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Helmet Detection and Number Plate Recognition for Safety and Surveillance System

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***Abstract*: With bikes becoming a less expensive and normal mode of transportation, the range of bike accidents is increasing unexpectedly as maximum motorcyclists are not wearing helmets, making every experience on a bike risky regularly. Even though the present CCTV-based systems are powerful, they require an excellent deal of human help, their efficiency declines through the years, and human bias is also a problem. Automation of this method is consequently fantastically ideal. In recent years, traffic accidents have increased sharply, and many people have been seriously injured or killed because of driving without wearing a motorcycle helmet. Not wearing a helmet is declared as a criminal offense by the government but even then, many people do not follow it. Traffic cops cannot arrest all violators at once, especially when traffic is heavy. In this study, we have proposed a system that can identify cyclists without helmets automatically and obtain information about their bike owners by recognizing license plates. The objects from video frames are identified using Object Detection API named TensorFlow. The proposed model is trained to recognize helmet-less cyclists using a faster R-CNN. A Tesseract OCR engine is then used to detect the license plate. Whenever any Helmetless rider is found or detected then the License Plate is fetched and then the number of that License Plate is identified by the use of an Optical Character Recognizer. In real-time, this system can be used by using a Web camera or a CCTV for providing input to the system. Experimental results of this model will show better performance than the prior art.**

***Keywords*: Helmet detection, Optical Character Recognition (OCR), License number plate detection, YOLO.**

1. Introduction

Motorcycle accidents account for the majority number of accidents by road. The main reason for these accidents is rough and fast driving. Head injuries caused by road accidents are a major reason for fatalities from them. Studies show that if people wore helmets properly then more than one -fifth of those who died in road accidents could have been able to survive. The proper usage of helmets can protect against accidental fatalities by 40 to 50%. Death studies show that a falling-off from motorcycle can cause head injuries even when the speed is 65km per hour. The sudden fall of the person at this speed has a similar impact as of falling from a building's fifth floor. Due to all these reasons, the government has made it a compulsion to wear helmets when driving a motorcycle. To keep a check on this rule and that people are abiding by it, systems based on video surveillance are being widely used nowadays. These systems help the government to keep a record of defaulters. A Law enforcement agency has set up a widespread network of CCTV cameras that cover all susceptible areas of cities including railway stations, airports and networks of road. In all the heavily crowded areas like railway stations, road networks and airports, large numbers of CCTV cameras are being used. In order to discriminate between the traffic obiters and defaulters, it is essential to monitor road traffic. The video surveillance system that are already there are effective but there is one problem with them that they require a lot of humans who cannot continuously perform without any delays. Studies show that the human work is not very efficient and thus automation of these processes if necessary and required to obtain a systematic and reliable surveillance of the traffic and differentiation of violators. Surveillance cameras are being used in different public places as a part of upgradation into a smart city. Thus using the smart video capturing system is effective as it will reduce the overall cost. In our project, we are going to detect that a rider of two-wheeler is wearing a helmet or not. The number plate is being extracted if the rider of the bike is detected without a helmet. We are using the YOLO model based on CNN for fetching the number plate. The motive of this project is to make a system that enforces wearing helmets. This system is built with the intention of reducing accidents on the road.

2. Literature Survey

The Hough transform-based circular arc detection method was proposed by Wen et al.. On the ATM's monitoring system, they used it to detect the presence of a helmet. However, this work's flaw was that it relied solely on geometric traits to identify the existence of a helmet. Geometric characteristics frequently confuse the head with the helmet, so they are insufficient to identify the existence of a helmet.

A computer vision-based method has been utilised by Chiu et al. to detect and segment motorcyclists that are partially blocked by another vehicle. The use of a helmet-detecting device made it easier to know there was a motorcycle. The possible helmet region was estimated in this particular paper to identify the edges of the helmet.

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A system for the detecting helmets was proposed by Silva et al. that begins with the segmentation of moving objects using descriptors, followed by the detection of helmets by tracing the (ROI) Region of interest, which is the head region, and then classifying them as either wearing or not wearing helmets.

