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AUTOMATED HELMET MONITORING SYSTEM USING DEEP LEARNING

Kavuri.K.S.V.A.Satheesh[1], Nandam Sai Akhila[2], Dondapati Amarnadh[3], Paruchuri Sagar Swetha[4], Avula Venkata Sohan[5], Vasireddy Pardhiv[6]

[1,2,3,4,5,6]*Department of Artificial Intelligence and Data Science, Vasireddy Venkatadri Institute of Technology,Guntur*

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Abstract **- Safety and compliance are the uppermost and fundamental concerns in the modern transport subsystems. As a result, the project is essentially designed to come up with an advanced solution by combining YOLOv8 for precise identification of objects and, on the other hand, EasyOCR for reading characters. The key goals are to detect helmets, those without helmets, and identify number plates of the respective motor vehicle. With YOLOv8, we start training the model to identify not only helmets but the lack of helmets, which is necessary for compliance monitoring based on the law. Further, YOLOv8 is also designed to determine the Regions of Interest . Regarding vehicles, the model focuses mainly on license plates which are key objects. After finding the appropriate areas, EasyOCR is designed for applying optical character recognition, helping to obtain vehicle numbers of any type in the most organized, quick way. Therefore, combining YOLOv8 at the stage of object detection and EasyOCR for the recognition of characters creates a novel but, at the same time susceptible system for a vehicle control company.**

This integrated system is a sophisticated device for monitoring helmeted and unhelmeted riders, promoting a safe and stable journey gadget. By leveraging real-time records, our answers provide precious insights into protection compliance. In summary, the aggregate of YOLOv8 and EasyOCR presents a effective answer for item popularity and conduct reputation, so that our system contributes to the development of secure and green urban mobility by means of preserving rider protection and safety.
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Index Terms - Helmet, Deep Learning, Object Detection, Character Recognition, ROI

I. INTRODUCTION

Advancements in deep learning technology have changed many fields in recent years, such as object detection and laptop vision. One crucial area of software where such developments continue to have enormous potential is in the improvement of road safety through automated tracking systems. Revolutionary solutions that might reduce hazards and ensure adherence to safety regulations are desperately needed given the growing problem of traffic-related injuries and fatalities. Our challenge focuses on using Deep Learning techniques to enhance an Automated Helmet Monitoring machine in response to this need.

Installing cutting-edge deep learning algorithms to discover motorcycle riders' helmet-wearing habits is the main objective of our task. We use the power of YOLOv8, a relatively green object detection set of rules renowned for its quickness and accuracy, to do this. Our system uses YOLOv8 to detect cyclists in real-time who are wearing helmets and who are not, allowing for timely intervention to enforce safety procedures.

In addition, our project handles registration code detection, one more crucial aspect of roadway safety, in addition to helmet monitoring. YOLOv8 is used to find license plates on automobiles once more. After identification, we merge EasyOCR, a robust optical character recognition (OCR) library, to accurately read the license plate characters. This makes it possible for license plate data to be automatically retrieved, enabling a variety of services like vehicle identification, tracking, and law enforcement.

Our device's functionality and performance have been enhanced with the use of OpenCV, an open-source computer vision library. For the purposes of object monitoring, feature extraction, and picture preprocessing, OpenCV provides an extensive range of tools and features. Through the use of OpenCV, we will ensure stability and dependability when handling a wide range of real-world circumstances, including different lighting conditions, occlusions, and vehicle orientations.

The importance of our project resides in its ability to dramatically improve roadway safety outcomes through the application of cutting-edge deep learning technologies. Our equipment enables law enforcement to effectively enforce helmet usage policies and take preventative action to save lives by automating license plate identification and tracking helmet usage. Our method is also well-suited for implementation in various contexts, such as parking enforcement, toll road monitoring, and urban visitor management, due to its scalability and adaptability.

We may go into further detail about our project's technique in the areas that follow. Section 2 provides an overview of relevant literature. The suggested computer vision-based automatic helmet-wearing or non-helmet-wearing detection algorithm is presented in Section 3. The dataset, experimental setup, and performance on the dataset are covered in Section 4. Section 5 listed the conclusions and next steps in order of importance.

