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HELMET DETECTION USING OPENCV

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ABSTRACT

This project is about detecting two-wheeler riders without helmets with the help of machine learningand provide them a notice to pay their challans. The proposed approach first captures the real time image of road traffic and then differentiates the two-wheelers from other vehicles in the road. It thenprocesses to check whether the rider and pillion rider are wearing helmets or not using OpenCV. If any one of the riders and the pillion rider is found not wearing the helmet, their vehicle number plateis processed using optical character recognition (OCR). After extracting the vehicle registration number, a challan will be generated against the respective vehicle and all the details of the challan will be sent via e-mail and SMS to the concerned person.

INTRODUCTION

PROJECT INTRODUCTION

In almost all countries, a motorcycle is a popular means of transport. However, due to less protection high risk is involved in two-wheelers. It is highly desirable for two-wheeler riders to use helmets to reduce the risk. Most of the deaths in the last few years in accidents are due to head injury. It is a punishable offense to ride a bike without a helmet and many manual strategies have been adopted to catch the violators due because of its importance. Still, a largenumber of two-wheeler riders do not follow the rule. Automation of this process is the needof the hour is real-time and accurate monitoring of these violations as well as it also significantly reduces the amount of human intervention. In numerous countries systemswhich involve surveillance cameras have been installed at public places, Therefore, using the existinginfrastructure the solution for detecting traffic rule violators is the project's objective..

OBJECTIVE

The main objective is to minimize or eliminate fatalities. The predefined data models will process and generate the output, which provides the real-time status of the helmet. It helps us identify the section of people who don't follow traffic rules with reference to the helmet. The model separatestwo-wheelers from four-wheelers using OpenCV and focuses the image on the head region of

the person to detect whether he/she is wearing a helmet or not. If a helmet is not detected, thenumber plate is recognized using OCR(Optical Character Recognition).

DATA SET

The dataset is the interface for the model and user. It serves as the primary form of data storage,but also as a common container for results returned by most algorithms. datasets mayinclude dataset objects to return the required index based on rows and columns. The dataset object comes into the picture when the data gets loaded initially and also comprises the metadata consisting of other important information. Datasets are used for training and testing the model.Any model's first and foremost step is to implement libraries and upload the datasets. The uploaded dataset will be a source for the model to understand the data, evaluate input and produce output. The dataset we use here is a video clip of moving traffic for testing the model.The training dataset consists of image samples of bike riders with and without helmets from different angles.

EXISTING SYSTEM

In recent years, several studies were performed to analyze traffic on public roads, including detection, classification, and counting of vehicles and helmet detection. Eight three- dimensional models were created to classify the objects. These models were calculatedbasedon the size of the vehicle. A disadvantage of this study is that a single model is employed for motorcycles and bicycles. In addition, only geometric information is utilizedto classify the vehicles, which has been proven to be insufficient for describing these typesof objects. Another disadvantage of this method is that some parameters, such as the camera height and angle and the lens focal distance, should always have the same values. If these parameters arechanged, new models should be created, as no vehicle would correspond to the models.

PROPOSED SYSTEM

This study proposed a computational vision methodology for the detection of helmet use by motorcyclists on public roads. The study is divided into two stages: vehicle segmentation andclassification, and the detection of helmet use. The stage of vehicle segmentation and classification has the following objectives: determining which objects are moving in the sceneand classifying these objects. Similar to the majority of computational vision systems, the proposed system requires a calibration stage. Using OpenCV and OCR, we are detecting the rider’s safety helmet.

SYSTEM ANALYSIS

FUNCTIONAL REQUIREMENTS

MOVING OBJECT DETECTION

The first task in helmet identification is to detect a moving vehicle. It is the first step before performing more sophisticated functions such as tracking or categorization of vehicles. Rather than immediately processing the entire video, the example starts by obtaining an initial videoframe in which the moving objects are segmented from the background. Processing only the initial few frames helps to take the steps required to process the video.

VEHICLE CLASSIFICATION

The next step is to classify the moving vehicle extracted in the last part. A vehicle can be classifiedinto two categories two-wheelers or four-wheelers. We are only interested in two- wheelers. The images were converted to grayscale. Raw pixel values were fed to the classifier. The training images contain a vehicle surrounded by other objects of interest such as trees, footpaths, buildings, and other noise objects. The images mimic how a vehicle is normally seenon roads. Using synthetic images isconvenient, and it enables the creation of a variety of trainingsamples through the use of image augmentation.

