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Helmet Detection and Number Plate Recognition

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***Abstract*: Developing countries have always relied on motorcycles as their primary mode of transportation, but unfortunately, the number of motorcycle accidents has been on the rise in recent years. One of the leading causes of fatalities in these accidents is the lack of helmet usage by motorcyclists. To ensure that motorcyclists wear helmets, traditional methods include manual monitoring by traffic police at intersections or the use of CCTV footage to identify those not wearing a helmet. However, these methods require significant human effort and intervention. This system proposes an automated approach to identify non-helmeted motorcyclists and retrieve their license plate information from CCTV footage. The system first differentiates moving objects as motorcycles or non-motorcycles. For classified motorcyclists, the system identifies whether they are wearing helmets or not. If the motorcyclist is not wearing a helmet, the system extracts the license plate number using an OCR algorithm.**
Keywords: Helmet, Number plate, OCR Algorithm, YOLO Algorithm, CNN Algorithm

I. INTRODUCTION

In many countries, wearing helmets while riding motorcycles is mandatory by law to ensure the safety of the riders. Currently, the responsibility of monitoring helmet usage falls on the police force. However, due to the limitations of human senses and insufficient police force, this method has proven to be inefficient. CCTV surveillance-based methods are also used in major cities, but they require human assistance and are not automated. As the number of motorcycles on the road increases and concern for human safety grows, research in the domain of road transport has also increased. This paper proposes a system that automates the monitoring of motorcyclists by detecting those not wearing helmets and retrieving their license plate numbers in real time from CCTV camera videos at road junctions using machine learning. The problem of increasing road accidents in India has become a major concern, with a high number of deaths caused by head injuries due to a significant portion of the population not wearing helmets. To address this issue, an automated system is needed to detect individuals not wearing helmets and identify the license plates of the motorcycles to penalize the offenders.

The use of machine learning in transportation systems has become increasingly popular in recent years. Automated systems that detect helmet usage and license plates on motorcycles are just one example of how technology can improve road safety. In addition to improving enforcement, such systems can also provide valuable data for policymakers to make informed decisions about road safety regulations. However, there are some challenges in implementing such systems. For instance, the accuracy of license plate recognition algorithms can be affected by factors such as lighting conditions, weather, and the distance between the camera and the vehicle. In addition, the implementation of such systems requires significant investment in terms of infrastructure and manpower. Therefore, it is essential to carefully evaluate the feasibility of such systems and their potential impact on road safety. Despite these challenges, the use of machine learning and other advanced technologies has the potential to revolutionize road safety in developing countries. By improving enforcement and providing valuable data for policymakers, such systems can help reduce the number of deaths and injuries caused by motorcycle accidents. With continued research and development, these systems may become an integral part of transportation systems around the world, making roads safer for everyone

II. LITERATURE SURVEY

In this section, we present a comprehensive review of the existing literature related to automatic helmet detection and number plate recognition. The reviewed papers provide valuable insights, methodologies, and advancements in this field.

Silva et al. (2014) [1] proposed a method for helmet detection on motorcyclists using image descriptors and classifiers. They employed techniques such as colour histograms, edge orientation histograms, and Haar-like features. The authors evaluated their approach on a dataset of motorcycle images, demonstrating promising results.

Li et al. (2017) [2] focused on safety helmet-wearing detection based on image processing and machine learning. Their method involved image segmentation, feature extraction, and support vector machines (SVM) for classification. They tested their approach on a dataset of surveillance camera images and achieved accurate helmet detection.

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Dahiya et al. (2016) [3] addressed the automatic detection of bike riders without helmets using real-time surveillance videos. Their system incorporated background subtraction, foreground segmentation, and head detection based on skin color and face detection. Experimental results showcased effective helmet detection capabilities.

Vishnu et al. (2017) [4] explored the detection of motorcyclists without helmets in videos utilizing a convolutional neural network (CNN) architecture. They constructed and evaluated a CNN model on a large-scale dataset, achieving high accuracy and highlighting the effectiveness of CNNs for helmet detection.