II. LITERATURE REVIEW

There are various authors and researchers who have proposed different types of solutions to the problem of automatic helmet monitoring in real-time situations. J. Chiverton and colleagues (2012)[1] have proposed a system to detect helmets using Support Vector Machine (SVM) algorithm along with background subtraction, but this system tend to have low accuracy where most of people are identified as people without helmets even they are wearing helmets, another drawback is that the model take a lot of computational time. Rattapoom Waranausast and colleagues (2013)[2] used KNN classifier to retrieve the region properties to classify moving items as motorcycles or the other, which helps system determine whether or not segmented head region is wearing a helmet, their experiment findings resulted in correct detection rate for near lane is 84%. Maharsh Desai and colleagues (2016)[3] proposed a method which involves using computer techniques like background subtraction and Hough Transform to detect the whether rider is wearing helmet or not, they have also used optical recognition to detect falls which is useful to alert authorities or family members. Vishal Jain and his group(2016)[4] proposed their work to automatically detect and recognise the license plates using Deep CNN methods, they have used CNN to detect number plates and also trained CNN classifier for individual characters in parallel with spatial transformer network (STN) for character recognition, they have robust model in both localization and recognition. Jie Li and team (2017)[5] proposed an innovative approach to identify people with helmets. At first, the ViBe background modelling algorithm is used to monitor moving things. After the Histogram of Oriented Gradient (HOG) feature is extracted to identify people in the region. And then the Support Vector Machine (SVM) is trained to classify the helmets. Hui Li and team (2018)[6] have proposed a method to read the license plates of cars, their main intention is not to break them into the several letters, they have used CNN to detect the plate and implemented BRNNs and LSTM to identify the features of the plate, then used CTC to decode those features, but this took high computational time due to use of various technologies. Dikshant Manocha and team (2019)[7] have used combination of ADE along with CNN to identify motorcycles in real-time videos and focused on helmets, and they have achieved accurate results, however they dealt with challenges like bad lighting, bad video quality, and different weather conditions. B. Yogameena and team (2019)[8] have presented a system which automatically detects the motorcyclists with and without helmets, the system uses faster R-CNN for detection of motorcyclists and subsequently it is also used for detection of helmet presence, then LP number is recognised using character-sequence encoding CNN model and spatial transformer which outperforms the state-of-the-art algorithms at that instance. Izidio and group (2020)[9] presents a smart system to read license plates on cars, they used convolutional neural networks (CNNs) to make this system work and tested it in Brazil which has good results even in tricky situations like bad lighting or weird angles, they have combined numerous CNN together to produce a robust sytem even though it took long to train. Aphinya Chairat and team (2020)[10] proposed a model which demonstrate the effectiveness of computer vision and machine learning methods to track helmet violation, their architecture has a GPU server and multiple clients with communication over HTTP, their system is able to detect 97% of helmet violations with a 15% of false alarm rate. Ankit and Nilesh (2020)[11] proposed a practical approach of detecting the helmets as well as optimizing the performance of SSD MobileNet model for smaller size objects, first SSD model is used to detect persons and second SSD model identifies whether person is wearing the safety helmet, but the learning rate appears to be very low and model takes more time to converge. Pengfei Wang and colleagues (2021)[12] proposed an improved helmet detection method based on Yolov5, they made use of lightweight GhostBottleneck instead of Bottleneck structures which raised the accuracy by 2.0% comparitively which turned out to have good adaptability even in poor light. Wei Jia and his colleagues (2021)[13] have presented a method that consists two steps, first they used Yolov5 object detection algorithms to detect the motorcyles, second step takes the output of first step whose task is to identify the motorcyclists who wear helmets, using the sequential combination of models helped them achieve mAP of 97.7%. Adil Afzal and team (2021)[14] have collected custom images of traffic in Lahore, first they have identified regions of interest using RPN and then the results are used to train faster R-CNN model, they have achieved 97.26% accuracy in detecting bikeriders with and without helmets. P. Sridhar and colleagues (2022)[15] have proposed a model which is mainly trained with Yolov2, they have used their custom dataset in order to obtain exceptional results and their model achieve good accuracy at detecting motorbike riders with and without helmet. YueJing Qian and team (2023)[16] have proposed an approach to optimize the BottleneckCSP structure in yolov5 backbone network, they mainly aimed to propose a robust sytem to detect helmets which turned out to reduce the complexity of model with no changes in size of inputs and output, their method is proved to be better compared with existing methods with fastest interference speed. A. Vandana Peter and colleagues (2023)[17] have proposed an application to detect helmets and read license plates using deep learning algorithms, they have used Yolov3

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to detect motorcycles and another CNN to determine whether bicyclist wears helmet or not, TesseractOCR is used to read the license plate number of motorcycles which are already captured using Yolov3. Xiaowen and team (2023)[18] proposed a model to detect safety helemts using Yolov7 models which proved to be better compared to previous versions and they have found that the model works with good stability and high precision in different application scenarios. Moreover, certain systems mentioned above are unable to distinguish between a scarf and a helmet. A scarf and a helmet can be distinguished from one another with ease by the suggested method. The suggested approach also outperforms the current algorithms in terms of accuracy and was created utilizing a large dataset. specifically in low-resolution video, occlusion, scale variations, lighting, profile, and frontal views, and different versions of an item.

