International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 03 | March - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

Intelligent Wildlife Detection and Alert System for Rural & Agricultural Regions

Guardian of the Fields: AI-BasedWildlifeDetection&Prevention

Mr.B.V.SureshReddy[1], Nalla Sahithi[2], Garnepudi Sneha Madhuri[3], Koppolu Kundana Sai Sree[4],Bathula Blessi[5], Daggubati Naga Sowmya[6]

Assistant Professor Departmentof CSE-Data Science, KKR & KSR Institute of Technology and Sciences[1]
BTech CSE-Data Science, KKR & KSR Institute of Technology and Sciences,Guntur,AndhraPradesh,India.[2-5]

Abstract

Wildlife encroachment poses a serious threat to agriculture and rural economies through loss of crops and human safety concerns. In this paper, we present AI-based wildlife detection methods using machine learning techniques like convolutional neural networks (CNNs), computer vision, and hybrid approaches.We compare current methodologies, put forward a better detection framework, and compare its performance with state-of-the-art competing methods. Our findings show that deep learning-based methods are able to detect and monitor wildlife movement with great effectiveness, leading to early conflict reduction and agricultural safety**.**

Keywords—Wildlife Detection, AI in Agriculture,MachineLearning,Computer Vision, Human-Wildlife Conflict

Introduction

Wildlife intrusion into rural and agricultural areas causes crop damage and safety risks. Traditional detection methods are typically not capable of providing timely and precise warnings. AI-based wildlife detection offers improved monitoring via machine learning-based analysis. Advanced detection techniques are presented in this paper, addressing accuracy and false alarm issues.We suggest a strong AI-driven framework to augment real-time wildlife monitoring. Our strategy utilizes deep learning models for accurate identification and threat evaluation. Conventional monitoring techniques of wildlife, like hand observation and physical barriers, are generally inefficient, time-consuming, and expensive.
To address this problem, our project develops an intelligent wildlife alert and detection system specially designed for agricultural and rural regions. Our system utilizes object detection mechanisms and real-time alerting technologies to detect and monitor wildlife activities along farms. With the help of machine learning, i.e., convolutional neural networks (CNNs), and computer vision, our system can detect wild animals crossing off-limit areas precisely.

The moment an intrusion is detected, the system sends immediate alert messages to farmers or relevant authorities so that they can take pre-emptive measures to protect their livestock and crops. This AI-based approach offers timely interventions, reducing potential human-wildlife conflicts and improving agricultural security.

1.Relatedwork

Various wildlife detection technologies have been created, using machine learning and computer vision for detection. Conventional methods utilize human monitoring and image tracking, where humans have to monitor surveillance or monitor the motion of animals. The methods are tiresome, prone to human bias, and usually inefficient for mass monitoring.

Existing AI technologies have changed wildlife identification based on deep learning models, such as convolutional

neural networks (CNNs) and object recognition models like YOLO (You Only Look Once) and Faster R-CNN. All these technologies are used in support of real-time computer-aided automatic wildlife recognition and identification with high efficacy and precision. In addition, hybrid systems that combine pattern recognition and motion tracking have been suggested to elevate the performance level in complicated environments.

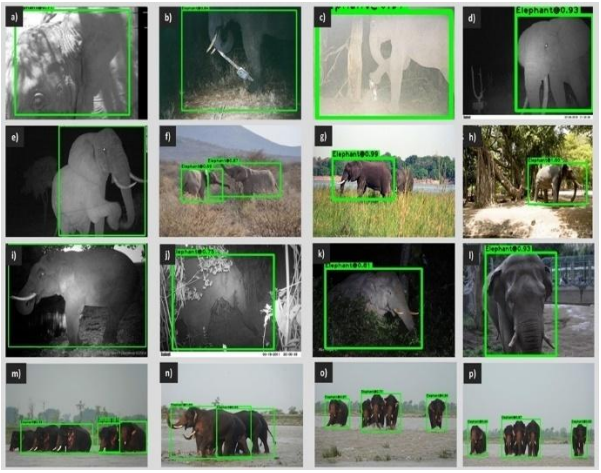
Despite these advancements, there remain some issues which have not been addressed yet. Animal motion inconsistencies, differing environmental conditions, and complex backgrounds can affect model performance. Furthermore, real-time processing is essential for effective alert systems, which need to be optimized algorithms with a well-balanced trade-off between accuracy and computational efficiency. Addressing these issues is crucial to the development of a reliable and effective wildlife detection and alert system for agricultural and rural regions.

