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# Real time license plate number extraction of non-helmet person using YOLO algorithm

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**Abstract**--One of the problems in traffic regulations in India is riding motorcycle/mopeds without helmet, which increases accident and deaths. In the existing system, the traffic police monitor the traffic violations through CCTV recordings, and in case if the rider without helmet is detected, then its vehicle number is recorded. But the constant monitoring is required to control the traffic rule violation which happens very frequently. To overcome these problems, we will require a system which would automatically handle traffic violations for non-helmet rider and thus would automatically extract the vehicles' license plate number. The various research has successfully done in this area using CNN, R-CNN, LBP, HoG, Haar features etc., but the results are limited with respect to efficiency, accuracy and

speed. To overcome the problems associated with it, we develop a Non-Helmet Rider detection system, which attempts to satisfy the automation of detecting the traffic violation of non-helmet person and extracting the vehicles' license plate number. The main principle involved in this system is Object Detection using Deep Learning at three levels. The person, motorcycle/moped is detected at first level using YOLOv2, helmet at second level using YOLOv3, License plate at the last level using YOLOv2. Then the license plate registration number is extracted using OCR (Optical Character Recognition). Since, this work takes video as its input, the speed of execution is crucial.

**Keywords**---YOLO, Helmet detection, LP detection, OCR.

## Introduction

As per the report by the world health organization, around 50 million people are getting injured due to road accidents, and this burden is unevenly borne by motorcyclists, cyclists and pedestrians. The alarming fact is that, India ranks number one as far as road crash deaths are concerned because of rapid urbanization, avoiding helmets, seat belts and other safety measures while driving. When a two-wheeler meets with an accident, due to sudden deceleration, the rider is thrown away from the vehicle. In such times the helmet acts as a life savior. A helmet reduces the chances of the skull getting decelerated, hence sets the motion of the head to almost zero. Traffic rules are there to bring a sense of discipline, so that the risk of deaths and injuries can be minimized significantly. However, in reality, strict adherence to these laws is not followed. Manual surveillance of traffic using CCTV is an existing methodology. But a number of iterations have to be performed to attain the objective and also it demands a lot of human resources. So, in cities with millions of populations with many vehicles running on the roads cannot afford this inadequate manual method of helmet detection. So here we propose a methodology for full helmet detection and license plate extraction using YOLOv3 and OCR.

The main aim of the system is to build a Non-Helmet Detection System in order to automate the traffic rules and detect the violators by extracting the license plate number. The automated system, for detecting and penalizing motorcycle riders without a helmet, will naturally motivate the two-wheeler riders to wear helmets. It will not only reduce the number of accidents but also reduce the requirement for manpower in monitoring the traffic violations.

## Literature review

Hanhe Lin, Jeremiah D. Deng, Deike Albers, Felix Wilhelm Siebert[1] suggested a method of Automated detection of motorcycle helmet use through video surveillance. They proposed a CNN-based multi-task learning (MTL) method for identifying and tracking individual motorcycles, and register rider specific helmet use. They further release the HELMET dataset, which includes 91,000 annotated frames of 10,006 individual motorcycles from 12 observation sites in Myanmar. Along with the dataset, we introduce an evaluation metric for helmet use and

rider detection accuracy, which can be used as a benchmark for evaluating future detection approaches. We show that the use of MTL for concurrent visual similarity learning and helmet use classification improves the efficiency of our approach compared to earlier studies, allowing a processing speed of more than 8 FPS on consumer hardware, and a weighted average F-measure of 67.3% for detecting the number of riders and helmet use of tracked motorcycles. Our work demonstrates the capability of deep learning as a highly accurate and resource efficient approach to collect critical road safety related data.

This paper [2] presents the real-time detection of LP for non-helmeted motorcyclist using the real-time object detector YOLO. The paper uses a single convolutional neural network to automatically detect the license plate of a non-helmeted motorcyclist from the video stream. The centroid tracking method with a horizontal reference line was used to eliminate the false positive generated by the helmeted motorcyclist as they leave the video frames. The overall LP detection rate was 98.52%.

