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# Real-Time Helmet Detection of Motorcyclists without Helmet using Convolutional Neural Network

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***Abstract: CNN models were used to solve pattern recognition and feature extraction problems. In order to classify helmets the preprocessing step for extracting the area in the image is mostly required before applying CNN. In this paper, an SSD model is applied to the helmet detection problem.***
***This model is able to use only one single CNN network to detect the bounding box area of motorcycle and rider. Once the area is selected we classify whether the biker is wearing or not wearing a helmet at the same time.***
***Convolutional Neural Network is used to select motorcyclists among the moving objects and recognition of motorcyclists without a helmet.***
***Further we detect the License Plates of motorcyclists without helmets using the YOLO model. So we have used three models in total the custom CNN Model, SSD Model and the YOLO model***
***Index Terms: helmet detection, SSD, YOLO, Convolutional Neural Network.***

## I. INTRODUCTION

The importance of automatic systems in traffic control has increased in the recent years. One goal is to improve the utilization of a traffic flow system.
Further it can be also used to reduce the causes of an accident. Road traffic accidents are being recognized as a major problem in developing countries.
Since motorcycles are a daily mode of transport, there has been a rapid increase in the number of accidents due to the fact that most of the bikers do not wear helmets and most of the deaths happen due to head injuries. As per traffic rule, it is mandatory to wear a helmet while riding a motorcycle.
But many bikers ignore the rules and use their vehicles without safety equipment. The ideal solution is to develop an electronic detection system that can be automated to recognize this kind of problem without human cost. To detect the bikers who do not wear a helmet, we need methods to detect the motorcycle and driver from the video frames.
Further we have to detect an area of the biker's head and classify whether the person is wearing a helmet or not. Several CNN models have been introduced, but most of these models can be used only to categorize or recognize one object from the image, not for multiple objects.
For accomplishing this task, here we apply a method of deep learning called Single Shot Multibox Detector technique. We used this method to solve the helmet detection problem from surveillance video using CNN models and SSD technique. We also capture the number plates of the riders who don't wear helmets using the YOLO model.

## II. PROPOSED METHOD

The task of the proposed system is to detect motorcyclists who don't wear helmets. In order to achieve this task video datasets are collected from surveillance cameras and the bounding boxes containing motorcyclists are obtained from each video frame. We have used an SSD Model for detecting motorcyclists. After that we crop the head portion from the saved bounding box images. Further we train on the cropped images by creating a custom CNN Model. Images with and without helmets are detected. Finally the YOLO Model is used to detect the number plates of motorcyclists not wearing helmets.

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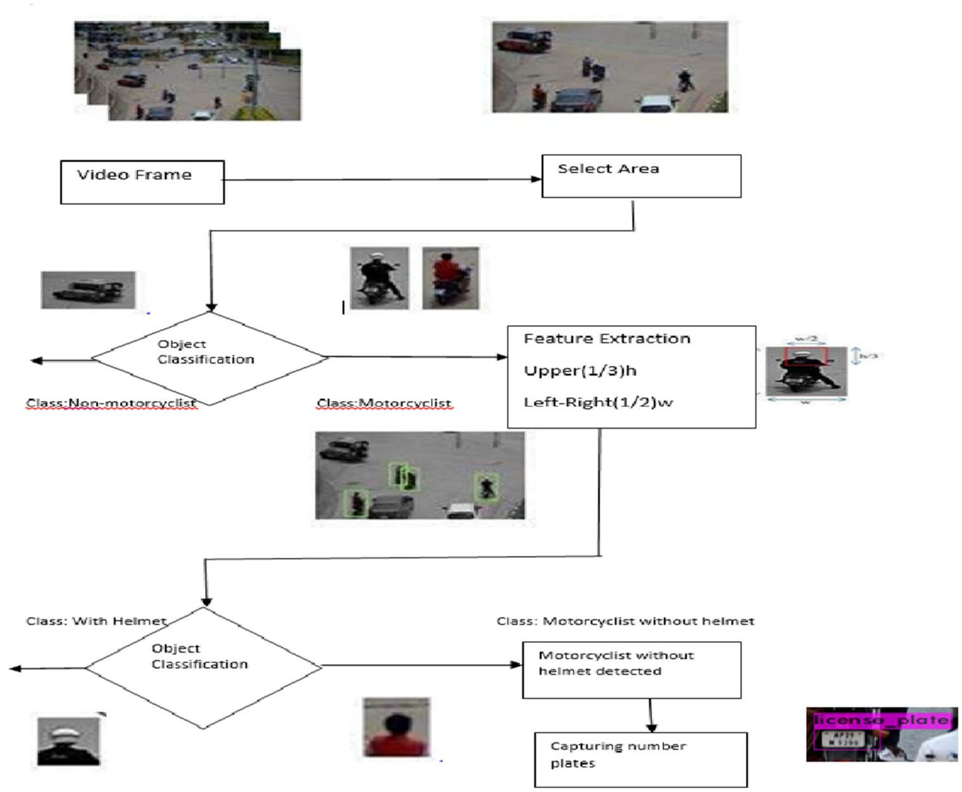
### *A. Architecture*