HELMET DETECTION

Using the same approach as applied to identify the type of vehicle, we detect whether the rider is wearing a helmet. The images that have been used to train a helmet detector are the cropped version of the two-wheeler images focusing on the head region of the rider.

LICENSE PLATE EXTRACTION

After the previous steps, in case the rider of a two-wheeler is not wearing a helmet, our next step is to extract the license plate of the vehicle. We extract the region of interest from our cropped image by giving the appropriate coordinates of the license plate

SYSTEM DESIGN

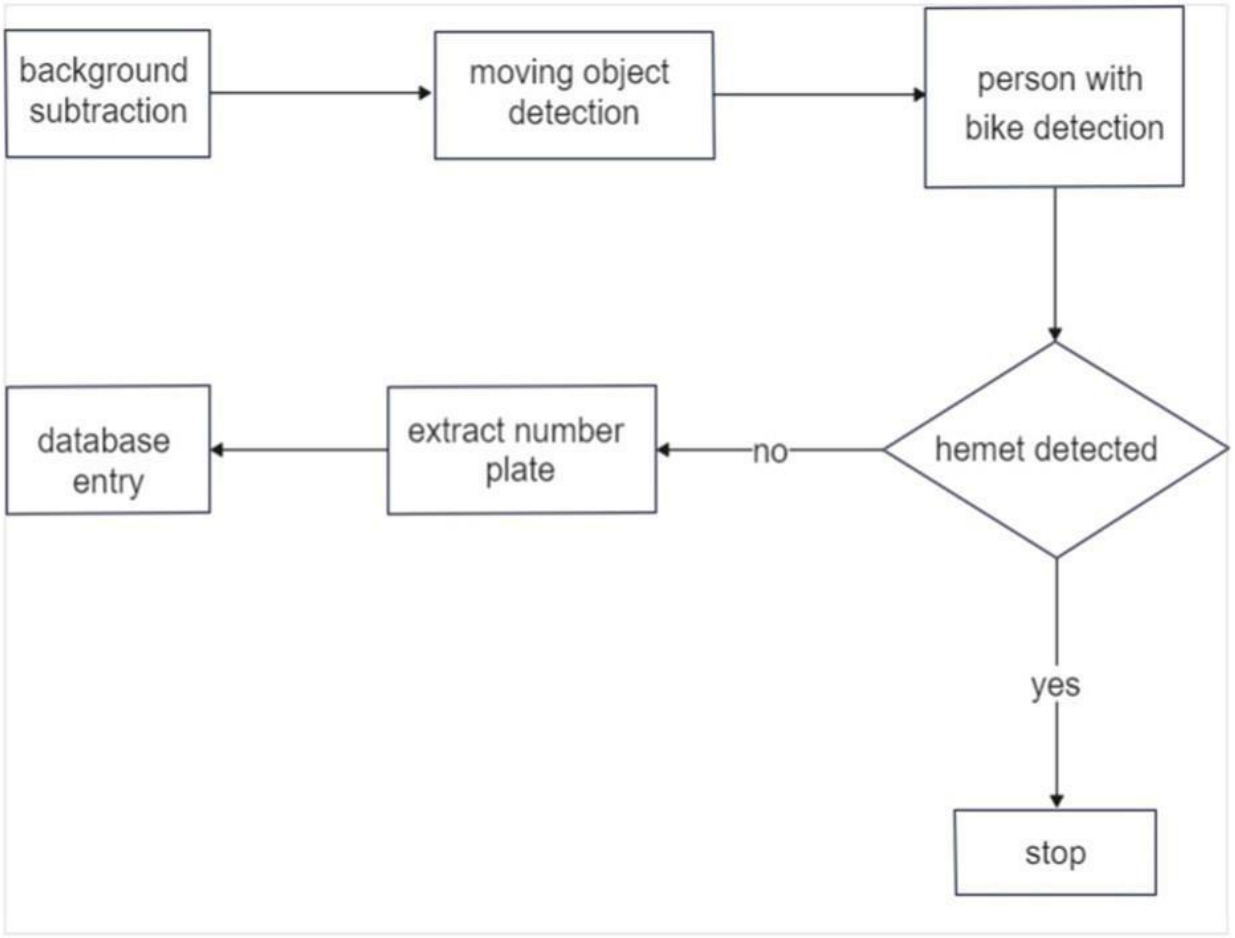
SYSTEM ARCHITECTURE

A system architecture is the conceptual model that defines the structure, behavior, and more views of a system. An architecture description is a formal description and representation of a system, organized in a way that supports reasoning about the structures and behaviors of the system. A system architecture can consist of system components and the sub-systems developed that will work together to implement the overall system. There have been efforts toformalize languages to describe system architecture, collectively these are called architecture description languages.

System Architecture of Helmet Detection

DATA FLOW DIAGRAM

A data-flow diagram is a way of representing a flow of data through a process or a system . The DFD also provides information about the outputs and inputs of each entity and the processitself. A data-flow diagram has no control flow , there are no decision rules and no loops. Specific operations based on the data can be represented by a flowchart. There are several notations for displaying data-flow diagrams. For each data flow, at least one of the endpoints must exist in a process. The refined representation of a process can be done in another data- flow diagram, which subdivides this process into sub-processes. The data-flow diagram is a tool that is part of structured analysis and data modeling. When using UML, the activity diagram typically takes over the role of the data-flow diagram. A special form of data-flow plan is a site-oriented data- flow plan.



Data Flow Diagram Of Helmet Detection

MODULES

CV2

OpenCV (Open Source Computer Vision Library) is an open-source computer vision and machine learning software library. The library has more than 2500 optimized algorithms, whichincludes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms. These algorithms can be used to detect and recognize faces, identify objects, classify human actions in videos, track camera movements, track moving objects, extract 3D models of objects, produce 3D point clouds from stereo cameras, and stitch images together to produce a high-resolution image of an entire scene, find similar images from an image database, remove red eyes from images taken using flash, follow eye movements,recognize scenery and establish markers to overlay it with augmented reality, etc.