Felix Wilhelm Siebert, Hanhe Lin [3] developed an algorithm using a deep learning approach for the automated registration of motorcycle helmet usage from video data. They used 91,000 annotated frames of video data, collected at multiple observation sites in 7 cities across the country of Myanmar, and trained the algorithm to detect active motorcycles, the number and position of riders on the motorcycle, as well as their helmet use. This algorithm registers motorcycle helmet use rates with an accuracy of -4.4% and +2.1% in comparison to a human observer, with minimal training for individual observation sites. This approach can be implemented in existing roadside traffic surveillance infrastructure and can facilitate targeted data-driven injury prevention campaigns with real-time speed. Implications of the proposed method, as well as measures that can further improve detection accuracy are discussed.

MeghalDarji, Jaivik Dave, K. Upla[4] proposed an end-to-end approach for detecting and extracting a license plate of the motorcycle. They implemented MobileNet based SSD model to detect License plates as Mobile Net i.e., a light-weight CNN model which is more suitable for mobile and embedded vision applications to obtain fast operation. They also prepare a dataset of Indian motorcycle license plates which consists of 1524 images to train and validate the SSD model. From experiments, they found that the detection module detects the Indian motorcycle license plate accurately. Once the License plates are detected, the detected license plate is extracted and the characters of the extracted license plate are recognized through optical character recognition (OCR) module.

## **Proposed Methodology**

### **YOLO Algorithm**

YOLO “You Only Look Once” is an extremely fast real time multi object detection algorithm. The algorithm shown in figure 2 applies a neural network to an entire image and divides image into an SxS grid with bounding boxes. It can detect multiple objects simultaneously and will determine the classes of the entire image in a single scan. The bounding box is drawn around images and thus predicted

probabilities for each of the regions. The logistic regression method is used to find out these probabilities. The bounding boxes are weighted by the associated probabilities. For class prediction, independent logistic classifiers are used. YOLOv3 is extremely fast and accurate and on par with Focal Loss but about 4 times faster. But it can easily tradeoff between speed and accuracy simply by changing the size of the model, no retraining is required.

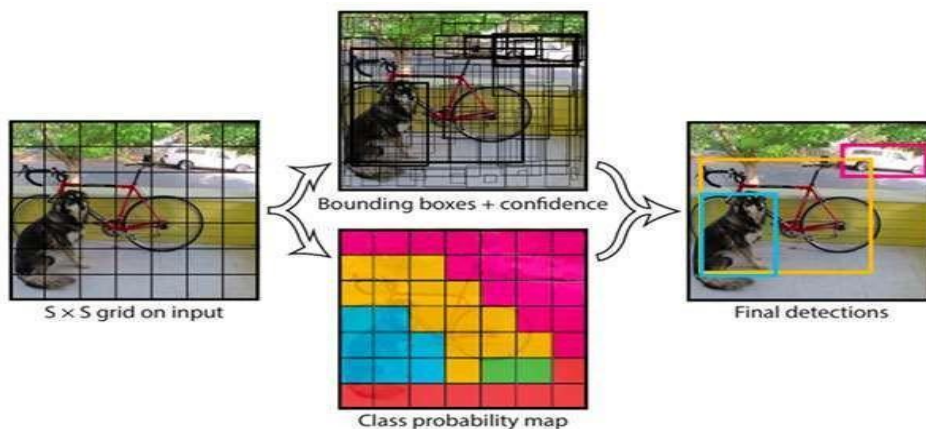


Fig. 2: Example of YOLO Algorithm

### Optical Character Recognition

Optical character recognition (OCR) is used to convert scanned paper documents, or images of documents captured by a digital camera into readable, editable and searchable data. The OCR examines the text of a scanned document and translates the characters into code that makes the text machine-readable so that it can be transferred into an electronic format.

### Text Recognition

There are two basic types of core OCR algorithm, which may produce a ranked list of candidate characters.

- Matrix matching involves comparing an image to a stored glyph on a pixel-by-pixel basis; it is also known as "pattern matching", "pattern recognition", or "image correlation". This relies on the input glyph being correctly isolated from the rest of the image, and on the stored glyph being in a similar font and at the same scale. This technique works best with typewritten text and does not work well when new fonts are encountered. This is the technique the early physical photocell-based OCR implemented, rather directly.