However, the drawback was that it used the computationally expensive circle Hough transform to distinguish between helmets and non-helmets, which also causes misclassification between heads and helmets because both have a circular shape.

Waris, T., et al., [1], The proposed technique in this work aims to address the issue of helmet violations among motorcyclists by introducing an automatic detection system for Intelligent Transportation Systems (ITS). The system utilizes a Faster R-CNN deep learning model that processes real-time video inputs to detect instances of helmet violations. The experimental results have shown a high level of accuracy, reaching 97.6%. This system has the potential to greatly enhance road safety by detecting and penalizing those who do not comply with traffic regulations. In the future, there is scope to expand the system to include additional features such as license plate recognition and detection of other types of traffic violations. It is important to ensure that the implementation of this technology is done in a responsible and ethical manner, taking into consideration privacy and data security concerns.

Ghonge, S.A. et.al [2], In light of the limitations uncovered in prior research, a new motorcycle monitoring system has been proposed that utilizes real-time vision-based technology. This system aims to detect and track motorcycles in a series of images by employing a combination of edge detection algorithms (1st and 2nd order derivatives) and neural networks. The system has two main components: detection of the presence or absence of a helmet, and recognition of the license plate number through Optical Character Recognition (OCR) with a neural network. The goal of this design is to detect traffic rule violations such as not wearing a helmet, and to automatically record the vehicle's license plate number and issue a challan.

Roy, R., et al.,[5], The motorcycle detection and tracking device operates without the need for human intervention. It has proven to be effective in identifying motorcycle usage, specifically those riding without helmets. This marks a significant step towards the larger goal of regulating motorcycle usage. The device is capable of accurately identifying motorcycles based on their unique serial number and can also determine a vehicle's license plate information through a registry. This will ensure accountability for irresponsible drivers. The device is able to function regardless of the motion of the motorcycle, as long as it is within the designated detection area.

Allamki, L., et al., [3], The results from the YOLO object detection method demonstrate its suitability for real-time processing. The proposed end-to-end model is capable of accurately classifying and localizing all objects in an image. This model has the potential to be automated and deployed for monitoring purposes. To identify license plate numbers, multiple techniques have been employed to handle various cases, including multiple riders without helmets. All of the software and libraries used in this project are open source, making it a cost-effective and flexible solution. The main purpose of this project is to address the issue of inefficient traffic management, and if adopted by traffic management departments, it could make their job easier and more efficient.

Albert, N., et.al [6], The data used for this project was structured and labeled in such a way that the model could determine if an image contained a cyclist or not. A vehicle detection algorithm was created and successfully tested on a test dataset. The cyclist detection algorithm was also developed using the rapid learning approaches of RCNN on a dataset of vehicle information. This system can identify when a cyclist is riding without a helmet and can also detect a bike's license plate number, allowing for the generation of an e-challan. This application provides insight into the number of traffic rule violators in a local area.

