Neural Network Based Smart City Application for Traffic Violation Detection

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Abstract - *The main application of helmet detection is in traffic roads where accidents are more. Even though various measures are taken by government, it is not followed correctly by the motorcyclists, so several smart techniques should be employed. In developing countries like India, the two-wheeler is the most common means of transportation. Though it is convenient to ride, negligence of Helmet compulsion law by the riders is leading to many accidents. According to the statistics provided in the Road Accident Report, at least 98 riders, who were not wearing a helmet, died daily in 2017. Deaths caused by not wearing helmet rose to 36,000 in 2017 which was 10,135 in 2016. WHO has declared that the negligence of riders in using safety devices as one of the causes for the rise in road accidents. Government has implemented many methods to catch the violators. But those methods require human assistance, which decreases the performance and reliability of the system. In this project, an automatic helmet detection system is designed using Faster RCNN machine learning algorithm. Faster RCNN algorithm is used to detect the helmet.*

***Key Words*: Faster-Region Based Convolutional Neural Networks(F-RCNN), Helmet Detection, Machine Learning, Mean Average Precision (mAP), You Only Look Once (YOLO), Single Shot Detector(SSD).**

1. INTRODUCTION

Since, motorcycles are affordable and a daily mode of transport, there has been a rapid increase in motorcycle accidents due to the fact that most of the motorcyclist do not wear a helmet which makes it an ever present danger every day to travel by motorcycle. In the last couple of years alone most of the deaths in accident are due to damage in the head. Because of this wearing helmet is mandatory as per traffic rules, violation of which attract hefty fines.

Machine learning is an application of Artificial Intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. Machine learning focuses on the development of computer programs that can access data and use it learn for themselves. Machine learning is a category of algorithm that allows software applications to become more accurate in predicting outcomes without being explicitly programmed. It is the scientific study of algorithms and statistical models that computer systems use to perform a specific task without using explicit instructions, relying on patterns and inference instead. It is seen as a subset of artificial intelligence. Machine learning algorithms build a mathematical model based on sample data, known as "training data", in order to make predictions or decisions without being explicitly programmed to perform the task. Machine learning algorithms are used in a wide variety of applications, such as email filtering and computer vision, where it is difficult or infeasible to develop a conventional algorithm for effectively performing the task.

Machine learning is closely related to computational statistics, which focuses on making predictions using computers. The study of mathematical optimization delivers methods, theory and application domains to the field of machine learning. Data mining is a field of study within machine learning, and focuses on exploratory data analysis through unsupervised learning. In its application across business problems, machine learning is also referred to as predictive analytics. Road accidents are one among the major causes that leads to cause of human death. There is a speedy increase in motorbike accidents owing to the fact that majority of the motor bicyclist fail to wear helmet that makes it an ever-present danger. Within the last few years, most of the accidents are caused because of the head injury. According to transport ministry, in 2016 about 28 two-wheeler riders died daily because of not wearing helmet. In 2017, 31 out of 100 people died in road accidents which. shows increased rate from 21.6death per 100 accidents in 2005. Each year there are1.4 million Traumatic Brain Injuries (TBI's) in INDIA. About $76.5 billion dollars is spent in treatment related to these injuries. More than 50,000 individuals die from TBI. Due to this, wearing helmet is made necessary by means of traffic rules. But most of the motor bicyclists never obey the rule. Many cities make use of a surveillance network to monitor the motorcyclists violating the helmet laws. But such a system will need human intervention. Today's surveys say that human interventions prove ineffective, due to the increase in the time of monitoring and also due to the errors made by human during monitoring. Different methods are there for detecting the motor bicyclist who does not wear helmet. Identifying the actual rate of motor bicyclists without helmets is challenging due to obstruction, illuminance, poor quality of videos etc...

2. RELATED WORK

Over the past years, multiple approaches are proposed to unravel the matter of helmet detection. The authors in [7] use a background subtraction method to detect and differentiate between moving vehicles. and that they used Support Vector Machines (SVM) to classify helmets and human heads without helmets. Silva et al. in [9] proposed a hybrid descriptor model supported geometric shape and texture features to detect motorcyclists without helmet automatically. They used Hough transform with SVM to detect the top of the motorcyclist. Additionally, they extend their add [10] by multi-layer perception model for classification of varied objects.

Wen et al. [10b] uses a circle arc detection method based upon the Hough transform. They applied it to detect helmet on the closed-circuit television . the disadvantage of this work is that they only use geometric features to verify if any safety helmet exists within the set. Geometric features aren't enough to seek out helmets. In [11b] it proposes a computer vision system getting to detect and segment motorcycles partly. A helmet detection system is employed , and therefore the helmet presence verifies that there's a motorbike . so as to detect the helmet presence, the sides are computed on the possible helmet region. The Canny edge detector [12b] is employed .

Waranusat et al. [11] proposed a system to detect moving objects employing a k-NN classifier over the motorcyclist's head to classify helmet. These models were proposed supported statistical information of images and had a limitation to the extent of accuracy that would be achieved.

With the evolution of neural networks and deep learning models there was further improvement within the accuracy of classification. Alex et al. [13] introduced a convolutional neural network (CNN) based method for object classification and detection. A. Hirota et al. [12] use a CNN for classification of helmeted and non-helmeted riders. Although they use CNN, their helmet detection accuracy is poor with limitations to helmet color and multiple riders on one motorcycle.

