HELMET DETECTION AND NUMBER PLATE RECOGNITION

A MINI PROJECT REPORT

18CSC305J - ARTIFICIAL INTELLIGENCE

Submitted by

ANDLEEB TANVEER	**[RA2011051010044]**
K PRAJWAL SAI REDDY	**[RA2011051010046]**
DIVYANSH MOHAN SRIVASTAVA	**[RA2011051010059]**

Under the guidance of

Dr. P.C. KARTHIK

(Associate Professor, Department of Data Science and Business Systems)

in partial fulfillment for the award of the degree

Of

BACHELOR OF TECHNOLOGY

in

COMPUTER SCIENCE AND ENGINEERING

of

FACULTY OF ENGINEERING AND TECHNOLOGY

S.R.M. Nagar, Kattankulathur, Chengalpattu District

MAY 2023

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Under Section 3 of UGC Act, 1956)

BONAFIDE CERTIFICATE

Certified that this project report titled **"HELMET DETECTION AND NUMBER PLATE RECOGNITION"** is the bonafide work of **" ANDLEEB TANVEER [RA2011051010044], K PRAJWAL SAI REDDY [RA2011051010046], DIVYANSH MOHAN SRIVASTAVA [RA2011051010059] "**, who carried out the project work under my supervision.

Certified further, that to the best of my knowledge the work reported herein does not form any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

SIGNATURE

Dr.P.C. KARTHIK
GUIDE
Associate Professor
Dept. of Data Science and Business Systems

SIGNATURE

Prof. M. LAKSHMI
HEAD OF THE DEPARTMENT
Dept. of Data Science and Business Systems

Signature of the Internal Examiner

Signature of the External Examiner

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my guide, **Dr. P.C. KARTHIK** , his valuable guidance, consistent encouragement, personal caring, timely help and providing me with an excellent atmosphere for doing the project. All through the work, in spite of his busy schedule, he has extended cheerful and cordial support to me for completing this project work.

ANDLEEB TANVEER
K PRAJWAL SAI REDDY
DIVYANSH MOHAN SRIVASTAVA

Table of Contents: Page no.

ABSTRACT

Now-a-days two wheelers is the most preferred mode of transport. It is highly desirable for bike riders and the pillions to use helmet. This paper uses image processing technique by which motorcyclists without helmet will be detected. In this project moving vehicles can be detected using the input as image or a video and then classified into motorcyclists and non-motorcyclists by background removal and based on size of the image being detected. If in case motorcyclist is detected without a helmet, the vehicle details with the person(s) on vehicle and the number plate is captured in the form of an image. An algorithm is designed to recognize number plates of motor cyclists using images or videos taken by camera. The recognition of number plate algorithm has different steps like Vehicle Classification, Pre-processing, choosing the ROI(Region of Interest), Recognition of number plates characters using image processing algorithms, storing in the database with the image as the proof with date and time recorded. A database will be designed with the proof stored with the offence to identify every offender accurately and arrest the suspect's vehicleand hence imposing violation fines, the system uses pure machine learning in order to identify different types of helmets that it comes across with minimum cost.

Motorcycle accidents have been rapidly growing through the years inmany countries. In India more than 37 million people use two wheelers.

Therefore, it is necessary to develop a system for automatic detection of helmetwearing for road safety. Therefore, a custom object detection model is created using a Machine learning based algorithm which can detect Motorcycle riders. On the detection of a Helmetless rider, the License Plate is extracted, and the License Plate number is recognized using an Optical Character Recognizer.

This Application can be implemented in real-time using a Webcam or a CCTVas input.

CHAPTER 1

INTRODUCTION

This project of automated helmet detection uses methods of machine learning to categorize vehicles as two wheelers or not and if it’s a two-wheeler then recognize the head part as the person wearing the helmet or not. If the rideror the pillion is not wearing the helmet, then the image of the person with the vehicle is captured. Using different mechanisms, the number plate of the vehicleis recognized as the string of characters and numbers and stored in a database the details of the vehicle number plate and the captured images as the proof. Using this data fines can be imposed on the riders who repeated commit themistake of not wearing the helmet.

This project performs handwritten digit recognition. To build the project, thetechnologies used are:
Neural Networks
Deep Learning
Convolutional Neural Network
Tensorflow
Keras
YOLO v3
Video Capture
Tesseract OCR

Neural Networks:

Neural networks (NN) aren't stand-alone algorithms. Rather, they provide a structure or framework for combining machine learning algorithms in order tosolve certain tasks.

