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Smart Motorcycle Accident Prevention System using Convolutional Neural Network

Vanitha L[1], Venmathi A R[2], Jullie Josephine D C[3]

[1]*Associate Professor*
Department of Electronics and Communication Engineering
Prathyusha Engineering College, Chennai, India.

[2]*Associate Professor*
Department of Electronics and Communication Engineering
Kings Engineering College, Chennai, India.

[3]*Professor*
Department of Computer Science and Engineering
Kings Engineering College, Chennai, India.

Abstract

The identification ofviolators on traffic rules isa highly essential but challenging task. A surveillance system is mandatory to insist onroad safety measures, especially in two-wheeler motorists. The system is capable of detecting non-helmet wearing persons and preventing deaths.This work presented an automatic method for motorcycles detection on public roads, image handling technique, and more advanced computer vision thatenhances machine learning classifier Convolutional Neural Network (CNN) used to solve the problem. In the proposed system, the backgroundsubtraction technique used on the surveillancevideo imagesto separate the subject from the surrounding object.Then the network is used toclassify motorcyclists with and without a helmet.Then Hough transform edge detection techniqueis applied to detect the number plate of the vehicle. Thus the information of the person without a helmet is given to the control room through GPS. The personidentified without a helmet warnedandpunished with penalty amount via the GSM system.The proposed system give an averageaccuracy rates of the motorcyclist classified from other images is 93.94% and persons without helmet identification and number plate detection were 93.25%.

Keywords:*Background subtraction,Convolutional Neuralnetwork, Hough transforms, Classification Hough transform*

1. Introduction

Riders neglect road safety,which leads to accidents and deaths.In the modern world normally people uses two-wheelers for short distance transportation. This practice increased use of vehicles and two wheelers are prone to accidents and are increasing day by day in our country. Hence to control the accidents in our country, [8] a safety measures is necessary, and usage of helmets have become important factor for safety, which people normally avoid.To address this issue,many of the countries have laws that are mandatory for the usage of helmets, especially for two-wheelers. Recently helmets have been made strictly compulsory, but still, people drive without helmets. Thereforefor public safety,a mechanism required for automatic detection of drivers without helmets,and hence extracting the number plate of the vehicle. The system developed in this work will help the government to handle this problem efficiently. According to a report by TOI (Times of India)[1], in the year 2018 and 2019 about 40 and 98, motorbike riders died respectively daily on Indian roads because of not wearing helmets. On survey, almost 60% of the people who died in an accident were not wearing a helmet. And as per the record number of persons who died because of not wearing helmet in road accidents were 15,285 in 2017 and increased to 42,000 in

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2018 [2].However, helmet wearing become the primary security measure for bike riders. The study conducted by the United Nations indicates wearing a helmet increased the survival chances to 62%.

2. Literature Study

Mistry et al. [4] test with other existing methodologies showed helmet images performed better than non-helmet images when contrasted. Vishnu et al. [5] inducted a method to detect motorbike riders without helmets in surveillance videos. Kunal et al. [6] introduced a real-time approach to detect motorcyclist who is without helmet using the surveillance images. Surrounding subtraction to segment the object from the subject was used.Rattapoom et al. [8]Introduced a moving object detection mechanism which classified heads, comprising of mainly the head extraction and classification techniques. The existing tool to check whether a bike rider is riding with a helmet or not by police at check post or other personnel to review each rider manually.The proposed system is a new and advanced methodology to identify the defaulters, to reduce the number of accidents, increase safety, and to create realization in the minds of the public about the necessity of wearing a helmet.

3. Proposed Method

Therefore, this work presents a method based on CNN classifier and image detection technique to solve the problem. The surveillance camera regularly captures the moving object images, which subtracts the two-wheeler images from the surroundingimages. The system separatesthe helmet-wearing person from withouthelmet andcaptures the pictures of numberplates. The number plate extracted applying the Hough transform, and this information transferred to the control room using GPS. Warning or penalty information intimated to the corresponding person via GSM. The flow diagram of the proposed diagram is explained in Figure 1.

