School of
Electronics and Communication Engineering

Mini Project Report

on

ADAPTIVE HEADLIGHT TO REDUCE DAZZLING EFFECT

By:

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SCHOOL OF ELECTRONICS AND COMMUNICATION ENGINEERING

CERTIFICATE

This is to certify that project entitled **" ADAPTIVE-HEADLIGHT TO REDUCE DAZZLING EFFECT "** is a bonafide work carried out by the student team of **"RAJASHEKAR I GANIGER (01FE20BEC205), VISHAL K KULKARNI (01FE20BEC192), REVATI KARALATTI (01FE20BEC092), ABHISHEK KUDACHI (01FE20BEC191)"**. The project report has been approved as it satisfies the requirements with respect to the mini project work prescribed by the university curriculum for BE (V Semester) in School of Electronics and Communication Engineering of KLE Technological University for the academic year 2022-2023.

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The feeling of fulfillment that lies within the effective completion of our Mini-project would be unfinished without citing the names of the individuals who made a difference in completing this project as their consistent direction, support and encouragement brought about in its realization. We are thankful to our esteemed institute KLE Technological University, Hubballi which has provided us an opportunity to fulfill the most cherished desire to reach our goal. We express a deep sense of appreciation and gratitude to our Head of School of Electronics and Communication, Dr. Nalini Iyer for giving us the motivation and for having provided us academic environment which nurtured our practical skills contributing to the success of our project. Furthermore, we would also like to acknowledge with much appreciation the decisive role of our guide Heera G. Wali, for encouraging our efforts and guiding us in the right manner. We have to appreciate the guidance given by other supervisors as well as the panels especially in our project management that has improved our project management skills. Thanks for their comments and advice. Lastly, we would like to thank all our classmates for their support and help.

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ABSTRACT

The adaptive lighting system is a safety feature created to improve your nighttime vision without interfering with other drivers. The device might also enable the driver to see more of the turn's bend. When driving on the highway, the strong high beam coming from the opposite vehicle will seriously threaten the safety of the drivers. To avoid traffic accidents, the Adaptive Driving Beam (ADB) has been proposed in recent years. According to a report from the National Highway Traffic Safety Administration (NHTSA), almost 50 percent of fatal car accidents happen at night, despite the fact that only about 25 percent of vehicle travel during the night hours . This automatic adjustment technique can modify the lighting shape of the high beam according to the position of the opposite vehicle, which can prevent dazzling and improve the safety when driving on road, Adaptive headlights (ADHL) have been introduced by several car manufacturers as a technology to help the driver to better see in a curve in the dark. The headlights' horizontal aim is directed where the vehicle is heading based on the speed of the vehicle and the direction of the steering wheel. Previous research has suggested that adaptive headlights have significant real-world benefits in reducing injury crashes with passenger cars. Headlight evaluation has also been included in car rating protocols. However, there are few effectiveness figures for specific crash types or situations. The objective of this study was therefore to investigate the real-world benefits of adaptive headlightsIn this paper we compared the result of the LED matrix and Adaptive Driving Beam(ADB) method .LED matrix method uses the position of the vechiles to control the sub-led of LED matrix ,where as ADB uses angle detecting technique which can calculate and predict the angle of the vehicle coming from the opposite road andchange the trajectory of the high beam to avoid dazzling effect . Based on the flexibility,latency and visibility of the surrounding provided by each of the method we conclude that Adaptive Driving Beam(ADB) is superior when compared with LED matrix method.

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Chapter 1

Introduction

This project was created to demonstrate a more sophisticated approach to modern/standard headlight technology used in present cars by comparing 2 models . In addition to having mandatory low and high beams, this project aims to demonstrate how the flexibility of LEDs can be used to create safer driving environment under low light/dark conditions. The main objective of this technology is to illuminate as much of the road as possible while not dazzling other drivers for both oncoming and preceding traffic to avoid accident. This is made possible in this project by comparing between led matrix and adaptive headlight model,we used 2 sub-systems in communication. First is the module to control the hardware (LED matrix, servo motor), second is a trained object detection model to detect vehicles, locate them and determine where to lighten/darken.