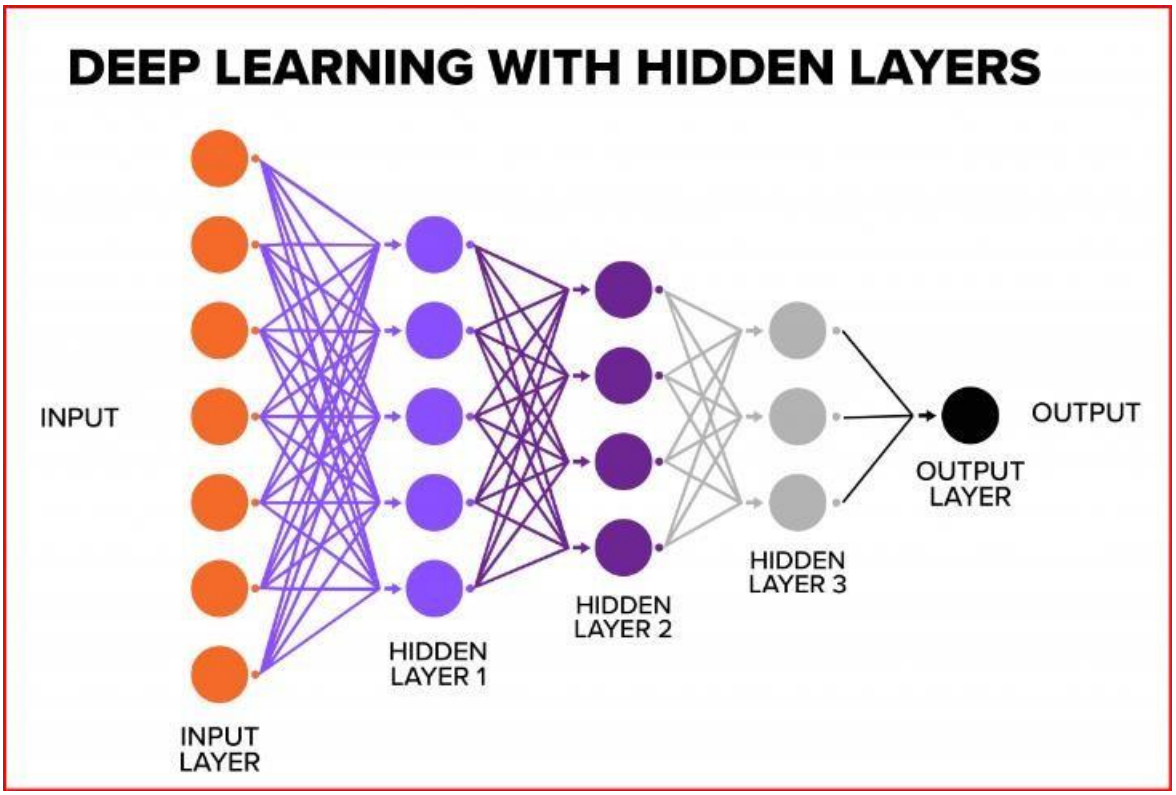
A neural network is essentially a collection of neurons connected via connections. A neuron is a function that has several inputs and only one output.Its job is to take all the numbers from the input, apply a function to them, and output the result.

Neurons communicate through connections, which act as channels. They link the outputs of one neuron to the inputs of another so that they can exchange digits. There is just one parameter for each connection: weight. It's similar to asignal's connection strength.

These weights tell the neuron to respond more to one input and less to another.Weights are adjusted when training.

Deep Learning:

Deep learning refers to a type of machine learning techniques that employ numerous layers to extract higher-level characteristics from raw data. Lower layers in image processing, for example, may recognize edges, whereas higher layers may identify human-relevant concepts like numerals, characters, or faces.



Convolutional Neural Network:

Convolutional Neural Network (CNN) used to search for objects on photos andin videos, face recognition, style transfer, generating and enhancing images, creating effects like slow-motion and improving image quality. CNNs are usedin all cases that involve pictures and videos.

The defining feature of the CNN is that it performs the convolution operation incertain layers — hence, the name Convolutional Neural Network. The architecture varies slightly from the traditional NN, starting with the makeup ofthe individual layers. Convolution can be represented as a layer of a neural network because each neuron can act as any function.

Tensorflow:

TensorFlow is a machine learning and artificial intelligence software library thatis free and open source. It may be used for a variety of applications, but it focuses on deep neural network training and inference.

The Google Brain team created TensorFlow for internal Google usage in research and production. In 2015, the first version was released under the Apache License 2.0. In September 2019, Google launched TensorFlow 2.0, animproved version of TensorFlow.

TensorFlow is compatible with a broad range of programming languages, including Python, Javascript, C++, and Java. This adaptability lends itself to awide range of applications in a variety of industries.

Keras:

Keras is an open-source high-level Neural Network library written in Python that can be used with Theano, TensorFlow, and CNTK. Francois Chollet, a Google developer, was the one who created it. It has been made user-friendly, expandable, and modular to allow for speedier deep neural network research. Itnot only supports individual Convolutional and Recurrent Networks, but also their combination.

It uses the Backend library to resolve low-level calculations because it can't handle them. The backend library wraps the low-level API in a high-level API,allowing it to operate on TensorFlow, CNTK, or Theano.

YoloV3:

YOLO is the latest state-of-the-art real-time object detection algorithm. It is a single convolutional neural network that simultaneously predicts multiple bounding boxes and classes of the entire image in the single scan. YOLO v3, a better feature extractor was introduced with the introduction of 53 convolutional layers trained on ImageNet.

Video Capture:

A video capture is a digitized version of an external video feed. Capturing videousually requires encoding or post-production software in addition to whatever hardware is being used to transmit the original feed into its digital file format (which can include a tape deck, digital storage or a video camera).

Tesseract OCR:

Tesseract is an open-source text recognition (OCR) Engine, available under theApache 2.0 license. It can be used directly, or (for programmers) using an API to extract printed text from images. It supports a wide variety of languages.