3.1 Vehicle classification

In the first step, we apply adaptive background subtraction to detect moving objects. These moving objects separated as two-wheeler and other moving objects using CNN [22] classifier. Then the background objects were discarded, and only the motorcyclistsconsidered for the next process.Table 1 shows the accuracy calculation for the first stage classification.

S.No.	Day	Total two-wheeler images	Images identified as two-wheelers	Accuracy %
1	Mon	2093	1789	85.48
2	Tue	2078	1975	95.04
3	Wed	2087	2054	98.42
4	Thu	3001	2679	89.27
5	Fri	1987	1902	95.72
6	Sat	1876	1795	95.68
7	Sun	1025	993	96.88
8	Mon	2098	1896	90.37
9	Tue	2134	2003	93.86
10	Wed	2067	2040	98.69
		2044.60	1912.60	93.94

Table 1 :Accuracy Calculation for two wheeler classification

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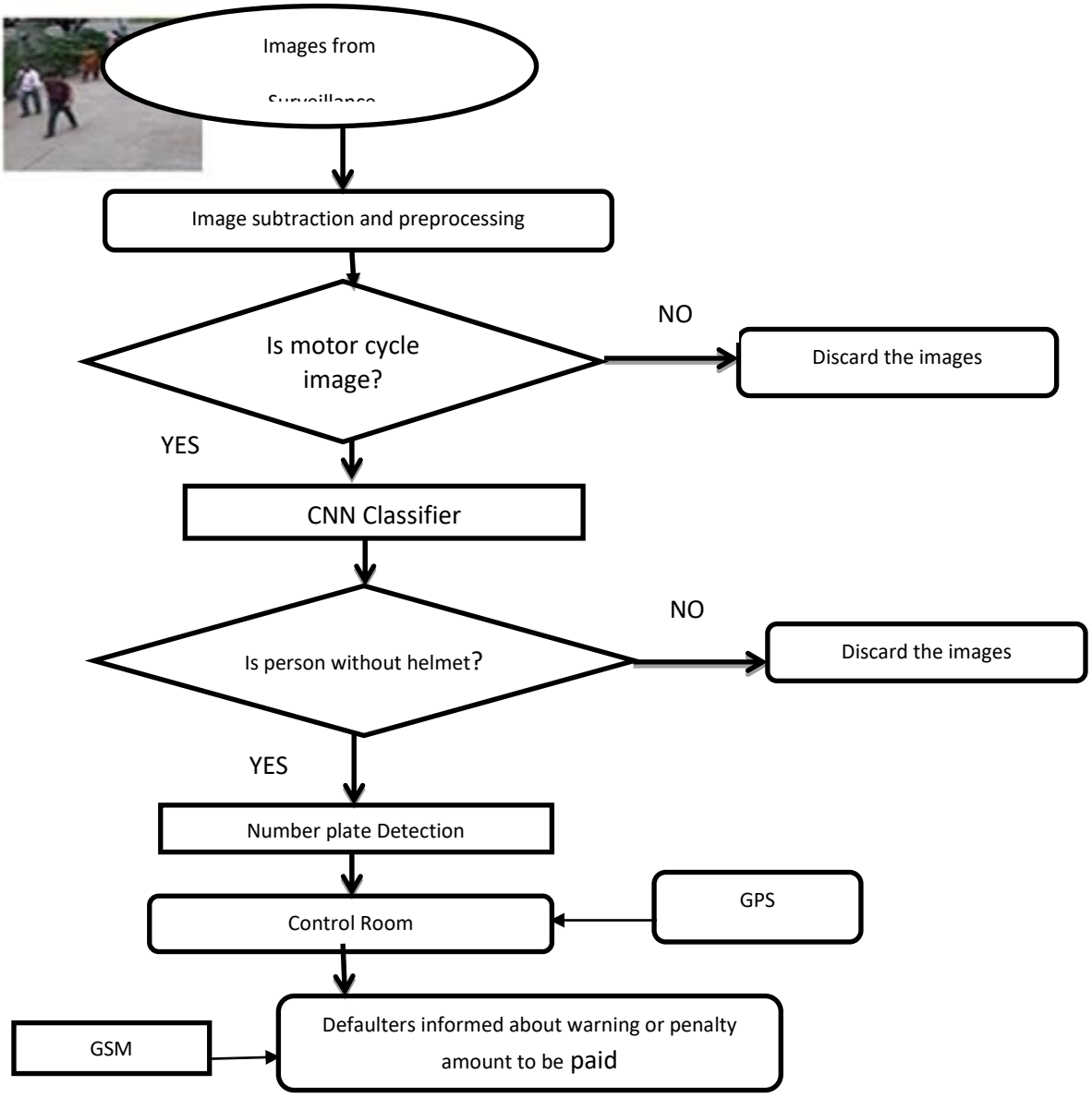