1.1 Motivation

The primary driving force behind this initiative is to advance vehicle security, which is currently a top priority for the automotive industry.There are more technique to reduce accident at day time when compared with night time .According to a report from the National Highway Traffic Safety Administration (NHTSA), almost 50 percent of fatal car accidents happen at night, despite the fact that only about 25 percent of vehicle travel takes place during the night hours.While driving a car, there are many parameters that have to be kept in check to avoid accidents and sometimes these parameters become one too many for the driver but an adaptive headlight(automated machine) can handle things perfectly.Adaptive LED headlights are able to adapt to various road conditions. The benefits of adaptive LED headlights include Increased Visibility,Less Distracted Driving and Safety.A large number of lives can be saved by making use of autonomous vehicles. The detection feature in autonomous vehicles is very helpful to the system in making decisions about its intended course and final destination. This project's significance and the effects it will have on autonomous vehicles are its main sources of inspiration.

1.2 Objectives

- To reduce the dazzling effect due to high beam.
  - Using LED dot matrix
  - Adaptive LED high beams
  - Compare both the models
- Achieve minimum latency possible.

1.3 Literature survey

1.3.1 Adaptive high beams using PWM

Introduction : Team of Dahou et al.[1] work on "Adaptive high beams using PWM" introduces a method, depending on which side the car turns, the headlamp's beam lobes are change.
Body Headlight is divided to four parts LB(L/R)- Low Beam (Left/Right), HB(L/R)- High Beam (Left/Right), LBM- Low Beam Middle, and LB(R/L)- Low Beam (Right/Left). LBL LBR of the left headlight are positioned at 10 degrees and 20 degrees to project the beam side lobes, the HB and LBM lamps are parallel to the roll axis.lights is altered in response to input from the steering wheel. The HB lamp emits bright light along the trajectory line, while the PWM Modulator regulates the projection of the LB lamps by turning them on and off in response to vehicle motion.
Conclusion : Light beams are controlled over steering angle, high beams are kept constant while low beams are adjusted from 0 to 45 degree using PWM
.

1.3.2 Adaptive frontlight systems

Introduction : Team of Dahou et al.[2] work on "Adaptive frontlight systems (AFS)" using steering angle, mathematical model and direction indicators
Body:AFS, will adjust the beam lobes to alter the lighting pattern when travelling through a bend in order to account for the change in trajectory and enhance night vision. AFS will greatly assist the driver at road intersections by illuminating the direction in which the car would turn.Nissan Global teams created an AFS that automatically adjusts low beam based on vehicle speed and steering to provide better visibility and Ford Dynamic LED headlights with Adaptive Lighting have an LED configuration that produces an accurate light pattern and its strongly recognisable light provides superb illumination.
Conclusion : Limited beam modifications and no vehicle ongoing /oncoming detection.

Table 1.1: . Comparison of the different adaptive headlight systems.

System	Methodology	Observations
Adaptive headlamps using PWM on FPGA	Parabolic lamp design with four lamps in each headlamp that are placed strategically certain angles to produce different beam lobes in response to the steering angle	The work caters to test cases with bending angles in the range of 0 degrees to 45 degrees effectively.
Nissan Global AFS	Beam adjustment according to steering angle and direction indicators and mathematical model is developed	1. Turns on low beam as per vehicle speed and steer to give better perceivability 2. At road junctions, AFS will illuminate the direction to which the vehicle would take a turn and reduces accidents due to low illumination. 3. Limited features of beam modification. No detection of oncoming traffic or adjustment
Ford Global Tech AFS with dynamic LED headlights	The electronic driving light framework has an illumination source, a projection lens, combined with a digital micro-mirror, and has a camera for object detection using image processing	1. Correlations between lamp and wheel turn are found to be good. Identifies the object and beams less light on the objects to make an intensity variation and alert the driver. This reduced intensity also reduces Troxler' effect on the subject if the object is a living being. 2. High processing capability makes it not viable for smaller vehicles. The cost factor also hinders its use in mid and range vehicles.

1.4 Problem statement

To develop an appropriate solution for headlight high beam that avoids glare using machine learning algorithm, to demonstrate how the flexibility of LEDs can be used to create safer driving environment under low light/dark conditions. The main objective of this technology s to illuminate as much of road as possible while not dazzling other drivers.