Tesseract doesn't have a built-in GUI, but there are several available fromthe 3rdParty page.

Tesseract is compatible with many programming languages and frameworks through wrappers that can be found here. It can be used with the existing layout analysis to recognize text within a large document, or it can beused in conjunction with an external text detector to recognize text from an image of a single text line.

CHAPTER - 2

LITERATURE REVIEW

- **Romuere R.V.e Silva, Kelson R.T. Aires, Rodrigo de M. S. Veras** "Detection of Helmet on MotorCyclists" In this paper, the processof classification and descriptors are used to detect the vehicles and then detect the persons with 2 wheelers and detect if they are wearing the helmet or not. The processes used in this projects are:

Vehicle segmentation and classification:

Detection of the background-

A reference of the road as background is considered so that the motion ofthe vehicle can be detected with respect to the stable object (road).

Segmentation of moving objects-

Using background subtraction, the moving objects(vehicles) are differentiated with the background which gives only an image of the vehiclesand the background will be eliminated.

Vehicle classification-

The vehicles are classified as motorcycles or non-motorcycles and a feature vector is obtained for each generated image and passed on to randomforest classifier to categorize vehicle as motorcycle or a non-motorcycle.

Detection of helmet: Determining RoI-

This step is performed so that only the region of interest is chosen whichreduces the processing time and increases processing time.

Extracting the features-

A sub-window is formed in the above generated RoI and the main part ofthe image(head in this case) is extracted and passed as input for the classifier tocheck if the biker has put on his helmet or not.

This project/paper does mainly deal with helmet detection. For it to be used in surveillance system, it should be able to detect the number plate of thevehicle to impose fines on the rider which lacks in this project.

- **Lokesh Allamki, Manjunath Panchakshari, Ashish Sateesha, K S Pratheek**

"Helmet detection using machine learning and Automatic NumberPlate recognition"

This paper does the process of extracting the objects from the image usingYOLO object detection and has 3 3segments in the entire process

1. **Helmet detection –**

Annotated images are given to YOLOv3 model for training and the actualinput for detection is given after training the model.

2. **License plate Extraction –**

once the person without helmet is detected then the class with respect toperson and corresponding vehicle and its number plate is detected and the number plate is cropped and saved.

3. **License plate recognition –**

The extracted number plate detected previously is passed on to OCR(OpticalCharacter Recognition), the module outputs the string of numbers and alphabets with the accuracy percentage of the string recognized.

This paper does not deal with the ability to detect the difference betweenmotorcycle and a nonmotorcycle and this project cannot be implemented forinput as videos since the input given through OCR is images only.

 Felix Wilhelm Sieberta, Hanhe Linb "Detecting motorcycle helmet use with deep learning" There are 3 divisions in this project in which the datais collected in the form of videos, preprocessed and used in detecting the riders of motorcycle with and without helmets.

1. **Dataset creation and annotation –**

Random data in the form of videos is collected from Myanmar and is preprocessed to each video of 100 frames each and object detection is donethrough YOLO9000 algorithm with pre trained weights and the recognizedvehicle with person is bounded using boxes.

2. **Helmet use detection algorithm –**

For object detection, the single stage approach of RetinaNet is used to detect the helmets. ResNet50 as backbone initialized with pre-trained weights from ImageNet. The models were implemented using python keras library withtensor flow as backend

3. **Results –**

The helmet use detection results of the algorithm on the test set, using theoptimal model developed on the validation set (where it obtained 72.8% weighted mAP)

The limitation for this project is that in many instances there will be 2 persons travelling in the motor-cycle and this model does not recognize is the

pillion is wearing the helmet or not. This can detect only one person with ahelmet or not and the accuracy is low for a CNN network.

 M. Swapna, Tahniyath Wajeeh, Shaziya Jabeen "A HybridApproach for Helmet Detection for Riders Safety"

In this model various previous methods related to automatic helmet detection has been taken into consideration and the new model has been given. This is a technique of automatic helmet detection , where the input is of either the video which has been recorded or it might be a video through a web camera.This method includes 4 different steps in it.

1. **Image procurement –**

This is the very first step of any vision system , where cameras are used tocapture images of riders on road.

2. **Preliminary processing technique –**

This step is mainly focused on elimination of background noise,enhancement of contrast and image binarization.

3. **Vehicle classification –**

This step is mainly focused on vehicle classification based on two main parameters i.e aspect ratio and size of the particular vehicle and then the vehicleare classified.

4. **Helmet detection –**

This step includes extraction of head part from the classified image and providing it to ROI where the matching of ROI and trained features happen todetermine whether helmet is there or no.

This model gives a idea of the number of people who violate the traffic rules. It is also cost effective as we use open source technology like OpenCV ,etc. for development purpose. Further this model can be used to detect people talking on phone while driving and to identify people driving at a high speed.

