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Advancements in Safety: Utilizing CNNs for Helmet Detection and License Plate Recognition

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Abstract: In contemporary times, road accidents stand out as significant contributors to human fatalities. Among these, motorcycle accidents are prevalent and often result in severe injuries. Helmets serve as crucial protective gear for motorcyclists, yet adherence to helmet laws remains lacking. To overcome this issue, a system that uses image processing and convolutional neural networks (CNNs) has been created. This system encompasses motorbike detection, helmet classification (helmet vs. no helmet), and motorbike license plate recognition. Motorbikes are initially identified using YOLOV3. Afterward, a CNN evaluates if the biker is wearing a helmet. In cases where a helmet violation is detected, the system utilizes tesseract OCR to recognize the motorcycle's license plate, facilitating enforcement measures.
Keywords: Helmet detection, CNN, Tesseract OCR, License Plate Detection, yolov3

I. INTRODUCTION

Motorcycle riders rely largely on their helmets for protection. Motorcycle helmets keep motorcyclists safe from accidents. Most nations require motorcycle riders to wear helmets, although some do not. Recent traffic analysis research has focused on vehicle recognition, classification, and helmet detection. Computer vision methods such as image identification, moving object segmentation, and picture information extraction were used to develop intelligent traffic systems. Machine learning is a sort of artificial intelligence that enables a trained model to act independently by utilizing inputs supplied during the training process. Machine learning algorithms develop a mathematical model utilizing sample data known as "training data" to make predictions or judgments, and they are also used in object recognition applications. As a result, by training on a specified dataset, a helmet detection model may be constructed. This helmet identification model can readily detect helmet-less bikers. Based on the recognized classifications, the rider's license plate is cropped and stored as an image. This picture is sent into an Optical Character Recognition (OCR) model, which detects the text and outputs the license plate number as machine-encoded text. It may even be accomplished in real-time using a webcam.

II. RELATED WORKS

In recent years, the use of Convolutional Neural Networks (CNNs) has dramatically boosted helmet identification and license plate recognition, resulting in improved road safety and traffic management. Hu et al. (2018) presented a CNN-based solution for motorcycle helmet recognition that achieved excellent accuracy and real-time performance (Hu, Wu, and Zhang, 2018). Their system uses deep learning algorithms to reliably detect motorcycle helmets in a variety of environments, allowing for more efficient enforcement of helmet legislation and boosting rider safety. In parallel, Zhu et al. (2019) introduced a CNN-based license plate detection and identification system that uses deep learning algorithms to successfully recognize and extract license plate information from photos (Zhu, Lin, and Fu, 2019). Their methodology shows strong success across varied Recent advancements in traffic management and law enforcement have been marked by innovations addressing various challenges, such as fluctuations in lighting conditions and picture quality. Notably, Li, Zhang, and Chen (2020) introduced an integrated system utilizing Convolutional Neural Networks (CNNs) for simultaneous helmet detection and license plate identification, enhancing traffic monitoring capabilities. This solution enables real-time assessment of motorcycle riders' compliance with helmet requirements and facilitates the identification of vehicles through license plate recognition, thereby enhancing overall traffic safety and enforcement procedures. Ongoing developments in CNN designs and training methodologies continue to drive progress in helmet detection and license plate recognition technologies.Wang et al. (2021) proposed a unique CNN architecture that includes multi-scale feature extraction and attention techniques to increase accuracy and efficiency in helmet identification and license plate recognition tasks. Their methodology outperforms standard methods, demonstrating the effectiveness of deep learning techniques in solving challenging real-world situations.