1.5 Application in Societal Context

It is challenging to drive huge cars in the mountainous area. If the motorist makes a deep turn, visibility is compromised. The suggested system is an ADAS headlamp that features automatic beam management and a way to eliminate blind spots during sharp turns for better visibility. When a vehicle travelling in the other direction is detected, the smart headlamp installed on trucks helps to automatically transition from high beam to low beam. It does away with the necessity of the driver manually switching. The truck's additional fog lamp is integrated into this module so that it may adjust its direction automatically based on the angle of the steering wheel. This will aid in improving object visibility on curvy roadways. Most of the time, the late recognition of the objects in the curve plays a key role in accidents.These headlights have different ways of focusing on the road. The intelligent headlamp boosts safety and increases comfort and visibility for the driver.

1.6 Project Planning

PROJECT NAME	PROJECT DURATION	PROJECT START DATE	PROJECT END DATE
An Adaptive Driving Beam(ADB) System based on Angle and position information of opposite vehicle	40	September 21, 2022	December 18 , 2022

Tasks	Task discription	Task duration	Start date	End date	30-09-2022	15-10-2022	18-11-2022	25-11-2022	15-12-2022	18-12-2022
1	Generating problem statement	1	Sep-29	Sep-30						
2	Initiation	1	Sep-31	Oct-01						
3	Literature survey	2	Oct-13	Oct-15						
4	Analysis of multiple solution	2	Oct-30	Oct-02						
5	Project Planning	2	Nov-04	Nov-06						
6	Functional specification	2	Nov-15	Nov-17						
7	Design	2	Nov-23	Nov-25						
8	Simulation	2	Dec-04	Dec-06						
9	Implementation	3	Dec-12	Dec-15						
10	Closure	1	Dec-17	Dec-18						

Figure 1.1: Gant Chart

1.7 Bill of materials

Sr no	Part name	Specification	Quantity	Price
1	Arduino Mega 2560	5V, digital pin=54, analog pin=16	1	2000
2	LED matrix MAX7219	8x8 dot matrix, 5v, 16 pins	1	200
3	Servo motor	Sg90, 3 pin, 3v-7v operating voltage	2	105 x 2 = 210
4	Bread board	14.2x8x2.2 cm, 400 points	1	375
5	Jumper wire	Male to male, male to female	10	20
6	LED	White, 3.3 V	3	6
Total				2811

Table 1.2: Bill Of Material

Chapter 2

System design

This project aims to demonstrate how the flexibility of LEDs can be used to create safer driving environment under low light/dark conditions. The main objective of this technology is to illuminate as much of the road as possible while not dazzling other drivers for both oncoming and preceding traffic. This is made possible in this project with 2 sub-systems in communication. First is the module to control the hardware (LED matrix and servo motor), second is a camera feed with a trained object detection model to detect vehicles, locate them and determine where to lighten/darken.