 C. Vishnu, Dinesh Singh, C. Krishna Mohan and Sobhan Babu"Detection of Motorcyclists without Helmet in Videos using Convolutional Neural Network"

This model tells us that since the motorcycles are affordable, people use itfor daily transportation. Due to this increased use the occurance of accidents arehigh . Major of the accidents include head injury, which is due to helmet violation by the motorcycle users. As many cities have surveillance system for safety purpose , we can use it for detecting non helmet riders which would be a

cost effective approach. This approach uses a machine learning technique , CNN(Convolution Neural Network) for getting good images inspite of variousproblems like illumination, climate changes , etc. There are four different stepsincluded in the process of this model:

1. **Background modeling and object detection:**

This step is basically used for applying adaptive background subtraction toget the images properly and of same quality no matter what ever the conditionsmight be whether its day time, night or rainy, etc. To separate various factors not needed we use Gaussian mixture model.

2. **Object detection using Convolution neural network**:

This technique is basically a type of feed forward neural network using back propagation network. The idea of using this technique was due to the ability to extract interdependent data from the images. This technique involvesvarious levels for detecting the object , where in each level we get the data andin final level the entire image is finally formed.

3. **Recognizing motorcycle from moving objects:**

We use bounding boxes technique for the identification of the motorcycle from other objects. These boxes are evaluated by providing them as an input tothe CNN model , which in reference to the various data in test model gets to know motorcycle and other .

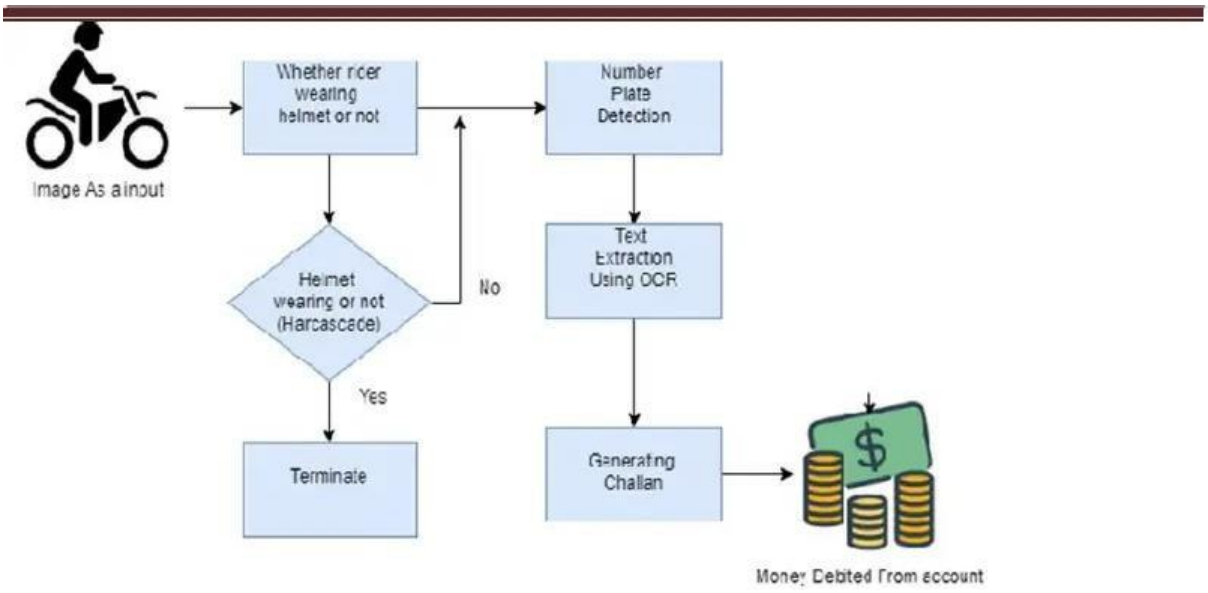
4. **Recognizing motorcyclists with helmet:**

To identify motorcyclists we apply cropping for the top one fourth of the image, cause that’s the position where the head of the motorcyclists would always be. Then we find the doing subtraction of the binary image of the same.Then CNN is applied to get the output. This model gives a well defined way of dealing with helmet detection and various way of getting rid from the problem. Thus this is a new approach usingmachine learning apart from the previous approach which used image processing and other old technologies.

