# Malnad College of Engineering

**(An Autonomous Institution under Visvesvaraya Technological University, Belgaum)**

**Hassan – 573202**

**INTELLIGENT NIGHT VISON AND PEDESTRIAN DETECTION SYSTEM FOR AUTOMOBILES**

A Project report submitted to Malnad College of Engineering, Hassan, during the year 2021 in partial fulfilment for the award of the degree of

**Bachelor of Engineering**

in

**Automobile Engineering**

by


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**PROJECT TITLE:**

# INTELLIGENT NIGHT VISON AND PEDESTRIAN DETECTION SYSTEM

A major project report submitted in partial fulfilment of the requirements forthe degree of Bachelor of Engineering in **Automobile Engineering** by the students,


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## Department of Automobile Engineering

# CERTIFICATE

*Certified that the Project Work titled*

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*is a bonafide work carried out by*

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*in partial fulfilment for the award of*

**Bachelor Degree in Automobile Engineering**

*of*

**Malnad College of Engineering**

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**Visvesvaraya Technological University, Belgaum**

*During the year 2021, It is certified that all corrections/ suggestions indicated for Internal Assessment have been incorporated in the Project report deposited in the Department Library. The Project Report has been approved, as it satisfies the academic requirements in respect of Project Work prescribed for the Bachelor of Engineering Degree.*

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| 2. | |

**ABSTRACT**

Recent surveys suggest that more than 4000 pedestrians are killed, and tens of thousands more are injured struck by a car. Out of which 70% of those impact happen at night, when drivers have limited visibility. Especially remote areas where electricity is barely available and street lamps are difficult to install, absence of light makes detection of pedestrians and animals crossing by the road unfeasible. Also, according to customer reports vehicle headlamps allow limited vision especially during low light conditions. One reason that driving at night is so difficult is that high-beam headlights can rarely be used owing to the frequent presence of oncoming traffic. The experience is especially challenging for older drivers, who typically have shorter detection distances of just 30–50 m for dark objects when driving with low-beams and facing oncoming vehicles. The main safety benefit of night-vision systems is to increase the driver’s range of vision when using low-beam headlights and emphasize the presence of animals, pedestrians, cyclists and other vulnerable road users. An automotive night vision system is used to improve a vehicle driver’s perception and seeing distance in darkness or poor weather.

In this project work, night vision and pedestrian detection system is developed. The night vision system includes a light source and a camera. The method includes activating the light source i.e., IR illuminator as a sequence of light pulses, where in each light pulse is increasing in intensity for a predetermined number of pulses to form a pulse train. The IR pulses are outside of the visible spectrum of humans and can only be detected with a camera. The camera is turned on by a series of detection frames, each of which corresponds to a light source detected scene. A video is being created from the detected scene. Whereas the pedestrian detection is the pre-defined program to the vehicle’s computer which process each frame to detect animals, people and obstacle and warn driver before collision. The Dynamic spotlighting is the additional feature for the traditional Night vison system which functions to reduce the blind spot at the air pin or blind curves.

The developed system is tested for its low light conditions as a working model. It is found that the results/images are displayed successfully on LCD TFT display unit.

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## DECLARATION

I hereby declare that the project titled "INTELLIGENT NIGHT VISON AND PEDESTRIAN DETECTION SYSTEM FOR AUTOMOBILES" submitted to Malnad College of Engineering (UGC-Autonomous), affiliated to Visveswaraya Technological University, Belagavi (VTU) for the award of the degree in Bachelor of Engineering in **Automobile Engineering** is a result of original research carried-out in this thesis. I understand that my report may be made electronically available to the public. It is further declared that the project report or any part thereof has not been previously submitted to any University or Institute for the award of degree.

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| Department | : Automobile Engineering |
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# ABBREVIATIONS

FARS - Fatality Analysis Reporting System

NHTSA - National Highway Traffic Safety Administration

CCD - Charge Coupled Device

VES - Vision Enhancement System

ECS - Electronic Stability Control

IC - Integrated Chip

HFOV - Horizontal Filled of View

FOV - Field of View

HUD - Heads Up Display

LED - Light Emitting Diode

FIR - Far Infrared Rays

NIR - Near Infrared Rays

NVA - Night Vision Aid

ARM - Advanced RISC Machines

SRAM - Static Random-Access Memory

MP - Mega Pixel

LCD - Liquid Crystal Display

SAS - Steering Angle Sensor

CAN - Controller Area Network

DC - Direct Current

SMPS - Switch Mode Power Adapter

LXDE - Lightweight X11 Desktop ENVIRONMENT

FPS - Frames Per Second

CMOS - Complementary Metal Oxide Semiconductor

YOLO - You Only Look Once

CNN - CONVOLUTION Neural Networks

RCNN - Region Based Convolutional Neural Networks

SSD - Single Shot Detector

COCO - Common Object in Context

GTIO - General Purpose Input/Output

GPU - Graphic Processing Unit

# LIST OF FIGURES

# CHAPTER 1

## 1.1 INTRODUCTION

Night-time driving is dangerous and is one of the most challenging driving situations for most drivers. A road at night can look very different from the same road in broad daylight. Between the glare of oncoming headlights and the deep shadows, upcoming curves and obstacles are harder to notice. While some people might be confident in their ability to adjust to night driving conditions, not everyone they share the road with is, and that requires everyone to be more careful to minimize the risk of accidents. Fatality rates are higher at night than in the day, particularly for crashes involving pedestrians and cyclists. Although there are multiple contributory factors, the low light levels at night are believed to be the major cause of collisions with pedestrians and cyclists at night, most likely due to their reduced visibility. Not only it is harder to see because of the darkened surroundings, but the glare of oncoming headlights can momentarily blind us to the curves of the road and obstacles in our way. The difficulty to see through the darkness, oncoming Vehicle’s headlights glare and pedestrians are not the only factors that affect the maneuverability. Some people will be suffering from various ocular diseases i.e., Myopia, Hypermetropia, Astigmatism, Glaucoma and Cataracts. They may not see the night traffic just like normal people do, symptoms include blurred vision, halos, glares and clouded vision. There is miss detection of temporarily stopped vehicles and pedestrians at intersections by using both appearance and motion cues at some predefined areas. Night-time driving due to poor vision is not only the major cause of the collision, poor vision is also because of the mist and cloud present in the early morning even during day times especially in hilly areas. Additionally due to lack of resources in remote areas it’s difficult to install street lamps which makes it nearly impossible to detect the pedestrians and animals crossing the roads which makes night vision and pedestrian detection systems a pivotal feature to automobiles to increase safety.

Illuminating the forest roads and alerting the drivers about animal crossing by the road by means of sign boards. Installing proper road signs and street lamps where ever necessary to warn the drivers before the collision. Educating people to follow road safety regulations and use their headlights in subtly and suitably. Basic safety features like collision warning system, Emergency automatic braking, Obstacle warning system should be made standard even for low end cars. Equip the vehicles with advanced illumination systems which adjusts itself automatically so that they don't affect the vehicles approaching from opposite direction. Applying Anti-Glare film on wind shield for better vision of approaching vehicles. Properly aligned headlights will help to see the road better and also prevent you from blinding oncoming drivers. Installing advanced night vision system which aid the better visibility during night and also in poor weather conditions.