In addition to algorithmic breakthroughs, the availability of large-scale datasets and open-source frameworks has accelerated the development of CNN-based systems for helmet identification and license plate recognition. Wu et al. conducted research. Wu, Zhang, and Li (2019) focus on dataset construction and annotation approaches to assist the training and assessment of CNN models for helmet detection and license plate recognition tasks. Furthermore, collaboration among academia, business, and government organizations is critical to improving research and development in this field. Joint research initiatives, such as those done by academic institutions in collaboration with law enforcement agencies and technology businesses, promote the deployment of CNN-based systems in real-world applications for improved traffic management and safety enforcement (Chen et al., 2020). Overall, the research highlights the rising relevance of CNN-based techniques in solving critical difficulties such as helmet detection and license plate identification in traffic surveillance and law enforcement. Continued research and interdisciplinary collaboration are crucial to fully harness the capabilities of CNN-based systems in enhancing road safety and traffic management. By fostering ongoing innovation, we can propel the development of cutting-edge solutions in this field

III. PROPOSED METHODOLOGY

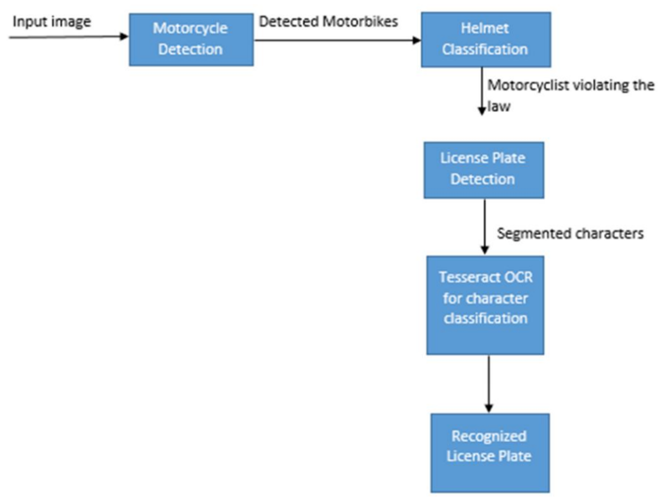

Fig 1: Block diagram

The following are the different units involved:
1) Using Yolo to Detect Motorcycles.
2) CNN-based helmet classification.
3) License plate recognition
4) Utilizing Tesseract OCR for Character Classification

The block diagram outlines a detailed process for analyzing photos involving motorcycles. The technique starts with motorbike detection using YOLOv3, a powerful object detection algorithm. Initially, motorcycles are accurately detected by scanning the input image. Then, helmet categorization follows using CNNs. This section scrutinizes recognized motorcycles to ensure riders are wearing helmets and adhering to safety standards. The CNN-based model determines if motorcyclists are wearing helmets and identifies potential violations of helmet legislation. The technique then progresses to License Plate Detection, a crucial stage of analysis. Advanced algorithms are employed to detect and separate license plates within a photograph. This stage sets the groundwork for the subsequent phase, which involves character categorization using Tesseract OCR. Tesseract OCR's Optical Character Recognition algorithms are utilized in this step to segment and process the license plate characters. The technology detects license plate numbers by decoding and extracting the alphanumeric characters. This comprehensive procedure leverages a range of computer vision and machine learning technologies to fulfill a wide range of tasks. Each phase contributes to ensuring that photographs, particularly those involving motorcycles, undergo proper scrutiny, adhere to safety criteria, and facilitate simplified license plate identification for future action or recording. These steps range from detecting motorcycles and evaluating helmet usage to identifying license plates and extracting relevant information.