3. Proposed Methodology

A. General Architecture

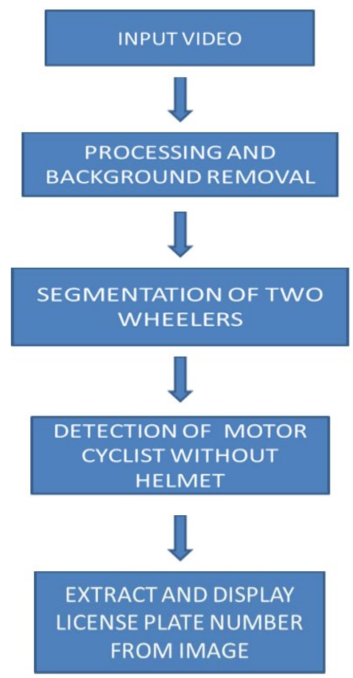


Fig. 1. Flowchart of the system

Speed and accuracy are necessary for real detecting helmets in real-time. So, a model that works on deep neural networks – YOLO model was selected. A cutting-edge, real-time object-detecting technology is called YOLO. It is very fast and results are accurate and is much improved from the previous YOLO versions that existed before. A single network assessment is all that is required to create predictions, as opposed to systems such as R-CNN that needs approximately thousands of network assessments for one image. As a result, it is very quick—more than a 1000 times quicker than R-CNN and hundred times faster than Fast R-CNN. Object detection is a method of detecting instances of a particular class, like humans, animals and many more in an image or video. In order to automate the process of identifying the traffic infraction of not wearing a helmet and obtaining the license plate of the vehicle, a Non-Helmet Rider noticing system is built. People and motorcycles are picked up by YOLOv2 in the first step, helmets are picked up by YOLOv3 in the second step, and license plates are picked up by YOLOv2 in the last phase. After that, optical character recognition (OCR) is used to find the license plate registration number. All of these approaches—especially the one for extracting license plate numbers—are tested against certain circumstances and restrictions. Given that this project uses video as an input, efficiency is essential. We have developed a successful technique for extracting license plate and helmet numbers using the mentioned procedure.

B. Modules Description

1) OpenCV

The Python bindings for OpenCV were developed to overcome challenges associated with computer vision. A file is supplied, and the cv2.imread() method is used to load the file with an image. If the image cannot be read due to reasons like missing file, invalid format, incorrect permissions, etc this method will return an empty array.

2) NumPy

To use arrays in Python, you'll need the NumPy module. This module lets you work with arrays. Additionally, it offers matrices, Fourier transformations, and linear algebra operations. This software project is available as an open-source tool, meaning that there is no cost associated with using it. NumPy is a shortened form of the phrase "Numerical Python.”. It can make array objects about fifty times faster than simple Python lists. The NumPy array objects are known as ND arrays, and they provide a variety of support methods that make using ND arrays rather much simpler. Commonly, arrays are used in data research, where efficiency and availability of resources are essential.

3) Operating system (OS)

offers functionality for interacting. The standard utility modules for Python includes the operating system. This module offers a portable solution to use capabilities that are OS-dependent. The Python programming language offers many built-in functions that allow developers to interact with the file system. Two popular modules for file system operations are *os* and *os.path*. These modules provide a wide range of functions for tasks such as file and directory manipulation, path construction, and more.

4) Image

For rendering PIL pictures, the Image Module provides a class with the same name. The Python interpreter may manipulate images using the Python Imaging Library (PIL). The factory functions offered by this module include those for generating new images as well as those for loading images from files.

5) IMUTILS

IMUTILS are a collection of useful functions for OpenCV, Python 2.7, and Python 3, which make it easy to execute common image processing tasks including translation, rotation, resizing, skeletonization, and Matplotlib picture presentation.

6) TensorFlow

Data flow and several programming tasks are performed in several activities using the free and open-source software library known as TensorFlow. It serves as a math iconography library in addition to being used for machine learning applications like neural networks. It is used by Google for both production and research. The software was released to the public on November 9, 2015, under the Apache 2.0 open-source license. This license allows anyone to use, modify, and distribute the software as they see fit, subject to certain conditions outlined in the license agreement.

C. Algorithms Used

YOLO stands for "You Only Look Once." This technique is used to instantly find and identify different items in images. The class probabilities of the perceived images are provided by object detection, which is carried out in YOLO as a regression issue. The YOLO approach uses Convolutional neural networks (CNN) for the recognition of objects in real-time. With just one forward propagation across the neural network, the algorithm can detect objects. This demonstrates that the prediction for the full image was carried out using a single algorithm run. CNN is employed to simultaneously bind the boxes and forecast various class probabilities.

Python's Python-tesseract utility is used for optical character recognition (OCR). That means that it is going to identify and "read" any textual content that is embedded in images. A wrapper for Google's Tesseract-OCR Engine is called Python-tesseract. As a result of its ability to read all image formats, including jpeg, png, gif, bmp, and tiff, it is also utilized as a standalone script. Additionally, Python-tesseract will print the recognized textual content if it is used as a script instead of than saving it to a file. It can recognize more than 100 different languages.

