DESIGN AND DEVELOPMENT OF HIGH BEAM REDUCTION SYSTEM

Esuyawkal Melaku Temesgen

A Thesis Submitted to

The Department of Mechanical Systems and Vehicle Engineering

School of Mechanical, Chemical and Materials Engineering

Presented in Partial Fulfillment of the Requirement for the degree of Master of Science in Automotive Engineering

Office of Graduate Studies

Adama Science and Technology University

July, 2021GC

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Advisor: Amana Wako (Ph.D)

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DECLARATION

I hereby declare that this Master Thesis entitled “Design And Development Of High Beam Reduction System” is my original work. That is, it has not been submitted for the award of any academic degree, diploma or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation.

_____	_____	_____
Name of the student	Signature	Date

RECOMMENDATION

I, the advisor of this thesis, hereby certify that I have read the revised version of the thesis entitled “Design and Development of High Beam Reduction System” prepared under my guidance by Esuyawkal Melaku submitted in partial fulfillment of the requirements for the degree of Mater’s of Science in Automotive Engineering.

Therefore, I recommend the submission of revised version of the thesis to the department following the applicable procedures.

_____	_____	_____
Major Advisor	Signature	Date

APPROVAL PAGE

I, the advisors of the thesis entitled “Design And Development Of High Beam Reduction System” and developed by Esuyawkal Melaku, hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

Advisor	Signature	Date

We, the undersigned, members of the Board of Examiners of the thesis by Esuyawkal Melaku have read and evaluated the thesis entitled “Design and Development of High Beam Reduction System” and examined the candidate during open defense. This is, therefore, to certify that the thesis is accepted for partial fulfillment of the requirement of the degree of Master of Science in Automotive Engineering.

Chairperson	Signature	Date
Internal Examiner	Signature	Date
External Examiner	Signature	Date
Head of the Department	Signature	Date
School Dean	Signature	Date
Post Graduate Dean	Signature	Date

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ACRONOMY

AATA	Addis Ababa Transport Authority
AATM	Addis Ababa Traffic Management
AC	Alternative Current
DC	Direct Current
EBG	Equatorial Business Group
ECU	Electronic Control Unit
EEPROM	Electrically Erasable Programmable Read-Only Memory
FTA	Federal Transport Authority
FMVSS	Federal Motor Vehicle Safety Standards
I/O	Input Out Put
ICSP	In circuit Serial Programming
IDE	Integrated Development Environment
LDR	Light Dependent Resistor
LED	Light Emitting Diode
MISO	Master In Slave Out
MHz	Mega Hertz
MOSI	Master-Out, Slave-In
NHTSA	National Highway Traffic Safety Administration
PWM	Pulse Width Modulation
RTAs	Road Traffic Accidents
SCL	Serial Clock Line
SD	Secure Digital
SPSS	Statistical Package For The Social Sciences
SRAM	Static Random Access Memory
TD	Derba Transport
TT	Tana Transport
USB	Universal Serial Bus
VSM	Virtual System Modeling

ABSTRACT

The vehicle lighting system is the most important vehicle electrical system. The headlight helps to increase the visibility of the driver at night time and to enhance the driver to see an object on the road and roadside clearly at a long distance. While driving at night has a great problem on an opposite vehicle due to high beam headlights of vehicles pose a great danger during night driving. Driver's experiences a sudden glare for a short time. This is caused due to the high intense headlight beam from the other vehicle coming towards him from the opposite direction. This glare causes temporary blindness to a person resulting in road accidents during the night like vehicle rollover, vehicle to vehicle collision, and, a vehicle collided with the un-movable object and, loss of its lane. To mitigate this problem by design and develop a high beam reduction system. This system automatically reduces high beam to low beam by sensing the approaching opposite vehicle light intensity to LDR sensor-based mechanism is utilized to develop the system. The system used the Arduino UNO board and application-specific sensors LDR. The light sensor takes the "lux" reading of the headlight rays from the opposing vehicle and checks for a threshold value assigned in the coding. Based on the threshold value the beam switches from high to low state and vice-versa when both the vehicles pass by each other. The LDR senses the light of the opposite vehicle and warns the driver using a buzzer. If the driver does not take action the system will reduce the high beam to low beam. Also when the opposite coming vehicle with high beam and the newly designed system give different warning colored light which is when the light intensity of opposite coming vehicle with high beam. This research has been conducted by field observation on a vehicle that is driving at nighttime and ask the driver to know the severity of the problem and analyzing the existing head lighting system. Design and developing a high beam reduction system, simulate by proteus professional 8.7 software and assemble the part, and show the prototype.

Keywords: - *Arduino UNO Microcontroller, Glaring effect, LDR, Temporary Blindness*

CHAPTER ONE

INTRODUCTION

1.1. Background of the study

Light is electromagnetic radiation within a certain portion of the electromagnetic spectrum. The word light refers to visible light, which is visible to the human eye and it is responsible for the sense of sight. Visible light has a wavelength in the range of 400-700 nanometers (nm), between the infrared (with longer wavelengths) and the ultraviolet (with shorter wavelength). Light can be produced by nature or by humans. Artificial light is typically produced by lighting systems that transform electrical energy into light.

The most fundamental reason for using light at night is to enable people walking outdoors after dark to see obstacles on their path ahead and thereby avoid colliding with them or tripping over them (Boyce, 2019). Because at night time it's difficult to do their activity properly. At nighttime human being,'s eye vision minimizes the ability to identify objects easily or the human eye completely does not see objects during nighttime.

Driving in the dark is very different from driving during daylight hours. Night driving is difficult for many drivers. The human eye's field of vision is much smaller without the help of natural light. By enabling vision the use of light at night delivers several benefits to people. Such benefits include greater safety for pedestrians and drivers, reduced fear of crime, more use of outdoor facilities after dark, enhanced economic growth, and the creation of built and natural environments that are a source of beauty and entertainment (Boyce, 2019).

Vehicle travel at night for transporting goods and passengers from one place to another place. Especially vehicles which carry goods travel from one place to another place not only in the daytime. Also, travel at night time. Because different goods are perishable that lose their value. Vehicle headlight illuminates the area ahead of a vehicle, including overhead signs. They also make the vehicle itself visible to other road users.

So vehicle uses their headlight to assists the driver for better vision during night travel. These headlights of a vehicle has a great role for the driver to identify obstacle on the

road and roadside object. Obstacles like pedestrians, constructed roads, holes on the road, road crossing animals, etc. Also a lighting system of a vehicle not only use for night vision but is also used for different purposes on the vehicle for example used for transferring road information for another vehicle as well as it is used for showing the direction the driver wants to go, vehicle size and height, and position. The driver has control of the headlight which can be switched from high beam to low beam during pitch-black conditions where there are no other sources of light, high beam is used to. On the other case like when another vehicles oncoming from the opposite direction uses a low beam.

In our country the road serves as a two-way traffic, vehicles are plying on both sides of the road. When high beam light from the headlight of a vehicle coming from the opposite direction falls on a driver, it glares him for a certain amount of time. This confuses that driver. This discomfort will result in the involuntary closing of the driver's eyes momentarily. This fraction of distraction is the prime cause of many road accidents. In contrast to the problem of distracted driving, most drivers and popular media seem less concerned about the limitations of visibility at night. Nowadays many accidents at night are caused due to the high intensity of headlight from the opposite vehicles. So many health issues like eye problems, headaches, mental stress, etc. are caused due to high headlight intensity (Sourav, et al. 2019).

Glare is a sensation caused by the bright light in one's field of view. Glare can reduce one's ability to see, create feelings of discomfort, or both. The term headlight glare is defined hereas visibility reductions or discomfort caused by viewing oncoming vehicle headlights or headlight in rearview mirrors reflection.

Glare reduces seeing distance because it causes light scatter in the eyes, which in turn reduces the contrast of roadway objects. This effect is known as disability glare. The greater the intensity of the glaring light and the closer the glaring light is to where one is looking, the greater the disability glare will be. Due to disability glare can lead to different effects. These are decreasing visibility distance. Which means the distance at which an object can be seen. This distance is reduced when disability glare is present, increasing reaction times. As the intensity of oncoming high beam light increases, drivers' reaction times to objects in and along the roadway become longer.

The other one increasing recovery time. After drivers pass an oncoming vehicle, the glare has a lasting effect that increases the time it takes for the drivers' eyes to recover their ability to detect objects. During that time, the visibility distance is reduced and reaction times are increased.

Several factors associated with a recent vehicle and lighting developments may explain the driving public's passion regarding nighttime glare. These include increasing light intensity levels, headlight mounting height on larger vehicles, novel headlight color appearance (specifically the bluish appearance of some headlight), smaller headlight size, variations in headlight an increase in the presence of auxiliary lightings, such as fog lamps. The glare that is uncomfortable but does not cause significant visual degradation is termed discomfort glare, whereas glare that causes a reduction in contrast due to intraocular light scatter (degradation of the visual image due to stray light within the eye) is termed disability glare (Friedland, 2012).

The visual system changes as people age, resulting in differences that are important in the context of nighttime driving and headlight glare. These differences can be categorized as optical and neurological. As people age, less light enters the eye due to smaller pupils and thicker, less transparent optical media. This latter effect results in more scattered light in the presence of a glaring light for older drivers. This increased scatter results in lower perceived contrast of a potential hazard against its background for an older driver than for a younger one. Older drivers also take longer for their eyes to recover their sensitivity after being exposed to glare.

Nighttime fatality rates have been 3 to 4 times higher than daytime rates for decades. Although the difference in road safety between day and night involves multiple factors, including increased incidence of fatigue and alcohol consumption, the entire population experiences poor visibility when driving at night. Crash data show that poor visibility at night is the leading contributor to fatal collisions with pedestrians, cyclists, and most likely other low-contrast obstacles. most drivers do not use high-beam headlights when appropriate (Mikoski, et al. 2019).

Due to which over five lakh accidents take place in the country out of which, 41% are due to road mishaps during the night, and 18% are due to vehicle headlight glare (Sharma, et al. 2016).

To improve drive at night and reduce the occurrence of potential safety accidents, a high beam reduction system for vehicle high-low beams arises. These systems can be helpful to improve the driver's front vision and illumination condition and reduce the driver's manual operation and fatigue load. There are many types of high beam reduction systems based on the method of operation of each include analog, digital, using different sensor types like proximity sensors, light-dependent resistor sensors, infrared, and so on.

1.2. Statement of the Problem

In our country, road traffic accidents occur every day with a higher rate at night. This is because visibility at night is much less than drive daytime. To increase their visibility driver use high beam light. Driver faces a huge problem due to high beam light falls directly on their eyes when driving at night time. This high beam effect includes temporary blindness, fading effect of image, glare and can cause of road traffic accident.

In Ethiopia, during night-time road traffic accident was very high. According to Addis Ababa police commission official report from 2011 – 2017 road traffic accident increase year to year during night. In 2017 about 16322 road traffic accident happen during night time. The reason for this road accident was happened due to a high beam which comes from the opposite oncoming vehicle losing its visibility for a short time. To avoid such glare of high beam driver will try to turn the steering to another side. Hence they collide with other vehicles, pedestrians, and an un-movable objects like curbstone, roadside pavement, rollover which is some accident can cause total damage and death for a human being. Also when drivers drive a vehicle for a long time they forget to reduce the high beam to low beam and some drivers careless to reduce the glare of the high beam.

1.3. Objectives

1.3.1. General Objective

The general objective of this thesis is to design and develop a high beam reduction system.

1.3.2. Specific Objectives

The objective of this thesis was achieved through the following specific objectives:

- To design and develop a high beam reduction system.
- To test the performance of the newly developed system.

1.4.Significance of the study

The final result of this study indicates the use new design and developed high beam instead of the existing system. After the accomplishment and implementation of the study, it is expected to have the following basic significances:

- Reduce the effect of high beam glare on the driver and road user.
- Reduce accidents caused by high beams.
- To increase the safety of driver and pedestrians
- To reduce forgetfulness of high beam due to long driving at night time.
- Minimize problems which come by the careless driver who are not reducing the high beam

1.5. Scope of the thesis work

- The spatial scope of this thesis will to design and development a high beam reduction system for ISUZU NPR 75-190.
- ISUZU NPR is light in weight and used to carry goods from one place to another. This vehicle work always at night time from agricultural area carrying perishable goods like chat, different vegetable, and fruits are reaching the market area at right time.

1.6. Limitation of the study

In executing this thesis work, there were different limitations. From those limitations, the following are the major ones:

- Unavailability of material that used for practical assembly. Specially the LDR sensor with required specification.

- Inflation in costs of transport and different electronics components. Due to the global pandemic disease COVID-19.
- The budget for the thesis was a great limitation.

CHAPTER TWO

2.1. LITERATURE REVIEW

Low beam light is used when the vehicle in a city or when much more of the vehicle moves at a limited speed at a city or congested road during the night. This light up a small area in front of you, usually about 70 meters. The effect of the low beam did not show clearly the object at a longer distance and decrease the driver visibility at night. Therefore driver uses another option which is to increase his visibility.

These lights are known as high beams. It cast a brighter light in a wider area, around 106.68 meters or more. Which is used to show an object (or vehicle which comes from in opposite direction, pedestrians, animals, the road condition if the driver does know the road before) to detects and take off for himself and others.

This high beam light has a great impact on the driving visibility as shown above but also it has a negative impact if we do not use it properly or if we don't use it at the right time and right place. Also, it may Couse of an accident in different ways because when two vehicles move at night and go in the opposite direction on a two-way road one of its uses high beam light, for head moved the vehicle to increase visibility and for the opposite vehicle driver decrease his visibility during the moment this kind of incident can cause of vehicle lose it lane, rollover, collide with each other, collide with an object near the roadside, pedestrian lose their life by loose lane vehicle.

Also pedestrian cannot see what come in front of them because of this high beam light effect during the night. 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 (Asaduzzaman, et al. 2013).

High beam of a vehicle is an important device which is used to identify road obstacle from far away and driver to identify the obstacle and take action before reaching the obstacle. A high beam is used for illuminating a road that doesn't have very much traffic on it. In that way, the driver can see further ahead for any road obstructions. High beam is also used when a driver is on an unfamiliar road and if there isn't much in the way of lighting such as street lamps (Asaduzzaman, et al. 2013). The headlight beam is assumed to be enclosed horizontally by the horizontal spread angle (α), where only external boundaries are considered; bounded vertically by the upward vertical spread angle (β);

and the distance ahead circumscribed to the headlight range (Santos et al. 2019). Vehicle lighting systems are very important, particularly where road safety is concerned. If headlights were suddenly to fail at night and at high speed, the result could be catastrophic. A key point to remember with vehicle lights is that they must allow the driver to: See in the dark and be seen in the dark (or conditions of poor visibility).

Sidelights, tail lights, brake lights, and others are relatively straightforward. Headlights present the most problems, namely that, on the dipped beam they must provide adequate light for the driver but without dazzling other road users (Denton, 2007). Night driving is difficult for many people.

Driving in the dark is very different from driving during daylight hours. The human eye's field of vision is much smaller without the help of natural light. If a driver feels less than confident driving at night, the light from a front-lighting system will help improve his or her night vision and safely reach the destination (Chen & Chiu, 2018). Vehicle headlamps are a primary safety system. Research data from the National Highway Traffic Safety Administration (NHTSA) indicates that roughly 25 percent of automotive travel occurs at night. However, nearly 52 percent of all driver fatalities and 71 percent of all pedestrian deaths occur during dark driving times (NHTSA, 2018).

This data leads to the conclusion that driving in dark or low-light conditions increases the likelihood of a collision at least partially due to limited forward illumination by current automotive lighting systems combined with the speeds at which drivers travel. Human eyes are very sensitive to light. If eyes suddenly get in contact with light after darkness, cornea present in the eyes gets contract i.e. vision gets blank and requires some time to recover vision.

Much time the situation comes when suddenly vehicle approaches from the front with the headlight in upper mode causes blindness to the eyes of the driver, during that time vehicle cover some distance and accident may occur. This temporary blindness of the eyes is called a glaring effect (Journal & Special, 2016).

Glare illuminance is vertical illuminance at an oncoming driver's eyes. Headlights of vehicles are inherent for night driving. These bright headlights which assist the driver for vision, while driving at night, pose a great threat to the other road users coming in the opposite direction. The bright light of the vehicles causes discomfort in the form of glare to the oncoming driver (Verifikasi, et al. 2005).

The terms photopic, mesopic and scotopic refer to three ranges of human vision adaptation level, which differ in anatomical response, spectrum and their effect on visual acuity.

Photopic: This term refers to cone vision and generally covers adaptation levels of 3 candelas per square meter (cd/m^2) and higher. Adaptation level is the overall brightness of your environment that your eyes have adjusted to. Translated into illuminance, if the average reflectance of your environment is 30%, an adaptation level of 3 cd/m^2 (candelas per square meter) would result from illuminance of approximately 30 lux (3 footcandles). The combined peak sensitivity of the cones is at 555 nm, in the yellow-green part of the visible spectrum. The lumen, the basic metric of visible light, is defined by the combined cone response only.

Mesopic: This term refers to a range of human vision with both rods and cones active. There is no hard-line transition at either end, but for most intents and purposes the mesopic range is generally considered to be from 3 cd/m^2 down to 0.01 cd/m^2.