NUMPY

NumPy is a Python library used for working with arrays. It also has functions for working in the domain of linear algebra, Fourier transform, and matrices. It is an open-source project andyou can use it freely. NumPy stands for Numerical Python. In Python, we have lists that servethe purpose of arrays, but they are slow to process. NumPy aims to provide an array object thatis up to 50x faster than traditional Python lists. The array object in NumPy is called ndarray, itprovides a lot of supporting functions that make working with ndarray very easy. Arrays are very frequently used in data science, where speed and resources are very important.

TENSORFLOW

TensorFlow is an end-to-end open source platform for machine learning. TensorFlow is a richsystem for managing all aspects of a machine learning system; however, this class focuses on using a particular TensorFlow API to develop and train machine learning models.

TensorFlow APIs are arranged hierarchically, with the high-level APIs built on the low-level APIs. Machine learning researchers use low-level APIs to create and explore new machine learning algorithms. In this class, you will use a high-level API named tf.keras to define and train machine learning models and to make predictions. tf. keras is the TensorFlow variant of the open-source keras API.

IMUTILS

Imutils is a package based on OpenCV, which can call the opencv interface more simply. It can easily perform a series of operations such as image translation, rotation, scaling, skeletonization, and so on.
Its usage:

1. image translation: Compared with the original CV, using imutils can directly specify the translated pixels without constructing the translation matrix
2. image scaling: The zoom of the picture should be ensured to maintain the aspect ratio in OpenCV. In imutils, the aspect ratio of the original image is automatically maintained, and onlythe width, weight, and height can be specified.

3 image rotationAffine transformation is used when rotating in OpenCV. Here, the image rotation method isimutils.rotate(), followed by two parameters, the first is the picture data, thesecond is the rotation angle, and the rotation is counterclockwise. meanwhileimutilsAnother similar method is also provided,rotate_round(), it rotates clockwise..

PYTHON - MODULES

A module allows you to logically organize your Python code. Grouping related code into a module makes the code easier to understand and use. A module is a Python object with arbitrarily named attributes that you can bind and reference. Simply, a module is a file consisting of Python code. A module can define functions, classes, and variables. A module can also include runnable code.