2.1 Functional block diagram

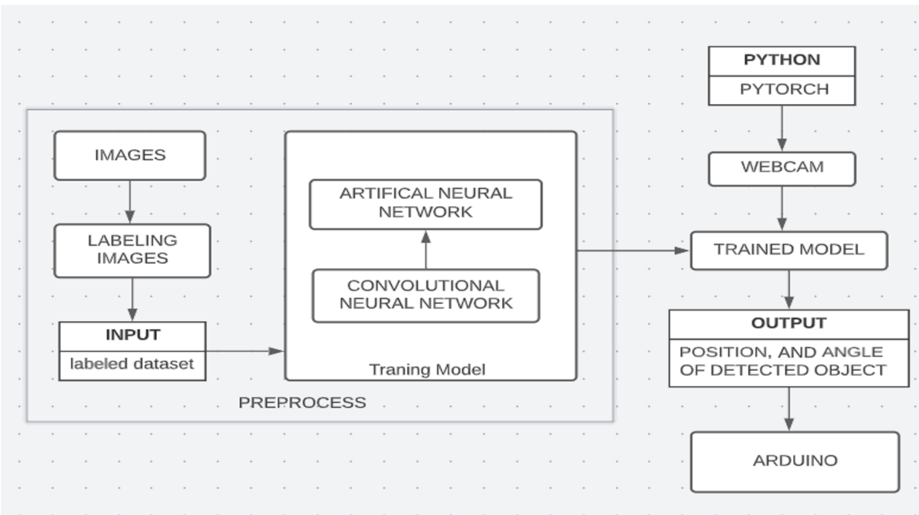

Figure 2.1: Functional block diagram

2.2 Design alternatives

2.2.1 Automobile Adaptive Headlamps using PWM

An automatic front light system framework ensures improved eyesight for drivers by moving the beam projections as the vehicle goes [5]. In order to help the driver see the road more clearly and avoid collisions with other vehicles, pedestrians, or other objects, an AFS system alters the beam lobes of the headlamp depending on which side the vehicle turns. This serves as the framework. The PWM circuit alters the brightness of the low-beam lighting depending on the type of state it receives. The study covers the majority of test scenarios, and the usefulness of the findings is verified for bending angles between 0 and 45 degrees. However, the system's response time, or latency It is crucial and demands discussion.

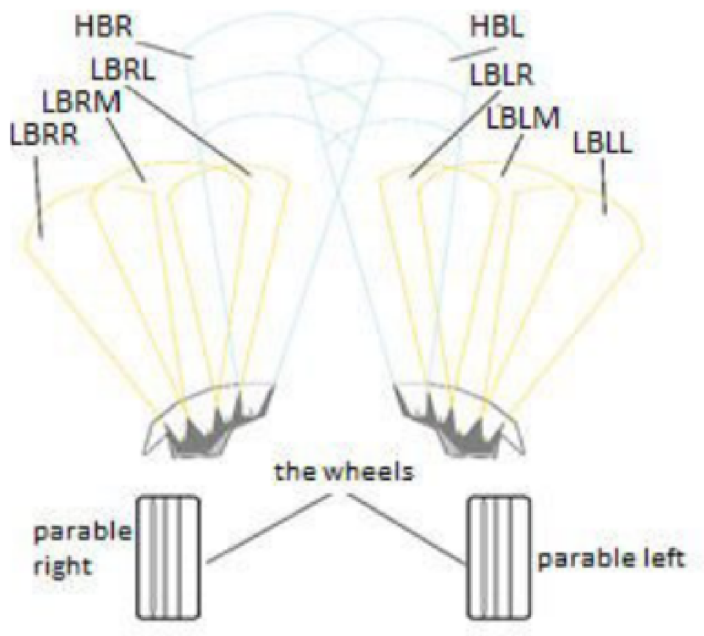

Figure 2.2: Adaptive high beams

2.2.2 Adaptive frontlight systems (AFS) :

[3]To distinguish dipped headlight and high beam light, detection the position of vehicle light is an indispensable procedure. Due to the dynamic range limitation of digital image, overexposure is common in traffic monitoring at night because of the high beam light from the vehicle and reflection of the ground [18]. As shown in Fig. 1(a), the coming vehicles are blurred by overexposure, and the vehicle light is covered up by the background. Thus, detection the position of vehicle light becomes a tough task.

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2.2.3 Headlight control using steering angle:

[4]The low beams are always ON, whereas the high beams are turned ON or OFF according to the oncoming and same-direction vehicles. Taking the middle part as the boundary, the left illumination areas are divided into L1, L2, L3, L4; and partially displayed L5 zones, whereas the right illumination areas are divided into R1, R2, R3, R4; and partially displayed R5 zones. According to the mirror-projection principle, the projection angle of light source through the reflector lens is the minimum projection angle. The smallest zone of light source depends on the light source size and the distance from the reflector lens. The lighting range is 0.642 under a light source size of 1.12 mm and a focal length of 100 mm, which is set as 0.64 in the ideal zone .

2.3 Final design

When we are driving with high beams on at night, the camera in the system can record the position of each vehicle ahead, and then calculate the distance and angle between it and our car. The vehicle speed sensor can detect the speed of the vehicles. At every angle, the car will turn off the high beam in the corresponding position to prevent the oncoming driver from dazzling and causing traffic accidents; when the vehicle passes by, it will automatically turn on the high beams.

