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A YOLOv5-Based Framework for Real-Time Wildlife Detection and Intrusion Alert Systems

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ABSTRACT:

An advanced wild animal detection and alert system is developed using the YOLOv5 (You Only Look Once version 5) model. The system uses an object detection algorithm to identify wild animals and provide real-time alerts to users. A camera captures live video footage, which is processed by a computer running the YOLOv5 model to accurately detect and classify animals. When a wild animal is detected, the system immediately generates alerts such as warning sounds or notifications to prevent potential danger. These alerts can also act as deterrents to scare animals away and improve safety. The system is useful in areas where wild animal movement is common, such as forest borders, agricultural fields, and highways. Overall, the system provides an efficient and real-time solution for monitoring wildlife and reducing human-animal conflicts. Future improvements can focus on increasing accuracy and enhancing real-world performance under different environmental conditions.

INDEX TERMS: Wild Animal Detection, YOLOv5, Object Detection, Deep Learning, Computer Vision, Real-Time Monitoring, Alert System, Wildlife Surveillance, Image Processing, Human-Wildlife Conflict Prevention.

I. INTRODUCTION

An enhanced wild animal detection and alert system based on the YOLOv5 (You Only Look Once version 5) model is proposed for analyzing images and detecting the presence of wild animals in real time. The system identifies animals using deep learning-based object detection and immediately alerts authorities through alarms or SMS notifications. This approach provides an effective solution for preventing damage caused by wild animals while also helping to reduce human-animal conflicts and support wildlife conservation [9], [10].

The proposed system utilizes advanced computer vision techniques to accurately detect and notify the presence of wild animals in a given area. YOLOv5, one of the most widely used deep learning models for object detection, is employed due to its high speed and accuracy in real-time applications [5], [9]. Compared to earlier methods such as R-CNN, Mask R-CNN, and SSD, which offer high accuracy but require more computational time, YOLO-based models provide faster detection suitable for real-time monitoring systems [1], [2], [4].

The system integrates cameras and sensors installed on drones or surveillance devices to capture real-time data from the environment. The captured images or video frames are transmitted to a central processing unit where they are analysed using the YOLOv5 algorithm. The model processes live video feeds and detects wild animals efficiently, even in dynamic environments [3], [7].

Once a wild animal is detected, the system generates an immediate alert through alarms and sends notifications to users via mobile devices. This enables timely action to prevent dangerous encounters. The system is especially useful in areas with high wildlife activity, such as forest borders, wildlife reserves, agricultural fields, and rural regions. By providing early warnings, the system helps reduce risks to human life and property while ensuring better monitoring of wildlife movement [8], [10].

II. LITERATURE SURVEY

[1] presents an animal detection and warning system based on the Faster R-CNN model. The system is designed to detect animals on roads and alert drivers to prevent accidents. The authors created and labelled a dataset consisting of various animal species commonly found on Indian highways. The Faster R-CNN model was trained using the TensorFlow object detection API and deployed with a camera module connected to a Raspberry Pi for real-time detection and alert generation.

[2] proposes a wildlife detection system using the Mask R-CNN model for automatic identification of animals in natural environments. The authors collected and annotated a dataset of different animal species commonly found in China. The model was trained using the PyTorch deep learning framework, enabling accurate detection and segmentation of wildlife for conservation purposes.

[3] presents a wildlife detection and monitoring system based on EfficientDet and transfer learning techniques. The authors used a dataset of various animal species and applied transfer learning to fine-tune the model for improved performance. Additionally, data augmentation techniques such as adjusting brightness, contrast, and saturation were applied to enhance model generalization and accuracy.

[4] describes a real-time wildlife detection system using the Single Shot Detector (SSD) model. The authors created a labelled dataset of animal species observed in Korea and trained the model using TensorFlow. A dynamic Region of Interest (RoI) selection method was introduced to reduce false positives by focusing on important regions of the image. The system was tested using camera traps and successfully detected animals in real time by generating bounding boxes around detected objects.

III. SYSTEM ANALYSIS

A. EXISTING SYSTEM

The existing wild animal detection systems mainly rely on traditional surveillance methods, which lack efficient real-time detection and alert mechanisms. These systems often depend on manual monitoring, where human operators continuously observe camera feeds or field conditions to identify the presence of animals. This approach is time-consuming and prone to human error, leading to delayed responses in critical situations [10].