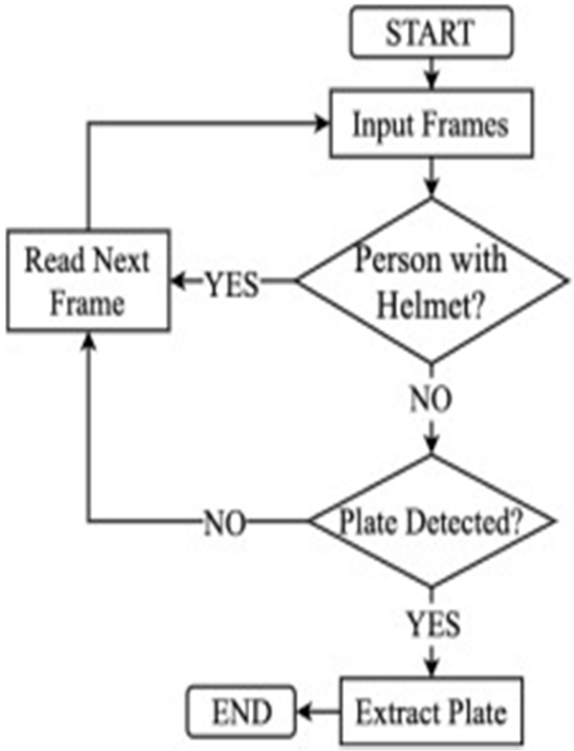

Fig 2: Flowchart

A. Algorithm used

YOLOv3, or You Only Look Once version 3, stands out as a real-time object recognition system renowned for its ability to identify specific items in images, videos, and live feeds swiftly. Functioning as a Convolutional Neural Network (CNN), YOLO operates in real-time, distinguishing itself by its rapidity and efficiency in recognizing objects. CNNs, such as YOLO, are characterized by their classifier-based systems, adept at discerning patterns within input images through the transformation of visual data into structured arrays. YOLO has the benefit of being exact while running at substantially higher speeds than other networks. During testing, it allows the model to view the entire image. Thus, the image's global environment influences its predictions. YOLO and other neural network algorithms "scored" areas depending on their proximity to certain categories (Connect with).YOLO can detect different sorts of automobiles in a live traffic stream based on high-scoring zones for specific categories. This method is used in the initial phase of motorbike rider identification.

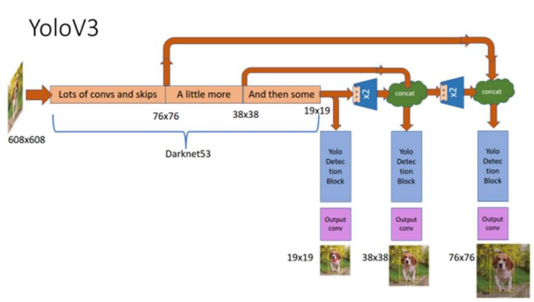

Fig 3:yolov3

Optical Character Recognition (OCR) stands as a pivotal technique used to convert printed images containing text, alongside handwritten or typed text, into machine-readable digital formats. Through this process, vast volumes of paper-based content can be seamlessly transformed into digital files, facilitating streamlined text processing, searching, and storage. OCR technology revolutionizes document management by enabling efficient digitization, thereby enhancing accessibility and usability of textual information across various applications and industries.

The steps in a modern OCR training workflow are as follows:

1) *Acquisition:* extracting non-editable text information from various types of scanned documents, such as live surveillance video, mobile image data, and flatbed scans of corporate archives.
2) *Pre-processing:* Reducing or removing noise and enhancing text readability by cleaning
3) Feature extraction and segmentation involve examining the image's content for groupings of pixels likely to form a single letter and categorizing them individually. The machine learning framework then attempts to extract features for the discovered pixel groupings using generic OCR templates or previous models. Verification will follow this step.
4) *Training:* Once all features are specified, the data can be processed using a neural network.
5) *Retraining and verification:* After processing, people analyze the results and make appropriate improvements for future training sessions. At this stage, the data's quality may need assessment. While early data cleaning can be expensive and time-consuming, training runs will utilize de-skewing, high-contrast processing, and other advantageous techniques to build a robust algorithm with minimal pre-processing. However, more thorough data refinement may still be necessary.

