Animal Detection Alert System Using Machine Learning

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Abstract - - This paper introduces a software-based animal detection alert system designed to reduce animal-vehicle collisions, which can result in significant ecological, financial, and human safety issues. Leveraging machine learning (ML) techniques, the system analyzes images to detect animals in specific environments and generates alerts. The methodology includes image preprocessing, feature extraction, model training, and classification to accurately identify animals. This system's software-centric approach offers a scalable and efficient solution, enabling broader implementation compared to hardware-intensive systems.

Key Words: Animal detection, Machine learning, Image processing, Software-based alert systems, Conservation.

1.INTRODUCTION

Road accidents involving animals have become a significant global concern, causing severe ecological, financial, and human safety impacts. Animal-vehicle collisions often result in the loss of biodiversity, disruption of ecosystems, and substantial economic costs for vehicle repairs and medical treatments. Furthermore, such incidents pose grave risks to human lives, particularly in regions with high wildlife activity.

Globally, efforts to mitigate these issues have led to the development of various animal detection and alert systems. In Brazil, for example, over 475 million animals are estimated to be killed annually on roads, with many accidents involving medium-to-large vertebrates posing direct threats to drivers and passengers. These alarming statistics underscore the urgency of implementing effective detection systems to safeguard both wildlife and human lives.

2. LITERATURE REVIEW

The integration of technology in wildlife management and human safety has been a topic of extensive research. Traditional methods, such as manual monitoring and physical barriers, have shown limitations in efficiency and scalability. Recent advancements in computer vision and machine learning offer promising alternatives. Studies have demonstrated the effectiveness of techniques such as object detection algorithms, thermal imaging, and motion sensors in detecting and identifying animals in real-time.

3. SYSTEM OVERVIEW

The architecture of the proposed software-based animal detection alert system comprises the following components:

1. **Data Acquisition:** Collection of labeled animal and non-animal images from publicly available datasets.
2. **Preprocessing:** Conversion of images into a format suitable for ML models through resizing, normalization, and augmentation.
3. **Feature Extraction:** Extraction of features using techniques like RGB, LAB, and HSV color spaces.
4. **Model Training:** Training supervised ML models to classify animals.

5. **Detection and Alert Generation:** Real-time image analysis and alert creation upon detecting animals.

4. METHODOLOGY

4.1. Data Preparation

Images of animals and non-animals are preprocessed to standardize their resolution and format. Augmentation techniques such as rotation, flipping, and scaling are applied to improve model robustness. The dataset is divided into training and testing subsets.

4.2. Feature Extraction

Key features, including texture, color, and shape, are extracted from images. Techniques like edge detection and entropy-based segmentation are employed to enhance feature representation.

4.3. Model Training and Evaluation

The detection model is built using the YOLO (You Only Look Once) architecture, specifically a custom-trained version using pre-labeled datasets. YOLO offers real-time object detection capabilities by predicting bounding boxes and class probabilities directly from input images.

The training process involved:

- Using the YOLO framework and training on a dataset of images containing animals such as lions, tigers, elephants, and foxes.
- Hyperparameter tuning for optimal detection performance.
- Evaluating the model on unseen test datasets using metrics such as precision, recall, and F1-score.

4.4. Real-Time Implementation

The detection system is integrated into a Python application utilizing the following technologies:

- Streamlit: To build an interactive user interface for uploading and analyzing images or videos.
- OpenCV: For handling real-time video capture and frame-by-frame processing.
- Pygame: To play an alarm sound when an animal is detected.

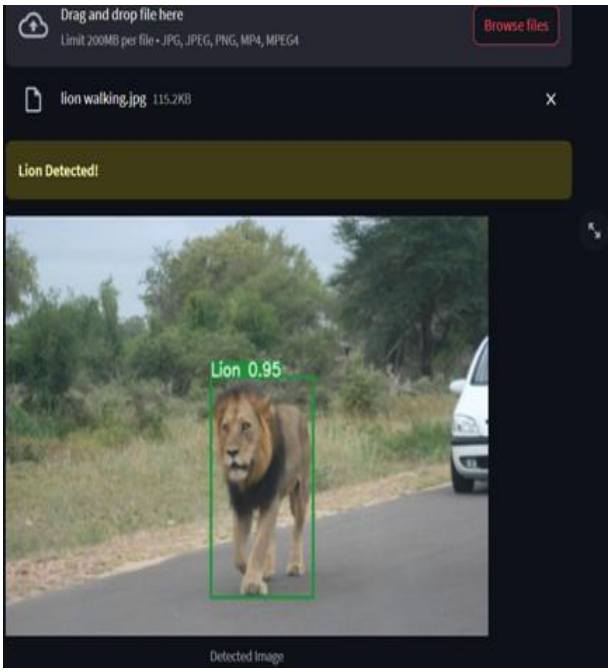
5. RESULTS AND DISCUSSION

The system's effectiveness was evaluated using a combination of synthetic and real-world data. Key results include:

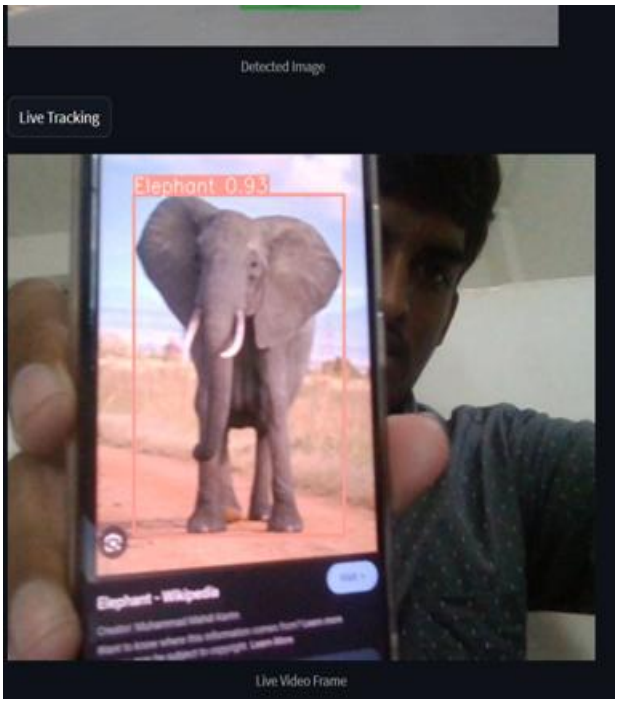
- **Real-Time Image Detection:** The system accurately identified animals in uploaded images and highlighted them with bounding boxes. Alerts were triggered with minimal latency.
- **Video Detection Performance:** Live and pre-recorded videos were analyzed frame-by-frame, with the system successfully detecting multiple animals within dynamic scenes.
- **Detection Accuracy:** The YOLO model achieved an average precision of 85%, with recall rates exceeding 90% for well-lit images.

The alarm system effectively notified users by playing a sound whenever an animal was detected, enhancing the practicality of the system for immediate response scenarios.

VIDEO OUTPUT



LIVE TRACKING



CONCLUSION AND FUTURE WORK

This paper presents a scalable, software-based animal detection alert system leveraging machine learning techniques, specifically the YOLO framework. The system effectively identifies animals and issues alerts, providing a practical solution for wildlife conservation and road safety. Future work will include:

- Expanding the dataset to include more animal classes and diverse environments.
- Optimizing the real-time performance for edge devices.
- Implementing cloud-based detection to enable remote monitoring.

By incorporating these improvements, the system aims to enhance its impact on conservation efforts and public safety.

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