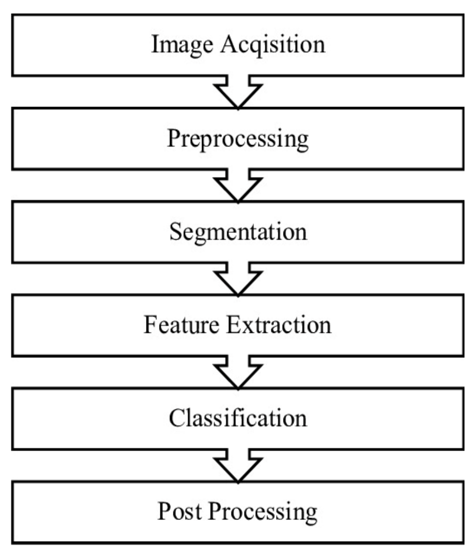


Fig. 2. OCR

The OCR algorithm includes the following steps –

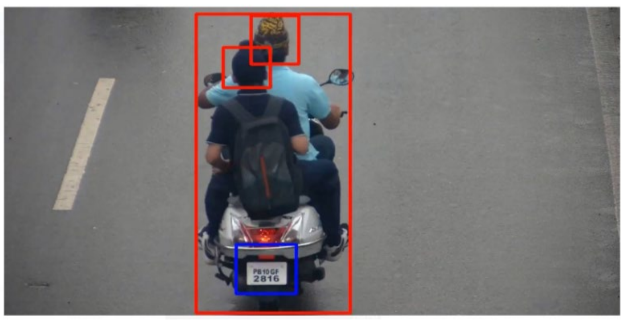
1) Image Acquisition - In this step, the digital form of the image is inputted.
2) Preprocessing – In this step, enhancement, noise

removal, slant, and skew correction of the image are done.

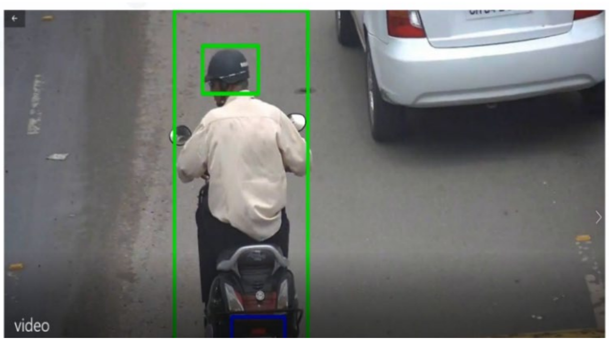
3) Segmentation – In this step line, word and character segmentation of the image is done so that it can be processed easily.
4) Feature Extraction – In this step, the data that is received after segmentation is transformed into numeric features for further processing.
5) Classification - In this step, the pixels of an image are grouped and labeled according to specific rules.
6) Post processing – This step involves implementing various pruning techniques, applying rule-based filters, or integrating knowledge to refine the results.

D. Input Screens

The Fig. 3(a), (b), (c) and (d) are taken from the pretrained input video of the system.



(a)



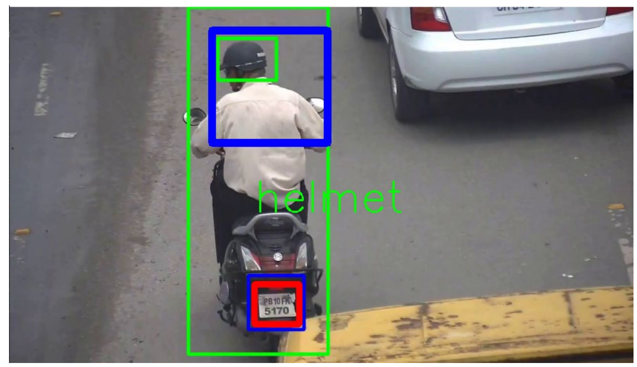
(b)

(c)

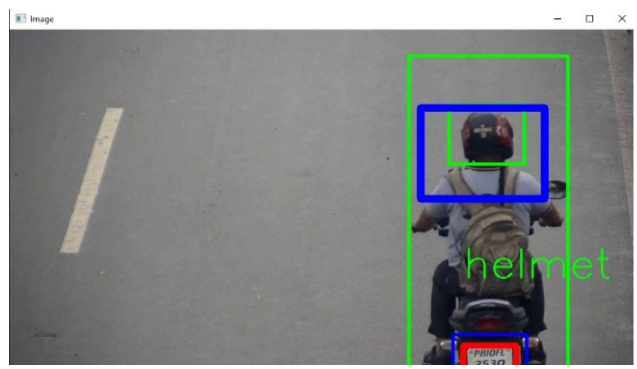
(d)

