COPVISION

Capstone Project Proposal-UCS793

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ABSTRACT

As per Indian scenario, motorcyclists break traffic rules very frequently by not wearing helmets, and tripling. Our project “CopVision " offers an automatic detection and generation e-challan for riders of two-wheelers with restricted activities such as, without helmet and tripling using the surveillance videos uploaded to the system. Firstly, we detect bike riders from uploaded video using the background subtraction method as well as object segmentation technique. Afterwards, the system finds whether the two wheeler rider is wearing a helmet or not using the visual features of rider and binary classifiers. The technique involves detecting moving vehicles by thresholding and background subtraction and then classified into motorcyclists and non-motorcyclists by area and aspect ratio, further detecting defaulters by machine learning models. There is also an effort to promote the use of technology in the public domain. This in turn, would bolster efficiency and save resources. Expanding such operations over a long duration would improve accountability on the part of the citizen and help in the progression of our society. The existing surveillance techniques are outdated and need a lot of human help. Making this process automated is needed for quick and accurate monitoring of these traffic rule violations as well as it helps in the reduction of the human assistance needed therefore helping to reduce human resources. So, this solution is also cost-effective.

DECLARATION

We hereby declare that the design principles and working prototype model of the project entitled ‘CopVision’ is an authentic record of our own work carried out in Computer Science and Engineering Department, TIET, Patiala, under the guidance of Dr. Rohit Ahuja during 6th and 7th semester (2020).

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UN	United Nations
CV	Computer Vision
RC	Registration Certificate
OCR	Optical Character Recognition
CNN	Convolutional Neural Network
DFD	Data Flow Diagram

INTRODUCTION

1.1 Project Overview

Safety is the utmost concern in today's world of growing technologies and commutation. Two-wheeler is a popular mode of transportation in our country. But, there is a high risk involved because of less protection. People often ride two-wheelers without wearing helmets because of their carefree attitude. Many people do not follow traffic rules at the same time due to which it becomes a tedious task for the cops to catch everyone violating the rules and generate challan for each one of them. The question of road safety has been coming down since the advent and increase in use of transportation mediums which are private- and the most concerning and known to be least-safe being a two wheeler. Further in populated countries like India, traffic becomes an adding factor along with negligence on the part of the rider.

To reduce the risk involved, it is mandatory for bike-riders to use a helmet and avoid tripling. The biggest reason behind people not wearing helmets is their carefree attitude. People think that it's okay to pay a fine once or twice a month but it will create a difference to pay it daily. So, we came up with the idea "CopVision".

CopVision project is to create a web interface that shall aid any kind of surveillance system, primarily the traffic system in detecting and charging the defaulters who are not wearing a helmet and tripling. Our project shall remove the factor of human error and laziness; and decrease the number of casualties in accidents by increasing awareness and strictness in following safety rules for the general welfare of the public.

The UN Motorcycle Helmet Study says, "Motorcyclists are 26 times more likely to die in a road crash than drivers of passenger cars. Wearing an appropriate helmet and avoiding tripling improves their chances of survival by 42% and helps avoid 69% of injuries to riders."

The main aim of our project is to increase awareness and strictness in following safety rules for the general welfare of the public by the means of e-challan. So,we came up with the idea to build a product that detects bike riders without helmets and tripling from a video frame to avoid accidents and decrease human effort.

Firstly, Bike riders will be detected from video frames. At that point it is resolved if the bike rider is utilizing a protective helmet or not and whether they are tripling or not. Then the image of a bike rider without a helmet and tripling will be given to traffic police. Then a web interface will be made to check the real time implementation of the project and furthermore to generate an e-challan/warnings to the riders.

In any case, to receive such programmed arrangements certain provokes should be tended to, for example, Real-time Execution, Occlusion, Motion's Direction, Changes in Environment, Quality of Video.

We aim to make this system functional in populated and developed countries which are confronting a dramatic expansion in the quantity of vehicles and ensuing traffic; which in turn raises the question of road safety. Loss of lives due to accidents are increasing day by day and one of the primary actions that can be taken on an individual level are precautions like ‘wearing a helmet and tripling’ which are sadly ignored most of the time in a hurry or carefree attitudes. We aim to encourage awareness as well develop a monitoring system that is effective and devoid of human errors, i.e. involves machine learning.

Hence, the surveillance systems of traffic police shall be upgraded with high cost-effectiveness in order to become more feasible and advantageous to the general welfare of the public. This shall also track down defaulters in institutional and office parking areas/campuses which will further decrease the prevalence of such ignorance of these safety measures.

We have applied efforts to develop an automated surveillance system which will automatically detect bike riders who are not wearing helmets, which is in its field of vision. The system will have a motorized dashboard which will extract the licence plate of traffic rule violator riders. When the camera is switched on, it will capture video in a particular direction and apply object detection algorithms on them.

These object detection algorithms will use Machine Learning algorithms present in the python library. The system will use the result of the object detection algorithms to detect the bike, riders and helmets.The system will be continuously detecting any bike riders which appear in front of the camera. Whenever a bike is detected, an image of the bike will be clicked, which will be used to apply machine learning algorithms on it to classify it into bike riders violating traffic rules. If it is classified as a rule violating rider, then it's licence plate will be extracted.

Whenever a bike is detected, an image of the bike will be clicked, which will be used to apply machine learning algorithms on it to classify it into bike riders violating traffic rules. If it is classified as a rule violating rider, then its licence plate will be extracted and a challan will be generated.

1.1.1 Technical Terminology

Table 1: Brief description of the technical terms used frequently in this document

Sr. No.	Term	Definition
1	OpenCV	It is a library of programming functions mainly used for computer vision
2	OCR	Optical Character Recognition is the process of recognizing characters in an image
3	Functional Requirements	Defines the functionality of the system or one of its subsystems. It describes what the system is intended to perform
4	E-R Diagram	Graphical representation of entity sets and their relationships to each other
5	Entity	Any object in the system that we want to model and store the information about

6	Python	An interpreted high level language for programming

Table 2: Description of the abbreviations used in this document

S.No.	Mnemonic	Full Form
1	APP	Application
2	DFD	Data Flow Diagram
3	ER diagram	Entity Relationship diagram
4	GUI	Graphic User interface
5	OCR	Optical Character Recognition
6	SRS	Software Requirement Specification
7	UML	Unified Modeling Language

1.1.2 Problem Statement

Safety is the utmost concern in today's world of growing technologies and commutation. Bike riding is a well known method of transportation in India. There is a high danger involved because of lesser security. To decrease the danger in question, it is obligatory for bike riders to :-

- Wear a helmet while driving,
- Avoid tripling

People often ride two-wheelers without wearing helmets because of their carefree attitude. Many people do not follow traffic rules at the same time due to which it becomes a tedious task for the cops to catch everyone violating the rules and generate challan for each one of them. It is a tedious task for cops to catch and fine 2-wheeler drivers violating the traffic rules due to :

- High traffic
- High speed of riders

- casual behaviour of cops

1.1.3 Goal

The aim is to make an automated surveillance system which will detect two-wheeler riders who are not wearing helmets or triple riding and detect the number plate of the violator and generate an e-challan for the violation.

1.1.4 Solution

We have applied efforts to develop an automated surveillance system which will automatically detect bike riders who are not wearing helmets, which is in its field of vision. The system will extract the licence plate of traffic rule violator riders. When the user uploads the video to the software it will apply object detection algorithms on them. These object detection algorithms will use Machine Learning algorithms present in the python library. The system will use the result of the object detection algorithms to detect the bike, riders and helmets.The system will be continuously detecting any bike riders which appear in the video. Whenever a bike is detected, an image of the bike will be clicked, which will be used to apply machine learning algorithms on it to classify it into bike riders violating traffic rules. If it is classified as a rule violating rider, then its licence plate will be extracted and a challan will be generated.

1.2 Need Analysis

As indicated by an investigation of information shared by states with the vehicle service, around 28 bike riders passed on every day on Indian streets in 2016 for not wearing protective caps. It has consistently expanded from 21.6 passings per 100 mishaps in 2005 to 29.1 in 2015. To decrease this rate, it is significant for bike riders to keep following traffic rules, for example, wearing a head protector and abstaining from triple riding.

The current video reconnaissance based techniques are uninvolved and need critical human support. By and large, such frameworks are infeasible because of association of people, whose proficiency diminishes over the long term. It is also very costly and difficult to provide 24 hours of human assistance. “CopVision” automates the whole process, decreasing human effort and helps to implement traffic rules in an effective way. The UN Motorcycle Helmet Study says,"Motorcyclists are multiple times bound to bite the dust in a street crash than drivers of traveler vehicles. Wearing a fitting protective cap improves their odds of endurance by 42% and dodges 69% of wounds to riders."

Our project is unique because we aim to make this system functional in populated and developed countries which are confronting a dramatic expansion in the quantity of vehicles and ensuing traffic; which in turn raises the question of road safety. Loss of lives due to accidents are increasing day by day and one of the primary actions that can be taken on an individual level are precautions like ‘wearing a helmet and tripling’ which are sadly ignored most of the time in a hurry or carefree attitudes. We aim to encourage awareness as well develop a monitoring system that is effective and devoid of human errors, i.e. involves machine learning. Hence, the surveillance systems of traffic police shall be upgraded with high cost-effectiveness in order to become more feasible and advantageous to the general welfare of the public. This shall also track down defaulters in institutional and office parking areas/campuses which will further decrease the prevalence of such ignorance of these safety measures.

Moreover there is also a need to reduce casual behaviour of cops by deploying an automatic e-challan generation system.

1.3 Research Gaps

Research is the crucial and integral part of any system development. We have carried out research on various topics related to our project using different literature surveys, internet resources, and studying the existing systems and we have identified some research gaps. Very less work has been carried out in these fields, and a few algorithms are generated for them.

- Interfacing of camera setup with the source code.
- Interfacing the source code with the database and linking it with the front end required to view the same.

1.4 Problem Definition and Scope

1.4.1 Problem Definition

The question of road safety has been coming down since the advent and increase in use of transportation mediums which are private- and the most concerning and known to be least-safe being a two wheeler. Further in populated countries like India, traffic becomes an adding factor along with negligence on the part of the rider. Traffic police monitoring of the helmet wearing and tripling is rather inefficient due to human involvement and the lack of strictness. If the defaulters are detected with the help of the currently installed surveillance cameras, they can be charged more efficiently; hence creating more awareness and prevalence of the following of this safety rule.

1.4.2 Scope

The scope of the CopVision project is to create a web interface that shall aid any kind of surveillance system, primarily the traffic system in detecting and charging the defaulters who are not wearing a helmet and tripling. Our project shall remove the factor of human error and laziness; and decrease the number of casualties in accidents by increasing awareness and strictness in following safety rules for the general welfare of the public.

1.5 Assumptions and Constraints

The project has the following assumptions as illustrated in Table 1 :

Table 3: Assumptions and Constraints

S. No.	Assumptions
1	The video that is used for detection should be of good resolution (a minimum requirement) for the procedure to be effective.
2	The number plate of the two-wheelers must be in the Indian Standard Format.
3	The observation camera should be put at the upper right half of the street to identify the defaulters.
4	Our system will work only for 2-wheelers.
5	Compulsory Helmets for all the people riding on the same bike.

1.6 Standards

Standards used for proposed design solution:

i. IEEE 1471: It is the IEEE standard for software/system architecture according to which the entire architecture of our working prototype was designed.

ii. IEEE 1233: IEEE standard for system requirement specifications. It was followed while preparing the SRS document for this system, which is a structured collection of information that embodies the requirements of a system.

iii. IEEE 830: IEEE standard for software requirement specifications. It was used for the developing the software requirements specification for this system. The software requirements specification is a description of a software system to be developed and lays out functional and non-functional requirements, and includes a set of use cases that describe user interactions that the software must provide.

iv. IEEE 1016: It is the IEEE standard for software design description. A software design description is a written description of a software product that describes the overall architecture of the software project. An SDD usually accompanies an architecture diagram with pointers to detailed feature specifications of smaller pieces of the design. Practically, the description needs to outline all parts of the software and how they will work. The standard was followed while describing specific details of the system such as data flow diagrams, architecture diagrams etc.

v. IEEE 829: An IEEE standard for documenting the testing of software. The standard typically applies to any stage in the testing of developing software, and each stage in the software's development typically is documented using the same application of the standard. The IEEE specifies eight stages in the documentation process, each stage producing its own separate document.

vi. IEEE 1008: An integrated approach to systematic and documented unit testing is defined. It uses unit design and unit implementation information, in addition to unit requirements, to determine the completeness of the testing. The testing process is composed of a hierarchy of phases, activities, and tasks and defines a minimum set of tasks for each activity.

vii. IEEE 1012: Verification and validation (V&V) processes are used to determine whether the development products of a given activity conform to the requirements of that activity and whether the product satisfies its intended use and user needs. V&V life cycle process requirements are specified for different integrity levels. The scope of V&V processes encompasses systems, software, and hardware, and it includes their interfaces. This standard applies to systems, software, and hardware being developed, maintained, or reused

viii. IEEE 1058: The format and contents of software project management plans, applicable to any type or size of software project, are described. The elements that should appear in all software project management plans are identified.

ix. IEEE 1219: The process for managing and executing software maintenance activities is described.

Application Standard

i. UX-B1: The app does not replace a system icon with a completely different icon if it triggers the standard UI behaviour. The app does not redefine or misuse Android UI patterns, such that icons or behaviours could be misleading or confusing to users.

ii. UX-N3: Pressing the Home button at any point navigates to the Home screen of the device.

iii. FN-P1: The app requests only the absolute minimum permissions that it needs to support core functionality.

iv. FN-U1: The app supports both landscape and portrait orientations (if possible).

v. FN-U2: The app uses the whole screen in both orientations and does not account for orientation changes.

vi. FN-U3: The app correctly handles rapid transitions between display orientations without rendering problems.

vii. PS-S1: The app does not crash, force close, freeze, or otherwise function abnormally on any targeted device.

1.7 Approved Objectives

The main objectives of this project are as follows:

- Deployment of Automatic e-challan for 2-wheeler motor vehicle riders for:
    - ➢ not wearing helmets,
    - ➢ and to detect triple riders in real time.
- To avoid casual behaviour of cops by deploying an automatic e-challan generation system.
- Extend the use of Matlab techniques and Machine Learning to achieve highly accurate results.
- To create a web interface for application.

1.8 Methodology

To finish our target, we began with literature review to know the necessities of our project CopVision and furthermore break down the feasibility of our venture in all habits imaginable that makes it a decent choice for ongoing execution in government traffic police observation frameworks.

Prototype models will be talked about alongside various modules and their separate coding. A short time later we will push ahead on the useful execution.

In the principal stage, we identify a bike rider in the frames of video.

In the second stage, we find the top of the head of the bike rider and distinguish if the rider is utilizing a protective cap. Moreover we will also extract details of triple bike riders and store their RC details from vehicle Number plate. For the reduction of the false predictions, we combine the outputs from consecutive frames for final prediction.

In third phase, we will make a web interface using web development which uses the methodology to achieve our objectives as follows:

Background Modeling: Background subtraction is utilized to isolate the items moving, for example, bikes, people, vehicles from static articles, for example, trees, streets and structures in frames removed from the video. Gaussian filter (smoothing) operation is applied on it to improve quality. Further, thresholding accompanied with Morphological operations like closing operations are carried out, through which contours are drawn.

Phase I:

Detection of Bike-riders:-

1. Thresholding: Image segmentation is done by performing thresholding operation on the frames obtained in order to get contours, which further are attached by performing another morphological operation- closing.
2. Aspect ratio: Centre of mass is tracked and we try to distinguish between a car and a bike, a horizontal center line(CL) on the frame enables us to do the same by using the concept of aspect ratio;

Phase II:

Detection of Bike-riders not following traffic rules:-

1. Feature Extraction: Identified region (25%) around the top of the bike rider is utilized to decide whether the bike rider is utilizing the helmet or not.
2. Classification: (through SVM- support vector machine; Machine Learning algorithm) The strategy needs to decide whether the biker is abusing the law (i.e. not using the helmet and tripling). For this we think about two classes, Bike-rider not keeping traffic rules (Positive outcome) and Bike-riders adhering to traffic rules (Negative outcome).

Subsequent to building all the modules we will incorporate them. Testing will be our next stage to make it more achievable, solid and viable in each viewpoint. Likewise, we will attempt to make further enhancements.

1.9 Project Outcomes and Deliverables

The project will have the following outcomes:

1. Eliminate temporal environment conditions and provide high quality images for detection of defaulters; by taking care of the excess traffic, illumination, fog and mist conditions.
2. Detects bike riders without helmets and tripling by use of machine learning models with a high accuracy by minimizing human errors in surveillance of safety rules.
3. Web Interface used as a platform for the application initially which can check any kind of video to extract the frames of the defaulters.

1.10 Novelty of Work

The Novelty of our task is that no such programmed framework exists till now that can recognize 2-wheelers riders without helmets and tripling and generate an e-challan against vehicle RC details extracted from vehicle number plates.It uses different machine learning algorithms like CNN, etc and make it highly efficient and accurate.The system involves a sign-in from admin page through which an e-challan is sent after viewing at the surveillance frames extracted by the system.The item conveys sheer novelty by first of its sort since no such framework till now has been implanted with comparable highlights of producing e-challans, hassle free and helpful for the cops.

2.1 Literature Survey

2.1.1 Theory Associated With Problem Area

Safety is the utmost concern in today's world of growing technologies and commutation. Bike riding is a well known method of transportation in India. There is a high danger involved because of lesser security. To decrease the danger in question, it is obligatory for bike riders to :-

- Wear a helmet while driving,
- Avoid tripling

People often ride two-wheelers without wearing helmets because of their carefree attitude. Many people do not follow traffic rules at the same time due to which it becomes a tedious task for the cops to catch everyone violating the rules and generate challan for each one of them. It is a tedious task for cops to catch and fine 2-wheeler drivers violating the traffic rules due to :

- High traffic
- High speed of riders
- casual behaviour of cops

2.1.2 Existing Systems and Solutions

Table 2 illustrates the research findings for existing literature:

Table 4: Literature Survey

S. No	Name	Features	Technology	Citation
1	Motorcyclists Helmet wearing detection using Image Processing	Detects motorcycle with accuracy 98.22% Detects helmet with accuracy 77% Database with 255	Back Subtraction Threshold and Mathematical method Feature Extraction Neural Network	[18]

		images	Hough Transform	
2	Machine Vision Techniques for Motorcycle Safety Helmet Detection subtraction	automatically recognize bike riders and discover that they are wearing protective helmets or not	K-Nearest-neighbor Classifier Feature extraction	[24]
3	Automatic Helmet Detection on Public Roads	Fall detection Helmet detection	Hough transform descriptor	[6]

2.1.3 Research Findings for Existing Literature

Table 3 illustrates the all the results of research conducted in the existing literature papers:

Table 5: Research Findings for Existing Literature

S. No.	Roll Number	Name	Paper Title	Findings	Tools/Technology	Citation
1	101703376	Nishant Goel	Recognition of Motorcyclists without Helmet in Videos utilizing Convolutional Neural Network	Adaptive Background modelling	CNN	C. Vishnu [23]
2	101703376	Nishant Goel	Optical character recognition techniques	Helmet detection		E. N. Bhatia [3]
3	101703376	Nishant Goel	Object detection from videos captured by moving camera by	Optical Character recognition	HOG algorithm	B. N. Subudhi [8]

			local histogram matching			
4	101703376	Nishant Goel	Multi- Task vehicle detection with region of interest voting	Hardware		W. Chu [4]
5	101703376	Nishant Goel	A Study of Low-resolution Helmet Image Recognition Combining Statistical Features with ANN	Fog removal image processing technique		H. Xue [10]
6	101703376	Nishant Goel	ROI Segmentation for feature extraction	HOG features		V. Arora [2]
7	101703376	Nishant Goel	An Efficient Method Of Vehicle Number Plate Detection And Recognition	The Wiener2 channel was utilized to eliminate noise and the Sobel channel was utilized for finding the edges before the assurance of completely associated segments	Morphological operations, thresholding and Sobel edge detection.	Lazrus et al. [14]
8	101703376	Nishant Goel	License plate recognition from still images and video sequences: A survey	Methodologies and underlying framework for various Automatic Number Plate	Public image database for researchers	Anagnostopoulos et al. [1]

				Recognition Algorithms have been studied and compared.		
9	101703376	Nishant Goel	Automatic Number Plate Recognition Based on Connected Components Analysis Technique	Usage of OCR method for recognition of green Punjab plates.	Image processing license plate detection using MATLAB	Malik and Hafiz [16]
10	101703382	Paras Arora	Automatic Detection of Bike-riders without Helmet using Surveillance Videos in Real-time	Use of HOG, SIFT and LBP algorithm for extraction of features from upper part of body for helmet detection	HOG,SIFT and LBP algorithm	Kunal Dahiya, Dinesh Singh, C. Krishna Mohan [5]
11	101703382	Paras Arora	Vehicle Speed Detection from Camera Stream Using Image Processing Methods	Use of DBSCAN clustering along with Gaussian mixture model to create more precise object representation and use of Kalman filter tracking to improve speed detection.	DBSCAN clustering, Kalman filter	Jozef Gerát, Dominik Sopiak, Miloš Oravec, Jarmila Pavloviˇ cová [7]
12	101703382	Paras	An Efficient Approach	Usage of	Contour	Tarun

