Mask and Helmet Detection in Two-Wheelers using YOLOv3 and Canny Edge Detection

Shravani Maliye[1], Jayom Oza[2], Jayesh Rane[3], Nileema Pathak[4]

[1,2,3]*Student, Information Technology Department, Atharva College of Engineering, Maharashtra, India*
[4]*Professor, Atharva College of Engineering, Maharashtra, India*

Abstract - *There is no automated existing system which can detect motorcyclists who are not wearing helmets as well as masks due to which the traffic policemen have to manually keep records of such traffic rules violators either by remembering the number plate or by capturing a photo of the number plate. This manual administration can sometimes lead to errors. In order to overcome these drawbacks, we have designed an automated helmet and face mask detection system which is able to catch all the motorcyclists who are not wearing helmets and masks just by storing the number plate of those bike riders. The system is divided into four modules. It begins by classifying the Two Wheelers from a frame generated by the traffic camera feed. Once the two wheelers are classified by the system then it checks for the presence of a helmet on the bike rider first and then it finds the presence of face mask on the bike rider. If the bike rider is found without a helmet or face mask or both then it extracts the number plate from the image and stores it in the system. The Motorcycle, Helmet and Mask Detection modules use the YOLOv3 algorithm to detect their respective images. The License Plate is extracted using Canny Edge Detection method. The system demonstration has been shown on Google Colab. This system will help to catch traffic rule violators thereby creating more strictness in traffic rules and thus reducing risk of injuries.*

Key Words: **Motorcycle, Helmet, Mask, Detection, License Plate, YOLOv3, Canny Edge Detection.**

1. INTRODUCTION

Two-wheeler vehicles such as scooters and motorcycles are the most popular type of vehicles in India because of their availability and convenience. They are owned by a major part of the population in the country according to the statistics provided by the Department of Statistics and Implementation Systems (MSPI), the Government of India. According to a report released by the Department of Transport and Highways, more than 37% of people die in road accidents (56,136) or six every hour on an average - including two wheelers. It is highly recommended for two-wheeler riders to use a safety helmet to reduce the risk of injury. It is a criminal offense to ride a two-wheeler without a helmet and many hand-to-hand tactics have been adopted to catch violators because of their importance. So, the automation of this process in real time is a need of the hour and will help to accurately monitor passengers who break the rules, and greatly reduce the number of human interventions. In the existing system, the police officer has to manually capture the image of the number plate of the bike rider who is not wearing the helmet and the face mask. A very big disadvantage of this method is that often such rule-violators speed up and run off and are not penalized for their actions. To overcome the disadvantages of the existing system, we have proposed an automated system which is more accurate and requires minimum human efforts. The main application of this system is to catch all the motorcyclists who are not wearing helmets and face masks. Now let us understand the working of the system. The system will divide the traffic video into various images(frames) and from those images the system is able to detect bike riders from an image consisting of both two wheelers and other vehicles using YOLOv3. Once the bike riders are detected, the system is able to detect if the motorcyclist is wearing a helmet or not using YOLOv3, also the system is able to detect if the motorcyclist is wearing a mask or not using YOLOv3. The system will then record the number plate of those bike riders who are not wearing helmet or face mask or both using the Canny Edge Detection Method.

2. LITERATURE REVIEW

Fahad A Khan, Nitin Nagori, Dr. Ameya Naik [1]

In today's world, the increasing use of Motor-bikes has prompted increment in road accidents and injuries. Helmet not used by the motorcycle rider is one of the major causes. Currently, the police officer has to manually capture the image of the number plate of the bike rider who is not wearing the helmet. The proposed system distinguishes the difference between motorcycle rider with or without helmet from frames. Based on feature extractor the system extracts object class. The system uses You Only Look Once (YOLO)-Darknet deep learning framework which consists of CNN algorithm trained on Common Objects in Context (COCO) and combined with computer vision. YOLO's convolutional layers are modified to detect specified three classes and it uses a sliding-window process. The map (Mean Average Precision) on validation dataset achieved 81% by using training data.