Scotopic: This term refers to rod vision and corresponds to an adaptation level below 0.01 cd/m^2. The peak sensitivity of the rods is at 507 nm, in the blue-green part of the visible spectrum. While there may be some (very little) cone activity at 0.01 cd/m^2, once the light level drops to 0.001 cd/m^2, only the rods are active. At this point, the ability to discern colors is gone. In addition, since there are no rods at the fovea and the cones there are not receiving enough light to be stimulated, the ability to discern fine details is gone. This light level is what you will find on a moonless night out in the desert, far from any town or highway luminaires. Drive out, turn off the car lights, and wait for your eyes to adapt. With light only from the stars overhead, you will be able to see large objects like boulders and shrubs and perhaps a rabbit scampering by. But no colors, and you can't read the newspaper! Scotopic vision plays a major role in night vision. Human eye consist of two types of photoreceptor cells- rod cells and cone cells.Scotopic vision occurs due to rod cells. Rod cells can function in less intense of light. There are approximately about 90 million rod cells are present in a human eye. Rod cells are usually present at an outer edge of the human eye. Rod cells are usually more sensitive than cone cells so it plays a very little role in color vision. This is the main reason that the colors are not so obvious in the dim light.Scotopic vision is also called as night vision. The intensity of light is measured in lumens per steradian(lm/sr) or candela (cd).

The luminance level of scotopic vision is 10-3 to 10-6 cd/m2.It distinguishes shapes and not the colors. Photopic vision is also known as day vision or bright light vision (Lakshmi, et al.2019).

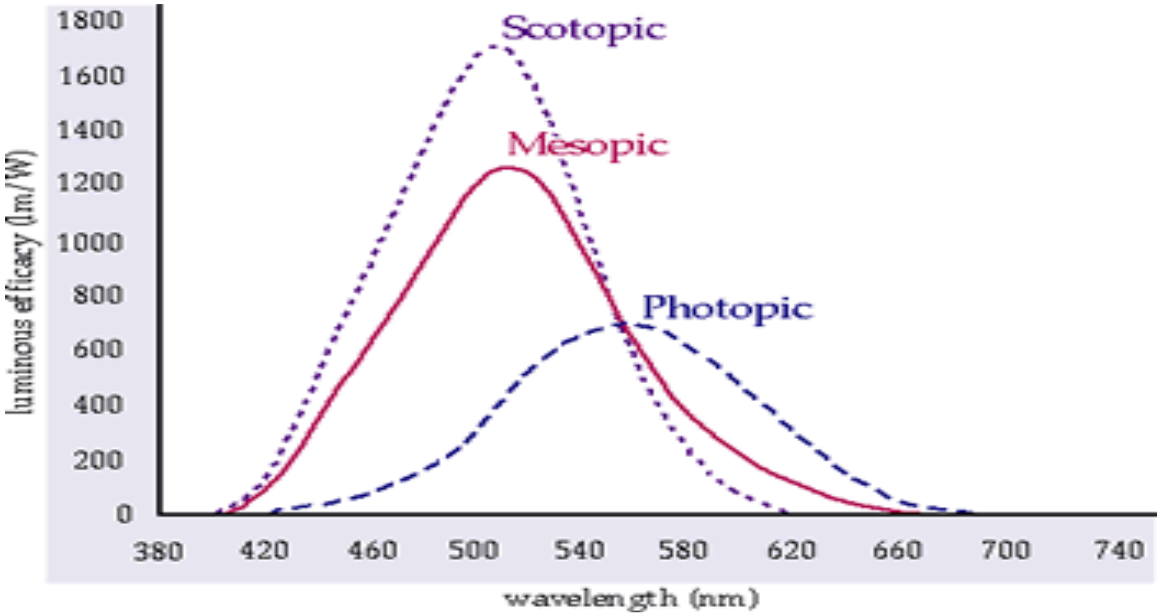

Figure 2. 1. Different visions of eye

Source: (Lakshmi, et al.2019)

Troxler's effect is also known as Troxler fading. It is an optical illusion affecting Visual perception. When a constant amount of light falls on the neuron inside the eyeball, that individual neuron gets desensitized to the stimulus and also reduces the signal strength to the brain. Thus, the view will not be clear which may lead to temporary blindness that may lead to collision or accident during night driving.

In the medical world, the Troxler effect is used to describe a kind of temporary blindness. It is otherwise known as the 'fading effect'. A study shows that if our eyes are exposed to a very bright light source of around 10,000 lumens, we experience glare. This glare is produced due to over-exposure of the rods and cones inside our eye.

Even after the source of glare is removed, an after-image remains in our eye that creates a blind spot. This phenomenon is called the Troxler effect. This means that the driver's reaction time is increased by 1.4 seconds. For example, let us assume a motorist traveling at 60miles per hour takes 0.5 seconds to react to a hazard and will stop within 41 feet.

Due to the Troxler effect, the same person traveling under the same conditions will take 0.9 seconds longer to react and hence will come to a complete halt only at 123 feet. There is a huge difference of 82 feet. This is more than enough to cause a disaster on the road (Sharma, et al. 2016).

Due to this Troxler affects different country accident reports shows the severity of the problem. According to Forbes, the statistics shown in Figure below give the details of the accidents that had occurred in the year 2013 in Asia due to over-bright light.

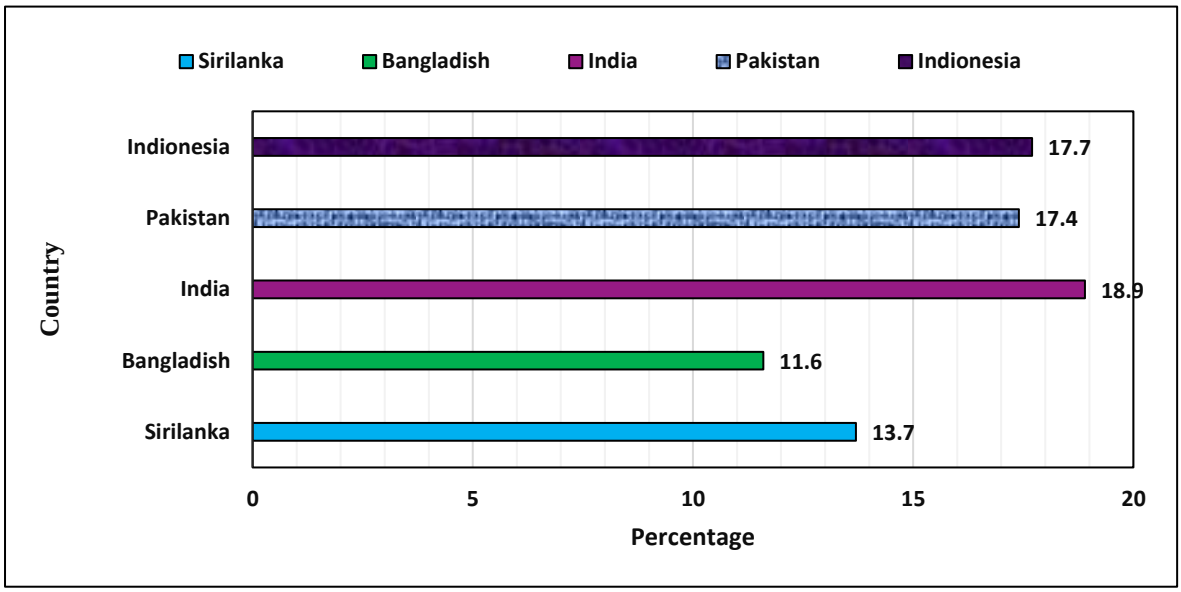

Figure 2. 2. Accident report of Asia due to Troxler effect in 2013

Source: (Sharma, et al. 2016).

The major cause of accidents during the night, as the opposing driver will not be able to see the road clearly due to the brightness of the oncoming vehicle's lights (Verifikasi et al, 2005). Increases in headlamp intensity to improve forward visibility will simultaneously, but necessarily, increase glare (Bullough, 2015).

One problem that drivers experience at night when traversing a road is the headlights of another vehicle. When another vehicle approaches a driver from the rear or the front of the driver's vehicle, the headlights of the approaching car can create significant temporary vision impairment. As the driver's eyes adjust to the intense light source, the driver is at an increased risk of an accident (Data, et al. 2007). Glare is the visual effect of scattering light within (or in front of) the eye caused by a relatively bright light source in the field of view.

The scattered light (veiling) reduces retinal contrast across the visual field and thus reduces overall visibility (disability glare), in addition to causing distraction and annoyance (discomfort glare). If the glare is strong, it may cause a total wash-out of the scene. The contrast reduction makes it difficult to perform various visual tasks related to driving, such as detecting pedestrians detecting other on-road objects and, following the lane. Disability glare, as well as discomfort glare caused by oncoming headlights, has been associated with nighttime traffic accidents (Hwang & Peli, 2013).

Nighttime fatality rates have been 3 to 4 times higher than daytime rates for decades (NHTSA, 2007). Although the difference in road safety between day and night involves multiple factors, including increased incidence of fatigue and alcohol consumption, the entire population experiences poor visibility when driving at night (Mikoski et al. 2019). Crash data show that poor visibility at night is the leading contributor to fatal collisions with pedestrians, cyclists, and most likely other low-contrast obstacles. Moreover, the evidence indicates that drivers do not compensate behaviorally for limited visibility at night. Research has shown, for example, that

(a) Traffic speeds are roughly the same in day and night conditions

(b) Most drivers do not use high-beam headlights when appropriate and

(c) Drivers don't notice the deleterious effects of dirty headlights that are common in inclement winter weather. These findings suggest that drivers are unaware of normal limitations of night vision and, therefore, they seem overconfident in their ability to drive safely (Mikoski, et al. 2019).

The headlight of vehicles poses a great danger during night driving. The drivers of most vehicles use high, bright beams while driving at night. This causes discomfort to the person traveling from the opposite direction and therefore experiences a sudden glare for a short time. This is caused due to the high intense headlight beam from the other vehicle coming towards the one from the opposite direction (Varudharajulu & Ma, 2018).

Generally, the glare of high beams during the night time was can cause different road accidents. So safety measure was necessary to mitigate the effect of the glare of high beam.

2.1.1. Battery

A battery is a device that stores chemical energy and converts it to electrical energy and it uses as a source of power for a vehicle. Batteries are widely used as sources of direct current electrical energy in automobiles, boats, aircraft, ships, portable electric/electronic equipment, and lighting equipment. The vehicle battery is used as a source of energy in the vehicle when the engine is not running (Denton, 2007).

In some instances, they are used as the only source of power; while in others, they are used as a secondary or standby power source (Bhatia, 2012). It consists of two or more voltaic cells that are connected in series to provide a steady dc voltage at the battery's output terminals. A battery consists of several cells assembled in a common container and connected to function as a source of electrical power. The automobile storage battery is a common example of a secondary cell (Bhatia, 2012).

2.1.2. Light Dependent Resistor

A Light Dependent Resistor also we call is known as a photo resistor or LDR is a device whose resistivity is a function of the incident electromagnetic radiation.it is a semiconductor material that is between conductor and non-conductor material. A semiconductor is somewhere between an insulator and a conductor: it has a band gap, typically of order 1 e V (Methods, 2013). It works on the principle of photoconductivity. The Light-dependent resistor works on the principle of photo-conductivity.

LDR is a sensor that changes its resistance according to the amount of intensity of light falling on it. Increasing the intensity of light decreases the resistance and increases the conductivity of LDR. The output of LDR is an analog output The Light-Dependent resistor works on the principle of Photoconductivity i.e. the conductivity of the LDR increases by increasing the intensity of light falling on it. When the LDR is kept in dark, its resistance is very high that is up to $10^{12}\Omega$. At the same time, when the LDR is placed in sunlight, there is a drastic fall in the resistance of LDR (Lakshmi, et al. 2019).

LDR is a resistor that can be controlled by light. The resistance of the LDR decreases when incoming light is incident on the circuit and resistance increases when there is no source of a light present (kumar,et al. 2021). Photoconductivity is an optical phenomenon in which the material's conductivity is increased when light is absorbed by the material. LDR's are light-dependent devices whose resistance is decreased when light falls on them and that is increased in the dark. When a light-dependent resistor is kept in dark, its resistance is very high.

This resistance is called dark resistance. It can be as high as 1012 Ω and if the device is allowed to absorb light its resistance will be decreased drastically. These are the light-sensitive devices that are used for detecting the presence or absence of light in a wide range of applications, or to measure the intensity of light falling on it (Ciffee, et al. 2021). This LDR has a wide range of application and have low cost and simple structure and are often used as light sensors. Other applications of photoresistors include Light intensity meters, Alarm clocks, also used for Automatic street lights, and so on. (Al-Subhi, et al. 2019)

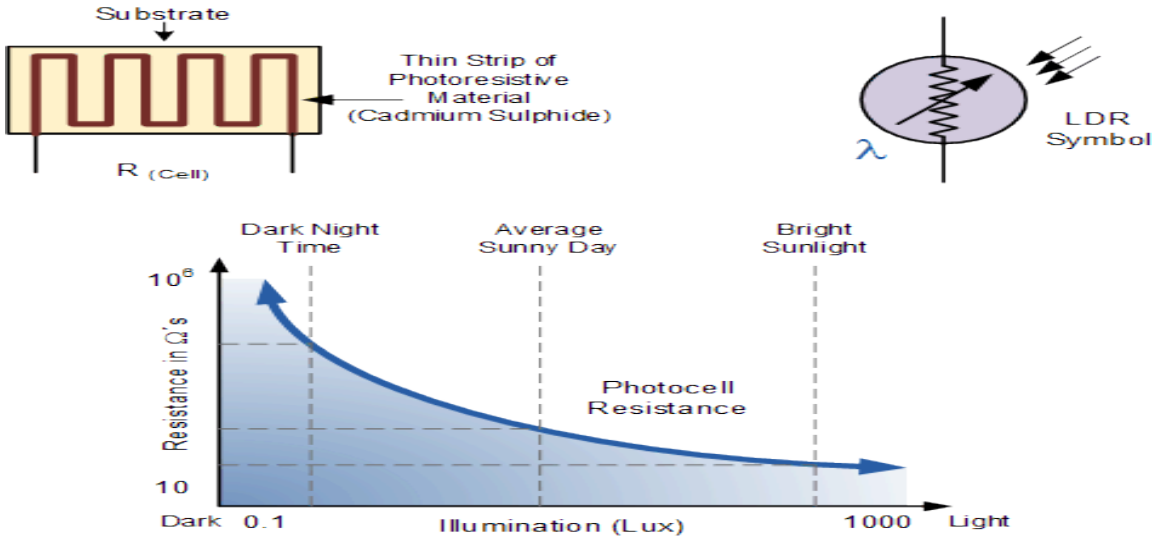

Figure 2. 3. Illumination (Lux) vs resistance in Ω

A light-dependent resistor changes its resistance according to the light which falls on it from the opposite vehicle or car. The relation between the intensity of light and resistance of LDR is: $RL = \frac{500}{LUX}$ Now the light intensity of 1000 LUX causes temporary blindness in the eyes. Hence we substitute LUX=1000 in the above equation (Sharma, et al. 2016). The system device was able to automatically switch the headlight to a low beam when it sensed a vehicle approaching from the opposite side using an LDR sensor. It was observed that the maximum spread angle of the headlight was 135^{o} (Arpita, et al. 2018).

2.1.3. Sensitivity of Light Dependent Resistor

The sensitivity of a photodetector is the relationship between the light falling on the device and the resulting output signal. In the case of a photocell, one is dealing with the relationship between the incident light and the corresponding resistance of the cell. (Applications & Function on light dependent resistor, 28-Jul-08

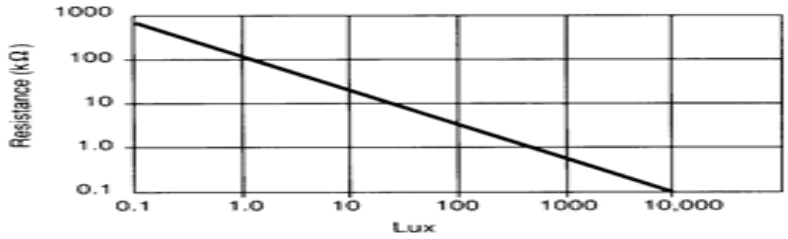

Figure 2. 4. Resistance K Ω vs Illuminance Intensity (Lux)

Table 2. 1.Electrical Characteristics of LDR

Parameter	Conditions	Min	Typ	Max	Unit
Cell resistance	1000 LUX	-	40	-	Ohm
	10 LUX	-	0	-	K
			9		Ohm
Dark Resistance	-	-	1	-	M Ohm
Dark Capacitance	-	-	3.5	-	pF
Rise Time	1000 LUX	-	2.8	-	ms
	10 LUX	-	18	-	ms
Fall Time	1000 LUX	-	48	-	ms
	10 LUX	-	12	-	ms
			0		
Voltage AC/DC Peak		-	-	320	V max
Current		-	-	75	mA max
Power Dissipation				100	mW max
Operating Temperature		- 60	-	+75	Deg. C

2.1.4. Transistor BC547

A transistor is a type of semiconductor device which is used to both conduct and insulate electric current or voltage. A transistor acts as a switch and an amplifier. It is normally used for the amplification of current. The larger current at the emitter and collector can be controlled by the small amount of current at the base. It is composed of three layers of semiconductor materials or more specifically terminals that help to make a connection to an external circuit and carry the current. A voltage or current that is applied to any one pair of terminals of a transistor controls the current through the other pair of terminals. There are three terminals for a transistor. They are;

- Base: This is used to activate the transistor.
- Collector: It is the positive lead of the transistor.
- Emitter: It is the negative lead of the transistor.