III. Proposed Methodology

This section proposes a system for automatically detecting helmet violations in roadside surveillance camera videos. The suggested technique uses the Yolov8 deep learning model to detect helmet violations in traffic videos which help us take appropriate action against violators. The suggested approach executes various operations in sequence. Firstly, it recognizes motorcycle riders and divides them into two categories: "With Helmet" and "Without Helmet." Secondly, it identifies riders license plates and uses EasyOCR to extract the text. The figure Fig. 1 shows the proposed technique's block diagram. The sections below details each component of the suggested approach

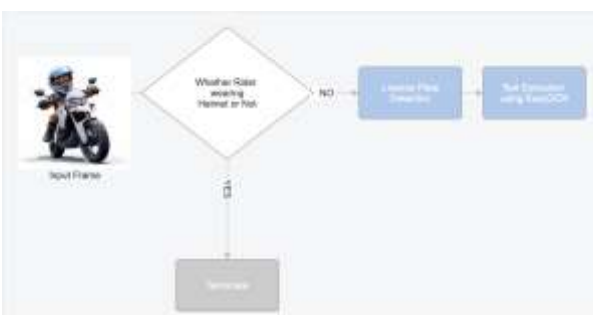

Fig1: Flow diagram prepared for proposed methodology

A. HelmetDetection

1. Getting the dataset Ready

The system starts with the aid of preparing a dataset for an object research model using the Roboflow package. The dataset is made up of snap pictures of bikers wearing and without wearing helmets, with labels for clarity. This thorough information is utilized to train the version, allowing it to screen motorcyclists' adherence to helmet requirements as intended. This strategy ensures the model's learning and development, laying the groundwork for effective deployment and genuine international impact.

Fig: Helmet Detection Dataset from RoboFlow

2. Get the Model Trained

To train the helmet detection model, we used an existing method called yolov8, which is more robust and advantageous than previous versions of it. Training involves creating a Google colaboratory, installing ultralytics, connecting to the drive where the dataset is located, and using commands to train the model with the collected dataset. We have conducted training over 150 epochs and it took around 1 hour, which is significantly less than other object detection algorithms.

Fig: Model Differenciating between Scarf and Helmet

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3. Assessing the functionality of the mode

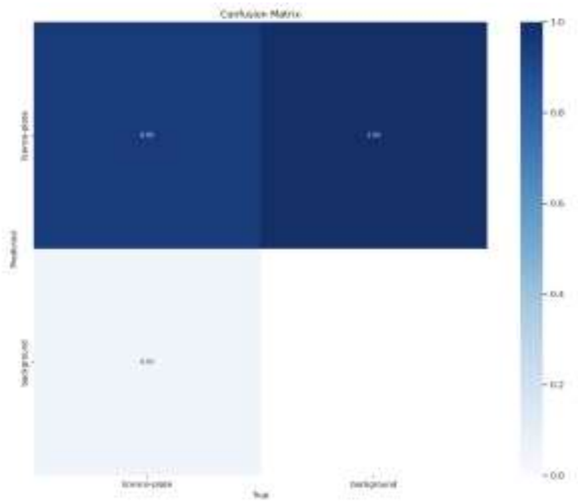

Fig:Confusion Matrix Of Model

4. Verifying the Model's output

Fig:Helmets identified by Yolov8

B. Extraction of License plate Text

1. License plate Training and Detection

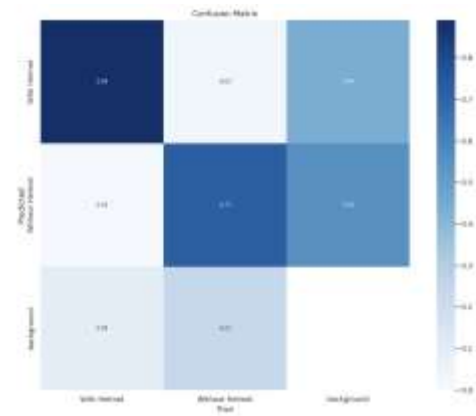

Fig:Confusion Matrix Of Model

Roboflow datasets resemble well-organized photo libraries from which computers can extract knowledge. They aid in the training of computers to recognize objects, such as license plates on bikes. To detect license plates, we gathered relevant datasets and trained the yolov8 model on a new Google collaboratory. The resulting model was trained over 150 epochs in approximately 0.9 hours, demonstrating the robustness of the yolov8 model in comparison to previous iterations and other object detection models. Our primary focus was on google colaboratory training, which helps to increase clarity by reducing code complexity. Instead of utilizing Python code, training is carried out by commands, where we have given clear paths to the dataset that is stored on a drive.

