AUTOMATIC VEHICLE HEADLIGHT CONTROLLER

A final capstone report submitted in fulfillment of the requirement for the award of the degree of

Bachelor of Engineering

in

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CERTIFICATE

This is to certify that the project work entitled "**Automatic Vehicle Headlight Controller**" is a bonafide work carried out by Shriyesh Chandra, Prakhar Gupta, Deepali Sharma, and Garima Monga for the report of "Capstone" of "Thapar Institute of Engineering & Technology." It is certified that all the corrections and suggestions indicated for internal assessment have been incorporated in the report deposited. The project report has been approved because it satisfies the educational necessities and satisfies the academic requirements in respect of project work prescribed.

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December 5, 2020

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And finally thanks to God who is most beneficent and merciful. This was an incredible opportunity that helped us discover many more unexpected and significant lessons.

ABSTRACT

The number of automotive vehicles on roads is getting amplified day by day. Headlights of vehicles pose a great danger while driving during the night. The drivers of most vehicles use high, bright beams while driving at night. This causes a discomfort to the person travelling from the opposite direction as they experience a sudden glare for a short period of time contributing to the night time accidents. An adaptive headlight intensity control system could be installed in the vehicles to overcome this problem by actively changing the intensity of the night lamp according to the incoming vehicle.

In this project we present an effective system for detecting vehicles in front of a camera-assisted vehicle during night time driving conditions in order to automatically change vehicle head light between low beams and high beams avoiding glare for the drivers. To achieve this we have used many algorithms like distance estimation, black hat transform and finally implemented a supervised machine learning algorithm to accordingly change headlight output when traffic is present.

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INTRODUCTION

1.1 PROJECT OVERVIEW

Studies show that despite the fact that the traffic volume at night is somewhat lower than during day-time, 40% of all the traffic accidents occur after dark between 6pm and 6am when traffic is relatively less. The risk involved in an accident at night is three times more in comparison to daytime according to the National Safety Council. Among the numerous reasons why driving during night can be hazardous, headlight glare is one of the most common hazards encountered by the drivers.

Fig 1.1 Glare from headlight

Headlights are typically controlled to alternately generate low beams and high beams. Low beams provide less illumination and are used at night to illuminate the forward path when other vehicles are present. High beams provide significantly more light and are used to illuminate the vehicle's forward path when other vehicles are not present.

The primary task of a headlight is to illuminate the road for the driver. Secondly, it also generates a typical signal aspect to identify the vehicle for the oncoming traffic. But the glare of the high beam of the headlight from the incoming vehicle dazzles the eyes of the driver and results in wrong judgement and contributing to fatalities and accidents.

1.1.1 Technical Terminology

Troxler Effect - It is a visual phenomenon that arises when a bright light falls onto the eyes of an individual. The effect that creates temporary blindness in the driver is known as troxler's effect or also known as 'fading effect'. A study shows that if our eyes are exposed to a very bright light source of around 10,000 lumens, we experience a glare [27] This glare is caused due to the over exposure inside the eye. Even after removing the source of the glare, an after-image remains in our eye that produces a blind spot. Troxler's effect is the cause of many accidents. Troxler effect applies to all age groups. Anyone exposed to sudden bright light experiences it.

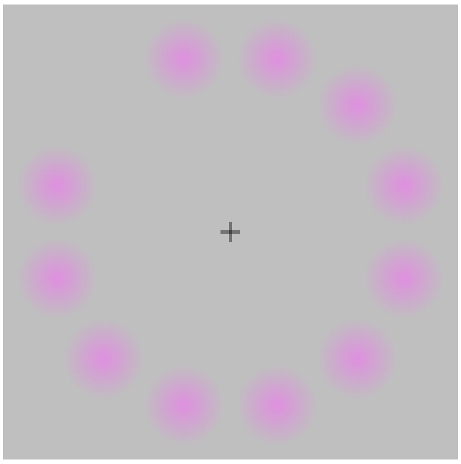


Fig 1.2 Example of an illusion caused due to troxler effect

So as stated above the glare of headlights from the incoming vehicle blinds the driver and leads to accidents. However this problem may be solved while automating the headlights to detect the intense light in front of the car and automatically dim the headlights so as to avoid temporary blindness of the driver in front. This is a complex task that involves for the system to:

1. Detect the bright object.
2. Clustering the bright objects obtained in step 1.

3. Refining this by creating masks and contours and applying Gaussian filters.
4. Calculating the distance between the object and our vehicle.
5. Classifying the object as an unwanted one or a vehicle using SVM.
6. Dimming our headlights accordingly.

1.1.2 Solution

In order to prevent drivers of other vehicles from being subjected to excessive glare levels and avoid accidents due to temporary driver blindness, an automatic control of the vehicle headlights can be done. To minimize the temporary blindness, the headlights automatically switches from high beam to low beam and returns back to high beam after the incoming obstacle has passed, hence it will reduce the sudden glare effect.

An effective system can be designed for detecting vehicles in front of a camera-assisted vehicle during night time driving conditions in order to automatically change vehicle headlights between low beams and high beams avoiding glares for the drivers. Accordingly, high beams output will be selected when no other traffic is present and will be turned on low beams when other vehicles are detected. Implementing this system in every car so as to dim the headlight of our own vehicle to avoid accidents.

Additionally, it exempts the manual switching of the headlights back and forth by the driver.

1.1.3 Scope and comparison with existing solutions

An automatic headlight dimming system ideally built for automotive vehicles is one that automatically switches between the high and low beams of the vehicle's headlights only at the right time to ensure that the driver has the best road visibility at all times. This concept is very useful in the automobile field applications. Car manufacturers can allude to this automatic feature as being equivalent to manual operation, if not superior. However this feature is already present in some high end car models such as BMW but the problem lies in affordability. The solution this project proposes is to make this feature implementable and available to a larger group of car owners independent of their car manufacturer.

1.2 NEED ANALYSIS

The need for an automated headlight controller arises in the following case:

1. Night-time vision temporarily impaired due to the sudden headlight glare.

2. At times it becomes hard for the driver to judge whether the glare that obstructs his vision is from reflection of his own headlights by a signboard, some light reflected from the road or due to a car coming from the opposite direction.

3. Our system assists the driver by distinguishing between both these environments and prompting further assistance by reducing his own headlights if need be so.

This will encourage the driver to dim or deflect his driving lights downwards to prevent the blinding glare otherwise put on the driver of the oncoming vehicle and of course, for other reasons, whilst also allowing him, after the oncoming vehicle has passed, to turn quickly to his bright or high beam lights.

1.3 NOVELTY OF WORK

The novelty of the solution provided by us through this project lies in the way we have made use of each and every frame that we receive from our source video by applying the algorithm that we concluded upon after a thorough study of different methods available as of now and phase of software based trial and error analysis of all these methods to finally select the one where we achieved the best quality results. We tried out by beginning our work by analysis of normal colour video generated by a camera and eventually ended up making use of black an white video from the source as it provided better results after going through filters to identify brightness patches and the frames available in them were easy to be masked so as to gain the area of importance.

CHAPTER-2

LITERATURE SURVEY

This chapter includes literature, local and international studies about all the topics of the research, which was collected by reviewing different books and studies from different libraries of different universities. The studies done in India or in abroad postulating direct or indirect effect on the present study had been reviewed and presented in this chapter. The purpose of this section is to explore those current studies that have yielded significant findings and have application to this study.

2.1 RESEARCH PAPERS ON FACTORS CONSIDERED

2.1.1 Bright Object Detection

Kartik Umesh Sharma and Nilesh Singh V. Thakur (January 2017) [14] wrote "*A review and an approach for object detection in images*" in the International Journal of Computational Vision and Robotics stating- In a digital image or video, an object detection system identifies objects from the real world where the object can belong to any class of objects, namely people, vehicles, etc. In order to detect an object in an image or a video, the device needs to have a few components, a model database, a feature detector, a hypothesis and a hypothesis verifier, to complete the task of detecting an object. This paper provides a view in images and videos of the different techniques used to detect an object, locate an object, classify an object, extract characteristics, appearance information, and many more.

Faŕes Jalled and Ilia Voronkov (November 2016) [15] wrote an article *"Object detection with Image processing"* with the objective to create an OpenCV-Python code using the Haar Cascade Unmanned Aerial Vehicle (UAV) Object Detection Algorithm in the Border Protection Army to prevent unwanted collisions and UAV harm by eliminating the downside of artefacts that are not properly detected, causing the object to strike the UAV.

Chandan G, Ayush Jain, Harsh Jain and Mohana (2018) [16] wrote on *"Real Time Object Detection and Tracking Using Deep Learning and OpenCV "* stating that In recent years, deep learning has had a huge effect on how the environment has adapted to Artificial Intelligence. Region-based Convolutional Neural Networks, Faster- RCNN, Single Shot Detector (SSD) and You Only Look Once are some of the common object detection algorithms. Among these, Faster-RCNN and SSD have better precision, while YOLO performs better when preference is given to speed over precision. Deep learning combines SSD and Mobile Nets to perform efficient implementation of detection and tracking.

2.1.2 Distance Estimation

Mahdi Rezaei, Mutsuhiro Terauchi and Reinhard Klette (2015) [17] wrote *" Robust Vehicle Detection and Distance Estimation Under Challenging Lighting Conditions"* This paper proposes techniques based on real-time monocular vision for simultaneous vehicle detection and inter-vehicle distance estimation, in which the system's performance and robustness remain competitive, even for highly difficult benchmark data sets. By detecting vehicles ahead, and by understanding safety distances to assist a distracted driver, the paper establishes a collision alert device before an inevitable accident occurs. To improve the accuracy and robustness of our algorithm, we implement adaptive global Haar-like features for vehicle detection, tail-light segmentation, virtual symmetry detection, inter-vehicle distance estimation, as well as an effective single-sensor multi-feature fusion technique.