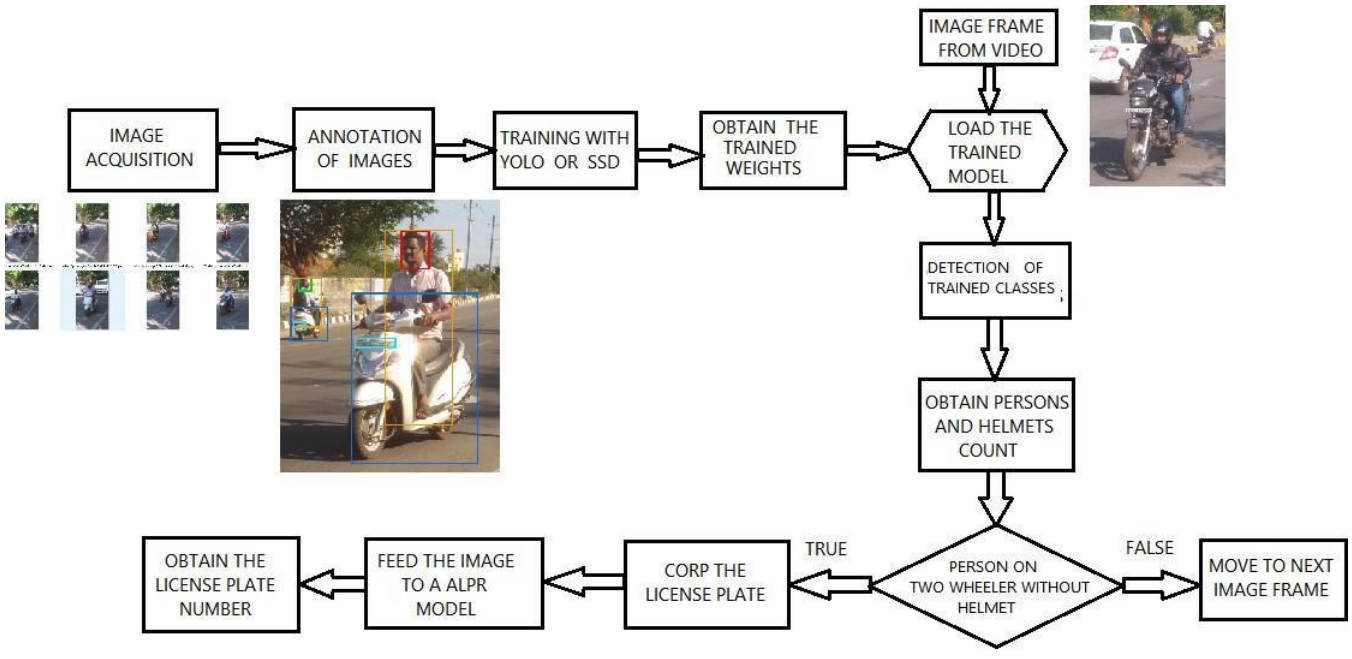
CHAPTER - 3

PROPOSED METHODOLOGY

System Architecture:



3. PROPOSED METHODOLOGY



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 ridingmotorbike. 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.

3.2 License Plate Extraction

Once the helmetless rider is detected, the associated person class is detected. This is done by finding whether the co-ordinates of the no helmet classlie inside the person class or not. Similarly, the same steps are followed to detect the associated motorbike and license plate. Once the coordinates of the License plate are found, it is cropped and saved as a new image.

3.3 License Plate Recognition

The extracted license plate is given to an Optical Character Recognition(OCR) model. The OCR recognizes text in the given image and outputs the recognized strings in the machine-encoded text. The OCR module within will output a list of predicted license plate numbers along with a confidence value.The confidence value indicates how confident it is in recognizing the given license plate accurately. Then, the license plate recognized with highest confidence value is stored in a text file for further use

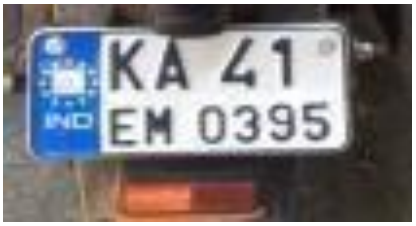


Plate #1

	Plate	Confidence
-	KA41EM0395	89.353058
-	KA41M0395	80.161301
-	KA416M0395	79.876579
-	KA41KM0395	79.874893
-	KA41BM0395	79.874687

CHAPTER - 4

TOOLS AND SOFTWARES USED

4.1 DATASET DESCRIPTION

First take sample bike images from google and create a folder and import those images in to that file. Using Command ‘labelimg’ we shouldpoint to the face of the person and label whether he is wearing helmet ornot. This is done using the yolo. Like this we should label all the images and we should build the model using this dataset.

4.2 TOOLS DESCRIPTION (1-2 PAGES)

The tools and libraries used in the project are:

- NumPy Library
- Pillow Library
- Matplotlib Library
- Pandas Library
- Jupyter Notebook

NumPy:

NumPy, which stands for Numerical Python, is a library consisting of multidimensional array objects and a collection of routines for processing thosearrays. Using NumPy, mathematical and logical operations on arrays can be performed.

NumPy is a Python package. It stands for ‘Numerical Python’. It is a libraryconsisting of multidimensional array objects and a collection of routines forprocessing of array.

Pillow library:

The Python Imaging Library adds image processing capabilities to your Pythoninterpreter.

This library provides extensive file format support, an efficient internal representation, and fairly powerful image processing capabilities.

The core image library is designed for fast access to data stored in a few basicpixel formats. It should provide a solid foundation for a general image processing tool.

Matplotlib:

Matplotlib is a plotting library for the Python programming language and its numerical mathematics extension NumPy. It provides an object-oriented APIfor embedding plots into applications using general-purpose GUI toolkits likeTkinter, wxPython, Qt, or GTK. There is also a procedural "pylab" interface based on a state machine (like OpenGL), designed to closely resemble that ofMATLAB, though its use is discouraged. SciPy makes use of Matplotlib.

Pandas:

Pandas is a Python package providing fast, flexible, and expressive data structures designed to make working with “relational” or “labeled” data both easy and intuitive. It aims to be the fundamental high-level building block fordoing practical, real-world data analysis in Python. Additionally, it has the broader goal of becoming the most powerful and flexible open-source data analysis/manipulation tool available in any language.