BC547 is an NPN Bipolar Junction Transistor. Mostly it is used for switching purposes as well as for amplification purposes. This transistor similar to the other transistors BC547 is also used for the amplification of current. BC547 is working when the input voltage is applied at its terminal, some amount of current starts to flow from the base to the emitter and controls the current at the collector.

2.1.5. Light Emitting Diode

LED lights are just tiny light bulbs that fit easily into an electrical circuit. But unlike incandescent bulbs, they don't have filaments that burn out, they use less electricity, and they don't get especially hot. They're illuminated solely by the movement of electrons in a semiconductor material, and they last just as long as a standard transistor. The life span of an LED surpasses the short life of an incandescent bulb by thousands of hours.

LEDs have several advantages over conventional incandescent lamps, but their main advantage is efficiency. In incandescent bulbs, the light-production process involves generating a lot of heat (the filament must be warmed to illuminate). This energy is completely wasted unless you're using the lamp as a heater because a huge portion of the available electricity isn't going toward producing visible light. LEDs generate very little heat, relatively speaking.

A much higher percentage of the electrical energy is going directly to generating light, which cuts down the electricity demands considerably Per watt, LEDs output more lumens (or quantities of visible light) than regular incandescent bulbs. Light-emitting diodes have a higher luminous efficacy (how efficiently electricity is converted to visible light) than incandescent – a 60-watt incandescent bulb can generate between 750-900 lumens, but you can get the same output from a LED bulb using only 6-8 watts. And that same LED bulb can last 25,000 hours, but the 60-watt incandescent is only likely to light up for about 1,200 hours. In other words, one LED bulb can last as long as 21 60-watt incandescent bulbs burned consecutively (You, et al. 2018).

2.1.6. Diode (1N4001)

The diode is a semiconductor device is which acts is as a one-way switch for current. It used to allow current to flow easily in one direction, this means that it restricts current from flowing in the opposite direction. The diode is a semiconductor component that functions as a single-way current switch (Madupoju, et al. 2021).

Also, it is used for rectifying current AC to DC. The rectifier is an electronic device that transforms alternating current (AC) into a direct current (DC), which flows out of one

direction only (Madupoju et al., 2021). Also, 1N4001 diode is used for reverse voltage protection, a staple for many power, DC to DC step up, and breadboard projects. 1N4001 is rated for up to 1A/50V. A diode allows electrical current to flow in one direction -- from the anode to the cathode. A 1N4001 diode is used to protect the transistor from reverse voltages created in the relay coil (Service, 2016).

2.1.7. Variable Resistor

Resistors are broadly classified as fixed and variable resistors. A variable resistor is a resistor of which the electric resistance value can be adjusted. It can be change resistance from zero to a certain maximum value. A variable resistor is in principle an electro-mechanical transducer and normally works by sliding contact or wipe over a resistive element. They are commonly used as volume controls and voltage regulators. When resistance increases in the variable resistor the current through the circuit decreases and vice versa. Therefore A variable resistor is a resistor whose resistance value can be changed.

2.1.8. Buzzer

A buzzer or beeper is a signaling device, usually electronic, typically used in automobiles, household appliances such as a microwave oven, or game shows. It most commonly consists of several switches or sensors connected to a control unit that determines if and which button was pushed or a preset time has elapsed, and usually illuminates a light on the appropriate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound. This device installs on a vehicle when the driver changes gear to reverse direction.

Initially, this device was based on an electromechanical system that was identical to an electric bell without the metal gong. Often these units were anchored to a wall or ceiling and used the ceiling or wall as a sounding board. Another implementation with some AC-connected devices was to implement a circuit to make the AC into a noise loud enough to drive a loudspeaker and hook this circuit up to a cheap 8-ohm speaker. Nowadays, it is more popular to use a ceramic-based piezoelectric sounder like a Son alert which makes a high-pitched tone. Usually, these were hooked up to "driver" circuits which varied the pitch of the sound or pulse the sound on and off (Arpita, et al. 2018).

2.1.9. Relay

Relays are the switches that aim at closing and opening the circuits electronically as well as electromechanically. It controls the opening and closing of the circuit contacts of an

electronic circuit. A relay is an electromagnetic switch operated by a relatively small electric current that can turn on or off a much larger electric current.

The heart of a relay is an electromagnet. Relay is a kind of electric lever: switch it on with a tiny current and it switches on another appliance using a much bigger current. Many sensors are incredibly sensitive pieces of electronic equipment and produce only small electric currents. But often we need them to drive bigger pieces of apparatus that use bigger currents.

Relays bridge the gap, making it possible for small currents to activate larger ones. That means relays can work either as switches turning things on and off or as amplifiers converting small currents into larger ones (Arpita, et al. 2018). When the relay contact is open (NO), the relay isn't energizing with the open contact. However, if it is closed (NC), the relay isn't energize given the closed contact. However, when energy (electricity or charge) is supplied, the states are prone to change.

2.1.10. Automotive Headlight

A headlight is a lamp attached to the front of a vehicle to illuminate the road ahead. Automotive front lighting solutions have been focusing on how to achieve optimal illumination of the road space in front of the driver. A good front lighting function provides maximum visibility with minimum inconvenience for other road users (Service, 2018).

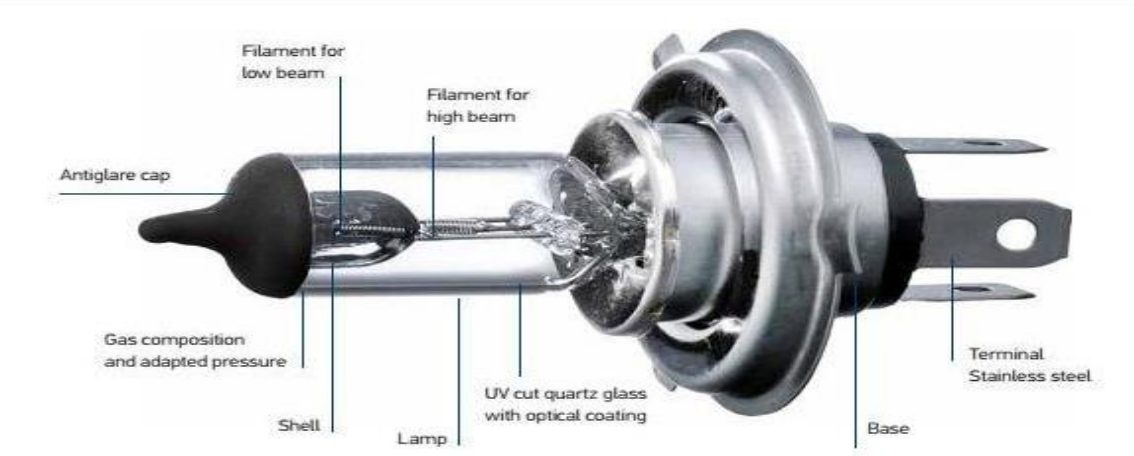

Figure 2. 5. Filament for the low beam is fitted with a shell

Source: (vehicle light source, 2018.)

The objective is to illuminate the road and its surroundings as much as possible so that the driver can identify obstacles and pedestrians on the roadway. Conversely, they should protect preceding or oncoming drivers from excessive glare (Beam & Beam, 2019).

Glare during driving is a serious problem for drivers. This is caused due to the sudden exposure of our eyes to very bright light; the bright headlights of vehicles in this case. This causes temporary blindness called the Troxler effect. Eventually, this becomes the major reason for night accidents.

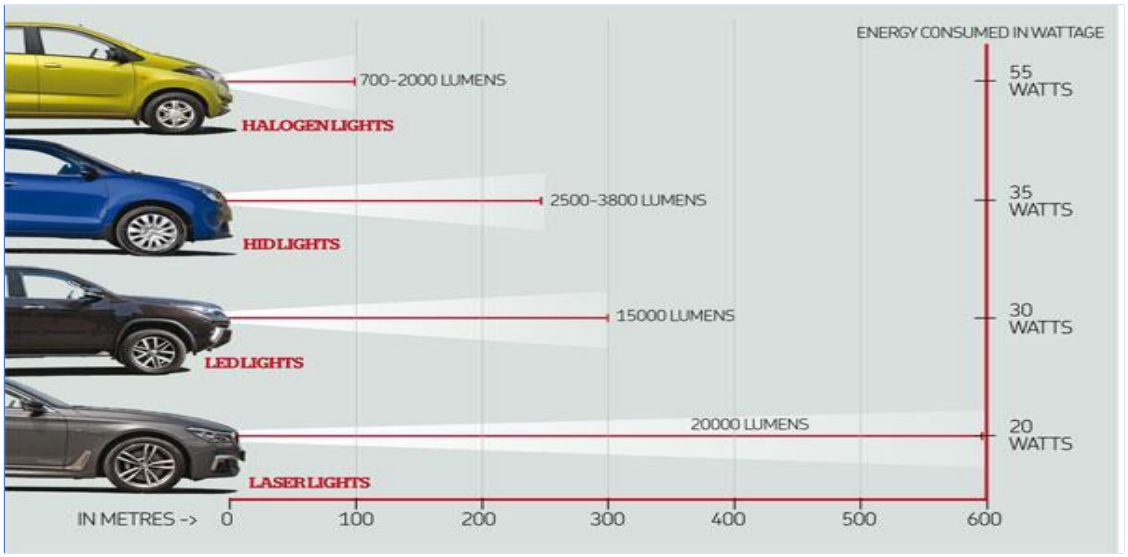

Figure 2. 6. Different vehicle light lumens and lamps have a throw different distance (m) source :(Chenani, et al. 2017)

The headlamp is attached to the front side of the vehicle to provide a light vision of the road ahead. The light beam from the headlamp is called a headlight. Two types of beams emerge from the headlamp. They are low beam and high beam.

2.1.11. Low Beam

The low beam which is also called a dipped beam, passing beam, meeting beam headlamp provides a distribution of light designed to provide lateral and forward illumination that is limited which helps to control the glare for the other road users (Lakshmi, et al. 2019). Low beams provide a light distribution to give adequate forward and lateral illumination without dazzling the oncoming vehicles (Service, 2018).

Low beams also known as a dipped beam or passing beam, provide an asymmetrical illumination pattern that ensures sufficient lateral and forward illumination while minimizing glare towards oncoming cars and other road users.The Society of Automotive Engineers (SAE) specification for headlamps was J579 (31) but this has been canceled instead of an effort to harmonize headlight design worldwide. Both SAE J579 and the Federal Motor Vehicle Safety Standards (FMVSS 108) standards apply to all vehicles registered in the U.S. regardless of the design of the headlamp filament or

light source. The output of two- and four-headlamp systems in the U.S. is limited by these specifications. Lower beam (each lamp):15,000- 20,000 candelas (Chrysler, et al. 2003).

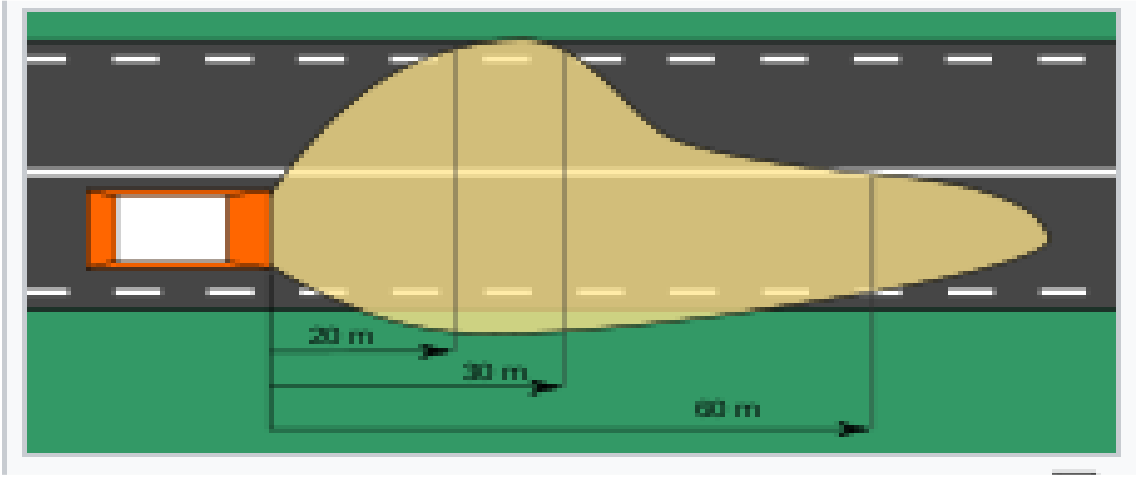

Figure 2. 7. Low beam of Car headlight

Source: (Lakshmi, et al.2019)

2.1.12. High Beam

High Beam is also called the main beam, a driving beam, a full-beam that provides a bright, center-weighted distribution of light and it does not possess any control of light that is directed towards the other road users. A high beam is only suitable for the road with no other users, as the glare from the high beam may dazzle the other drivers (Lakshmi, et al. 2019). A high beam is necessary to illuminate the rod ahead of the automobile to reveal objects ahead from a safe distance but improper lighting arrangements of the vehicles on the road cause difficulty in driving at night. Bad driving habits and infrequent use of beam shifting/signals further enhances this problem and often remain the main reason for road accidents at night (Arpita et al. 2018).

Under high-beam, head lighting conditions with peak luminous intensities (for each headlight) of 60,000 cd (a typical peak luminous intensity of North American high beam headlights), 116,250 cd, or 227,000 cd (which is close to the maximum permitted peak intensity based on European requirements (Bullough, 2015). The Society of Automotive Engineers (SAE) specification for headlamps was J579 (31) but this has been canceled instead of an effort to harmonize headlight design worldwide. Both SAE J579 and the Federal Motor Vehicle Safety Standards (FMVSS 108) standards apply to all vehicles registered in the U.S., regardless of the design of the headlamp filament or light source. The output of two- and four-headlamp systems in the U.S. is limited by these

specifications to the following: Upper beam (each lamp): 20,000 - 75,000 candelas (Chrysler, et al. 2003).

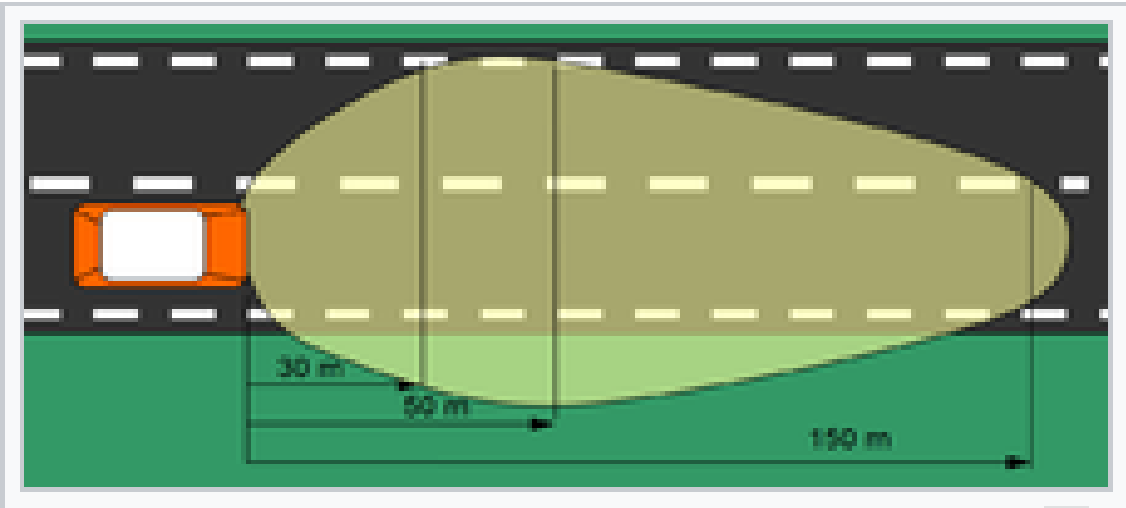

Figure 2. 8. High Beam of Car headlight
Source: (Lakshmi, et al.2019)

2.1.13. Illuminance (lux)

Illuminance refers to the incidence of the light flux on a surface, per unit of surface. The flux from a luminaire travels in various directions through space until it strikes a surface. The amount of light falling per unit area of the surface is called the illuminance and is measured in lumens per square meter or lux (lx).

If the luminaire is at a reasonable distance from the surface it can be regarded as a point source, and the illuminance (lux) on a surface perpendicular to the intensity direction is simply the intensity I (cd) divided by the square of the distance D (m) (*road transport lighting for developing countries*, 2007). The unit of illumination is the lumen per square meter (lux). A single lux is equal to one lumen per square meter.

2.1.14. Luminous Flux (Lm)

The total amount of light emitted in all directions by the light source. The lumen is unit lumen (lm) gives the total luminous flux of a light source by multiplying the intensity (in candela) by the angular span over which the light is emitted. Luminous flux", which comes from a lamp, is measured in lumens (lm). This quantity allows for the fact that the sensation of "light" experienced by the human eye/brain system depends on the wavelength of the radiation entering the eye (*road transport lighting for developing countries*, 2007).