NUMPY

NumPy is a Python library. NumPy is used for working with arrays. NumPy is short for "Numerical Python". The main data structure in NumPy is the NumPy array. All the data is stored in arrays. NumPy provides a vast repertoire of mathematical and statistical operations which can be performed on these arrays. NumPy arrays have a fixed size at creation, unlike Python lists (which can grow dynamically). Changing the size of an ndarray will create a newarray and delete the original. The elements in a NumPy array are all required to be of the same data type, and thus will be the same size in memory.

The exception: one can have arrays of (Python, including NumPy) objects, thereby allowing for arrays of different-sized elements. NumPy arrays facilitate advanced mathematical and other types of operations on large numbers of data. Typically, such operations are executed more efficiently and with less code than is possible using Python's built in sequences. A growing plethora of scientific and mathematical Python-based

packages are using NumPy arrays; though these typically support Python-sequence input, they convert such input to NumPy arrays prior to processing, and they often output NumPy arrays. In other words, in order to efficiently use much (perhaps even most) of today's scientific/mathematical Python- based software, just knowing how to use Python's built-in sequence types is insufficient - onealso needs to know how to use NumPy arrays. NumPy fully supports an object-oriented approach, starting, once again, with ndarray.

PANDAS

Pandas (all lowercase) is a popular Python-based data analysis toolkit that can be imported using import pandas as pd. It presents a diverse range of utilities, ranging from parsing multiplefile formats to converting an entire data table into a NumPy matrix array. This makes pandas a trusted ally in data science and machine learning. Similar to NumPy, pandas deal primarily with data in 1-D and 2-D arrays; however, pandas handles the two differently. In pandas, 1-D arrays are referred to a series. A series is created through the pd. Series constructor, which hasa lot of optional arguments. The most common argument is data, which specifies the elementsof the series. A DataFrame is simply a 2-D array.

It can be created through the pd.DataFrame constructor, which takes in essentially the same arguments as pd.Series. However, while a series could be constructed from a scalar (representing a single value Series), a DataFrame cannot. The index (row) and column labels of a DataFrame can be defined in the constructor. Rows can be added to a DataFrame using the append function, which takes in either a series or another DataFrame. In the case of a series,we either need to specify the index for the series or use the ignore_index keyword. Setting ignore_index=True will change the row labels to integer indexes. The append methoddoes notalter the original DataFrame. Instead, a new DataFrame with the appended row is created.

SKLEARN

Scikit-learn is probably the most useful library for machine learning in Python. The sklearn library contains a lot of efficient tools for machine learning and statistical modeling including classification, regression, clustering and dimensionality reduction. Please note that sklearn is used to build machine learning models. It should not be used for reading the data, manipulatingand summarizing it. There are better libraries for that (e.g. NumPy, Pandas etc.)Scikit-learn comes loaded with a lot of features. Here are a few of them to help you understand the spread.Supervised learning algorithms: Think of any supervised machine learning algorithm you might have heard about and there is a very high chance that it is partof scikit-learn. Starting from Generalized linear models (e.g Linear Regression), Support Vector Machines (SVM), Decision Trees to Bayesian methods – all of them are part of scikitlearn toolbox.

The spread of machine learning algorithms is one of the big reasons for the high usage of scikit-learn Cross-validation: There are various methods to check the accuracy of supervised modelson unseen data using sklearn. Unsupervised learning algorithms: Again there is alarge spread of machine learning algorithms in the offering . Various toy datasets: This came in handy while learning scikit-learn. I had learned SAS using various academic datasets (e.g. IRIS dataset, Boston House prices dataset). Having them handy while learning a new library helpeda lot. Feature extraction: Scikit-learn for extracting features from images and text (e.g.Bag of words). Scikit-learn comes with a few standard datasets, for instance the iris and digitsdatasetsclassification and the diabetes dataset for regression.