Jupyter Notebook:

The Jupyter Notebook App is a server-client application that allows editing andrunning notebook documents via a web browser. The Jupyter Notebook App can be executed on a local desktop requiring no internet access (as described inthis document) or can be installed on a remote server and accessed through the internet.
In addition to displaying/editing/running notebook documents, the Jupyter Notebook App has a “Dashboard” (Notebook Dashboard), a “control panel” showing local files and allowing to open notebook documents or shuttingdown their kernels

CHAPTER - 5

RESULTS AND DISCUSSION

5.1 CODE IMPLEMENTATION: -

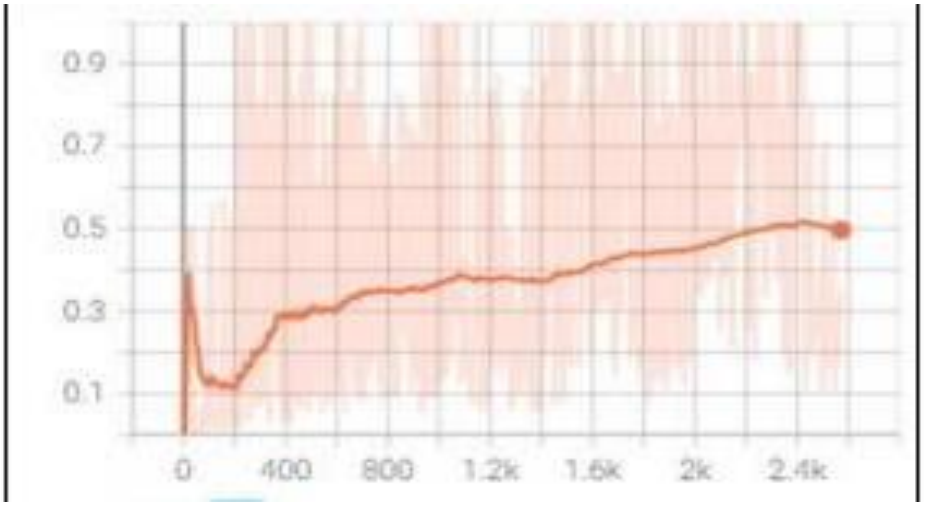
```
import cv2
import numpy as npimport
random import os
from PIL import Imageimport
time
import imutils
from tensorflow.keras.models import load_model

os.environ['TF_FORCE_GPU_ALLOW_GROWTH'] = 'true'

net = cv2.dnn.readNet("yolov3-custom_7000.weights", "yolov3-custom.cfg")
net.setPreferableBackend(cv2.dnn.DNN_BACKEND_CUDA)
net.setPreferableTarget(cv2.dnn.DNN_TARGET_CUDA)


model = load_model('helmet-nonhelmet_cnn.h5')print('model
loaded!!!')

cap = cv2.VideoCapture('testing videos/test2.mp4')COLORS =
[(0,255,0),(0,0,255)]

fourcc = cv2.VideoWriter_fourcc(*"XVID")
writer = cv2.VideoWriter('output.avi', fourcc, 5,(888,500))
writer = VideoWriter('output.avi',(frame.shape[1], frame.shape[0]))writer.open()
```

```
def helmet_or_nohelmet(helmet_roi):try:
        helmet_roi = cv2.resize(helmet_roi, (224, 224)) helmet_roi =
        np.array(helmet_roi,dtype='float32')helmet_roi =
        helmet_roi.reshape(1, 224, 224, 3) helmet_roi = helmet_roi/255.0
        return int(model.predict(helmet_roi)[0][0])except:
            pass

layer_names = net.getLayerNames() output_layers =
[layer_names[i[0] - 1] for i in
net.getUnconnectedOutLayers()]

ret = True
while ret:
    ret, img = cap.read()
    img = imutils.resize(img,height=500)# img =
    cv2.imread('test.png')
    height, width = img.shape[:2]

    blob = cv2.dnn.blobFromImage(img, 0.00392, (416, 416), (0, 0, 0),True, crop=False)

    net.setInput(blob)
    outs = net.forward(output_layers)

    confidences = []
    boxes = []
```