2.1.15. Luminous Intensity (Candela) or cd

Candela is the base measurement for describing luminous intensity. It tells you how bright the light source is which shows how far away from an object you can be and while still being able to see it. The luminous intensity of a candle is 1 candela. The flux emitted in a given direction within a very small solid angle "surrounding" the direction, divided by the solid angle, is the intensity in that direction. The unit of measurement, lumens per steradian, is called the candela (cd) (road transport lighting for developing countries, 2007).

2.1.16. Electrical Breadboard

A breadboard is a great way to construct electronic projects easily and in less time without the need for soldering. A problem that is faced by beginners in the field of electronics is that they cannot solder the components neatly on printed circuit boards. One bad solder joint can lead to the project not working. Another problem faced by them is that if they try to solder and make a project, it does not work because of poor soldering or the circuit that was taken from a book or magazine lacked instructions or it was wrong (Al-Subhi, et al. 2019).

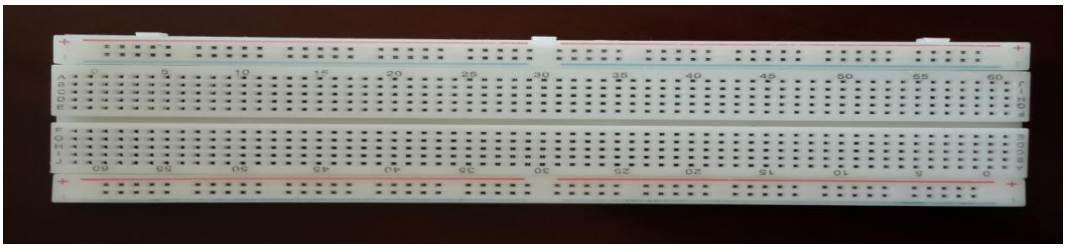

Figure 2. 9. Electrical Breadboard

2.2. Microcontroller

A microcontroller refers to a single device; however, it contains the entire microcomputer on that single chip. Therefore, a microcontroller will have a processor, onboard memory, and a variety of IO devices. While using a microcontroller instead of a microcomputer simplifies the overall 16 design, to accomplish this it sacrifices flexibility. A microcomputer can be configured to have specific quantities of memory or devices attached.

Arduino ATMEGA-328 microcontroller has been programmed for various applications. By using the power jack cable, the Arduino microcontroller has been programmed so that the execution of the program may take place. Arduino ATMEGA-328 microcontroller consists of 14 input and output analog and digital pins (from this 6 pins are considered to

be PWM pins), 6 analog inputs, and the remaining digital inputs. A power jack cable is used to connect the Arduino board with the computer. Externally battery is connected with the Arduino microcontroller for the power supply. Arduino is an open-source microcontroller from which there is no feedback present in the microcontroller. This Arduino board consists of an I2C bus that can be able to transfer the data from the Arduino board to the output devices.

These Arduino boards are programmed over RS232 serial interface connections with atmega Arduino microcontrollers. The operating volt ranges from 5v. The input voltage recommended for the Arduino microcontroller is from 7v and the maximum of 12v. The DC input current given to the Arduino board is in the range of 40mA (Sudhan, et al. 2015).

The microcontroller was introduced in the electronics industry to make our tasks easy which comes with even a remote connection with automation in any way. Microcontrollers are widely used in embedded systems and make devices work according to our needs and requirements.

2.2.1. Arduino Uno

Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

Arduino is an open-source programmable circuit board that can be integrated into a wide variety of maker space projects both simple and complex. This board contains a microcontroller that can be programmed to sense and control objects in the physical world. By responding to sensors and inputs, the Arduino can interact with a large array of outputs such as LEDs, motors, and displays. Because of its flexibility and low cost, Arduino has become a very popular choice for makers and maker spaces looking to create interactive hardware projects.

Arduino Uno is an open embedded source system as shown in figure 2.7 it is a small computer system integrated on the minute chip. Arduino is an essential part of this system which is used to control the whole process of the system by reading and

manipulating the input from sensors. It has six analog input pins that used a sine wave signal. Also, 16 input/output pins were used for the digital signal. Six digital output pins from the 16 digital input/output pins which used for pulse width modulation (PWM) which used digital pulse signal. It can be powered up by using a USB cable, battery, or DC-AC adapter. The operating voltage of Arduino Uno is 5 volts with a current of 20 mA (Al-Subhi, et al. 2019).Here are the components that make up an Arduino board and what each of their functions is.

1. **Reset Button** – It is used to restart the program from the first line of its sketch. A reset button is not a power supply button and is controlled by the microcontroller. Note that this reset button cannot be controlled or changed by the program that we burn on the bootloader.

2. **AREF** – AREF means Analogue reference. It allows us to feed the Arduino a reference voltage from an external power supply. For example, if we want to measure voltages with a maximum range of 3.3V, we would feed a nice smooth 3.3V into the AREF pin – perhaps from a voltage regulator IC.

3. **Ground Pin** – There are several GND pins on the Arduino, any of which can be used to ground your circuit. 5V (4) & 3.3V (5): The 5V pin supplies 5 volts of power, and the 3.3V pin supplies 3.3 volts of power. Most of the simple components used with the Arduino run happily off of 5 or 3.3 volts.

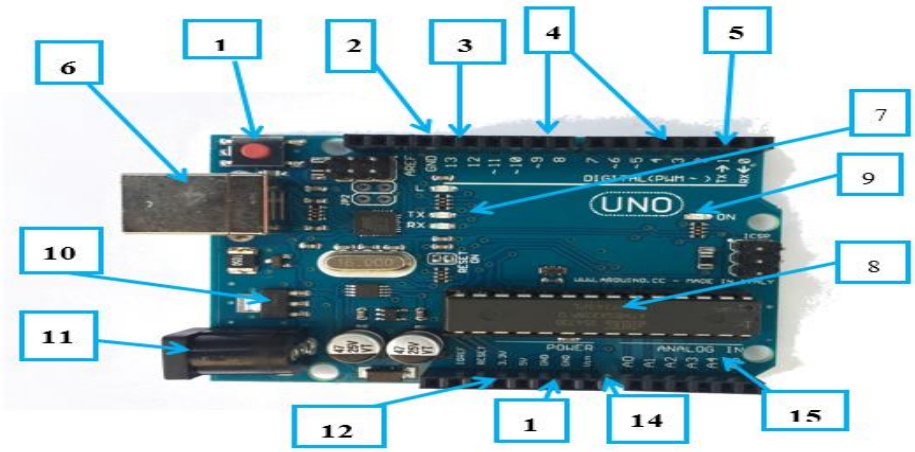

Figure 2. 10. Arduino Uno ATmega328P

4. **Digital Input/output** – The digital inputs and outputs (digital I/O) on the Arduino are what allow you to connect the Arduino sensors, actuators, and other ICs. Arduino to do some really useful things, such as reading switch inputs, lighting indicators, and

controlling relay outputs. Arduino has 0-13 Pins and it can be used for digital input or output

5. **PWM** – Pulse Width Modulation, or PWM, is a technique for getting analog results with digital means. Digital control is used to create a square wave, a signal switched between on and off. The pins marked with the (~) symbol can simulate analog output

6. **USB Connection** – USB cable type A/B. Use it to connect Arduino Uno, Arduino Mega ATmega328, Arduino 101, or any board with the USB female port of your computer. It is used for powering up your Arduino and uploading sketches.

7. **TX/RX** – The TX and RX on the Digital 0 and Digital 1 pins are designated for connecting to your own serial devices, whether a USB cable is connected or not. From the official Uno page: Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data.

8. **ATmega Microcontroller** – ATMEGA328P is a high performance, low power controller from Microchip. ATMEGA328P is an 8-bit microcontroller based on AVR RISC architecture. It is the most popular of all AVR controllers as it is used in Arduino boards. This is the brains and is where the programs are stored

9. **Power LED Indicator** – This LED lights up anytime the board is plugged in a power source

10. **Voltage Regulator** – This controls the amount of voltage going into the Arduino board

11. **DC Power Barrel Jack** – DC can only be used for power - but it's great for when you want to connect your Arduino and leave it plugged in for a long-term project. You can use any adapter that is Center Positive and 7 to 12VDC output - we recommend 9V DC if possible.

12. **3.3V Pin** – The ATmega MCU running at 5 V will sense 3.3 V as HIGH because of the threshold level to convert voltage to logic state. ATmega will read the pin HIGH from 0.6 * Vcc, so at 5 V Vcc the threshold is 3 V.

13. **5V Pin** – This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board.

14. **Ground Pins** – There are a few ground pins on the Arduino and they all work the same.

15. **Analog Pins** – The Arduino can input and output analog signals as well as digital signals. An analog signal can take on any number of values, unlike a digital signal which has only two values: HIGH and LOW. The pin is the PIN used for the PWM output. Value is a number proportional to the duty cycle of the signal. These pins can read the signal from an analog sensor and convert it to digital.

2.2.2. Arduino Uno Technical Specifications

Table 2. 2. Arduino Uno microcontroller datasheet

Microcontroller	**ATmega328**
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory loader	32 KB (ATmega328) of which 0.5 KB used by boot
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock	16 MHz

2.2.3. Jumper Wire

A jump wire cable is an electrical wire or group of them in a cable, with a connector or pins at each which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering. Individual jump wires are fitted by inserting their "end connectors" into the slots provided in a breadboard, the header connector of a circuit board, or a piece of test equipment. There are different types of jumper wires. These are female-female, male-male, and male-female configurations. Male jumpers are designed to plug securely into the holes in a breadboard. Female jumpers are useful for connecting male header posts and pin terminals on components.

Figure 2. 11. Jump wire

2.3. Research Gap

A different researcher was done their research on the effect and safety measures and able to show the severity of the problem and reduced the effect of the problem. According to (Arpita et al., 2018) drivers of most vehicles use high bright beams while driving at night. This causes inconvenience for the person traveling from the opposite direction. To avoid such incidents. The proposed system can be demonstrated with the help of two vehicles where the high beam of the vehicle can be controlled with help of other cars coming in the opposite direction and vice versa using LDR sensor and zigbee communication which avoid accidents to a greater extent.

According to (Asaduzzaman et al., 2013) the Automatic High Beam Controller can switches the high beam of a vehicle to a low beam whenever it gets a signal from another vehicle giving a high beam of light. If the opposite vehicle also has this device the opposite vehicle will turn its high beam to low beam automatically. The device will also work even it can detect the presence of any nearby object at the same time.

The drawback of IR and a proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact. In that, if any other object approach to the sensor reduces high beam to low beam. Also according to (Lakshmi, et al. 2019) automatic headlight dimmer uses LDR. Here, the high beam is automatically switched to a low beam when a high beam of light another vehicle falls on the LDR.

Therefore the majority of a researcher when doing their research they could not consider the driver because the driver must get information before the newly designed device reduce high beam to low beam. So driver warring device was designed with the system also they do not consider the opposite coming vehicle light intensity

CHAPTER THREE

MATERIALS AND METHODS

3.1. Materials

The high beam reduction system needs a number of electrical components for receiving a analog signal from light dependent resistor and send to microcontroller and changing it to digital output. Table 3.1 below lists the utilized materials for the high beam reduction system.

3.1.1. Materials required for design development of high beam reduction

Table 3. 1. List of material for the system

S .No	Items	Quantity
1	Arduino Uno	1
2	+12v battery	1
3	Light Dependent Resistor, LDR	1
4	Transistor BC547	4
5	Relay	4
6	LED	5
7	Diode	4
8	Resistors	16
9	Variable Resistor	1
10	Rotary Switch	1
11	Buzzer	1
12	Electrical breadboard	1
13	Jumper wire	40

3.1.2. Engine Isuzu 4HKI-TCC

To conduct this research ISUZU NPR 75-190. The following data was the specification of this vehicle.

- Type: 4 cylinders 16 valve SOHC
- Displacement: 5,193 cc

- Compression ratio: 17.5:1
- Bore x Stroke: 115 mm x 125 mm
- Max power (DIN-NET): 140 kW (188HP) @ 2,600 RPM
- (JIS Gross): 145 kW (194HP) @ 2,600 RPM
- Max torque (DIN-NET): 513 Nm (378 lb.ft) @ 1,600 - 2,600 RPM
- (JIS Gross): 531 Nm (392 lb.ft) @ 1,600 - 2,600 RPM
- Induction system: Electronically controlled variable nozzle turbocharger with air-to-air intercooler.
- Fuel injection: Direct injection high-pressure common rail system.
- Emission control system: Cooled EGR with Exhaust Diesel Particulate Diffuser (DPD). ADR 80/03 (Euro V) compliant. EEV compliant.

Table 3. 2. Vehicle specification

Weight(Kg)												
Model				Rating		Loading Limit		Cab Chassis Weight				
				GVM	GCM	Front	Rear	Front	Rear	Total		
NPR 75-190 MWB				7500	11000	3100	6000	1800	890	2690		
Dimension(mm)												
WB	OAL	FOH	ROH	EA	CE	RT	ORT	CH	FFA	RFA	RFH	KERB TO KERB
3365	5985	1110	1510	2680	4302	1650	2115	2270	675	790	830	12.4

3.1.3. Electrical System

- 12-volt electrical system.
- 4.5 kW starter motor.
- 2 x80D26L (630CCA) batteries connected in series.

3.2. Methods

To show the general and specific objectives of this design and development high beam reduction methodology will be followed.

To know the existence of the problem the researcher goes to the field and observes how much serious problem of vehicle high beam light for the opposite coming vehicle during night time. After field observation, the researcher was read different literature on the issue of vehicle headlight and their merit and demerits. Then identify high beam merit

and its problem. After all, identify the targeted population and drivers who are affected by this high beam. So the researcher was decided on the population and sample for the study.

The population for these study vehicle drivers who are driven at night time, long and short distance were purposively selected and prepared questionnaires for heavy and light duty freight vehicle drivers that drive the different direction of the country. Also, the questionnaires were distributed to different company vehicle drivers, and collect primary data collected by this method and field observation. The collected data analyzed using SPSS 22.v software and interpreted to meaningful results.

After all the researcher was studying the current (existing) Isuzu NPR75-190 lighting system and how much light intensity is measured by lux meter. Draw the existing lighting system on proteus professional 8.7 software and simulate it. The newly designed high beam reduction system was designed after the existing lighting system simulates on proteus and the new system work analog.

These analog convert to digital by writing the algorithm for microcontroller by Arduino programming software and interfacing program with corresponding Arduino Uno.

Finally, develop the new system on a small prototype and test the functionality.

3.3. Population and Sampling

3.3.1. Target population

Target population means the total number of subjects under the study. So target populations of the study will be vehicle driver's especially heavy and light duty freight vehicle drivers. The researcher was used both probability sampling (simple random sampling) and non-probability sampling (purposive) techniques will be applied to select representatives of a vehicle driver. In the non-probability sampling, the heavy and light duty freight vehicle drivers were purposively be selected for research questionnaires. The questionnaires were consisting of both closed-ended and open-ended questions.

3.3.2. Sample frame

A list containing all such sampling units is known as a sampling frame. Thus sampling frame consists of a list of items from which the sample is to be drawn (Kothari, 2004). To confirm the generalization and validity of the study, taking sufficient sample size and

utilizing sample technique special concern will be given. The list of heavy and light-duty freight vehicle drivers will be considered as a sample frame.

3.3.3. Sample Unit

The elementary units or the group or cluster of such units may form the basis of the sampling process in which case they are called sampling units. Therefore, the sampling units will be the sample of all heavy and light duty freight vehicle drivers.

3.3.4. Sampling Technique

In this study, a probability sampling method were used. Simple random sampling and purposive sample techniques are employed to select units. Simple random sampling can be used for small populations that contain more than 1000 sampling units.

3.3.5. Sample Size

The size of the sample should neither be excessively large, nor too small. It should be optimum. To take the appropriate and representative sample size the researcher decided on the following statistical calculation. For this study, the statistical formula uses for sample size N≥ 10,000 set by Kothari (2004), is used and applied as follows by considering the level of acceptable margins of error at 5%. Therefore sample size:

$$n = \frac{z^2 pq}{e^2}$$ For N≥ 10,000)

Where,

N = population size

n = the desired sample size

z = standard normal variable at the required level of confidence at 95%=1.96

p = the proportion in the target population estimated to have characteristic being measured

q =1-p the probability of failure

$e -$ Is the acceptable margin of error for proportion being estimated it will be 5%.

Expecting to produce an accuracy level of 95%,

e= (100% - 95%) =1-0.95 =0.05,

z=1.96 and since there is no estimate available of the proportion in the target population assumed to have the characteristic of interest, it is possible to predict the proportion of target population 'p' to be 0.5 and 'q' 0.5 will be taken (Sataloff et al., n.d.) Therefore: assuming that the size of the population greater or equal to 10,000, the sample size of the study is:

Where

Z = 1.96, p = 0.5, q = 1-0.5 = 0.5, and e = 0.05 Where: $q -$ Is $1 - p$

$$n = \frac{z^2 pq}{e^2} n = \frac{z^2 p(1-p)}{e^2}$$

$$n = \frac{(1.96)^2.(0.5)(1-0.5)}{0.05^2} = 384.16$$

Therefore:$n = 384$

The sample size of this study will be 384 heavy and light duty freight vehicle drivers representing the total population at a 95% confidence interval. The researcher decides 54.9% of the share for heavy-duty freight vehicle drivers and 45.1 % for light-duty freight vehicle drivers. Therefore, the sample size is summarized in the following table.