Jong Bae Kim (September 2019) [19] wrote *"Efficient Vehicle Detection and Distance Estimation Based on Aggregated Channel Features and Inverse Perspective Mapping from a Single Camera"* where using a single black-box camera mounted in a car, a method for detecting and calculating the distance of a vehicle going forward was suggested. It was important to minimise throughput and speed up processing in order to apply the proposed approach to autonomous vehicles. To do this the proposed method decomposed the input image for real-time processing into multiple-resolution images, and then extracted the aggregated channel features (ACFs). The idea was to symmetrically remove only the most significant characteristics from images at various resolutions. A method of detecting an object and a method of estimating the distance of a vehicle from the view of a bird's eye using inverse perspective mapping (IPM) have been used. ACFs were used in the suggested method to generate the vehicle detector based on AdaBoost.

Liqin Huan, Ting Zhe, Junyi Wu, Qiang Wu, Chenhao Pei and Dan Chen (April 2019) [20] published "*Robust Inter-Vehicle Distance Estimation Method Based on Monocular Vision"* where to improve the robustness of a distance estimation system, the attitude angle information of the target vehicle is obtained using the angle regression model (ARN). The network of dimension estimation specifies the actual dimensions of the target vehicle. Then in accordance with the image analytic geometric theory, a 2D base vector geometric model is constructed to accurately recover the back region of the target vehicle. Finally, to estimate distance, area-distance modelling based on the camera projection theory is performed. KITTI, the experimental results on the real-world computer vision benchmark, show that our approach achieves superior performance for different types of vehicles compared to other existing published methods (including front and side vehicles)

Ahmed Ali, Ali Hassan, Afsheen Rafaqat Ali, Hussam Ullah Khan, Wajahat Kazmi and Aamer Zaheer (2020) [21] published *"Real-time vehicle distance estimation using single view geometry"* where they proposed a lightweight, single-view geometric approach using geometric features of road lane markings for distance estimation that integrates well with the existing ADAS lane and vehicle detection modules. Their method introduces novelty on two fronts: (1) to estimate horizon (2) it uses cross-ratios of lane boundaries to calculate an Inverse Perspective Mapping (IPM) and camera height from a known lane width and the observed horizon. Distances of vehicles on the road are then determined by the image point projected back to a ray that intersects the reconstructed road plane.

2.1.3 Intensity Level

Nahid Negar, Drew Marie Williams, Jaclyn K Schwartz & Sheikh Ahmad (June 2014) [1] conducted a study *"Smartphone based light intensity calculation application for accessibility measurement"* where they developed and implemented a novel method of measuring light using proxy measures, by making an app which replaced a generic light meter with a smartphone app to detect intensity of light using exposure time, ISO value and brightness to predict the lighting levels. This algorithm improved the accuracy of the app based light meter compared to other apps in the iTunes store, but was less accurate than current light meters. The purpose of the research paper was to describe the development of the app based light meter, access Light, and the initial reliability testing.

KavitaA. Bajaj & Tushar S. Mote (2013) [4] worked on *"Intelligent Street Lightning System"* LDR is used to optimize management and efficiency of street lighting systems to save power and energy. Control system is used to turn the street lights on and off. To achieve the high efficiency in the street lighting one way is to choose light emitting diode (LED) technology, instead of sodium vapor lamp and compact fluorescent lamp (CFL), because it is the best solution since it offers benefits like power saving and long life. The second solution uses a sensor combination to control and guarantee the desired system parameters; the information is transferred point by point using ZigBee transmitters and receivers and is sent to a control terminal used to check the state of the street lamps and to take appropriate measures in case of failure and the third possibility would be the use of renewable energy sources like solar energy rather than conventional power sources with a positive effect on the all environment issues.

Rodrigo Cassio de Barros, Jaoa Marcus Soares Callegari, Dayane do Carmo Mendonca & William Caires Silva Amorim (2018) [9] worked on the *"Low-cost Solar Irradiance Meter using LDR Sensors"* when the amount of solar irradiance reaches beyond the desired value the solar panel stop receiving the sunlight . This is an important variable to be considered in the orientation of projects that consider solar energy, such as: used in meteorological research, remote sensing, buildings natural lighting and in the energy sector for the correct sizing of power capture systems.

Ghassan Maan Salim, Hashimah Ismail, Niranjan Debnath and A. Nadya (October 2015) [11] proposed a *"Optimal Light Power Consumption Using LDR Sensor"* based on the intensity of light present in the environment, intensity of light in the room will be adjusted using the LDR sensor.It also proposes a system in order to provide a solution to reduce the number of accidents occurring every day due to blinding high beam headlight and it is accurate in determining the position of the cars on the roads and depending upon that further communication is established and thus dipping of the headlights is done based upon the threshold condition.

Sanal Malhotra & Shiv Taneja (2014) [7] designed an *"Automatic brightness light based embedded system using LDR sensors"* . In this system brightness is controlled using LDR sensors and an array of LEDs which are interfaced with the microcontroller. According to the value of LDR sensors the brightness is controlled. At the daytime, when there is a need for less light, LDR sensors sense the light and accordingly the programmed LED glows, but when there is a need for more light LDR sensors sense the light in nearby areas and based on the amount of light required the LEDs are turned on. LED is a diode which works based on the concept of Electroluminescence so during night time when highest amount of light is needed, all the LED will glow, during the time when some of the light is required in the room, only some of the LED's glows based on the amount of light needed.

B. K. Subramanyam, K. Bhaskar Reddy & P. Ajay Kumar Reddy (July 2013) [10] worked on *"Design and Development of Intelligent Wireless Solar Street Light Control and Monitoring System Along With GUI"* by implementing a proper solar based lighting system on streets. For automatic mode operation LDR sensors are used. Its main principle is to when the light intensity is low, light will ON automatically and if light intensity is high, light will OFF automatically.The Street lights are controlled through a specially designed Graphical User Interface (GUI) in the PC. The Zigbee technology can be used for the street lights monitoring and controlling at the PC end.

2.1.4 Classification Using SVM

Sachin Bhaskar; Vijay Bahadur Singh; A. K. Nayak (March 2015) [23] *"Managing data in SVM supervised algorithm for data mining technology"* Support Vector Machines, a robust algorithm based on the theory of statistical learning. For classification, regression, and anomaly detection, Oracle Data mining implements Help Vector Machines. It also offers the scalability and usability required in a data mining system for production quality. This paper presents and analyses the algorithm supervised by SVM, which will allow new researchers to understand the process of tuning data preparedness and the benefits of SVM in Oracle Data Mining. SVM can model complex, real-world problems such as classification of text and images, recognition of handwriting, and analysis of bioinformatics and biosequences.

Jair Cervantes, Farid Garcia-Lamont, Lisbeth Rodríguez-Mazahua and Asdrubal Lopez (September 2020) [24] *"A comprehensive survey on support vector machine classification: Applications, challenges and trends"* In multiple areas of use, SVMs are one of the most efficient and robust classification and regression algorithms. The SVM has played a significant role in the identification of trends, which is a widely popular and active research field among researchers. The development of other applications such as SVM for large data sets, SVM for multi classification and SVM for unbalanced data sets has been stimulated by research in some fields where SVMs do not perform well. In addition, SVM has been combined with other advanced techniques, such as emerging algorithms, to improve classification ability and optimise parameters. In many scientific and engineering fields, SVM algorithms have gained recognition in research and applications.

2.1.5 Gaussian Filter

Manyu Wang, Sheng Zheng, Xiaolong Li and Xiongjie Qin (November 2014) [25] *"A new image denoising method based on Gaussian filter"* published in: 2014 International Conference on Information Science, Electronics and Electrical Engineering. They suggest a new method of image denoising based on the Gaussian philtre and philtre of non-local means. The new algorithm that deals with image noise is based on the weighted average particle philtre ideas. We examine the difference between the method proposed and two other algorithms, then we conduct multi-group experiments to compare the denoising effect of these methods and measure their output primarily by visual effect and peak signal-to-noise ratio (PSNR).

Abhishek Jain and Richa Gupta (July 2015) [26] *"Gaussian filter threshold modulation for filtering flat and texture area of an image"* published in 2015 International Conference on Advances in Computer Engineering and Applications. There are some regions that correspond to the flat area in digital images and some others correspond to the texture area. Depending on the sort of area, different image processing needs to be done. This paper introduces the Gaussian philtre threshold modulation for an image's flat and texture region filtering. For the differentiation between flat and texture area, standard deviation is used. The Gaussian adaptive philtre acts as a normal distribution philtre in the texture area, and the Gaussian adaptive philtre acts as an average philtre in the flat area. Experimental findings on different test images demonstrate the Gaussian philtre threshold modulation approach's capabilities for effective noise reduction.

2.2 RESEARCH PAPERS ON SIMILAR IDEA

Sushil Kumar Choudhary, Rajiv Suman, Sonali, Honey Banga (2014) [18] in their research *"Electronic HeadLamp Glare Management System for Automobile Applications"*, International Journal of Research in Advent Technology found the headlamp glare is a concern that has developed significantly during the past decade. High beam of a headlamp on-coming vehicles have a blinding impact and limit visibility resulting in hazardous driving throughout the night. This model idea reduces the driver's need for manual switching, which is not performed at all times. This solution is very useful in applications to the automotive sector.

L.M. Bergasa, P. Jimenez, M.A. Sotelo, I.Parra, D. Fernandez & P.F. Alcantarilla [2] worked on *"Night Time Vehicle Detection for Driving Assistance Light Beam Controller"* where they made a system to detect and automatically dim the lights of any vehicle between low and high beam to avoid glares for drivers using a B&W micro-camera mounted on the windshield and digital image processing techniques where accordingly, high beams output will be selected when no other traffic is present and will be turned on low beams when other vehicles are detected.

Williams. E.A, K Okrah, S. Kumassah (2016) [3] proposed a *"Design and implementation of automatic headlight dimmer for vehicles using light dependent resistor (LDR) sensors"*.In this project, an automatic headlight dimmer which uses a Light Dependent Resistor (LDR) sensor has been designed to dim the headlight of on-coming vehicles to avoid human eye effects. The device is able to switch the headlight low when it is sensed by the light dependent resistor automatically. Keil software was also employed to program the microcontroller. The system device was able to automatically switch the headlight to low beam when it sensed a vehicle approaching from the opposite side using an LDR sensor and the maximum spread angle of the headlight was 135.