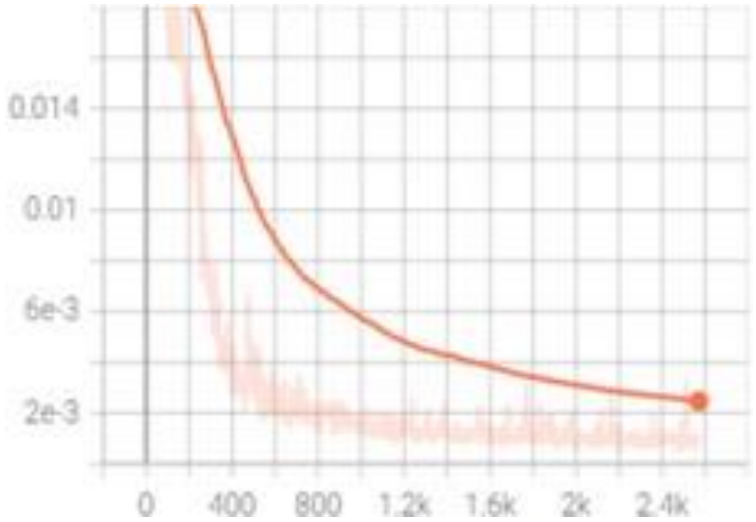
```
classIds = []

for out in outs:
    for detection in out: scores =
        detection[5:]
        class_id = np.argmax(scores)
        confidence = scores[class_id] if
        confidence > 0.3:
            center_x = int(detection[0] * width)center_y =
            int(detection[1] * height)

            w = int(detection[2] * width) h =
            int(detection[3] * height) x =
            int(center_x - w / 2)
            y = int(center_y - h / 2)

            boxes.append([x, y, w, h]) confidences.append(float(confidence))
            classIds.append(class_id)
indexes = cv2.dnn.NMSBoxes(boxes, confidences, 0.5, 0.4)for i in
range(len(boxes)):
    if i in indexes:
        x,y,w,h = boxes[i]
        color = [int(c) for c in COLORS[classIds[i]]]# green -->
        bike
        # red --> number plate if
        classIds[i]==0: #bike
            helmet_roi = img[max(0,y):max(0,y)+max(0,h)//4,max(0,x):max(0,x)+max(0,w)]
        else: #number platex_h =
            x-60
```

```
                y_h = y-350 w_h
                = w+100h_h =
                h+100
                cv2.rectangle(img, (x, y), (x + w, y + h), color, 7)
                # h_r = img[max(0,(y-330)):max(0,(y-330 + h+100)) ,
max(0,(x-80)):max(0,(x-80 + w+130))]
                if y_h>0 and x_h>0:
                    h_r = img[y_h:y_h+h_h , x_h:x_h +w_h]c =
                    helmet_or_nohelmet(h_r)
                    cv2.putText(img,['helmet','no-helmet'][c],(x,y-
100),cv2.FONT_HERSHEY_SIMPLEX,2,(0,255,0),2)
                    cv2.rectangle(img, (x_h, y_h), (x_h + w_h, y_h +h_h),(255,0,0),
10)


    writer.write(img)
    cv2.imshow("Image", img)

    if cv2.waitKey(1) == 27:break

writer.release() cap.release()
cv2.waitKey(0)
cv2.destroyAllWindows()
```