In this project, an Intelligent Night Vision and Pedestrian Detection System for Automobile is developed and fabricated. The fabricated system works on Direct current which is generated by vehicle's battery.

# CHAPTER 2

## 2.1 LITERATURE REVIEW

The review mainly aimed on the design analysis of the intelligent night vision and pedestrian detection system for automobiles.

The literature review of this paper is as follows: -

Sullivan and Flannagan (2002) et. al., estimated the size of the influence of ambient light level on fatal pedestrian and vehicle crashes based on crash data from 1987 to 1997. Method of analysis of crash data from the Fatality Analysis Reporting System (FARS) of the National Highway Traffic Safety Administration (NHTSA), for an 11-year period between 1987 and 1997. The sensitivity to light level was evaluated by comparing the number of fatal crashes across changes to and from daylight saving time, within daily time periods in which an abrupt change in light level occurs relative to official clock time. Three scenarios: 1. Pedestrian crashes at intersections 2. Pedestrian crashes on dark, straight, high-speed roads 3. Single-vehicle, runoff-road crashes [1].

Owens et. al., (1993) studied the role of reduced visibility in nighttime road fatalities. In an analysis of 100,000 accidents during twilight hours, fatal accidents were found to be overrepresented during darker portions, but unrelated to time of day, day of week, or alcohol consumption. Reduced visibility was also indicated by higher overrepresentation of fatal accidents in low illumination under adverse atmospheric conditions and with pedestrians and pedal cyclists as opposed to all other accidents. Reduced visibility was more important than drivers' drinking as a contributor to fatal pedestrian and pedal cycle accidents. The reverse was true for all other fatal traffic accidents. The study raises the need for intervention in night driving (which VES may solve). [2]

Tsz-Ho Yu et. al., have implemented the intelligent night vision system for vehicles by using camera and computer vision system. The arrangement in the proposed system is found useful from safety point of view. It was convenient to use for night driving and provides features like zooming, spotlight projection, and road sign detection. It provided the complete information about the object present on road [3].

Hollnagel et. al., reported a simulator study in which they tested the effect of a vision enhancement system with two levels of field of view and two levels of brightness contrast on the quality of driving performance. Forty-two drivers (age unreported) drove a wide view (115 degrees) simulator on rural roads with no traffic. A Vison enhancement system (VES) image with a new set of textures, adjusted to provide a monochromatic IR-like image, was superimposed on the road scene. Every 10-20 minutes there was an obstacle on the road (pedestrian, moose, car parked with person standing outside), to which subjects had to respond [4].

Prajkta vikas Adhav et. al., had developed a system which had image sensor and servomotors to adjust the headlamp positions as the vehicle is steered. The system gave real time information of curved roads and **a**nalyzed performance of vehicle at corner. It is found that, when a motor turns, the headlamps will also turn with the vehicle body. Due to this the illumination was less. The article proposed the damping front system based on charge coupled device (CCD)[5].

Prateek Khurana et. al., developed an Electronic Stability Control (ESC) system. The system was effectively suitable for the situation where driver loses traction. Here, the headlamps are turned with turning direction of vehicle. The microcontroller-based system used to inputs the ECS. The whole system was fabricated onto single IC and installed in four wheeler drive commercial vehicle with a brake force distribution system[6].

Ward, Stapleton et. al., examined night-time gap acceptance and time-to coincidence judgements with a video recording of Vison Enhancement System (VES). Sixteen subjects (eight ages 20-25, eight ages 55-70) are simulated with, 38 degrees Horizontal Field of view (HFOV) infrared thermal camera 8-13 micron and a visible light video camera[7].

Meftah Hrairi et. al., Authors have performed various tests on the designed system to examine its performance, response and system impact. implemented steerable headlights by adapting conventional static headlamp. The implemented system was found reliable and cost effective[8].

Nilsson and Alm (1996) et. al., studied the changes in driving performance when using a simulated VES in a driving simulator. Method Twenty-four subjects (ages 23-46) Moving base simulator HFOV=120 degrees Targets: Red square 400 m ahead, standing van 400 m ahead, oncoming traffic. VES - clear video 17x12 cm 140 cm straight ahead[9].

Brickner et. al., (1993) studied the effect of image polarity on target recognition. Method 20 flight candidates viewed 60 images and touched the screen when they recognized a target they were requested to find. Independent variables Polarity (2): Black-hot and white-hot Dependent variables Response time Correct responses Findings • Polarity effects were found in segments where the targets were vegetation, natural terrain, or square buildings. There were no polarity effects among other human placed objects or among heat-emitting objects. The polarity effects, when found, were not in a single direction. Therefore, a recommendation cannot be given for either black-hot or white-hot. It is recommended that the operator be allowed to switch between polarity based on his/her specific needs[10].

Krebs et. al., (1999) tested detection of a pedestrian in sensor-fused images with two levels of glare from an oncoming vehicle. Method Eleven military observers (age unspecified) viewed nighttime driving images collected by a visible light camera (400-700 nm) and an NIR camera (700-1250 nm). The task was to determine whether a pedestrian, crossing the road in front of the opposing vehicle, was present or absent[11].

Mc Carley et. al., (2000) tested two methods of sensor fusion for detection of pedestrians under different levels of illumination from an opposing vehicle. Method Nine naval officers (30-38 years old) observed images of an outdoor night-time scene arranged to simulate the forward view of a road seen through the windshield of a vehicle using a 34 x 26degree FOV camera and viewed at 11 x 9 degrees. An opposing vehicle, parked 70 m in front of the sensors, varied the illumination level of its headlamps. A pedestrian was either absent from the scene or appeared at a distance of 23 m or 38 m[12].

## 2.2 PROJECT OBJECTIVE

The main objective of this project is to ensure safety and provide clear visibility of the field or an object to the driver during low light or unclear weather conditions and to minimize the occurrence and consequences of automobile accidents. Implementation of this technology to lower end cars by reducing cost. Intensive research to improve a vehicle driver's perception and seeing distance in darkness or poor weather. Such systems typically use infrared cameras, sometimes combined with active illumination techniques, to collect information that is then displayed through a LCD screen to the driver. Such systems are currently offered as optional equipment on certain premium vehicles. To minimize accidents by addressing the main causes of collisions: driver error, distractions and drowsiness. Systems which warn the driver if the vehicle is leaving its lane with visual, audible, and vibration warnings (lane departure warning, LDW). This project presents new way of vehicle and pedestrian recognition at intersection using benefits of both motion and appearance.

## 2.3 CASE STUDIES

1. An Intelligent Night Vision System for Automobiles

(Based on research done by Tsz-Ho Yu, Yiu-Sang Moon, Jiansheng Chen, Hung-Kwan Fung, Hoi-Fung Ko and Ran Wang)

### Summary

The above case study presents an intelligent night vision system for automobiles in this paper. This system, implemented mainly by adopting infrared cameras and computer vision techniques, aims at enhancing safety and convenience of night driving by providing functionalities such as adaptive night vision, road sign detection and recognition, scene zooming and spotlight projection. The authors have tested the system in both simulated laboratory environments and in field highway environments. Initial results show the feasibility of constructing such a system.