ALGORITHMS USED

YOLOV3

You Only Look Once or more popularly known as YOLO is one of the fastest real-time objectdetection algorithms (45 frames per second) as compared to the R-CNN family (R-CNN, Fast R-CNN, Faster R-CNN, etc.)The R-CNN family of algorithms user regions to localize the objects in images which means the model is applied to multiple regions and high-scoring regions of the image are considered as objects detected. But YOLO follows a completely different approach. Instead of selecting some regions, it applies a neural network to the entire image to predict bounding boxes and their probabilities. It allows the model to look at the wholeimage at test time, so its predictions are informed by the global context in the image. YOLO and other convolutional neural network algorithms "score" regions based on their similarities to predefined classes. High-scoring regions are noted as positive detections of whatever class they most closely identify with. For example, in a live feed of traffic, YOLO can be used to detect different kinds of vehicles depending on which regions of the video score highly in comparison to predefined classes of vehicles.

STEPS PERFORMED:

1. **Bounding Box Prediction** During training, sum of squared error loss is used.
   And objectness score is predicted using logistic regression. It is 1 if the bounding box prior overlaps a ground truth object by more than any other bounding box prior. Only one boundingbox prior is assigned for each ground truth object.
2. **Class Prediction** : Softmax is not used.
   Instead, independent logistic classifiers are used and binary cross-entropy loss is used. Becausethere may be overlapping labels for multilabel classification such as if the YOLOv3 is moved to other more complex domains such as Open Images Dataset.
3. **Prediction Across Scales**:3 different scales are used.Features are extracted from these scales like FPN.
   Several convolutional layers are added to the base feature extractor Darknet-53 (which ismentioned in the next section).
   The last of these layers predicts the bounding box, objectness and class predictions.
   This method allows us to get more meaningful semantic information from the upsampledfeatures and finer-grained information from the earlier feature map.
   Then, a few more convolutional layers are added to process this combined feature map, and eventually predict a similar tensor, although now twice the size.

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4. **Feature Extractor**:000-class ImageNet Top-1 and Top5 error rates are measured as above.Single Crop 256×256 image testing is used, on a Titan X GPU.

Compared with ResNet-101, Darknet-53 has better performance (authors mentioned this inthe paper) and it is 1.5× faster.

Compared with ResNet-152, Darknet-53 has similar performance (authors mentioned this inthe paper) and it is 2× faster.

OPENCV

OpenCV Open Source Computer Vision Library. It is a library of programming functions mainly aimed at real time computer vision. It was originally developed by Intel. It is a huge Open Source cross-platform library for machine learning, computer vision, and image processing. The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms. It helps to process images, and videos and identify objects. OpenCV has a large community of more than 47 thousand users. OpenCV has many applications as listed below:- Counting the number of people, Face recognition, Detecting the speed of vehicles on the highways, Driver less car controlling, and Video/image search. In our project the capturing and preprocessing of the live-video of the motorist is done by the OpenCV tools.

OpenCV Applications

- Street view image stitching
- Automated inspection and surveillance
- Robot and driver-less car navigation and control
- Medical image analysis
- Video/image search and retrieval
- Movies - 3D structure from motion
- Interactive art installations

OpenCV Functionality

- Image/video I/O, processing, display (core, imgproc, highgui)
- Object/feature detection (objdetect, features2d, nonfree)
- Geometry-based monocular or stereo computer vision (calib3d, stitching, videostab)
- Computational photography (photo, video, superres)
- Machine learning & clustering (ml, flann)
- CUDA acceleration (gpu)

UNIFIED MODELING LANGUAGE (UML)

UML is a standard language for specifying, visualizing, constructing, and documenting the artifacts of software systems. UML was created by the Object Management Group (OMG) andUML 1.0 specification draft was proposed to the OMG in January 1997. OMG iscontinuouslymaking efforts to create a true industry standard.

UML stands for **Unified Modeling Language**.

UML is different from the other common programming languages .UML is a pictorial language used to make software blueprints.

UML can be described as a general purpose visual modeling language to visualize,specify, construct, and document software system.

Although UML is generally used to model software systems, it is not limited within this boundary. It is also used to model non-software systems as well. For example, the processflow in a manufacturing unit, etc.

UML is not a programming language but tools can be used to generate code in various languages using UML diagrams. UML has a direct relation with object oriented analysis and design. After some standardization, UML has become an OMG standard.

GOALS OF UML

A picture is worth a thousand words, this idiom absolutely fits describing UML.
Object-oriented concepts were introduced much earlier than UML. At that point of time, there were no standard methodologies to organize and consolidate the object- oriented development. It was then that UML came into picture.