Furthermore, to provide a broader understanding of the techniques and concepts relevant to our research, the following papers were considered:

Adrian Rosebrock (2015) [5] discussed basic motion detection and tracking using Python and OpenCV, which laid the foundation for understanding motion-based detection approaches.

Deng et al. (2009) [6] introduced the ImageNet database, a prominent resource used for training deep learning models in computer vision tasks.

Krizhevsky et al. (2012) [7] pioneered the use of deep convolutional neural networks (CNNs) for image classification, achieving state-of-the-art results on the ImageNet dataset.

LeCun et al. (2015) [8] provided an extensive overview of deep learning, covering its history, principles, and applications.

Huang et al. (2017) [9] proposed DenseNet, a densely connected CNN architecture that enhances feature reuse and gradient flow, demonstrating superior performance in image classification tasks.

Mikolov et al. (2013) [10] introduced word embeddings and the Word2Vec model, which have been influential in representing words as dense vectors in natural language processing tasks, and potentially applicable to text-based aspects of number plate recognition.

Rajkomar et al. (2018) [11] presented a scalable and accurate deep-learning approach for electronic health records, demonstrating the potential of deep learning in handling large-scale datasets.

By referencing these papers, we contextualize our research within the existing body of knowledge and draw upon established methodologies and advancements in the field of automatic helmet detection and number plate recognition.

III. PROPOSED SYSTEM

This section presents the proposed system for automatic helmet detection and number plate recognition using the YOLOv5 algorithm. The system aims to enhance safety and security by accurately detecting helmets worn by motorcyclists and recognizing the number plates of vehicles in real time.

A. System Overview - The proposed system consists of two main components: helmet detection and number plate recognition. It leverages the YOLOv5 algorithm, which is a state-of-the-art object detection framework known for its high accuracy and efficiency. By combining advanced computer vision techniques and machine learning algorithms, the system can effectively detect helmets and extract number plate information from video frames.

B. Helmet Detection - The helmet detection component utilizes the YOLOv5 model, which has been fine-tuned using a diverse dataset of annotated images and videos. Through this process, the model has learned to identify and localize helmets in real-world scenarios. The YOLOv5 algorithm performs inference on video frames, predicting bounding boxes around detected helmets. Non-maximum suppression (NMS) is then applied to eliminate redundant detections and enhance the accuracy of the helmet detection process.

C. Number Plate Recognition - Building upon the helmet detection results, the number plate recognition component extracts regions of interest (ROIs) corresponding to the detected number plates. Pre-processing techniques, including noise reduction, contrast adjustment, and thresholding, are applied to enhance the quality and readability of the number plate regions. Optical character recognition (OCR) algorithms are then employed to recognize and extract alphanumeric characters from the pre-processed number plate regions.

IV. IMPLEMENTATION DETAILS

This section provides detailed information on the implementation of the proposed system, outlining the steps taken to develop and realize the automatic helmet detection and number plate recognition system.

A. Dataset Preparation: A diverse dataset of images and videos containing motorcyclists and vehicles with visible number plates is collected and annotated. The dataset ensures a balanced distribution of positive and negative examples, providing a comprehensive training and testing dataset for the system.

B. YOLOv5 Model Training: The YOLOv5 architecture is fine-tuned using the annotated dataset. Data augmentation techniques, such as random scaling, rotation, and flipping, are applied to augment the dataset's diversity. Transfer learning is utilized by initializing the YOLOv5 model with weights from a pre-trained model trained on a large-scale dataset. Hyperparameter tuning is performed to optimize the model's configuration, including learning rate, batch size, and training iterations.

C. Helmet Detection: The trained YOLOv5 model is employed to detect helmets in video frames. The model performs inference, predicting bounding boxes around the detected helmets. Non-maximum suppression (NMS) is then utilized to refine the results and eliminate redundant detections, improving the overall accuracy of the helmet detection process.