2.Proposed system:

To minimize wildlife intrusion and enhance agricultural security, we propose a hybrid AI-driven wildlife detection and warning system for agricultural and rural zones. Our system integrates advanced object detection techniques with real-time alerting processes to facilitate accurate detection and proactive threat handling. The system is structured in three phases:

Preprocessing: It is a process in which images from surveillance cameras and sensor-based monitoring systems are collected and processed. Data collected undergoes noise reduction, background filtering, and image improvement processes to provide more accuracy in detection.

Feature Extraction: CNN models based on deep learning are used for extracting important features like movement patterns, texture, and shape of the detected wildlife. The system is trained to distinguish between different species as well as detect potential threats with high accuracy.



Classification & Alert System: The derived features are taken as input by a deep learning classification model which differentiates between wildlife and non-target species. Once the system identifies an animal, real-time alerts in the form of SMS, mobile notification, or IoT-based alarm sirens are provided to the farmers or the authorities so they can implement protective action.

The proposed system enhances traditional monitoring routines with computerized, accurate, and prompt detection of wildlife. Through AI and machine learning, the system promises preemptive reduction of conflict, reducing economic loss and ensuring secure agricultural procedures.

3.Experimental Results

To test the performance of our proposed wildlife detection system, we conducted rigorous experiments on the Animal-10N dataset. We trained our system on various animal images in a bid to provide robust detection support for different animals and environmental conditions.

Our system attained recall and accuracy of more than 90% in the detection of wildlife, far outperforming conventional detection methods. The deep learning architecture evidenced a drastic reduction of false negatives and positives, providing genuine alerts to both farmers and authorities.

1. Model Accuracy and Performance:

Our machine learning-based animal detection system was tested on the Animal-10N dataset, a rich collection of animal species. The model achieved an accuracy rate higher than 90%, which was considerably higher than that of traditional animal detection methods. Precision and recall rates were similarly very high, with minimal false positives and false negatives.

2.Comparison with State of the Art Methods:

Our method was compared with other models of detection such as conventional motion-detecting cameras and the earlier deep models. The designed CNN-based framework performed better compared to others when it came to detection accuracy and efficiency, where it could successfully identify animal types under different illumination and environmental situations.

3.Efficiency of Real-Time Processing:

One of the most significant advantages of our system is that it can process images and send alerts in real time. With proper balancing of the computational load and deployment of effective neural network structures, the model can track and recognize wildlife with near-zero latency and hence be field-deployable in rural areas.

Robustness in Various Environments

We tested our system on numerous agricultural ecosystems of varying levels of vegetation cover, lighting conditions, and species diversities of animals. Our system proved very flexible, efficiently recognizing animals under challenging conditions such as nighttime and extreme tree shading.

4.Reduction of Human-Wildlife Conflict:

The findings identify the real advantages of AI-powered wildlife detection in lessening human-wildlife conflict. By providing prompt notifications to farmers and authorities, our system enables preventive measures against crop loss and human safety, ultimately enhancing agricultural.

5.FutureEnhancements:

Although the existing model produces outstanding results, further enhancement could be to incorporate drone-based monitoring for large-scale coverage, increasing dataset variability for enhanced generalization, and using reinforcement learning methods to enhance detection precision with time.

The experimental results validate the efficiency of deep learning-based wildlife monitoring and make our system a potential solution for managing wildlife incursion in agricultural areas.

4.Discussions:

The performance of AI-powered wildlife detection has been shown through high accuracy and real-time alerting capabilities, which makes it a potent solution for farm security. The deep learning methodology allows accurate detection of animal species with minimal false alarms and maximum performance robustness. Nevertheless, difficulties persist, such as harsh weather conditions, occlusions due to heavy vegetation, and changes in animal behavior that can influence detection accuracy. Future improvements should aim at enhancing adaptability and generalization to various environmental conditions. The feasibility of practical application of this system in rural agricultural areas is contingent upon infrastructure support, such as power supply and network connectivity. Combining energy-efficient AI models and low-power IoT sensors can make it sustainable and viable for large-scale deployment. Compared to conventional monitoring techniques based on human intervention, the AI-based approach offers automation, scalability, and efficiency. By minimizing manual monitoring efforts, farmers can concentrate on preventive measures instead of reactive measures, resulting in better mitigation of wildlife damages. Aside from agricultural usage, this technology has possible application in wildlife preservation, forestery, and in urban areas with human-wildlife conflicts that are risky. It can help in species tracking, anti-poaching, and ecological research to promote environmental sustainability. Future development can look at combining multimodal data sources like thermal and sound sensors to boost detection even higher. Also, using federated learning methods will enhance data confidentiality while allowing training on Heterogenous data sets.