The system begins with obtaining the videos from the surveillance cameras .Each video contains numerous video frames. Object Classification is done from the selected area of each video frame. The images that don't contain motorbikes are neglected. Once the images with motorbike are detected the obtained images are compared using a scale invariant feature transform (SIFT) technique to cluster the similar images into groups. The head portion of cluster images are cropped and saved separately. A custom model is then created to train the helmet images. Object classification is done using the custom model to classify the images into classes namely; with helmet and without helmet. Finally the number plates of the motorcyclists without helmets are detected using the YOLO model.

### *B. Classification module*

The System mainly consists of Video and Image Gathering Module, Image Training Module, Image Detection Module and Additional Functionality Module.

1) *Implementation of Video and Image Gathering Module:* In this module input datasets were collected from the video surveillance system .After that, object detection of motorbike is done from the video frames of the collected dataset. Then we crop an area of a motorcycle with a biker and helmet. Further similar images are grouped into clusters and finally the head portion is cropped and stored separately in each cluster.
2) *Implementation of Image Training:* In this module helmet images are split into two groups, one for training data and another for test data for use in classification experiments. We test data by creating a custom CNN model. The training networks are trained using Python TensorFlow library and we calculate the accuracy of the trained model.
3) *Implementation of Image Detection Module:* Once training is completed helmet detection is done for the images in the cropped folder with the custom model. The images with or without helmets are listed.
4) *Implementation of Additional Functionality Module:* After the motorcyclists without helmets are detected the additional functionality module captures the number plate of those motorcyclists without helmets. The YOLO model is used for capturing number plates. It can run and save predictions on more than one image at a time.

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## III. MODELS USED

### A. *Single Shot Multibox Detector*

SSD is a popular algorithm in object detection. It is a deep neural network model to use only one single network to do both tasks of image segmentation and image classification at the same time. An idea of SSD is to find a proper bounding box in each image that should be considered as an object first,and then use that area of bounding box to classify the type of object. Moreover, the best part is that it can detect multiple objects in the image using only one runtime and is significantly faster in speed and high-accuracy object detection algorithm. SSD object detection composes of 2 parts: Extract feature maps and apply convolution filters to detect objects. SSD uses VGG16 to extract feature maps. Then it detects using the Con4 3 layer. SSD is more accurate than YOLO.

### B. *YOLO*

YOLO is a Convolutional Neural Network for object detection in real-time. The algorithm applies a single neural network to the full image, and then divides the image into regions and predicts bounding boxes and probabilities for each region. The bounding boxes are weighted by the predicted probablities.It is extremely fast. YOLO is similar to FCNN. YOLO is popular because it achieves high accuracy while also being able to run in real-time.

## IV. RELEVANCE

1) This system can be installed in major traffic intersections and highways to automate the task of traffic management.
2) If improved it also automates the task of challan generation in case of rule violation.

