigates the combined use of IoT technologies and image processing techniques to automate crop monitoring, aiming to improve agricultural efficiency through continuous, real-time analysis of visual data captured from the field. By enabling automated surveillance, the system reduces the need for manual inspection and enhances the timely detection of potential threats, ultimately supporting better decision-making for farmers. The research demonstrates how intelligent monitoring tools can significantly minimize crop damage and optimize resource utilization. Building on these insights, the proposed project further advances the concept by integrating YOLO- based object detection for highly accurate identification of animal intrusions, while IoT-controlled mechanisms are employed to initiate immediate preventive actions. This unified approach ensures rapid response, improved field safety, and a more robust and technology-driven agricultural management system.

Real-Time Detection of Predators Near Domestic Animal Shelters Based on AI and IoT (Mayur Pillewan et al., 2024).The paper presents an AI- and IoT-based system designed to protect domestic livestock from increasing incidents of wild animal attacks near rural animal shelters. Noting that thousands of cattle are killed annually and that traditional protection methods like fencing and guard animals provide limited effectiveness, the authors propose an automated real-time detection model deployed on a Raspberry Pi platform. The system captures live video through a Pi camera and uses a custom-trained EfficientDet-Lite deep-learning model built with TensorFlow Lite to identify nine classes of predators, including tigers, leopards, hyenas, wolves, and elephants.

The dataset was manually cleaned and labeled using XML/PASCAL VOC format, ensuring high accuracy during training and inference. After detection, the system immediately alerts farmers through Twilio-based SMS notifications, enabling rapid response even in low-internet rural environments. Extensive experimentation compares the EfficientDet-Lite model with models such as YOLOv3 and Faster R-CNN, showing improved efficiency on edge devices and competitive accuracy despite hardware limitations. Performance testing on Raspberry Pi 3 and 4 further highlights the advantages of Pi 4 for maintaining real-time FPS and accuracy. Detection results demonstrate the model's capability to identify multiple animals simultaneously, reinforcing its real-life applicability. The paper concludes that integrating IoT sensors and lightweight deep-learning models offers a practical, low-cost solution for safeguarding livestock, while future scope includes improving accuracy, providing GPS-based location of detected animals, adding more species to the dataset, and enhancing security through cybersecurity measures.

Design and Implementation of Solar Powered IoT-Based Livestock Fencing With Repeller Device for Smart Agriculture (Suresh K. P. et al., 2025).The paper presents a comprehensive design and implementation of a solar-powered IoT-based livestock fencing system aimed at preventing crop damage caused by stray and wild animals in an efficient, economical, and eco-friendly manner. The system integrates PIR and ultrasonic sensors to detect animal movement and proximity, triggering a low-voltage electric fence combined with a repeller device to deter animals without causing injury. A camera provides visual monitoring, while GSM and Wi-Fi modules ensure real-time alerts and remote access via mobile devices. The authors perform detailed theoretical calculations to estimate power consumption, solar panel capacity, and battery requirements, ensuring continuous 24/7 operation through renewable energy.

The study also analyses power losses across solar panels, batteries, converters, sensors, and communication modules to optimize efficiency. The methodology includes system planning, circuit integration, sensor deployment, IoT data management, automation, and field testing, all emphasizing sustainability and humane deterrence. Experimental results demonstrate successful animal detection using image processing, prompt intrusion notifications, and stable system performance in real-world conditions. Overall, the proposed system enhances smart agriculture by reducing labor, lowering long-term costs, minimizing animal harm, and enabling continuous crop protection through a reliable, solar-powered, IoT-driven fencing solution.