PF. Alcantarilla, LM. Bergasa, P. Jiménez, I. Parra, D. F. Llorca, M. A. Sotelo, S. S. Mayoral (November 2010) [5] used camera assisted vehicles in night time to change beam intensity to high automatically when no vehicles are detected and to low when traffic is present or when the vehicle is in a well lit or urban area. LightBeam Controller is used to assist drivers in controlling a vehicle's beams, increasing its correct use, since normally drivers do not switch between high beams and low beams or vice versa when needed. This system uses a B&W forward looking micro-camera mounted in the wind-shield area of a C4-Picasso prototype car and the system is able to classify between vehicle lights and road signs reflections or nuisance artifacts by means of support vector machines.

Abdul Kader Riyaz .M, S. Arun Jayakumar, M. Abdul HMeed Sharik & A. Tamilarasi (2017) [6] proposed an *"Graphene coated LED based automatic street lighting system using an arduino microcontroller"*. They state that normal LEDs are not provided with a heat sink which degrades the performance of the overall lighting system. This is why introducing a GaN based LED which acts as a heat sink and it is proved that it is 10% efficient than the normal LEDs. Currently, street lights are illuminating at all the time unnecessarily even in the midnight and also in the absence of human beings or vehicles, it is merely a wastage of energy so they have used an Arduino UNO microcontroller to implement automatic street lighting systems.

Lakshmi K, Nevetha R, Ilakkiya S N & Ganesan R (July 2019) [8] worked on *"Automatic Vehicle Headlight Management System to Prevent Accidents Due To Headlight Glare"* where the headlight beam is reduced in the vehicle according to the intensity of light from the opposite vehicle.They state that while driving there may be an irritating situation due to the headlight lamp focus from the opposite vehicle which may cause temporary blindness that leads to collision or sometimes it may lead to accidents. So for the solution LDR is used to detect the high beam from the opposite vehicle to avoid the manual way to adjust the headlight focus.

Farooque Abdullah, Brindha, Divya, Anitha & Nimisha (March 2016) worked on "*Real Time Obstacle Detection and Automatic Headlight Dimmer for Automobiles"* [12] where the system is presented to avoid accidents caused by careless driving of the driver. Here the system warns the driver when it finds obstacles on its path which aids the driver in preventing accidents.To improve the safety of the vehicle by using ultrasonic sensors for getting a picture of the obstacles in the path of the vehicle or to automate the head lamps of the vehicle from high beam to low beam by sensing the intensity of light from opposite vehicle.

Aslam Musthafa R, Bala Krishnan T, Seetha Raman N, Shankar M, Swathi R (2017) built up an *"Automatic headlight beam controller"* which uses a Light Dependent Resistor (LDR) [13] sensor that has been designed to dim the headlight of our vehicles to avoid human eye effects which causes a discomfort to the person travelling from the opposite direction and therefore experiences a sudden glare for a short period of time. It will sense the light intensity value of opposite vehicles and automatically switch the high beam into low beam and to reduce the glare effect.The MP lab software was employed to program the microcontroller. At the time the spread light from other sources reached the sensor, its intensity would be very much reduced below the triggering threshold level. The sensitivity of a photo detector determined the relationship between the light falling on the device and the resulting output signal.

2.3 HARDWARE SCOPE

Even though making a hardware setup wasn't possible during the pandemic, the rough ideas we had for the implementation of hardware were as follows:

-Using a mounted camera setup over a car to capture frames of road in front.

-Feeding the input frames to a connected Raspberry Pi Module which would process the frames and generate the output state for our headlight.

-Using this digital output state from the system with relays and 12V battery to switch states of a headlight bulb.

2.4 GAPS IN LITERATURE

- Hardly one or two of all the research papers that we came across used Stereo cameras, which provide more information per frame/ image allowing for creating a 3D presentation of the image/video signal (depth) which in turn accounts for better distance estimation. Using monocular cameras has a drawback of not being able to create a 3D presentation which thus causes difficulty in having accurate distance estimation. [22]

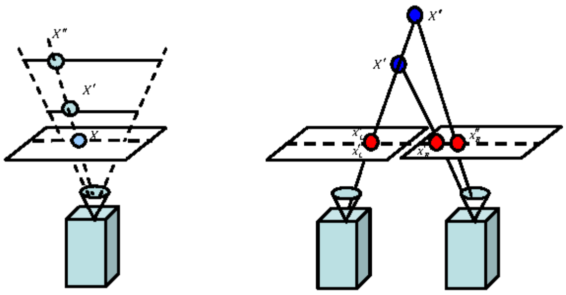


Fig 2.1 Monocular camera vs Stereo camera

- While all the research papers provide a generic model needed for automatic headlight dimming, no one takes in consideration that all the cars have distinct parameters like width, height, angle at which camera shall be kept, which can cause variation in the final results and distort the accuracy of our model.
- All the research papers work on headlight dimming in night or dark conditions but any dataset we found had images of daylight and this in itself can affect the efficiency and robustness of the model trained and cause faulty results.

CHAPTER-3

FLOWCHART

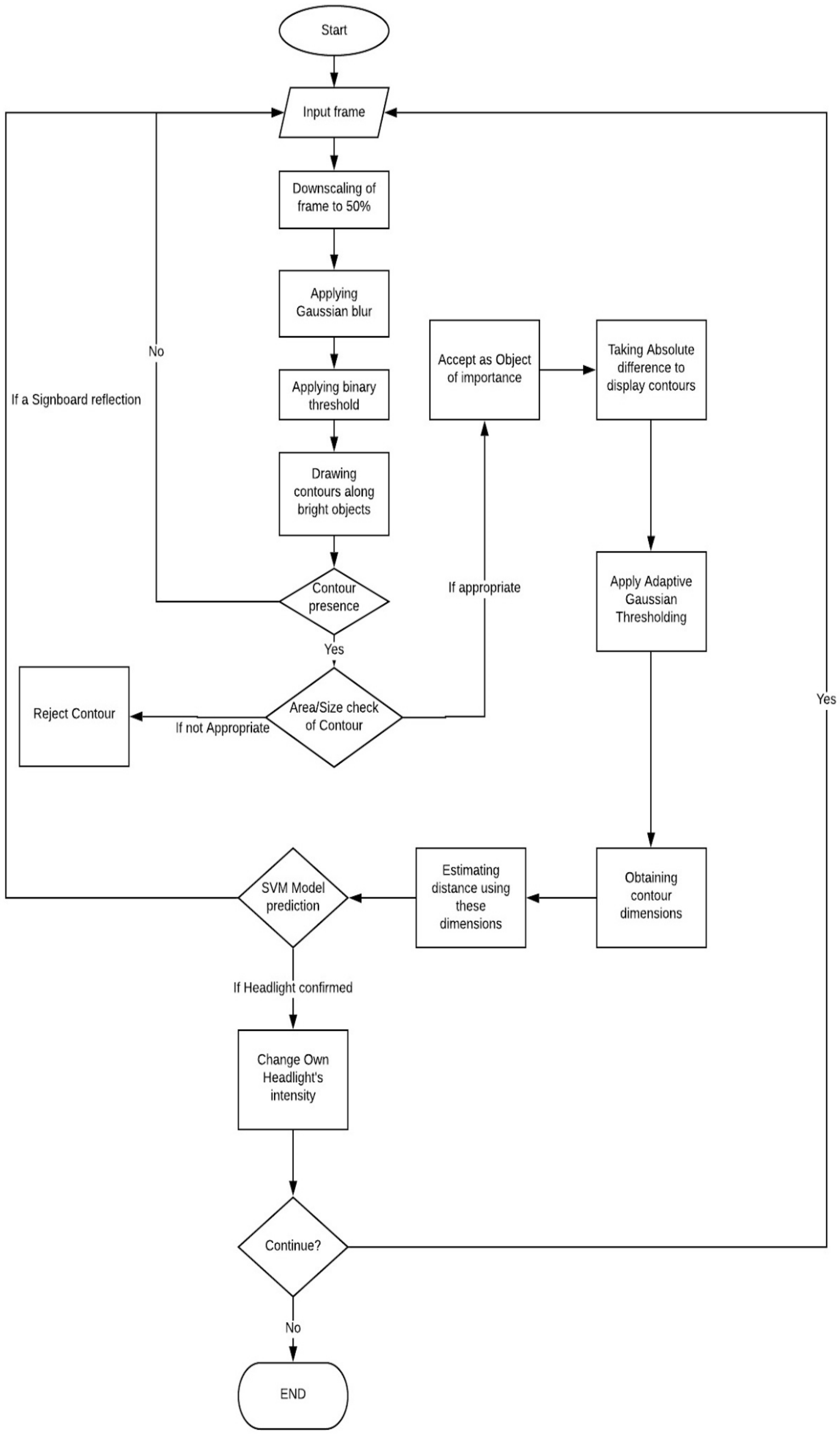


Fig 3.1 Flowchart of the project

3.1 ALGORITHM USED

1. A Camera is mounted on top of the car so as to capture the frames of incoming traffic during night in 100% resolution.

2. These captured frames are then downscaled to 50% resolution so as to decrease the processing power and the processing time taken.

3. Apply Gaussian Blur so as to get a more smooth resultant image, with more dense clusters of bright areas of importance.

4. Apply Binary Threshold over the resultant so as to get a better differentiation between the bright patches and the dark ones.

5. Draw Contours over these obtained bright patches and thereby get information of the estimated dimensions according to the detected bright areas.

6. Check the area of the contours to differentiate between the headlight and the reflection that it makes with the same level of brightness on the road.

7. Take Absolute difference of the resultant from the original image so as to highlight the contours and apply adaptive gaussian threshold.

8. Once all the contours in-frame are confirmed and highlighted, use their dimensions with focal length of the camera used to get the estimate of the distance from our vehicle.

9. Use the SVM model to check if the object inside the area of interest is a car’s headlight or is it a reflection from an on-road signboard due to our own headlights.

10. If all the above steps give a positive response for the object to be a headlight then change the intensity of your own headlight according to the distance of the car from the highlighted object.

