EYE IN THE WILD: REAL-TIME POACHING DETECTION WITH YOLO AND IOT

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Keywords:

Anti-Poaching Strategies, Artificial Intelligence (AI), Internet of Things (IoT), Wildlife Protection, Real-Time Monitoring Systems, Machine Learning Techniques, Convolutional Neural Networks (CNN), Object Recognition, Wildlife Security, Forest and Habitat Protection.

Introduction:

The practice of poaching body parts of animals continues to be a significant threat to many species worldwide, resulting in the near-extinction of species such as rhinos, elephants, and tigers. Conventional methods for wildlife conservation, such as foot patrolling and camera trapping, are effective only when threats are identified after damage has already been done. To overcome these challenges, the proposed project aims to introduce a new paradigm for wildlife conservation based on Artificial Intelligence (AI) and Internet of Things (IoT). AI can be used for effective and efficient monitoring and analysis of wildlife habitats in real-time, while IoT can be used for efficient data collection and communication in remote areas such as forests. These two technologies can be used together to develop a highly effective and efficient system for wildlife conservation that can identify suspicious activities and unusual movements in wildlife habitats before incidents of poaching occur.

The need for effective solutions for wildlife conservation can be understood from the alarming statistics on wildlife crimes reported globally between 2007 and 2022, resulting in the deaths of 100,000 elephants, 7,245 rhinos, and 2,359 tigers. In addition to these species, many pangolin and bird species are also being poached on a large scale. Marine species are also threatened due to large-scale illegal harvesting. In India alone, between 2000 and 2021, more than 1,160 elephants, 206 rhinos, and 1,059 tigers have become victims of poaching activities.

Objectives:

1. To utilize AI and IoT technology to continuously monitor wildlife habitats.
2. To send instant alerts to forest authorities, allowing them to respond quickly.
3. To promote advanced conservation strategies for long-term sustainability.
4. To analyze collected data to predict poaching patterns and enhance preventive measures.

Methodology:

The proposed system for preventing poaching is beneficial to the security of wildlife since it will provide alerts regarding unauthorized access to protected areas. This system will comprise hardware and software components, including a camera and a compute engine, to capture images or videos. This system will detect suspicious human activity with the help of an intrusion detection system based on machine learning and will provide alerts through an SMS module.

The system is developed with the help of the Python programming language and the Visual Studio IDE. This system will make use of the YOLO v8n model to detect objects in real-time since it is fast and efficient. This model will be trained with a publicly available dataset with various environmental conditions to achieve high accuracy. This system will be evaluated based on certain metrics to detect intruders effectively.

Result and Conclusion:

The anti-poaching system using YOLOv8n and IoT demonstrated high precision (81.4%) and moderate recall (59.1%) in detecting poachers, non-poachers, animals, and tools. The confusion matrix and Precision-Recall curves show strong performance for poacher detection but challenges in identifying non-poachers under poor lighting, occlusion, or dense backgrounds. Real-time alerts via SMS were successfully tested in simulated forest environments, and heatmaps revealed peak poaching activity during early nighttime hours. Limitations include moderate recall, false positives, and untested performance under real-world conditions.

The system is effective for real-time wildlife surveillance, combining object detection with IoT notifications. It provides timely alerts and shows robust precision, making it suitable for operational deployment. Future improvements include expanding the dataset, incorporating thermal cameras, testing in real forest environments, and enhancing recall to reduce missed detections and false positives.

Project Outcome & Industry Relevance:

This paper has been able to present a successful implementation of a real-time poacher detection system, using YOLO and IoT, which not only detects the presence of any suspicious activity but can alert the concerned authorities instantly. This application has shown very promising results regarding the detection of poachers, their equipment, and the wildlife itself as well as SMS alerts about all these issues in a timely manner. Industry-wise, this solution has great importance as far as wildlife conservation organizations and forest departments are concerned.

