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Automatic Detection of Motorcycle Registration Number in case of Helmet Rule Violation by Motorcyclists

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Abstract: Many riders ride motorcycles without helmets, even though it's risky and against traffic rules. To help spot these cases more easily, we built a system that can look at traffic footage and figure out if someone is riding without a helmet. If it finds one, it also checks the number plate on the bike and reads it using OCR. All this runs using object detection models and can work on videos or images. Whenever a violation is found, the system saves the picture and the license number in a database. It's meant to help traffic police catch violations without watching cameras all day. We think this can make road safety enforcement faster and more accurate.

Keywords: Helmet Detection, Number Plate Detection, YOLOv8, Easy OCR, Deep Learning.

I. INTRODUCTION

In Rural areas, helmet violations by motorcycle riders are a common issue. On most times, you can easily spot several riders without helmets, especially in traffic junctions, near markets, roads. Although helmet laws exist, enforcement is inconsistent and often manual. That means violators frequently go unnoticed unless there's a traffic stop nearby.

As part of our final-year project at Dr TTIT, we decided to create an automated system that can catch helmet rule violations in real time. We wanted the system to not just detect the rider but also read the vehicle's number plate so that further action can be taken by authorities.

To build this system, we used YOLOv8, which is an object detection model. We trained it to recognize motorcyclists, helmets, and when a rider's head is visible without one. We also used EasyOCR, which helps convert license plate images into readable text. It worked well in daylight, but we had some trouble in low-light videos.

In our initial tests, we took footage from roads, Traffic and ran in the system frame by frame. One of the main issues we faced was camera angle—if the number plate of motorcycle was tilted, EasyOCR sometimes failed. We added some filtering to improve this, but the system still needs better accuracy at night.

We also had to think about privacy. Since we are recording and analyzing vehicle information, we made sure to keep everything offline and not store any data after testing. If this system is used publicly, those rules should be strictly followed.
Overall, proposed system was able to detect helmet violations and extract number plates in most clear conditions. While there's room to improve, it shows that enforcement can be automated with relatively simple tools and some training data.

This type of setup could help traffic police a lot. Instead of checking every vehicle, they could focus on flagged violations. It would also discourage people from riding without helmets if they know they're being watched.More than anything, we believe that using technology can help save lives. Helmets don't stop accidents, but

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they do reduce the damage. And if enforcement becomes smarter, maybe compliance will too.

II. RELATED WORK

Sharma et al. [1] used YOLOv3 for helmet violation detection in traffic. In their research, Sharma and his team decided to apply YOLOv3, a cutting-edge model, to detect motorcyclists who weren't wearing helmets in real-time traffic footage. They used a collection of city-based images to train the model, aiming to identify violators quickly and accurately. However, as with many deep learning systems, their was trouble when the images were taken in low-light situations. This limitation is something we've taken into account in our own work, and we decided to go with YOLOv8, which is better equipped to handle such conditions. YOLOv8's ability to process highquality images in varying light conditions allows us to focus on improving detection accuracy, especially in scenarios where visibility is compromised.

Kumar and Singh [2] experimented with OCR for number plate reading.Kumar and Singh tried using OCR to automatically read motorcycle number plates, which is a big part of detecting traffic violations. They used Tesseract OCR, which is a go-to tool for many in the field. But they have some issues when the plates were tilted or partially blocked—something we all know happens in real traffic. Their research showed that OCR engines like Tesseract aren't perfect, especially when it comes to dealing with the messiness of real-world conditions. That's when we realized we needed to make sure our system could handle that too. After looking at what they did, we decided to give EasyOCR a try. It's been more reliable for us when the plates are skewed or covered up, which made it an easy choice for our project. It's one of those decisions you make after seeing what doesn't work first!

Joshi et al. [3] used CCTV infrastructure for helmetless rider detection.Joshi and his team had an interesting approach—they used CCTV cameras already installed in the city to detect riders who weren't wearing helmets. This saved on the cost of additional hardware, which is a great idea, but they have issues when trying to detect fast-moving riders or when the helmets weren't fully visible. It made us realize that just using existing infrastructure wouldn't be enough for accurate detection in real-time, especially in busy traffic. Based on what they learned, we figured that tried something that could handle quick movements and partial obstructions better. That's when we decided to go with YOLOv8. It's much better at picking out smaller objects and fast-moving targets, even when things aren't perfectly clear. We're hoping this makes our system much more reliable in detecting violations in crowded, fast-moving traffic.