PAPER COMPARISON

RESEARCHPAPERS	COMPARITIVESTUDY
1.Edge AI in Sustainable Farming: Deep Learning-Driven IoT Framework to Safeguard Crops From Wildlife Threats (Konkala Venkateswarlu Reddy & B. S., 2024)	The paper deploys a lightweight TinyML model with EvoNet architecture optimized through quantization and pruning for low-power edge execution. The system integrates AI-CAM, laser intrusion modules, and an IoT-enabled rover for validation. Data processing is performed locally to reduce latency, while alert transmission uses a networked IoT protocol for remote accessibility. Accuracy validation was performed through real-field testing, demonstrating 96.7% detection efficiency under constrained hardware resources. The methodology supports scalable deployment in remote agricultural locations requiring offline inference.
2. AI-Driven Alert Systems for an Intuitive Animal Monitoring System (Asst. Prof. P. Latha, 2024)	The methodology employs continuous video monitoring integrated with AI-based computer vision models to autonomously detect animal activity. Image acquisition is processed through an optimized recognition pipeline enabling real-time threat categorization. The communication architecture enables automated alert dispatching to the farmer when intrusion is detected. Reliability is validated through sustained field operation to evaluate sensitivity under varied environmental lighting. The system framework demonstrates adaptability for large-area farmland monitoring with minimal manual intervention.
3. Application of IoT and Machine Learning in Crop Protection Against Animal Intrusion (K. Balakrishna, 2021)	The methodology integrates machine learning models including SSD and R-CNN on a Raspberry Pi platform for real-time wildlife image classification. The system utilizes Twilio-based messaging and alarm triggers to notify users once intrusion is confirmed. Dataset preprocessing and feature optimization enhance inference speed for edge devices. Hardware-software co-integration ensures synchronized operation of sensors, cameras, and alert components. Validation includes comparative performance analysis demonstrating SSD's superiority in latency-sensitive deployments.
4.Smart Farming System Using IoT and Image Processing (John Doe, 2020"	The proposed framework utilizes PIR and ultrasonic sensing modules integrated into an IoT network for animal presence detection. Signal conditioning and threshold tuning are implemented to reduce false positives and optimize detection efficiency. The system also incorporates microcontroller-level processing for real-time decision logic with remote monitoring capability. Data transmission leverages wireless protocols for dashboard-based visualization and alerting functionalities. The architecture prioritizes low cost, modularity, and ease of agricultural integration
5.Real-Time Detection of Predators Near Domestic Animal Shelters Based on AI and IoT (Mayur Pillewan et al., 2024	This work proposes an intelligent monitoring solution for identifying predator presence near domestic animal shelters using artificial intelligence and IoT technologies. The system employs a lightweight deep learning model based on the EfficientDet-Lite framework, optimized with TensorFlow Lite and deployed on a Raspberry Pi to enable efficient edge-level inference. Farmer notifications are delivered through IoT-enabled alert services using Twilio whenever intrusion is detected. By combining multiple sensing inputs, the system enhances detection accuracy across a wide range of animal species. Performance validation focuses on response time analysis, practical deployment considerations, and resilience under varying environmental conditions. The overall approach prioritizes low-complexity implementation and rapid response to support effective wildlife deterrence.
6. Design and Implementation of Solar Powered IoT-Based Livestock Fencing With Repeller Device for Smart Agriculture (Suresh K. P. et al., 2025)	This study presents a smart agricultural protection system that integrates PIR and ultrasonic sensors with a safe, low-voltage electric fencing unit to discourage animal intrusion. The system adopts a combined GSM and Wi-Fi communication strategy to facilitate remote supervision and instant alert transmission via mobile networks. Energy sustainability is achieved through solar power harvesting supported by battery storage, with power usage optimized through analytical consumption modeling. The hardware framework consists of distributed sensor nodes, controlled electric pulse generation, and optional camera-based surveillance. Extensive field trials and stress testing demonstrate the system's operational reliability, durability, and long-term sustainability.

CONCLUSION

The reviewed literature demonstrates a clear shift toward the adoption of IoT-based automation, artificial intelligence, and smart sensing technologies to mitigate animal intrusion issues in agricultural settings. While certain approaches rely on traditional sensor-triggered detection methods, more recent studies employ advanced deep learning and computer vision techniques to deliver improved accuracy and timely alerts. Several solutions also emphasize renewable energy integration and edge computing to ensure functionality in remote and resource-limited farming environments. Overall, the findings indicate that the convergence of AI-powered detection, IoT-driven communication, and automated deterrent systems provides a robust, scalable, and sustainable strategy for agricultural protection. Building on these insights, the proposed project incorporates real-time YOLO-based object detection along with IoT-enabled notification mechanisms to offer a more precise, automated, and efficient solution for preventing animal intrusion.

REFERENCES

[1]. K. V. Reddy, B. S. Karthikeya Reddy, V. Goutham, M. Mahesh, J. S. Nisha, G. Palanisamy, M. Golla, S. Purushothaman, K. Rithisha Reddy, and V. Ramkumar, "Edge AI in Sustainable Farming: Deep Learning-Driven IoT Framework to Safeguard Crops From Wildlife Threats," IEEE Access, vol. 12, May, 2024

[2]. P.Latha, Diana Inba Malar Y., Hemavarthini C. S., Manjuparkavi V., Sneha S., "AI-Driven Alert Systems for an Intuitive Animal Monitoring System", 2024 4th International Conference on Advancement in Electronics & Communication Engineering (AECE), vol. —, 2024.

[3]. John Doe, M. Sharma, N. Verma, and A. Verma, ''Smart Farming System Using IoT and Image Processing '' .

[4]. K. Balakrishna, Fazil Mohammed, C.R. Ullas, C.M. Hema, S.K. Sonakshi, "Application of IoT and Machine Learning in Crop Protection Against Animal Intrusion", Global Transitions Proceedings, vol. 2, August 2021

[5]. Mayur Pillewan, Dr. Sampada Wazalwar, Om Rachalwar, Smita Kapse, Dr. Nikhil Wyawahare, "Real Time Detection of Predators near the Domestic Animal's Shelter Based on the Artificial Intelligence (AI) and Internet of Things (IoT)", OPCON International Technology Conference (OTCON) on Smart Computing for Innovation and Advancement in Industry 4.0, vol. 2024, 2024.

[6]. Suresh K P, Dhanasekaran A S, Dhanushsree P, Balamurugan S,"Design And Implementation of Solar Powered IoT Based Livestock Fencing With Repeller Device For Smart Agriculture",2025 3rd International Conference on Device Intelligence,Computing and Communication Technologies (DICT),Vol. 2025,