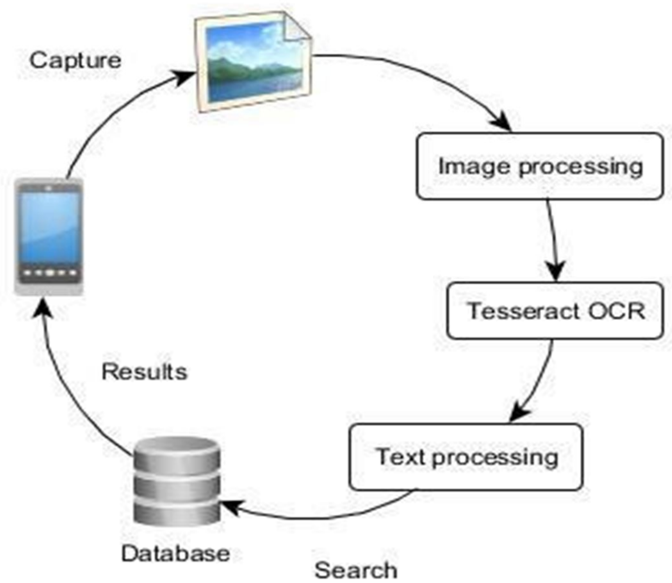

Fig 4: OCR

IV. IMPLEMENTATION & RESULTS

In this project, we built a CNN model to detect HELMETS and number plates from 25 different images. We can detect more images, but we don't have enough datasets to train the CNN model. Our application can detect the presence of a helmet from 25 different images, and if the helmet is not present, it will identify the number plate. If the helmet is present, it will not identify the number plate. To run project double click on 'run.bat' file to get below screen

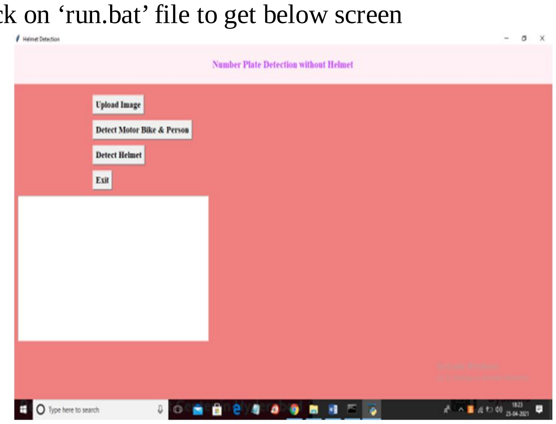

Fig5: To upload an image, use the 'Upload image' button at the top of the screen.

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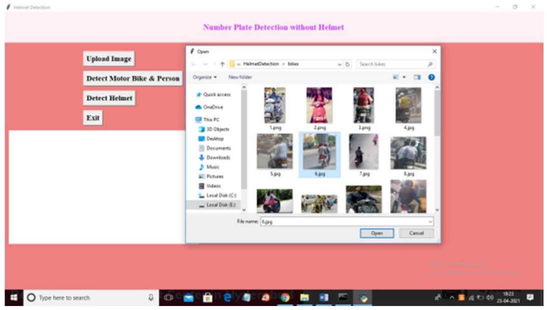

Fig6:Once on the upload page, choose the '6.jpg' file and press the 'Open' button to load it. Then, select the 'Detect Motor Bike & Person' option to determine whether the image contains a person riding a bike.

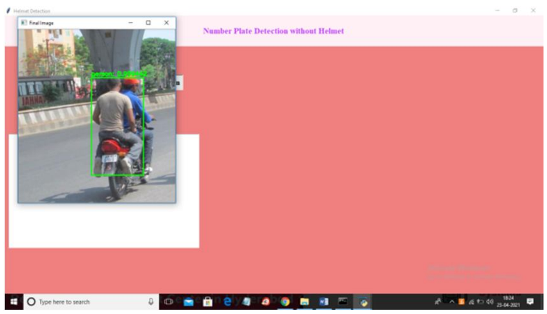

Fig7:In the above screen, if a person with a bike is spotted, it creates a bounding box and then clicks the 'Detect Helmet' button to receive

