A Review Paper on Various Motorcycle Helmet Detection Techniques

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Abstract*—*One of the main things that we have to keep in mind while travelling is Safety. But the people are neglecting this element and violating the rules for their enjoyment. In present days we are observing a steady increase in accidents which resulted to death due to violation of traffic rules and regulations. In order to increase more surveillance on the motorcyclists who are not following the traffic rules and regulations. In this paper we would like to show an automatic method to detect a motorcyclist without helmet using surveillance cameras, so that it would be helpful for the traffic police, to society and to decrease the death rate due to accidents. This paper shows the various methods that can be used to identify or classify motorcycle riders. Most of the methods and some papers that are used to detect or identify motorcycle which uses Machine Learning concepts.

Keywords: **Helmet detection, Surveillance cameras, Convolutional Neural Network, Traffic Management, Cross Line, ROI, K-Nearest Neighbor, SVM classifier.**

1. AIM

The aim of this review paper is to provide, an overview of the different methodologies used for Motor-cycle Helmet Detection and also the main concepts that are used in the methodologies are discussed and tried to give the brief explanation about each method and also tried to give the comparison between each method that are mentioned in this review paper. The accuracy of each method is also given so that it would clear, that which method is the best out of all the three methods that are mentioned in this paper.

2. INTRODUCTION

Over the decades the only vehicle which is available to most of the citizens at an affordable price in our country is undoubtedly a motorcycle because every person in this country uses it for their daily transportation even though it has countless advantages however we cannot ignore the fact that most of the motorcyclists ignore the most important and basic safety measure which is wearing a helmet while riding a motorcycle, which is leading to accidents of many people and in some worst scenarios it may lead to death as well. Even though there were multiple awareness campaigns and events to educate and encourage the people society to wear helmets, however their efforts gone vain in most of the cases. Even though government has set some rules such as imposing a fine of a huge amount if the motorcyclist is caught riding the motorcycle without a helmet, public did not take that seriously because they always think that they could escape from the police by taking a different route or any other means necessary. However, as we know that humans are not capable of working for long hours under certain critical weather conditions and sometimes could be manipulated by others, this might lead for some people to violate the rules and might results in accidents.

The main safety equipment of a motorcycle rider is a helmet. A helmet protects the motorcyclist from danger. Although the use of helmets is mandatory in many areas, there are some motorcyclists who do not use or use them properly. Over the years many works have been done on traffic analysis. Intelligent traffic systems are implemented using computer viewing algorithms, such as: background and front image detection to separate moving objects in the scene and image descriptions to extract features. Computational intelligence algorithms are also used, such as machine learning algorithms to distinguish objects.

According to the India Accident Report 2018 released by the Union Ministry of Road Transport and Highways, approximately 2385 people, including passengers (1,707) and experienced passengers (678) of two-wheeled passengers, were killed in road accidents as they did not wear a helmet. It was 33 percent higher than the number of deaths in 2017

when the number of homicides killed by non-helmets was 1,586, and it was 477 in 2016. Enforcement agencies are particularly focused on making the helmet force on passengers even though the government made it mandatory for both passengers and millions of passengers.

India with a population of 1.3 billion has millions of vehicles traveling on the roads. Violations of traffic laws have become commonplace, but the consequences are not tolerable. According to an NDTV report about 400 cyclists die every day in India due to not wearing protective helmets. Using protective helmets can increase survival by up to 42 percent. It also reduces injuries by up to 70 percent. As a citizen, one must obey the law and order and follow the same in full. But the seriousness of our situation is not so great. One should read the WHO report entitled "why are protective helmets needed?" In this report, there is a broader definition of what happens to the head in the event of an accident and how the helmet actually minimizes the impact.

As discussed above issue can be resolved which should be done swiftly, this research paper talks about a few methods which involves advanced Machine Learning concepts and its related techniques. Some of the struggles in this approach is that quality of the video, weather conditions, lighting and also the classification of multiple objects in which the irrelevant objects or vehicles should be ignored so that main focus would be on the motorcycles.