## V. EXPERIMENTAL ANALYSIS AND RESULTS

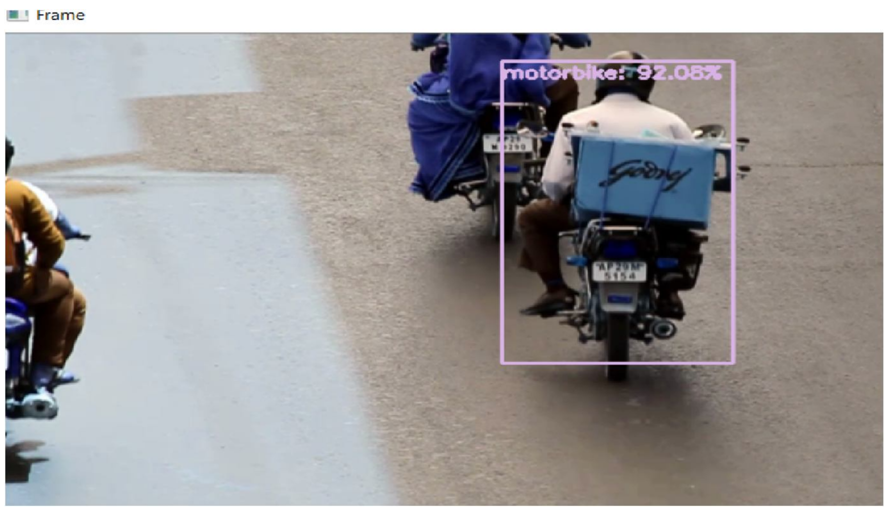



Fig. 1. Motorbike Detection Phase

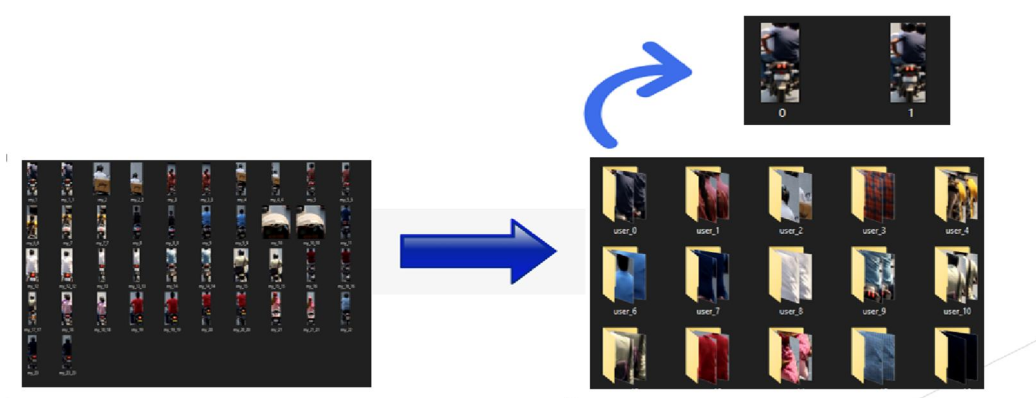
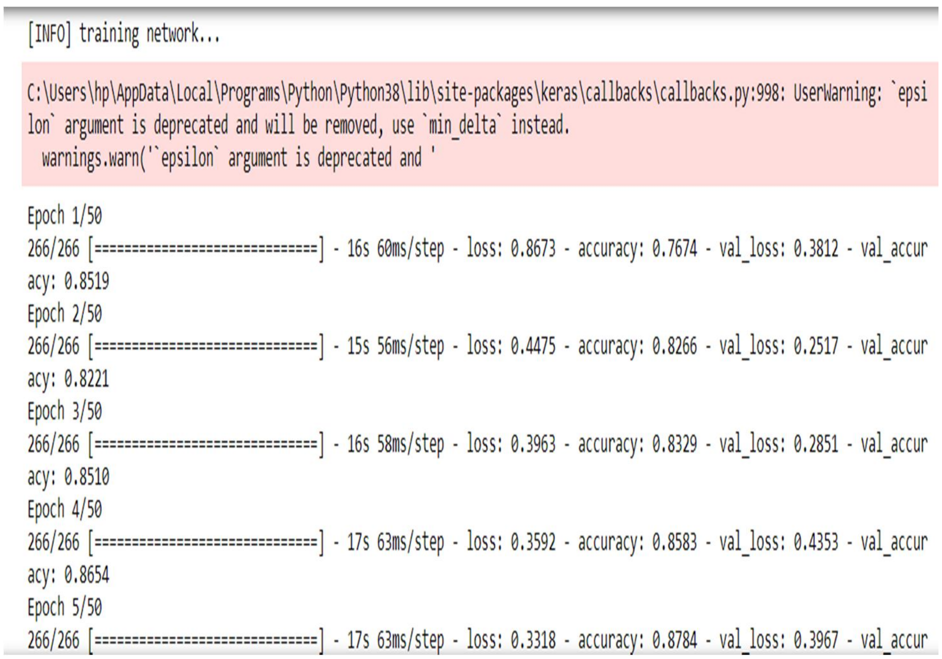