## Problems Identified

- Practically, drivers may experience more difficulties in recognizing objects ahead of the road obstructing their way, leading to a much higher probability of traffic accident.
- Besides this, drivers lacking of attention largely reduced visual acuity and field of vision at night due to low illumination caused by factors such as bad ather condition.
- Obscure street lamps and limited range of headlight is also a major reason for accidents during night. For example dipped headlight only illuminate about 56 meters when the breaking distance at 100 km/h about 80 meters.

## SOLUTIONS OVER ABOVE PROBLEMS

- Facing above stated problems attention have been attracted to research of automobile night vision system which helps to improve the visibility of objects on the road at night.
- In general, such a system is equipped with infrared cameras from which the information of objects presents on the road such as bends poles, pedestrians, animals can be extracted.
- This system will inform drivers by means of visual acoustic or other signal about the obstacles approaching in their way.

**Fig.2.3.11** Utilizing VES for better visibility

- Computer vision techniques such as image enhancing object detection are used intensively by analyzing image captured by infrared camera.

**Infared camera image** **Webcam image**

**Fig.2.3.12** difference between IR camera and web camera

- Road sign detection and recognition functions are implemented to reduce the probability of missing traffic signs in dark environment.

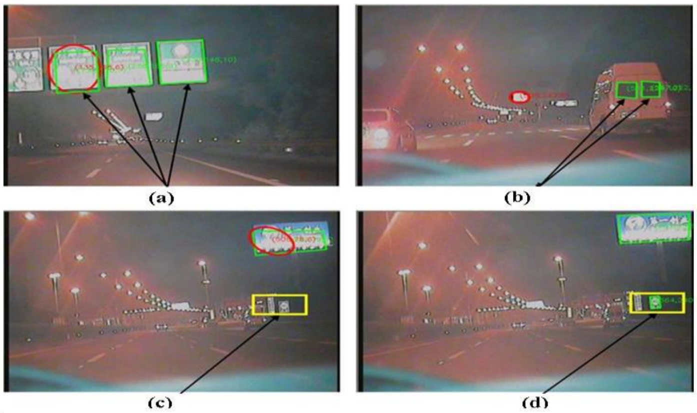



**Fig.2.3.13** Road sign detection for better driver information

- The system can be operated by the driver through a touch screen and auto notification are used for informing the driver of the possible dangers.

**Fig.2.3.14** Output warning video

# 2. Automotive Night Vision Systems –Status and Development Trends

(Prof. Dr.-Ing. habil. **Peter M. Knoll**, Karlsruhe Institute of Technology, Germany)

## Summary

First generation Night Vision Enhancement Systems with image presentation in the dashboard have been introduced on the market some years ago. Far Infrared and Near Infrared systems are currently competing technologies. The systems present a Camera-picture in the dashboard, in the center console area or on the windscreen. While Japanese systems prefer to present the camera picture via Head-up Display (HUD) in the windscreen, European car-makers prefer the presentation in the dashboard region with a graphic LCD screen. Ergonomic investigations have shown that the reconfigurable LC display located in the instrument cluster was found to meet best the requirements of a quick and distraction-free reading. A precondition for a quick recognition and identification of relevant obstacles is a high-contrast and brilliant picture quality. Meanwhile, the next generation has been introduced on the market in 2009. Due to technical progress in picture processing this 2nd generation makes an object classification for pedestrians and cyclists and warns the driver. The third generation will use a contact analogue HUD to warn the driver with icons projected onto the wind screen.

## Recent and Future Developments

Meanwhile, the second generation of night vision systems has been developed and is being introduced in the market during the year 2009. These systems do not only show a picture to the driver but they have the feature to detect, and to classify objects (to a certain extent) and to warn him in hazardous situations [2.3.21]. After tracking a detected object a contour matching step is performed. The head and shoulder part of a human is very characteristic, allowing a reliable classification of pedestrians and bikers.

In a first step a warning symbol is shown on the display. This makes it easier for the driver to detect relevant information within the picture. Fig. 2.3.21 shows the display of the new Mercedes 2009 E-Class. The warning symbol is in the upper right corner of the picture close to the detected pedestrian. The multifunction graphic display of the E-Class is located in the center console region.


Fig.2.3.21 Night vision warning system

The third generation will allow the realization of systems without graphic screen, but warning the driver according to the prevalent situation only in those cases where a relevant object is detected. Insofar a secure detection of lane markings and a reliable course prediction is essential to correlate the position of an object with the course of the own lane.

This feature requires a contact-analogue HUD with Laser projection, being able to project warning symbols anywhere on the windscreen where objects can appear within the field of view of the driver. Systems of the kind are under development. Fig. , left picture, shows how a warning symbol could appear for the driver.

Another, simpler solution could be a LED-chain located at the basement of the windscreen. The direction to the detected obstacle in the horizontal is indicated with a single LED from the chain. Fig.2.3.22, right picture, shows an example. This technical solution is significantly cheaper than the contact-analogue HUD.

Fig.2.2.22 Warning symbol on a contact analogue HUD (left) and with a LED-chain (right)

## Summary and future aspects

A comparison of the technology and of the aspects of image representation and image processing shows that the NIR-system is superior to the FIR-system on some criteria. The NIR technology will enjoy at a long-term basis a massive cost benefit due to the meanwhile low price of the video camera and due to its usage by several applications at a time. Furthermore, research has shown that although the wider reach of the FIR system represents an increase in comfort, this does not automatically translate into any considerable plus in term of safety and acceptance.

Current first-generation night vision systems presenting live images in the primary field of the driver's view can be realized with Head-up- and Head-down displays. Investigations have shown that the latter produce less distraction to the driver while reading the display than HUDs. On a longer-term basis these systems will be substituted by systems based on object detection. These second-generation systems provide warnings instead of images to the driver, and will also be used e.g., for lane departure warning or obstacle collision warning, which will require new ideas for human machine interfaces. Further on, object detection will be the basis for controlling actuators for lane keeping functions and collision mitigation and collision avoidance functions at night.

With the increase of embedded micro-controller performance and the ongoing development of software algorithms, functions based on object classification will be able to control special safety features.

The evolution of night vision functions is a process which depends on one hand on the development of hardware and software technologies, on the other hand on the acceptance of each driver and the overall contribution to the communities in reducing fatalities.

# 3. AUTOSAFETY SYSTEMS IN AUTOMOBILES

(Abhideep D. Ramnagariya, 2Akshay G. Wanjari Dept. of Mechanical Engineering Jawaharlal Darda Institute of Engineering & Technology Yavatmal

**Introduction**

Automobile safety is the study and practice of vehicle design construction and equipment to minimize the occurrences and consequences of automobile accidents.

**N.V.A(Night Vision Assistant)**

The Intelligent Night Vision System uses images obtained from two far infrared cameras positioned in the lower section of the front bumper to detect the position and movement of infrared heat-emitting objects and determine whether they are in or approaching the vehicle's path. Based on size and shape, the system also determines if the detected object. In addition to the conventional night vision function of giving the driver an enhanced view of the road ahead, the system is the world's first to provide cautions that inform the driver of the presence of pedestrians that are on the road or about to cross the vehicle's path.

## Problems Occurring with This Systems

Driver need to trained with these systems or he must be familiar with these types of systems.

- Driver has to pay attention at both views of path across him that is on dashboard screen and windshield.
- System is costly.
- This do note than showing you live images.