		Arora	for Detection and Speed Estimation of Moving Vehicles	Background Subtraction, Contours Processing, Camera Calibration, and Moving Object detection	Detection,ROI	Kumar, Dharmendra Singh Khushwaha [13]
13	101703382	Paras Arora	Real-Time Vehicle Speed Detection Algorithm using Motion Vector Technique	Use of Video Processing and Vector -Valued function for vehicle motion velocity estimation in MATLAB	Vehicle speed detection using MATLAB	Ranjit, S.S.S., Anas, S.A., Subramaniam, S.K., Lim, K.C [20]
14	101703382	Paras Arora	Automated Over Speeding Detection and Reporting System	Use of Radar gun and Doppler effect for speed detection of vehicle and automatic number plate recognition using OCR and Digital image processing	Doppler effect,OCR	Malik, S.M., Iqbal, M.A., Hassan, Z., Tauqeer, T., Hafiz, R. and Nasir, U. [17]
15	101703374	Nipunn Malhotra	Vehicle speed detection in video image sequences using CVS method	Captured videos were collected by a stationary	Video and Image Processing techniques used	Karim, M.R. and Dehghani, A.

				camera which was calibrated based on geometrical equations and speed calculated using position of each frame.		[11]
16	101703374	Nipunn Malhotra	Speed detection of vehicles from aerial photographs	Extraction of vehicles and shadows from two consecutive images and linking of corresponding vehicles and detection of moving speed and azimuth angle	Test on aerial photograph done	Liu, W., Yamazaki, F., Vu, T.T. and Maruyama, Y. [15]
17	101703374	Nipunn Malhotra	An Approach towards Detection of Indian Number Plate from Vehicle	Used an efficient morphological operation and sobel edge detection method to segment all the letters and numbers on the number plate	MATLAB 7.4.0	Roy, S, Choudhury, A. and Mukherjee, J. [21]

18	101703374	Nipunn Malhotra	An Efficient Approach for Number Plate Extraction from Vehicles Image under Image Processing	Preprocessing of input image using iterative bilateral filter and adaptive histogram equalization. Used Preprocessing, number plate extraction, character segmentation, character recognition of input image.	Image processing techniques like contrast enhancement and RGB to gray conversion used	Kaur, S. and Kaur, S. [12]
19	101703374	Nipunn Malhotra	Canny Edge-Detection Based Vehicle Plate Recognition	Using canny edge detection algorithm and plate number recognition algorithm to identify number plates	Digital Image Processing using edge detection as a tool used	Mousa, A. [19]
20	101703374	Nipunn Malhotra	Automatic Detection of License Number Plate of Motorcyclists Without Helmet	To extract features of the upper part of the segmented image and gave them as an input to the SVM to train the classifier based upon the features	Image processing and machine learning technology used	Saklani, N. [22]

				extracted. For vehicle number plate detection, they have used image based template matching.		
	101703374	Nipunn Malhotra	Vehicle Tracking and Speed Estimation using Optical Flow Method	Using optical flow method to detect motion of vehicles and the distance traveled by the vehicle is calculated using the movement of the centroid over the frames and the speed of the vehicle is estimated	MATLAB and SIMULINK	Indu, S., Gupta, M. and Bhattacharyya, A. [9]

2.1.4 Problem Definition

The problem identified by us through the literature survey done by the team is that the work on improving the helmet and tripling detection process is being carried out but the accuracy of detection has been quite low until now and there has been a general difficulty in the use of the software. Certain reasons behind that have been that there is a clear lack of proper image enhancement techniques. An added usage of Machine Learning will go a long way in improving the overall performance and efficiency.

2.1.5 Survey of Tools and Technologies Used

1. In the first research finding [23], CNN technology was used for adaptive background modelling. This innovation helped in discovery of Motorcyclists without helmets in Videos utilizing Convolutional Neural Networks. This technology captures images of motorcyclists in the video and through CNN detects whether he is wearing a helmet or not.
2. In the research paper [3], OCR technique is used to capture the details of the licence plate of the two wheeler. The camera clicks an image of the two wheeler and OCR helps to extract the details of the licence plate of the two wheeler and then it is matched with the database to generate e-challan for the traffic rule violations.
3. In this research [5], tools used were HOG, SIFT and LBP algorithms, these algorithms helped in extraction of features from the upper part of the body for helmet detection purposes.

2.1.6 Summary

The literature papers studied had helmet detection under different conditions. Our project started from getting the helmet detected after taking inferences from the literature papers and aiming to detect them better by increasing the accuracy and improving the dataset. The same steps were followed for motorcycle detection. The project involved vast exposure to computer vision and ML. After this, the experiments were conducted in order to obtain the change in coordinates of the box plot points w.r.t the position of motorcycle in order to get the position of rider as well. No literature paper had any information about tripling detection, so it had to be done from scratch. The Optical Character Recognition is a very important part of the number plate detection and it was done extensively using gradients of the number plate. To improve the accuracy of the OCR, API was used. After taking a lot of inferences from the literature papers, improved accuracy, better results, new utilities made new innovations in this domain. No findings were there to generate

E-challans which was an entirely new concept. The project only used experiences of other researchers as mentioned in their literature papers and then drives them in its own direction.

2.2 Software Requirement Specification

2.2.1 Introduction

2.2.1.1 Purpose

The reason for this SRS record is to give a detailed explanation and review of our product, its boundaries and objectives. This document depicts the task's intended interest group and its UI, equipment and programming necessities. This report spreads out a venture plan for the advancement of "CopVision" programmed reconnaissance framework by our group. The proposed pursuers of this record are current and future designers chipping away at this venture.

2.2.1.2 Intended Audience and Reading Suggestions

This report must be perused by the advancement group, the project managers, advertising staff, deals office, analyzers and documentation essayists. Our partners, organization producing the related equipment, organization giving working framework, investors and wholesalers who market the completed programming, may audit and archive to find out about the undertaking and to comprehend the prerequisites. The SRS has been coordinated roughly arranged by expanding explicitness. The engineers and venture supervisors need to turn out to be absolutely acquainted with the SRS. This SRS is proposed for the two designers and clients. The clients can be of different spaces and fields, for example, understudies, finance managers/ladies, kids, grown-ups, laborers, and so forth The SRS controls the designer to actualize and additionally adjust the usefulness of the product. The SRS assists clients with understanding the different functionalities that accompany the application.

2.2.1.3 Project Scope

The objective of this project is to help in detection of two wheeler riders who are driving without helmets and tripling which is done by machine learning algorithms using python libraries. The object detection will be used on live images captured by a camera. This project will help in making the work of traffic surveillance automatic and reduce the workload of traffic police by automatic e-challan generation for violating the traffic rule of driving without helmet and tripling.

2.2.2 Overall Description

2.2.2.1 Product Perspective

CopVision is an automatic surveillance system. The work aims to make the traffic surveillance fully automatic by detecting the two wheeler riders not wearing helmets and tripling and then generating an e-challan for them using the number plate captured by the system. The software uses the video which is processed to extract the images of bikes and upper body parts of humans to further check for helmet detection and tripling and if any traffic rule violation is found then e-challan is generated using the details of the number plate captured by the camera itself. Our main objective is to create an effective automatic surveillance system which will help traffic police by reducing their workload and help in reducing human error in traffic surveillance.

2.2.2.2 Product Features

The automated surveillance system will automatically detect bike riders who are not wearing helmets, which is in its field of vision. The system will have a motorized dashboard which will extract the licence plate of traffic rule violator riders. When the camera is switched on, it will capture video in a particular direction and apply object detection algorithms on them. These object detection algorithms will use Machine Learning algorithms present in the python library. The system will use the result of the object detection algorithms to detect the bike, riders and helmets.The system will be continuously detecting any bike riders which appear in front of the camera. Whenever a bike is detected, an image of the bike will be clicked, which will be used to apply machine learning algorithms on it to classify it into bike riders violating traffic rules. If it is classified as a rule violating rider, then it’s licence plate will be extracted.

2.2.3 External Interface Requirements

The data is secondarily stored in the folder with which our CNN model is trained. The software system uses the video uploaded by the user externally for processing and capturing images. Further the captured image acts as an input to the trained model.Then helmet detection and tripling is detected and violation of these two traffic rules is checked. External interface requirement is further divided into user, hardware and software requirements.

2.2.3.1 User Interfaces

The user has to log in to the software system to view the captured image of the traffic rules violators and to check the details of the two wheelers for which the e-challan is generated. The user can turn on and turn off the camera using the software too.

2.2.3.2 Hardware Interfaces

There are no such hardware interfaces required.

2.2.3.3 Software Interfaces

The utilities used for developing software interfaces in the project are as follows:

Table 6: Software Interfaces

Software	Description	Usage
Django	Django is a high-level Python web framework that enables rapid development and clean pragmatic design.	Helped in making the front end of our project

2.2.4 Functional Requirements

This section illustrates the functional features using the template in table below:

Table 7: Functional Requirements

System Feature	Background subtraction,Thresholding
Priority	Medium
Description	Removing the unwanted details of the background, due to environmental and external factors.
Action	This module is activated first when a video is selected to carry on the process of detection.
Result	It gives an image/frame of higher visual quality for good processing to follow.
Functional requirements	Python
System Feature	Bike-rider detection
Priority	High
Description	Using the concept of Center line and aspect ratio,distinguishing between bike riders and non-bike riders and capturing that frame part in a rectangular blob.
Action	This module is activated second when a frame has been extracted from a video and its quality has been enhanced.
Result	It gives a frame of a bike rider in a rectangular blob.
Functional requirements	Python
System Feature	Rule Violation Detection
Priority	High
Description	Using the concept of feature extraction and classification of Machine

	Learning to determine if a frame captured has violated any traffic rule(Helmet,Tripling)
Action	This module is activated last when a frame of a particular bike-rider has been extracted.
Result	It gives a result- positive if rule is not violated, and negative for if rule is violated.
Functional requirements	Python, Machine learning models for classification (SVM, CNN) and a dataset of positive and negative results.

2.2.5 Non-Functional Requirements

2.2.5.1 Performance Requirements

- **Performance Requirements -** A high rate of accuracy in detection is aimed to be achieved as it is supposed to cut down human error and human effort, fully in a surveillance system.
- **Security and Privacy Requirements -** Only the creators of the project are able to make changes to the functionality in terms of Machine learning models; and only the authorized/registered users are allowed to login and use this software and get an access to the database or upload a video.
- **Software Quality Attributes:**
    - ➢ **Compliance:** Action performs with minimum latency.
    - ➢ **Interoperability:** Communication between backend and frontend of the application is maintained.
    - ➢ **Maintainability:** Easily maintainable.
    - ➢ **Privacy/Security:** Only users which are authorized to use the application can access the web application and its database of videos.
    - ➢ **Portability:** Easy to handle, as it is a web application.
    - ➢ **Quality:** Good quality algorithms and good resolution videos are used for training the Machine learning models.
    - ➢ **Reliability:** Highly reliable.

- ➢ **Resilience:** Accurate decision should be taken as all the bike riders who are not wearing a helmet and tripling should be detected.
- ➢ **Robustness:** Highly efficient and effective in all terms.
- ➢ **Testability:** High scale testing will be done before the deployment of the web application to the users/government.

2.2.5.2 Safety Requirements

For proper functioning of the automatic surveillance system the camera must be placed properly on the poles near traffic lights so that it doesn't fall off and cause any accident. Also there must be proper connectivity and power backup so that the surveillance system doesn't shut down.

2.2.5.3 Security Requirement

For security, to make sure no one else controls the functioning of the surveillance camera and the software, the software can be logged on and off by the admin of the software. We need to ensure that no one can interfere with the e-challan generation by the software so that there is no misuse of it.

2.3 Cost Analysis

This section illustrates the approximate cost required for completion of our capstone project. The cost requirement of our project is very minimal, as we aim to create a web app which requires certain resources like languages Python, HTML, OpenCV and Django etc. These resources are found easily and are open source, therefore there is no such cost that we need to invest for the project. Although some investment would be required for domain name.

2.4 Risk Analysis

i. Individuals not involved in criminal activity may consider the deployment of the CopVision System as an unjustified intrusion of their privacy.

ii. Inappropriate disclosure of data.

iii. Excessive data is collected.

iv. Data is retained longer than necessary

v. Transparency regarding CopVision System with provisions of information concerning why it is needed and how it is used.

vi. Process for managing lists of vehicles of interest to ensure that data for circulated vehicles remains accurate and relevant.

vii. Provisions for monitoring and audit of data access and use.

viii. Decisions taken following strategic assessment taking account of identified privacy concerns.

This segment clarifies about the prerequisites which were useful to make the task more exact and dependable. This segment incorporates Software Requirements, Cost Analysis, and Work Breakdown Structure of the task.

3.1 Investigative Techniques

Table 9: Investigative techniques

S.No	Investigative Project Technique	Investigative Techniques Description	Investigative Projects Example
1	Descriptive	An examination where logical inquiries are researched and perceptions of phenomenon are recorded and listed.	Activities dependent on planning totally new framework models, ideas, algorithms and so forth
2	Comparative	Examinations where perceptions are made that look at two objects or phenomena.	Correlation Based (Algorithm based, System based ,and so forth)
3	Experimental	A coordinated examination that incorporates a benchmark group and is intended to test the speculation, incorporates free and ward factors	ML, Deep Learning or Artificial Intelligence based Projects and so on

As per the previously mentioned strategies this undertaking utilizes the exploratory method of the insightful procedures this is a result of Machine Learning being utilized. An algorithm is being trained with a dataset and the result extracted frames from the video are used upon by the same trained algorithm to detect whether a rule is violated or not. Thus, our objective mainly lies on classifying our input video frames as positive or negative in terms of rules violated.

3.2 Proposed Solution

As a proposed answer for the above expressed issues, we have applied efforts to develop an automated surveillance system which will automatically detect bike riders who are not wearing helmets, which is in its field of vision. The system will have a motorized dashboard which will extract the licence plate of traffic rule violator riders. When the camera is switched on, it will capture video in a particular direction and apply object detection algorithms on them. These object detection algorithms will use Machine Learning algorithms present in the python library. The system will use the result of the object detection algorithms to detect the bike, riders and helmets.The system will be continuously detecting any bike riders which appear in front of the camera. Whenever a bike is detected, an image of the bike will be clicked, which will be used to apply machine learning algorithms on it to classify it into bike riders violating traffic rules. If it is classified as a rule violating rider, then it's licence plate will be extracted.

3.3 Work Breakdown Structure

The work breakdown structure of an item is a key venture deliverable that arranges the teams' work into sensible segments. Figure 1 shows the same :

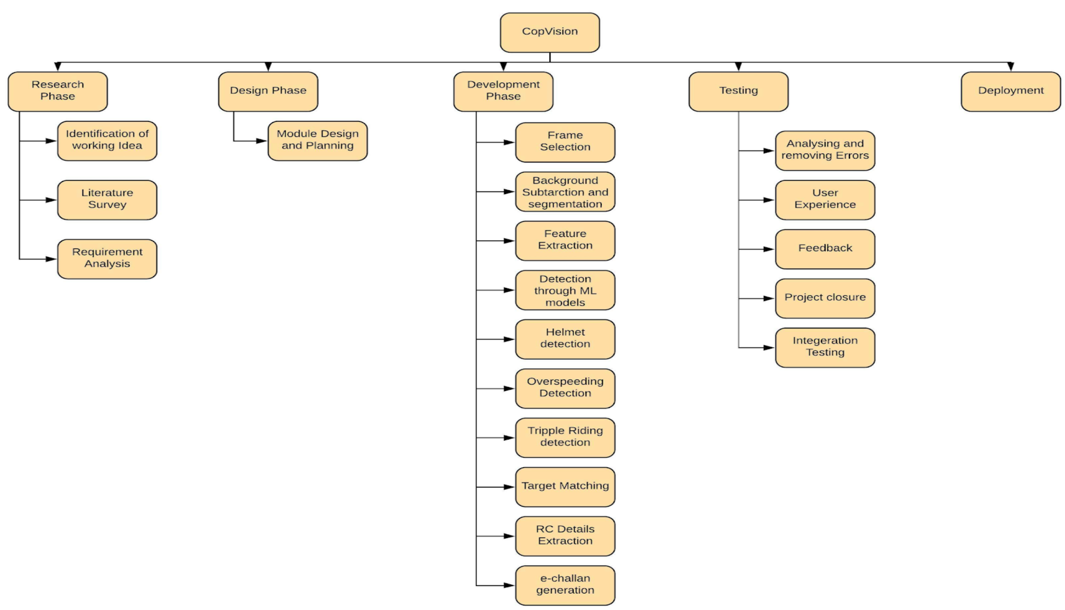

Figure 1: Work breakdown structure

3.4 Tools and Technology

The following technologies were used in making of this project:

- CNN
- YOLOV-3
- Batch Normalization

The following tools were used for the project:

- TensorFlow
- ImageAI
- Matplotlib
- Keras
- Platform
- Cvlib
- Cv2
- PascalVoc
- Opencv

4.1 System Architecture

The following figure has three-level design that is separated into three sections: Presentation layer (Client Tier), Application layer (Business Tier) and Database layer (Data Tier). Client system handles Presentation layer, Application server handles Application layer and Server system handles Database layer; as shown in figure 2:

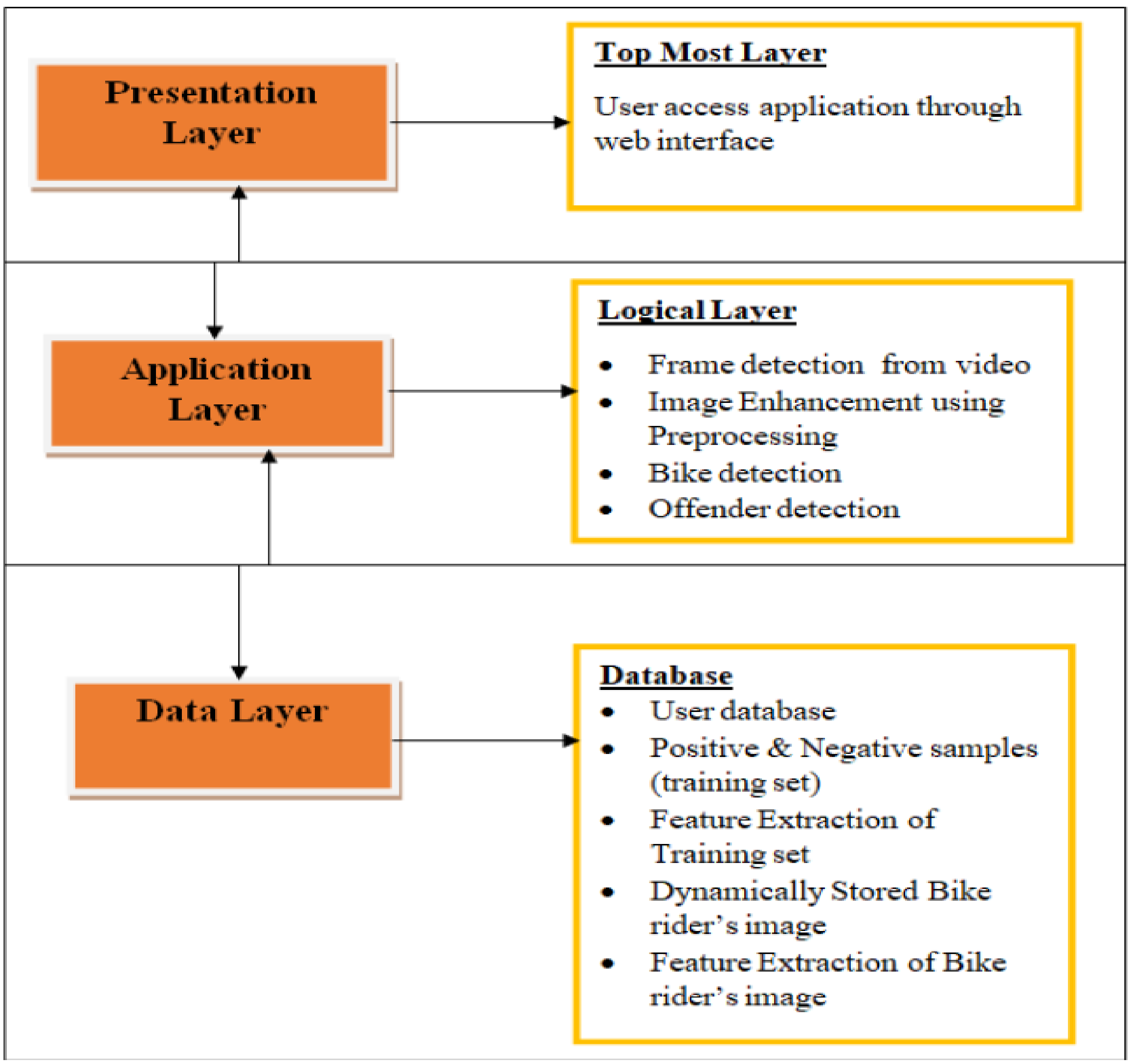

Figure 2: System architecture

4.2 Design Level Diagrams

4.2.1 Data Flow Diagram

4.2.1.1 DFD Level 0

A data flow diagram (DFD) is a graphical representation of the "flow" of data through an information system, modeling its process aspects. Figure 3 shows the same:

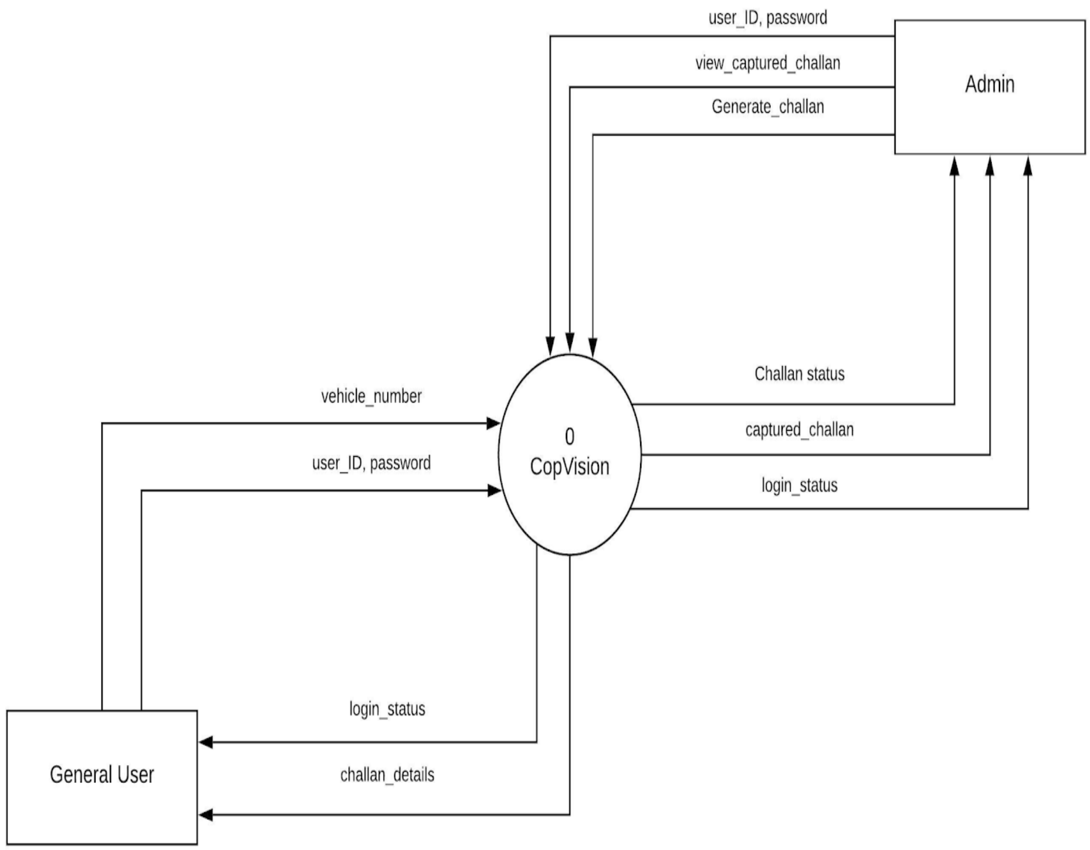

Figure 3: Level 0 DFD

4.2.1.2 DFD Level 1

Figure 4 shows the Level 1 DFD which demonstrates how data flows from / to the external agent i.e. user who may be a sender or receiver to the repositories where the data is stored.

