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Wild Animal Detection System for Residential Area

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Abstract - Human-animal conflicts are a rising concern in regions adjacent to forests, leading to loss of life and property. Traditional methods of wildlife monitoring and management often lack real-time applicability. This paper presents a novel solution combining Artificial Intelligence (AI), Internet of Things (IoT), and real-time detection technologies to address the issue. The proposed system uses the YOLO (You Only Look Once) algorithm for fast and accurate identification of wild animals entering residential areas. Integrated with an Arduino-based siren and manual verification by forest departments, the system minimizes false positives and ensures timely warnings to the public.

Key Words **-** YOLO algorithm, animal detection, IoT, real-time detection, wild animal alerts, human-animal conflict.

Introduction

Human-animal conflicts have been increasing due to urbanization near forested areas. Incidents like wild elephants destroying crops and leopards attacking livestock are common in rural regions of India. These conflicts have devastating impacts, both socially and economically. Existing detection systems primarily focus on theoretical studies and machine learning techniques that fall short in real-world applications. This paper proposes a system that leverages modern AI techniques and IoT integration to provide an effective and scalable solution to mitigate these conflicts.

Problem Statement

The aim is to develop an automated system that detects wild animals, such as lions, tigers, and leopards, entering residential areas, confirms their presence through manual verification by forest authorities, and triggers an alert to notify the local population.

Literature review

In recent years, numerous studies have explored wild animal detection systems, primarily focused on using machine learning and image processing techniques.

Sreedevi K.L. and Dr. Anitha Edison (2022**)** proposed a deep learning approach for animal detection using Convolutional Neural Networks (CNNs) for image classification. While their model demonstrated accuracy in identifying animal species, it lacked real-time applicability and struggled with false positives in complex backgrounds, reducing its reliability in practical scenarios.

Similarly, Meera et al. (2022) designed an animal detection alert system aimed at enhancing rural safety. Their system combined basic image recognition with sensor-based detection; however, its limited real-time capability and high false-positive rate reduced its effectiveness. This often resulted in unreliable alerts, failing to differentiate accurately between animals and other environmental elements.

Another study **by** Zihang Song, Wenkang Gong, Chenxi Li, and Teoh Teik Toe (2022) focused on enhancing CNN architectures for animal image classification. While their improvements increased classification accuracy, the study lacked a real-time alert mechanism, making it unsuitable for applications requiring immediate threat detection, such as residential area safety near forests.

Objective

Following are the objectives behind the idea of the project:

1) Develop a reliable animal detection system using AI.
2) Send real-time alerts to nearby communities.
3) Reduce crop and livestock damage in rural areas.

4) Increase community safety.

Proposed System

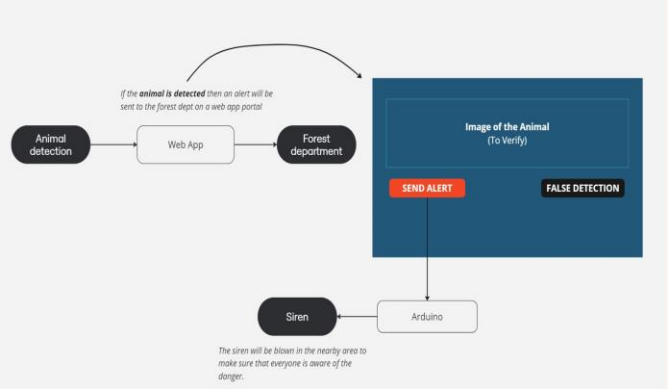

Fig 1. Architecture of proposed Model

The proposed system integrates AI, IoT, and manual verification layers to ensure real-time animal detection and alerting.

1) **Input Data:** Camera's capture images in areas vulnerable to wildlife intrusion.
2) **Preprocessing Unit:** The captured images are processed to ensure clarity and reduce noise.
3) **Animal Detection Model:** The YOLO algorithm processes the images, detecting wild animals by dividing the input image into a grid and predicting bounding boxes and class probabilities in a single pass.
4) **Classification Layer:** This layer determines the type of animal detected, classifying it based on predefined categories (lion, leopard, tiger, etc.).
5) **Manual Verification:** The detection is sent to the forest department for verification to reduce false alarms.
6) **IoT-Based Alert System:** Once verified, the Arduino-based siren is triggered, alerting the local population.

Algorithmic Approach

YOLO Algorithm

YOLO is a state-of-the-art, real-time object detection system that processes entire images at once, as opposed to scanning regions of interest. The image is divided into grids, and bounding boxes and class probabilities are predicted simultaneously, resulting in fast and accurate detection. YOLO is particularly efficient for this application because it processes images in one pass, minimizing latency in real-time systems.

The YOLO (You Only Look Once) algorithm follows several key methodologies for efficient real-time object detection:

1) Single-Pass Detection: YOLO processes the entire image in a single forward pass, treating object detection as a unified regression problem, allowing for high speed.
2) Grid Division: The image is divided into an S×S grid, with each cell predicting bounding boxes and class probabilities for objects centered within that cell.
3) Bounding Box Prediction: Each grid cell predicts multiple bounding boxes with coordinates (x, y, width, height) and a confidence score, indicating both object presence and localization accuracy.
4) Class Probability Assignment: Each bounding box is assigned a class probability score to classify detected objects.
5) Non-Max Suppression (NMS): NMS removes overlapping bounding boxes by retaining only the highest-confidence box, preventing duplicate detections of the same object.
6) Multi-Scale Detection: YOLO can detect objects at various scales by applying multi-scale prediction, enabling it to identify small and large objects within the same image.
7) Custom Loss Function: YOLO uses a custom loss function that balances errors in localization, confidence, and classification, optimizing both accuracy and efficiency.

These methodologies together make YOLO a highly suitable algorithm for real-time applications, balancing speed, and detection accuracy.

Advantages

1) Enhanced Public Safety: By detecting wild animals in real-time, the system alerts nearby residents and reduces the risk of potentially dangerous encounters with wildlife.

2) Reduced Property Damage: Timely alerts allow people to secure their property and livestock, preventing destruction of crops, gardens, and other assets.
3) Minimized Human-Animal Conflict: Early detection helps manage encounters peacefully, reducing harm to both animals and humans, and promoting coexistence.
4) Real-Time Alerts: IoT-enabled systems can trigger alarms or send notifications, providing immediate warnings to residents and local authorities, which is essential in emergency scenarios.
5) Cost-Effective Solution: Compared to continuous patrolling or extensive physical barriers, automated detection systems offer a scalable, economical approach to wildlife monitoring.
6) Support for Conservation Efforts: By monitoring animal movement, these systems help wildlife management agencies track animal behaviors, potentially aiding conservation efforts.
7) Improved Accuracy with AI: Systems using advanced algorithms like YOLO (You Only Look Once) offer high detection accuracy with low false-positive rates, ensuring that alerts are reliable and actionable.

Conclusion

The Wild Animal Detection System represents a significant step forward in addressing human-animal conflicts in regions near forests. By using the YOLO algorithm for real-time detection and incorporating an IoT-based alert system, the project provides a scalable, cost-effective solution that enhances public safety. Future work will focus on improving detection accuracy for a wider range of animal species and extending the system to larger geographical areas.

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