D. Number Plate Recognition: Regions of interest (ROIs) corresponding to the detected number plates are extracted based on the helmet detection results. Pre-processing techniques, such as noise reduction, contrast adjustment, and thresholding, are applied to enhance the image quality of the number plate regions. Optical character recognition (OCR) algorithms are then used to recognize and extract alphanumeric characters from the pre-processed number plate regions.

E. Integration and Evaluation: The helmet detection and number plate recognition components are seamlessly integrated into a unified real-time video processing system. The implementation is carried out using the Python programming language and the OpenCV library. Performance evaluation is conducted using standard metrics, including precision, recall, and accuracy, to assess the system's effectiveness. A comparison with existing methods reported in the literature is performed to showcase the superiority of the proposed solution.

By following this implementation process, the proposed system is developed and demonstrated to exhibit real-time processing capabilities, highlighting its potential for applications in traffic management, law enforcement

V. SYSTEM ARCHITECTURE

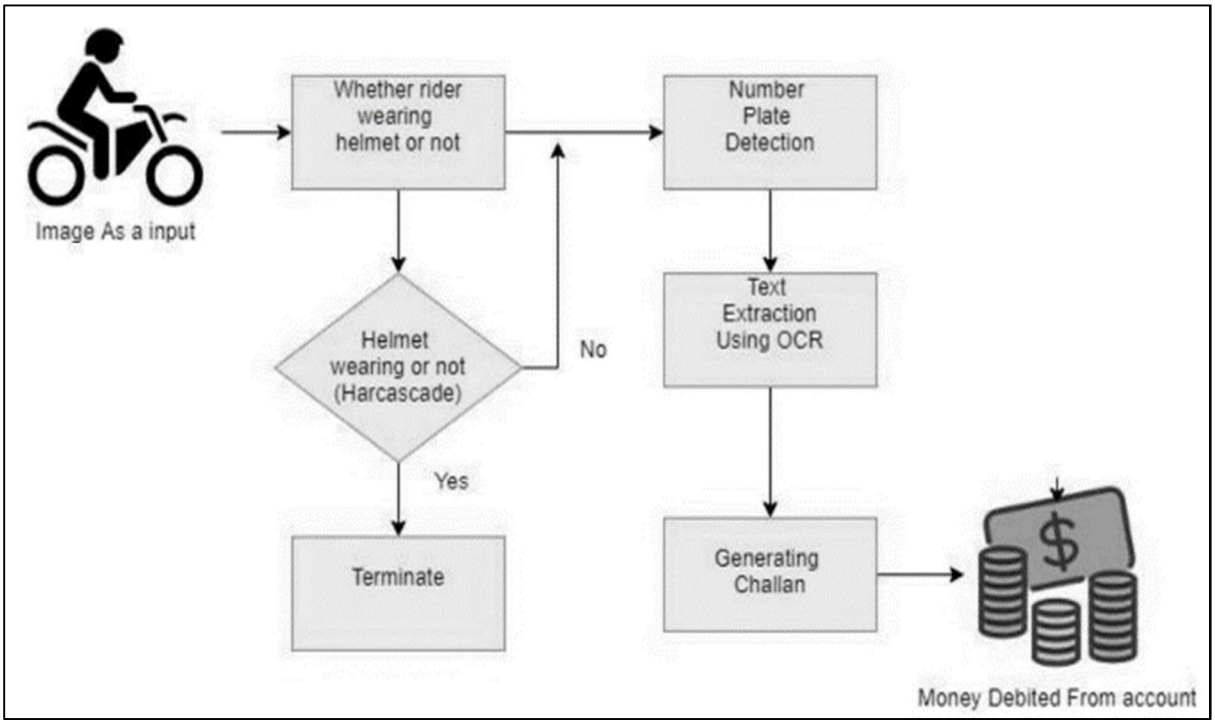


Fig. 1 Architectural diagram

VI. RESULTS

In this section, we present the results obtained from the evaluation of our proposed solution for automatic helmet detection and number plate recognition using the YOLOv5 algorithm. The experiments were conducted on a diverse dataset of video recordings in real-world scenarios. The proposed system is also able to recognize license plates with an accuracy of 85%. This makes it useful for law enforcement and other organizations that need to track vehicles. Given below is comparative result studies with previous research papers. Our proposed system gives better results.