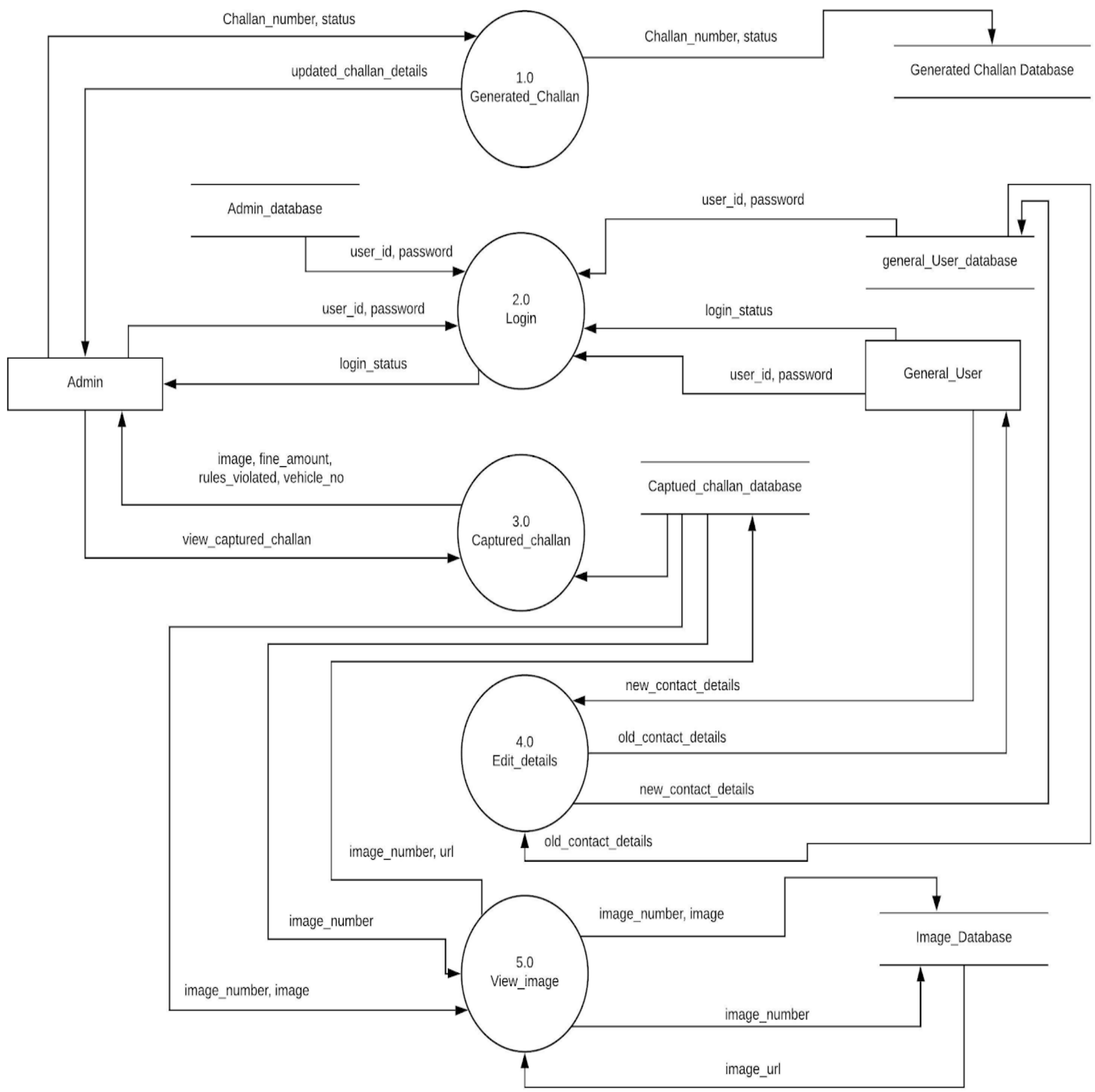

Figure 4: Level 1 DFD

4.2.2 ER Diagram

Figure 5 shows the ER diagram which explains the relationship between different databases of the system and how they interact with each other:

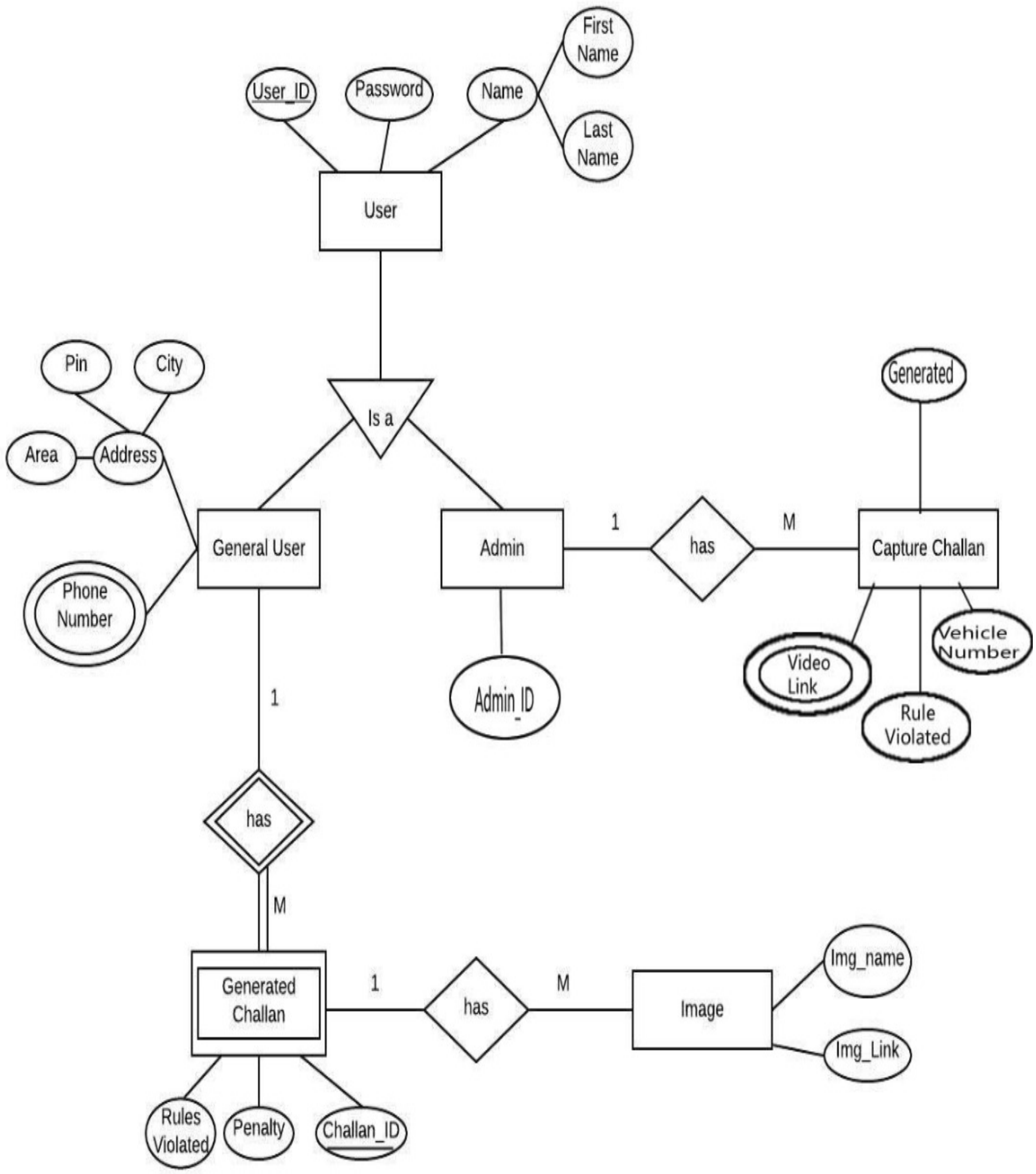

Figure 5: ER diagram

4.2.3 Activity Diagram

Figure 6 shows the activity diagram which explains the flow of different procedure from start to the end while explaining the activity that takes place at each step:

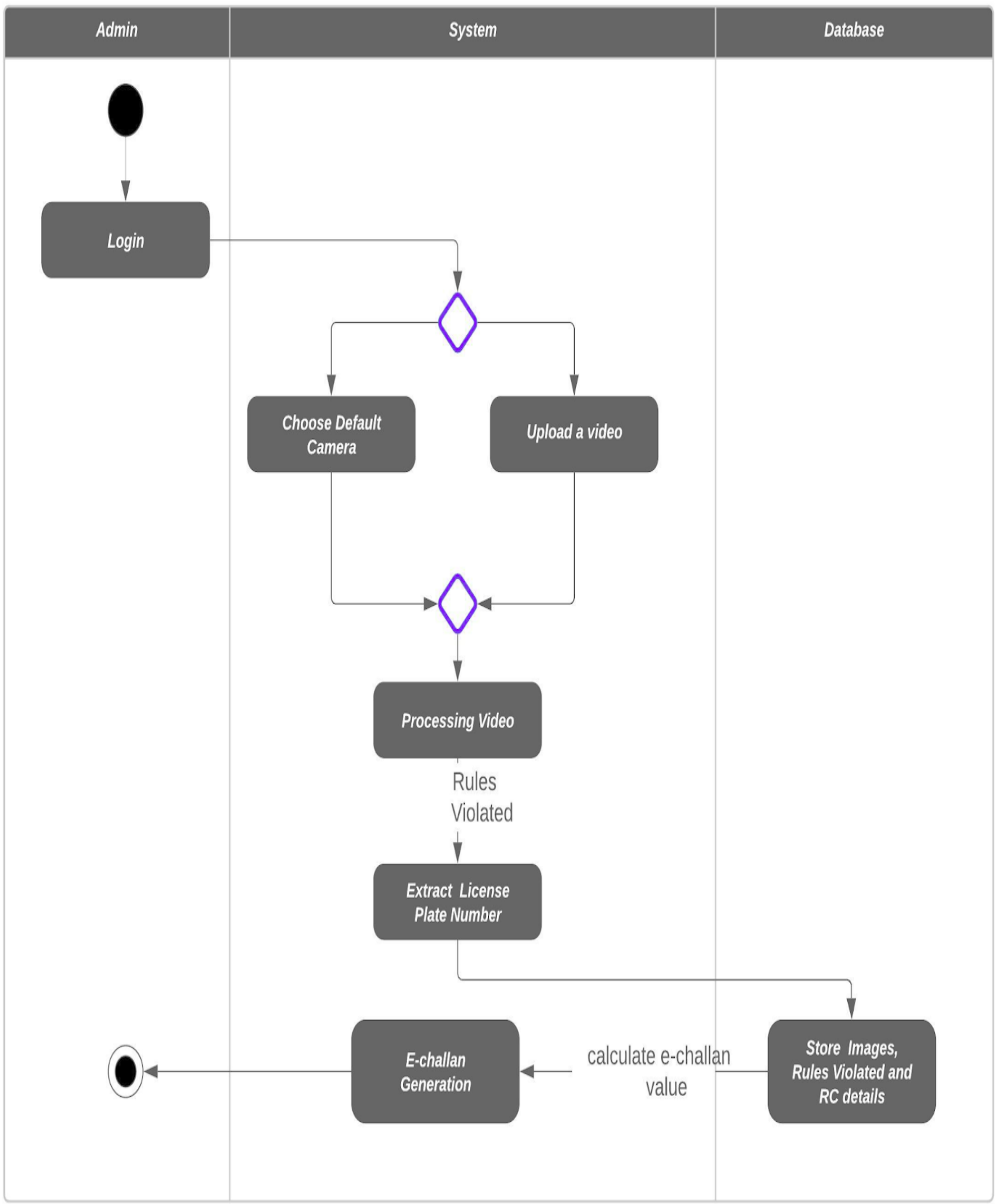

Figure 6: Activity Diagram

4.2.4 Sequence Diagram

Figure 7 shows the sequence diagram which explains the interactions that take place between different objects of the project :

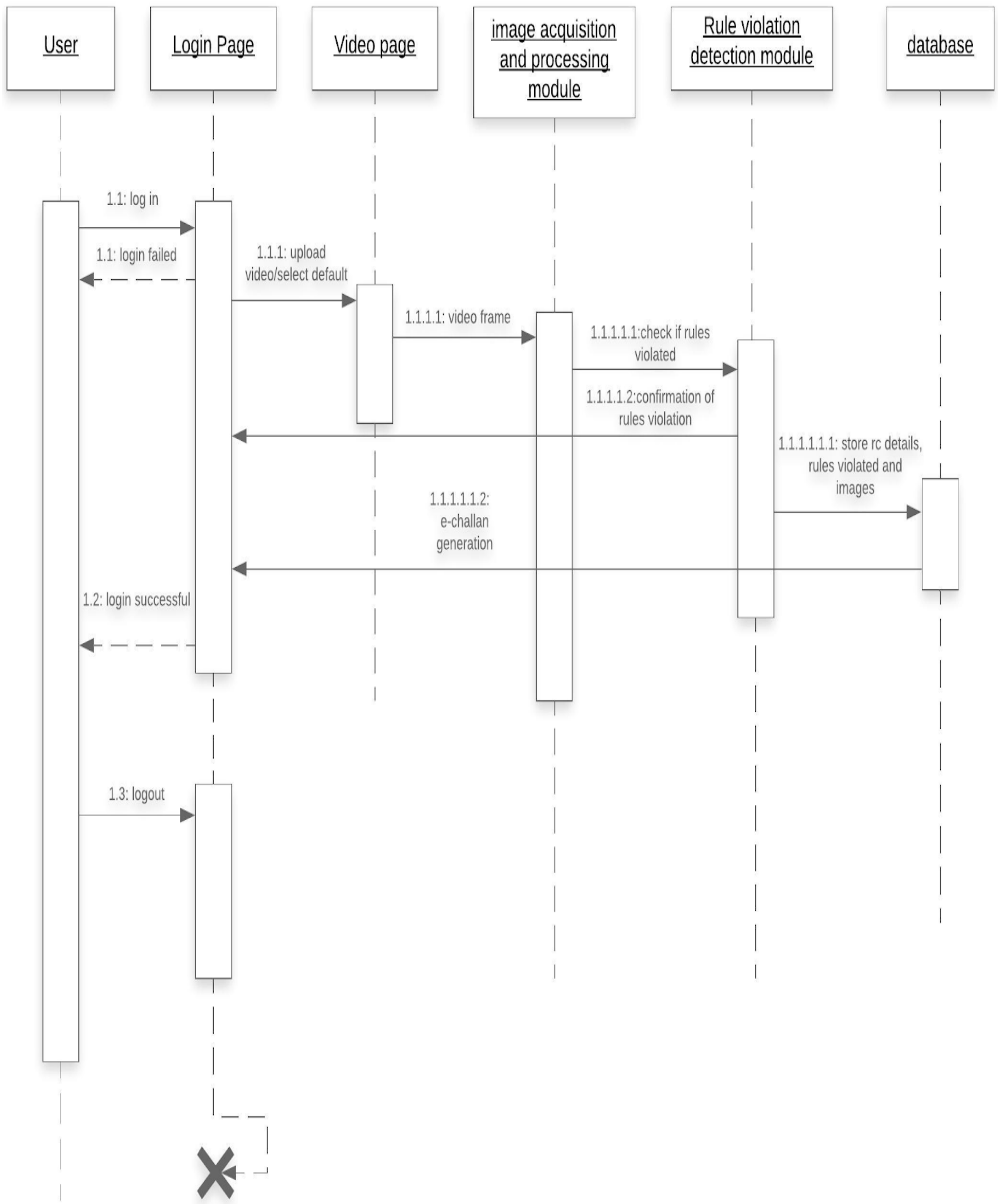

Figure 7: Sequence diagram

4.2.5 State Chart Diagram

Figure 8 shows the sequence diagram which illustrates the different states and the change of states due to different events:

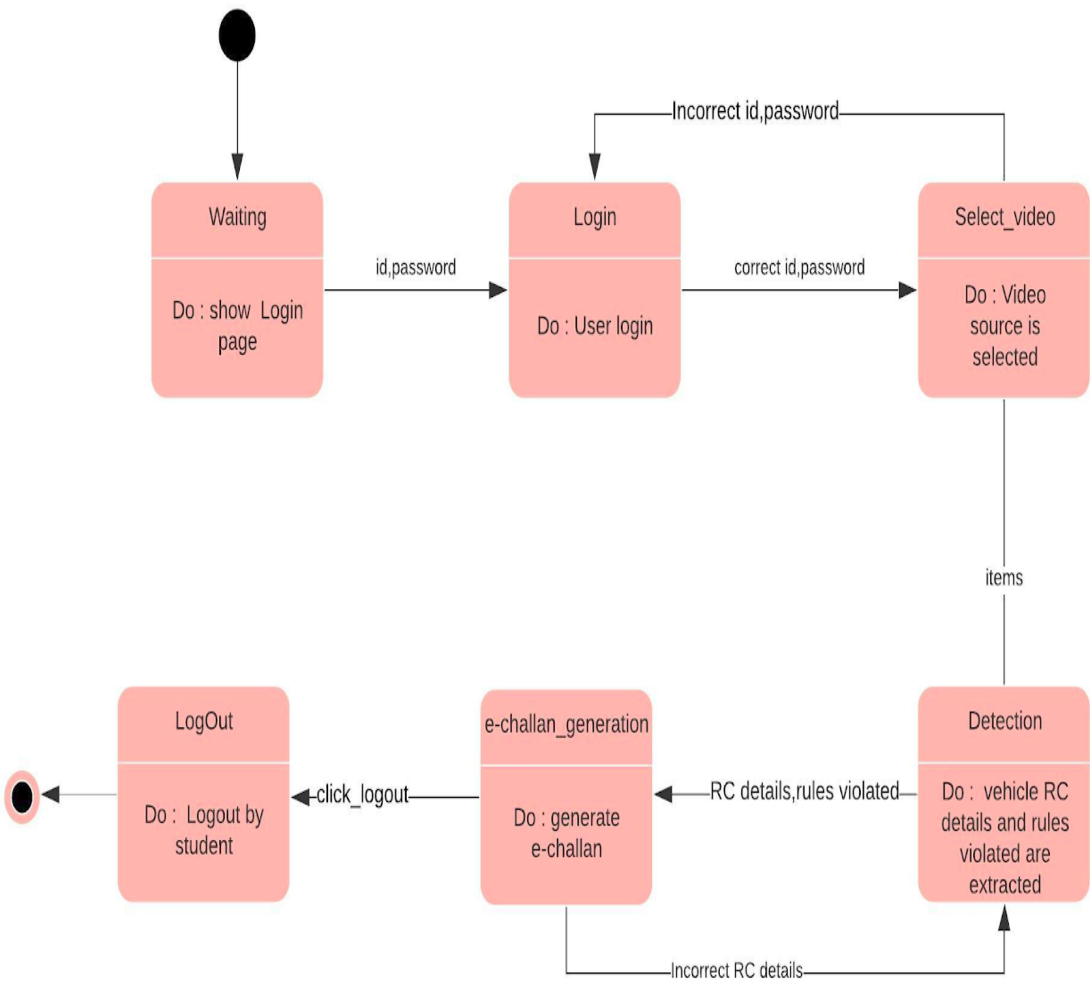

Figure8: State Chart diagram

4.2.6 Class Diagram

Figure 9 shows the class diagram and the relationship between different classes and the scope resolution of their data and also defines the member functions of each class:

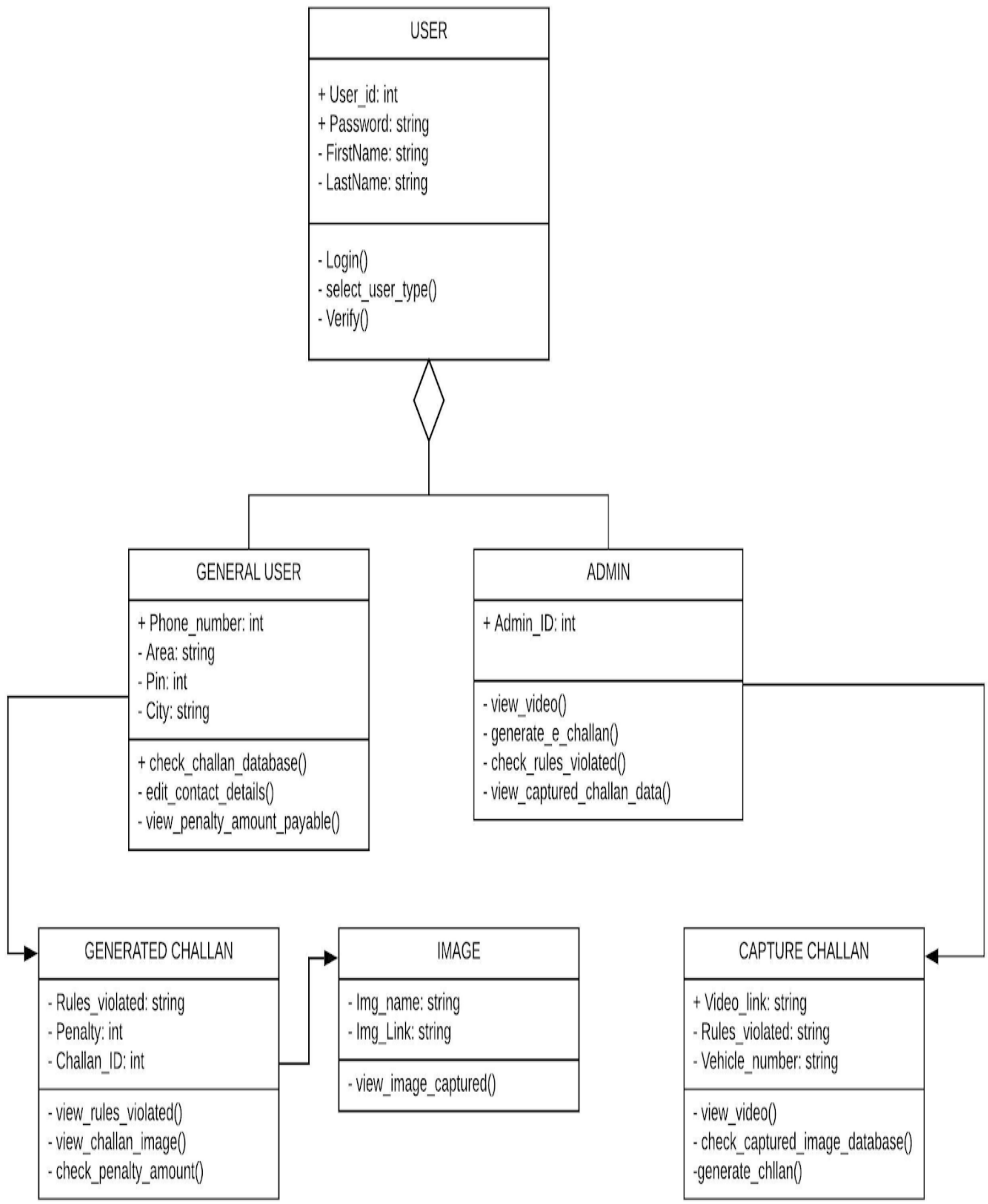

Figure 9: Class diagram

4.2.7 Component Diagram

Component diagrams are basically class diagrams based on the components of a system and are mostly used to model the static system implementation. A component diagram splits the existing system into separate high levels of functionality under construction. The figure 10 shows the component Diagram describing the components used to make the functionalities.

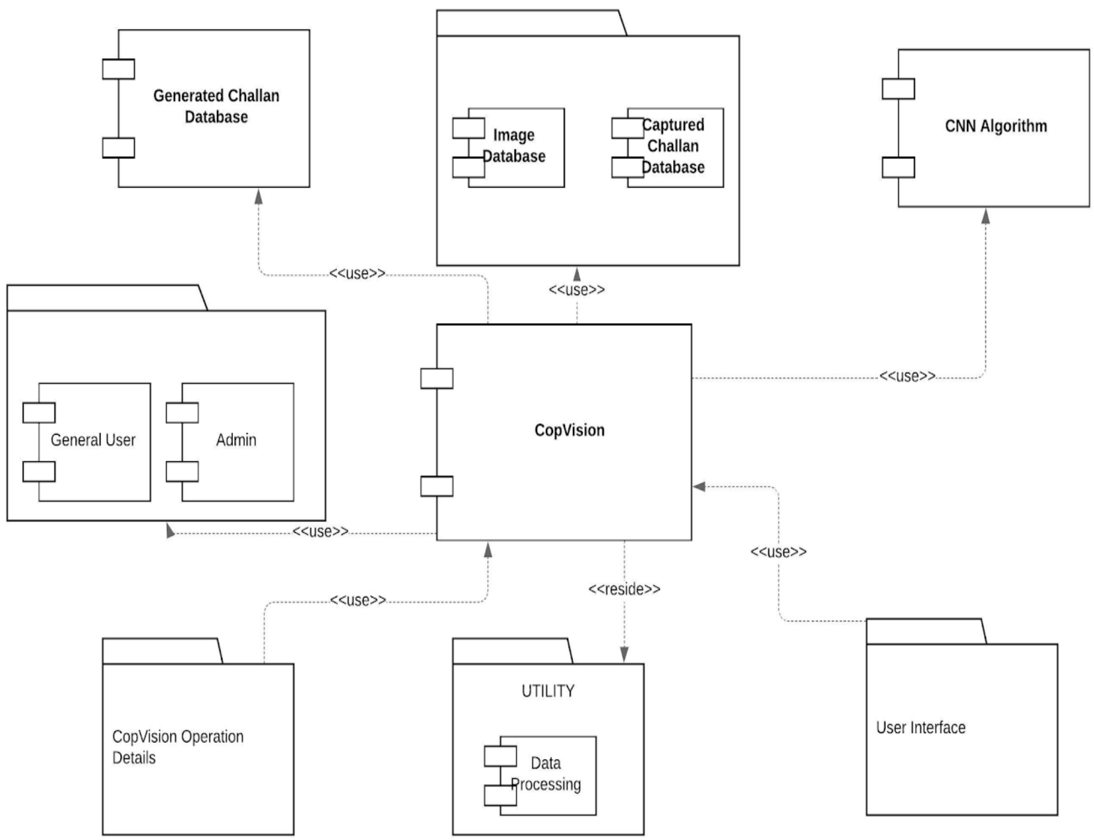

Figure 10: Component diagram

4.3 User Interface Diagram

4.3.1 Use Case Diagram

Figure 11 shows the use case diagram and explains the use case of a user trying to view a challan or an admin trying to upload a video:

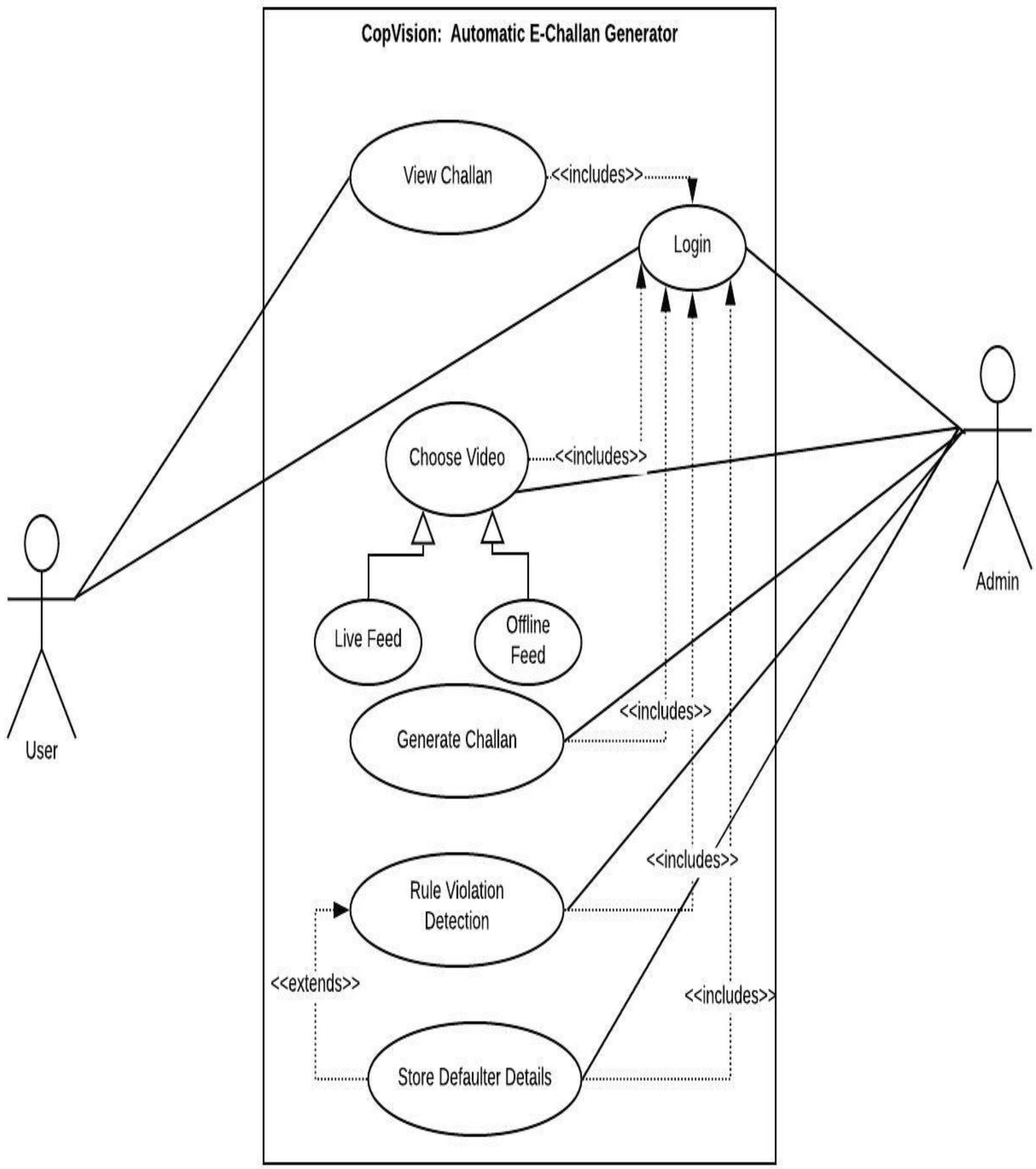

Figure 11: Use Case Diagram

4.3.2 Use Case Template

Use case is a methodology used in system analysis to identify, clarify, and organize system requirements. Table 8 illustrates the use case template.

Table 10: Use case template

ID:	UC_1
Title:	Detect the rule violation
Description:	We feed the input taken from the system to the software which checks the video to find if any violation of registered rules in the application is made by the target person.
Primary Actor:	Vehicle Driver
Secondary Actor:	Admin
Preconditions:	Video is fed into the application and a connection is established between feeder and receiver (in case of live feed).
Post-conditions:	Information about rule violations (if any) is stored into the database.
Includes Use Case:	Login
Extends Use Case:	Store Defaulter Details
Extension:	• The information about the target is not sufficient or not of good quality in order to compare with database • The License number of the person is not visible so a challan cannot be generated.
Frequency of Use:	Always
Modification History:	13/04/20

4.3.3 Use Case Scenario

4.3.3.1 Normal Scenario

1. (SA) System receives the video and segments it to focus on the target.
2. (SA) System derives information from the video.
3. (SA) System inputs the information to compare with the database.
4. (AA) Person has violated a registered rule.
5. (SR) System reports “Fault committed” status.
6. (SA) The information about the number plate is derived.

7. (SA) The person’s details (such as name) are derived from the national database.
8. (SA) The penalty is calculated.
9. (SR) The details are stored into a local database.

4.3.3.2 Alternate Flow

1. (SR) The target's detail (derived information) when compared with information in the database results in “No fault committed” status, thus the program is terminated.

4.3.3.3 Extensions

1. (SR) The information about the target is not sufficient or not of good quality in order to compare with the database and thus the program is aborted.
2. (SR) The License number of the person is not visible so a challan cannot be generated and the system reports an error.

5.1 Experimental Simulation

The experimental setup includes a Web Application in which the user uploads a video in which vehicles are passing on a road and then the user has to press the 'Submit' button. After this, a folder containing images of bike riders with traffic violations i.e. bike riders without helmets and riders with triple riding will be generated and offenders images will be displayed.

We checked the change of coordinates of the motorcycle in order to take the person riding the motorcycle into consideration. The result we got was as follows :

Image Size	Type	Original X1	Original Y1	Original X2	Original Y2	Change X1	Change X2	Change Y1	Change Y1	X2-X1	Y2-Y1	Old(X2-X1)	Old(Y2-Y1)
TESTS SET 1													
900x1200		635	471	827	839	-0.448818897	0	0.380042462	0	477	189	192	368
800x800	Bike	394	393	581	711	0.116751269	-0.07056798	-0.61832061	0	100	561	187	318
800x800	Scooty	41	470	241	727	0.707317073	-0.17012448	-0.61914893	0	130	548	200	257
800x800	Bike	191	364	307	657	0.1151832461	-0.05537459	-0.62087912	0	77	519	116	293
800x800	Bike	368	390	468	604	0.0190217391	-0.01709401	-0.62051282	0	85	456	100	214
800x800	Scooty	30	217	229	655	0.7	-0.17030567	-0.61751152	0	139	572	199	438
800X800	Scooty	230	396	427	722	0.043478260	-0.01639344	-0.74747474	0	180	622	197	326
800x800	Scooty	403	335	745	807	0.114143920	-0.12751677	-0.62089552	0	201	680	342	472
RESULTS SET 1	Mean Change Values(For Bike Width)					0.083652084	-0.04767886	-0.61990418	0				
						0.391234813	-0.07230539	-0.62070417	0				

Figure 12: Simulation

Results obtained were: Focus on hands and head of a person to detect a person, results can change according to traffic,vehicle and span of object in image. The height detection ratio is almost similar for both scooters and bikes.Also, we can make changes according to that of the bike or for scooty and may get satisfactory results.

5.2 Experimental Analysis

5.2.1 Data

The training data for the project CopVision includes various images of two-wheeler riders wearing helmets and without helmets, and also images of bike riders with triple and double riding and images of number plates of different vehicles. Testing data for the project consists of videos with vehicles passing on a road.

5.2.2 Performance Parameters

1. **Time Delay:** Time taken between the video submission to the software and generation of the output images folder is one of the most important performance parameters. The delay is inversely proportional to the efficiency of the software. The lesser the delay the better the efficiency and performance of the system. The delay is caused due to processing of images while extraction of the frames consisting of the bike images, signal from the app to the surveillance area and back to it.
2. **Accuracy:** The accuracy of the recognized traffic rules violators is also an important performance parameter that might produce false output if not taken into account. The more the accuracy of the system the better is the performance as true output would be generated.
3. **Ease of use:** In the end it is the user who will benefit from the system so it is important for the team to generate a system front end which is set according to the user perspective. Our system takes care for the "ease of use" of the user by using a simple front end of the application.

5.3 Working of the Project

5.3.1 Procedural Workflow

Phase I:

Detection of Bike-riders:-

1. Thresholding: Image segmentation is done by performing thresholding operation on the frames obtained in order to get contours, which further are attached by performing another morphological operation- closing.
2. Aspect ratio: Centre of mass is tracked and we try to distinguish between a car and a bike, a horizontal center line(CL) on the frame enables us to do the same by using the concept of aspect ratio;

Phase II:

Detection of Bike-riders not following traffic rules:-

1. Feature Extraction: Identified region (25%) around the head of the bike-rider is used to determine if the bike rider is using the helmet or not.
2. Classification: (through SVM- support vector machine; Machine Learning algorithm) The method needs to determine if the biker is violating the law (i.e. not using the helmet and tripling). For this we consider two classes, Bike-rider not following traffic rules (Positive result) and Bike-riders following traffic rules (Negative result).

After building all the modules we will integrate them. Testing will be our next phase to make it more feasible, reliable and compatible in every aspect. Also, we will try to make further improvements.