## Solutions Over Above Problems

- The NVA system screen can be placed above the dashboard rather than placing on the dashboard. So, driver can focus on both the views of path across him that is on dashboard screen and windshield.
- No training required if first solution is followed.

- As these systems are imported ultimately its cost factor increases. For that they can disassemble this system, make some modifications in it and launch in our country.
- If automotive companies in our country select this product to manufacture so cost will reduce to a lot extent.
- And when you are going with this product at cheap cost no industry will excuse you, to manufacture this product.

## Conclusion from statics

Hence the authors have observed from above statics that if the production of this systems is done our country itself then there will be large difference in manufacturing cost which ultimately reduces selling price for cracking the technology.

# 4. PEDESTRIAN DETECTION SYSTEM

(Based on the researches done by Jayan Eledath, Bogdan Materi, Sang - Hack Jung, David Hains)

### PROBLEMS IDENTIFIED

- Over the past decades the total population around the world has significantly increased. At the same time, the number of vehicles around grew noticeably. These two growths have led consequently to a greater interaction between both vehicles and pedestrians, which sadly resulted in large number of accidents and deaths.
- Now a days people are more distracted by their vulnerable devices, whether they enter a cross road. As a result, a fatal accident or injury will occur.
- It can be seen that there is a high increase in accidents occurring due to pedestrian and vehicle collision. Overall, Toronto city has faced 67% of pedestrian death within a span of 10 years, thus the research and efforts have been made to lower the pedestrian death rate by alerting the drivers.
- Even though, many researches were being carried out most of the methods had drawbacks on false detection which means objects that are incorrectly detected as pedestrians.

## SOLUTIONS OVER ABOVE PROBLEMS

- To detect real time pedestrian using smart phone camera attached to the vehicle while the developed software can detect the pedestrian on the roadside when the vehicle turns.
- The method used to detect the pedestrian is very simple and thus prevent the accident occurring across roadside

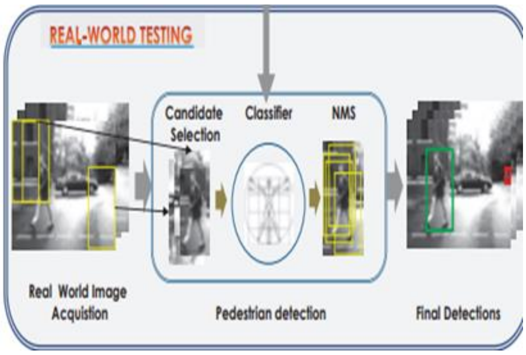



Fig.2.3.41 Real world testing of pedestrian detection system

- Pedestrian visibility can be increased by improving the road light since most pedestrian injuries occurs during night. IN such cases visibility can be improved by using radar waves which can be attached to the bumper side on the vehicles.
- Pedestrian safety methods are improving through different ways and these can be summarized as: Infrastructure improvement, situational awareness, cautionary signals, auto braking and deploy collision mitigation.

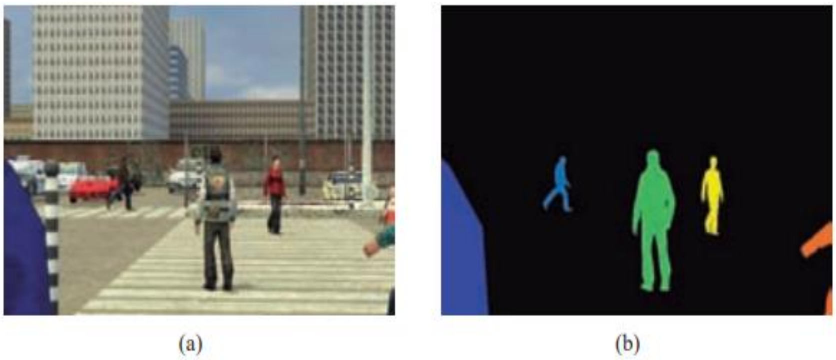



Fig. 2.3.42 Virtual image with corresponding to automatically generated pixel-wise ground truth for pedestrians. (a) Original Image, (b) the pixel-wise ground truth image, where each pedestrians have different color label

## 5. DYNAMIC LIGHT SPOT SYSTEM

(Based on researches done by Eriko Nurvitadhi, Mei Chen, Anthony Rowe, Takeo Kanade)

### Summary

The primary goal of an automotive headlight is to improve safety in low light and poor weather conditions. But, despite decades of innovation on light sources, more than half of accidents occur at night even with less traffic on the road. Recent developments in adaptive lighting have addressed some limitations of standard headlights, however, they have limited

flexibility - switching between high and low beams, turning off beams toward the opposing lane, or rotating the beam as the vehicle turns - and are not designed for all driving environments. This paper introduces an ultra-low latency reactive visual system that can sense, react, and adapt quickly to any environment while moving at highway speeds. Our single hardware design can be programmed to perform a variety of tasks. Anti-glare high beams, improved driver visibility during snowstorms, increased contrast of lanes, markings, and sidewalks, and early visual warning of obstacles are demonstrated.

PROBLEMS SPOTTED

- Driving at night or in poor visibility is far more stressful than daylight driving for most drivers.
- One of the reasons for this late and more difficult recognition of the road in dark surroundings- which is also due to the reduction of the color perception of the eye.
- In addition, there are strong bright/dark contrasts which forces the eyes to constantly adapt to brightness or darkness adaptability noticeably falls with increasing age.
- Constantly driving on high beam significantly of objects on road but it cannot be done because other drivers are blinded by the glare.

POSSIBLE SOLUTIONS

- Dynamic Light spot functionality as a part of the Night Vision system helps the driver using thermal imaging camera for anticipatory and safe driving at night.
- It automatically directs a beam of light onto pedestrians at an early stage, thus alerting the driver.
- It also acts as a Glare free high beam assistant by locating the vehicles approaching from the opposite direction and vehicles ahead, prevents glare, despite the high beam being switched on.
- This system identifies the position of pedestrian accurately, once this position is known, a headlight can focus on that area and show directly on a pedestrian.

Fig.2.3.51 Dynamic spotlighting of headlights.

# CHAPTER 3

## 3.1 COMPONENTS USED

### 1.Raspberry Pi 3 B+

Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation in association with Broadcom. Early on, the Raspberry Pi project leaned towards the promotion of teaching basic computer science in schools and in developing countries. Later, the original model became far more popular than anticipated, selling outside its target market for uses such as robotics. It is now widely used in many areas, such as for weather monitoring, because of its low cost, modularity, and open design.

**Specification:**

| | |
|---|---|
| Spec | Raspberry Pi 3 B+ |
| CPU type/speed | ARM Cortex-A53 1.4GHz |
| RAM size | 1GB SRAM |
| Integrated Wi-Fi | 2.4GHz and 5GHz |
| Ethernet speed | 300Mbps |

Fig.3.1.1 Raspberry pi 3 B+

## 2. Camera

This Raspberry PI Infrared IR Night Vision Surveillance Camera Module 500W Webcam is daylight as well as in the darkness of night.

