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Traffic Rule Violation Detection System

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Abstract: *The project introduces a robust system designed to identify instances of traffic rule violations and promptly notify offenders, thereby contributing to the enhancement of road safety and enforcement of traffic regulations. Leveraging advanced computer vision and machine learning techniques, the system performs real-time detection of violations such as the absence of helmets and seat belt usage, while also capturing vehicle number plates for subsequent identification. Key algorithms utilized include YOLOv5 for efficient object detection, EasyOCR for accurate optical character recognition, and OpenCV for sophisticated image processing tasks. Upon detecting violations, the system swiftly dispatches notifications to offenders via email, facilitated by the SMTP protocol, ensuring timely communication of infractions. Additionally, an intuitive administrative dashboard is implemented to systematically record violation details, enabling comprehensive monitoring and reporting functionalities. Through rigorous testing and evaluation, the system demonstrates its efficacy and reliability, underscoring its potential to significantly improve traffic management and foster adherence to safe driving practices.*

Keywords: Traffic Rule Violations, Road Safety, Computer Vision, Machine Learning, Yolov5, Easyocr, Opencv, Object Detection, Optical Character Recognition, SMTP Protocol, Administrative Dashboard, Monitoring, Reporting.

I. INTRODUCTION

The project's scope, significance, and relevance in the context of contemporary traffic management challenges. It highlights the increasing importance of leveraging technological advancements to enhance the efficacy of traffic enforcement mechanisms and improve overall road safety. By introducing a sophisticated system for detecting traffic rule violations, the project aims to address critical issues such as the prevalence of accidents due to non-compliance with safety regulations.

1.1 Overview:

The project's scope, significance, and relevance in the context of contemporary traffic management challenges. It highlights the increasing importance of leveraging technological advancements to enhance the efficacy of traffic enforcement mechanisms and improve overall road safety. By introducing a sophisticated system for detecting traffic rule violations, the project aims to address critical issues such as the prevalence of accidents due to non-compliance with safety regulations.

1.2 Problem Statement:

In the context of this project, the problem statement revolves around the inadequacies of conventional traffic enforcement methods in ensuring compliance with safety regulations. It underscores the persistent challenges faced by authorities in effectively monitoring and penalizing instances of traffic rule violations, such as non-wearing of helmets and seat belts, and the absence of vehicle number plates. These violations pose significant risks to road safety, leading to a higher incidence of accidents and injuries. The project revolves around the pressing need to enhance road safety through the effective enforcement of regulations concerning helmet and seatbelt usage.

1.3 Research Objectives:

The main objectives of the research are: -

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- Enhance Traffic Safety: Promote adherence to traffic rules and safe driving practices to reduce accidents and improve road safety.
- Identify and Report Violations: Utilize road-mounted cameras to detect violations like helmetless riding and vehicles without number plates in real-time.
- Detect Specific Violations: Focus on common infractions such as helmetless riding and vehicles lacking number plates to prioritize safety measures.
- Read Number Plate Information: Extract vehicle registration details from captured images using OCR technology for accurate violation reporting.
- Explore Modularity and Optimization: Design the system for scalability, allowing easy integration of new features while optimizing performance and efficiency for enhanced functionality.
- Real-time Notifying: Designing a system that provides real-time e-mail notification to the person who as violated the traffic rule such as not wearing helmet or not wearing a seatbelt.

1.4 Scope of the Research:

This research focuses on the development and implementation of an automated system for detecting traffic rule violations, specifically targeting helmet and seatbelt compliance among vehicle drivers. The scope includes the use of advanced computer vision techniques, such as YOLOv5 for object detection, EasyOCR for number plate recognition, and OpenCV for image processing. The system's capabilities extend to real-time violation detection, notification of offenders via email, and logging of violations in an administrative dashboard for further analysis. The research also explores the potential impact of this system on enhancing road safety, the scalability of the solution, and its integration with existing traffic management infrastructures.