- Feature extraction decomposes glyphs into "features" like lines, closed loops, line direction, and line intersections. The extraction features reduce the dimensionality of the representation and makes the recognition process computationally efficient. These features are compared with an abstract vector-like representation of a character, which might reduce to one or more glyph prototypes. General techniques of feature detection in computer vision are

applicable to this type of OCR, which is commonly seen in "intelligent" handwriting recognition and indeed most modern OCR software. Nearest neighbors' classifiers such as the k-nearest neighbors' algorithm are used to compare image features with stored glyph features and choose the nearest match.

### **Proposed System:**

The system for Non-Helmet Detection and Extraction of License Plate Number involves following steps

- collection of datasets from Open Images dataset
- Training the YOLOv3 Dataset of person, motorcycle and helmet
- Conversion of video to regular interval frames, selection of best frame for detection,
- Cropping of image for better accuracy
- Detection of person, motorcycle and helmet,
- Training of dataset of license plate, ,
- License plate detection and license plate extraction using OCR.

The system is divided into four parts which is defined using the use case diagram shown in figure 2.

1. Training the YOLOv3 Dataset of Person-Motorcycle and Helmet
2. Convert video to regular interval frames
3. Person-Motorcycle and Helmet Detection
4. License plate Detection and Extraction

The entire working of the system is defined using various levels of DFD diagram as in figure 3, figure 4 and figure 5.