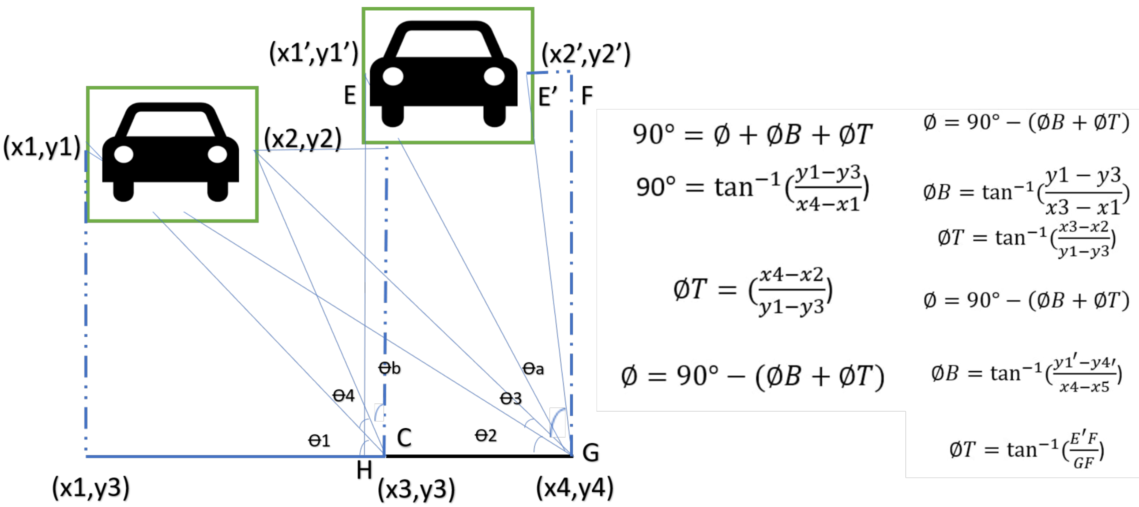

Figure 2.3: Angle calculation

Chapter 3

Implementation details

3.1 Specifications and final system architecture

Table 3.1: Hardware specification

Sr no	**Device**	**Specification**	**Output**
1	Servo motor(sg90)	Rotate angle: 180° Operating voltage: 4.8 ∼6V. Gear: plastic.	Rotate LED(high beam) with angle
2	8X8 LED matrix MAX 7219	Display Size 130 x 32 mm (5.1 x 1.3)	Turn on appropriate led column
3	Arduino Mega 2560	Operating Voltage 5V, Input Voltage 7-12V, Analog Input Pins 16, DC Current per I/O Pin 20 mA	Control Servo motor and LED matrix

Table 3.2: Model specifications

MODEL	
Pre-trained model	Faster RCNN ResNet -50 FPN
Image type	Pytorch tensors
Processing	Needs GGPU

Table 3.3: Parameters

PARAMETERS	
Polling method	Max polling
Polling size	2x2
ROI feature extractor	Softmax
Padding	Same
Activtaion function	Relu
Bounding box format	Normalised (xmin,ymin,xmax,ymax)
Image type	PIL , tensor

Table 3.4: Hyperparameters

HYPERPARAMETERS	
Image size	480x680
Pixels	307200
Train images	500
Test images	100
Validation images	50
Annotation file format	VOC XML
Number of classes	1
Epochs	50
Learning rate	0.01
Batchsize	10
Strides	2
Score filter	0.6

3.2 Software specification

Python programming language used to implement the model, python is one of the high-level languages which is an object-oriented language with programming support of GUI with the free and open-source with many extensible features such as easy to plot the graph, complex calculations by importing standard libraries. In Google, colab code is implemented easily and freely. Different languages of code can be run on this platform. which can be extracted as a pdf or .ipynb file and can be shared easily to edit in the code, Labelimg is an software used for annotation of images that are required for training model. the Pytorch object detection model ResNet-50 from model zoo has following elements.

beginitemize

- **A 7×7 kernel convolution** alongside 64 other kernels with a 2-sized stride.
- **A max pooling layer** with a 2-sized stride.
- **9 more layers**—3×3,64 kernel convolution, another with 1×1,64 kernels, and a third with 1×1,256 kernels. These 3 layers are repeated 3 times.
- 12 more layers with 1×1,128 kernels, 3×3,128 kernels, and 1×1,512 kernels, iterated 4 times.
- **18 more layers** with 1×1,256 cores, and 2 cores 3×3,256 and 1×1,1024, iterated 6 times.
- **9 more layers** with 1×1,512 cores, 3×3,512 cores, and 1×1,2048 cores iterated 3 times. (up to this point the network has 50 layers)
- **Average pooling**, followed by a fully connected layer with 1000 nodes, using the softmax activation function.