2. Assessing the performance of the model

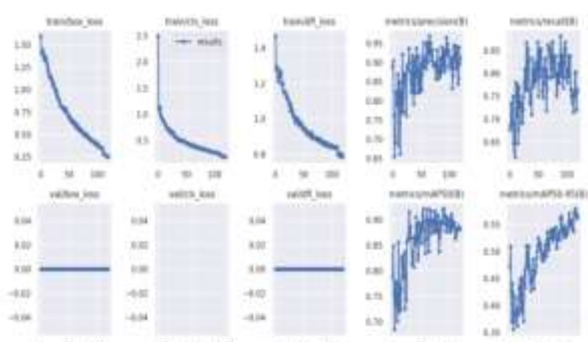

Fig:Metrix on object identification after testing the data

2. Examining the Model's output generat

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3.
4. Extracting text from License Plate using EasyOCR

In our project, we utilize YOLOv8 to detect license plates and then use EasyOCR to recognize the numbers on those plates. In order to accomplish this, we define Regions of Interest (ROI) surrounding the detected license plates. This allows EasyOCR to concentrate its attention on those regions for precise number recognition. The implementation of this focused strategy guarantees streamlined operations and dependable extraction of numeric data from license plates, enhancing the comprehensive efficiency of our system for a range of uses, including automobile monitoring, toll collecting, and law enforcement.

C. Combining Helmet Detection with License plate Recognition

The integration of license plate recognition with helmet detection adds benefit to society, particularly in intelligent transportation systems. There are three basic steps in this process.

In order to read frames from a video file, extract frame dimensions, and write processed frames to an output video file, first utilize OpenCV. This is a typical OpenCV pipeline for video processing jobs. It assists in going over every frame, identifying objects, and writing those details to a new output video file.

Second, in order to identify bike riders who are wearing helmets, helmets that are not, and license plates, we have loaded two models that we trained using different datasets.

Ultimately, every frame is subjected to both of the trained models, If the license plate is identified, the EasyOCR reader is activated, which divides the letters within that specific region of interest and extracts the string containing the license plate number.

The output video is composed of frames containing detections of riders who are adhering to helmet requirements and the license plates of each vehicle are identified in order to take further action in the event that rules are broken. Annotations are made on each output frame using the cv2 library.

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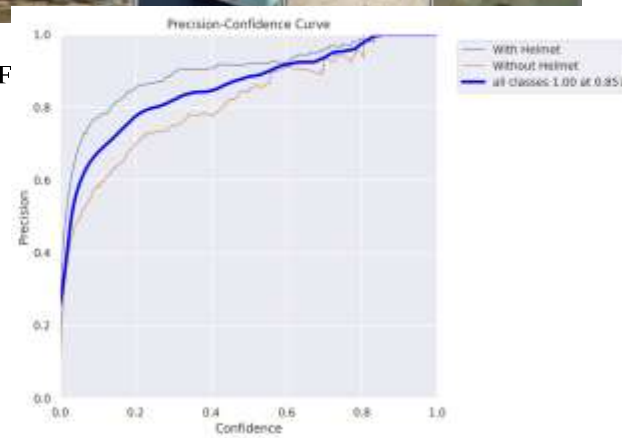

Fig:Precision of the model after testing

IV. EXPERIMENTAL RESULTS AND DISCUSSION

In the framework of our project, we utilized the capabilities of YOLOv8 specifically, the YOLOv8m version, played a crucial role in our pursuit of helmet detection. Through diligent after training on our own dataset, this model displayed remarkable proficiency in distinguishing riders with and without helmets inside images. It operates with a picture resolution of 640 pixels shown to be the best option for the assignment, balancing accuracy and computational efficiency. We refined the model through an extensive training routine lasting 150 epochs, enhancing its performance with a batch size of