Emy Barnabas, AmrithaB.J [2]

Nowadays, road accidents are one of the leading causes of death. Among them, bike accidents are common and cause serious injuries. A helmet is one of the most important aspects of a safety for a rider. However, many fails to follow the rule of wearing a helmet. They have implemented a system to find motorcyclists violating the rules of the helmet, using a system that uses image processing and a convolutional neural network. The program consists of the identification of a motor-bike, a protection helmet and the identification of the number plate. Motorcycles were found using the HOG vector. Once the motorcycle has been detected, using a convolutional neural network, it is determined whether the motorcyclist is wearing a helmet or not. When a motorcyclist is found to be without a helmet, a motorcycle license plate is obtained using the Tesseract OCR.

K G Shreyas Dixit, Mahima Girish Chadaga, Sinchana S Savalgimath, G Ragavendra Rakshith, Naveen Kumar M R [3]

In this paper authors use R-CNN, Fast R-CNN and Faster R-CNN for object detection and compare all three algorithms and also explained the YOLOv2 algorithm and why it is better from traditional approach. They concluded that Fast-RCNN have mean average precision up to 76.4 but it has between 5 to 18 frames per second(fps). On the other hand, YOLOv2 algorithm has mean average precision up to 78.6, and can attained speed up to 155 frame per second(fps). YOLOv2 attains an outstanding trade-off between accuracy and speed and also as a detector possessing powerful generalization capabilities of representing an entire image.

Rohith C A, Shilpa A Nair, Parvathi Sanil Nair, Sneha Alphonsa, Nithin Prince John [4]

In this paper the authors intend to make an automated system to distinguish whether a biker is wearing a helmet or not and to impose fine to defaulters as a part of law enforcement. For execution of the following idea, they have used Caffe model and InceptionV3. According to our research, such a system is not currently used by the police or by any other authority. Executing the proposed framework can convey more mindfulness and need to wear a helmet at any rate with the goal that they don't get captured on camera and avoid fine. This project intends to make deep learning based automated detection system for helmet identification using trained models and datasets that would be useful for the police department to enforce the law for the betterment of the society.

Mohammad Marufur Rahman, Md. Motaleb Hossen Manik, Md. Milon Islam, Saifuddin Mahmud, Jong-Hoon Kim [5]

The COVID-19 epidemic caused by the novel coronavirus continues to spread worldwide. The impact of COVID-19 has fallen on almost all development sectors. The health care system is in trouble. Many precautionary measures have been taken to reduce the spread of the disease when wearing a mask is one of them. In this paper, they propose a program that finds naked people who are not wearing face mask on a smart city network where all public areas are monitored by Closed-Circuit Television (CCTV) cameras. When a person without a mask is found, the corresponding officer is informed. Deep architecture is trained in a database that contains images of people with and without masks collected from various sources. Professional facilities have found 98.7% accuracy in distinguishing people with face masks for previously unseen test data.

3. MATERIALS

OID stands for Open Image Dataset. It is of great help when it comes to computer vision applications. There are around 9 million images in the dataset spanning over various categories. The images in the OID Dataset have been prepared by Google with labels, bounding boxes, segmentation masks, localized narratives and visualized relationships.

Kaggle is an online community where people can download datasets, share the datasets that have been created by them- in short, they have a plethora of options when it comes to dealing with data.

Image datasets spanning over three different categories were required for this project- motorcycle images, images with helmet and without helmet and people wearing face mask as well as not wearing face masks. Google's OIDv4 which stands for Open Image Dataset version 4, was used for providing images for the first two categories. Images of type Detection already have bounding boxes drawn on them corresponding to the category selected. Motorcycle images, were downloaded directly for the first detection module. Images with human face and helmets were downloaded for the second detection module. With respect to the third module, Mask Detection, the required images were downloaded from Kaggle which provided a dataset which contained images with mask and without mask. The manual work of drawing bounding boxes on each image and preparing a custom dataset was reduced to a great extent. Each category contained approximately a little above 4000 images which included test data as well as training data.