Reddy et al. [4] added posture analysis to helmet detection.You know, one thing I found really interesting was what Reddy and his group did. Instead of only checking if a rider had a helmet on, they looked at how the rider was sitting—like if someone was just adjusting their helmet instead of not wearing one. That helped them avoid marking someone as a violator when they weren't. We actually talked about doing something similar, but we realized that might make our system more complicated than it needed to be at this stage. We just wanted to make sure the basics—helmet detection and number plate recognition—were working smoothly first. Maybe later we'll come back and try adding the posture thing, but right now, we're keeping it simple.

Khan et al. [5] used deep learning with thermal cameras to detect helmet usage at night. Khan and his team were trying to solve a tricky problem—how to check for helmet usage when it's dark outside. They went with thermal imaging instead. By combining thermal cameras with deep learning, they managed to detect whether or not a rider was wearing a helmet, even in nighttime

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conditions. We thought that was a creative workaround, especially for areas without proper street lighting. While we didn't use thermal tech ourselves, their work made us think more seriously about lighting issues, and it's one reason we leaned towards YOLOv8, which handles low-light images better than older models.

III. METHODOLOGY

All over the world, people have different modes of transport, from bicycles to trains, and where twowheeler is a favor. The road safety issue, especially when it comes to wearing a helmet, poses a problem. Physical helmet control requires a lot of manpower, making it impossible to supervise all the zones needing monitoring. This takes time but opens up endless opportunities for human error. The goal of this project is to develop a vehicle surveillance solution that detects helmetless motorcyclists and automatically retrieves the vehicle registration information. The project uses advanced computer vision to license plate recognition technology to super-fast and accurate log book control processes done manually by a person. In summary, the methodology applied aims to achieve the same result as a traffic officer— manual verification of helmet and plate but done in an effortless, faster, and efficient manner.

We present a solution which uses deep learning for object detection (YOLO) in tandem with optical character recognition (EasyOCR) which we have put together to present a very robust end to end solution. We trained the system on a set of labeled data which included motorcyclists and license plates and which we also put to use real time video or image input. It is able to identify rule breakers in real time and at the same time extract their registration numbers which we in turn put into a structured database for report or legal action. This section we go into each stage of the process in detail from data prep to model training, real time detection, OCR processing and data storage which in turn gives a full picture of how the system functions under the hood.

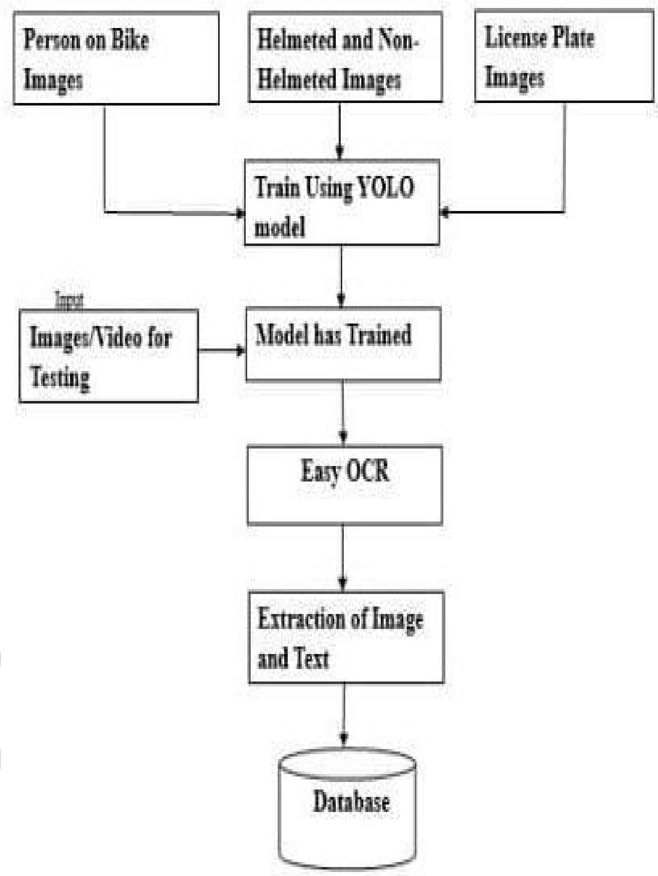

Fig.1: Proposed System Architecture

A. Acquiring and Annotating Photographs

To begin with, we searched for motorcycle riding images which contain people of different age groups. All the images were annotated manually by marking areas of interest such as riders with helmets, riders without helmets and their vehicles registration plates and stored in the dataset for training each model. Three datasets has been created for rider on the bike, rider with helmet and without helmet and number plate. This process is beneficial in training the model as well as making sure that the model is trained appropriately.