Figure 1. (a)Block Diagram for the Proposed System (b) CNN application

3.2 Process on the Motorcyclist Images

The next phase is to identify the person wearing a helmet or without a helmet. For this process, a model developed to classify a person wearing a helmet, or not and 1000 images considered for training this model. The frames are drawn to crop the person from the overlapping of bike images.Table 2 shows the system accuracy in the second stage.

S.No.	Day	Two-wheelers wearing helmet	Picture of Two-wheelers with helmet correctly identified	Accuracy %
1	Mon	649	585	90.14
2	Tue	589	535	90.83
3	Wed	723	667	92.25

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4	Thu	536	499	93.10
5	Fri	658	617	93.77
6	Sat	396	371	93.69
7	Sun	491	461	93.89
8	Mon	535	508	94.95
9	Tue	682	646	94.72
10	Wed	514	489	95.14
		577.30	537.80	93.25

Table 2 Accuracy Calculation for Helmet Detection

3.3 Convolutional Neural Network

The convolutional neural network is a feed-forward neural network that uses a backpropagation algorithm. The secret of success of this neural network is the more exceptional ability on classification.The extraction of interdependent information from the data is due to its multi-layer advancement. The localization of pixels is high enough compared to other neural networks. CNN consists of many layers like a convolutional layer, a fully connected layer including loss function. The first layers provide the edge details on the images. In contrast, the final layers give the ridge information, which is useful in extracting sensitive edges, which is very much useful for classification. Figure 2 explains the process of CNN.

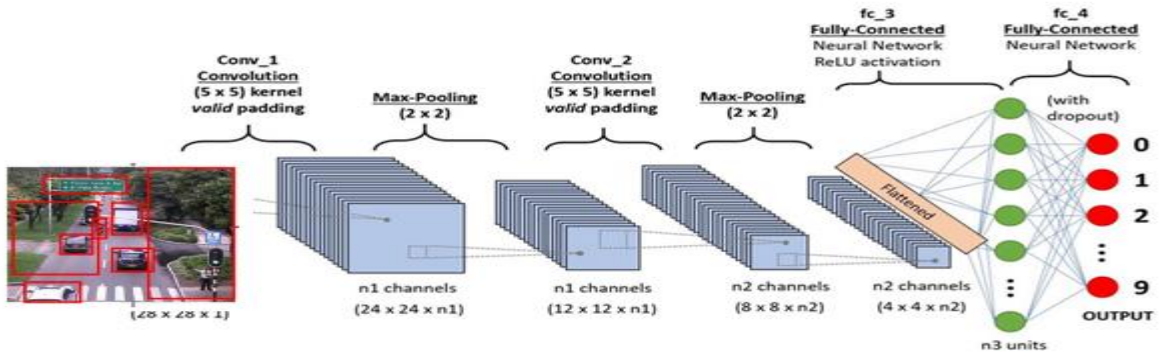

Figure 2: The Convolutional Neural Network process

3.4 Background subtraction

The moving objects on the road, additionally with motorcycle-like humans, cars, and heavy vehicles, are to be separated. The background subtraction technique is to separate these types of objects from the motorcycle.Adaptive multiple Gaussian models[23] are used for this purpose in which the illumination variation on the pictures read and unwanted image eliminated. The bounding boxes gave the difference for the required illumination.CNN network built to separate the motorcycle from other moving objects.CNN learnsfrom the hidden structures in the training sets and can classify the motorcycle from other entities.