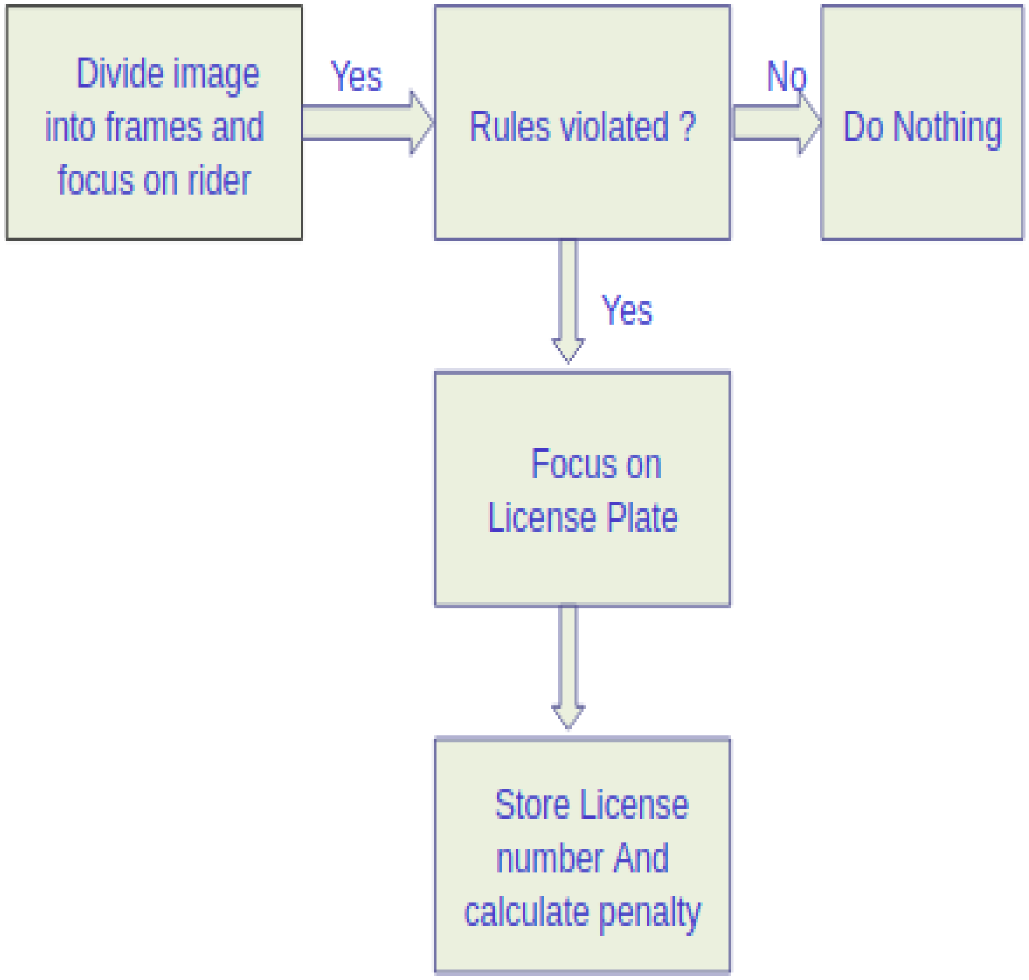

Figure 13: Procedural Workflow - Violation Detection

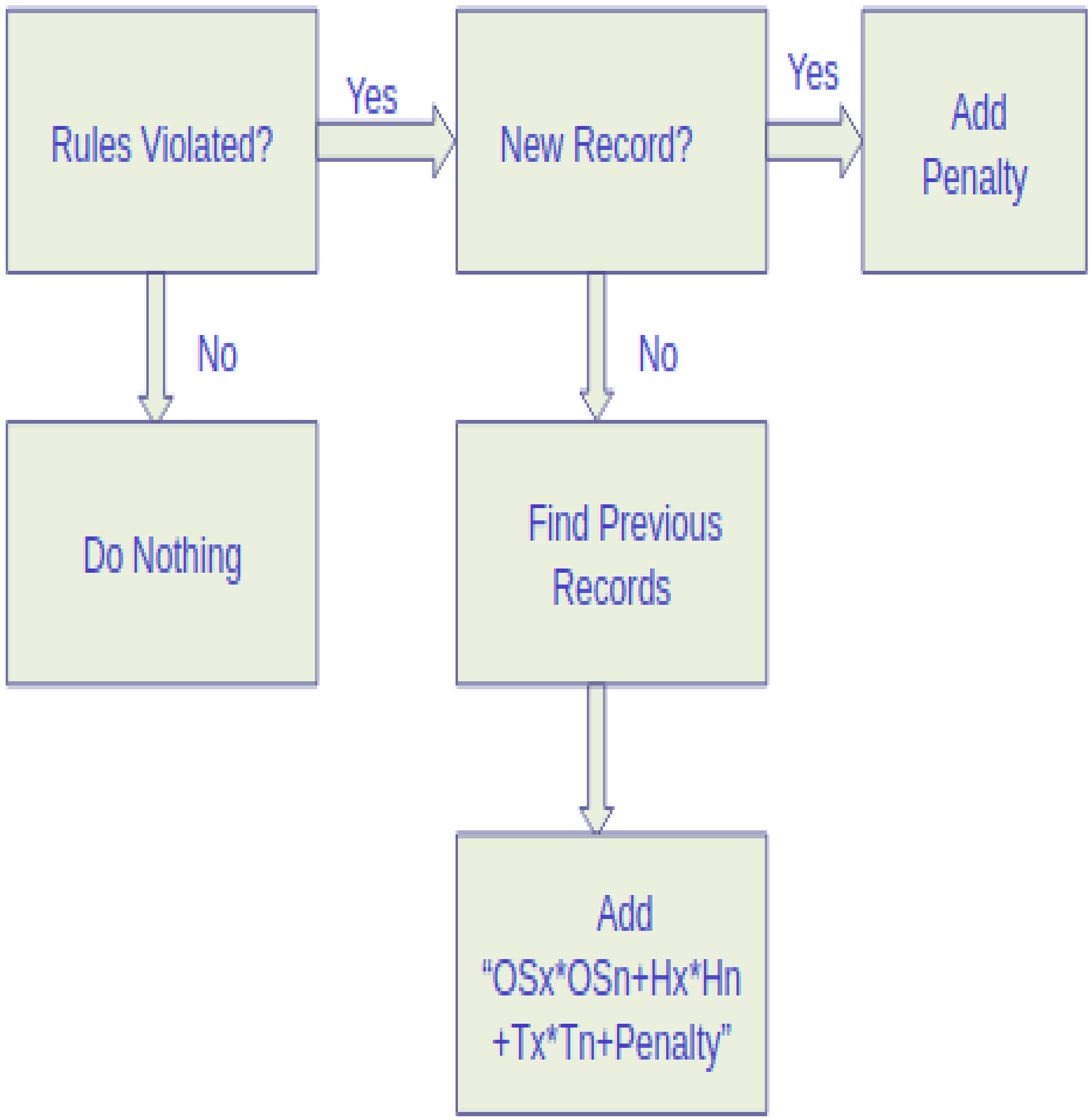

Figure 14: Procedural Workflow - Penalty Calculation

5.3.2 Algorithmic Approaches Used

Pseudocode of CopVision project:

All functions are represented in format :

function_name(formal-parameters{})

All functions in bold are user-defined while others (not in bold) are defined in the language used.

```
1.DefaultLoader():
    LoadFiles()
    LoadLibraries()
    LoadModel()
    video_path ← take_input("video path")
    no_of_images ← take_input("no of images")
    AnalyseVideo(video_path,no_of_images)

2.AnalyseVideo(video_path,no_of_images):
    video ← get(video_path)
    challans ← initialize-list(empty)
    frameIncrement ← 200
    imagesAdded ← 0
    deltay1 ← -0.29
    frameSize ← (800,800)
    while (video does not end) and (imagesAdded<no_of_images) do:
        frame ← get_frame_from_video(video)
        store(frame)
        detections ← make_detections(frame)
        for every motorcycle detected in detections do:
            x1,x2,y1,y2 ← box_plot_points[detected-motorcycle]
            y1 ← (y1+deltay1*y1)
            curr_frame ← frame[x1-x2,y1-y2]
            numberOfHelmets ← detect-helmets(curr_frame)
            store(curr_frame)
            curr_detections ← make_detections(frame)
            numberOfPeople ← 0
            for every person detected in detections do:
                numberOfPeople ← numberOfPeople+1
            end for
            marked_frame ← markItems(curr_frame)
            store(marked_frame)
```

```
                    challan_result ← markChallan(numberOfPeople,
                                                  numberOfHelmet)
                    if the person is a defaulter then:
                            numberPlate ← getNumberPlate(curr_frame)
                            Store data in challans
                    end if
                    count ← count+frameIncrement
                    imagesAdded ← imagesAdded+1
                    Forward video to count frame
            end for
    end while
    return challans
```

3.**make_detections**(image):

```
    model ← get(model_path)
    result ← detect_items_in_model(model,image)
    return result
```

4.**detect-helmets**(image):

```
    model ← get(model_path)
    result ← detect_helmets_in_model(model,image)
    return result
```

5.**get_number_plate**(image):

```
    x1,x2,y1,y2 ← box_plot_points[numberPlateLocation(image)]
    new_image ← image[x1-x2,y1:y2]
    numberPlate_result ← result(Use OCR app using api)
    if numberPlate_result is equal to ”Not Detected” then:
            return “Number not detected”
    else
            return  number(numberPlate_result)
    end if
```

6.**markItems**(image):

```
    for every helmet in image do:
             x1,x2,y1,y2 ← box_plot_points[curr_helmet]
            make_a_rectangle(image,[x1,x2,y1,y2])
    end for
    for every person in image do:
             x1,x2,y1,y2 ← box_plot_points[curr_person]
```

```
        make_a_rectangle(image,[x1,x2,y1,y2])
    end for

7.markChallan(numberOfPeople,numberOfhelmets):
    if numberOfPeople<numberOfhelmets then:
        return "Machine Error or image issue occured"
    end if
    triplingFault←False
    helmetFault←False
    if numberOfPeople is greater than or equal to 3 then:
        triplingFault←True
    end if

    if numberOfHelmets<numberOfPeople then:
        helmetFault←True
    end if
    if helmetFault and triplingFault then:
        challan←"The faults are 1. Not wearing Helmet for all riders 2. Triple
        riding"
    elseif helmetFault or triplingFault:
        challan←("The fault is 1. " + ("Not wearing Helmet for all riders" if
        helmetFault else "Triple riding"))
    else
    challan="No challan"
    end if
    return challan
```

5.3.3 Project Deployment

Component diagrams are basically class diagrams based on the components of a system and are mostly used to model the static system implementation. A component diagram splits the existing system into separate high levels of functionality under construction. The figure 14 shows the component Diagram describing the components used to make the functionalities.

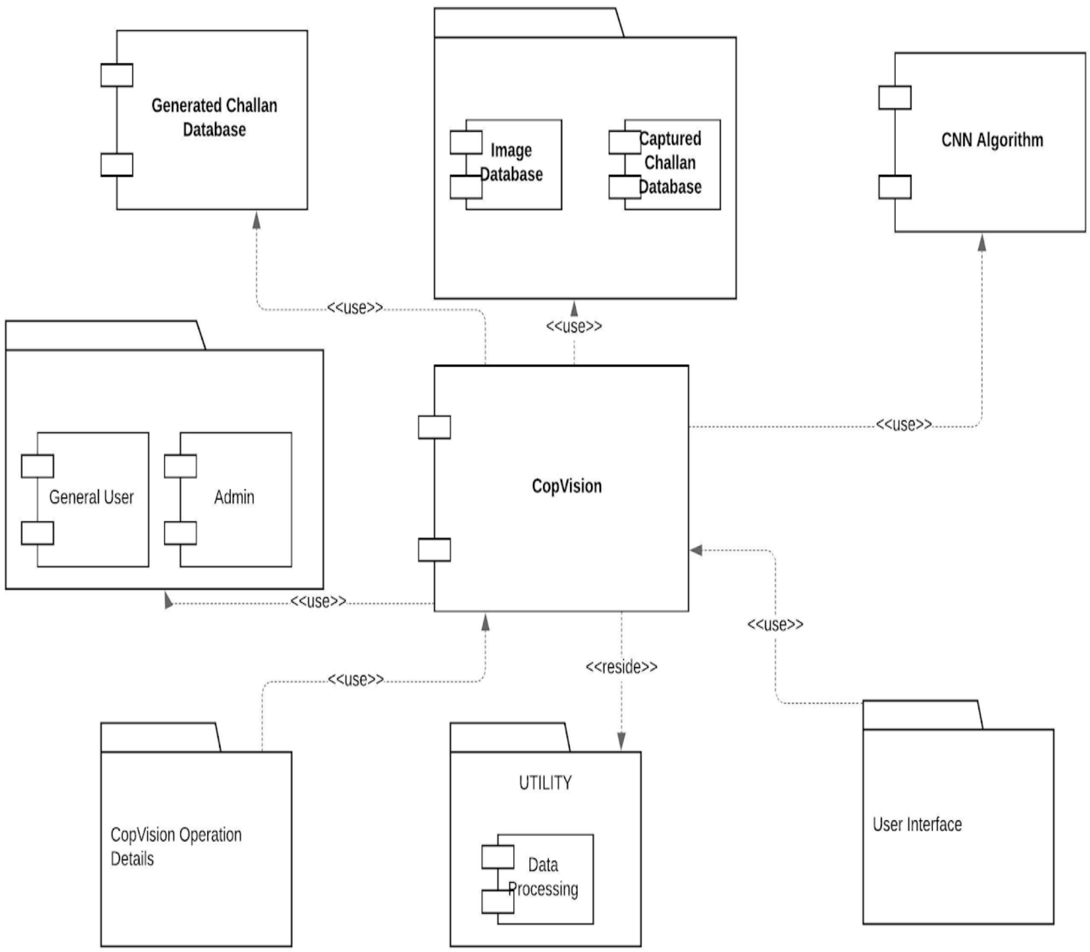

Figure 15: Component diagram

Figure 15 shows the Deployment diagrams which are a type of diagram used to model object-oriented system physical aspects. They are also used for modelling a system's static deployment view (hardware topology). The figure shows a Deployment Diagram of CopVision and shows how the components are running on each node.

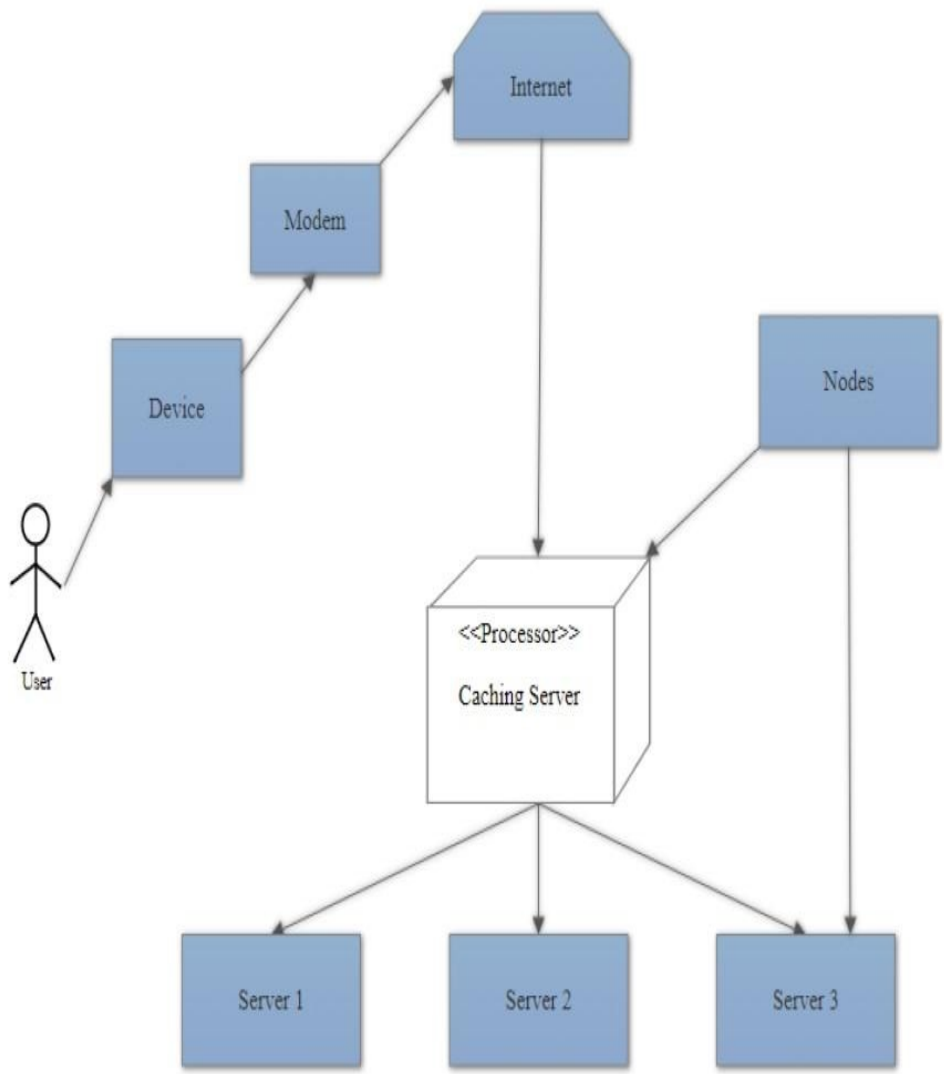

Figure 16: Deployment diagram

5.3.4 System Screenshots

Figure 16-29 illustrate the System screenshots:

