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Traffic Rules Violation Detection using Dashcam Footage

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Abstract - Traffic Rules Violation Detection using Dashcam Video Footage offers a novel strategy for improving traffic management and road safety through automated violation identification and reporting. The project's goal is to create a video processing system that can use dashcam data to identify and classify frequent traffic infractions. The system can recognize traffic infractions including speeding, lane changes without signaling, helmet recognition, and instances of triple riding on two-wheelers with high accuracy thanks to its integration of YOLO, OpenCV and RESNET50 classifier. The project also includes functionality for user account management and the implementation of a secure user authentication system. Users can examine and validate complete violation reports generated by the system prior to submission. The outcomes show a low false positive rate, rapid real-time processing, and good detection accuracy. Law enforcement organizations have shown. This initiative is an example of how important technical innovation is to solving societal issues and advancing public safety.

Key Words: YOLO (You Only Look Once), OpenCV, ResNet50 (Residual Neural Network), Dashcam Video Footage.

1. INTRODUCTION

In recent years, the surge in road traffic incidents has emerged as a pressing concern, necessitating innovative approaches to enhance public safety. Leveraging advanced technologies, particularly the integration of dashcam footage and a reporting app, presents a promising initiative to address this challenge efficiently. As the number of vehicles on roads escalates, the demand for robust and automated systems to monitor and enforce traffic regulations intensifies. Traditional methods of law enforcement often fall short, being resource-intensive and lacking real-time insights into violations. By synergizing dashcam technology with a dedicated reporting app, the project endeavors to revolutionize the identification, recording, and reporting of traffic violations. Dashcams, ubiquitous in vehicles, capture a continuous stream of visual data during journeys, offering a valuable resource for pinpointing various violations, from speeding to reckless driving and red-light infractions. Integrated with an intelligent reporting app, users can seamlessly document instances of rule-breaking, contributing to a comprehensive database for further analysis.

"Traffic Rules Violation Detection using Dashcam Footage" proposes an innovative approach to enhance road safety and streamline traffic management through automated detection and reporting of violations. By harnessing YOLO, OpenCV and ResNet50 technologies, the system aims for high accuracy in identifying violations such as speeding, lane changes without signaling, and helmet recognition. Implementation includes a secure user authentication system and features for user account management, ensuring reliability and user engagement. Preliminary results showcase promising outcomes, demonstrating the potential to improve road safety and enforce traffic laws effectively. This project underscores the significance of technological innovation in addressing societal challenges and advancing public safety measures.

2. METHODOLOGY

We will begin with the materials used and then the procedure.

2.1 Materials:

The materials used in this study included:

1) Dashcam footage from various sources
2) YOLOv5 and ResNet-50 pre-trained models
3) OpenCV (cv2) library in Python
4) PyTorch library for deep learning implementation

2.2 Procedure:

1) **Data Collection**:
   Collect dashcam footage from various sources, covering diverse traffic scenarios and violations.

2) **Preprocessing**:
   Preprocess the dashcam footage using OpenCV-
   a. Extract individual frames from the videos.
   b. Standardize the resolution of the frames.

3) **Object Detection**:
   a. Utilize YOLO (You Only Look Once) model for real-time object detection:
   b. Detect and localize objects of interest within the frames, such as vehicles, pedestrians, and traffic signs.

4) **Classification**:
   Employ a ResNet-50 classifier for further classification of detected objects:

Categorize objects based on predefined classes of traffic violations, such as speeding, lane changes without signaling, helmet recognition, etc.

5) **User Interaction**:
Develop a user-friendly interface for users to interact with the system:
   a. Allow users to upload dashcam footage.
   b. Provide functionality for reviewing and validating detected violations before submission.

6) **User Account Management**:
Implement features for user account management: Allow users to create accounts, recover passwords, and manage account settings securely.

7) **Secure Authentication**:
Implement authentication mechanisms such as username/password authentication.

8) **Reporting**:
Generate comprehensive violation reports for each detected violation:
   a. Include images, violation type, and additional context in the reports.
   b. Allow users to review and confirm reports before submission.