Table 3. 3. Sample size summary

No	Respondents	Population Size	Percentage share	Sample size
1	heavy duty freight vehicle drivers	211	54.9%	$0.549 * 384 = 211$
2	light duty freight vehicle drivers	173	45.1 %	$0.451 * 384 = 173$
Total			100 %	384

3.4. Sources of Data

To achieve the objectives of this study, both primary and secondary data will be used. The primary data will obtain through questionnaires from heavy and light duty freight vehicle drivers. The secondary source of data will include data and information from previous studies such as existing official reports of, Addis Ababa transport authority (AATA), and Addis Ababa traffic management (AATM, documents of the organization, and other empirical researches in the area, and any other relevant document from the libraries and internet.

3.4.1. Method of data collection

The data collection tools to gather primary data in this study were questionnaires, and field observation. The questionnaires was prepared for the respondents who are selected from heavy and light duty freight vehicle drivers. The questionnaires were consisted of closed-ended questions

3.5. Data Analysis and Interpretation

The data w analyzed according to their type either quantitative or qualitative data. The collected data enter into SPSS 22 software and Microsoft excels analysis. Due to the nature of the data different statistical tools such as frequency, percentage; graphs, and the

pie chart was used and interpreted with meaningful explanations. Analysis and reviewing different literature design development high beam reduction system was simulated by Proteus 8 professional software.

3.6. Arduino Uno Microcontroller Programming

The programming is done by ARDUINO UNO commercial software which is called as Arduino Integrated development environment (IDE). The C programming language is fragmented into blocks of code called functions that form the main building blocks of any program. In Arduino IDE there are two have two setups () and void loop (), each containing statements that do specific actions performed in order from top to bottom.

```
Void setup () {
}
Void loop () {
}
```

Statements inside the void setup will be used to configure the state of input and output pins, as well as other actions that we only need to run once. Conversely, loop () will perform whatever actions are inside of it over and over again for eternity, assuming limitless power as a pre-requisite.

Since the language that the Arduino microcontroller used is case sensitive a letter is uppercase or lowercase must match exactly between what is entered and the syntax of the function, variable, or other statement being used.

A variable declared inside the loop or another function is called a local variable but if it is declared before the setup function it is known as a global variable. Arithmetic Operators: +, -, *, /, Compound Operators: ++, --, +=, -=, *=, /= and Comparative Operators are available in the program.

Table 3. 4. Operator and their description

Description	Symbol	Examples
Parenthesis	( )	(x+ y) *z
Increment, decrement	++ -- , ,	x++, y--
Multiplication, division, modulus	* / %	x * 1.5
Addition, subtraction	+ -	y + 10
Less than, greater than comparisons	< > <= >=	if (x < 255)
Is, is not equal to	== !=	if (x == HIGH)
Logical AND	&&	if (x == HIGH && x > y)
Logical OR	||	if (x == HIGH || x > y)
Assignment and compound assignments	= += -= *= /=	x = y

Source of the table (Ciffee et al., 2021)

Table 3. 5. Data types and their size and range

Name	Size	Range
Boolean	1 bit	true or false
byte	8 bits	0 to 255
char	8 bits	-128 to 127
int	16 bits	-32,768 to 32,767
long	32 bits	-2,147,483,648 to 2,147,483,647
float	32 bits	3.4028235E+38 to 3.4028235E+38
unsigned char	8 bits	0 to 255
Unsigned int	16 bits	0 to 65,535
unsigned long	32 bits	0 to 4,294,967,295

3.6.1. Controlling Statements

The if statement checks for a condition and executes the following statement or set of statements if the condition is 'true. If statement is the simplest of the control structures and is among the most prominent method for Arduino decision making. It will perform a block of code if a specific condition is met.

The basic syntax for an if statement looks as follows:

```
If (condition) {
Statements
}
```

The for statement is used to repeat a block of statements enclosed in curly braces. An increment counter is usually used to increment and terminate the loop. The for statement is useful for any repetitive operation and is often used in combination with arrays to operate on collections of data/pins.

The for statement, or for loop, is an iterative statement that allows the Arduino to repeatedly perform lines of code in a loop a specified number of times. The basic syntax of a for loop follows:

```
For (initialization (declaration); condition; increment)
    {
Statements
    }
```

The while statement is a substitute for the for loops. Even if for statement is fairly common to Arduino programmers, but there are other ways to structure iterative loops. Where the if statement executed a statement once if a condition was met, and the for-loop cycles through a specified number of times, the while statement, or while loop, is used to continuously execute a statement so long as the condition remains true. The basic syntax of a while statement looks like the following:

```
While (condition)
  {
Statements
   }
```

Like if statements, switch case controls the flow of programs by allowing programmers to specify different code that should be executed in various conditions. In particular, a switch statement compares the value of a variable to the values specified in case statements.

When a case statement is found whose value matches that of the variable, the code in that case statement is run. The basic syntax of the switch statement is as follows:

```
Switch (expression)
    {
Case constant:
  Statements;
      Default:
```

}

Map () function will take the value from the variable analog Value with expected values that begin at 0 and go up to a maximum of 1023, and map these values to the new values of 0 to 255(2^8-1). This statement effectively converts a range of values from 0 to1023 (2^{10}-1) to 0 to 255(2^8-1). The beginning and ending values can be changed accordingly. The basic syntax of the map () function is:

Map (value, from Low, from High to Low, to High)

Delay () function is used to create a short pause in the middle of a program. The syntax for the function follows.

Delay (time)

Inside the microcontroller on the Arduino board, three onboard hardware timers work in the background to handle repetitive tasks like incrementing counters or keeping track of program operations. The attach Interrupt () function enables hardware interrupts and links a hardware pin to an ISR to be called when the interrupt is triggered. This function also specifies the type of state change that will trigger the interrupt. Its syntax follows:

Attach Interrupt (interrupt, function, and mode)

3.6.2. Analog and Digital Functions

In digital functions, the writing and reading of signals are only HIGH and LOW which is equal to 5V and 0V. The analog write ranges from 0 up to 255(2^8-1) and the reading range is from 0- 1023(2^{10}-1).

3.6.3. Flowchart of the program

A flowchart is an illustrative representation of an algorithm. The flowchart can be helpful for both writing programs and explaining the program to others.

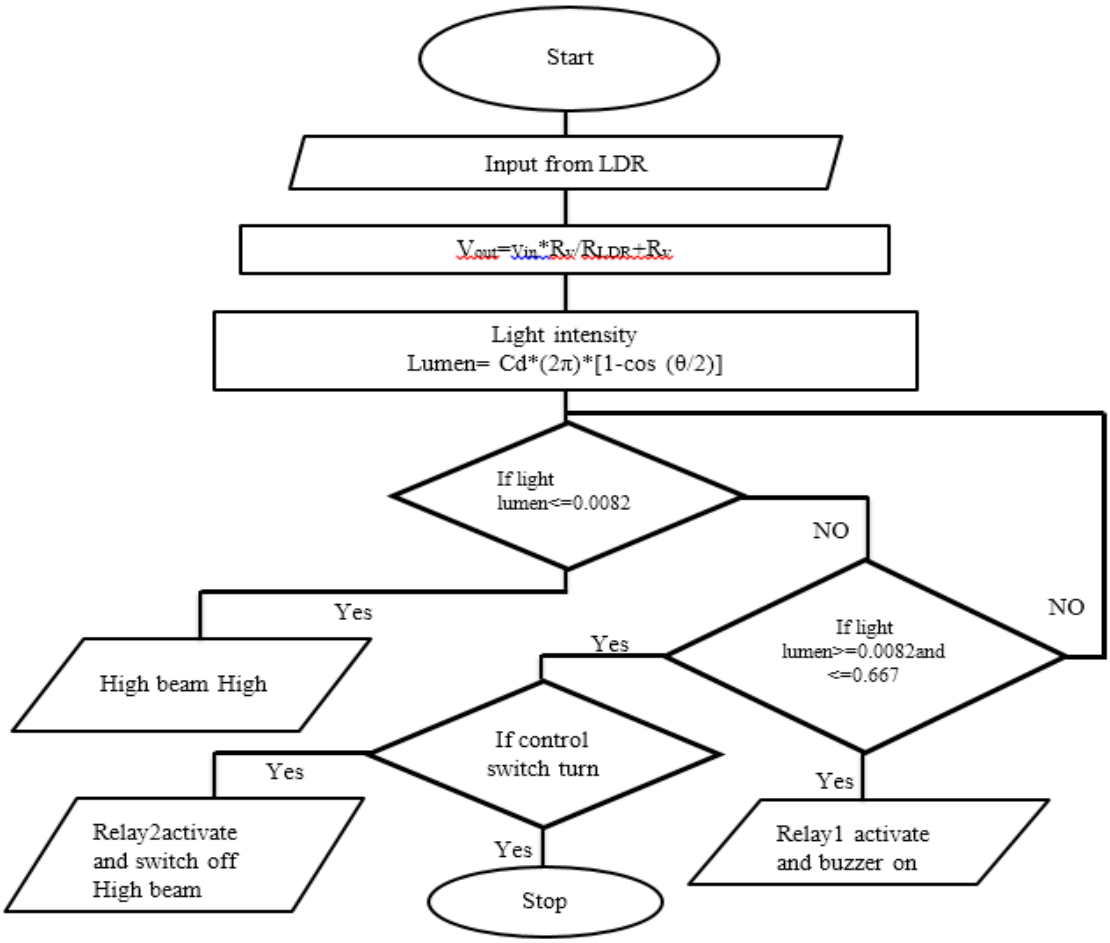

Figure 3. 1. Flowchart of the program

3.6.4. Simulation

After accomplishing all the circuit design of the high beam reduction system, simulation of the high beam reduction is done by using Proteus 8.7 professional simulation software.

3.6.5. Prototype Construction

After all the design and simulation of the high beam reduction system, the prototype was prepared to see the actual functionality of the system considering the opposite coming vehicle headlight intensity.

3.6.6. Process Description

In the project, the Arduino Uno microcontroller is chosen for its big flash memory for long program sketches and a greater number of digital and analog pins. Sensing the value of LDR resistance and connecting a variable resistor in series voltage output on serial monitor of the Arduino by connecting it with digital PIN A0.

The LDR sensor senses vehicle light intensity in a certain direction. Based on the sensor reading, the microcontroller reads the voltage output of LDR light intensity of the sensor

and by saving the time in a volatile data type the previous time and the current time, the time between two pulses which give the period of the light intensity will be calculated.

3.6.7. Proteus Software

Proteus is a simulation and design software used for lab Centre Electronics for Electrical and Electronic design circuits. Proteus is the best simulation software for various microcontrollers. It is mainly common software because of the availability of almost all microcontrollers in it.

Proteus is a Design Suite also known as Virtual System Modeling (VSM) offering the ability to simulate micro-controller code and also circuits. In this case, Proteus ISIS is for simulation from the schematic form of the hardware and also the microcontroller code. It is possible to develop and test designs before a physical prototype is constructed.

3.6.8. Procedure and working flow of the thesis

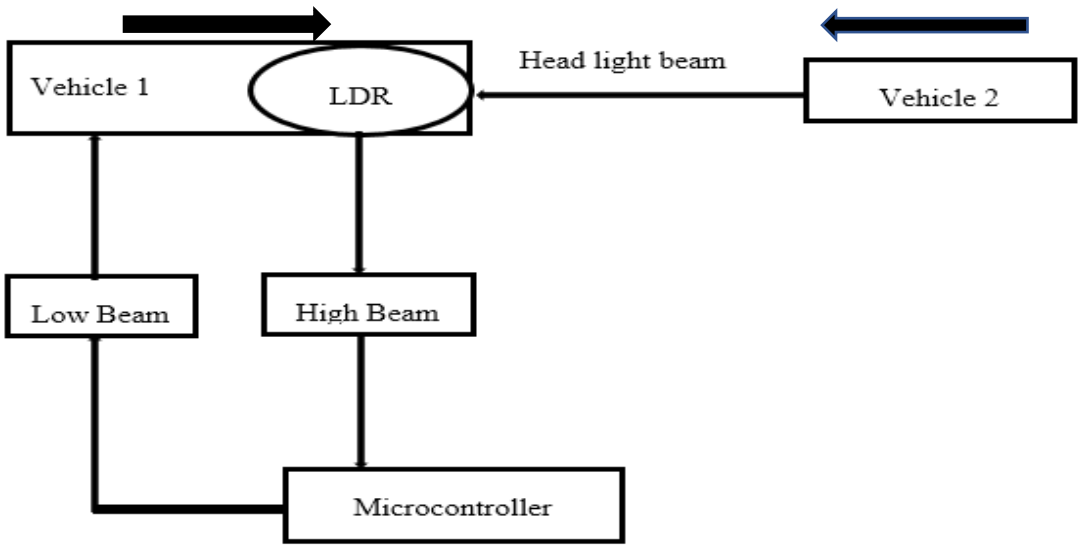

Figure 3. 2. Block diagram of high beam reduction system

Figure 3.2 block diagram shows that how the newly designed system work and clearify the system.

CHAPTER FOUR

RESULT AND DISCUSSION

4.1. Demographic Characteristics of Respondents

A total of 384 questionnaires were distributed and collected over one month from February 5 to March 5. From 384 total samples, 384 questionnaires were distributed to vehicle driver profiles are tabulated. During the data, collection vehicle driver were males this cover about (100%) and female respondents about zero percent (0%) because female respondent was not participating to fill these questionnaires due to the researcher purposively select vehicle driver at night time.

Majorities of drivers are with age between 20-30 years old 174(45.3 %) followed by with age between 31-40 years old 126 (32.8%) years old. The majority of the respondent was single about 255(66.4%) and 129(33.6%) were married. Also, the majority of a driver having about 2-3 or 222 (57%) families and followed 4-5 this is about 108(28.1%) family was managed by the driver. In this case, we can conclude that the respondents can understand the questions and respond well.

Table 4. 1. Demographic Characteristic of Respondent

Demographic	Item	Frequency	Percent (%)
Gender of driver	Male	384	100%
	Female	0	0%
	Total	384	100%
Age of driver	20-30	174	45.3%
	31-40	126	32.8%
	41-50	46	12%
	51-60	32	8.3%
	>61	6	1.6%
	Total	384	100%
Marriage Status driver	Single	255	66.4%
	Married	129	33.6%
	Total	384	100%
Family Status of driver	2-3	222	57.8%
	4-5	108	28.1%
	>=6	54	14.1%
	Total	384	100%

4.2. Age of driver vs Type of vehicle their drive

Figure 4.1 below indicated the type of vehicle and age categories of drivers that operate a vehicle. of 211 which is about 54.9% of total heavy freight vehicle driver about 37.44% were 20-30 years old drivers operate heavy freight vehicle, 36% were 31-40 years old, 13.27% were 41-50 years old, 11.37% were 51-60 years old and about 1.9% were greater than 61 years old was drive heavy freight vehicle at night time.

Also From 173 which is about 45.1% of total light freight vehicle driver about 55% were 20-30 years old drivers operate heavy freight vehicle, 28% were 31-40 years old, 10.4% were 41-50 years old, 4.6% were 51-60 years old and about 1.2% were greater than 61 years old was driving heavy freight vehicle at night time.

Therefore in both types of vehicle ages of driver from 20-30 years old was highly participating in vehicle drive at night time and from 31-40 years are followed and so on.

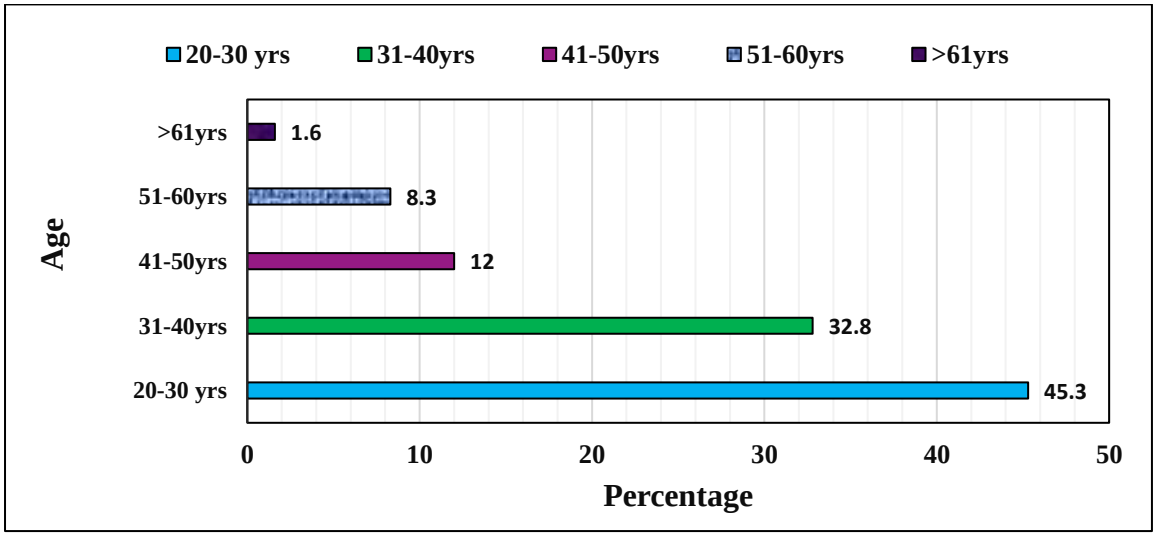

Figure 4. 1. Age of driver vs Type of vehicle their drive

4.3. Driving Time at Night

The figure below shows the driving time of drivers during nighttime. From this figure we understand driving at night time is a normal daily activity of drivers. About 19.53% of driver drives their vehicle for four (4) hours; about 14.06% of drivers drive their vehicle for six hours, about 13.02% drive their vehicle for five hours and so on.