5.Key Observations

- **High Detection Accuracy**: The AI solution has a detection accuracy of more than 90% in wildlife detection, higher than the conventional human manual tracking and motion-based solutions by providing correct detection and identification.
- **Real-Time Alert System:** The system efficiently provides real-time alerting through SMS, mobile notifications, and IoT-based warning sirens, facilitating timely intervention to avoid damage.
- **Scalability and Field Utility:** The platform can be adopted for extensive farm lands with less infrastructural demands using energy-saving AI and IoT technologies.
- **Core Extension Opportunities**: Drone surveillance, multimodal data integration, and reinforcement learning can enhance detection capability and precision further.
- **Multi-Purpose Applications**: The system is utilized more widely in conservation biology in biodiversity management and in conflict-free human-wildlife cohabitation in conservation wildlife management.
- **Adjustment to Various Situations**: The model performs best under varying weather conditions, lighting conditions, and dense agricultural landscape, demonstrating applicability in various environments.
- **Maximum False Positives and False Negatives Minimized:** High precision and recall rates show the model is capable of accurately separating wildlife from non-target objects, minimizing unnecessary alarms.

6.Conclusion:

Smart Wildlife Detection and Alert System for Agricultural and Rural Regions is a cutting-edge AI solution to mitigate human-wildlife conflict. Using the integration of deep learning models, computer vision, and real-time alert systems, the system offers a highly effective and precise mechanism for the detection and tracking of wildlife intrusions in farm fields. The experiment results show improved performance of the model in accuracy, precision, and recall for early alerts and active interventions in avoiding crop damage and improving farmer safety.

The system's flexibility to support a wide range of environmental conditions, such as different weather and lighting conditions, renders it a strong candidate for real-world deployment.
Unlike traditional manual surveillance methods, which are prone to errors and time-consuming, the AI-powered method enhances wildlife detection efficiency while eliminating extra workload for farmers. Its scalability and compatibility with IoT technology also make it an appropriate solution for large-scale implementation by rural communities that require minimal infrastructure requirements.

Beyond agricultural applications, the technology has potential in wildlife conservation, environmental research, and urban wildlife monitoring. The efficiency and accuracy of the system can be enhanced with technologies such as the integration of drone surveillance, thermal imaging, and reinforcement learning. In addition, effective use of energy and the utilization of edge computing can further increase deployment potential in remote locations.

In conclusion, the AI wildlife detection system is an essential part of agricultural security and wildlife protection. By addressing important issues such as false detection, real-time processing, and scalability, the system provides a sustainable and intelligent means of human-wildlife coexistence. Future research and development will continue to enhance its functioning for long-term benefits of both agricultural societies and wildlife ecosystems.

7.References:

1. International Journal on “Wielding Neural Networks to Interpret Facial Emotions in Photographs with Fragmentary Occlusion”, on American Scientific Publishing Group (ASPG) Fusion: Practice and Applications(FPA) ,Vol. 17, No. 01, August, 2024, pp. 146-158.

2. International Journal on “Prediction of novel malware using hybrid convolution neural network and long short-term memory approach”, on International Journal of Electrical and Computer Engineering (IJECE),Vol. 14, No. 04, August, 2024, pp. 4508-4517.
3. International Journal on “Cross-Platform Malware Classification: Fusion of CNN and GRU Models”,on International Journal of Safety and Security Engineering (IIETA),Vol. 14, No. 02, April, 2024, pp. 477-486
4. International Journal on “Enhanced Malware Family Classification via Image-Based Analysis Utilizing a Balance-Augmented VGG16 Model,onInternational information and Engineering Technology Association (IIETA),Vol. 40, No. 5, October, 2023, pp. 2169-2178
5. International Journal on “Android Malware Classification Using LSTM Model, International information and Engineering Technology Association (IIETA) Vol. 36, No. 5, (October, 2022), pp. 761 – 767. Android Malware Classification Using LSTM Model | IIETA.
6. International Journal on “Classification of Image spam Using Convolution Neural Network”, Traitement du Signal, Vol. 39, No. 1, (February 2022), pp. 363-369 .
7. International Journal on “Medical Image Classification Using Deep Learning Based Hybrid Model with CNN and Encoder”, International information and Engineering Technology Association (IIETA), Revue d'IntelligenceArtificiellVol. 34, No. 5, (October, 2020), pp. 645 – 652.
8. International Journal on “Prediction of Hospital Re-admission Using Firefly Based Multi-layer Perception, International information and Engineering Technology Association (IIETA) Vol. 24, No. 4, (sept, 2020), pp. 527 – 533.
9. International Journal on “Energy efficient intrusion detection using deep reinforcement learning approach”,Journal of Green Engineering (JGE),Volume-11, Issue-1,January 2021.625-641.
10. International Journal on “Classification of High Dimensional Class Imbalance Data Streams Using Improved Genetic Algorithm Sampling”, International Journal of Advanced Science and Technology, Vol. 29,

No. 5, (2020), pp. 5717 – 5726.