4. PROPOSED SYSTEM

4.1 System architecture

The frames created from the existing traffic camera feed is passed to the motorcycle detection module. If a motorcycle is detected, then the image is sent to the helmet detection system. If a helmet is not detected, then the license plate is extracted which is then stored in the system. Also, the same image is sent to the mask detection module. If no mask is found, then the number plate is found to store the required fines. The unnecessary frames are simply discarded, while, if any safety violations are found, then the information is stored in the system. The block diagram below highlights the system architecture:

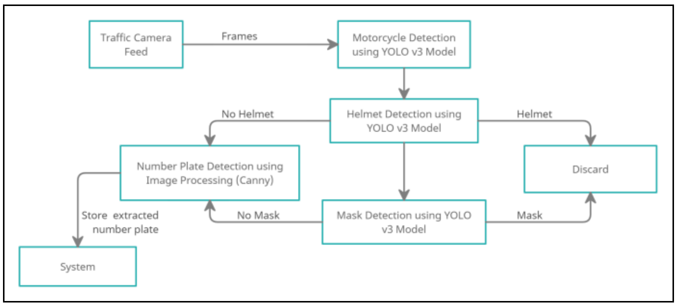

Fig-1: Block Diagram

5. METHODOLOGY

A model of the system has been created on Google Colab to simulate the working of the actual system. The annotated images have been used to provide the appropriate data for the training as well as testing processes. The MAP (Mean Average Precision) has also been calculated. License Plate has been extracted using the Canny edge detector.

5.1 MODULES IN THE SYSTEM

a. Motorcycle Detection: This module is used to detect two-wheelers from the image passed to it. The detected frames are sent to the next module while the other frames are simply discarded.
b. Helmet Detection: If the rider doesn't wear a helmet, then the vehicle's license plate is extracted and the data is stored in the system, else, it is discarded. Also, the same frame is sent to the third module.
c. Mask Detection: If the rider doesn't wear a mask, then the license plate is extracted, otherwise, the frame is simply discarded.
d. License Plate Extraction: Using Canny edge detection technique, the license plate is easily found and stored in the system for maintaining records.

5.2 YOLOv3 (You Only Look Once version 3)

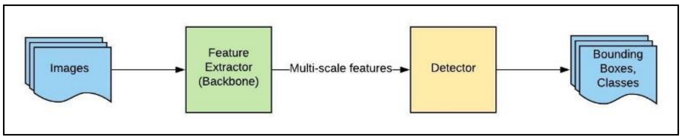

Fig-2: YOLO architecture

In this model, a single neural network is applied to the concerned image. The image is then divided into multiple regions and probabilities are calculated and depending on their values bounding boxes are mapped. Non max suppression is deployed so that each object is detected only once and the overall accuracy of the model is increased. The output is then provided in the format that it shows the bounding box along with the appropriate class label and the probability calculated for that label.

The version of YOLO used in the proposed system is version 3. A Darknet variant of 53 layers is used in this version in such a way that the architecture of this model consists of 106 fully functional convolutional layers. The most astounding features of this version is that it makes predictions at three different scales, also, it is more accurate in detecting even smaller objects.