II. RELATED WORK

While existing methodologies have shown promise in specific areas, they fall short in providing a comprehensive, real-time solution for traffic rule enforcement. Most approaches either focus on helmet detection or seatbelt detection but not both. Additionally, the majority of systems are not optimized for live video input, limiting their real-world applicability. These gaps highlight the need for an integrated, scalable, and efficient solution that can operate in real-time and address multiple types of traffic violations.

The proposed research aims to build upon these findings by developing a robust system that leverages advanced algorithms for real-time detection and notification, thereby improving road safety and compliance with traffic regulations.

Helmet Detection and Number Plate Recognition using Machine Learning

This paper was published at International Research Journal of Engineering and Technology (IRJET) Royetal. proposed a machine learning-based approach for helmet detection and number plate recognition using image inputs. Their methodology involved initial classification to determine the presence of individuals, followed by helmet detection using the Haar cascade algorithm and number plate recognition. However, the evaluation of the proposed approach's effectiveness lacked specific metrics or results. The research gap identified includes the absence of live video input processing and the lack of optimization in optical character recognition (OCR) for number plate recognition, which limits the real-time applicability and accuracy of their method. [1]

Accurate seat belt detection in road surveillance images based on CNN and SVM

This paper was published at Neurocomputing. They have also proposed a CNN-based approach to mitigate the automatic detection of Seatbelt in the image input provided. They aim to train a classification model though SVM (Support Vector Machine). They discuss the shortcomings of traditional and outdated approaches like the Haar-like Cascading Detection and propose a multi-layer, nested window neural network which uses gradient descent method to minimize the loss function. They hint at the possibility to detect the windshield region using edge detection methods

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like the Hough line transformation or the canny edge detection but fail to provide quantitative outputs and have also discussed to no lengths, ways to penalize the offenders. [2]

Helmet Detection & Number Plate Recognition using Machine Learning

This paper was published by Gauri Marathe, Pradnya Gurav, Rushikesh Narwade, Vallabh Ghodke, Prof. S. M. Patil in the year 2022, at International Journal of Innovative Research in Technology (IJIRT) Marathe et al. propose a machine learning-based method for helmet detection and number plate recognition using video inputs, implementing YOLOv3 for helmet detection and OCR for number plate character extraction. Their approach benefits from close-up pictures, facilitating information extraction. [3]

Automatic detection of vehicle occupancy and driver's seat belt status using deep learning

This paper was published at Institute of Electrical and Electronics Engineers (IEEE).They have made use of a very computationally expensive architecture for achieving exceptional results while detecting seatbelts. ResNet34 paired with a complex YOLOv5s architecture has been used to process the input images. They begin by first detecting windshield region in the input followed by the detection of occupants and seatbelts with the help of Temporal Pyramid Pooling (TPP), Spatial Pyramid Pooling (SPP) and Power Mean Transformation (PMT) layers. The TPP and SPP layers divide the outputs of the last convolution layer into a certain number of fixed spatial bins. Later all the features are concatenated. They used a dataset of 200,00 images and achieved a shocking accuracy of 99.2% but their model doesn't generalize very well to unseen data and no methods concerning the topic of penalizing the offenders was discussed in their research. [40]

Helmet Detection Using ML & IoT

This Paper was published at Institute of Electrical and Electronics Engineers (IEEE) Manocha et al. introduce a helmet detection system utilizing image inputs and OpenCV for detection, with the capability to issue challans to respective owners upon detection of violations. However, the research lacks a specified method for extracting owner details, and the reported low efficiency of the program is attributed to the absence of optimization techniques, which limits its effectiveness in enforcing regulations. [5]

III. METHODOLOGY

The methodology chapter embarks on a meticulous journey, crafted to bridge previously identified gaps. It delves into the analysis of various modules crucial in fetching, generating, and processing information. Each module's design and functionality are explored, revealing their interplay in achieving overarching goals. The focus intensifies on two significant services: Seatbelt Detection and Window Tint Detection, showcasing innovative technologies employed. Every step underscores the dedication and expertise of the team, emphasizing the pivotal role of these methodologies.