### SPECIFICATIONS:

| | |
|---|---|
| Resolution | 5 MP |
| Sensors | Omnivision 5647 fixed-focus |
| Interface Type | CSI(Camera Serial Interface) |
| Lens Focus | Fixed Focus |
| Image Size(Pixels) | 2592Ã—1944 |
| Aperture | 1.8 |
| Focal Length(mm) | 3.6 |
| Diagonal Resolution | 75.7Â° |
| Length (mm) | 25 |
| Width (mm) | 23 |
| Height (mm) | 25 |
| Weight (gm) | 10 |
| Shipment Weight | 0.015 kg |
| Shipment Dimensions | 12 × 5 × 3 cm |


Fig3.1.1OV5647 5MP 1080P IR-Cut Camera for Raspberry Pi 3/4 with Automatic Day Night Mode

### 3. LCD Display Module

A Liquid Crystal Display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals combined with polarizers. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and seven-segment displays. They use the same basic technology, except that arbitrary images are made from a matrix of small pixels, while other displays have larger elements. LCDs can either be normally on (positive) or off (negative), depending on the polarizer arrangement.

Fig.3.1.3LCD Screen for display

### 4. Steering Angle Sensor

The steering angle sensor (SAS) is a critical part of the ESC system that measures the steering wheel position angle and rate of turn. The SAS is located in a sensor cluster in the steering column. The cluster always has more than one steering position sensor for redundancy and to confirm data. The steering angle sensor (SAS) determines where the driver wants to steer, matching the steering wheel with the vehicle's wheels. Located within the steering column, the steering angle sensor always has more than one sensor packaged together in a single unit for redundancy, accuracy, and diagnostics.

BOSCH steering angle sensor

Specifications:

| Application | |
|---|---|
| Steering wheel angle | ± 780° |
| Angular speed | 0 to 1,016°/s |
| Operating temperature range | -40 to 85°C |

| Technical Specifications | |
|---|---|
| **Mechanical Data** | |
| Weight | Approx. 34 g |
| Size | 83 x 60 x 21.35 mm |
| Protection class | IP5K0 |
| **Electrical Data** | |
| Power supply | 7 to 16 V |
| Max input current | < 150 mA |
| CAN speed | 500 kbaud |

Fig.3.1.4 Steering Angle Sensor

## 5. Motor Shield

L298N 2A Based Motor Driver is a high power motor driver perfect for driving DC Motors and Stepper Motors (Now find out a wide range of motors at Robu.in). It uses the popular L298 motor driver IC and has an onboard 5V regulator which it can supply to an external circuit. It can control up to 4 DC motors, or 2 DC motors with directional and speed control. This motor driver is perfect for robotics and mechatronics projects and perfect for controlling motors from microcontrollers, switches, relays, etc. Perfect for driving DC and Stepper motors for micro mouse, line following robots, robot arms,

**Features:**

Maximum motor supply current: 2A per motor.

Current Sense for each motor.

Heatsink for better performance.

Power-On LED indicator.

Double H bridge Drive Chip: L298N.

Fig 3.1.5MOTOR SHIELD

6. **Servomotor**

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors. Servomotors are not a specific class of motor, although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system.


Fig.3.1.6 Servo motor

## 7. Gyroscope Sensor

Gyroscope sensor is a device that can measure and maintain the orientation and angular velocity of an object. These are more advanced than accelerometers. These can measure the tilt and lateral orientation of the object whereas accelerometer can only measure the linear motion. Depending on the direction there are three types of angular rate measurements. Yaw- the horizontal rotation on a flat surface when seen the object from above, Pitch- Vertical rotation as seen the object from front, Roll- the horizontal rotation when seen the object from front.


Fig.3.1.7. Gyroscope Sensor

## 8. 12V 2A DC adapter

**Specifications: -**

Input - 100-240 VAC 50/60Hz

Category - Switch Mode Power Adaptor (SMPS)

Output Type - DC

Output - 12Volts 2Amp

Fig.3.1.8 12V 2A DC Power Supply Adapter

## 3.12 Software Requirement

### 1. Raspberry Pi OS

Raspberry Pi OS is highly optimized for the Raspberry Pi line of compact single-board computers with ARM CPUs. It runs on every Raspberry Pi except the Pico microcontroller. Raspberry Pi OS uses a modified LXDE as its desktop environment with the Openbox stacking window manager, along with a unique theme. The distribution is shipped with a copy of the algebra program Wolfram Mathematica[4] and a version of Minecraft called Minecraft: Pi Edition, as well as a lightweight version of the Chromium web browser.

Fig 3.12.1 Rasbian logo

### 2. Python (Programming Language)

Python is an interpreted, high-level and general-purpose programming language. Python's design philosophy emphasizes code readability with its notable use of significant whitespace. Its language constructs and object-oriented approach aim to help programmers write clear, logical code for small and large-scale projects. Python is dynamically typed and garbage-collected. It supports multiple programming paradigms, including structured (particularly, procedural), object-oriented, and functional programming.

Fig 3.12.2 python logo

## 3.2 Methodology

### 3.2.1 Night Vision system

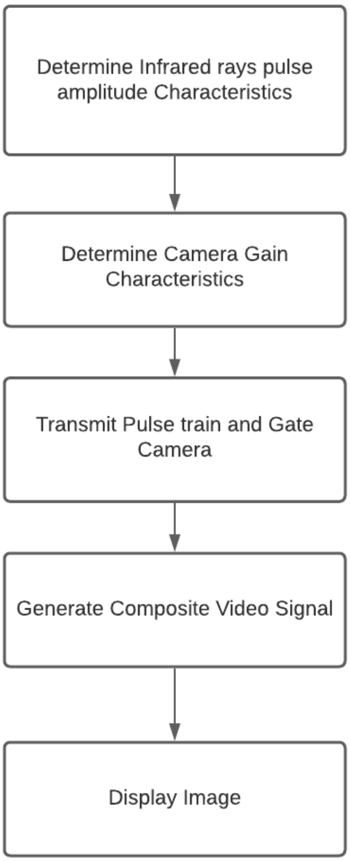



Fig.3.2.11, Logic flow diagram of one method of operating the night vision according to present invention.

For intelligent night vision and pedestrian system system we use Far infrared rays (FIR) as mode of illumination. FIR is a region in the infrared spectrum of electromagnetic radiation. Far infrared is often defined as any radiation with a wavelength of 15μm to 1mm. Infrared Rays pulse will be received by an infrared camera and converts infrared rays pulse into voltage signals using Active Pixel Sensor using CMOS technology by an infrared camera. The Series of such images are considered as Frames. Which is converted to video by processing series of such frames in unit time, which is represented in Frames Per Second (FPS). Then the video is being displayed on 1080P LCD display module.