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B. Training up the YOLO model.

Next out of the gate we used the YOLO (You Only Look Once) model which is known for speed and accuracy in the field of object detection. We trained YOLO on the annotated images which in turn enabled it to identify motorcyclists, determine if motorcyclists are wearing helmets, and to also find the license plate on the bike.

C. Feeding in New Images or Video.

After we train it up the model is put into real world use. We put in to it live feed from traffic cameras or past in images which didn't see during training.

D. Identification of Plate Numbers and Non Compliance of Wearing Helmets.

The trained model processes an image and scrutinizes whether the motorcycle rider has a helmet on or not. In cases where the motorcyclist is found not to have a helmet, it then searches for the plate number on the motorbike.

E. Capturing Plate Numbers.

When the motorbike plate number is captured, it is sent to EasyOCR, which performs Optical Character Recognition on images, reading texts from images. This process provides us with the actual registration number of the offending vehicle.

F. Documenting the Information

At end, the system captures the details from images and the registration text and stores them in the database. Traffic authorities can utilize this data to take required measures such as issuing penalties or producing documents detailing rule violations.

IV. RESULT

Non-helmeted person number plate detection has done in the three phases with three models separately. The bounded boxes shows region detected by each model. Fig.2, Fig.3, Fig.4 shows the sample output of proposed system and Fig.5 tells that all the characters of motorcycle number plate are stored in the database.

Fig.2 Detecting Person on the Bike

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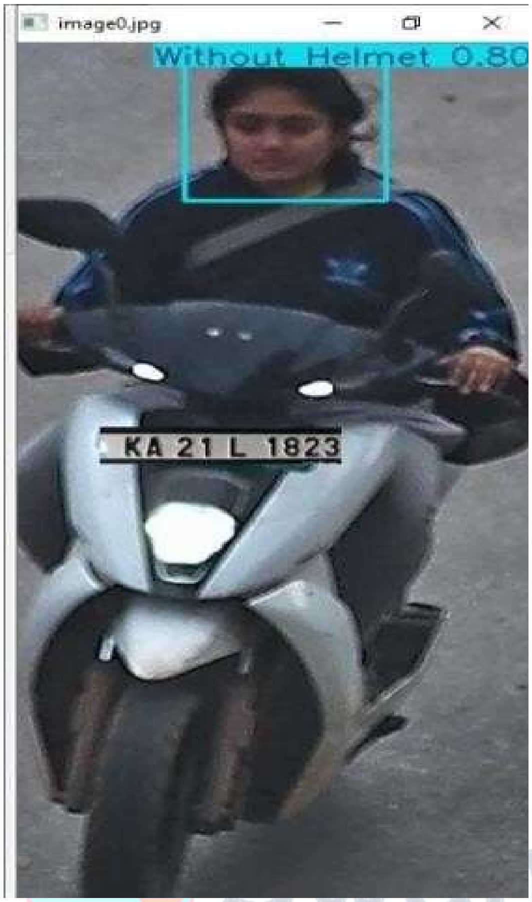
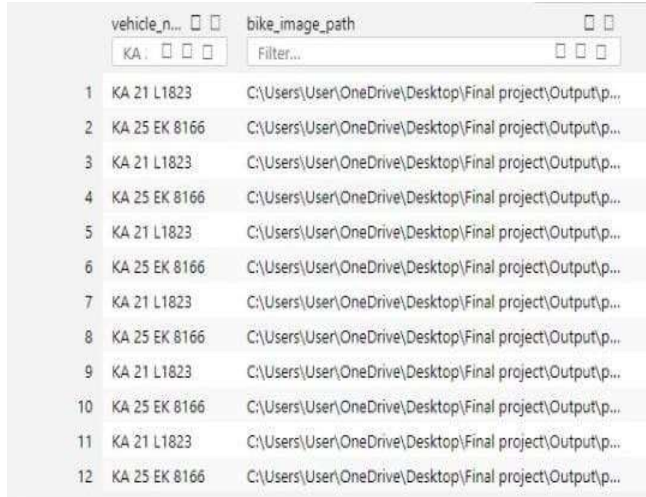