YOLO (You Only Look Once)

YOLOv5, which stands for "You Only Look Once version 5," is a popular real-time object detection algorithm. The annotations were then transformed into the YOLOv5 format, which involved assigning unique class indices to each seatbelt category and normalizing the bounding box coordinates. Additionally, a YAML file was created to specify the class names utilized in the dataset, ensuring consistency and clarity during subsequent stages. Post completion of the dataset building process this was the composition of our dataset. The primary advantage of YOLOv5 is its remarkable speed and accuracy, making it an efficient solution for real-time object detection tasks. Here's a detailed explanation of YOLOv5.

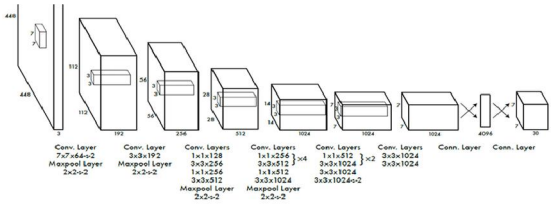

Figure1: Architecture of YOLO

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Roboflow:
Roboflow is a comprehensive computer vision platform that provides tools and infrastructure to simplify and accelerate the development of computer vision models. It offers a range of features, including data preprocessing, model training, deployment, and management. Roboflow is designed to streamline the entire computer vision workflow, making it easier for developers and researchers to build robust and accurate computer vision systems.

Optical Character Recognition (OCR):
OCR stands for Optical Character Recognition, which is a technology used to convert different types of documents, such as scanned paper documents, PDF files, or images captured by a digital camera, into editable and searchable data. ANPR systems use optical character recognition technology to capture and read license plate numbers. The OCR algorithm analyzes the patterns of text in the input document and attempts to recognize and convert them into machine-readable text.

SMTP (Simple Mail Transfer Protocol) for Notification Mechanism:
SMTP is a widely used protocol for sending emails over the internet. In the context of this project, SMTP will be utilized to set up the notification mechanism for alerting relevant authorities or stakeholders about detected traffic violations.

Inclusion of Activity Logs in Administrative Dashboard:
Create a dedicated worksheet within the Excel workbook to store activity logs related to system events, user interactions, and detected violations. Each row in the worksheet represents a specific activity log entry, while columns can include information.

IV. IMPLEMENTATION

The initial setup phase of the implementation, focusing on connecting with the dataset. It involves installing essential Python packages such as inference-sdk, easyocr, and imutils for image processing and analysis. Additionally, the code snippet demonstrates the integration of the Roboflow API for accessing and utilizing the dataset stored on their platform. This step is crucial for dataset acquisition and subsequent model training and evaluation.
The code snippet defines a function called take_photo() responsible for capturing photos using the device's camera. It utilizes JavaScript to access the camera, display the live video feed, and capture images upon user interaction. The captured image is then processed using the specified object detection models (helmet-detection and seat-belt-detection) through the Roboflow API. If a helmet is detected, the system confirms the driver's safety. Otherwise, it proceeds to check for the presence of a seat belt and provides feedback accordingly.

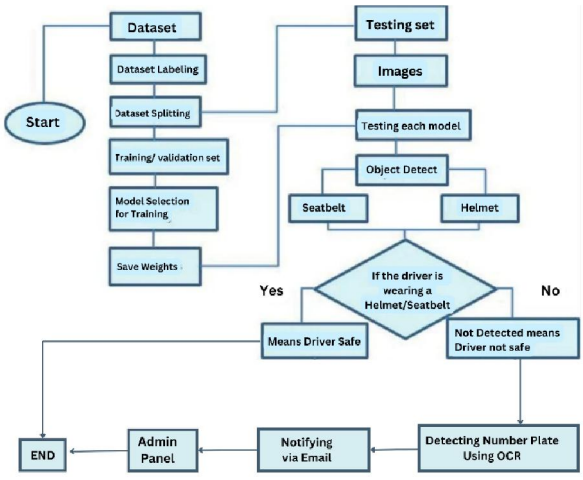

Figure.2: Flowchart of the project

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This project focuses on improving road safety through automated helmet detection for motorcyclists. It involves dataset acquisition and labeling, followed by splitting the dataset for training and validation. Various models are evaluated, and the best one is selected for training. After training, the model is tested on unseen images for object detection to identify heads and helmets. Detection of a helmet indicates compliance with safety regulations, while its absence suggests non-compliance and potential danger. Ultimately, the project aims to reduce head injuries and fatalities on the road by promoting helmet usage among motorcyclists.