There are a number of goals for developing UML but the most important is to define
some general-purpose modeling language, which all modelers can use and it also needsto be made simple to understand and use.

UML diagrams are not only made for developers but also for business users, common
people, and anybody interested to understand the system. The system can be a softwareor non-software system. Thus it must be clear that UML is not a development methodrather it accompanies with processes to make it a successful system.

In conclusion, the goal of UML can be defined as a simple modeling mechanism to model all possible practical systems in today's complex environment.

CONCEPTUAL MODEL OF UML

- A conceptual model can be defined as a model which is made of concepts and their relationships.
- A conceptual model is the first step before drawing a UML diagram. It helps to understand the entities in the real world and how they interact with each other.
- As UML describes the real-time systems, it is very important to make a conceptual model and then proceed gradually. The conceptual model of UML can be mastered bylearning the following three major elements −
- UML building blocks
- Rules to connect the building blocks
- Common mechanisms of UML

OBJECT-ORIENTED CONCEPTS

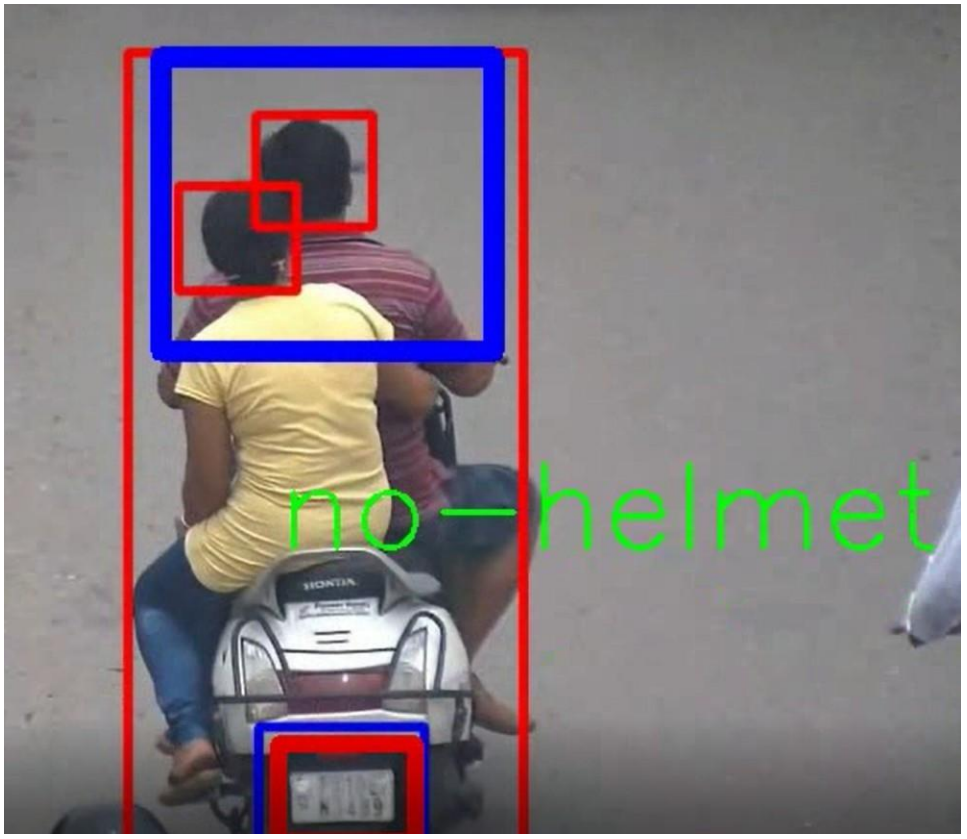
UML can be described as the successor of object-oriented (OO) analysis and design. An objectcontains both data and methods that control the data. The data represents the state of the object.A class describes an object and they also form a hierarchy to model the real-world system. Thehierarchy is represented as inheritance and the classes can also be associated in different waysas per the requirement.