3.5 Recognition of Motorcyclists without Helmet

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After categorizing the motorcyclist from the background, the next step is to differentiate the person whether he is wearing a helmet or not. The motorcyclist without helmet identifiedby capturing one-fourth image of the motorcyclist, thus capturing the head portion of the cyclist. This image is the input to theCNN network,which classifies the images without helmet from images with helmet.

3.6 Number plate extraction using edge detection

If in the previous step, the output is a person without a helmet then this step is initiated to determine the number plate image of the vehicle. The picturesof the numbersextracted from the background artifacts and numbers are identified by detecting the edges using Hough transform. [17].Hough transform linked edge chains into curves to group them into edge points. Figure 3 shows the change in edge for different cases.

Filtering Noise using a Gaussian Filter $J = I * G$

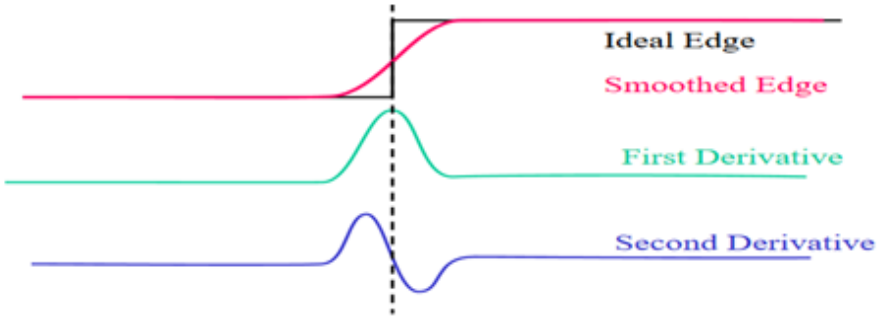

Figure 3. Changes of the edge for measured values

Computing the magnitude of the gradient

$$\nabla J + (J_x, J_y) = \left(\frac{\partial J}{\partial x}, \frac{\partial J}{\partial y}\right) \text{and} \|\nabla J\| = \sqrt{J_x^2 + J_y^2}$$

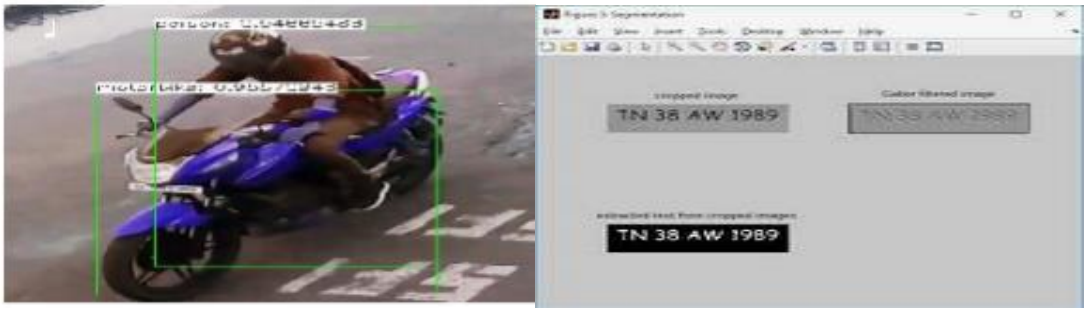

Figure 4. (a) Image captured by the surveillance camera (b) Number plate display

3.7 Intimation to the person through the control room

The numbers obtained from the number plate sent to the control room with the help of GPS,then the defaulters are informed about the penalty amount through GSM.The sample image acquisition through a surveillance camera, and the numbers obtained from the number plate is displayed in Figure 4.