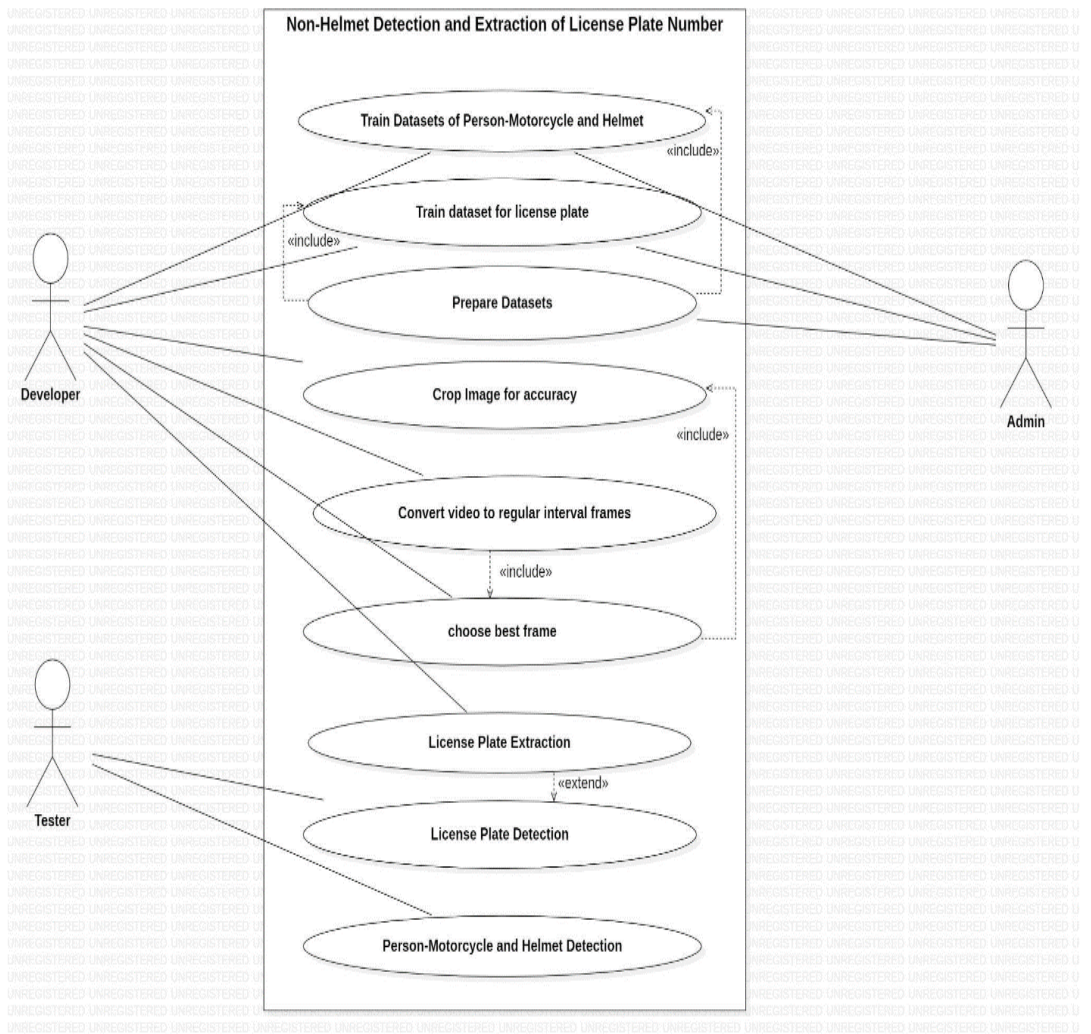


Fig. 3: Proposed System Modules

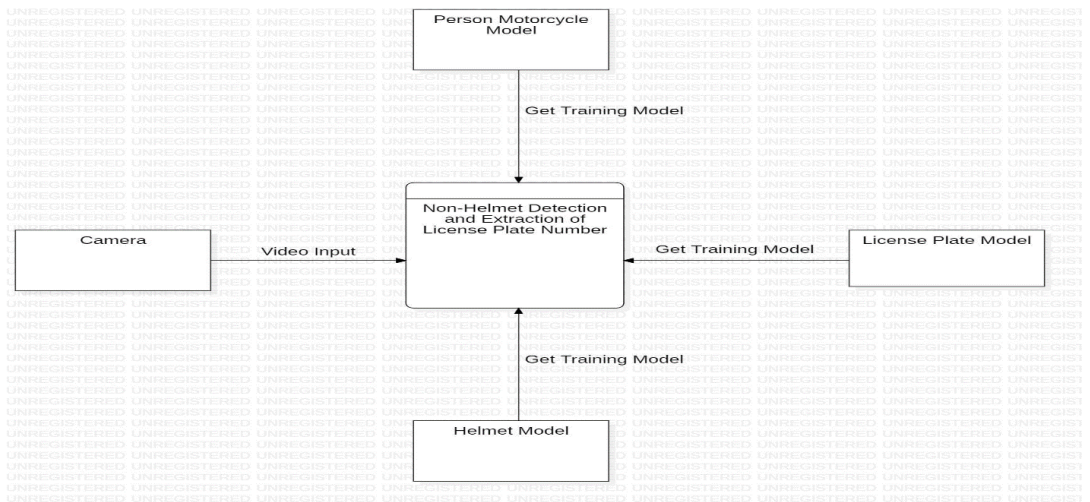


Fig. 4: Proposed System Working (level 0 DFD)

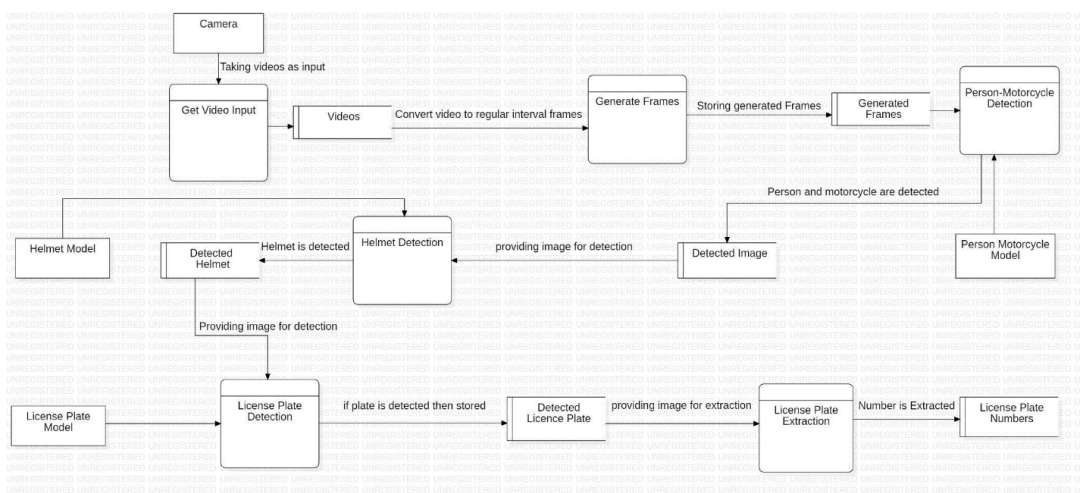


Fig. 5: Proposed System Working (level 1 DFD)