3.3 Data set description

Several five hundred images of night time driving containing headlights and taillights are used to train a model that can detect vehicles at night with high percentage of accuracy and low error rate. Those images were separated into train (80 percent) and test (20 percent) datasets. All of them were labeled using LabelImg application which is very useful when creating a custom object detection model.

3.4 Algorithm

step1 The model is trained on more than 500 images, has a detection accuracy of 0.86 to detect vehicle in dark.

step2 Estimate the vehicles position and determine the appropriate angle(refer fig Angle calculation) to adjust the high beam.

step3 The 8x8 LED matrix and servo motor is attached to Arduino mega as a peripheral, the position and angle data is sent and output is processed

step4 Transmitted angle is evaluated under a variety of circumstances to determine which headlight should be turned on or off.

3.5 Flowchart

Opencv library provides a real time Vision library through photos are captured with webcam and given as input to pytorch object detection model results in bounding boxes with four co-ordinates which is used to calculate position and angle which are further processed and calculated values are given to Arduino through serial communication and peripherals matrix and servo motor are processed.

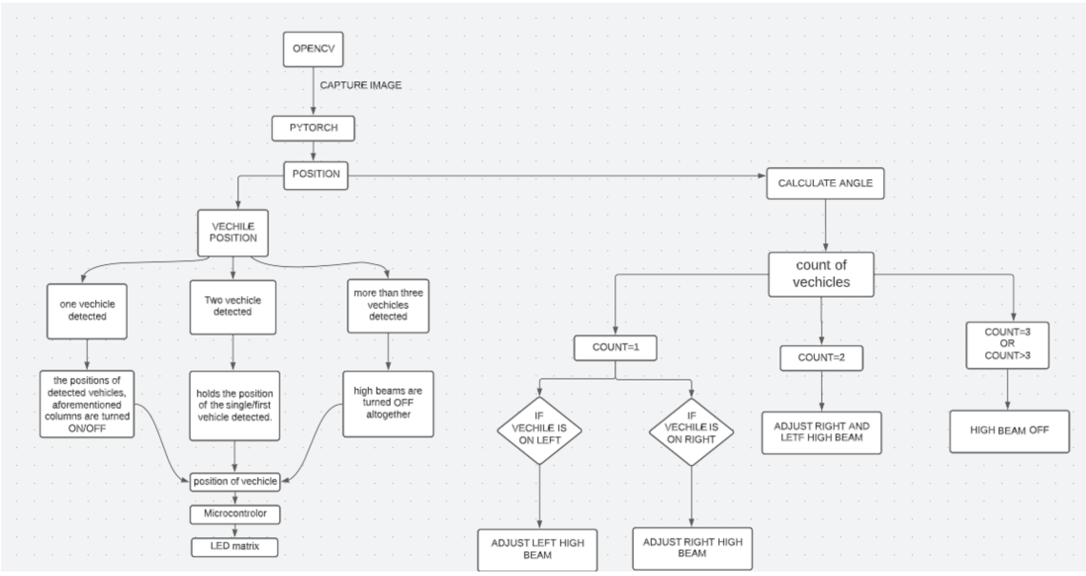

Figure 3.1: Flowchart

3.6 Model evaluation

3.6.1 Training loss

A model is better the lower the loss unless the model has over-fitted to the training data). The model's performance for these two sets is used to interpret the loss, which is determined using the training and validation data. Loss is not a percentage, in contrast to accuracy. It represents the total number of mistakes committed for every example in the training or validation sets.