5.3 Canny Edge Detection

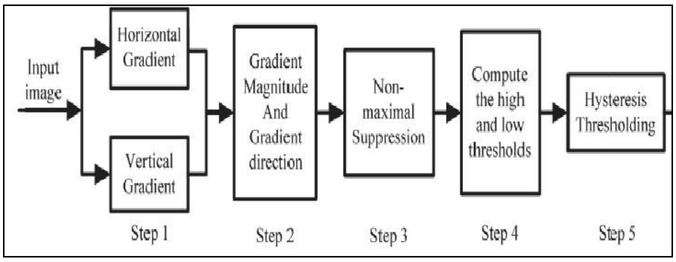

Fig-3: Canny Edge Detection [7]

Canny Edge Detection model is an algorithm used to detect edges in various images. The working of this model is pretty straightforward. [7] The original image is supplied to the algorithm as an input. This image is then converted to a greyscale format. The image is susceptible to a lot of noise; hence Gaussian Blur is performed on the image to smooth it out and get rid of all the noise. The Intensity Gradient is calculated for two important reasons- first, a sudden change in intensity means that an edge is detected at that particular location, second, it also specifies the direction of the edge. The final output that us received should consist of thin edges, hence, the step of non-maximum suppression is done. It is followed by Hysteresis Thresholding. If the calculated intensity lies between two values of minimum and maximum, then it is classified as an edge otherwise it is simply discarded. The final image is then cleaned appropriately and provides the necessary accurate output.

6. RESULTS

The accuracy of the models depends on the following factors- the training period for the model and the quantity of the dataset. If the number of iterations for the model is increased, then greater levels of accuracy can be achieved. When a variety of images are added regularly to the dataset, then it becomes relatively easy to attain the desired accuracy for the model.

The below image shows the output obtained on running the model with a particular image. The table below it compares the accuracy of other algorithms with the proposed algorithm.

Fig-4: Motorcycle Detection Output

Table-1: Accuracy of methods in Vehicle Detection

Algorithm	Detection accuracy (in %)
YOLOv3 (Proposed system)	95.92
HOG (feature vector) [2]	93
Faster R-CNN (VGG16) [3]	73.2
SSD300 [3]	74.3
Caffe Model [4]	76

The next part of the system is the Helmet Detection which is trained in such a way that it catches all the violators who fail to abide by the road safety rules. The below image shows a properly labelled output. The table below the image, discusses the accuracy of various algorithms applied for helmet detection.

Fig-5: Helmet Detection Output

Table -2: Accuracy of methods in Helmet Detection

Algorithm	Accuracy (in %)
YOLOv3 (proposed system)	90.84
YOLO [1]	81
CNN [2]	85
InceptionV3 [4]	81
CNN based MTL [10]	80.7

Mask Detection is the most important part of the system as it includes a new functionality which is an advantage when it comes to the pandemic situation. When the same image was provided as input, perfect output was obtained and all the people without masks were labelled. The image below shows the output achieved.

Fig-6: Mask Detection Output

Table 3 Accuracy of methods in Mask Detection

Algorithm	Accuracy (in %)
YOLOv3	99.37
CNN [5]	98.7
Sequential CNN [6]	95.77 / 94.58
SVM and MobileNetV2 [8]	97.1
DNN based on SSD [9]	97.25

Number Plate Detection makes use of the Canny Edge Detection Model which detects all the edges accurately and crops out only the part of the image that contains a number plate. Also, the image of the number plate can be worked upon to retrieve the number plate in a text format. The first image is the input provided to the module, while the image after that is the output achieved.

Fig-7: Original Input

Fig-8: Number Plate Output

7. CONCLUSIONS

A system has been developed for bike riders who violate laws like not wearing a helmet and mask. This project helps in imposing the rules like wearing a helmet and mask for a bike rider in a stricter manner as it is difficult for a traffic policeman to keep record of all the bike riders who violate such laws as the bike riders speeds up and runs away. In such scenarios, this system helps in imposing more strictness in the rule of wearing helmet and mask as all those bike riders who violate such laws can be detected with the help of their number plate and they can't run away from this system. This helps in reducing any kind of possibility of facing an injury for not wearing a helmet or coming in contact with any kind of virus for not wearing a mask. This system mainly consists of four parts - Detection of Bike, Detection of Helmet, Detection of Mask and Detection of Number Plate of those bike riders who don't wear helmet or mask. Firstly, the system checks if the vehicle in the image is a bike or not using YOLOv3. Then the detection of helmet and mask on the bike rider is checked using YOLOv3. Those bike riders who violate laws like not wearing a helmet or mask then the number plate of those bike rider is extracted using canny edge detector. The accuracy obtained for detecting a bike is 95.92% and the accuracy obtained for detecting a helmet is 90.84% and the accuracy for detecting a mask is 99.36%. The accuracy of the system can be increased further by increasing the training dataset and training the algorithm for more time.