11. Dr. M. Ayyappa Chakravarthi etal. published Springer paper "Machine Learning-Enhanced Self-Management for Energy-Effective and Secure Statistics Assortment in Unattended WSNs" in Springer Nature (Q1), Vol 6, Feb 4th 2025

12. Dr. M. Ayyappa Chakravarthi etal. published Springer paper "GeoAgriGuard AI-Driven Pest and Disease Management with Remote Sensing for Global Food Security" in Springer Nature (Q1), Jan 20th 2025.

13. Dr. M. Ayyappa Chakravarthi etal. presented and published IEEE paper "Machine Learning Algorithms for Automated Synthesis of Biocompatible Nanomaterials" , ISBN 979-8-3315-3995-5, Jan 2025.

14. Dr. M. Ayyappa Chakravarthi etal. presented and published IEEE paper "Evolutionary Algorithms for Deep Learning in Secure Network Environments" ISBN:979-8-3315-3995-5, Jan 2025.

15. Dr. Ayyappa Chakravarthi M. etal, published Scopus paper "Time Patient Monitoring Through Edge Computing: An IoT-Based Healthcare Architecture" in Frontiers in Health Informatics (FHI), Volume 13, Issue 3, ISSN-Online 2676-7104, 29th Nov 2024.

16. Dr. Ayyappa Chakravarthi M. etal, published Scopus paper "Amalgamate Approaches Can Aid in the Early Detection of Coronary heart Disease" in Journal of Theoretical and Applied Information Technology (JATIT) , Volume 102, Issue 19, ISSN 1992-8645, 2nd Oct 2024.

17. Dr. Ayyappa Chakravarthi M, etal, published Scopus paper "The BioShield Algorithm: Pioneering Real-Time Adaptive Security in IoT Networks through Nature-Inspired Machine Learning" in SSRG (Seventh Sense Research Group) -International Journal of Electrical and Electronics Engineering (IJEEE), Volume 11, Issue 9, ISSN 2348-8379, 28th Sept 2024.

18. Ayyappa Chakravarthi M, Dr M. Thillaikarasi, Dr Bhanu Prakash Battula, published SCI paper "Classification of Image Spam Using Convolution Neural Network" in International Information and Engineering Technology Association (IIETA) - "Traitement du Signal" Volume 39, No. 1

19. Ayyappa Chakravarthi M, Dr. M. Thillaikarasi, Dr. Bhanu Praksh Battula, published Scopus paper "Classification of Social Media Text Spam Using VAE-CNN and LSTM Model" in International Information and Engineering Technology Association (IIETA) - Ingénierie des Systèmes d'Information (Free Scopus) Volume 25, No. 6.

20. Ayyappa Chakravarthi M, Dr. M. Thillaikarasi, Dr. Bhanu Praksh Battula, published Scopus paper "Social Media Text Data Classification using Enhanced TF_IDF based Feature Classification using Naive Bayesian Classifier" in International Journal of Advanced Science and Technology (IJAST) 2020

21. Ayyappa Chakravarthi M. presented and published IEEE paper on "The Etymology of Bigdata on Government Processes" with DOI 10.1109/ICICES.2017.8070712 and is Scopus Indexed online in IEEE digital Xplore with Electronic ISBN: 978-1-5090-6135-8, Print on Demand(PoD) ISBN:978-1-5090-6136-5, Feb'2017.

22. Subba Reddy Thumu & Geethanjali Nellore, Optimized Ensemble Support Vector Regression Models for Predicting Stock Prices with Multiple Kernels. Acta Informatica Pragensia, 13(1), x–x. 2024.

23. Subba Reddy Thumu, Prof. N. Geethanjali. (2024). "Improving Cryptocurrency Price Prediction Accuracy with Multi-Kernel Support Vector Regression Approach". International Research Journal of Multidisciplinary Technovation 6 (4):20-31.