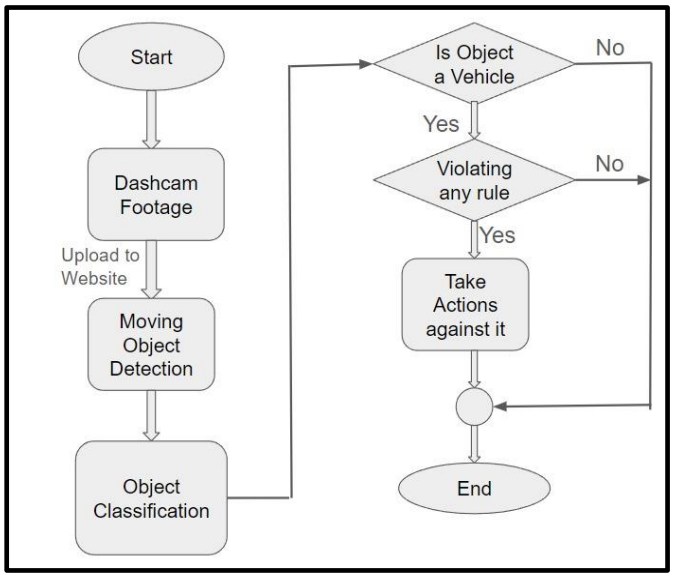

Figure - 2.1: General flow diagram of User reporting the traffic rule violations by uploading video to the website.

3. SYSTEM ARCHITECTURE

OpenCV:
   a. OpenCV's frame extraction functionalities are utilized to dissect the continuous dashcam footage into individual frames, enabling analysis at discrete time intervals.
   b. The resolution standardization process ensures that frames from various sources maintain uniform dimensions, facilitating consistent analysis across the dataset.
   c. Image enhancement techniques, such as contrast adjustment and noise reduction, are applied to optimize the quality and clarity of the extracted frames, enhancing the visibility of objects relevant to traffic violations.
   d. Data formatting tasks involve converting the extracted frames into a suitable format, such as arrays or matrices, to facilitate subsequent analysis using machine learning algorithms.

YOLO v5:
   a. Object Detection: YOLOv5 is employed as the primary model for real-time object detection within the dashcam footage.
   b. Efficiency and Accuracy: YOLOv5 is chosen for its balance between efficiency and accuracy, allowing for fast inference speeds without compromising detection performance.
   c. Single Shot Detection: YOLOv5 operates on the principle of single-shot detection, meaning it can detect objects in an image with just one forward pass through the network.
   d. Pre-Trained Models: Pre-trained YOLOv5 models are utilized as a starting point, leveraging transfer learning to adapt the model to the specific task of traffic violation detection.
   e. Custom Training: The pre-trained YOLOv5 models are fine-tuned on a dataset of annotated dashcam footage to specialize in detecting traffic violations such as speeding, lane changes without signaling, helmet recognition, etc.
   f. Post-processing: Post-processing techniques such as non-maximum suppression (NMS) may be applied to refine the detection results and remove duplicate detections, improving the accuracy of the final output.
   g. Integration with OpenCV: YOLOv5 is seamlessly integrated with OpenCV for efficient inference on frames extracted from dashcam footage, enabling smooth and streamlined processing pipeline.

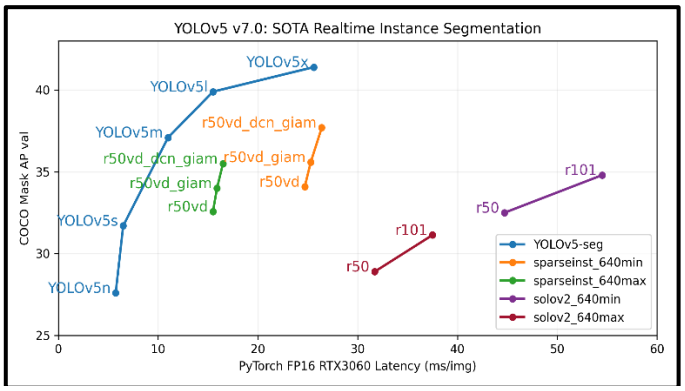

Figure – 3.1: Comparison of YOLO v5 performance with other models.