3.2 STEP BY STEP OUTPUT OF ALGORITHM

In the following set of images we show a side by side comparison of results having different distances to see the working of our algorithm.

Fig 3.2(a) Input frame

Fig 3.3(a) Input frame

Fig 3.2(b) After greyscaling

Fig 3.3(b) After greyscaling

Fig 3.2(c) After initial thresholding

Fig 3.3(c) After initial thresholding

Fig 3.2(d) Initial contouring

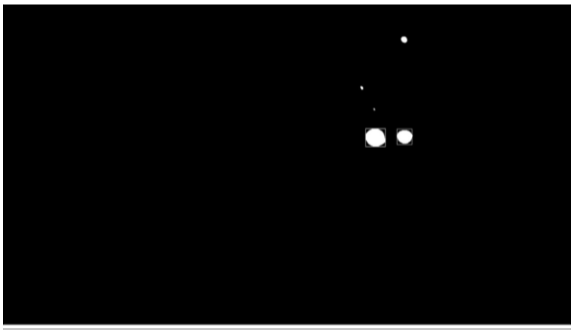


Fig 3.3(d) Initial contouring

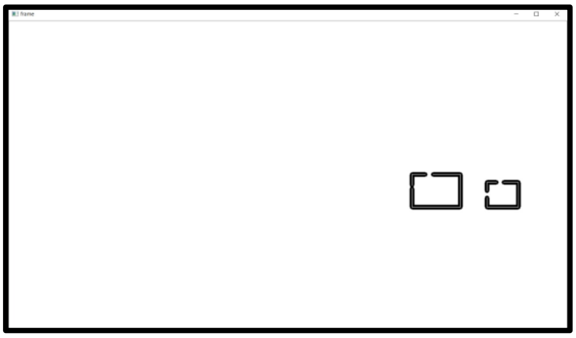


Fig 3.2(e) Adaptive Gaussian filtering

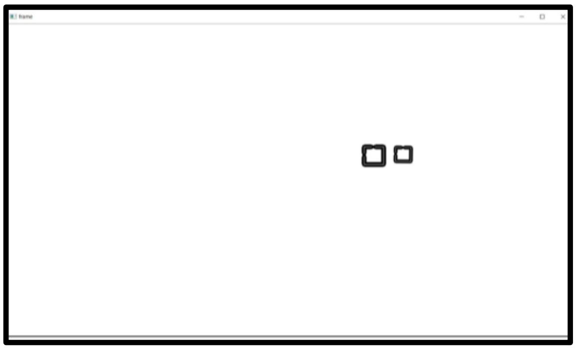


Fig 3.3(e) Adaptive Gaussian filtering

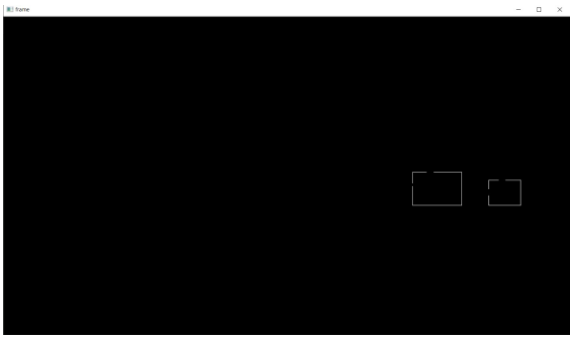


Fig 3.2(f) Only contours

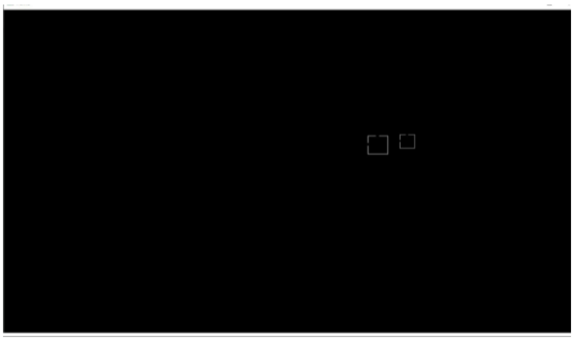


Fig 3.3(f) Only contours

Fig 3.2(g) Distance estimation and condition of our headlights

Fig 3.3(g) Distance estimation and condition of our headlights

Depending on how far or close is the oncoming car from our vehicle, we decide to have our headlights bright or dim. Fig 3.2 has the oncoming car closer as compared to Fig 3.3.

CHAPTER-4

PROJECT DESIGN AND DESCRIPTION

4.1 DESIGN SPECIFICATIONS

Video Stream Format Supported	.mp4
Resolution captured	1920*1080
Resolution converted to	1280*720
Python version	Python 3.7
RAM	8 GB
Processor Specification	intel CORE i7-7700HQ

Table 4.1 Design Specifications

4.2 DESIGN DESCRIPTION

We start with a video on which our algorithm works frame by frame, and downscale the frame to 50% to improve the efficiency by decreasing the processing power and processing time taken by our system. After that we use Gaussian blur, in which the image is convolved with Gaussian filter instead of the box filter. cv.GaussianBlur() is the function that is used for this purpose.The width and height specifications of the kernel should be positive and odd. Standard deviation in the X and Y directions, sigmaX and sigmaY respectively are also specified. If both are given as zeros, they are calculated from the kernel size. It is a great technique to remove noise from an image.

```
cv.GaussianBlur(img,(5,5),0)
```

The obtained image is a grayscale image, from which we create a binary image using threshold values so that our objects can be specified as dark or light

```
cv.threshold(img,xxx,xxx,cv.THRESH_BINARY)
```

It is a non-linear operation that converts our gray-scale image into a binary image where the two levels are assigned to pixels that are below or above the specified threshold value. In other words, if the pixel value is greater than a threshold value, it is assigned one value (may be white), else it is assigned another value (may be black).

Contour is a curve joining all the continuous parts along a boundary having the same color or intensity. Contouring is a great method for object recognition and detection. Before finding contour we applied thresholding to convert it to binary images for better accuracy.

Here is a snippet on how findContours function is used.

```
cv.findContours(thresh, cv.RETR_TREE, cv.CHAIN_APPROX_SIMPLE)
```

If contours are present in the current frame, we move on with checking the size of our contour, else we take a new frame as our input. On checking the size of our contour, if we find it appropriate to be accepted as an area of importance (headlights of an oncoming car) we take differences in our frames to display the contours properly and if we find the area to be not enough, we discard those contours.

After obtaining correct size contours we started estimating distance between our and oncoming car, while doing so we realised that the dark background of our frames is causing distances to be estimated wrongly, i.e our calculated distance was larger than actual one, so through trial and error we figured out using Adaptive Gaussian Thresholding to achieve white background gave us more accurate results for distance estimation. Adaptive thresholding helps when the image has different lighting conditions in different areas. This algorithm determines the threshold for a pixel based on a small region around it. So we get different thresholds for different regions of the same image which gives better results for images with varying illumination.

```
cv.adaptiveThreshold(img,255,cv.ADAPTIVE_THRESH_GAUSSIAN_C,\
                             cv.THRESH_BINARY,11,2)
```

Next we estimate the distance between the oncoming car and our car. For this to determine the distance from the camera to the object we use triangle similarity. One needs to know one of 2 things to do this step

- Focal-length (in mm and pixels per mm)
- Physical size of the image sensor (to calculate pixels per mm)

In this, to find the distance to an object we have used the known focal length of a monocular camera and taken average for the width of cars (using maximum and minimum width of cars) taking in account that we could not have any hardware testing due to current conditions.

```
def distance_to_camera(knownWidth, focalLength, perWidth)
```

While researching different kinds of implementations to attain our objective, we came across a method to differentiate between the bright spots from headlights and from the reflections due to signboards using SVM.

In machine learning, support-vector machines are supervised learning models with associated learning algorithms that analyze data used for classification and regression analysis.

In this step, the detected bright objects are classified as signs or vehicles depending on some discriminant parameters using SVMs.

Following parameters are used by us to train svm model-

1.area in pixel of contour

2.aspect ratio

3.coordinate of object's centroid

4.length of objects contour

This method seemed correct on paper, but due to lack of availability of datasets was not implementable properly in our final run of the project, we tried to use a dummy dataset to demonstrate the work of SVM to classify, but this dummy dataset can't be generalised over all samples.

Thus we eventually identified the headlights and got an estimated distance in such a way that we can use it to judge at what value our light bulb could be switched to.

4.3 BLOCK DIAGRAM

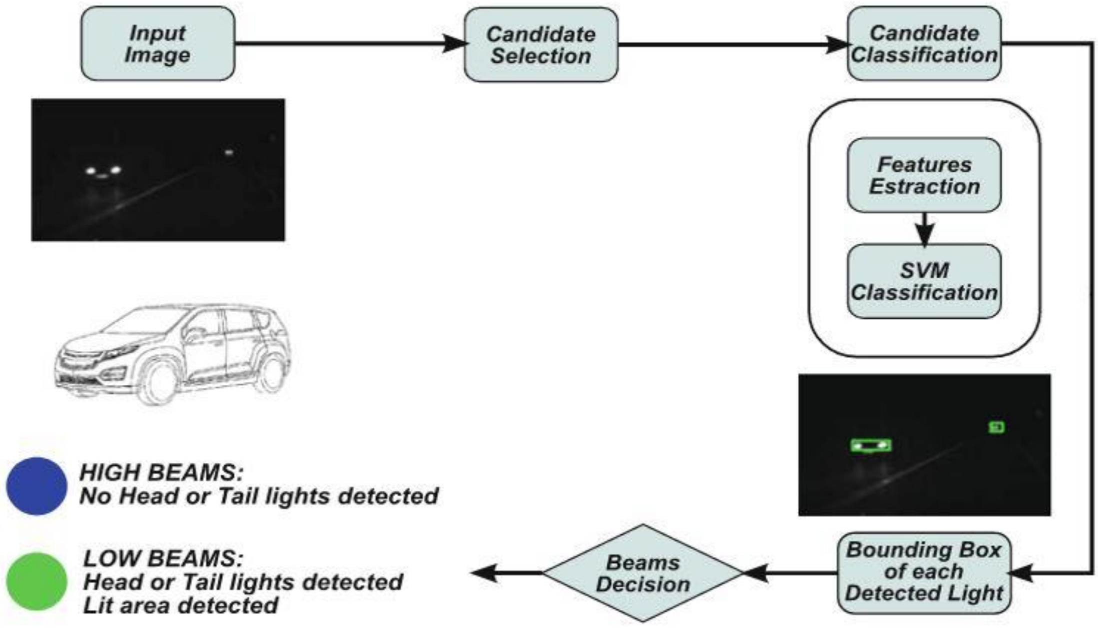


Fig 4.1 Block Diagram

4.4 COMPONENTS USED

S.No.	SOFTWARE/LIBRARY
4.2.1	PyCharm
4.2.2	OpenCV
4.2.3	Matplotlib
4.2.4	Numpy
4.2.5	Jupyter Notebook(Anaconda)
4.2.6	TkInter
4.2.7	Scikit Learn

Table 4.2 Software/Libraries used

4.5 DESCRIPTION OF EACH SOFTWARE/LIBRARY USED

4.5.1 I.D.E.'s Used

This section mentions all the Integrated development environments that were used while working on the programming section of this project, all the codes were written in Python interpreter language and utilised the libraries available in it so as to reach to a final observation using the algorithm mentioned in this report.