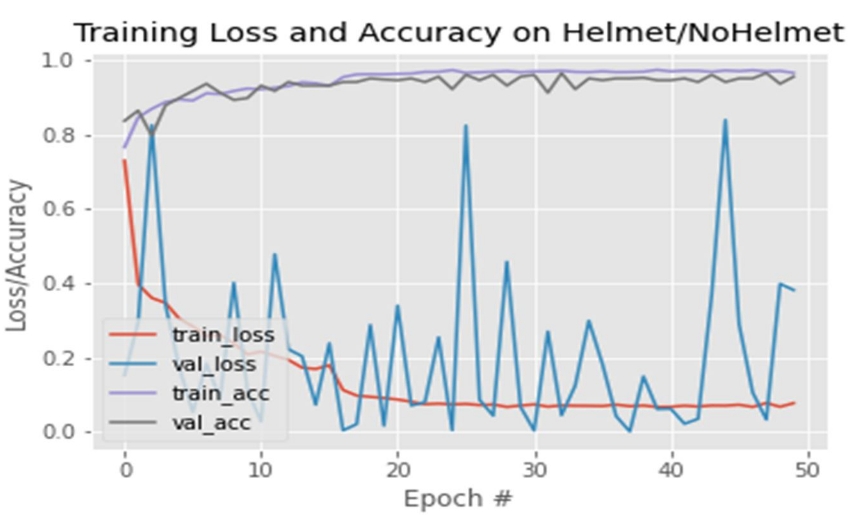
Fig. 2. Clustering Phase

Fig. 3. Cropping Phase



```
[INFO] training network...
C:\Users\hp\AppData\Local\Programs\Python\Python38\lib\site-packages\keras\callbacks\callbacks.py:998: UserWarning: `epsi
lon` argument is deprecated and will be removed, use `min_delta` instead.
  warnings.warn('`epsilon` argument is deprecated and '
Epoch 1/50
266/266 [==============================] - 16s 60ms/step - loss: 0.8673 - accuracy: 0.7674 - val_loss: 0.3812 - val_accur
acy: 0.8519
Epoch 2/50
266/266 [==============================] - 15s 56ms/step - loss: 0.4475 - accuracy: 0.8266 - val_loss: 0.2517 - val_accur
acy: 0.8221
Epoch 3/50
266/266 [==============================] - 16s 58ms/step - loss: 0.3963 - accuracy: 0.8329 - val_loss: 0.2851 - val_accur
acy: 0.8510
Epoch 4/50
266/266 [==============================] - 17s 63ms/step - loss: 0.3592 - accuracy: 0.8583 - val_loss: 0.4353 - val_accur
acy: 0.8654
Epoch 5/50
266/266 [==============================] - 17s 63ms/step - loss: 0.3318 - accuracy: 0.8784 - val_loss: 0.3967 - val_accur
```

Fig 4. Image Training



```
['Cluster_Dataset\\user_0', 'Cluster_Dataset\\user_1', 'Cluster_Dataset\\user_10', 'Cluster_Dataset\\user_11', 'Cluster_Data
set\\user_12', 'Cluster_Dataset\\user_13', 'Cluster_Dataset\\user_14', 'Cluster_Dataset\\user_15', 'Cluster_Dataset\\user_1
6', 'Cluster_Dataset\\user_2', 'Cluster_Dataset\\user_3', 'Cluster_Dataset\\user_4', 'Cluster_Dataset\\user_5', 'Cluster_Dat
aset\\user_6', 'Cluster_Dataset\\user_7', 'Cluster_Dataset\\user_8', 'Cluster_Dataset\\user_9']
user_0 => [0.908633 0.908633 0.908633 0.908633 ] => helmet
user_1 => [0.41535065 0.41535065 0.41535065 0.41535065 ] => no_helmet
user_10 => [0.5260474 0.39116117 0.5260474 0.39116117 ] => no_helmet
user_11 => [0.045150608 0.045150608 0.045150608 0.045150608 ] => no_helmet
user_12 => [0.39627513 0.5048856 0.39627513 0.5048856 ] => no_helmet
user_13 => [0.65805537 0.65805537 0.69958186 0.69958186 0.65805537 0.65805537 0.69958186 0.69958186 ] => helmet
user_14 => [0.99998665 0.45559448 0.99998665 0.45559448 ] => helmet
user_15 => [0.7349087 0.7349087 0.7349087 0.7349087 ] => helmet
user_16 => [0.5487834 0.4850496 0.5487834 0.4850496 ] => no_helmet
user_2 => [0.3373341 0.42776662 0.4936891 0.24883984 0.3373341 0.42776662 0.4936891 0.24883984 ] => no_helmet
user_3 => [0.46470627 0.73263603 0.46470627 0.73263603 ] => helmet
user_4 => [0.4383479 0.4383479 0.4383479 0.4383479 ] => no_helmet
user_5 => [0.54637295 0.4330255 0.54637295 0.4330255 ] => no_helmet
user_6 => [0.6341611 0.4271947 0.6341611 0.4271947 ] => helmet
user_7 => [0.38979304 0.38979304 ] => no_helmet
user_8 => [0.9891431 0.36411363 0.9891431 0.36411363 ] => helmet
user_9 => [0.4574392 0.4574392 0.5836356 0.5836356 0.4574392 0.4574392 0.5836356 0.5836356 ] => no_helmet

[1, 0, 0, 0, 0, 1, 1, 1, 0, 0, 1, 0, 0, 1, 0, 1, 0]
```

Fig 6: Image Detection


Fig 7: Numberplate Detection

## VI. CONCLUSION

In our project, deep learning techniques are used to solve the issues of motorcyclists not wearing helmets. Single Shot Multibox Detector is a popular algorithm in object detection. It does both the image segmentation and image classification at the same time. SSD technique can detect the images by using only one single runtime. It requires no other image pre-processing algorithms. Deep learning or CNN techniques are the good algorithms that we can apply on the problem of image detection and classification. Further, YOLO models can effectively detect the number plates of those motorcyclists who are not wearing helmets.

## VII. ACKNOWLEDGEMENT

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