V. RESULTS

Figure 3: Helmet not detected

The system's output, indicating violations for not wearing a helmet, along with the detected number plate. The notification process is demonstrated, confirming the successful dispatch of an email notification to the offender

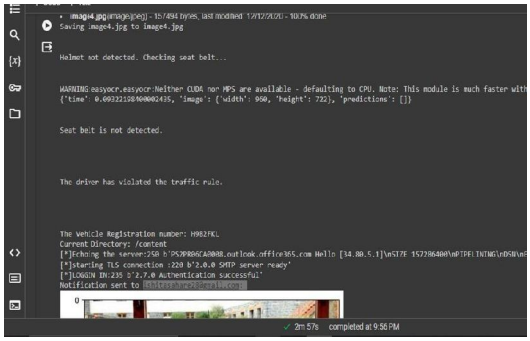

Figure 4: Seatbelt not detected

The system's output, indicating violations for not wearing a seatbelt, along with the detected number plate. The notification process is demonstrated, confirming the successful dispatch of an email notification to the offender.

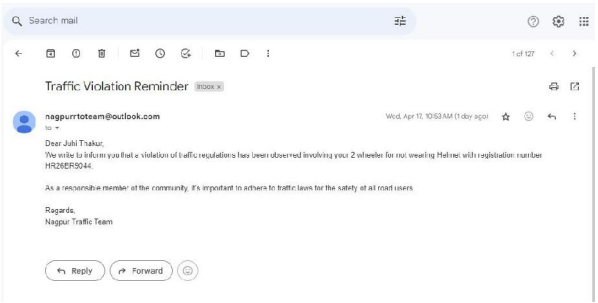

Figure 9: Email Notification

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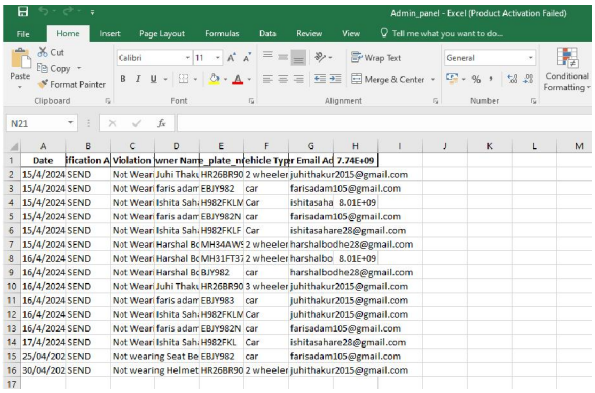

Figure 10: Admin Panel

Leveraging cutting-edge technologies such as SMTP, Outlook, and Excel, our system automates the process of notifying violators while providing authorities with actionable insights for strategic decision-making. This innovative approach not only enhances enforcement capabilities but also promotes accountability and awareness among violators, thereby contributing to safer roadways and improved compliance with traffic regulation.

VI. CONCLUSION

In conclusion, the project has successfully addressed the critical issue of enhancing road safety and enforcing traffic regulations through the implementation of advanced computer vision and machine learning technologies. By leveraging these cutting-edge tools, the system has demonstrated its ability to accurately detect instances of traffic rule violations, including non-compliance with helmet and seat belt regulations. Through the utilization of algorithms such as YOLOv5 for object detection, EasyOCR for optical character recognition, and OpenCV for image processing, the system has achieved commendable accuracy in identifying infractions and capturing relevant information from vehicle number plates.

The prompt notification mechanism, facilitated by the SMTP protocol, ensures that offenders are promptly informed of their violations via email, enabling timely intervention and corrective action. Additionally, the development of an administrative dashboard provides authorities with valuable insights into violation trends, enabling them to monitor and analyze traffic patterns effectively. This comprehensive approach empowers authorities to take proactive measures in addressing traffic violations and promoting road safety.

VII. ACKNOLEDGEMENT

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