(a) PyCharm IDE

PyCharm is an integrated development environment (IDE) used in computer programming, specifically for the Python language. It is developed by the Czech company JetBrains

(b) Jupyter Notebook

Jupyter Notebook is a browser based IDE which includes Live Code Interpretation which is majorly used for writing codes in python and to apply Data Visualisation and machine learning models over them.

4.5.2 Libraries Used

Here we have mentioned all the libraries that have been made use of while writing codes for our project, many of these libraries were downloaded and installed into the python environment and then utilised by importing into the code.

(a) OpenCV

OpenCV is a library in Python utilised majorly for Computer vision and Image Processing applications, this library has in-built functions for a lot many things that can be made use of directly, such as Filtering processes, Blurring, Noise Reduction that we can use to enhance the image quality received from the camera.

(b) Numpy

Library in Python used for performing mathematical functions on arrays and matrices. We make use of a numpy library when we work on the image by converting it into a numerical array format so as to find the bright spots in our code.

(c) ScikitLearn

We will be making use of this library in the further working of our algorithm where we will use Support Vector Machine model(SVM) available in the Scikit Learn library so as to classify between glare and bright spots received from headlights of the car and reflections from the surroundings.

(d) TkInter

This library is used to create GUI representations using python code. This library was made use of while creating the first code for evaluating the exact HSV boundation values for the bright spot detection, we used it to create scrolls that can be set to exact values of HSV bound manually.

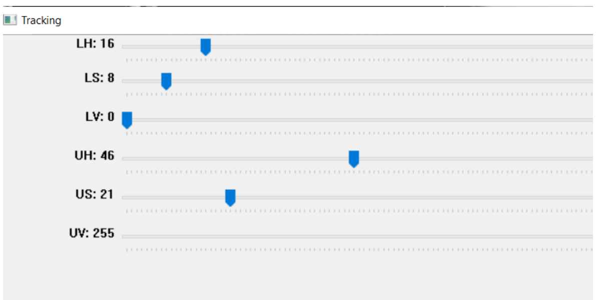


Fig 4.2 Upper and lower bound HSV slider to judge the best bounds for brightness area detection

(e) Matplotlib

This is a plotting and visualisation library in python which was used by us to represent the images processed by us in a single window (subplot window) simultaneously.

Fig 4.3 Subplotting masked and unmasked grayscale image together using matplotlib

4.6 UG COURSES USED

Name of Undergraduate Courses whose concepts we are going to use for the project are summarized in the Table 4.3 below:

Course Name	**Relevance in the project**
Image Processing and Computer Vision	To understand and implement the core principle of our project, i.e detecting and modifying luminous areas
Digital Signal Processing	To understand filters used for the image processing
Machine Learning	To develop machine learning models
Analog Communication	To understand communication between the 2 sensors
Engineering Design III	Would have been used for the hardware components for soldering techniques
Electronic Engineering	To understand the construction and working of electronic components
Data Structures and Algorithms	To make algorithms for the Machine learning models

Computer Programming I & II	In the coding of the models
Operating Systems	Used to create and compile the code base written for detecting certain areas of the image Used to control Raspberry Pi using the command line interface
Innovation and Entrepreneurship	To understand and implement the workflow of creating a whole project and having team spirit throughout
Embedded System	Using Raspberry Pi for implementing our project

Table 4.3: UG Courses used

4.7 IEEE STANDARDS REFERRED

Standards to be used in the project:

- 610.4-1990 - IEEE Standard Glossary of Image Processing and Pattern Recognition Terminology
- P3652. 1 - IEEE Draft Guide for Architectural Framework and Application of Federated Machine Learning
- 1858-2016 - IEEE Standard for Camera Phone Image Quality
- 802.11bg - IEEE standard for data transmission over Wi-Fi
- 802.15.4-2015-IEEE Standards forLow-Rate Wireless Networks
- 2700-2017-IEEE Standards for Sensor Performance Parameter Definitions
- 802.3-2015-IEEE Standard for Ethernet.
- 208-1995-IEEE Standard Video Techniques: Measurement Resolution Camera Systems
- 292–307 (2007)- A combination of extraction methods for SVM pedestrian detection. IEEE Trans. Intell. Transp. Syst.
- 830-1998 - IEEE Recommended Practice for Software Requirements Specification

- 62–66 (1979)-IEEE A threshold selection method from gray-level histograms
- 584–589 (2004)- IEEE : Pedestrian localization and tracking system with Kalman filtering
- 199–213 (1992)- IEEE Recursive 3-D road and relative ego-state recognition
- 371–376 (1995)- IEEE Noise and intensity invariant moments. Pattern Recognition

CHAPTER 5

OUTCOMES & PROSPECTIVE LEARNINGS

5.1 EXPERIMENTAL RESULTS

A detailed step by step result of all the techniques used to achieve the final result are provided and explained below

This is one of the frames of the video we performed our testing on.
Here we shall take it as the input image for performing all the following steps.

Fig 5.1(a) Input frame

First step - Masking of frame to produce an output image in black and white (i.e. grayscale) to gain region of importance according to HSV boundaries according to the required threshold

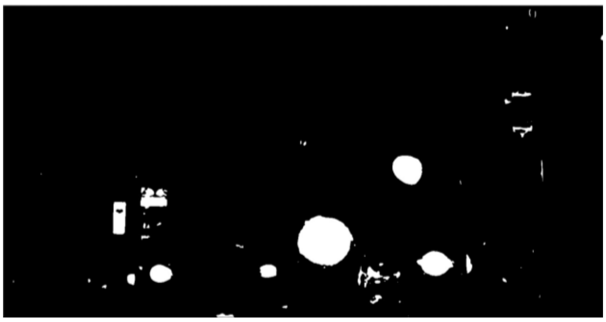


Fig 5.1(b) After initial thresholding

Second step - Adding contours i.e. boundaries around the desired highlighted areas for better visibility of headlights (the area that needs our focus)

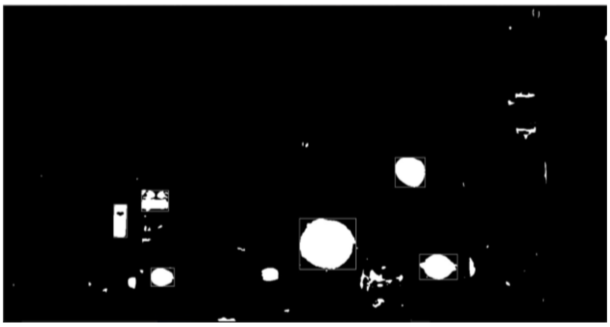


Fig 5.1(c) Initial contouring

An image with just the contours to realised that all the contours are being formed without any defects

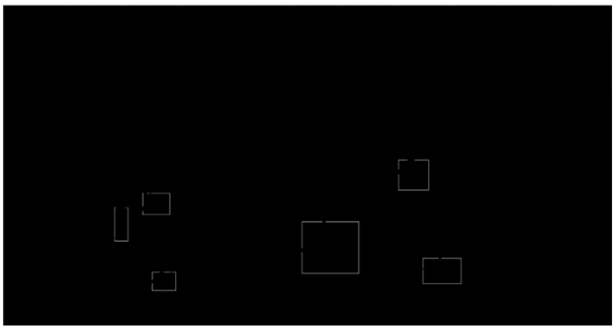


Fig 5.1(d) Only contours

Third step - Gaussian filter is used to reduce the noises and create unsharp masking or edge detection, it improved the quality of contours thus increasing accuracy in distance estimation