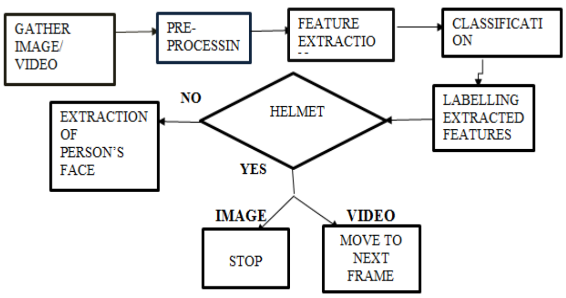

Figure 1: flow diagram

3. PROPOSED METHODOLOGY

After the creation of the dataset was finished, we applied a state-of-the-art object detection algorithm to the annotated data, to facilitate motorcycle helmet use detection on a frame-level. In this process, data from the training set is used to train the object detection algorithm. In the process of training, the validation set is used to find the best generalizing model, before the algorithm's accuracy in predicting helmet use is tested on data that the algorithm has not seen before, the so-called test set. Generally, the state-of-the-art object detection algorithms can be divided into two types: two-stage and single-stage approaches. The two-stage approaches first identify a number of potential locations within an image, where objects could be located. In a second step, an object classifier (using a convolutional neural network) is used to identify objects a these locations.

While two-stage approaches such as Fast R-CNN [28], achieve a higher accuracy than single-stage approaches, they are very time-consuming. In contrast, single-stage approaches simultaneously conduct object location and object identification. Single stage approaches like YOLO [24] and Retina Net [18] therefore are much faster than two-stage approaches, although there is a small trade-off in accuracy. In this paper, we used Retina Net [18] for our helmet use detection task. While it is a single-stage approach, it uses a multi-scale feature pyramid and focal loss to address the general limitation of one-stage detectors in accuracy.

3.1 Helmet Detection

The annotated images are given as input to YOLOv3 model to train for the custom classes. The weights generated after training are used to load the model. Once this is done, an image is given as input. The model detects all the five classes trained. From this we obtain the information regarding person riding motorbike. If the person is not wearing a helmet, then we can easily extract the other class information of the rider. This can be used to extract the license plate.

4. **REAL TIME IMPLEMENTATION**

4.1CONVOLUTION NEURAL NETWORK

A convolutional neural network (CNN) is a type of artificial neural network used in image recognition and processing that is specifically designed to process pixel data.

CNNs are powerful image processing, artificial intelligence (AI) that use deep learning to perform both generative and descriptive tasks, often using machine vison that includes image and video recognition, along with recommender systems and natural language processing (NLP).

A neural network is a system of hardware and/or software patterned after the operation of neurons in the human brain. Traditional neural networks are not ideal for image processing and must be fed images in reduced-resolution pieces. CNN have their "neurons" arranged more like those of the frontal lobe, the area responsible for processing visual stimuli in humans and other animals. The layers of neurons are arranged in such a way as to cover the entire visual field avoiding the piecemeal image processing problem of traditional neural networks.

A CNN uses a system much like a multilayer perceptron that has been designed for reduced processing requirements. The layers of a CNN consist of an input layer, an output layer and a hidden layer that includes multiple convolutional layers, pooling layers, fully connected layers and normalization layers. The removal of limitations and increase in efficiency for image processing results in a system that is far more effective, simpler to trains limited for image processing and natural language processing.

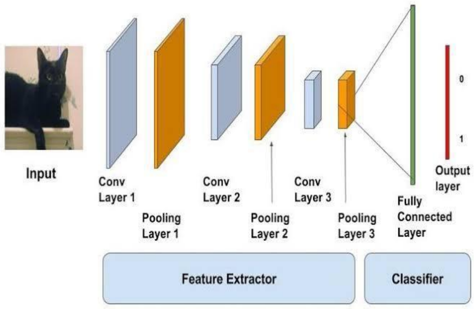

Figure 2: Architecture of CNN

The above Figure shows architecture of Convolution Neural Network. A CNN architecture is formed by a stack of distinct layers that transform the input volume into an output volume through a differentiable function. A few distinct types of layers are commonly used.

4.2 CONVOLUTIONAL LAYER:

The convolutional layer is the core building block of a CNN. The layer's parameters consist of a set of learnable filters (or kernels), which have a small receptive field, but extend through the full depth of the input volume. During the forward pass, each filter is convolved across the width and height of the input volume, computing the dot product between the entries of the filter and the input and producing a 2-dimensional activation map of that filter. As a result, the network learns filters that activate when it detects some specific type of feature at some spatial position in the input.

Stacking the activation maps for all filters along the depth dimension forms the full output volume of the convolution layer. Every entry in the output volume can thus also be interpreted as an output of a neuron that looks at a small region in the input and shares parameters with neurons in the same activation map.

5. RESULTS

A example of the input image and the output object detector are shown in the figure below

BEFORE HELMET DETECTION

Figure 3:Helmet detection before implementing CNN

AFTER HELMET DETECTION

Figure 4: Helmet detection after implementing CNN

The F-RCNN model is able to detect and recognize the Helmets present in an image with an accuracy up to 90 percent. An example of the recognized Helmets are shown in the image.

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6.CONCLUSION

In this project we are trying to create a model that could detect bike rider in images or video feeds. The dataset that was used in this project was made and annotated so that the model could differentiate between image having bike rider or not. The proposed bike rider detector has been successfully trained by using Faster RCNN learning methods on the sample vehicle datasets and the vehicle detection process has been successfully performed by the trained vehicle detector being tested on the test data set. In future, this model can be useful for project in which we detect a bike rider without helmet and recognize the license plate of the bike so that e-challan could be generated.

This system gives an idea about the number of traffic offenders in an area. It generates a database of all bike riders driving without wearing a helmet along a snapshot for proof. Use of open and free technologies like tensor flow, OpenCV and tesseract makes the software relatively less expensive. Under fair lighting conditions, this system was tested to give full proof and accurate results. The overall awareness to public will increase the impact of the system.

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