ACKNOWLEDGEMENT

First of all, we would like to thank Prof. Nileema Pathak, who has guided and supported us in this endeavour. Her suggestions have helped us immensely to successfully complete the implementation of this system. We have benefited a lot from her immense knowledge. Her suggestions and valuable inputs have helped us at each step. Further, we would like to thank the whole IT Department who has given us this opportunity. Last but not the least, we would like to thank all the people who have constantly supported us.

REFERENCES

[1] F. A. Khan, N. Nagori and A. Naik, "Helmet and Number Plate detection of Motorcyclists using Deep Learning and Advanced Machine Vision Techniques," 2020 Second International Conference on Inventive Research in Computing Applications (ICIRCA), Coimbatore, India, 2020, pp. 714-717, doi: 10.1109/ICIRCA48905.2020.9183287.

[2] Emy Barnabas, Amritha B.J. "Helmet Detection and License Plate Recognition Using CNN", 2019 IOSR Journal of Engineering (IOSRJEN), vol. 09, no. 06, pp. 21-24.

[3] K G Shreyas Dixit, Mahima Girish Chadaga, Sinchana S Savalgimath, G Ragavendra Rakshith, Naveen Kumar M R, "Evaluation and Evolution of Object Detection Techniques YOLO and R-CNN", 2019, vol. 8, pp 824-82, doi: 10.35940/ijrte.B1154.0782S319

[4] C. A. Rohith, S. A. Nair, P. S. Nair, S. Alphonsa and N. P. John, "An Efficient Helmet Detection for MVD using Deep learning," 2019 3rd International Conference on Trends in Electronics and Informatics (ICOEI), Tirunelveli, India, 2019, pp. 282-286, doi: 10.1109/ICOEI.2019.8862543.

[5] M. M. Rahman, M. M. H. Manik, M. M. Islam, S. Mahmud and J. -H. Kim, "An Automated System to Limit COVID-19 Using Facial Mask Detection in Smart City Network," 2020 IEEE International IOT, Electronics and Mechatronics Conference (IEMTRONICS), Vancouver, BC, Canada, 2020, pp. 1-5, doi: 10.1109/IEMTRONICS51293.2020.9216386.

[6] A. Das, M. Wasif Ansari and R. Basak, "Covid-19 Face Mask Detection Using TensorFlow, Keras and OpenCV," 2020 IEEE 17th India Council International Conference (INDICON), New Delhi, India, 2020, pp. 1-5, doi: 10.1109/INDICON49873.2020.9342585.

[7] A. P. Thombare and S. B. Bagal, "A distributed canny edge detector: Comparative approach," 2015 International

Conference on Information Processing (ICIP), Pune, India, 2015, pp. 312-316, doi: 10.1109/INFOP.2015.7489399.

[8] A. Oumina, N. El Makhfi and M. Hamdi, "Control The COVID-19 Pandemic: Face Mask Detection Using Transfer Learning," 2020 IEEE 2nd International Conference on Electronics, Control, Optimization and Computer Science (ICECOCS), Kenitra, Morocco, 2020, pp. 1-5, doi: 10.1109/ICECOCS50124.2020.9314511.

[9] I. Buciu, "Color quotient-based mask detection," 2020 International Symposium on Electronics and Telecommunications (ISETC), Timisoara, Romania, 2020, pp. 1-4, doi: 10.1109/ISETC50328.2020.9301079.

[10] 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.