In many cases, earlier systems used conventional machine learning or basic deep learning models, which required significant processing time and were not optimized for real-time detection. Methods such as R-CNN and Mask R-CNN provide good accuracy but involve high computational complexity, making them less suitable for real-time applications [1], [2]. As a result, the system struggles to quickly detect and notify users about the presence of wild animals.

Additionally, the lack of efficient data processing and automated alert mechanisms reduces the system's ability to ensure safety in areas with high wildlife activity. Therefore, there is a strong need to upgrade existing systems with advanced real-time detection models to improve accuracy, speed, and reliability [4], [9].

DISADVANTAGES OF THE EXISTING SYSTEM

The limitations of the existing wild animal detection system are as follows:

- **Manual Monitoring:**

The system heavily depends on human observation, making it labour-intensive and prone to errors due to fatigue or inattention [10].

- **Limited Coverage:**

Traditional systems are restricted in coverage and are not effective for monitoring large or remote areas such as forests and wildlife zones [4].

- **Lack of Real-Time Alerts:**

Many systems do not provide instant notifications, leading to delays in responding to the presence of wild animals [9].

- **Low Accuracy:**

Older detection methods may produce false positives or miss detections, especially under varying environmental conditions [1], [2].

- **Dependence on Human Operators:**

Continuous monitoring by humans is inefficient and not suitable for long-duration surveillance [10].

- **High Cost:**

Maintaining such systems is expensive due to the requirement of manpower and manual data handling [4].

- **Limited Adaptability:**

Existing systems may not perform well under changing lighting conditions, weather variations, or different animal species [3].

- **Inefficient Data Analysis:**

Collected data is not always properly analysed, reducing the ability to generate useful insights [3].

- **Lack of Remote Access:**

Many systems do not support remote monitoring, limiting accessibility and usability [6].

- **Safety Risks:**

Due to delayed detection and lack of alerts, these systems pose risks to human safety in areas with high wildlife activity [5].

B. PROPOSED SYSTEM

The proposed Advanced Wild Animal Detection and Alert System is based on the YOLOv5 (You Only Look Once version 5) model for real-time detection and monitoring of wild animals. The system begins with the collection of a diverse dataset that includes different species of wild animals under various environmental conditions. This dataset is used to train the YOLOv5 model using deep learning techniques to improve its accuracy and detection capability. Compared to traditional models such as R-CNN and SSD, YOLO-based models provide faster and more efficient performance, making them suitable for real-time applications [1], [4], [9].

Once trained, the YOLOv5 model is deployed to process live video feeds captured through cameras installed in wildlife-prone areas. The model detects animals in real time by generating bounding boxes and class labels around identified objects. In addition to detection, a tracking mechanism is incorporated to monitor the movement of animals continuously by updating their positions across video frames. This helps in understanding animal movement patterns and improves monitoring efficiency [5], [7], [8].

The system also includes an automated alert mechanism that provides immediate warnings when wild animals are detected near human-populated areas. Alerts are generated based on the proximity of animals and are sent to users or authorities through alarms or mobile notifications, enabling quick response to potential threats. A user-friendly interface is developed to display real-time video feeds, detection results, and alert messages, making it easy for users to monitor the system [6], [10].

Finally, the performance of the system is evaluated using standard metrics such as accuracy, precision, and recall to ensure reliability. The system is tested in real-world conditions to verify its effectiveness in detecting and tracking wild animals. Overall, the proposed system provides an efficient, cost-effective, and scalable solution for reducing human-animal conflicts and improving safety in wildlife-prone areas [3], [9].

IV. SYSTEM DESIGN

SYSTEM ARCHITECTURE

Below diagram depicts the whole system architecture.