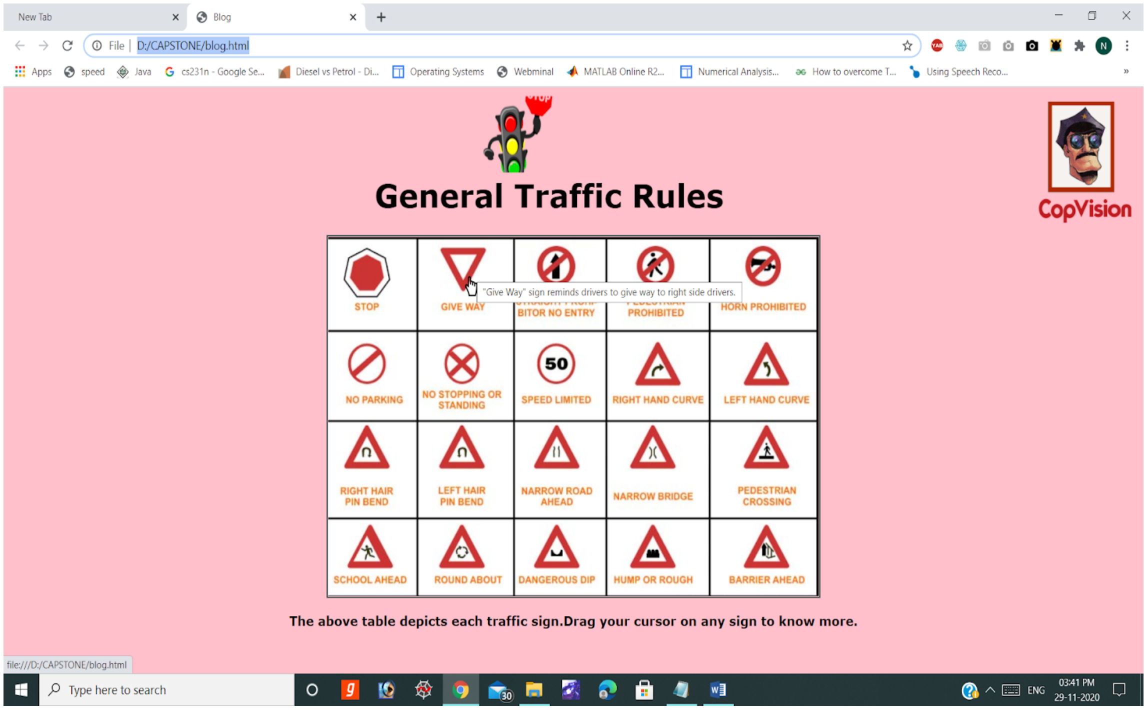

Figure 17: Web page explaining general traffic rules

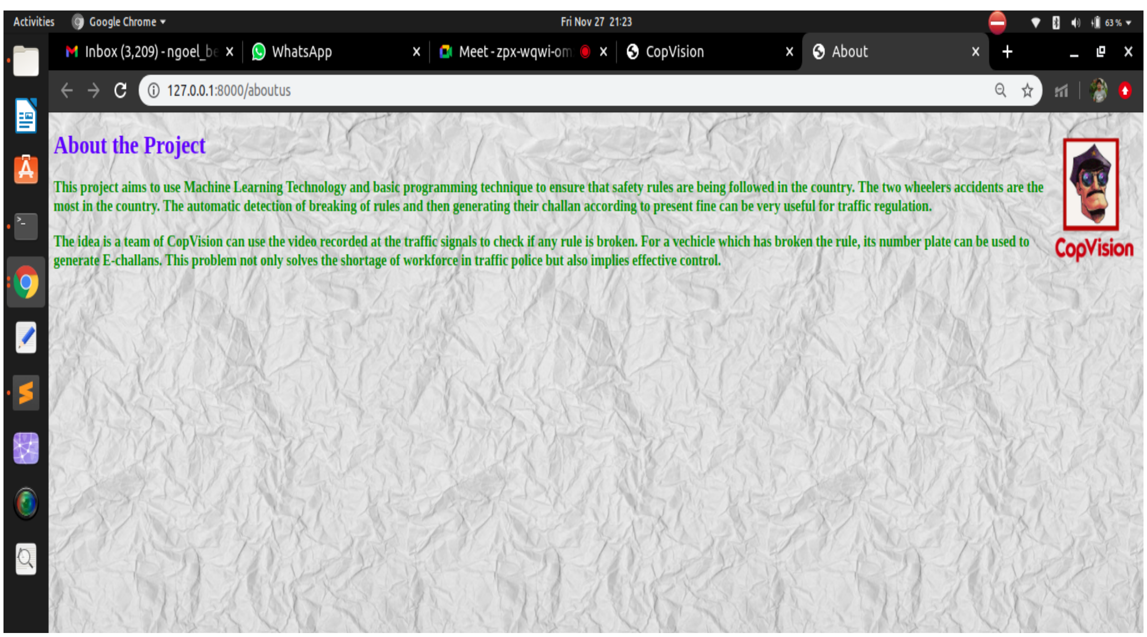

Figure 18: About Us page of website

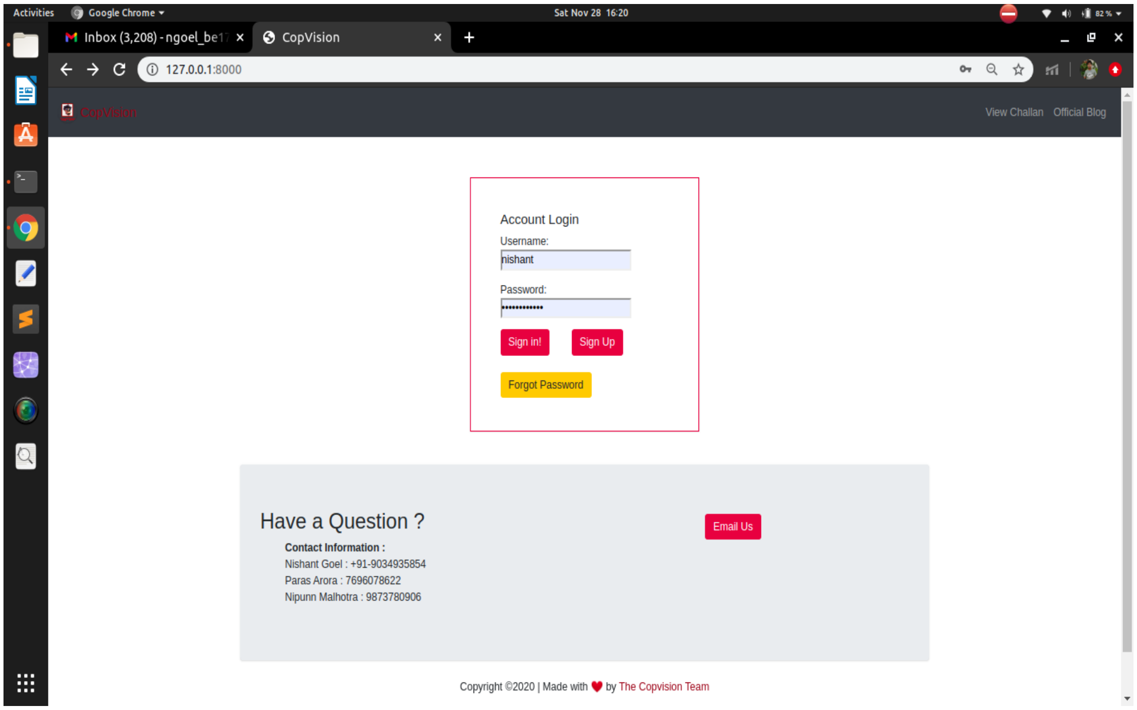

Figure 19: Login page

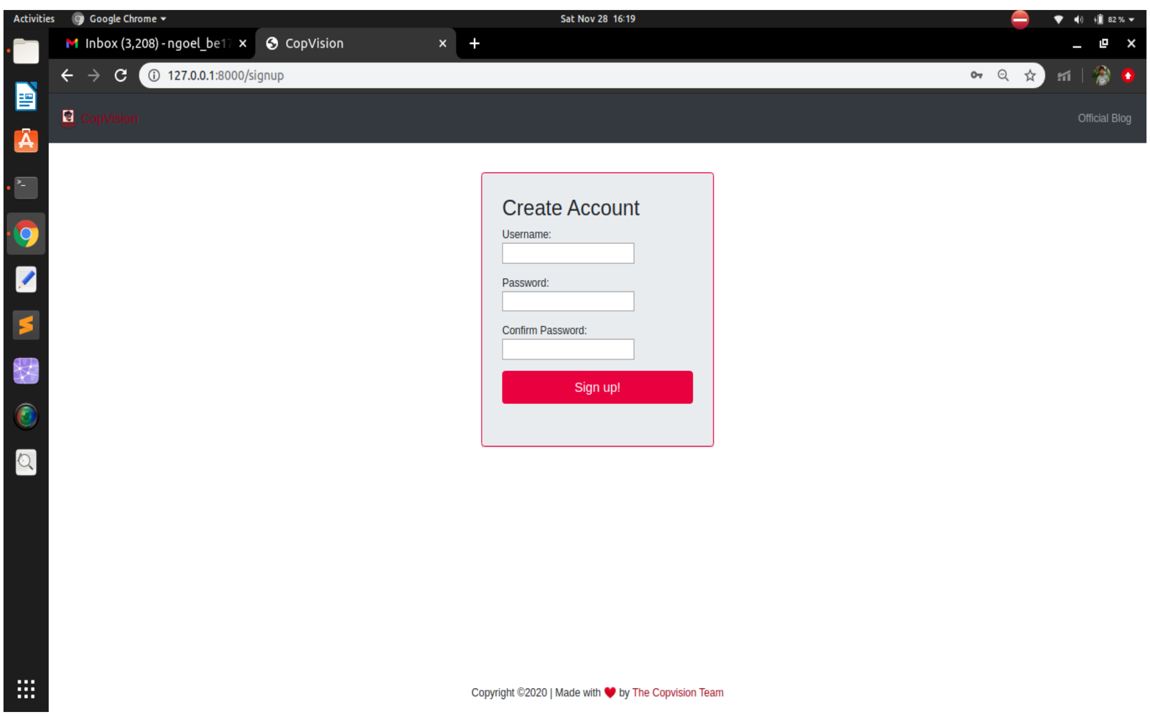

Figure 20: Sign-up page

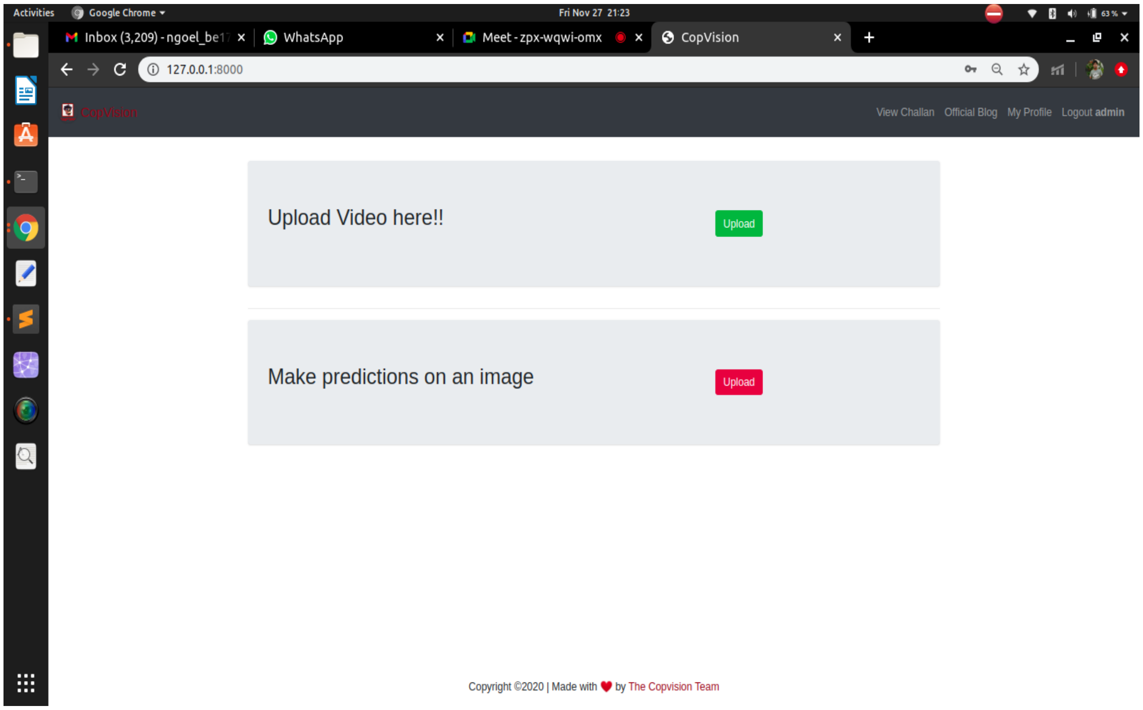

Figure 21: Home page

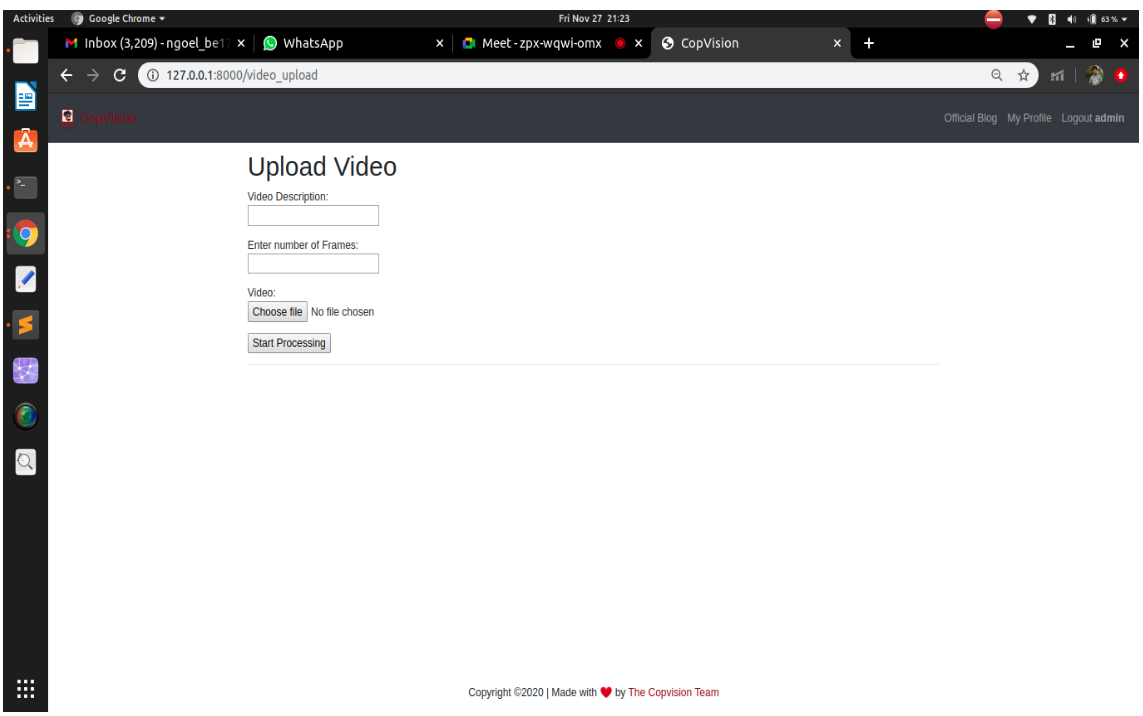

Figure 22: Upload video

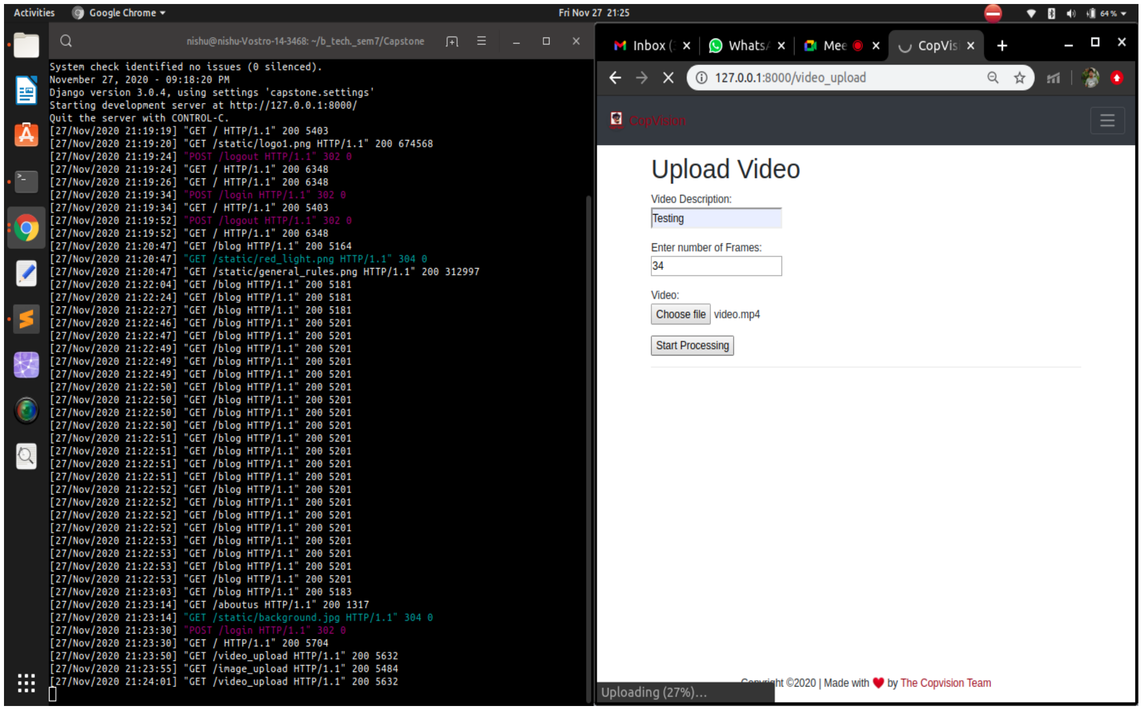

Figure 23: Processing the video

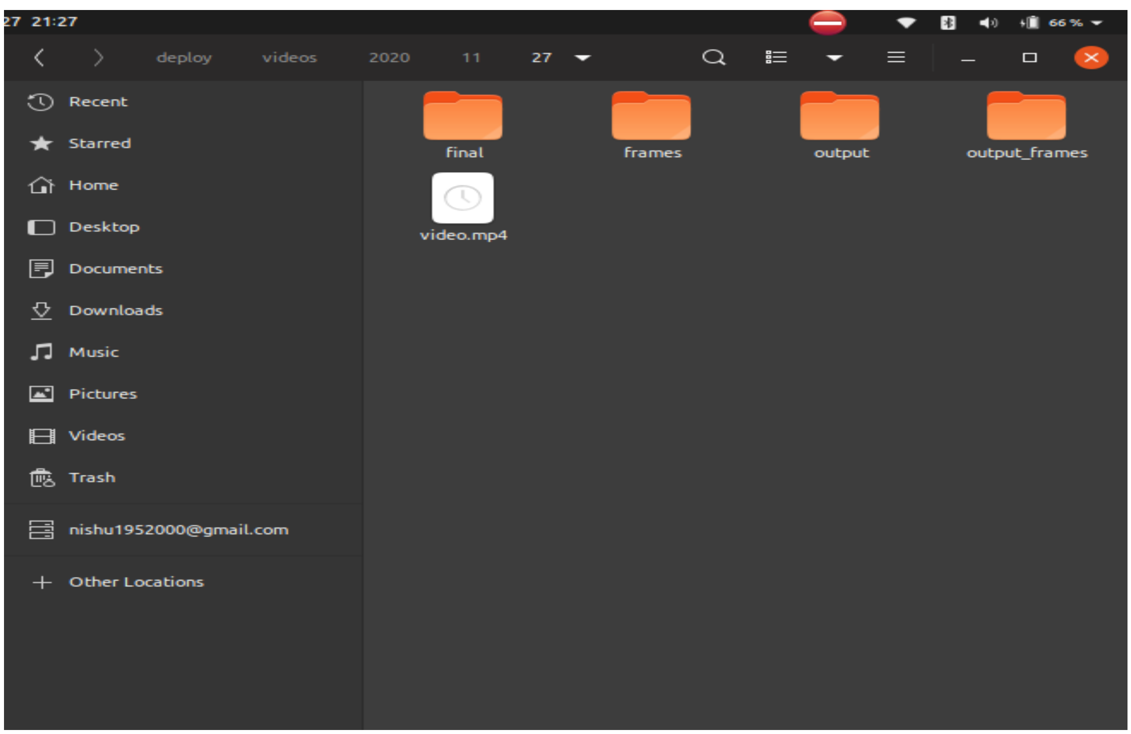

Figure 24: Output folder generated

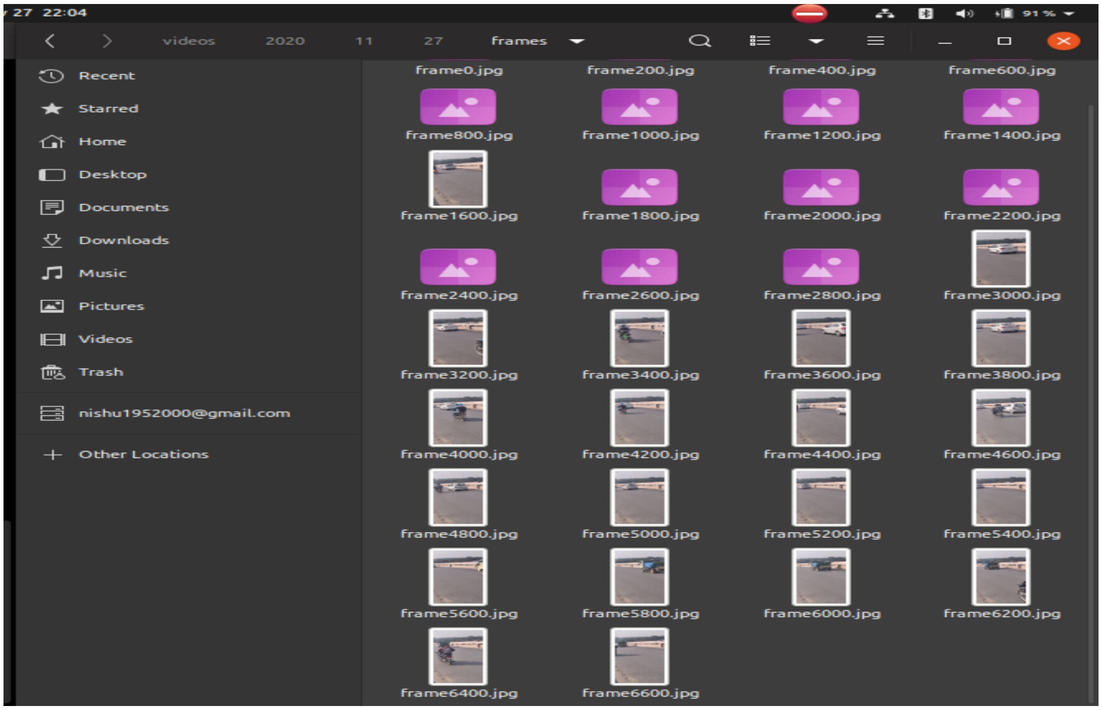

Figure 25: Final output folder

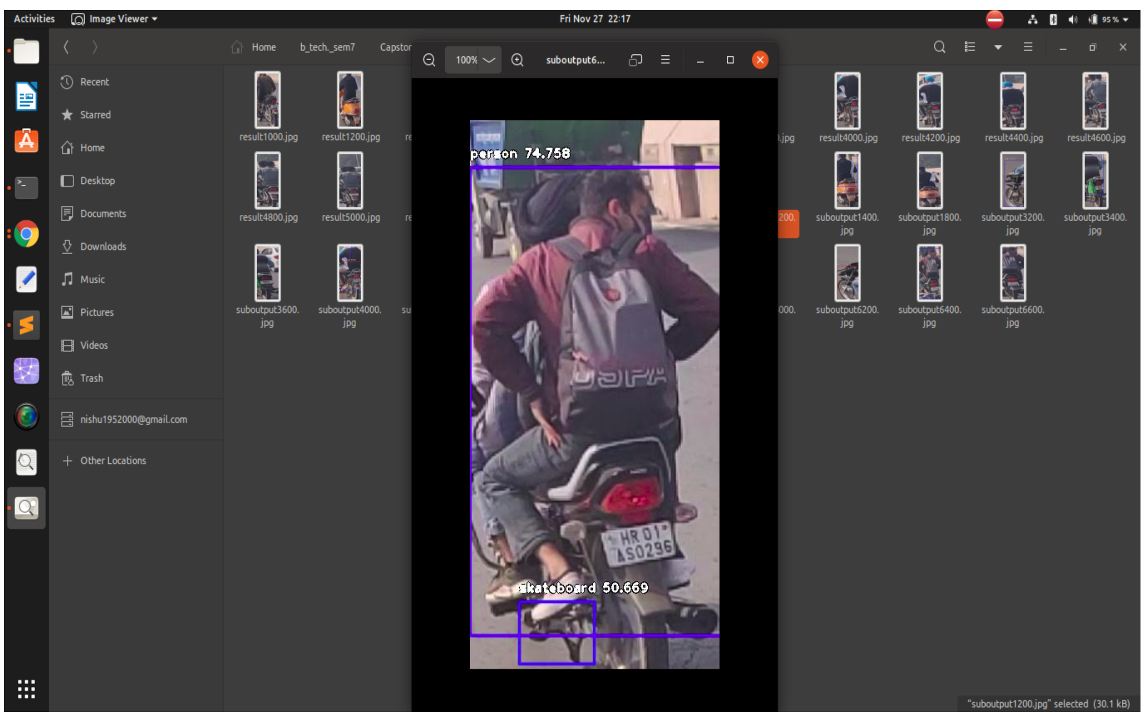

Figure 26: Offender detection

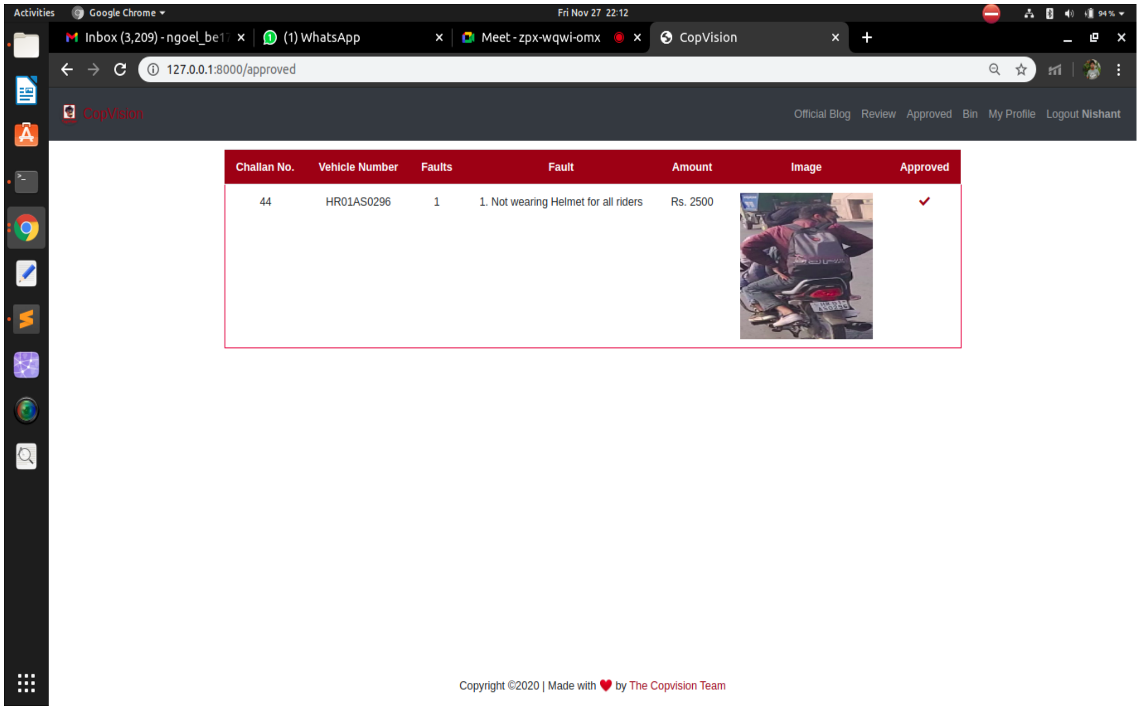

Figure 27: Offender detected moved to approve challan

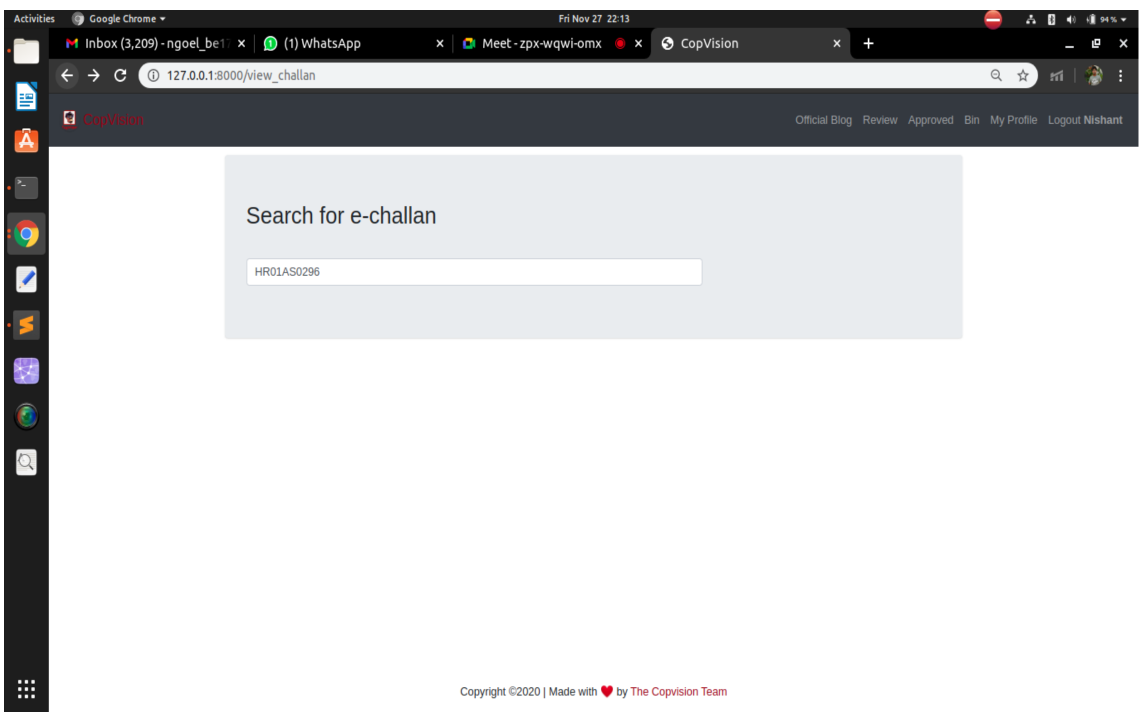

Figure 28: Challan search page

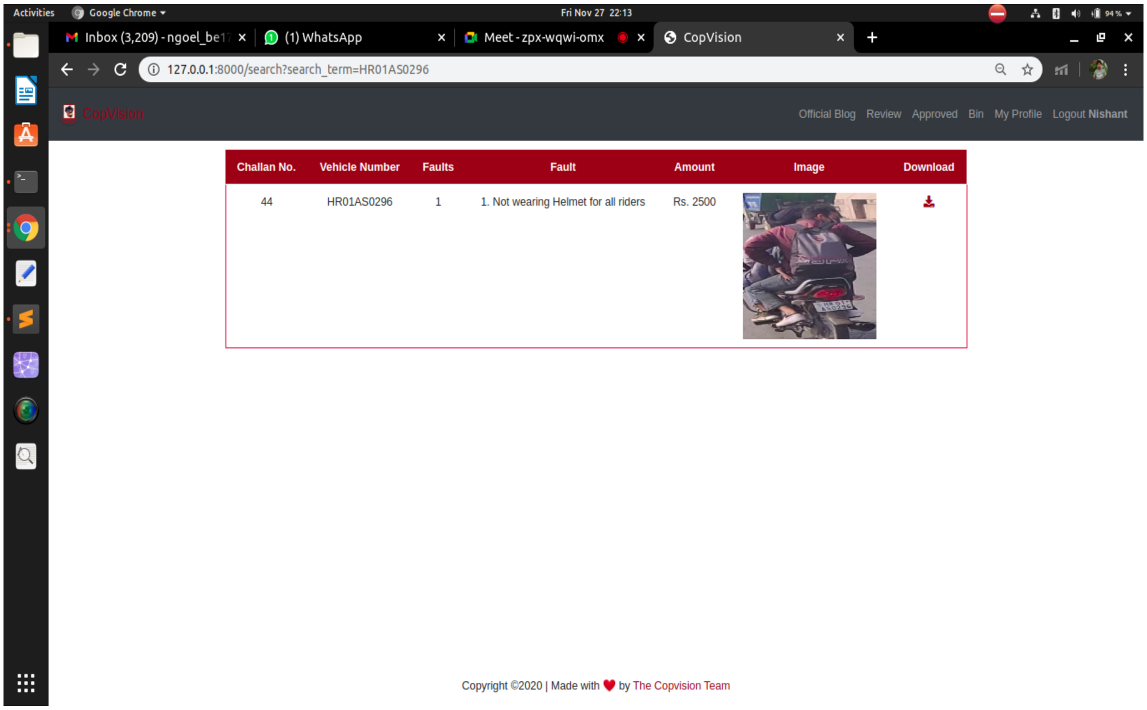

Figure 29: Challan pdf download page

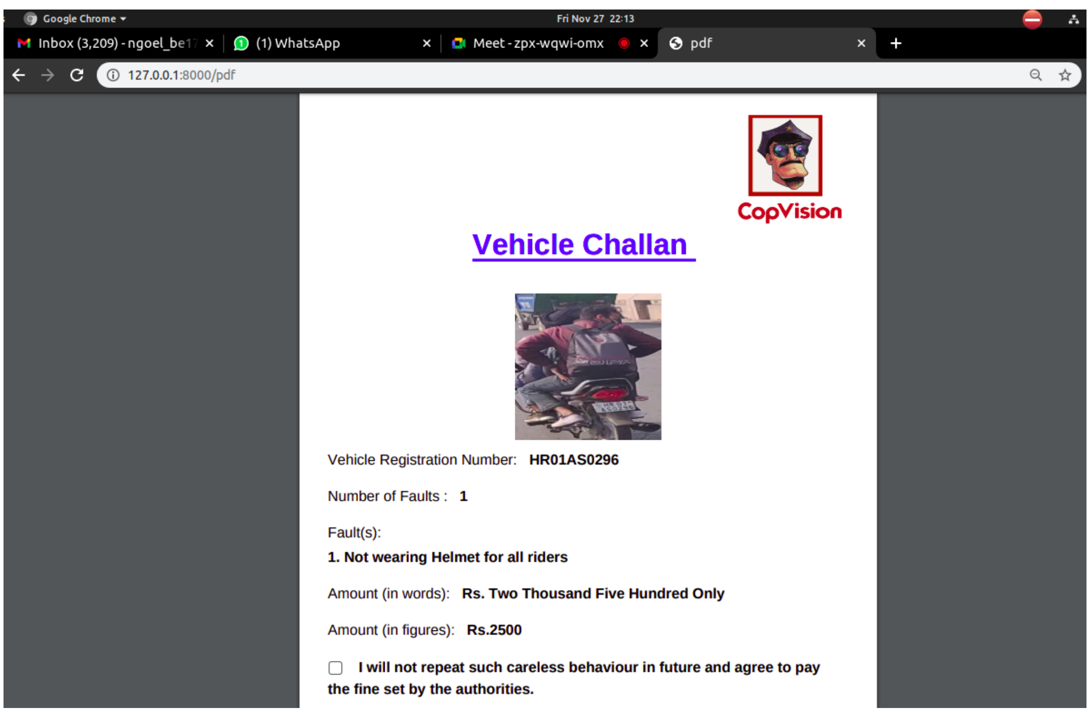

Figure 30: Pdf downloaded

5.4 Testing Process

5.4.1 Test Plan

The testing cycle incorporates testing of each and every part of CopVision. The testing singular parts which incorporate web application, python program, Feature Extraction program, and so on.

5.4.2 Features to be tested

The following features need to be tested:

- Video with .mp4 format should be uploaded successfully.
- The web application should be able to send requests to the web server
- The analysis of the video should be accurate and correctly in recognizing offenders.

5.4.3 Test Strategy

The following strategies were used while testing:

- Testing will be focused on meeting project objectives, efficiency and quality.
- Testing processes will be well defined, yet flexible, with the ability to change as needed.
- Testing activities will build upon previous stages to avoid redundancy or duplication of effort.
- Testing environment and data will emulate a production environment as much as possible.
- Testing will be a repeatable, quantifiable, and measurable activity.
- Testing will be divided into distinct phases, each of which is clearly defined.

5.4.4 Test Techniques

1. **Black Box Testing:** It is also known as Behavioral Testing, is a software testing method in which the internal structure/design/implementation of the item being tested is not known to the tester. These tests can be functional or non-functional, though usually functional.

   This method is named so because the software program, in the eyes of the tester, is like a black box; inside which one cannot see. This method attempts to find errors in the following categories:

   - Incorrect or missing functions
   - Interface errors