### 3.2.2 Pedestrian Detection System using Python

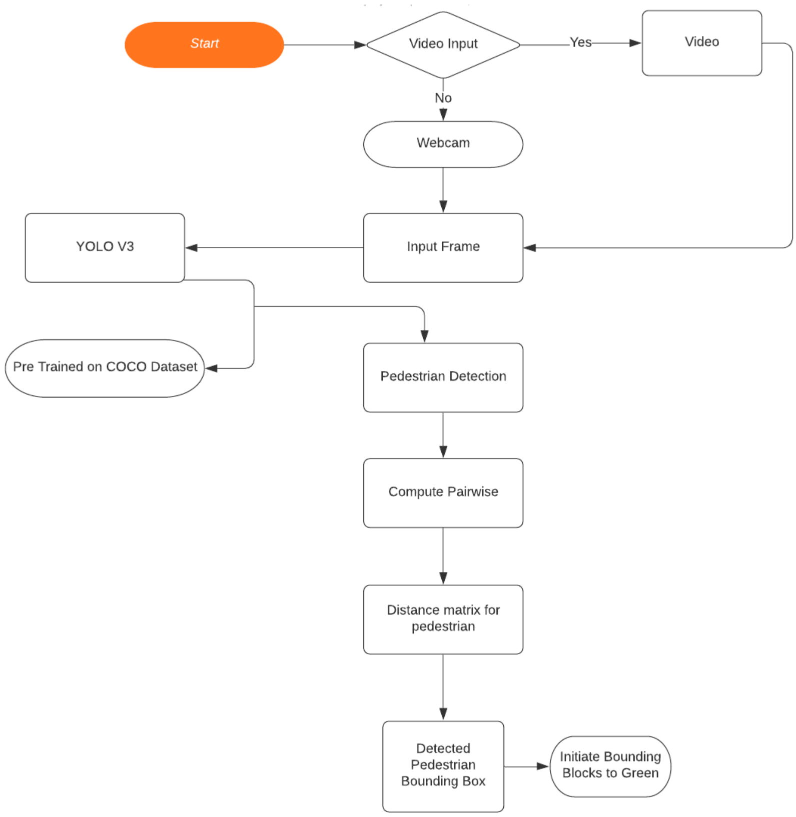



Fig.3.2.21 Pedestrian detection system Flowchart

**The system uses YOLO Object Detector which includes the following features:**

YOLO Object Detector

There are three basic object detectors that shall encounter when it comes to deep learning-based object detection: Region Based Convolutional Neural Networks (R-CNN) and their variations, original R-CNN, Fast R- CNN, and Faster R- CNN; Single Shot Detector (SSDs), and YOLO. While R-CNNs are generally correct, their major flaw is their speed — they were exceedingly slow, achieving only 5 frames per second on a GPU. Single Shot Detectors (SSDs) and YOLO both use a one-stage detector method to assist speed up deep learning-based object detectors. These algorithms approach object detection as a regression issue, learning bounding box coordinates and matching class label probabilities while learning a given input image. Single-stage detectors are less precise than two-stage detectors, but they are much faster. The project works with YOLOv3, which was trained on the COCO dataset. The COCO dataset has 80 labels in which the project's focus is on the people class of YOLO dataset.

## YOLO Architecture

YOLO has its own neat architecture based on CNN and anchor boxes and is proven to be an on-the-go object detection technique for widely used problems. YOLO divides up the image into a grid of 13 by 13 cells: Each of these cells is responsible for predicting 5 bounding boxes. A bounding box describes the rectangle that encloses an object. YOLO also outputs a confidence score that tells us how certain it is that the predicted bounding box actually encloses some object. YOLO uses a totally different approach. It applies a single neural network to the full image. This network divides the image into regions and predicts bounding boxes and probabilities for each region. These bounding boxes are weighted by the predicted probabilities.

### 3.2.3 Dynamic Spotlighting

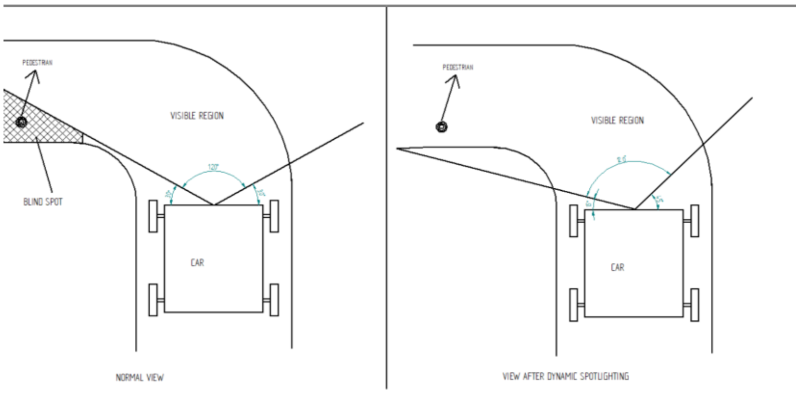



Fig3.2.31 Dynamic spotlighting representation

Dynamic Spotlighting is a feature that enables the VES to have better field of view during blind curves. This feature enables the camera to rotate using servo motors by taking driver's steering position using Steering angle sensor (SAS). Since the camera will be placed farther away from driver i.e, at the front bonnet of camera it has better access to the obstacle in the blind curves. Hence the camera is being tilted to the direction of rotation of steering wheel so that better field of view is achieved. The above figure is being designed by Solid Edge software and it represents the application of dynamic spotlighting of camera feature.

## Implementation of Dynamic spotlighting

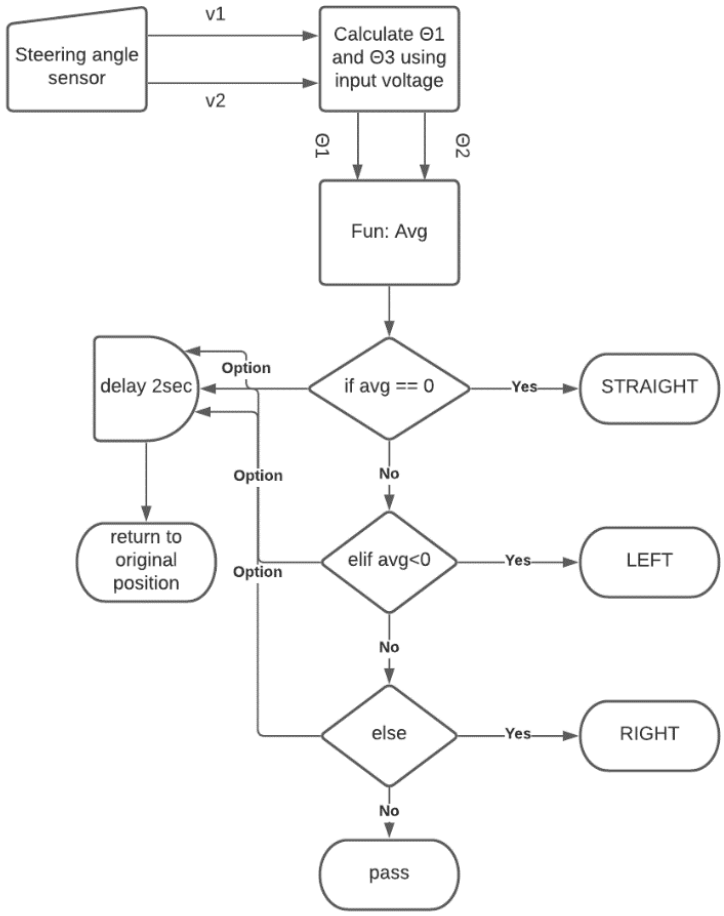



Fig 3.2.32 Dynamic spotlighting using SAS

The Steering Angle Sensor (SAS) is used as an input in this system, which offers real-time camera positions.

## Working of SAS

The steering angle can be measured with optical sensors, by assessing Hall effect and through other technologies. Theses sensors measure the movement of the steering wheel in degrees. The angle location of the measuring gears is detected by Hall effect components that vary their electrical resistance in response to the magnetic field direction. The voltages are A/D converted, and the angle computations are done by a microcontroller. On a CAN-interface, the steering angle and steering angle speed are given.