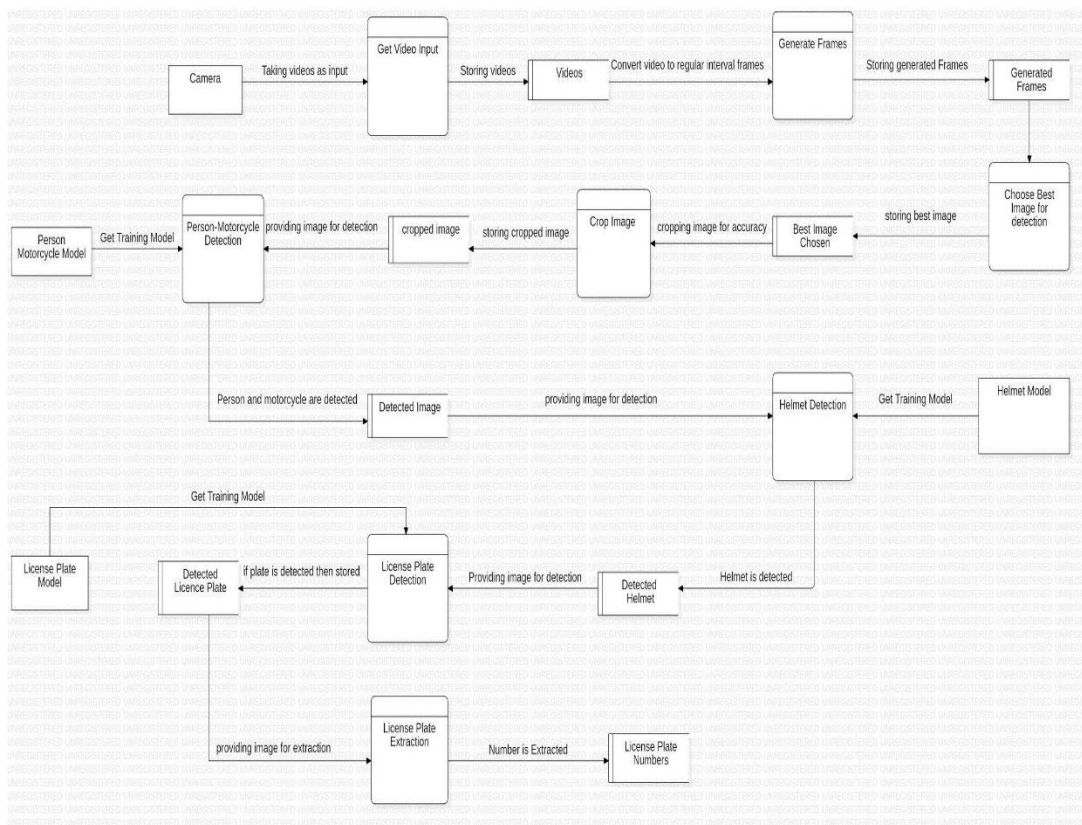


Fig.6: Proposed System Working (level 2 DFD)

The detailed description of the system is as:

### 1. Training theYOLOv3 Dataset of Person-Motorcycle andHelmet.

To create the dataset, 3000 images from the Open image's data set of helmet, person and motorcycle are downloaded. Then the OIDv4 toolkit repository is cloned. Now these images are converted into darknet using OIDv4 for dataset format. Finally, the dataset will be trained.

### 2. Convert video to regular interval frames.

At this phase, the frames are collected at regular intervals from the video file as shown in Fig.7. These collected frames are stored in a folder and are named such that they include the frame number in their name, for example frame50, frame100 etc...Where 50, 100 etc... indicates the frame number. Best frame is chosen for further processing. This will be given as an input to the person/motorcycle and helmet detection model