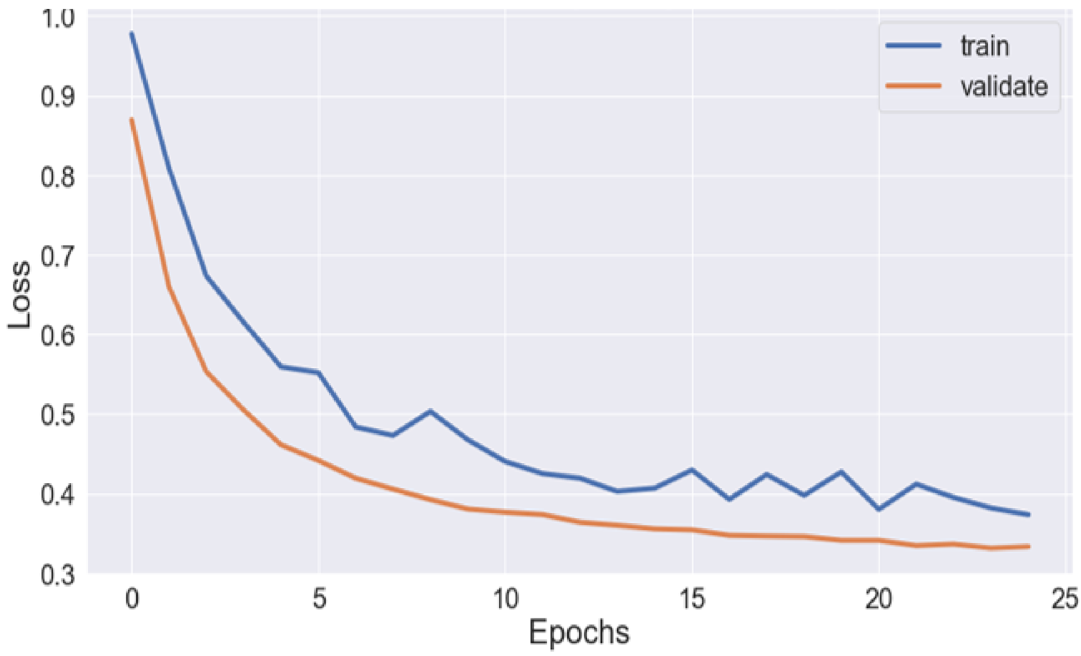

Figure 3.2: Train loss

3.6.2 Confusion Matrix

The confusion matrix is a performance statistic for machine learning classification tasks where the output can be two or more classes. The table contains four possible combinations of predicted and actual values.

Figure 3.3: Confusion matrix

3.6.3 Correlation

The term "correlation" refers to the relationships between two or more variables. These aspects of the raw data that we used to forecast our target variable may be these causes. The statistical technique of correlation looks at the relationship between two variables and how they change or shift over time.

RESULTS:	
Accuracy	0.86
Recall	0.85
F1 score	0.88

Figure 3.4: Accuracy,Recall,F1 score

Chapter 4

Optimization

4.1 Introduction to optimization

optimization of the model involves the major constraints like time complexity,space complexity,memory management,etc.The system can be optimized in multiple methods such as statistical method, analytical method,etc.In mathematical way of reduction of errors Using of the filters is one of the option.Filters helps in improvising the accuracy rate of the output by reducing the error present in the inputs to the it.

4.2 Types of Optimization

4.2.1 Code optimization

1.**Tensors** : Pytorch converts image to tensors which can perform big math easily using GPUs (graphics processing units) are made up of numerous smaller cores, training deep learning models runs significantly more quickly on them. For straightforward matrix multiplication, it is almost 15 times faster than Numpy! which can be useful in back propagation during training the model.

2.**Intra class variation** : Dataset which is used to train the model consist of one class 'vehicle' containing all varieties of vehicle whithout considering ongoing/oncoming condition which removes problem of intra class grouping which is difficult to classify due to similar features in the same class.

4.2.2 Latency optimization

Serial communication between python and Arduino is slow because of timeout condition to find end of data on serial port.hence making timeout to zero and putting the data (which are multiple in this case) into a stack and to receive one after other is faster approach of communication which reduces latency much extinct.