3.METHODOLOGIES

3.1 Method I:

One of the methods to identify a rider without helmet is as follows, to remove the false detection of vehicles, background subtraction and connected components the method of labeling is used. SVM classifier along with linear kernel is used for the classification the riders who are wearing and not wearing a helmet. To find out the correct region of helmet Grey level histograms are used.[1] To identify the moving objects, we can use the method of background subtraction and even after finding the objects, still there is a problem that is left which is the classification of the moving object whether it is motorcycle or not. There is an approach to deal with this and that is using KNN (K-Nearest Neighbor) classifier which takes components in the region into consideration. In this method, the rider's head is divided into four parts and based on the information collected from those parts KNN decides whether a person is wearing a helmet or not [2]. The identification of the motorcycle is done with a colored tire and protective helmet. The method involved here is a combination of shape, color and symbols on the edges to find the location of the motorcycle in the video frame.[8][9]

In this process, there are two significant steps and they are as follows, at first the images are considered and are used to classify whether the objects are moving or not, however to perform this the programmer has to define a Cross Line(CL) and after this, significant features are extracted to identify the object is motorcycle or not by using the technique Local Binary Pattern(LBP). After that, significant features or attributes are taken from the image by the Hybrid Descriptor those features and image is then sent to SVM classifier which in turn classifies whether it is an image of helmet or not.[3][9]

Segmentation is performed for testing only significant features in the image. After that annotations were used to remove image attributes. This set of information that is taken out is called a feature vector. Using vector classifiers features such as multi-layer perceptron classification was performed on images to determine the image that is captured is a motorcycle or not. After the motorcycle is detected, the next step is to get a helmet detection which is achieved in four steps they are, ROI extraction, Sub-window computation, extraction of the attribute, image classification. ROI is widely used to search the helmet that uses classifiers and subsequent sub-window calculations were performed only on the head of the person to determine whether a person wearing a helmet or not.[4][9]

3.2 Method II:

In this method we are going to use Convolutional Neural Networks (CNN) and a framework in which we are applying this methodology, we first use a background subtraction output technique to recognize the moving objects. Those things which are recognized as moving objects are being assigned to the Convolutional Neural Network (CNN) classifier as the

following input and then it divides them into two groups, namely, motorcyclists and non-motorcyclists.[5] After that, other objects besides motorcycle riders gets rejected and passed only the things predicted as a motorcyclist in the next step in which we determine whether the motorcycle riders wear a protective helmet or not, and this is also performed using CNN classifier. We are assuming that the head can be found in the upper part of in-coming photos or videos and thus put the head in one place in the top four part of the photos. The recognized head of the motorcycle rider at the time provided input to a second CNN trained to detect whether the rider is with a protective helmet or not. In the following paragraphs, we describe each step-in detail.[10]

Firstly, we have to eliminate the background images and detect the moving objects. We use a background detection method to distinguish moving objects such as motorcycles, people, cars from road videos and images using a well-developed Gaussian mixture model[6] that is strong in certain challenges such as daylight variations, shadows, tree branches, and sudden changes. We use a variable number of Gaussian models per pixel because single Gaussian is not enough to completely model this variation in a complex and dynamic environmental condition.[7] [10]

In the second step we are using convolutional neural network (CNN) for object classification. Convolutional neural network (CNN) is a form of feeding neural networks using the back-propagation algorithm that Reads high-level features from local data such as images. The recent success of convolutional neural networks lies in the ability to extract image-dependent data from images. The convolutional neural network training consists of layers of convolution, layers of relaxing max-pooling, layers that are fully connected to the function of loss are in the fully connected layer. In the main slots we get the edge information of images like other hand-made algorithms but, In the final stages, we begin to find the structure and information of the ridge which helps us to find the most useful information in stages. [10]

In the third step recognition of motorcyclists from moving objects is done here. To find binding boxes for a variety of items, using Gaussian background subtraction the method of making each background pixel model with a K Gaussian distribution mix. The background colors are probably the most durable and stays for a long period. From these different pixels, we draw a square rectangular box. After acquiring all the items for motorcyclists and non-motorcyclists, a CNN model was created using these images to distinguish motorcyclists from other moving objects. [10]

In the last step of this method is to recognition of motorcyclists. To see motorcyclists without a helmet, in pictures and videos of motorcyclists, we cut only one-fourth of the top of the image as that was the region where the head of the motorcyclist was most of the time. In this case, we get the head part by deleting the previous binary image of the same location. After that, we created a CNN model to separate the images without and with the helmet. This model is trained in the binary separation of the helmet and head. By following all these steps in this method, we can identify the motorcyclists whether he is wearing the helmet or not. [10]