   - Errors in data structures or external database access
   - Behavior or performance errors
   - Initialization and termination errors

2. **White Box Testing:** White Box Testing is a software testing method in which the internal structure/design/implementation of the item being tested is known to the tester. The tester chooses inputs to exercise paths through the code and determines the appropriate outputs. Programming know-how and the implementation knowledge is essential. White box testing is testing beyond the user interface and into the nitty-gritty of a system. This method is named so because the software program, in the eyes of the tester, is like a white/transparent box; inside which one clearly sees. This type of testing can be commenced at an earlier stage. One need not wait for the GUI to be available. This type of testing is more thorough, with the possibility of covering most paths.

5.4.5 Test Cases

The following table 9 mentions the various test cases that were tested for the system along with their expected and actual outputs.

Table 11: Test Cases

S.No.	Test Case	Input	Expected output	Actual Output	Result
1	Login to the web application	username and password	Should login successfully to the system	Login is successful	Successful
2	Logout from the web app	click logout button	Should log out of the app	Logout is successful	Successful
3	The user submits a valid video format	Valid video	The web application should be able to show images of offenders.	The web application shows images of offenders.	Successful
4	Offender detection	Valid video	Output images containing images of offenders.	Output images containing images of offenders.	Successful
5	Detect Bike rider frames from video	Valid video	Bike rider Frames extracted	Bike rider Frames extracted	Successful
6	Challan Approval	Approving correct prediction of offender	Challan should move under approved section	Challan moved under approved section	Successful
7	Challan Restore	Rejecting wrong prediction because of machine error	Challan should move under restored section	Challan moved under restored section	Successful

8	Model Building Helmet detection	Helmet_features.csv file	Acceptable accuracy	80.61% accuracy that is acceptable	Successful
9	Model Building Bike detection	Bike_dataset.PNG	Acceptable accuracy of bike detection	89.3333% accuracy that is acceptable	Successful
10	Pdf generation of challan	Vehicle number	Pdf should be generated and downloaded	Pdf generated and downloaded	Successful

5.4.6 Test Results

All the test cases were successful. The application worked as expected and as if there were any bug or corner cases, they were fixed while testing. Figure 17 to Figure 21 shows the screenshots of the test cases.