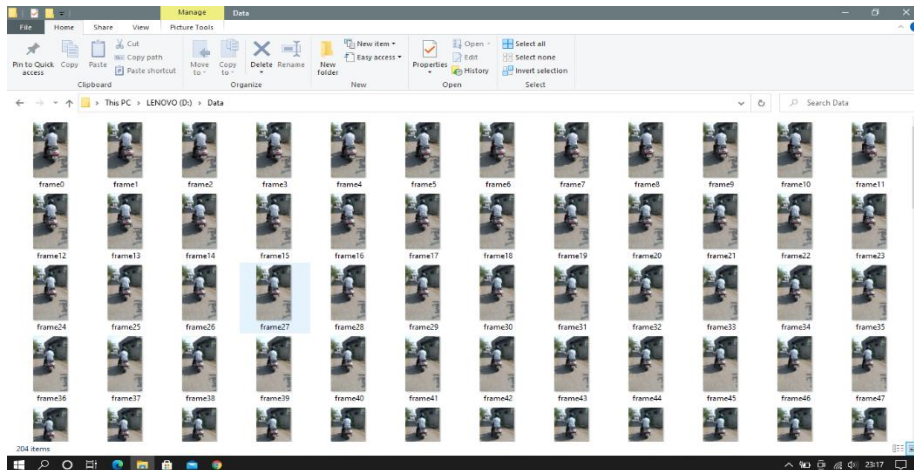


Fig. 7: Video to frames

### 3. Person-Motorcycle and Helmet Detection

Once the person-motor cycle pairs detected, the person image is cropped to get only the top one fourth portion of image. This ensures that false detection cases are eliminated as well as avoid cases leading to wrong results when the rider is holding a helmet in hand while riding or keeping it on motorcycle while riding instead of wearing. Further this person's image is given to the helmet detection model. The YOLO v2 model is used to detect the objects like motorcycle, person, helmet using bounding box coordinates. Using the logistic regression model, the bounding box around the helmet along with the detection probability is determined. Now, further processing will be based on following two cases:

Case1: When the motor cycle/moped rider is wearing a helmet, no further procedure is required.

Case2: When the motorcycle/moped rider is not wearing a helmet, then the motor cycle image is given as input to the license plate detection model.

#### **License plate Detection and Extraction**

If the rider is not wearing helmet, then the motorcycle image is given as input to the license plate detection model. For training purposes, a custom dataset of 2000 images were collected from Open images dataset and was converted in YOLOv3 format for storing information regarding bounding box. Then to extract the license plate image only, the bounding-box coordinates are extracted and the image is cropped. Optical Character Recognition is applied to the extracted license plate image and the characters of the license plate is obtained.

#### **Experimental results**

To create a dataset, Google's Open Image Dataset v6 is used. Regular interval frames are generated using Open CV. The real time object is detected using Darknet framework and Yolov3 algorithm. CUDA is used for GPU computation as a dependency of Darknet. Google Colab is used as a web IDE for python and OCR is used for extracting text from image. The experimental results are shown in figure 8 where the person with motorbike is detected and helmet gets

detected in figure 9, so no further action will be carried out. But as in figure 10, a person without helmet is detected, it will be further processed by the license plate detection model and the license plate is located and the license plate number is extracted shown in figure 12.

To evaluate the system and to check the correct detection rate of license plate of non-helmeted rider, the system is tested for 150 non helmeted rider. Out of this 150, the system is able to predict 148 non helmeted rider which achieves accuracy of 98.66. Then out of this 148, the license plate of 145 is detected & license plate number is extracted. The result is not 100% because of the location of the license plate in some vehicles.



Fig 8. Person - motorbike detection (with helmet)



Fig 9. Helmet detection

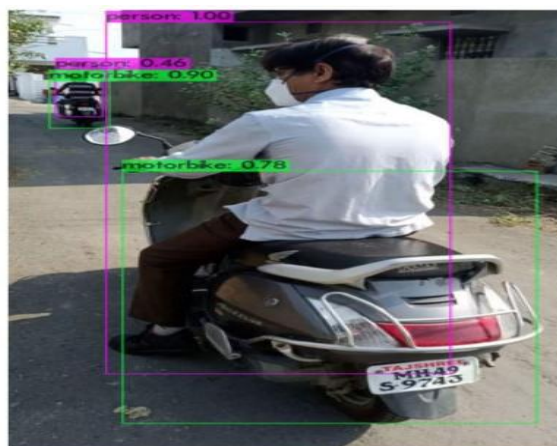


Fig 10. Person - Motorbike Detection (without helmet)



Fig.11: License Plate Detection

```
[ ] text = result[1][-2]
    text1 = result[2][-2]
    #text2 = result[3][-2]
    print(text)
    print(text1)
    #print(text2)
```