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4. Results and Discussion

The classifier was trained with 1000 images and day wise observations made for ten days. The classification accuracy is calculated for the first stage of classification to categorize the two-wheelers from other objects from the full image of surveillance. The average accuracy observed is 93.94%.The second stage classificationaccuracy to determine the two-wheelers not wearing helmets.The average accuracy obtained for the second stage is 93.25%. The challenges in identifying the motorcycle are not capturing the image accurately, thus not able to locate as a two-wheeler. The accuracy is less in the second stage because of the image not able to identify the different shapes of the helmet. The results are plotted in the below Figure 4.

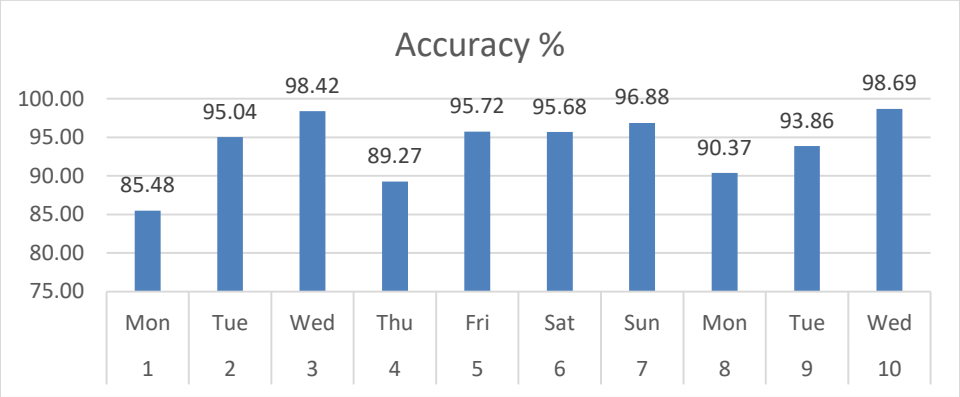

Figure 4.The graph plotted for Two-wheelers Classification accuracy

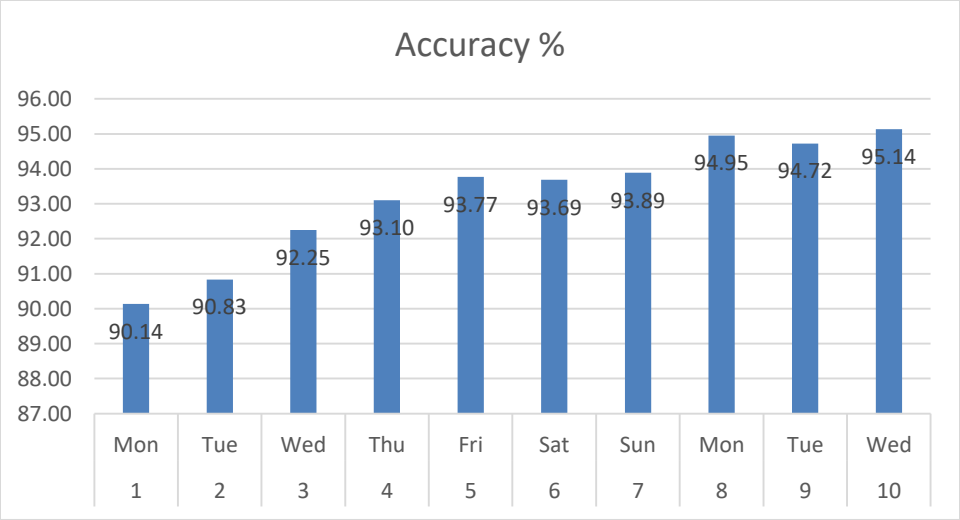

Figure 5. The graph plotted for images without Helmet Classification accuracy

5. Conclusion

The method selected for classifying the required frames is to subtract the unwanted images from the frame.Thus the developed system classified motorcyclists from other images. In the second step,the system separated the images ofpersons wearing a helmet from a person not wearing a helmet if the captured image is a two-wheeler. In the next step, the number plate images are extracted from the

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motorcyclists not wearing helmet. The obtained information is transferred to the control room, and warning and penalty message sent to the defaulters. This system helps the society to control the death rate due to accidents. The outcome of the experimental evaluation shows that using CNN improves the performance for classification tasks and hence develops more reliable system.

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