The majority of drivers drive at night time minimum for one hour and maximum for twelve (12) hours. This implies that drivers drive their vehicle on average about $6_{1/2}$

hours and get tired and forget to reduce the light of the vehicle from high beam to low beam light. Due to this reason, high beam glare is caused by road traffic accidents at night time.

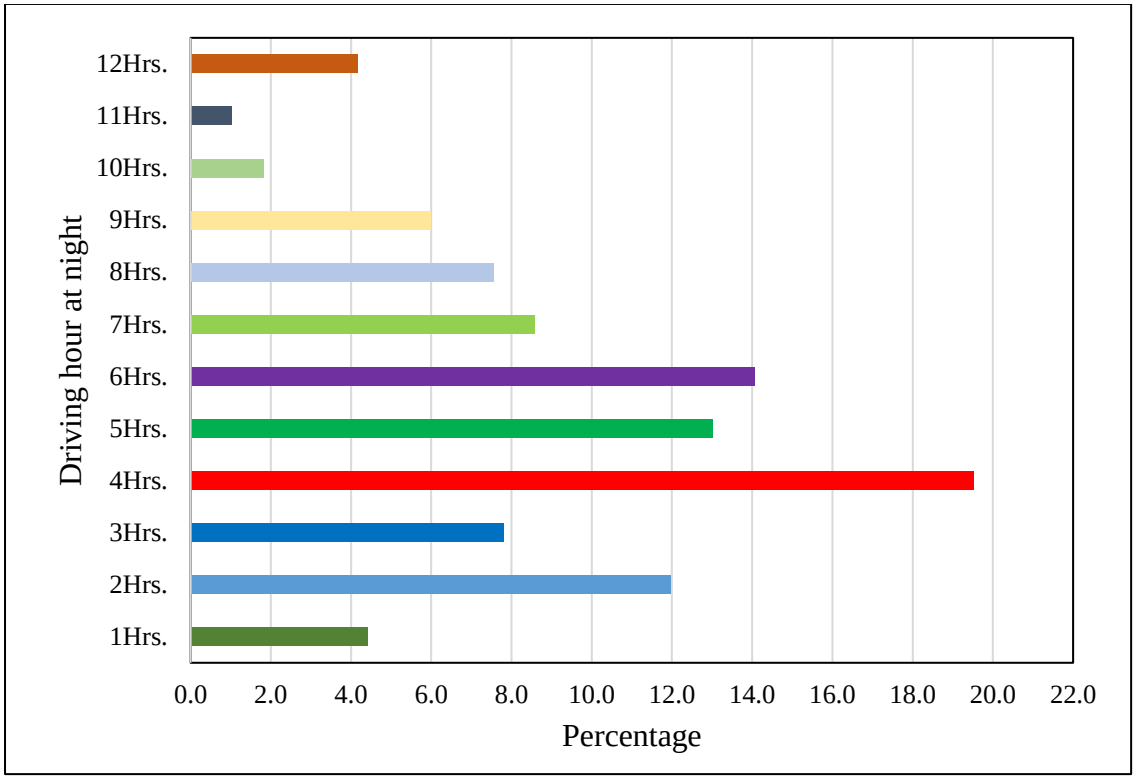

Figure 4. 2. Driving time of driver at night

4.4. Difficult to see object on the road due to high beam light

Table 4. 2. Difficulty to see the object on the road due to beam light

Difficulty to see the object on the road due to opposite coming vehicle high beam light	Frequency	Percent (%)
Yes	366	95.3%
No	18	4.7%
Total	384	100%

From a total, 384 respondent sample about 366 respondent which is about 95.3% was difficult to see the object on the road due to the opposite coming vehicle with high beam light and about 18 respondent which is about 4.7% of the respondent was responded to the opposite coming vehicle high beam light were not affect their vision to identify the object on the road. From the above data shows that vehicle with high beam was a serious challenge for drivers during a drive at night time.

4.5. Solution of Driver

Table 4. 3. A solution has taken by drivers

A solution is taken by drivers	Frequency	Percent (%)
Reduce Speed	37	9.6%
High beam - Low beam, High - Low beam	28	7.3%
stop on road sidelines	40	10.4%
High- low beam, reduce speed and stop on road sidelines	75	19.5%
I use high beam light also	82	21.4%
I use CD- disk which reflects the opposite come light	61	15.9%
I use a mirror to reflect the opposite coming high beam light	30	7.8%
Install additional powerful high beam light and use if the driver not reduce	12	3.1%
Reduce speed and high-low beam light	19	4.9%
Total	384	100%

From table 4.3 above different respondents of driver from the sample take a different solution to overcome difficulty to see the object on the road when the high beam of opposite coming vehicle. The figure shows that the respondent solution. About 37 respondent which is about 9.6% of driver reduce speed of their vehicle and try to minimize road traffic accident due to high beam, about 28 respondent which is 7.3% of driver take a solution by showing light of vehicle high beam to low beam and vice versa.

About 40 (10.4%) of respondent driver take a solution by stop their vehicle on the right side of a road, 75 respondent which is about 19.5% of driver to avoid the problem by high to low beam, reduce speed and stop on road sideline, 82 respondent which is about 21.4% of driver give a solution by their on high beam light to the opposite coming vehicle,About 61 respondent which is about 15.9% of driver take a solution by using back side CD-disk which is reflect the opposite coming vehicle high beam and the opposite coming vehicle will reduce by back side reflection of CD-disk, 30 respondent which is about 7.8% of driver take a solution by using mirror which quit similar with back CD-disk reflection and to reflect the opposite coming vehicle high beam to itself and the opposite coming vehicle driver his high beam to low beam, 12 respondent which is about 3.1% of driver install additional power full high beam on the top of the vehicle and if opposite coming vehicle driver will not reduce and drivers use this power full

beam light.

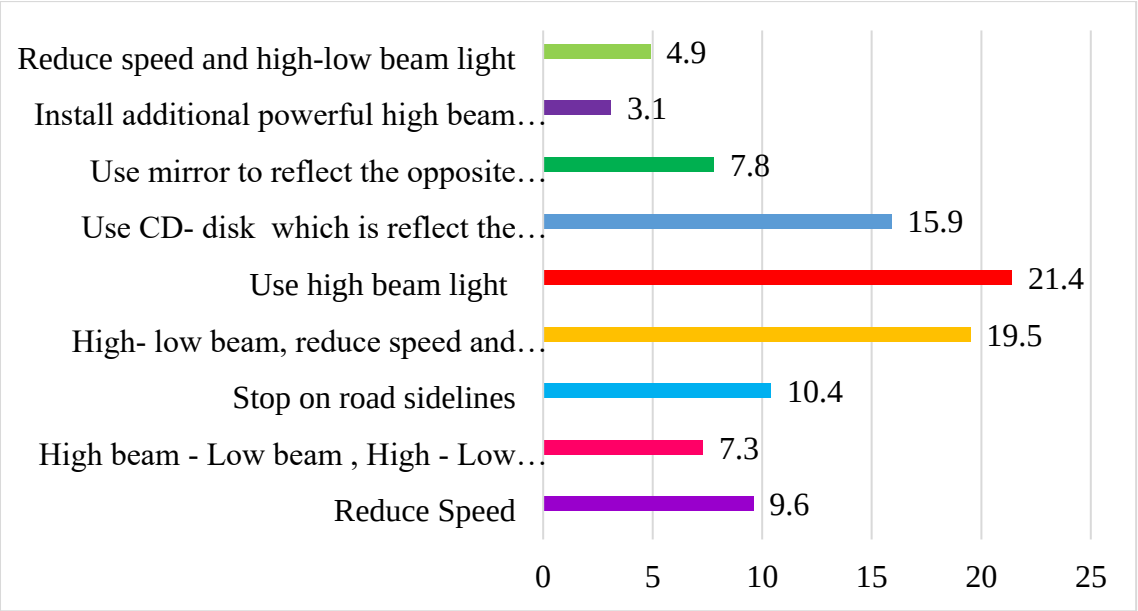

Figure 4. 3. A solution has taken by the driver

From the above figure, the solution of a driver has been positive and negative effects. The positive solution to avoid RTA by reducing their vehicle speed, high to low beam light flashing to the opposite coming vehicle will reduce by himself, stop on road sideline, high to low beam reduce speed and stop on right side of the road have been a positive solution but this solution also effect on the destination time of vehicle at a pre-determined time. The negative effect of the solution which is taken by the driver was using their high beam on opposite coming, use the backside of CD-disk to reflect the opposite coming vehicle to itself, mirror and installing additional power full light. This solution rather than reduces RTA it increase RTA on both side vehicle. Therefore it needs another best solution.

4.6. Problem High Beam Glare

Different road traffic accidents will happen due to high beams.

Table 4. 4. Problems happen by high beam glare

Do you have a problem with this high beam?	Frequency	Percent (%)
Yes	319	83.1%
No	65	16.9%
Total	384	100%

From 384 total samples of the respondent about problems that happen due to this vehicle's high beam glare were 319 which is about 83.1% of the respondent was said yes and about 65 which is 16.9% of respondent have been said no.

4.7. Type of Accident Happen at Night Due to High Beam Glare

Table 4.5 below shows that there are different types of road traffic accidents due to the glare of high beams. From the total sample 12.2% of the respondent the problem happen due to this high beam was vehicle rollover, about 3.4% of respondent enter in to bridge, about 16.7% of respondent says there is no accident, about 15.1% respondent head collision with the opposite coming vehicle, about 12.2% lose their lane, about 7.6% change their direction, about 7% collide with a roadside sign, about 12% enter to the pit and enter to work on progress road, about 5.2% collide with human and animals about 3.9% cannot see the object for short time also about 4.7% technical problem on their vehicle due to high beam glare.

Table 4. 5. Type of accident happen during drive at night due to high beam glare

What type of accident happen during drive at night due to high beam glare	Frequency	Percent %
Vehicle Roll over	47	12.2%
Enter in to bridge	13	3.4%
No Accident	64	16.7%
Head to head collision with opposite coming vehicle	58	15.1%
Lose of my lane	47	12.2%
Change my direction	29	7.6%
Collide with road side sign	27	7.0%
Enter into the pit and enter into on work road	46	12%.
Human and animal collision	20	5.2%
For short time I cannot see any object	15	3.9%
Technical problem occur on my vehicle	18	4.7%
Total	384	100%

4.8. Isuzu NPR 75-190 Headlight System

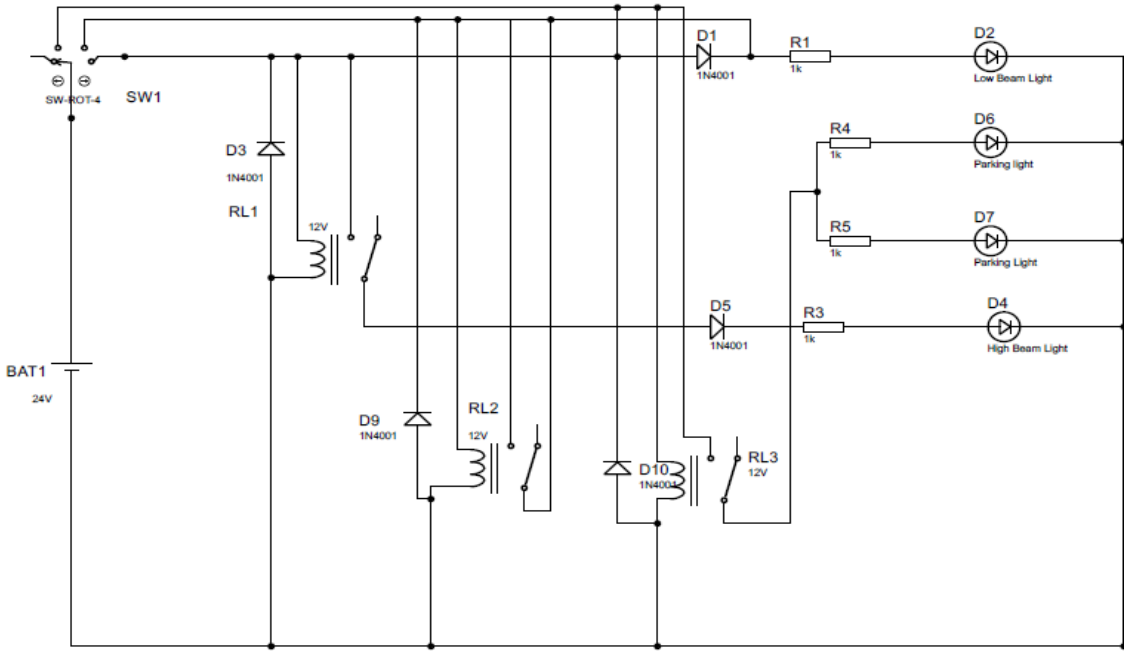

Figure 4. 4. Existing Isuzu NPR 75-190 headlight wire diagram

Source : Own develop 2021

The figure above shows that the existing Isuzu NPR 75-190 headlight system uses a12V DC battery. These 12V batteries are used for any activity of a vehicle like starting system of a vehicle and are used for lighting during nighttime. This light system uses different components like 12V batteries, Rotary (dimmer switch), fuse and relay, and headlight bulb with wire.

This lighting system is only controlled by the driver manually. When the driver needs to use light at dark he/she can manually switch on the parking light, when darkness is increasing turn to on low beam light and turn to on high beam. When the driver turns on the controlling switch it activates the parking relay and the relay will be energized and act as a magnet. So the parking light bulbs turn on. Similarly both low beam and high beam light will be on and off.

4.9. The intensity of Headlight of Vehicle

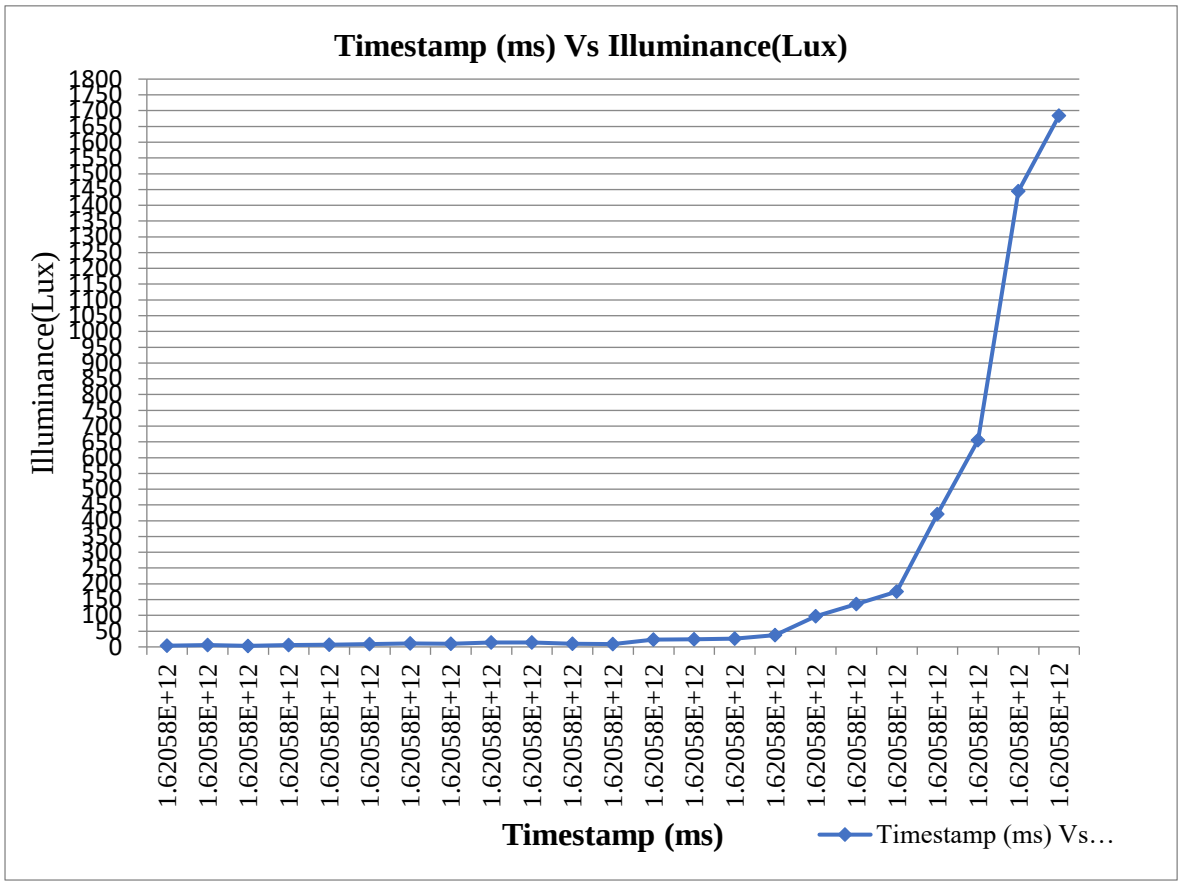

Figure 4. 5.Timestamp (ms) Vs Illuminance (Lux)

Source : Own develop 2021

The above figure shows that when tested by lux meter the intensity of the headlight of a vehicle increases as the distance between decreases through the increasing function of time. The result on the graph shows that when vehicles are approaching each other the effect of a glaring light increases on both sides which will highly affect the visibility of the drivers and everything at the front.