5.2 PERFORMANCE EVALUATION METRICS: -



Precision Graph

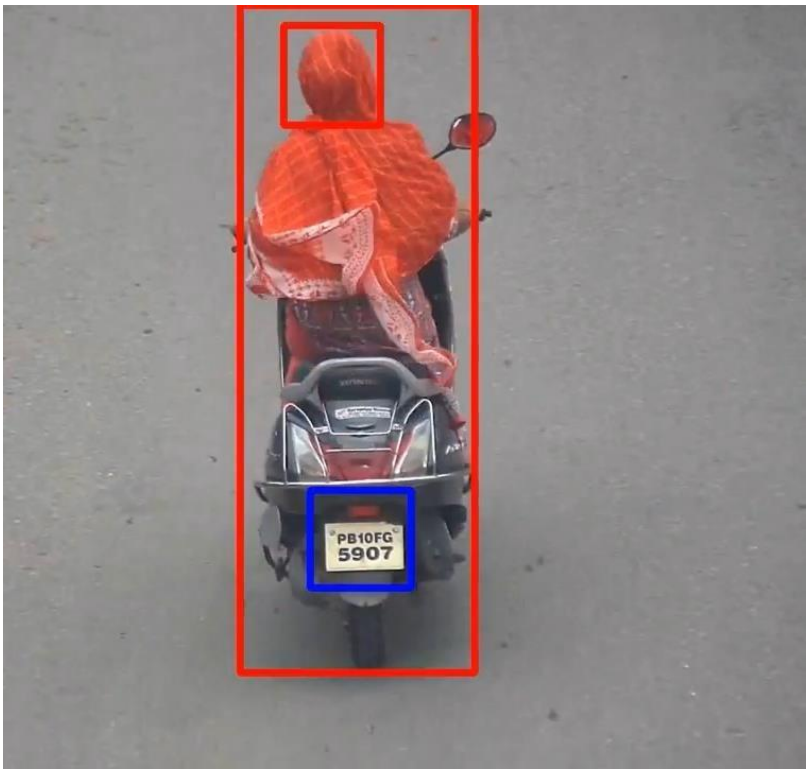


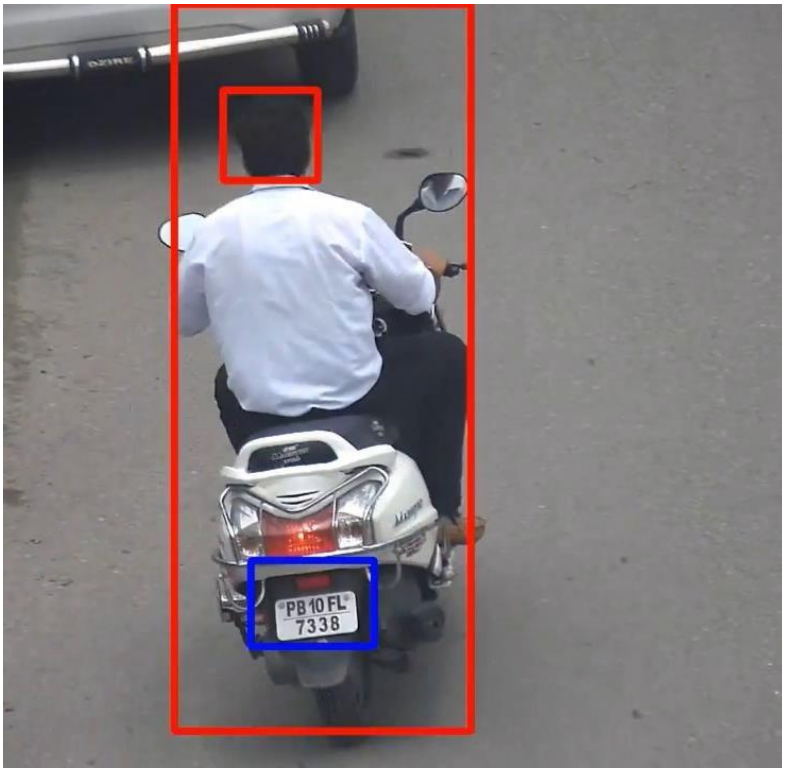
Loss Graph

5.3 RESULTS:-


HP 88
0704


PB10FH
5745


PB10FG
5907


PB10FL
7338

5.4 DISCUSSION: -

As we could see from the above metrics, the precision of both the YOLO models has been found to be low. However, the confidence score was found to be better for real-time detections. The metrics are always dependent on various factors such as the quality of the data, optimization of the model parameters, increasing the number of iterations of learning until it overfits the model. This research is limited by Hardware (GPU). Even though the model uses free GPU from Google Colab, it is limited by usage as Colab doesn't allow longertraining times using their GPU. By having access to better GPU and longer usage limits, the training could have been improved for (6000 Epochs for YoloV4 and 10,000 Epochs for YoloV5s) which improves can improve the precision of the model. The error in extracting thealphanumeric character in the final step can be avoided by mandating standardized license plate character fonts across the region.

Fahad *et al.* (2020) has performed the study with YoloV3-tiny and was able to achieve an mAP of 81%. Meghal *et al.* (2020) have 91% accuracy with lightweight MobileNet CNN. However, in both these experiments, better hardware is used and longer training times are achieved. For comparing the results with previous studies, this research has to be further continued with dedicated, high-performance GPU for a longer training period. It is notpossibleto conclude that the one Yolo model performed better than the other in general termsas they are different in architecture, framework and object detecting

techniques as discussed previously. But for this particular application, even though the Yolov4-darknet algorithm has higher precision than YoloV5s, due tohigher detection time (which is crucial for traffic surveillance) easier prototyping and deployment, YoloV5s is a better model for implementingthis system as precision can always be improved through other techniques

CHAPTER - 6
CONCLUSION

Hence, **HELMET RECOGNITION AND NUMBER PLATE DETECTION** project is implemented. From the results shown above it is evident that the YOLO object detection is well suited for real-time processing and was able to accurately classify and localize all the object classes. The proposed end-to-end model was developed successfully and has all the capabilities to be automated and deployed for monitoring. For extracting the number plates some techniquesare employed by considering different cases such as multiple riders without helmets and designed to handle most of the cases. All the libraries and softwareused in our project are open source and hence is very flexible and cost efficient.The project was mainly built to solve the problem of non-efficient traffic management. Hence at the end of it we can say that if deployed by any traffic management departments, it would make their job easier and more efficieny.

REFERENCES: -

[1] Detection of helmets on motorcyclists. By Remuera R.V.e Silva, Kelson R.T. Aires, Rodrigo de M. S. Veras

[2] Helmet Detection using Machine Learning and Automatic License Plate Recognition. By Lokesh Allamki, Manjunath Panchakshari, Ashish Sateesha, KS Pratheek(BNMIT, Bangalore)

[3] Detecting motorcycle helmet use with deep learning. By Felix Wilhelm Sieberta, Hanhe Lin (Department of Psychology and Ergonomics, TechnischeUniversit¨at Berlin, Marchstraße 12, 10587 Berlin Germany).

[4] A Hybrid Approach for Helmet Detection for Riders Safety using Image Processing, Machine Learning, Artificial Intelligence. By M.Swapna, TahniyathWajeeh, Shaziya Jabeen.

[5] C. Vishnu, Dinesh Singh, C. Krishna Mohan and Sobhan Babu Visual Intelligence and Learning Group (VIGIL), Department of Computer Science and Engineering Indian Institute of Technology Hyderabad, Kandi, Sangareddy-502285, India

[6] Viola and Jones, "Robust Real-time Object Detection", IJCV 2001.

[7] A. Adam, E. Rivlin, I. Shimshoni, and D. Reinitz, "Robust real-time unusualevent detection using multiple fixedlocation monitors," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 30, no. 3, pp. 555–560, March 2008.

[8] AlexeyAB, https://github.com/AlexeyAB/darknet#requirements

[9] C.-Y. Wen, S.-H. Chiu, J.-J. Liaw, and C.-P. Lu, "The safety helmet detection for atm's surveillance system via the modified Hough transform," in IEEE 37th Annual International Carnahan Conference on Security Technology.,2003, pp. 364–369.

[10] C.-C. Chiu, M.-Y. Ku, and H.-T. Chen, "Motorcycle detection and trackingsystem with occlusion segmentation," in WIAMIS '07, USA, 2007