Working Model vs Simulation:

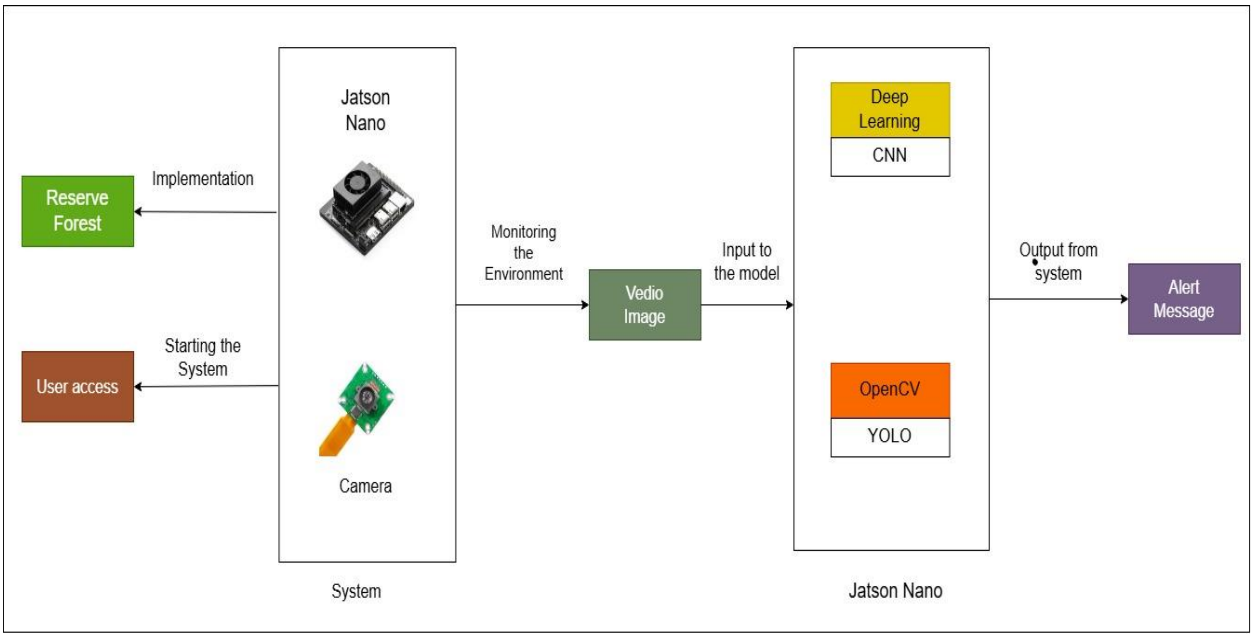

Fig 1: Architecture diagram

As shown in Fig. 1, the working model represents the actual implementation of the proposed system using real hardware and software components. In this project, it includes a camera for capturing real-time video, a processing unit such as Jetson Nano for executing the YOLO-based detection model, and an IoT module for sending alert messages. The working model operates in real-time and is intended for deployment in forest environments, providing practical insights into system performance.

In contrast, simulation involves testing the system in a controlled or virtual environment using pre-recorded videos or artificially created scenarios. In this study, simulated forest environments were used to evaluate the model's detection capabilities under varying conditions such as lighting and background complexity. However, these simulations do not fully replicate real-world conditions such as dense vegetation, weather variations, night-time visibility, and unpredictable wildlife movement.

Project Outcomes and Learnings:

The project led to the creation of an anti-poaching detection system with real-time capability that uses YOLO and the Internet of Things (IoT). From the process involved in developing this application, some important lessons were learned in various domains, such as object detection using artificial intelligence (AI), data sets creation and training, and the assessment of the performance of this technology based on measures such as precision and recall. Also, practical knowledge about implementing AI with the IoT, considering factors such as environmental fluctuations and limitations, such as false-positive cases and recall failures, was acquired.

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Future Scope:

Future scope in relation to the performance, reliability, and functionality of the project includes a number of areas that can be addressed to improve the overall system. The performance of the model could be enhanced through larger datasets, using night and multi-angle photographs and by utilizing more advanced algorithms and thermal cameras. The system could also be enhanced by adding functionality in the form of detecting fires and smokes in real time as a method of preventing forest fires from occurring. The system could become more reliable through its usage in an actual forest environment, in addition to better communications with the use of long-range Internet of Things and the use of solar energy. Furthermore, the system could be enhanced through the surveillance of forest regions against any forms of illegal activity including tree cutting and transportation.