Fig.3 Detecting non-helmeted rider

Fig .4 Detecting Number Plate



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3	KA 21 L1823	C:\Users\User\OneDrive\Desktop\Final project\Output\p...
4	KA 25 EK 8166	C:\Users\User\OneDrive\Desktop\Final project\Output\p...
5	KA 21 L1823	C:\Users\User\OneDrive\Desktop\Final project\Output\p...
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Fig.5 Vehicle Number Plate Characters are stored in database

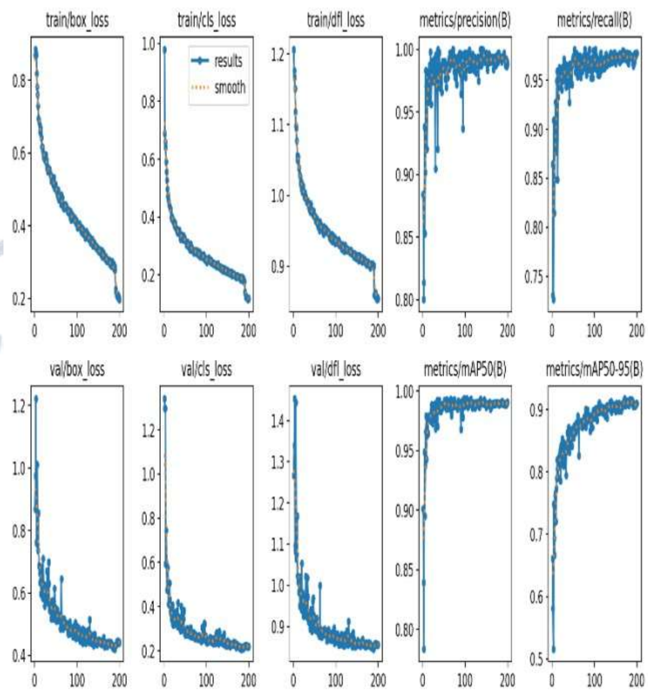

Fig 6: Performance Metrics for License Plate

Fig. 6 shows the various parameters of data on training and validating set against the epoch run. It is the number plate detection model performance metrics, where the loss metric for training data and validation data shows downward trend as epochs increases. This shows the improving in its performance.

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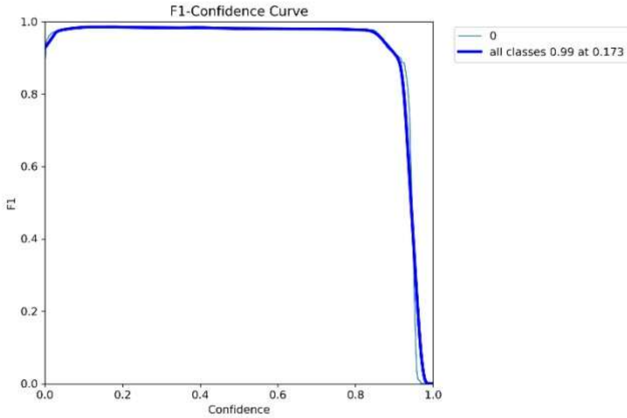

Fig 7: F1-Confidence Curve for number plate detection model

Fig 7 shows the F1-Confidence score of 0.99 for the number plate detection model of the proposed system. So the accuracy of model as been increased.

V. CONCLUSION

The completion of this project affirms the role of artificial intelligence and computer vision in aiding the enforcement of traffic order and improving safety on the roads. The combination of object detection using the YOLO model and optical character recognition using EasyOCR enables the system to automatically recognize motorcyclists who violate helmet laws and retrieve their registration numbers from still images or video streams. Such automation optimizes the manual traffic surveillance monitoring that is traditionally required, offering swifter and more effective enforcement that reduces human error. The violative data—the images and video footage of the violations with zoomed-in number plates—can also be captured, stored in a database, and later used for additional processes, including but not limited to, issuing citations or analytical reports.

VI. FUTURE WORK

Opting for better techniques will enhance system performance and scope. Reliability will be increased by incorporating infrared night-time and low-light detection or image enhancement techniques to ensure operation under all lighting conditions. Accuracy would be further enhanced by adding multi-angle detection for tilted and nonfrontal view plate captures. Privacy protection regulations could be complied with while identifying known face needed for repeat offender detection. Automated notifications and e-challan issuances would be possible with real-time integration enabling full control over traffic monitoring systems. The new features increase the systems effectiveness and applicability for near autonomous operation in urban traffic environments, improving enforcement efficiency and road safety for the city.

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