3.3 Method -III:

In this method we are using YOLOv3 network for helmet detection. It consists of the following modules Image acquisition, pre-processing, motorcycle, and helmet acquisition. CCTV footage is captured and analyzed by frame. Background extraction is used to find moving objects and separate them from standing objects on the scene, where a still camera is used. The simple threshold is then used to create a binary image, removing shadows from the process. Next, morphological functions such as opening, closing, erosion, and elasticity are used to reduce noise. The next step is to draw the outlines and connecting boundaries into the moving objects. Two reference lines are used to detect the movement of objects relative across the screen, and when a moving object crosses them, they are separated. Bonding box ratings are considered and used to determine whether a moving object is a motorcycle, car, or a separate heavy-duty vehicle. Implementation of the helmet acquisition system using the YOLOv3 network. Thousands of images are used to train this YOLOv3 network, which uses Darknet-53, Convolutional Neural Networks (CNN) analyzes Region of interest (ROI) to determine if a motorcyclist is wearing a helmet or not.[11]

The first thing we have to do is to acquire the CCTV footage. CCTV footage need to be processed and analyzed. The camera must be placed at a crossroads to determine the number of vehicles. The camera should be placed at a slightly higher angle so that one motorcycle is not hidden behind another. It should also be placed in a shady area to prevent

exposure to heavy rain or sunlight. A wide camera can be used, and it should be stable. Road lights can be used to respond to the system used during the night. Images are analyzed by frame. We use two guidelines to determine if the motorcycle is moving or not. If the motorcycle center crosses both lines, it will be available. Once the second reference line has crossed, the motorcycle will no longer be available. [11]

The second step is image pre-processing from the CCTV footage to detect the motorcycle and process the image. It includes Background subtraction, Thresholding, Morphological Operations and, motorcycle and helmet detection. Background subtraction is the first step in separating the moving parts of the frame, by dividing its background and foreground. Thresholding was then performed to create a binary image (black and white) according to the limit value. Pixels below the specified limit value are converted to 0 (black) and those above the maximum value are converted to 1 (white). This non-linear function is used to adjust image formation, using a layout object, to process each pixel individually. The opening and closing functions are performed to remove noise. The blog feature rating found was used to classify vehicle type. Measurement is the measure of the height of an object in its width. Only moving objects that satisfy conditions in this process will be treated as a motorcycle and will have a Region of interest (ROI). The region of interest is selected to be the top 50% of the rectangular block of the image.[11]

Finally, the extracted Region of interest (ROI's) for each detected motorcycle rider is fed to the YOLOv3 network and the probabilities of a detection are generated by using logistic regression. By threshold they are classified as wearing a helmet, while others are not.[11]

4. Comparison Table

Table: 1

Paper Title	Year	Accuracy	Technique
Method - I A Review on Helmet Detection by using Image Processing and Convolutional Neural Networks	2019	92%	Image Processing, Convolutional Neural Networks and Support Vector Machine
Method - II Detection of Motorcyclists without Helmet in Videos using Convolutional Neural Network	2019	92.87%	Gaussian mixture model and Convolutional Neural Networks
Method - III Automatic Helmet Detection System on Motorcyclists Using YOLOv3	2020	80%	YOLOv3 and Region of Interest

5. Conclusion:

In this review paper, the things that are discussed is regarding various techniques that are developed for Helmet Detection. Also, it is shown how each method functions and tried to highlight the important concepts that are used in those methodologies. It is also shown that, the comparison between all the methods that are mentioned to get better view or better idea of which method is better to use or which method is useful. In every method that are discussed above, the common important steps in all the three methods are obtaining images and classifying them as whether the detected image is of a motorcycle or non-motorcycle and the final step involved is detecting the motorcyclist with and without helmet using the suitable techniques that are mentioned above. As mentioned in the comparison table (Table:1) above, it clearly states that the method-II (Detection of Motorcyclists without Helmet in Videos using Convolutional Neural Network) has the highest accuracy and it is best the model out of the three methods that are discussed above.

6. Future research directions

Now-a-days we can observe that the technology is improving day by day and new methods are getting introduced and making tasks simpler than we expect. We cannot say that there will be no new method will be discovered in future. After the discovery the same work can be done again and we can compare these existing methods with the new methods and we can also add the method and its explanation into this paper for the better understanding and comparison. In the methods mentioned above we can observe that some methods are having high accuracy and some are having low accuracy, there can be some new methods which might be come in the near future with the help of those methods, We could strive to achieve high accuracy which would help in our research. Its good to find the methods that have high accuracy. However, its better to find the solution that would make things go faster with good accuracy so that the detection could be done faster and it can be used in real-time usage which might lead to a consistent usage of helmets by motorcyclists.

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