Fig. 3. Input screens

E. Output Screens



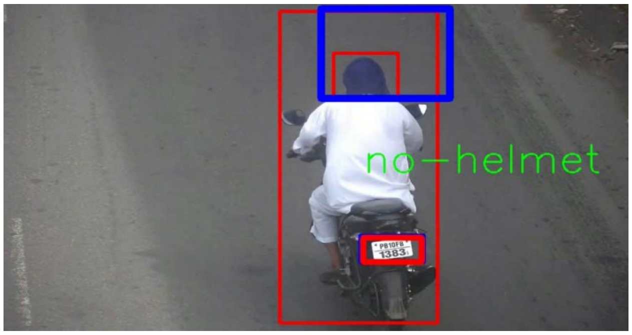
(a)



(b)

In Fig. 4(a) and (b), as we can see the rider on the two-wheeler is wearing a helmet which is being detected by the system, so a relevant message ‘helmet’ is being displayed thus confirming the presence of a helmet.

(c)



(d)
Fig. 4. Output screens

In Fig. 4(c) and (d), as we can see the rider on the two-wheeler is not wearing a helmet which is being detected by the system, so a relevant message ‘no-helmet’ is being displayed thus confirming the absence of a helmet.

4. Results and Discussions

This study proposes a helmet-wearing detection model based on YOLO. The approach involves integrating an attention mechanism into the YOLOv3 framework to enhance the model's feature representation and eliminate redundant features. This results in a more robust network that can better capture the relationships between different areas in the image.

To simultaneously enhance network performance and reduce inference costs, we integrate the best training method. To evaluate the effectiveness of these suggested solutions, we constructed a dataset and performed various assessment tests on it. The experimental outcomes show that the procedures described in this study enhance the YOLO network's functionality, making it an excellent key for the helmet-wearing identification approach in practical setting.

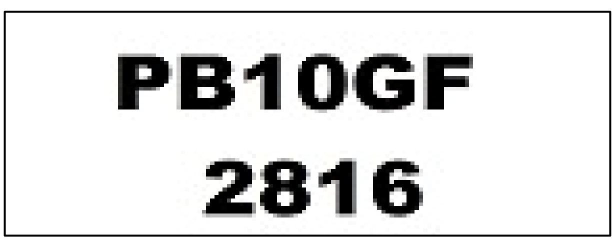


Fig. 5.

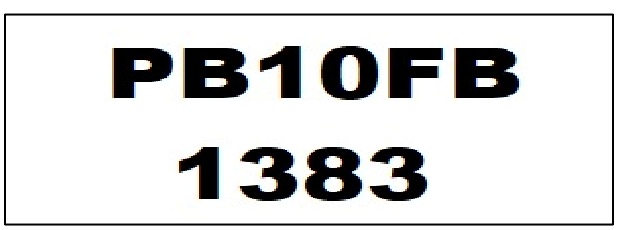


Fig. 6.

In Fig. 5 and 6, we can see the number plates of the two-wheelers whose riders are detected not wearing a helmet are extracted and displayed as the output.

5. Conclusion

A detection system for a rider not wearing a helmet is devised. The input for this system is a video. If the rider of the bike in the input video footage is detected without wearing a helmet while he is riding the bike, then an image of that rider is used to identify the number of number plates of that motorcycle is identified from image and shown as output. The principle of object detection using YOLO architecture is used for detecting person, motorcycle, helmets, and the license plate. For extracting the license plate number, OCR is used. All the objectives of the project are achieved successfully.

6. Future Scope

Future research could aim to enhance this area further in terms of accuracy and reliability of this system, and also expanding its capabilities to include other types of vehicles and road safety features. Additionally, the system can be integrated with other smart city initiatives to create a more comprehensive and efficient traffic management system.

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