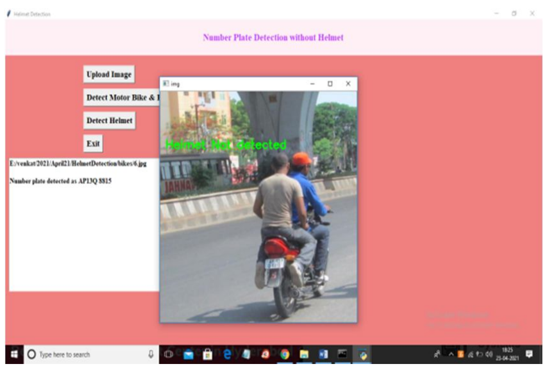

Fig8:In the above screen, we can see the helmet not detected, and then the application recognizes the number plate and shows it in the text field as 'AP13Q8815'.

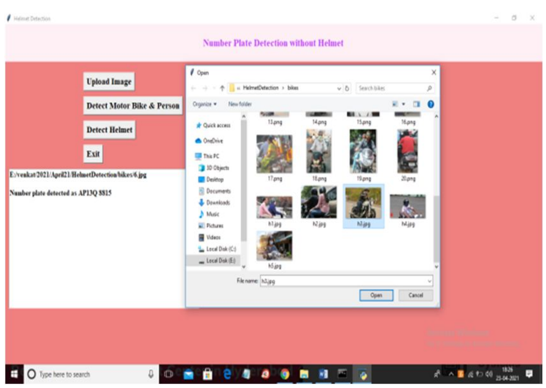

Fig9: In the above screen, choose and upload the 'h3.jpg' image, then click the 'Open' button, then click the 'Detect Motor Bike & Person' button to get the result shown below.

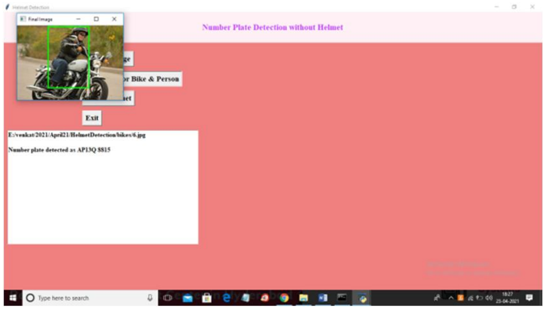

Fig10:In the above screen, a person riding a motorcycle is recognized. Now, shut the above image and click the 'Detect Helmet' button to receive the following result.

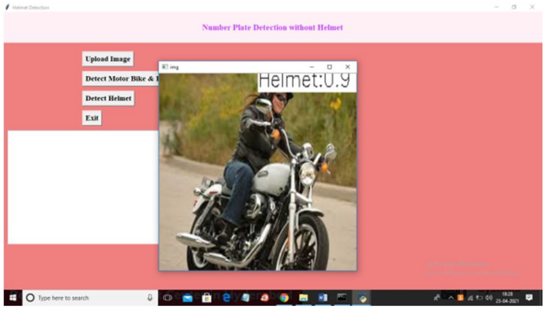

Fig11:In above screen application detected helmet with helmet

The Helmet and Number Plate Recognition System generates these various outputs. It should be noted that the identification algorithm draws a rectangle around the two-wheeler vehicles after recognizing them. If the recognition system identifies that neither the rider nor the pillion is wearing a helmet, the program concludes that neither is. The technology detects the two-wheeler's number plate once it establishes that neither the rider nor the pillion wears a helmet. The biker may face sanctions from the traffic police for employing this.

V. CONCLUSION

The results demonstrate YOLO object detection's efficacy in real-time processing, accurately identifying and locating various items. The implemented end-to-end model is fully equipped for monitoring and automation. Strategies are devised to handle diverse scenarios, like addressing instances of numerous motorcycle riders without helmets, by efficiently extracting number plates while considering different possibilities. Our approach is highly adaptable and cost-effective, relying solely on open-source software and libraries. The project's primary objective was to address inefficiencies in traffic control. Finally, we can claim that if applied by any traffic management departments, it would make their jobs easier and more efficient.

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