So if a remedy to decrease the intensity of the light is not taken, the intensity of the light will grow exponentially which will be harmful full. The low beam headlight registered different values due to the different patterns of light distribution. This was due to the low beam being designed with its headlamp and bulb type producing low light. The findings also found the average lux value for the low beam at the distance of 0m, 30m, 60m, 120m, and 150m to be 1.0, 0, 0, 0, and 0 for Proton Prevé; while the Perodua Myvi had 1.0, 0.5, 0, 0, and 0. Lux increased along with the distance as shown figure below. (Prasetijo et al., 2018)

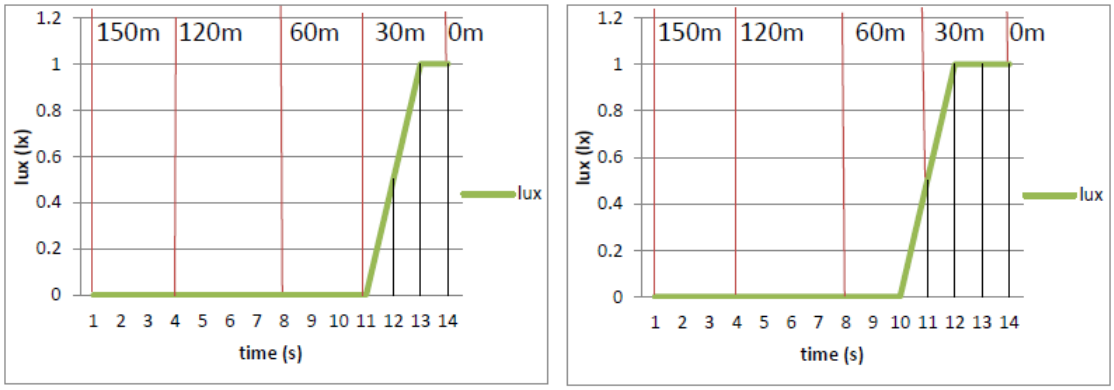

Figure 4. 6. Average data for Low Beam Headlight

Source: Proton Prevé (a) and Perodua Myvi (b) source(Prasetijo et al., 2018)

4.10. Distance and Illuminance Intensity Relationship

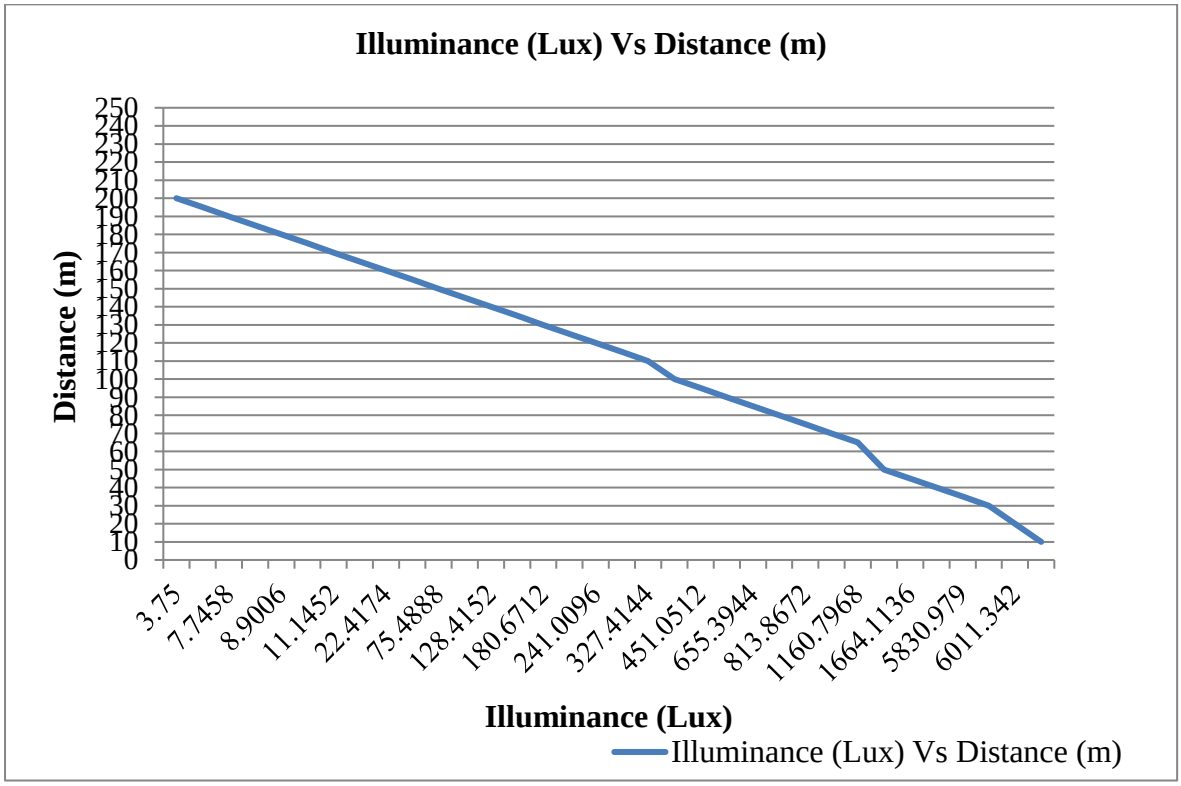

Figure 4. 7. Illuminance (Lux) Vs Distance (m)

Source : Own develop 2021

Figure above shows that the relationship between distance and Illuminance intensity of vehicle light. Illuminance intensity low means the opposite coming vehicle light present at a far distance also when the two-vehicle approach to each other the distance very small and the intensity of vehicle light very high. From the above figure vehicle at 200 meters, it releases about 3.75 lux, and when the distance decrease the value of the vehicle's light intensity will be about 6011.342 lux and more.

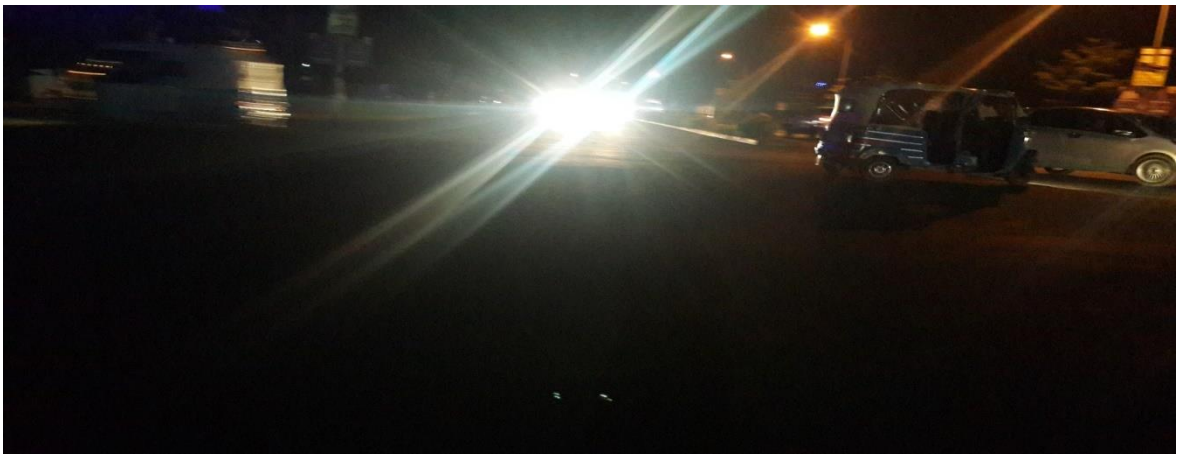

Figure 4. 8. When the vehicle at a far distance

Source: Captured by the researcher 2021

Figure 4. 9. When vehicle approach

Source: Captured by the researcher 2021

4.11. Vehicle Light Lumen vs. LDR Resistance

LDR changes its resistance according to the light which falls on it from the opposite vehicle or car. The relation between the intensity of light and resistance of LDR is:

$$\mathrm{RL} = \frac{500}{\mathrm{LUX}}$$

Due to the light intensity of the opposite coming vehicle LDR changes its resistance. Therefore vehicle low beam has lumens intensity of about 15000cd which means it has high lumens intensity. This implies that how much light hit on driver's eye in a specific direction. Also, lux is a measure of how much light hits the surface and it measures by lux meter. At 135^{o} and 150 m, the vehicle low beam has an intensity of about 58200 lumens is equal to 0.667 lux.

$$RL = \frac{500}{LUX} \quad \text{..... (1)}$$

$$RL = \frac{500}{0.667}$$

$$RL = 749.62\Omega$$

$$RL \approx 750\Omega$$

Also when an opposite coming vehicle with low beam intensity about 700 lumen which is equal to 0.00802 lux at 135^{o} and 150 m.

$$RL = \frac{500}{LUX}$$

$$RL = \frac{500}{0.00802}$$

$$RL = 62{,}344.14\Omega$$

$$RL \approx 62{,}344\Omega$$

4.12. Vehicle Light Lumen vs. LDR Resistance value

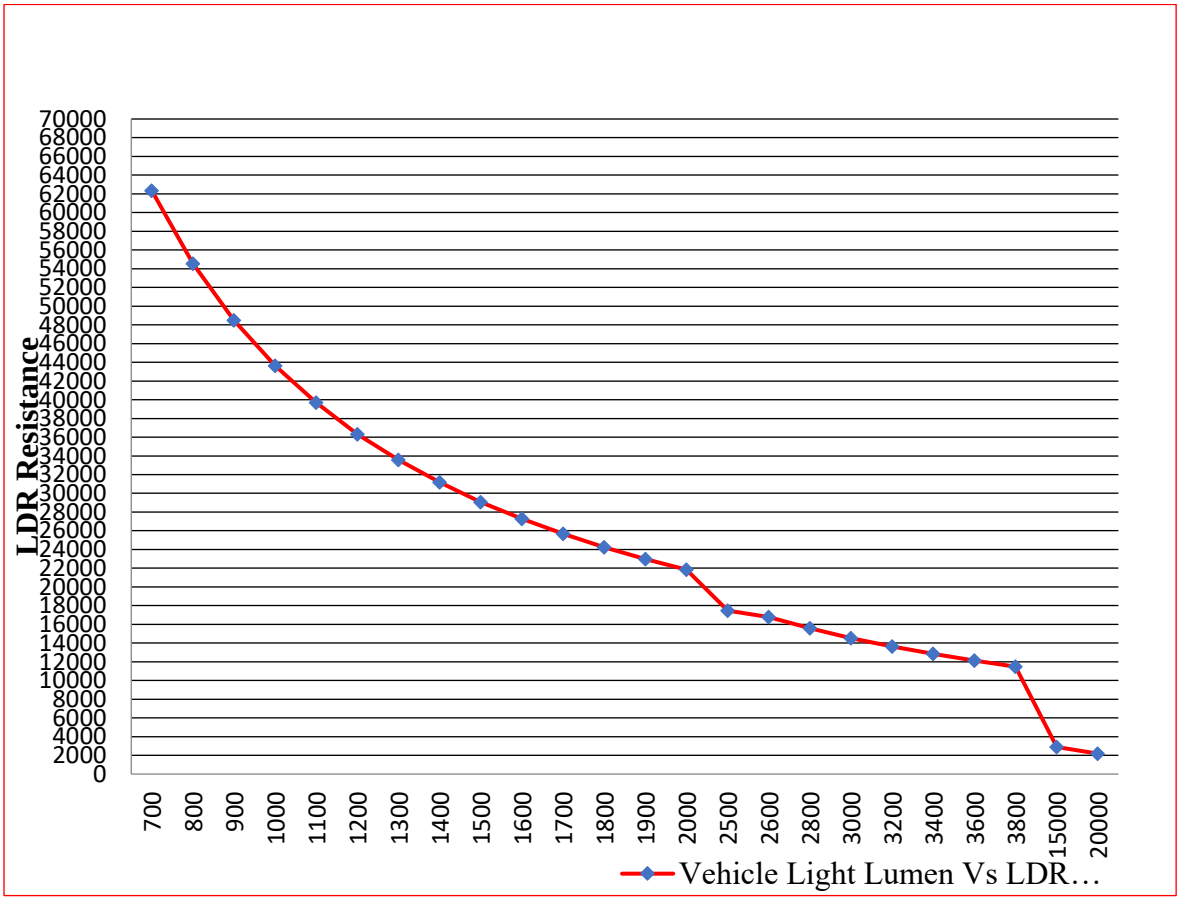

Figure 4. 10. Vehicle Light Lumen vs. LDR Resistance value

Source : Own develop 2021

Figure 4.10 above shows that when the opposite coming vehicle light increase due to the distance between two vehicles decreases the light intensity was increased. Therefore the opposite coming light hit on the LDR surface will be very high. Due to the high intensity of light, the LDR resistance automatically varies and drops up to hundreds of ohms. Conversely when two vehicles pass each other the resistance of LDR will be very high up to 10^6 ohms. As the result, the lumens intensity and LRD resistance will have an inverse relationship.

4.13. Light Dependent Resistor and Voltage Output Analysis

The photoresist is a highly light-sensitive device most often used to indicate the presence or absence of light or to measure the light intensity. It acts like a variable resistor. When LDR is connected in a series with another variable resistor we have to voltage divider network. Therefore the amount of voltage drop across the series resistor, R_V is determined by the resistive value of the light-dependent resistor, R_{LDR}. This ability to generate different voltages produces a very handy circuit called a "Potential Divider".

The current through a series circuit is common and as the LDR changes its resistive value due to the light intensity, the voltage present at V_{out} will be determined by the voltage divider formula. An LDR's resistance, R_{LDR} can vary from about 100Ω in the sunlight to over 10MΩ in absolute darkness with this variation of resistance being converted into a voltage variation at V_{OUT} as shown.

From ohms law

V= IR …… (2)

I= V/R……..…... (3)

R= V/I……..…….. (4)

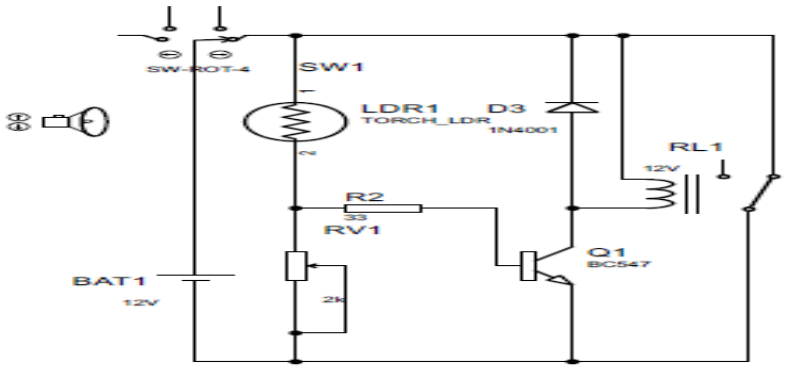

Figure 4. 11. Circuits of LDR and variable Resistor

Source : Own develop 2021

4.14. Voltage Divider Network

$$\text{Vout} = \text{Vin}\ \frac{\text{Rv}}{\text{RLDR+Rv}} \quad \text{..... (5)}$$

From equation (1) the value of LDR resistance at 135^{o} and 150 m vehicle low beam has intensity 700 lumen is equal to 0.00802 lux and resistance of LDR = 62,344Ω and the value of series-connected variable resistor R_v = 2000 Ω. Using the above circuit we can calculate voltage out put.