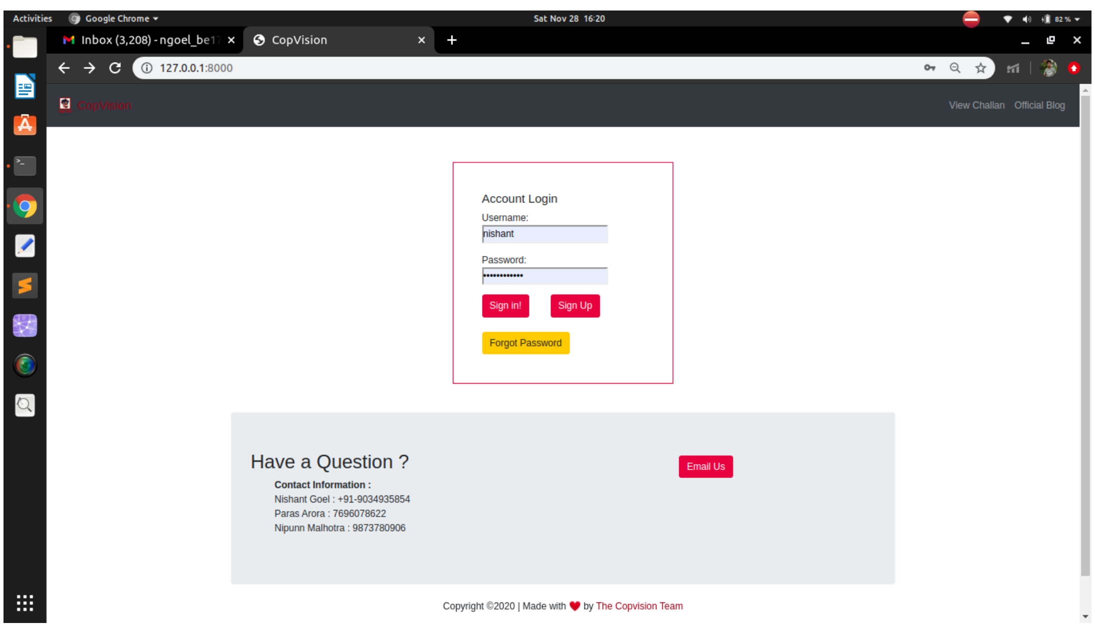

Figure 31: Login to the web application

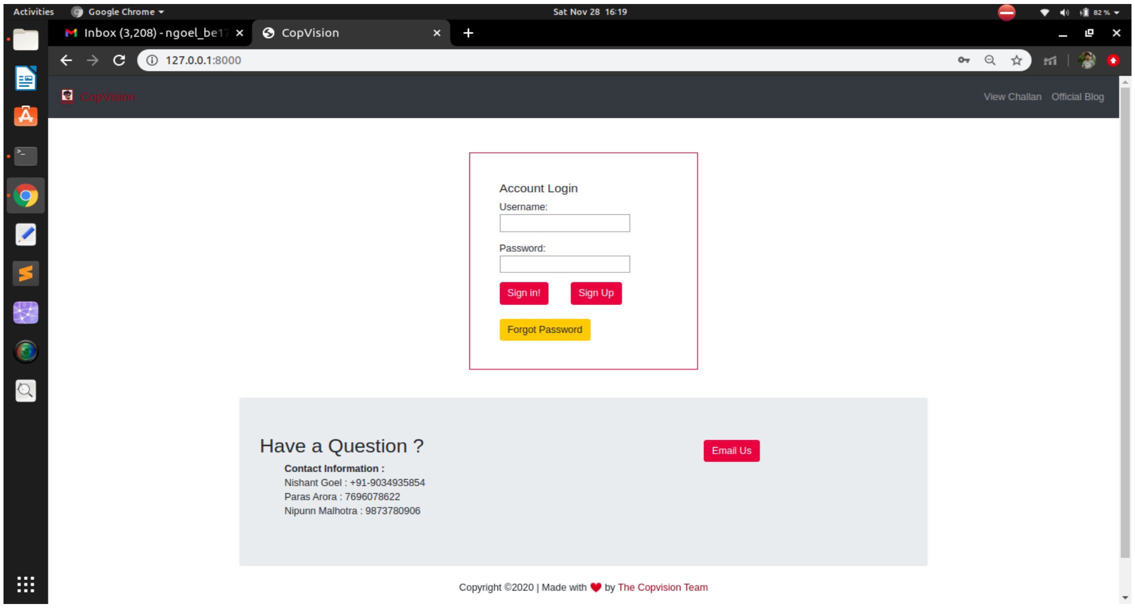

Figure 32: Logout from the web application

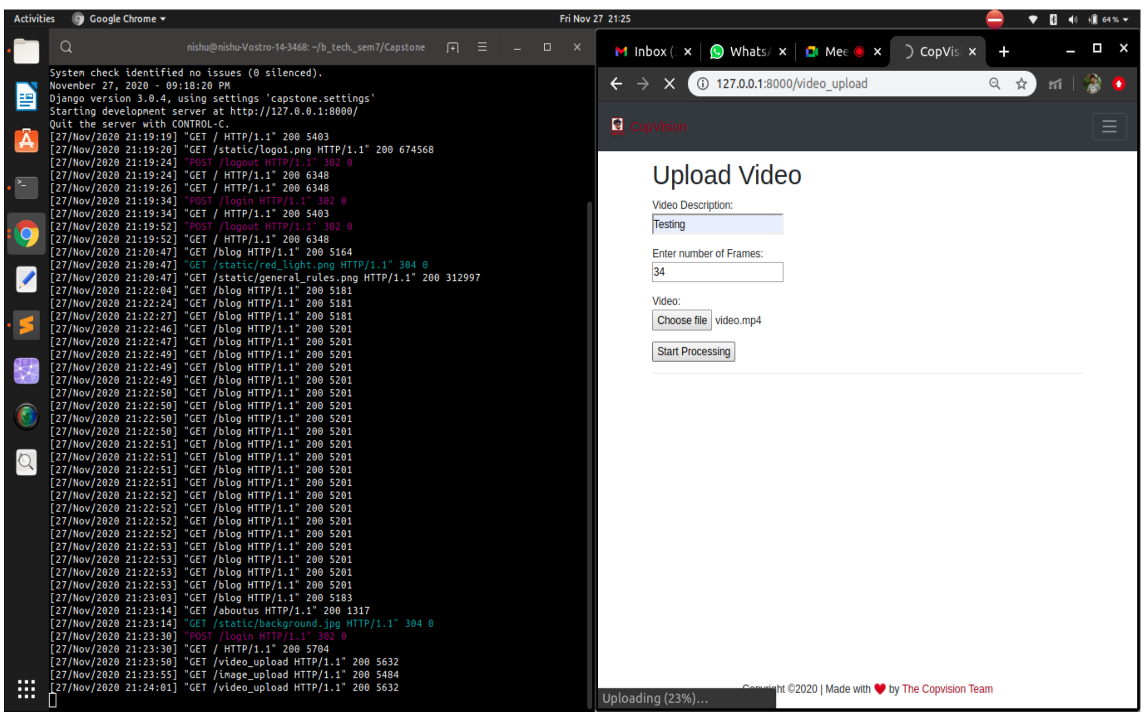

Figure 33: Valid Video

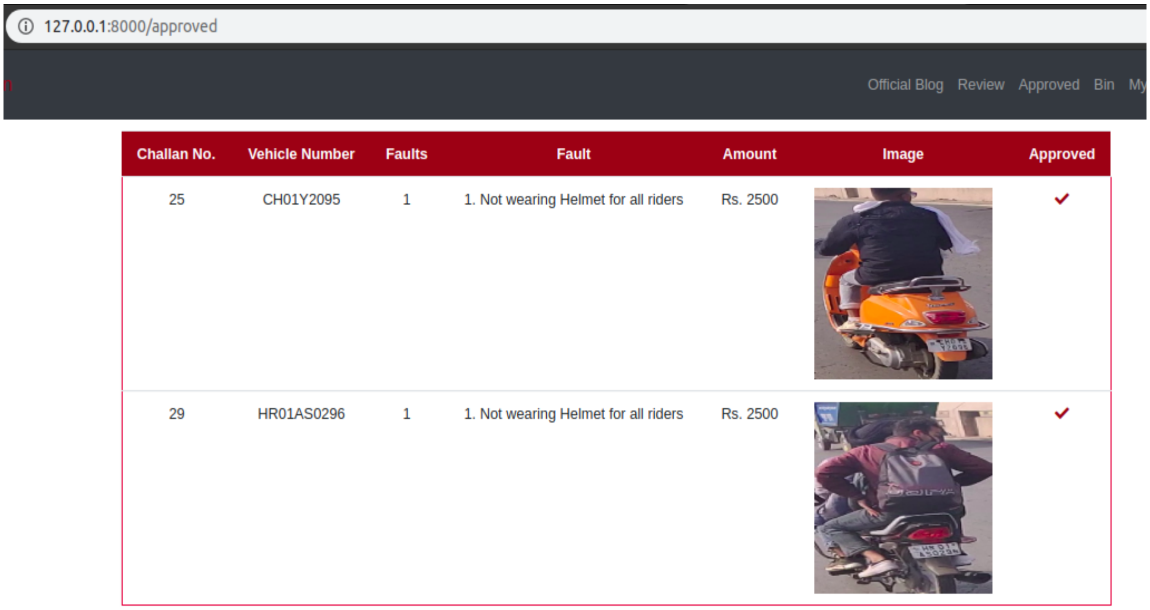

Figure 34: Offender Detection

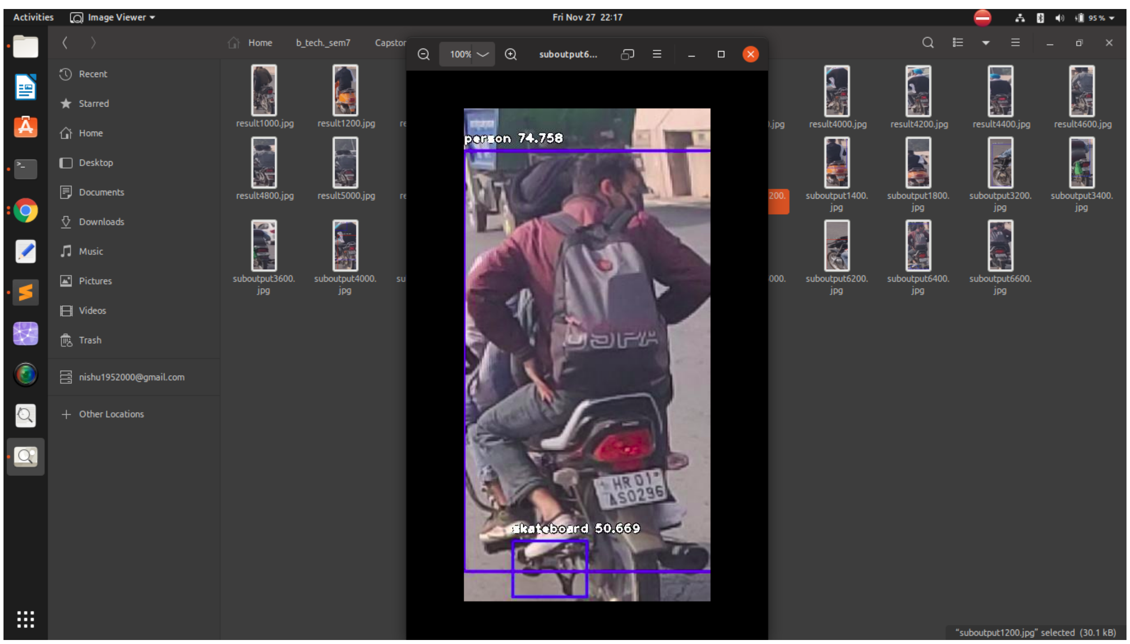

Figure 35: Detect Bike rider frames from video

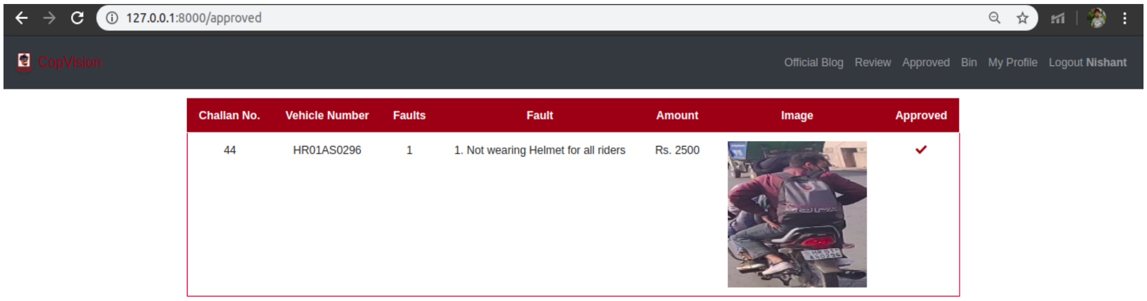

Figure 36: Challan approval

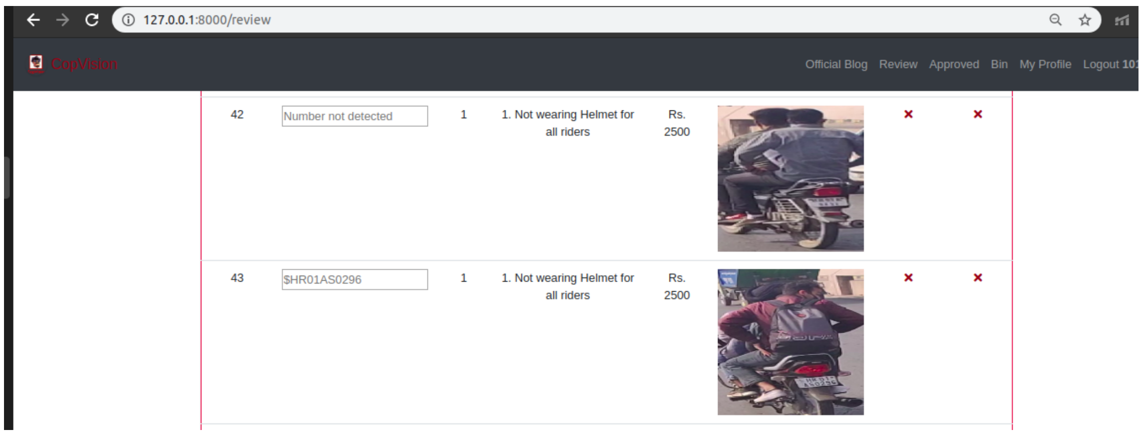

Figure 37: Challan restore

```
In [112]: result
Out[112]:
              Filename  Number of Helmets
0     BikesHelmets0.xml                  4
1     BikesHelmets1.xml                  1
2     BikesHelmets2.xml                  3
3     BikesHelmets3.xml                  2
4     BikesHelmets4.xml                  1
..                 ...                ...
93   BikesHelmets95.xml                  2
94   BikesHelmets96.xml                  1
95   BikesHelmets97.xml                  5
96   BikesHelmets98.xml                  0
97   BikesHelmets99.xml                  2

[98 rows x 2 columns]

In [113]: print("Samples Evluated: ",len(result))
     ...: print("Accuracy is: ",(accuracy/len(result)))
Samples Evluated:  98
Accuracy is:  0.8061224489795918
```

Figure 38: Model Building Helmet detection

```
In [44]: result
Out[44]:
       Id  isBike
0       0       1
1       1       1
2       2       1
3       3       1
4       4       1
..    ...     ...
145   145       0
146   146       1
147   147       1
148   148       1
149   149       1

[150 rows x 2 columns]

In [45]: print("Samples Evaluated ",len(result))
Samples Evaluated  150

In [46]: print("Accuracy is ",(float) (result['isBike'].sum()/
len(result)))
Accuracy is  0.8933333333333333
```

Figure 39: Model Building Bike detection

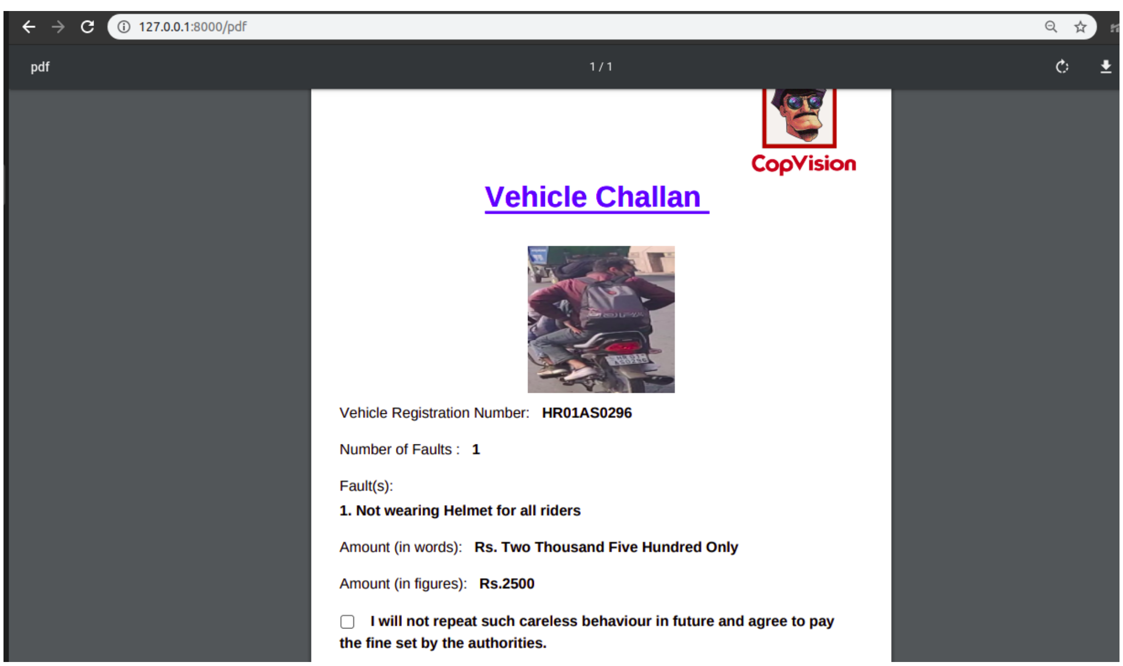

Figure 40: Pdf generation of challan

5.5 Results and Discussion

The error of the components of the system is under acceptable limits. The overall accuracy of the system is good. The device should require a video with format and good resolution for good results.

5.6 Inferences Drawn

Our task fulfills all the essential usefulness as we need yet, there is a lot to be improved particularly the quality of yield pictures. The precision of the framework can be improved by expanding the dataset containing more adverse example pictures like pictures of individuals wearing various sorts of caps.

5.7 Validation of Objectives

Table 12: Validation of Objectives

S.no.	**Objective**	**Result**
1	Minimize human efforts through automation.	Successful
2	Detect 2-wheeler motor vehicle riders wearing helmets or not.	Successful
3	Detect 2-wheeler motor vehicle riders tripling or not.	Successful
4	Create a web interface for application.	Successful

CONCLUSION AND FUTURE DIRECTIONS

6.1 Conclusions

Conclusion of the report is that implementation of the helmet, tripling detection and number plate detection was the first step after which other steps are performed. We have developed a project which has achieved motion detection along with differentiating between various vehicles using python and various machine learning algorithms. The dataset of bike riders were collected and analysed. Further, the vehicle was differentiated to ascertain its type whether it is a car or a bike. The frame containing a two wheeler is extracted, and the top 25 percent is further extracted to check the presence of a helmet. Similarly, the number of riders on the same bike are detected. A classification model is developed and an ongoing collection of the training dataset for the classification model to run on is being carried out, through outsourcing and tapping resources of other present institutions. This will be supported by an easy to use web interface.

6.2 Environmental, Economic and Societal Benefits

The main benefit of our project lies in the awareness that will be raised by the practical implementation in the field of road safety and traffic regulations. In the long term it will save lives and improve the general standard of driving in our country.

CopVision increases the general feeling of safety in the society. Actions against suspects can be taken more quickly and easily and it is also a cost effective solution for monitoring traffic rules violations so it is economically beneficial.

On the other hand it will also improve the mental attitude of the general public when it comes to following rules and regulations which will in turn lead to increased standard of living. This will give way to better practices when it comes to driving.

6.3 Reflections

During the course of the project we have learnt about project management, documentation. We have learnt how to work as a team and develop various diagrams and modules for this project, each of us contributing in our own way. We learnt a lot about time management and the process of effective project planning. The work done by us for the project helped us in gaining more and more knowledge about Image processing and also about machine learning algorithms. We also learnt how to do the validation of the project and how to develop a web app for the front end of the software. We even learnt about the scope of our project and how it benefits society. As we got a great idea of the above topics, now in future we would try to enhance our knowledge to get a wider and better view about the same and innovate with our knowledge.

6.4 Future Work Plans

There are two main aspects remaining:-

- Fog elimination and image enhancement
- Helmet differentiation

Image enhancement will help us in improving the accuracy of our detection and provide better performance along with the final helmet differentiation leading to the completion of our project.

The project can further be expanded by detection of the overspeeding vehicles and also detecting the vehicles violating the traffic light rules.

7.1 Challenges Faced

The challenges which were faced during the project are as follows:

Initial Challenge: First challenge which was faced by the team was when we had to select the project idea as a lot of literature survey had to be done to think about an impactful and unique idea which would help to solve some general daily issues faced by mankind.

Implementation Challenge: When the implementation of the project started, a lot of challenges were faced by the team: dataset challenge, software challenge and integration challenge.

> **1. Dataset Challenge**: As we have made a Machine Learning based project the initial task is to collect relevant data for processing, so the first challenge faced by the team was regarding the acquiring the relevant datasets, we recorded the videos of Indian traffic in real time and also captured images of various cars and bikes and people wearing various kinds of helmets etc. We also recorded the videos and got the image datasets from google datasets. But dataset collection still remains a challenge as high quality image datasets are unavailable over the internet therefore to get higher accuracy a larger and more diverse dataset is required for both videos and images.
>
> **2. Software Challenge:** In making the software we had to face many challenges as when we were writing the code for the software various libraries which were to be used were not installed and many other alternatives had to be considered to make the code work properly. Also we had no prior knowledge about how to code for the Raspberry Pi so we had to learn it first and then build the code from scratch. Another challenge faced by the team was most of the prior literature survey had used languages like C and C++ and as we were using Python 3.0 we had to develop the code from scratch.

3.Integration Challenge: This challenge was faced by the team when we had to integrate the code and develop the front end app so we had to learn to integrate the backend code with frontend software and one module to others for best performance.

Testing Challenge: After the completion of the CopVision project, the main task of the team was testing the final project and removing errors to make it as bug free as possible. But it was challenging for the team to consider the corner test cases on which error checks had to be made to improve the accuracy of the code.

Report making Challenge: Along with the coding challenges, dataset challenges and the software and integration challenges one other main challenge was to compile the data to make a report which is error free. This section helped our team to learn about how to display the work in a single document and provide a visualization about how the project has been made from start to completion.

All the challenges faced by our team were resolved by the help of respected mentors and the efforts made by the team in gaining knowledge, implementing various new concepts and also finding different alternatives to the problems which were faced by us as the work proceeded.

7.2 RELEVANT SUBJECTS

Table 13: Relevant Subjects

Subject Code	Subject Name	Description
UCS615	Image Processing	Image processing techniques were used for image pre-processing and object detection for detecting the riders not wearing helmets and also to capture number plates..
UML501	Machine Learning	The importance of Machine learning in our project lies in the

		object detection and extraction steps; along with model building and predicting values on new data. OpenCV library has been used to do video capture, extract frames, to make contours and to create bounding box around the two-wheeler.
UCS503	Software Engineering	Project management and software development lifecycle was the crux of the project. All the documentation and diagrams have been prepared conforming to the guidelines taught in this subject
UTA011	Engineering Design 3	Raspberry Pi works similar to Arduino, which we learnt about in Engineering Design 3.

7.3 INTERDISCIPLINARY KNOWLEDGE SHARING

We had to study about the Computer Vision subject for making the backend code of our project for the frame extraction and video processing. We have also used Image processing in this project for processing the images captured and feature extraction. We also had to learn object detection for detection of bike and helmets so we had to study varioys additional Compuer Vision and Image processing subjects.

7.4 PEER ASSESSMENT MATRIX

Table 14: Peer Assessment Matrix

		Evaluation of		
		NIPUNN	**NISHANT**	**PARAS**
Evaluation by	**NIPUNN**	5	4	5
	NISHANT	5	5	4
	PARAS	4	5	5

7.5 Role Playing and Work Schedule

Table 15: Roles

Student Name	Role Played
Nipunn Malhotra	Back-end python code for motorcycle detection, helmet detection and number plate detection, dataset collection, challan front-end, testing and debugging
Nishant Goel	Documentation, front-end development, tripling detection, testing , database design and development, django back-end, front-end and back-end integration
Paras Arora	Documentation, dataset collection, motorcycle detection code, testing, tripling detection, designing front-end, blog, challan generation, cost calculation

Table 16: Work Schedule

S.No.	Activity	Starting Date	Ending Date
1	Identification and Formulation of project	30-Jan	28-Feb
2	Frame selection, background subtraction, segmentation, bike rider detection	01-Mar	30-April

3	Helmet detection	01-May	30-June
4	Triple riding detection	01-July	31-July
5	Result evaluation	01-Aug	31-Aug
6	Design optimisation	01-Sept	15-Sept
7	Perform modification	15-Sept	30-Sept
8	Re-evaluation and web development	01-Oct	31-Oct
9	Final report	01-Nov	20-Nov

7.6 Student Outcome Description and Performance Indicators (A-K Mapping)

Table 17: A-K Mapping

S.No.	Description	Outcome
A1	Applying mathematical concepts to obtain analytical and numerical solutions.	Used basic principles of mathematics in image processing
A2	Applying basic principles of science towards solving engineering problems.	Applied computer vision and image analysis which uses basic principles of science for development of the project.
A3	Applying engineering techniques for solving computing problems.	Used machine learning and deep learning concepts and algorithms.
B1	Identify the constraints, assumptions and models for the problems.	Identified various constraints such as Indian Standard Number Plate Format
B2	Use appropriate methods, tools and techniques for data collection.	Used datasets of pictures of cars, numbers and characters available online
B3	Analyze and interpret results with respect to assumptions, constraints and theory.	Analyzed the test cases with respect to the assumptions and constraints

C1	Design software system to address desired needs in different problem domains.	Designed different user interfaces in consideration with problem statement
C2	Can understand scope and constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.	Made an economically feasible project while maintaining the quality standards and also complying the legality and other standards.
D1	Fulfill assigned responsibility in multidisciplinary teams.	Divided the project into sub tasks and distributed among various members of the team.
D2	Can play different roles as a team player.	Different members worked on different components of the project
E1	Identify engineering problems.	Problems identified were problems in classification of images and getting output through OCR analyzer
E2	Develop appropriate models to formulate solutions.	Designed various models for helmet detection, 2-wheeler detection and number plate detection
E3	Use analytical and computational methods to obtain solutions.	Used computational methods while developing the source code
F1	Showcase professional responsibility while interacting with peers and professional communities.	Behaved as professionals while giving presentations
F2	Able to evaluate the ethical dimensions of a problem.	The team was successful in evaluating the ethical dimensions of the problems faced
G1	Produce a variety of documents such as laboratory or project reports using appropriate formats.	Documentations and reports made at various points
G2	Deliver well-organized and effective oral presentation.	Various panel evaluations helped in achieving this
H1	Aware of environmental and societal impact of engineering solutions.	Will help in increasing security in the society

H2	Examine economic tradeoffs in computing systems.	Maintained an upper bound on memory processing and other requirements to make the project economically feasible in computing.
I1	Able to explore and utilize resources to enhance self-learning.	Studied research papers and journals to learn new concepts
I2	Recognize the importance of life-long learning.	Project made us appreciate the need to solve problems in real life using engineering
J1	Comprehend the importance of contemporary issues.	Identified surveillance issues
K1	Write code in different programming languages.	Used python for writing the source code
K2	Apply different data structures and algorithmic techniques.	Used various data structures such as list, dictionary, dataframes,etc and various machine learning algorithms and optimization algorithms
K3	Use software tools necessary for computer engineering domain	Project development used principles of software engineering

7.7 Brief Analytical Assessment

Q1: What sources of information did your group explore to arrive at the list of possible Project Problems?

Answer: Our team was aware of the requirements of the Capstone project and we brainstormed various problems which were left unattended in daily lives. We studied about many research papers which were similar to our projects to gather information which was most appropriate for the project. We solved the interfacing problems with the help of some textbooks and internet resources and the scope of our capstone project was decided with the help of our mentors. We also read about the packages, APIs and libraries linked to our project in various programming languages for proceeding with the code generation and implementing it.

Q2. What analytical, computational and/or experimental methods did your project team use to obtain solutions to the problems in the project?

Answer: Our team studied a lot of research papers and textbooks and tried various platforms for the development of the source code of the Capstone project. We also learnt different object detection and image segmentation concepts which used the knowledge of the Machine learning and Image Processing which we possessed. The team attempted at the relevant dataset collection too for training of the machine learning models. We have finally integrated different modules of the same type into one single system.

Q3: Did the project demand demonstration of knowledge of fundamentals, scientific and/or engineering principles? If yes, how did you apply?

Answer: Yes, the project demanded the demonstration of knowledge of fundamentals, scientific and engineering principles. In this CopVision project we have used various principles of Image processing and Machine Learning. Other engineering skills used in the project are web development and integration with backend and we also used the knowledge of software diagrams, software design and documentation techniques which were taught us in Software Engineering subject. Basic development and management of the project also used knowledge of the fundamentals and engineering principles.

Q4: How did your team share responsibility and communicate the information of schedule with others in the team to coordinate design and manufacturing dependencies?

Answer: Our team members individually took the responsibilities for various different components of the project. There was a bit of problem in time management as we are a group of three and one team member is a day scholar among us which led to a bit of miscommunication and lack of coordination, and also due to the Covid-19 virus we had to mostly communicate over the Google meetings and social media in order to share the relevant information regarding the development and management of project.

Q5: What resources did you use to learn new materials not taught in class for the course of the project?

Answer: Our team learnt various concepts used in the project which were not taught to us before with the help of the internet. We watched many YouTube videos and also gathered information from the help of research papers and Udemy courses and learnt the concepts which helped us develop this project smoothly.

Q6: Does the project make you appreciate the need to solve problems in real life using engineering and could the project development make you proficient with software development tools and environments?

Answer: CopVision project helps in solving a real life problem of automatic detection of traffic rules violation by detecting two wheeler riders not wearing helmets and triple riding using engineering. Working for this project made us appreciate the need for solving the real world issues and contribute towards society and it motivates our team members to take up new challenges and problems in various different fields in real life. We learnt different new technologies while making this project like concepts of Machine learning and Image processing and many different python libraries. Working with these concepts helped us a lot to increase our knowledge and make us proficient with software development tools and environments.

APPENDIX A - REFERENCES

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APPENDIX B - PLAGIARISM REPORT

Document Information

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