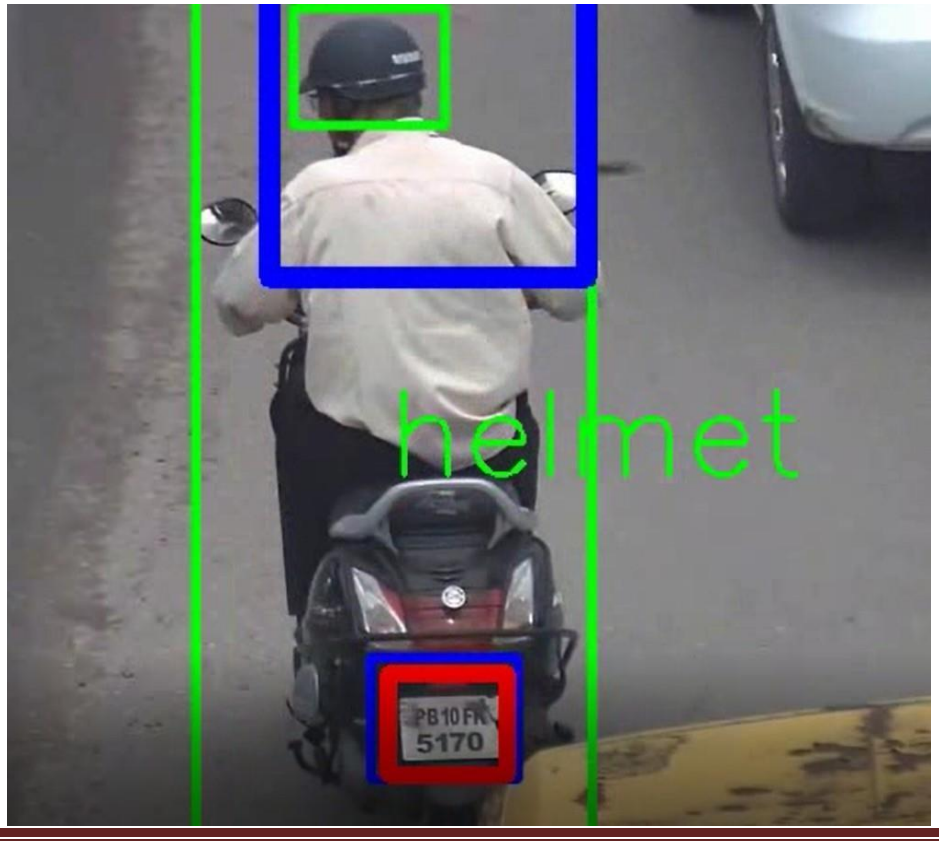
Objects are the real-world entities that exist around us and the basic concepts such as abstraction, encapsulation, inheritance, and polymorphism all can be represented using UML.UML is powerful enough to represent all the concepts that exist in object-oriented analysis and design. UML diagrams are representations of object-oriented concepts only. Thus, before learning UML, it becomes important to understand the OO concept in detail.

Following are some fundamental concepts of the object-oriented world −

- **Objects** − Objects represent an entity and the basic building block.
- **Class** − Class is the blueprint of an object.
- **Abstraction** − Abstraction represents the behavior of a real-world entity.
- **Encapsulation** − Encapsulation is the mechanism of binding the data together andhiding them from the outside world.
- **Inheritance** − Inheritance is the mechanism of making new classes from existing ones.
- **Polymorphism** − It defines the mechanism to exist in different forms.

5.1 RESULTS





CONCLUSION

Wearing a helmet is of utmost importance to reduce the number of fatal accidents and to reducethe impact itself. Hence we approached the solution using the Object Detection and Localization concept. For this we captured the real-time video feed of the motorist and fed it as input, frame by frame, to the Neural Network. We used the YOLO algorithm to analyze theframe, generate a weight matrix and to generate the 'bounding box' over the Helmet. YOLO does this so by breaking down the frame into equal sized blocks. Each block is checked to detect the central coordinate of the object here, Helmet. The block which contains this is identified and a bounding box is generated. If the Helmet is not detected, then a bounding boxwith a red outline is shown.

FUTURE SCOPE

- It is not possible to develop a system that meets all the requirements of the user. User requirements keep changing as the system is being used.
- This project can be used to implement an automatic challan system. It can be done by interfacing the Bluetooth module to arduino and based on helmet status for the amount of time automatic challan can be generated.
- The Helmet Detection system can be interfaced to motorcycles. Doing this we can control the Bike condition based on Helmet Detection. If Helmet is detected initially then the bike can turn ON. Else the bike cannot turn ON.

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