MH49  
S9743

Fig.12: License Plate Extraction

### Future work

The results are promising but can be improved in stage of image capturing, which should produce better quality images. The use of algorithms for feature selection can be evaluated to increase the obtained hit rates. The descriptors returned a large number of features, which frequently hinders the classification of objects. In these feature vectors, the possibility of features that are insignificant or duplicates is high. Therefore, a thorough analysis of the literature in search feature selection algorithms are necessary. Another future study is the detection of passengers on motorcycles. A motorcycle has the capacity to carry a driver and a passenger. The proposed system does not detect more than one helmet in the scene, that is, it does not detect a motorcyclist with a passenger. This functionality can be extended to the detection of more than one passenger, as two or more passengers constitute a traffic violation.

This system can be further improved by implementing advanced safety measures like to check collision detection, capturing images of vehicles who break the rule by riding with high speed, capturing images of drivers while talking on phone and driving. This lessens the work of traffic police and with affordable cost. Once installed correctly, this system will work and generate databases for a greater period of time under proper maintenance. The system can also be employed in the construction sites where it can ensure that the workers wear helmet which is important as the lives of workers are concerned.

### Conclusion

A Non-Helmet Rider Detection system is developed where a video file is taken as input. If the motorcycle rider in the video footage is not wearing a helmet while riding the motorcycle, then the license plate number of that motorcycle is extracted and displayed. Object detection principle with YOLO architecture is

used for motorcycle, person, helmet and license plate detection. OCR is used for license plate number extraction if the rider is not wearing a helmet.

## References

1. H. Lin, J. D. Deng, D. Albers and F. W. Siebert, "Helmet Use Detection of Tracked Motorcycles Using CNN-Based Multi-Task Learning," in *IEEE Access*, vol. 8, pp. 162073-162084, 2020, doi: 10.1109/ACCESS.2020.3021357.
2. Jamtsho, Yonten&Riyamongkol, Panomkhawn&Waranusast, Rattapoom. (2020). Real-Time License Plate Detection for Non-Helmeted Motorcyclist Using YOLO. *ICT Express*. 7. 10.1016/j.icte.2020.07.008.
3. Danian Zheng, Yannan Zhao, Jiabin Wang, "An efficient method of license plate location, Pattern Recognition Letters" , Volume 26, Issue 15, 2005, Pages 2431-2438, ISSN 0167-8655, <https://doi.org/10.1016/j.patrec.2005.04.014>.
4. Siebert FW, Lin H. Detecting motorcycle helmet use with deep learning. *Accid Anal Prev*. 2020 Jan;134:105319. doi: 10.1016/j.aap.2019.105319. Epub 2019 Nov 6. PMID: 31706186.
5. MeghalDarji, Jaivik Dave, K. Upla "Licence Plate Identification and Recognition for Non-Helmeted Motorcyclists using Light-weight Convolution Neural Network" Published 2020, Computer Science 2020 International Conference for Emerging Technology (INCET).
6. H. Lin, J. D. Deng, D. Albers and F. W. Siebert, "Helmet Use Detection of Tracked Motorcycles Using CNN-Based Multi-Task Learning," in *IEEE Access*, vol. 8, pp. 162073-162084, 2020, doi: 10.1109/ACCESS.2020.3021357.
7. Yange Li, Han Wei, Zheng Han, et al. "Deep Learning-Based Safety Helmet Detection in Engineering Management Based on Convolutional Neural Networks", Volume 2020 | Article ID 9703560 | <https://doi.org/10.1155/2020/9703560>.
8. Y. Kulkarni, S. Bodkhe, A. Kamthe and A. Patil, "Automatic number plate recognition for motorcyclists riding without helmet," 2018 International Conference on Current Trends towards Converging Technologies (ICCTCT), 2018, pp. 1-6, doi: 10.1109/ICCTCT.2018.8551001.
9. Wei Jia, Shiquan Xu, Yeon-Ju Yu," Real-time automatic helmet detection of motorcyclists in urban traffic using improved YOLOv5 detector", *IET Image Processing*, 2021
10. Jie Li and Huanming Liu and Tianzheng Wang, et al. "Safety helmet wearing detection based on image processing and machine learning" 2017 Ninth International Conference on Advanced Computational Intelligence (ICACI)