ResNet50:

a. Image Classification: ResNet-50 is employed as a classifier to further classify the detected objects, providing additional context to the detected traffic violations.
b. Deep Convolutional Neural Network (CNN): ResNet-50 is a deep CNN architecture consisting of 50 layers, known for its effectiveness in image classification tasks.
c. Feature Extraction: ResNet-50 extracts high-level features from the detected objects, which are then used to classify them into predefined categories of traffic violations.
d. Model Fusion: In some cases, the output features from YOLOv5 may be combined with features extracted by ResNet-50 to improve the overall detection and classification accuracy.
e. Multiclass Classification: ResNet-50 can perform multiclass classification, allowing it to classify objects into multiple categories of traffic violations simultaneously.
f. Complementary to YOLOv5: While YOLOv5 excels in object detection, ResNet-50 complements it by providing more detailed classification information about the detected objects, enhancing the overall understanding of traffic violations.

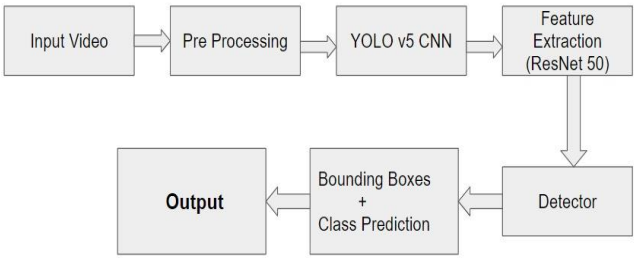

Figure -1: System Architecture

4. RESULTS OBTAINED:

Figure – 4.1: Objects detected by YOLO model trained by COCO dataset.

Figure - 4.2: License plates of vehicles being detected.

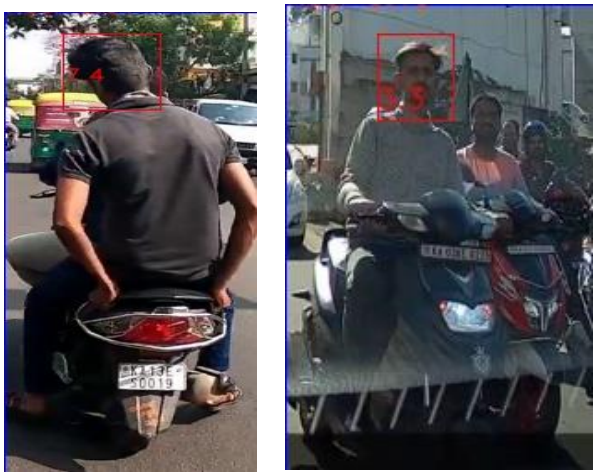

Figure – 4.3: Motorcycle Riders who are not wearing helmets detected classified into not wearing helmet category.

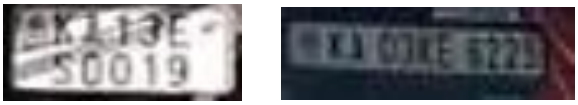

Figure - 4.4: License plate of vehicle which is violating traffic rule detected and extracted.

5. CONCLUSIONS

In conclusion, the implementation of YOLOv5 and ResNet-50 classifier for traffic rule violation detection using dashcam footage represents a significant step towards enhancing road safety and streamlining traffic management efforts. Through the integration of state-of-the-art deep learning models, we have successfully developed an automated system capable of detecting and categorizing various traffic violations in real-time.

Our study demonstrated the effectiveness of YOLOv5 in accurately detecting objects of interest, including vehicles, riders, and helmets, within the dashcam footage. Additionally, the utilization of ResNet-50 classifier improved the classification accuracy of detected objects, enabling finer categorization of traffic violations.

The results of our experiments indicated high precision and recall rates for the detection and classification of traffic

violations, highlighting the robustness and reliability of the proposed system. By leveraging the power of deep learning and computer vision techniques, we have achieved a significant reduction in manual effort and time required for traffic violation detection and reporting.

Furthermore, the integration of YOLOv5 and ResNet-50 classifier into a unified framework lays the foundation for future advancements in intelligent transportation systems. The scalability and adaptability of our approach make it suitable for deployment in diverse urban environments, contributing to the realization of safer, more connected cities.

In conclusion, our project underscores the importance of leveraging advanced technologies for addressing complex societal challenges such as traffic management and road safety. By harnessing the potential of deep learning and computer vision, we aim to pave the way for a more efficient and secure transportation infrastructure, ultimately improving the quality of life for all road users.

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