Table 4.1: Latency optimization

Optimization	**Latency**
When all conditions uses ' if ' operator	60 msec
'if' replaced with 'else if '	33 msec
Data sent in structure	15 msec
Data sent with single string format	12 msec

Chapter 5

Results and Discussions

5.1 Result Analysis

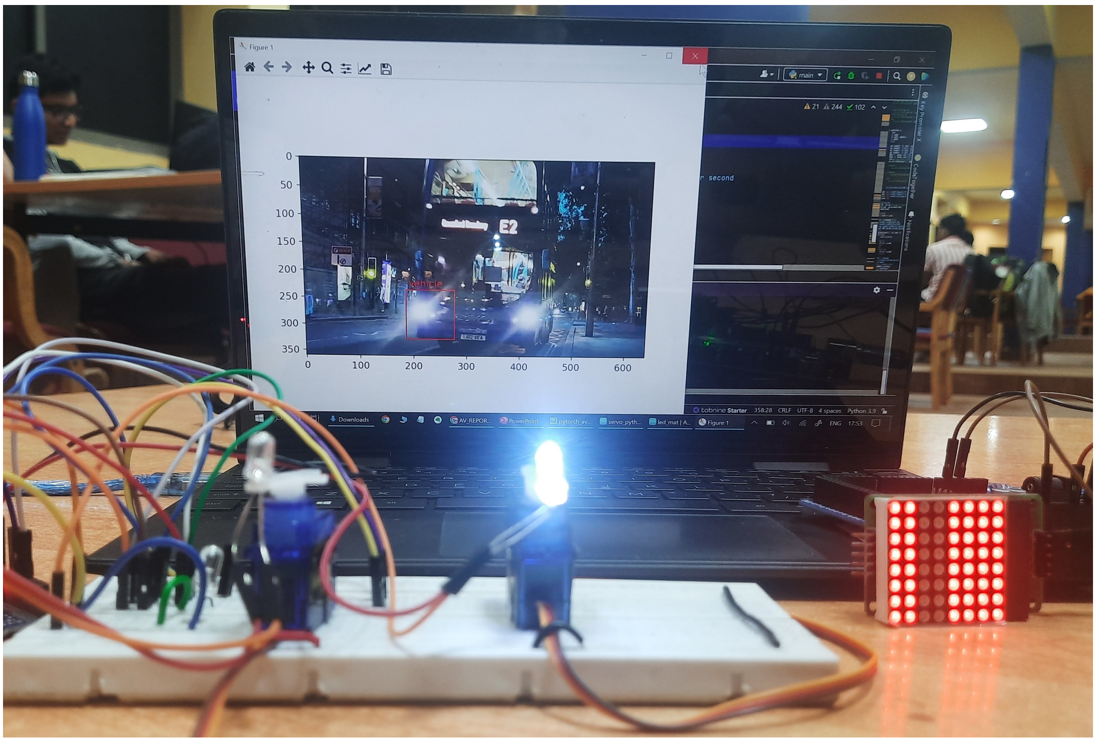

Figure 5.1: Result

Chapter 6

Conclusions and Future Scope

6.1 Conclusion

After comparing led matrix and adaptive headlight we came to the conclusion that adaptive headlight is a better choice than lead matrix because it is more volatile than led matrix ,which can reduces the dazzling effect for both near and long distance

6.2 Future Scope

Wouldn't it be fantastic if a smart system could recognise cars in oncoming lanes and turn off a section of that high beam? Or what if the light's position varied in response to the movement of oncoming traffic? In recent years, car manufacturers around the world have been investing in this area; some high-end vehicles are now even equipped with such technology. A German research alliance has recently produced three high resolution LED light sources, each of which has 1,204 individually programmable electromechanical light spots [8]. A glare-free high beam (GFHB), on the other hand, uses auto-switching between low and high lights to reduce glare and improve vision for the driver after detecting the approaching car with a camera and seeing the shades [14]. The feasibility, promise, and challenges of an intelligent laser-based adaptive headlight system (iLas) are being studied by the iLas consortium[2]. Organic LED (OLED) technology is also being developed [3]. When rotating, recent research studies include include area-based light modulation and digital micro-mirror devices (DMDs).

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