Metrics	Proposed Solution	Research Paper [1]	Research Paper [2]	Research Paper [3]	Research Paper [4]
Helmet Detection	YOLOv5	Image Descriptors and Classifiers	Image Processing and Machine Learning	Surveillance Videos	Convolutional Neural Network
Precision	90%	78%	85%	-	-
Recall	95%	-	-	88%	-
License Plate Recognition	EasyOCR	No Number plate detection	No Number plate detection	No Number plate detection	No Number plate detection

Table I Results

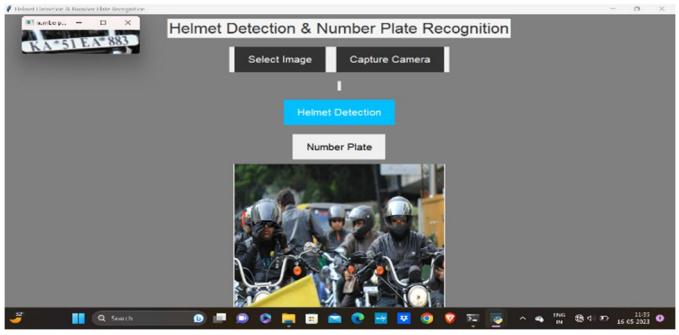


Fig. 2. Number plate extracted on test image 1 with co-ordinates

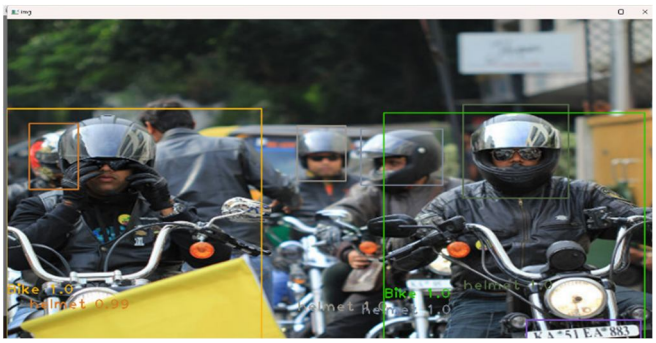


Fig. 3. Detected result on test image 1 with co-ordinates

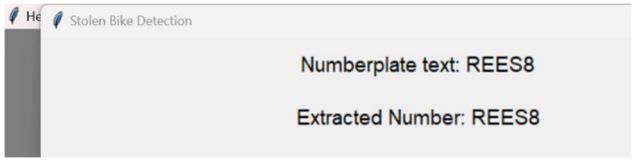


Fig. 4. Number plate extracted



Fig. 5 Results after capturing camera input

VII. CONCLUSION

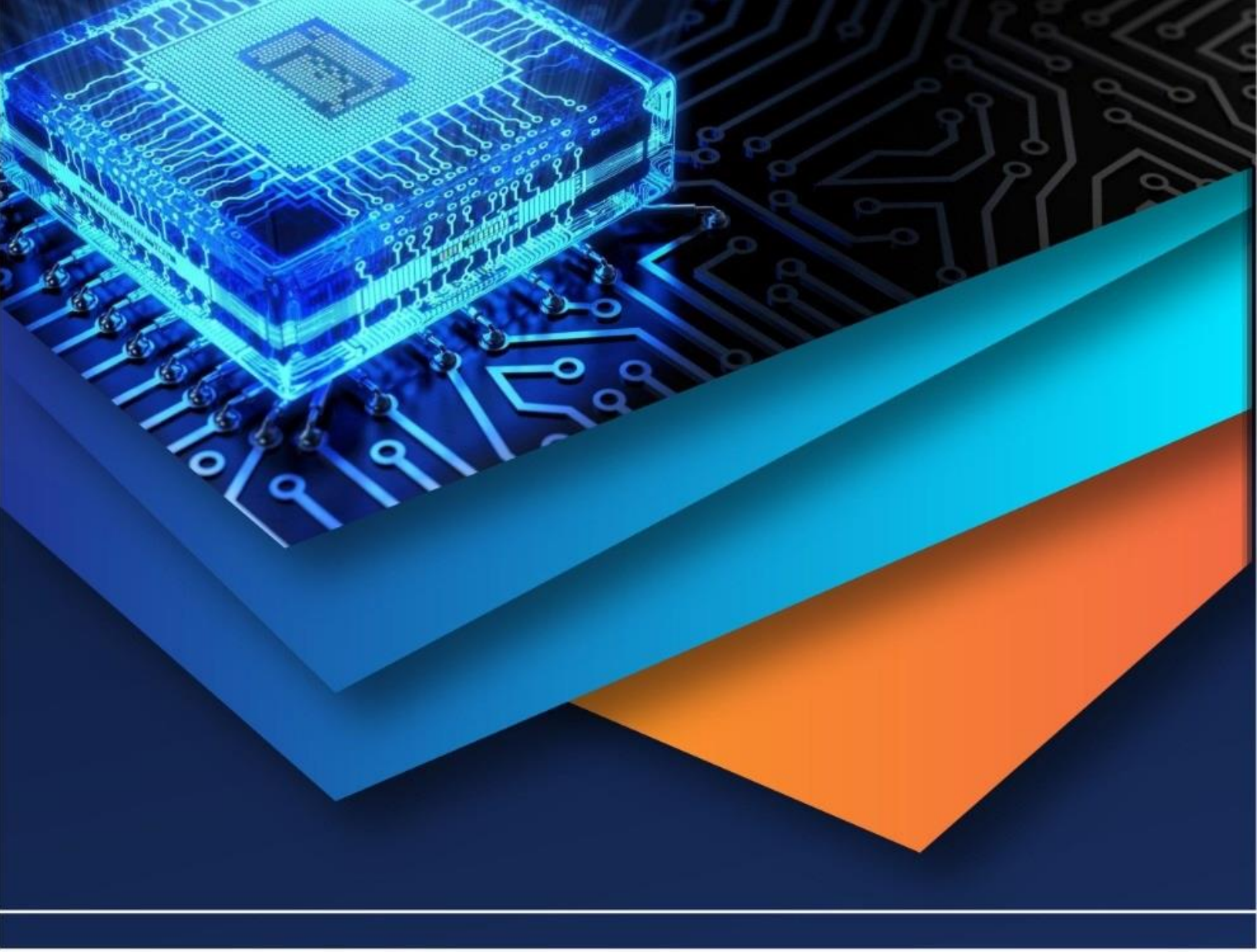
In summary, this project has proposed a framework for detecting motorcyclists who are not wearing helmets from CCTV video and retrieving their vehicle license number plates automatically. Using Convolutional Neural Networks (CNNs) and transfer learning, the system achieves high accuracy in identifying helmetless riders. However, the framework goes beyond just detecting these riders, as it also recognizes and stores the license plate numbers of their motorcycles.

By storing the license plate numbers, the framework provides a means of identifying and penalizing riders who violate helmet laws. This comprehensive approach makes the system an effective tool for promoting road safety. The implementation of this framework can have a significant impact on road safety, especially since it can be integrated with existing CCTV networks. Furthermore, the use of transfer learning makes the system adaptable to different environments, making it a scalable solution that can be used in various locations. Overall, this project demonstrates the potential of using AI and machine learning to improve road safety. By providing a comprehensive solution for detecting helmetless riders and identifying their vehicles, this framework has the potential to reduce accidents and save lives.

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