## Steering Angle Calculation

A current-carrying conductive plate crossed by a magnetic field perpendicular to the plane of the hall-plate develops a crossing potential voltage. This hall-effects is described by the Lorentz force. This is because the electron that moves the magnetic field generates a force as shown in Equation (1).

$$F = qv \times B \quad (1)$$

where F is the resulting force, q is the electrical charge of the electron, v is the velocity of motion and B is the magnetic field. The track of the electron changes because of the resulting force, developing a potential voltage across the plate shown in Equation (2).

$$V_H = IB_{vertical}/\rho_n qt \quad (2)$$

where VH is the hall voltage, I is the current passing through the plate, Bvertical is the perpendicular magnetic field, n is the number of carriers per volume, q is the charge and t is the thickness of the plate. The magnetic force characteristics acting on the plate points x1 and x2 in the Hall sensor are expressed by Equation (3). Furthermore, Bx and Bz acting perpendicularly to the plane of the Hall sensor are expressed by Equation (4).

$$X_1 = S_x B_x + S_z B_z \quad (3)$$

$$B_x = (x_1 - x_2)/2S_x, \quad B_z = (x_1 + x_2)/2S_z \quad (4)$$

where Sx, Sz are the respective sensitivity of Hall sensor for the x and z axis, it is generally seen that the sensitivity is the same. As the impulse ring is rotated, the Hall sensor is detecting the vector of the magnetic field from the impulse ring and generates signals Vx and Vz that are proportional to the Sin and Cosine signals respectively as shown in Equation (5).

$$V_x = S_x \times B_x \times \cos\Theta, \quad V_z = S_z \times B_z \times \sin\Theta \quad (5)$$

The absolute angle *q* can be derived from calculating the arctan of the voltages Vx and Vz as shown in the following Equations (6) and (7).

$$\Theta_1 = 90° + \tan^{-1}\frac{Vx}{Vz} \text{ if } V_z \geq 0 \quad (6)$$

$$\Theta_2 = 270° + \tan^{-1}\frac{Vx}{Vz} \text{ if } V_z < 0 \quad (7)$$

In Equations (6) and (7), Vx and Vz are cosine and sine signals measured through the pole-pair MTE, respectively. $\Theta_1$ and $\Theta_2$ are the absolute angles of two sensors in SAS.

## Working Of Dynamic Spotlighting

The Microcontroller takes input from CAN-interface of SAS. Then the average of two absolute angles are calculated. Then the average is used as positioning factor for camera. The range of SAS varies from ±720°. Where 0° is the mean angle where the camera is positioned straight. When the absolute angle average is less than 0° the camera is made to tilt to left with certain degrees with respect to absolute angle average. The SAS angle is being read spontaneously in real time for better result. Similarly, when the absolute angle average is greater than 0° the camera is made to tilt right. Then angle refinement of positioning of camera can be further developed by increasing and introduce more degrees of freedom to the program.

### 3.2.4 Circuit and Construction

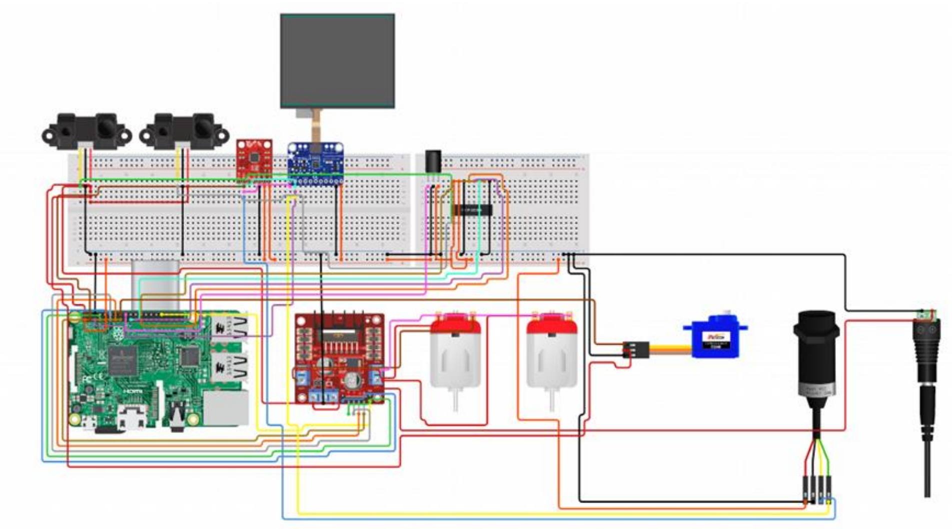
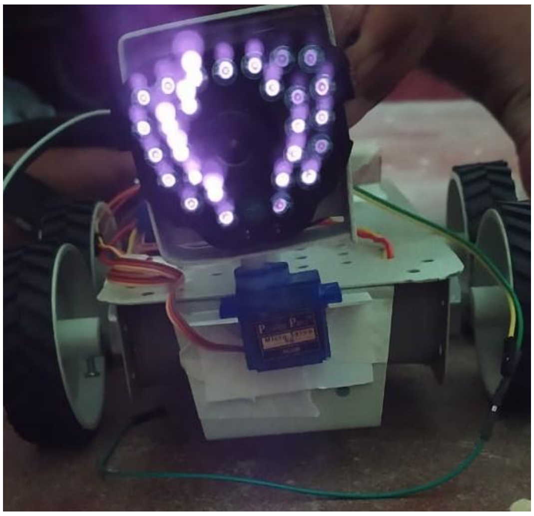
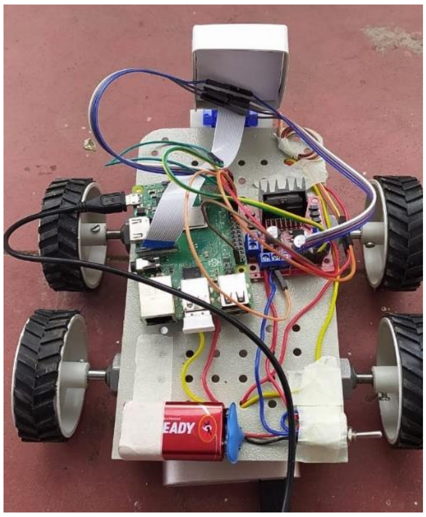


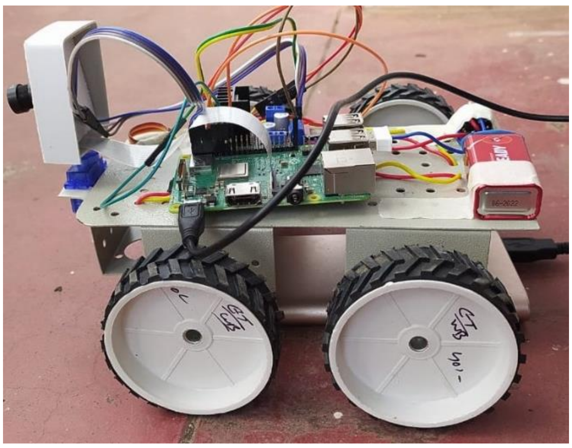
Fig3.2.41 Circuit diagram of the model



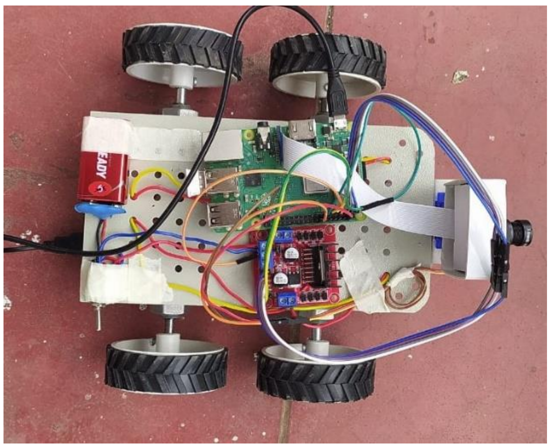
(a)