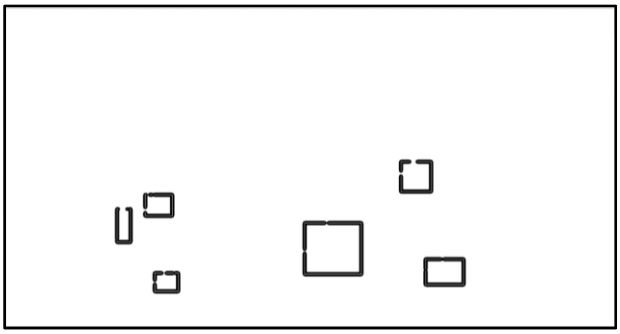


Fig 5.1(e) After Adaptive Gaussian thresholding

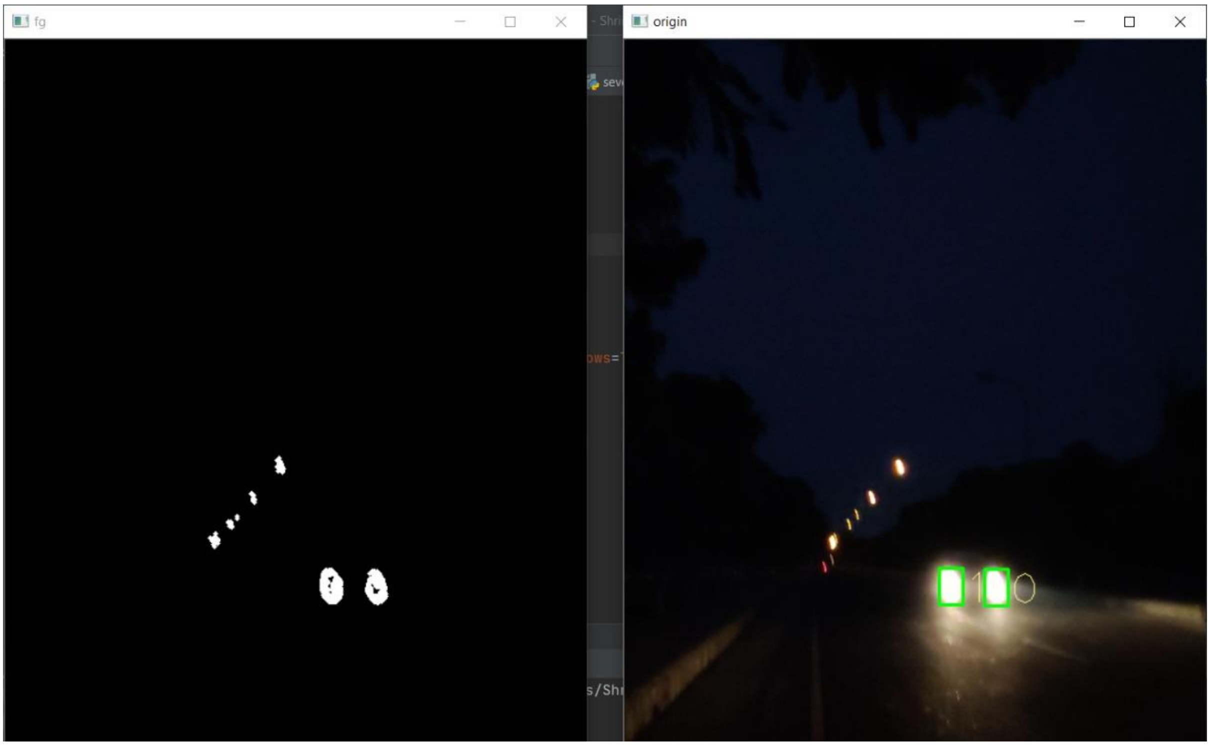


Fig 5.1(f) Distance estimation 1

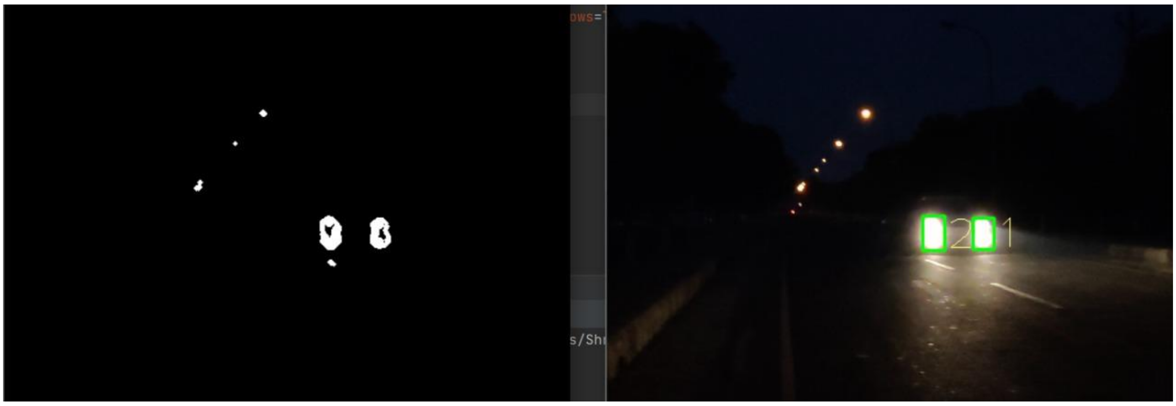


Fig 5.1(g) Distance estimation 2

Fourth Step - After achieving most accurate contours and discarding the unwanted light reflections, we measure the distance of the oncoming car from our vehicle/ camera.

5.2 OUTCOMES

A major outcome of the project is developing a model based on computer vision to detect the intensity of the headlight in front and analyse if there is a vehicle in front to lower down the headlight beam to avoid causing a hindrance in vision of the driver due to the glare. The solution automates the process of switching back and forth between dimming the headlight when required. Hence it also eliminates the need for the driver to manually control the beam.

First and foremost the outcome of the capstone has been integration. In the process of creating our capstone project we have successfully integrated various fields of disciplines.
For our project:

- We have successfully implemented a system to control the intensity of a vehicle headlight to ensure that there are few accidents during night travel.
- To achieve this we first of all placed a B&W camera on the dashboard of the vehicle which will keep clicking photos of the road ahead continuously.
- Then we processed these images to detect bright areas (regions of importance) in them. These bright areas are clustered together on the basis of distance. We assume areas nearer to each other belong to the same object but at this moment we can’t confirm whether the identified object is indeed a vehicle.
- Next we calculate distance between our vehicle and the identified object using distance perception algorithms.
- Lastly we classify whether the object is a reflection or the glare of headlight from a vehicle. In order to do so we make use of supervised machine learning algorithms.

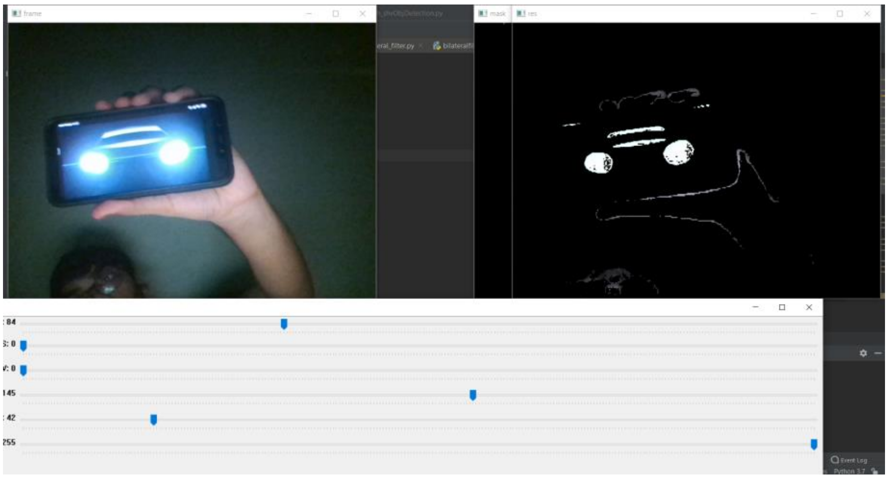
- If the object is indeed a vehicle we lower the intensity of headlight according to traffic rules for safety during night driving.

5.3 LEARNING OUTCOMES

After finishing our project, we would like to conclude the major learning outcomes for us through this project as follows:

- The first and foremost basic learning outcome for us was that we got to learn the basics of Computer Vision and Image Processing by using OpenCV library on Python to achieve our capstone projects major objectives.
- We learnt the importance of masking using bit operations on HSV color space so as to identify the area of importance on which we need to work.
- We got the understanding of different methods of distance estimation using computer vision which have been researched upon and selected one of them that best suits our project.
- Our literature survey led to us gaining a basic theoretical knowledge about the SVM model of machine learning proposed by us as a future addition to our project.

Fig 5.2 Masking of frame obtained to gain region of importance according to HSV boundaries



5.4 PROSPECTIVE LEARNING

The study conducted in the field gives us the significant knowledge to pursue the project. To work upon this project to implement software part one must learn the basics of python, openCV and associated libraries to develop the solution further. Also to analyse the object in front by employing the use of Support Vector Machine model(SVM) available in the Scikit Learn library so as to classify between glare and bright spots received from headlights of car and reflections from the surrounding. Further we are considering using supervised machine

learning algorithms to classify whether the object is a reflection or from a vehicle.
The knowledge of OpenCV, a library in Python utilised majorly for Computer vision and Image Processing applications, is used to filter out the results.

5.5 STUDENT LEARNING OBJECTIVES

C. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.	
C1. Analyze needs to produce problem definitions for electronics and communication systems.	Yes
C2. Carries out design process to satisfy project requirement for electronics and communication systems	Yes
C3. Can work within realistic constraints in realizing systems.	Yes
C4. Can build prototypes that meet design specifications.	No
D. an ability to function on multidisciplinary teams.	
D1. Shares responsibility and information schedule with others in team	Yes
D2. Participates in the development and selection of ideas.	Yes
G. an ability to communicate effectively.	
G1. Produce a variety of documents such as laboratory or project reports using appropriate formats and grammar with discipline specific conventions including	Yes

citations.	
G2. Deliver well organized, logical oral presentation, including good explanations when questioned.	Yes
H. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.	
H1. Aware of societal and global changes that engineering innovations may cause.	Yes
H2. Examines economics trade-offs in engineering systems.	Yes
H3. Evaluates engineering solutions that consider environmental factors.	Yes
I. recognition of the need for, and an ability to engage in life-long learning.	
I1. Able to use resources to learn new devices and systems, not taught in class.	Yes
I2. Ability to list sources for continuing education opportunities.	Yes
I3. Recognizes the need to accept personal responsibility for learning and of the importance of lifelong learning.	Yes
K. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	
K1. Able to operate engineering equipment.	No

K2. Able to program engineering devices.	No
K3. Able to use electronic devices, circuits and systems modelling software for engineering applications	No
K4. Able to analyze engineering problems using software tools	Yes

5.6 COURSE LEARNING OBJECTIVES

The learning outcomes for the Capstone project are as follows.