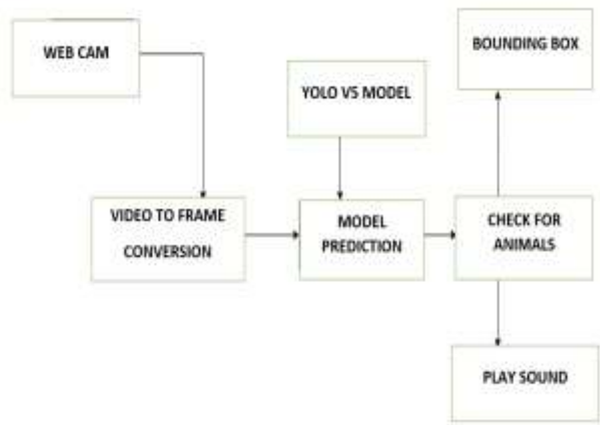

Fig 1. Methodology followed for proposed model

V. SYSTEM IMPLEMENTATION

MODULES

A. Image Acquisition and Preprocessing:

This module captures images or video streams from cameras or drones installed in wildlife-prone areas. The captured data is pre-processed using techniques such as resizing, noise reduction, and image enhancement to improve input quality for the YOLOv5 model [3], [9].

B. YOLOv5 Object Detection Model:

This is the core module of the system, where the YOLOv5 model is used for detecting wild animals in real time. The model is trained and fine-tuned to recognize different animal species. Compared to traditional models such as R-CNN and SSD, YOLOv5 offers faster detection and better performance for real-time applications [1], [4], [9].

C. Alert Generation and Communication:

Once a wild animal is detected, this module generates real-time alerts. Notifications can be sent through alarms, SMS, emails, or mobile applications. Integration with GPS can help in identifying the exact location of the detected animal [10].

D. Data Storage and Logging:

This module stores detection details such as time, location, and captured images or video frames. The stored data can be used for future analysis, monitoring animal movement, and research purposes [6].

E. User Interface and Monitoring:

A user-friendly interface is developed to display real-time video feeds, detection results, and alerts. It also allows users to access historical data, making the system easy to use for monitoring and decision-making [5], [6].

F. RESULTS AND DISCUSSION

The proposed system was implemented using the Python programming language in a Jupyter Notebook environment, which provided flexibility for model training, testing, and visualization. During the object detection phase, the YOLOv5 model was used to process input images and video frames. The model successfully detected wild animals by generating accurate bounding boxes and class labels around the identified objects. The pixel-level localization of animals in the images demonstrates the effectiveness of the model in identifying objects in real time [5], [9].

The system was able to detect animals under different conditions and highlight them clearly in the output frames. The bounding boxes drawn around the detected animals help in precise localization and improve understanding of object positioning within the scene. This confirms that the YOLOv5 model is capable of handling real-time detection tasks efficiently, even when multiple objects are present in a single frame [1], [4].

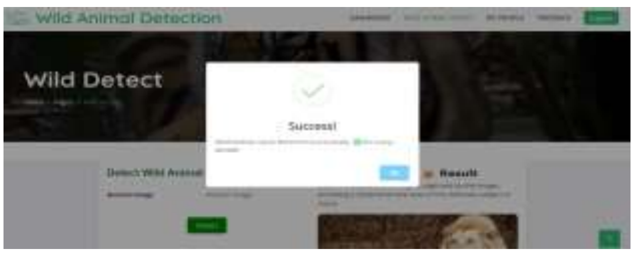

Fig 2. Wild animal detected

fig 3. Sending mail as an Alert when Wild animal is detected

VI. CONCLUSION AD FUTURE WORK

The Advanced Wild Animal Detection and Alert System based on the YOLOv5 model provides an efficient and cost-effective solution for detecting and tracking wild animals in real time. By utilizing the YOLOv5 object detection algorithm along with tracking techniques, the system can accurately identify animals and generate immediate alerts in case of potential danger. This real-time capability improves safety for people living in wildlife-prone areas and helps in reducing human-animal conflicts [5], [9].

The system also contributes to environmental protection by enabling better monitoring of wildlife movement and supporting conservation efforts. Its ability to provide timely and reliable information makes it suitable for deployment in various locations such as forests, agricultural lands, and rural areas with high wildlife activity [3], [10].

Overall, the proposed system enhances safety, improves monitoring efficiency, and offers a scalable solution for wildlife management. Further improvements can focus on increasing detection accuracy, integrating additional data sources such as environmental conditions, and expanding the system for wider real-world applications [4], [9].

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