(b)



(c)



(d)

Fig 3.2.42 Construction of model (a), (b), (c), (d) are front, back, side and top views respectively

The circuit includes following components: motor shield, raspberry pi 3, 4-12v dc motor, lcd display, raspberry pi camera, servo motor, and IR illuminator. Programs are provided to the Raspberry Pi, and when an operation needs to be performed, the Raspberry Pi takes control. In this project. aluminum support structure powered by four 12v servomotors is used. Four wheels and the motors are connected to the motor shield by jump wires. Motor shield, a microcontroller, is used to give input to motors by taking command from Raspberry pi. The motor shield receives electricity from the battery and the motor shield regulates the voltage there by controlling motors. At the front of vehicle model, a 5v servo motor is mounted which positions the camera by taking input from the user. The input from user is being given by tilting the steering or by keyboard. The 12v IR illuminator is powered by 12v power supply and the rays from the illuminators are detected by 5mp night vison camera. The results are shown on a 1080p LCD TFT display or Car's instrument cluster.

Raspberry pi's GPIO pins are represented as shown in the figure (3.2.43) below. The LCD TFT display is being connected to DSI Display connector and camera module is connected to CDI camera connector the 5v power supply is connected using Micro USB power adapter. The GPIO connections are as follows. The motor shield and 5v servo motor is being connected to GPIO pins of Raspberry pi. The IR illuminators are connected to external 12v power supply. When the power is switched on the raspberry pi, the rasbian OS is loaded. The regular testing of raspberry pi components needed to be done. Trouble shooting is required if necessary. The pedestrian detection and motor controlling programs are loaded and compiled and interpreted using Thonny Python. The camera accessing and GPIO initiation are inbuilt functions in Python program. When the programs start running, pygame module starts taking input from user either by steering wheel or keyboard and functions accordingly. The camera starts recording and the result is displayed in LCD TFT display which is mounted on Vehicle's instrument cluster.

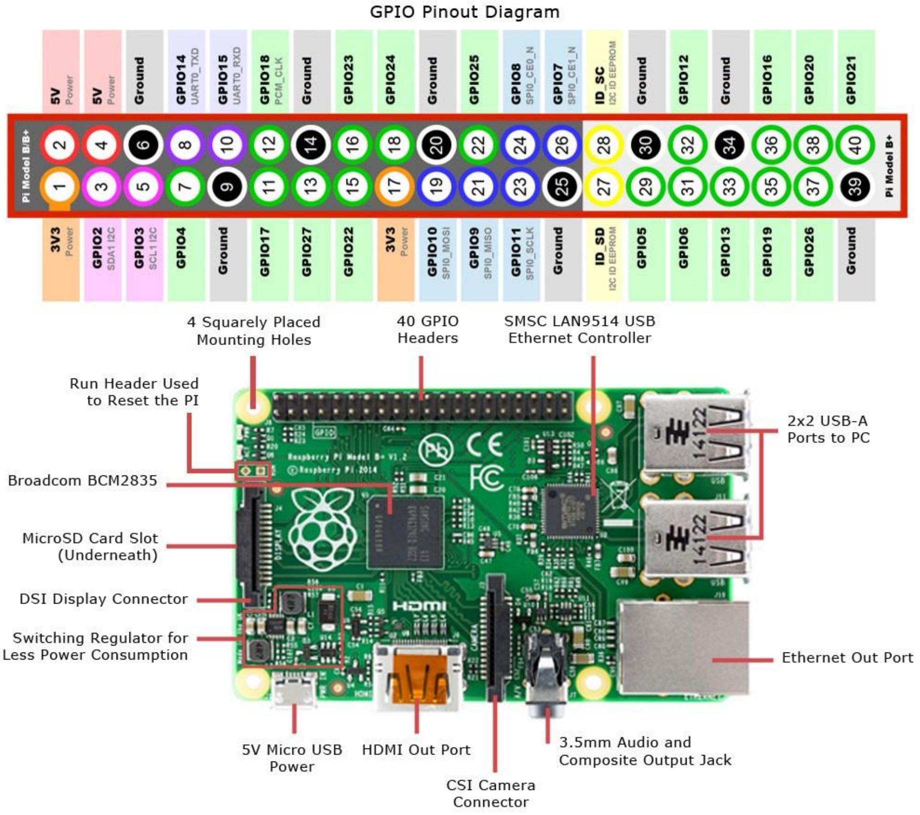



Fig 3.2.43 Raspberry Pi 3 B+ connection.

# Chapter 4

## 4.1 Results

The system is tested in a night time scenario under normal environment inside conventional room surrounding where there were various obstacles. It was observed that 5mp night vison camera performed well with optimum resolution. The following samples were the result of night vison system fig(4.1.1). The picture was taken under pitch black condition where the light was nearly negligible. Only IR lights were only source of illumination. The IR illuminators used were of lower range and capacity. For better illumination greater capacity IR illumnatorsmay be used. The video was also quiet impressive but particular circumstances like speed damages the quality of video, the solution for this problem was to use a prime lens which can zoom upto 3× to 4×times when the car reaches 30 kmph and above, and matching the shutter speed according to vehicle's speed.This method is called Image stabilisation. After implementing this technique the video qualty was substantially increased. The pedestrian detection syetem program whish is used, has the top notch accuracy of 76.5% in 224×244 resolution and can detect nearly 80 people in a frame. The slight delay in the video processing was observed i.e, nearly 15fps. Since raspberry pi B+ is low performance microcontroller with low capacity GPU video lag was observed. When desktop with GPU used, the video lag was reduced by 95%. Wich is greater improvement in performance when a good microcontroller used. The following figure(4.1.2) shows the result output from camera and accuracy of Pedestrian Detection System. The Dynamic spotlighting of camera was tested in blind curves and greater visibility of field was observed and the blind spot was reduced to null. The better refinement of positioning program i.e, by introducing more constrains to the program better performance, accuracy and better field of view can be achieve.

Fig 4.1.1 Results of Night Vison System.

Fig 4.1.2 Representing accuracy of  pedestrian detection system

Fig 4.1.3 Final results of  Night vison and pedestrian detection system

## 4.2 CONCLUSION

A night vison system is successfully developed. It is tested under low light condition the images are obtained successfully, the night vison images were clear and authentic. Pedestrian detection system is precise and lag free. The dynamic spotlighting is additional feature to the traditional night vison system. The blind spot is reduced drastically and corner visibility is increased.

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# INTELLIGENT NIGHT VISON AND PEDESTRIAN DETECTION SYSTEM

August, 2021

**Guide**

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