Course Learning Outcomes	Rate between 1-5 (5: achieved, 1: not achieved)
Developing new/multidisciplinary technical skills.	5
Using professional and technical terminology appropriately.	5
Effectively utilizing and troubleshooting a tool for development of a technical solution.	5
Analyzing or visualizing data to create information.	4.5
Creating technical report with usage of international standards.	4.5
Acquiring and evaluating information.	4

CHAPTER 6

PROJECT TIMELINE

GROUP GANTT CHART

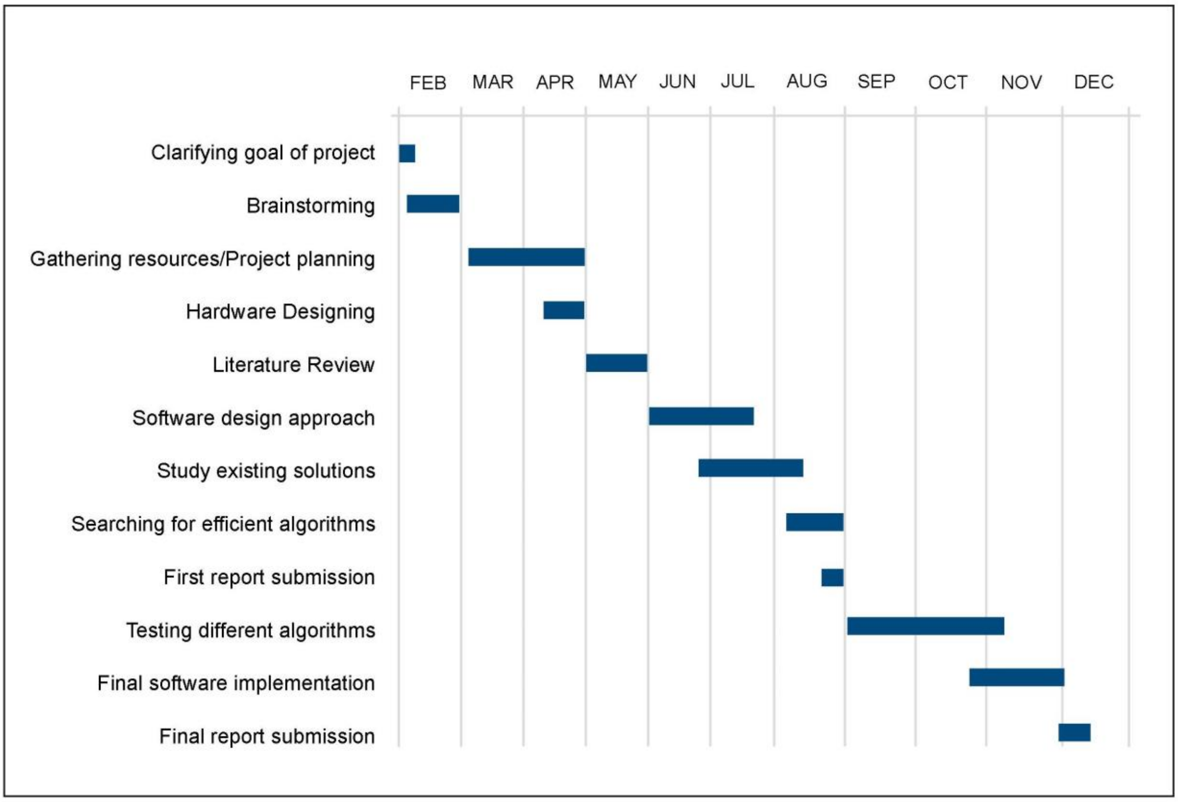


Figure 8.1 represents the workings of the whole group in the form of a timeline.

The timeline starts from February since that's when the teams were finalized and the work on the project started. Planning of the project was done from March to April. Initially the hardware part was thought of to be planned in march and along with the implementation but due to an unforeseeable future during covid-19, it was held off. And instead more time was dedicated to restructure and plan accordingly.

INDIVIDUAL GANTT CHARTS

Shriyesh Chandra (101895004) Gantt Chart

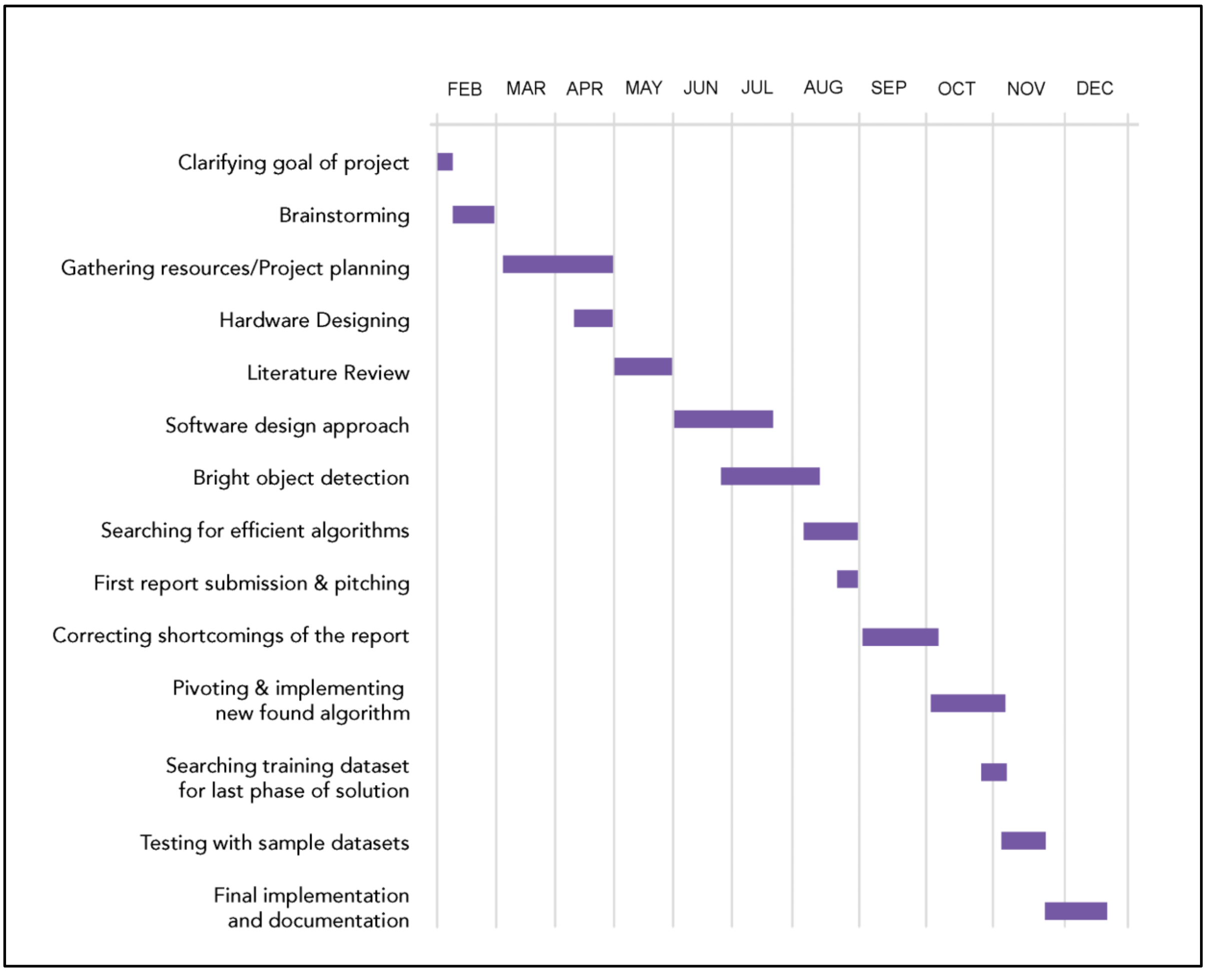


Figure 6.2 represents the workings of Shriyesh Chandra in the form of a timeline.

Prakhar Gupta (101715112) Gantt Chart

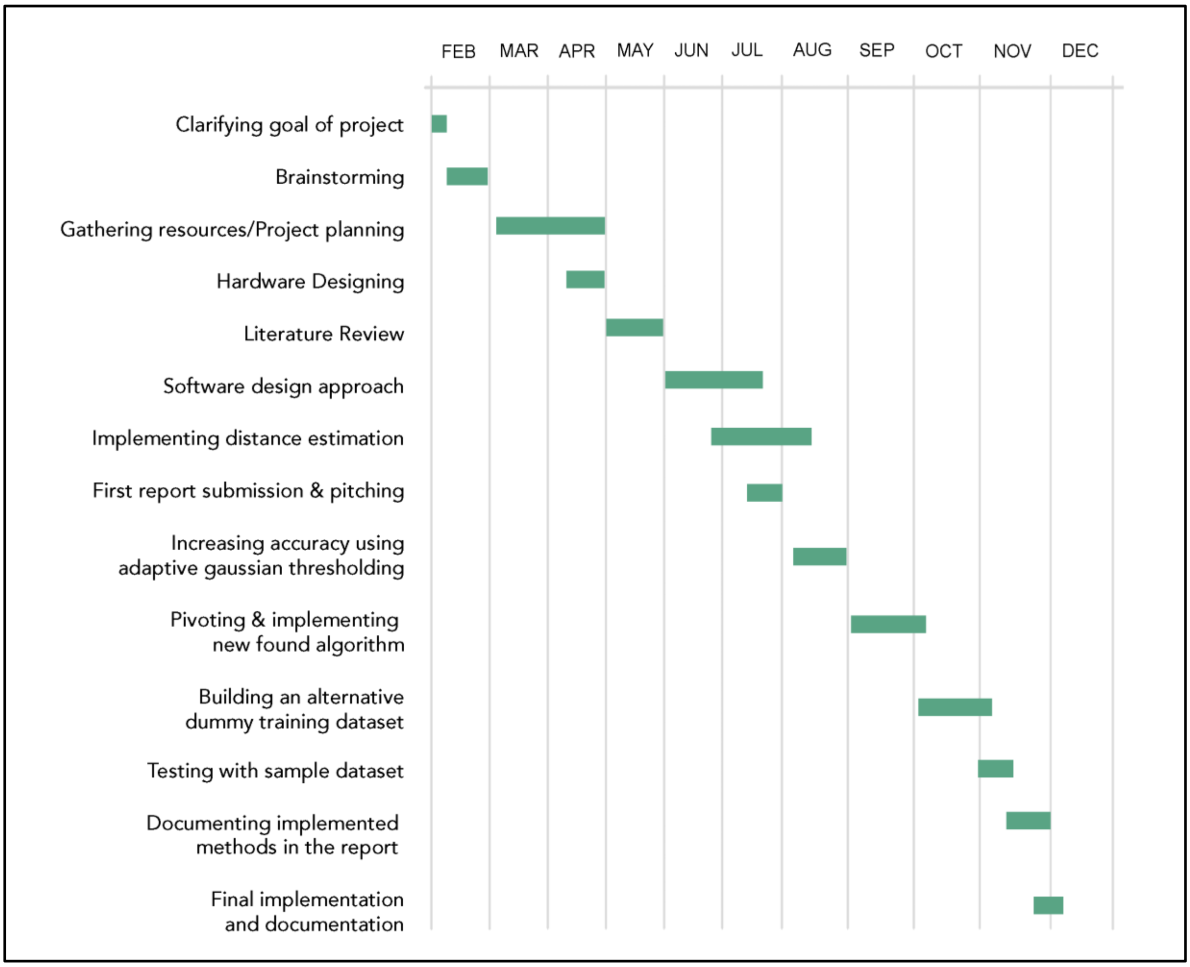


Figure 6.3 represents the workings of Prakhar Gupta in the form of a timeline.