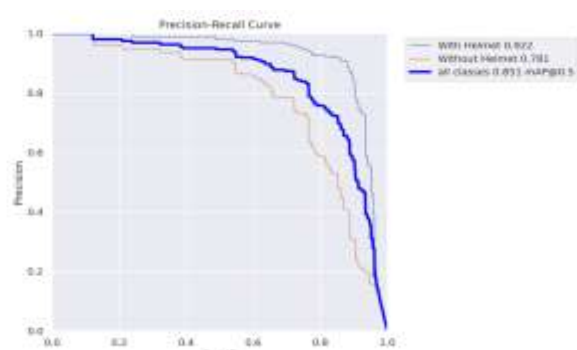

Fig: Recall of the results from testing model

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Fig: Output Frame

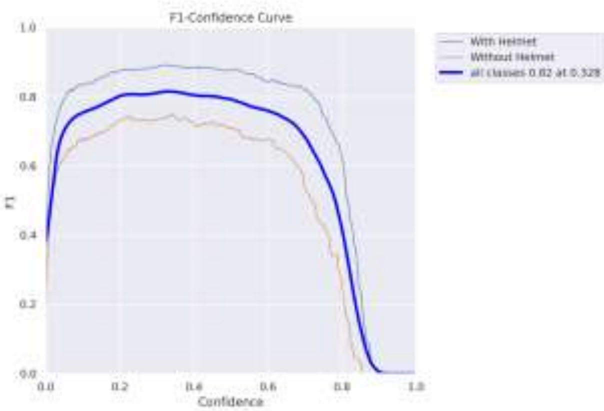

Fig : F1 score of model after testing

Fig: Number plate recognition using easyOCR

Once we were pleased with the helmet detection, we repeated the approach to train another model to detect motorcycle riders' license plates. This model was also efficiently trained using 150 epochs on the yolov8m version.

We used EasyOCR, a highly effective program, for character identification. EasyOCR's identification accuracy closely matches human perception, making it an ideal fit for our project. It performs best with clear, recognizable source photos. The quality of the original source photos directly affects the separation of characters from the backdrop, resulting in more precise OCR outputs.

In our experiment, we integrated these two trained models to collaborate. We used YOLOv8 to distinguish riders with and without helmets and number plates in high-speed video feeds at 60 frames per second. The YOLOv8 model, trained over 150 epochs, consistently surpassed other models in accuracy. Our smart combination of models and training parameters has resulted in reliable helmet and no-helmet detection, as well as license plate recognition, which aligns with our project objectives.

V. CONCLUSION

Using YOLOv8 and EasyOCR, we established real-time Automatic Helmet Monitoring capabilities. This integration uses GPU acceleration to speed up object detection and character recognition, making it ideal for real-time applications. YOLOv8 outperforms its predecessors in speed and accuracy, making it the best choice for object detection.

Our YOLOv8 model, trained on a proprietary dataset for object detection, outperforms earlier versions. EasyOCR demonstrates high accuracy in character recognition, making it a top choice for text extraction jobs.

Automatic helmet monitoring, powered by YOLOv8 and EasyOCR, offers a revolutionary solution for ensuring road safety and enforcing regulations to wear helmets. By accurately detecting whether motorbike riders are wearing helmets in real-time, our system promotes safe riding practices and minimizes the likelihood of severe head injuries during accidents. This technology aids law enforcement agencies in enforcing helmet-wearing regulations by automatically identifying non-compliant individuals and issuing warnings or citations as necessary, thereby preventing fatalities and reducing mortality rates associated with head injuries sustained in crashes. Seamlessly integrating with existing surveillance systems, our solution enables continuous monitoring of helmet compliance across various road networks and traffic junctions, allowing law enforcement personnel to allocate their resources more efficiently. Real-time alerts and notifications facilitate swift intervention and corrective action, ensuring comprehensive helmet compliance monitoring in diverse environments. Designed with scalability in mind, our system can be deployed across urban intersections, highways, and industrial zones, enhancing overall traffic management and enforcement capabilities. Through the collaborative efforts of YOLOv8 and EasyOCR, our automatic helmet monitoring system achieves a commendable accuracy rate, ensuring reliable performance and highlighting its potential impact in promoting road safety and regulatory compliance.

VI. FUTURE WORK

In future work for automatic helmet monitoring using YOLOv8 and license plate recognition using EasyOCR, efforts will focus on enhancing system accuracy and versatility. This includes integrating multiple camera views for improved detection, optimizing deep learning algorithms to reduce false positives, and developing real-time analytics for actionable insights. Adaptive algorithms will be explored to adjust detection parameters based on environmental factors, while edge computing may be employed for faster response times. Integration with smart infrastructure and privacy-preserving techniques will also be investigated, alongside user feedback mechanisms for continuous improvement. These advancements aim to make the system more efficient, reliable, and privacy-conscious, enhancing its impact on safety of riders and traffic management.

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