Garima Monga (101706063) Gantt Chart

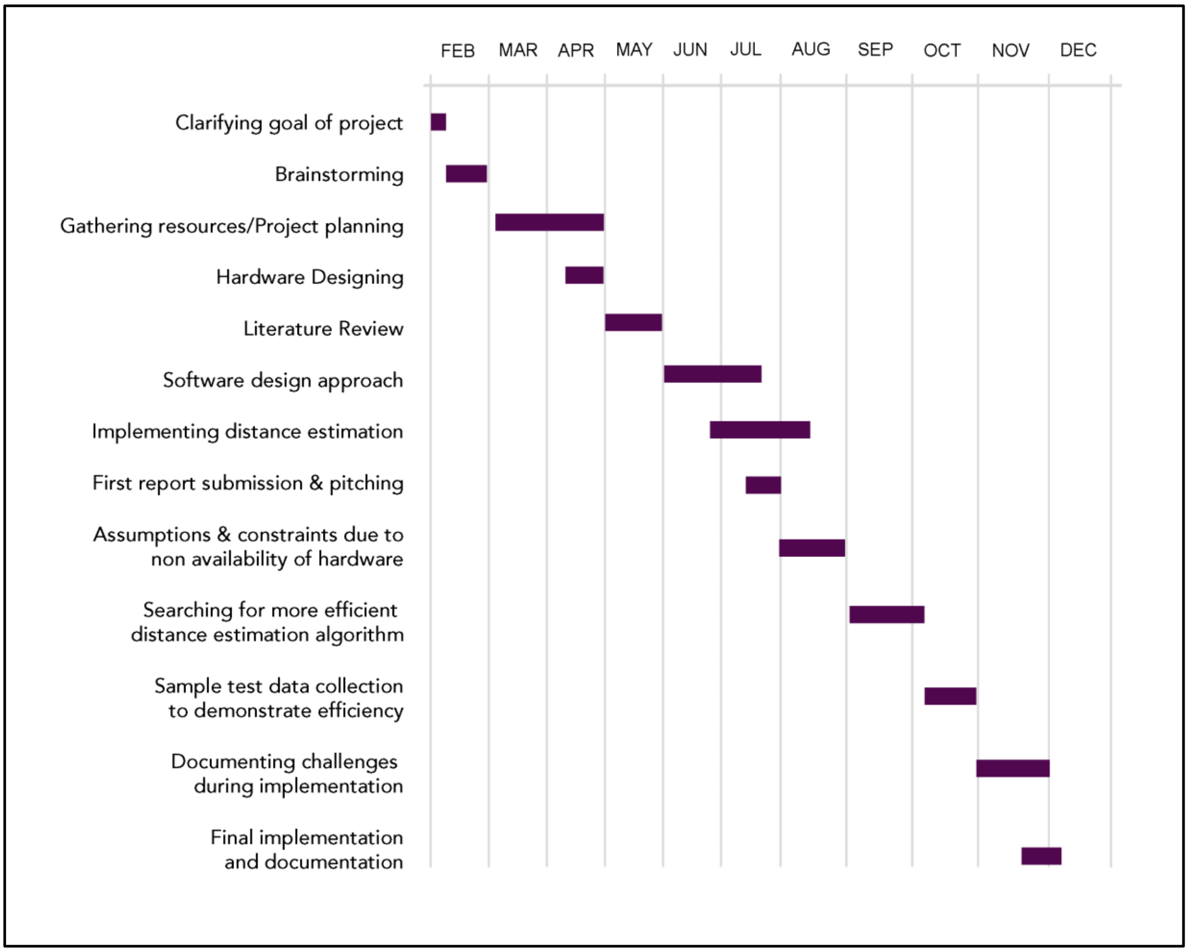


Figure 6.4 represents the workings of Garima Monga in the form of a timeline.

Deepali Sharma (101706050) Gantt Chart

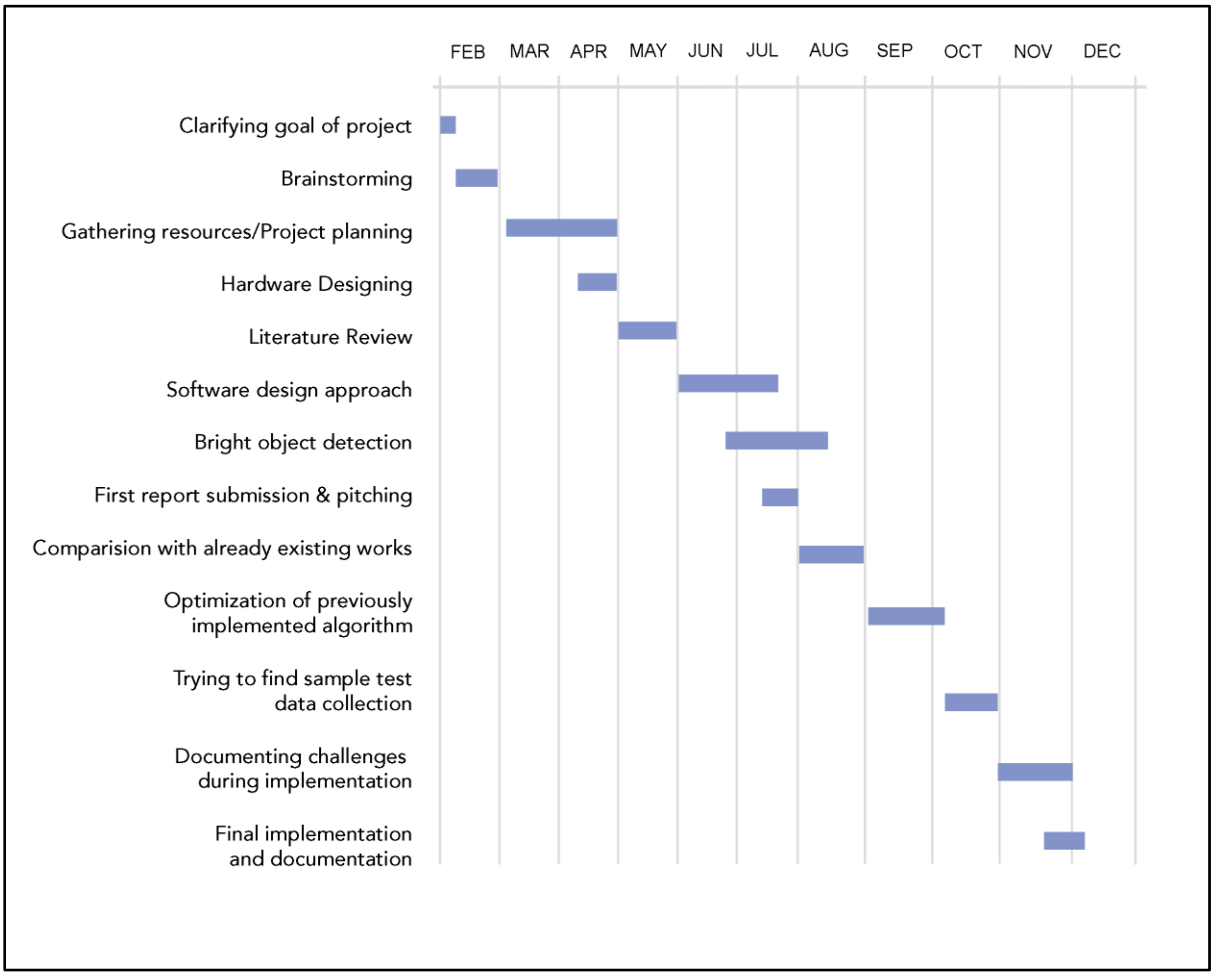


Figure 6.5 represents the workings of Deepali Sharma in the form of a timeline.

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APPENDICES A
IEEE STANDARDS REFERRED

IEEE Standard	Purpose
610.4-1990 - IEEE	Standard Glossary of Image Processing and Pattern Recognition Terminology
P3652. 1 - IEEE	Draft Guide for Architectural Framework and Application of Federated Machine Learning
1858-2016 - IEEE	Standard for Camera Phone Image Quality
802.11bg - IEEE	Standard for data transmission over Wi-Fi
802.15.4-2015-IEEE	Standards forLow-Rate Wireless Networks
2700-2017-IEEE	Standards for Sensor Performance Parameter Definitions
802.3-2015-IEEE	Standard for Ethernet.
208-1995-IEEE	Standard Video Techniques: Measurement Resolution Camera Systems
292–307 (2007)	A combination of extraction methods for SVM pedestrian detection.
830-1998 - IEEE	Recommended Practice for Software Requirements Specification
62–66 (1979)-IEEE	A threshold selection method from gray-level histograms
584–589(2004)- IEEE	Pedestrian localization and tracking system with Kalman filtering
199–213(1992)- IEEE	Recursive 3-D road and relative ego-state recognition
371–376(1995)- IEEE	Noise and intensity invariant moments. Pattern Recognition