Now using equation (5) we get the value of voltage output or voltage drop across the series resistor that is input into Arduino UNO A0 pin.

$$\text{Vout} = \text{Vin}\ \frac{\text{Rv}}{\text{RLDR} + \text{Rv}}$$

$$\text{Vout} = 12\text{v}\ \frac{2000\Omega}{62334\Omega+2000\Omega}$$

$$\text{Vout} = 0.373\ \text{V}$$

Also when the value of LDR resistance at 135^{o} and 150 m vehicle low beam has intensity 58200 lumen is equal to 0.667 lux and resistance of LDR = 750Ω

$$\text{Vout} = 12\text{v}\ \frac{2000\Omega}{750\Omega + 2000\Omega}$$

$$\text{Vout} = 8.73\ \text{V}$$

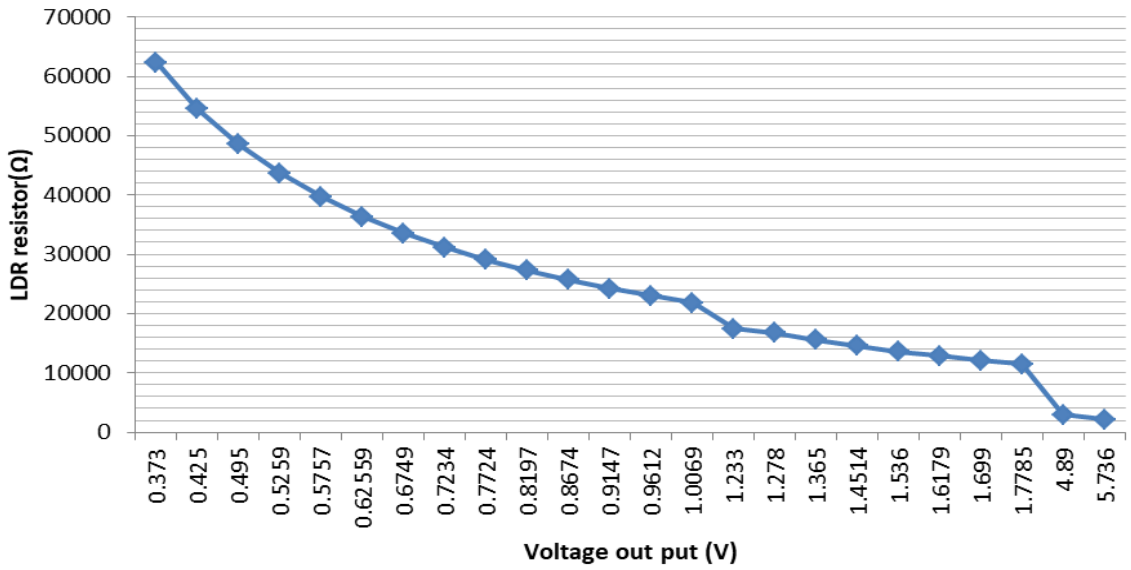

Figure 4. 12. LDR resistor (Ω) Vs Voltage output (v)

Source : Own develop 2021

Figure 4.12 indicated that the relationship between resistances of LDR when the light hit on LDR sensor and Voltage output. From the above figure, we understand when the resistance of LDR very high the voltage output will very low which is an input for Arduino UNO pin A0.

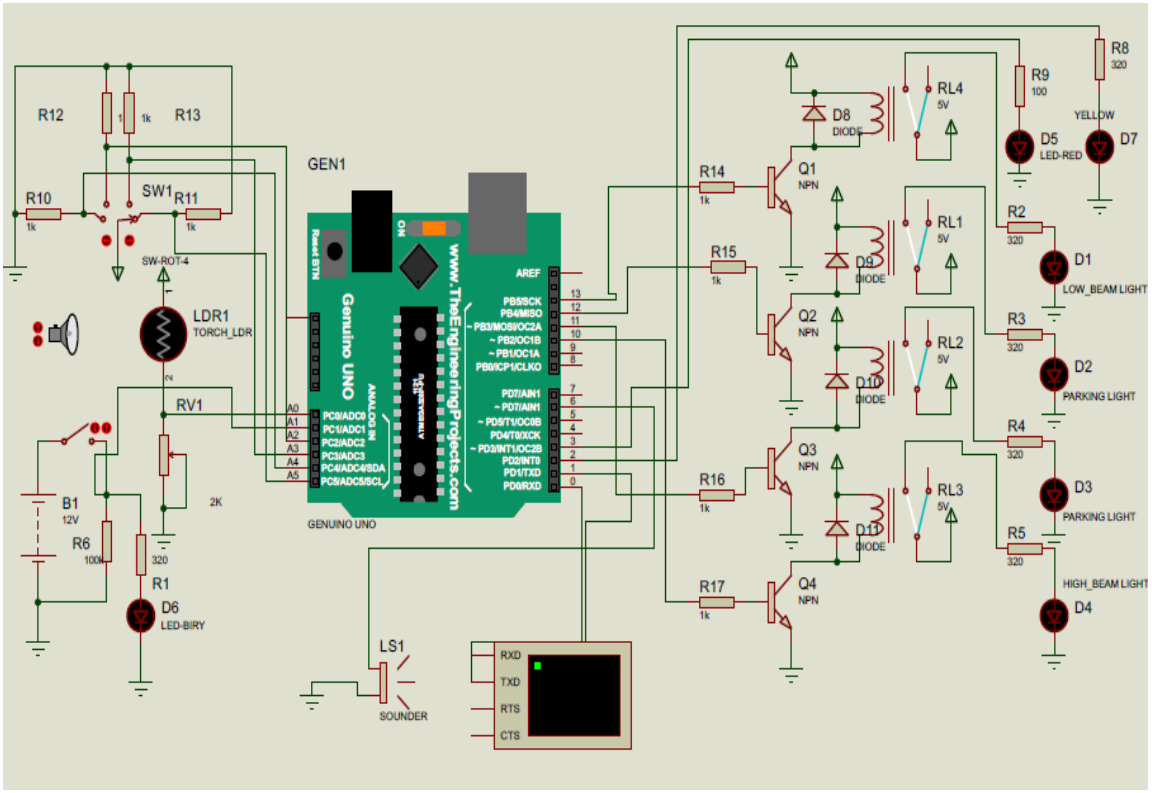

Figure 4. 13. Newly Designed High Beam reduction system circuit diagram

Source : Own develop 2021

The new design high beam reduction system is controlled by their control switch. Once the switch activates by the driver the system start work and the functionality light turns ON. When the value of light intensity at 135^{o} and 150 m distance less than 0.00802 lux the system will not give any response for any type of light like street light, hand torchlight, etc.

When the light intensity is greater than 0.00802 lux and less than or equal to 0.667 lux the buzzer activates and gives a warning sound for a driver. If the driver takes an action and reduces the high beam light to a low beam the buzzer stop to a warning sound.

If the driver will not give a response and the value of light intensity greater than 0.667 lux at 135^{o} and 150 m the voltage output very high. Due to incoming vehicle light

intensity increase, the resistance of LDR will be drop automatically. As the light level increases the resistance of the LDR starts to decrease causing the base bias voltage at Vout to rise. At some point determined by the potential divider network formed with resistor Rv, the base bias voltage is high enough and input for Arduino Uno microcontroller.

The system pin 10 will activate RL3 which controls high beam light. When no light (when two vehicles pass each other) is present i.e. in darkness, the resistance of the LDR is very high in the Mega ohms (MΩ) range so all almost zero voltage output and the relay is de-energized or "OFF.

When relay de-energized high beam automatically returns to its original position and gives high beam light. Also when the opposite coming vehicle with high beam and the newly designed system give different warning color light which is when the light intensity of opposite coming vehicle greater than 0.667 lux. The warning light was yellow when the intensity of light increase that means when close to each other the red warning light turns on automatically.

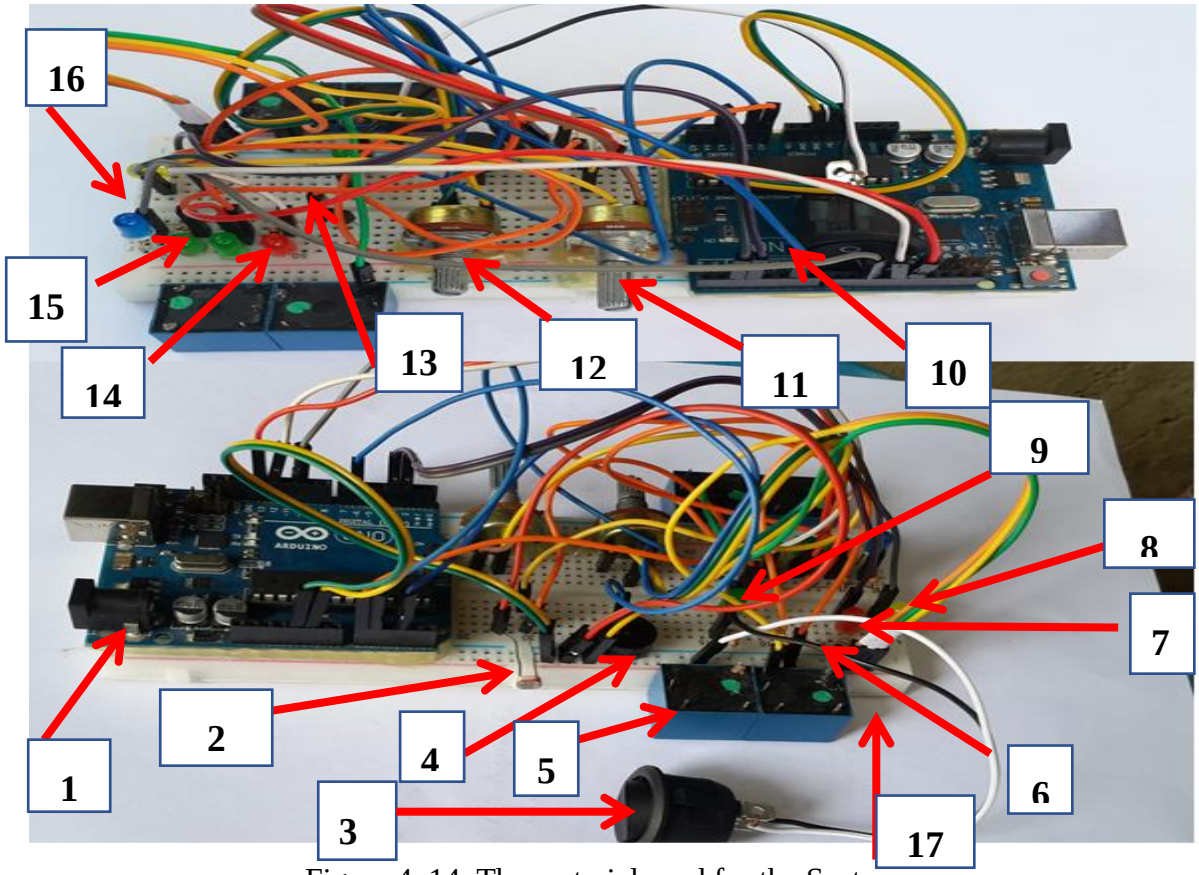

Figure 4. 14. The material used for the System

1. Arduino UNO 2. Light Dependent Resistor 3. System Control Switch 4. Buzzer

5. Relay 6. Resistor 7. Red color warning light 8. Yellow color warning light

9. System functioning light 10. Jumper wire 11. Variable Resistor 12. Rotary Switch

13. Transistor 14. Low Beam Light 15. Parking Light 16. High Beam Light

17. Breadboard

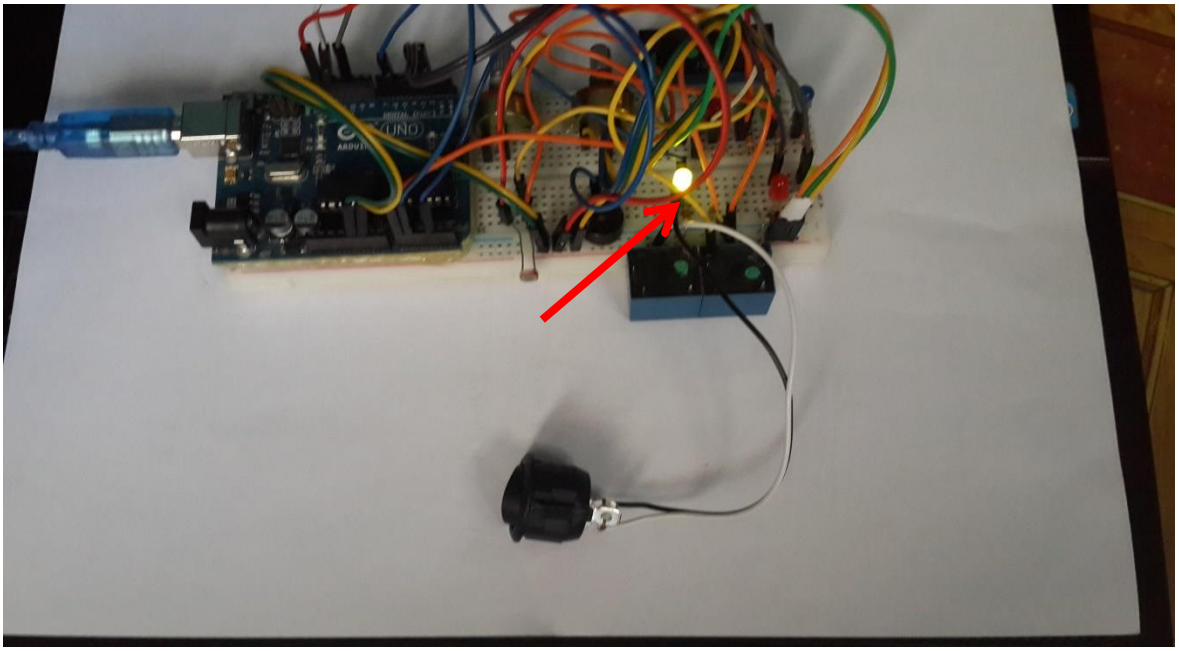

Figure 4. 15. System functioning light

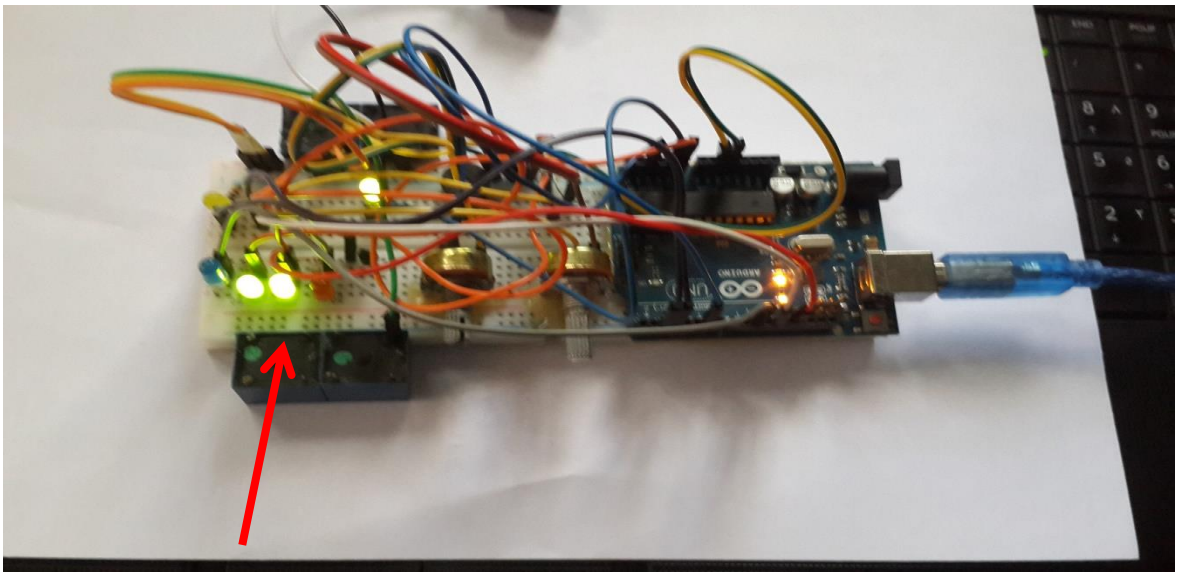

Figure 4. 16. Parking light switch ON

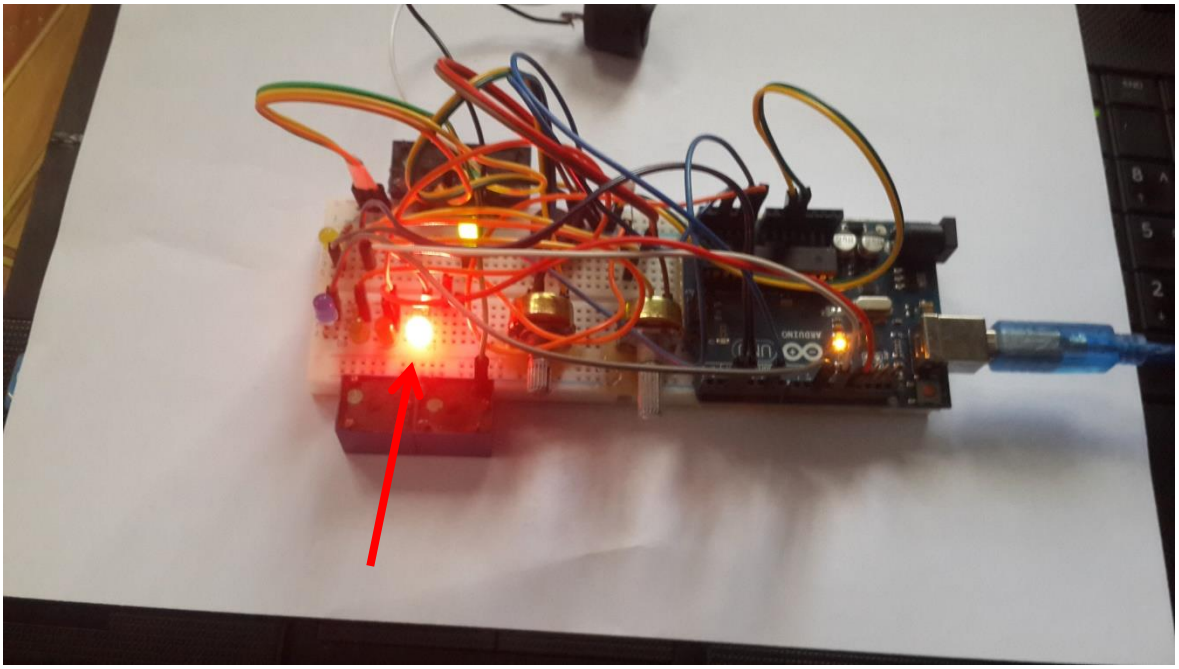

Figure 4. 17. Low beam light switch ON

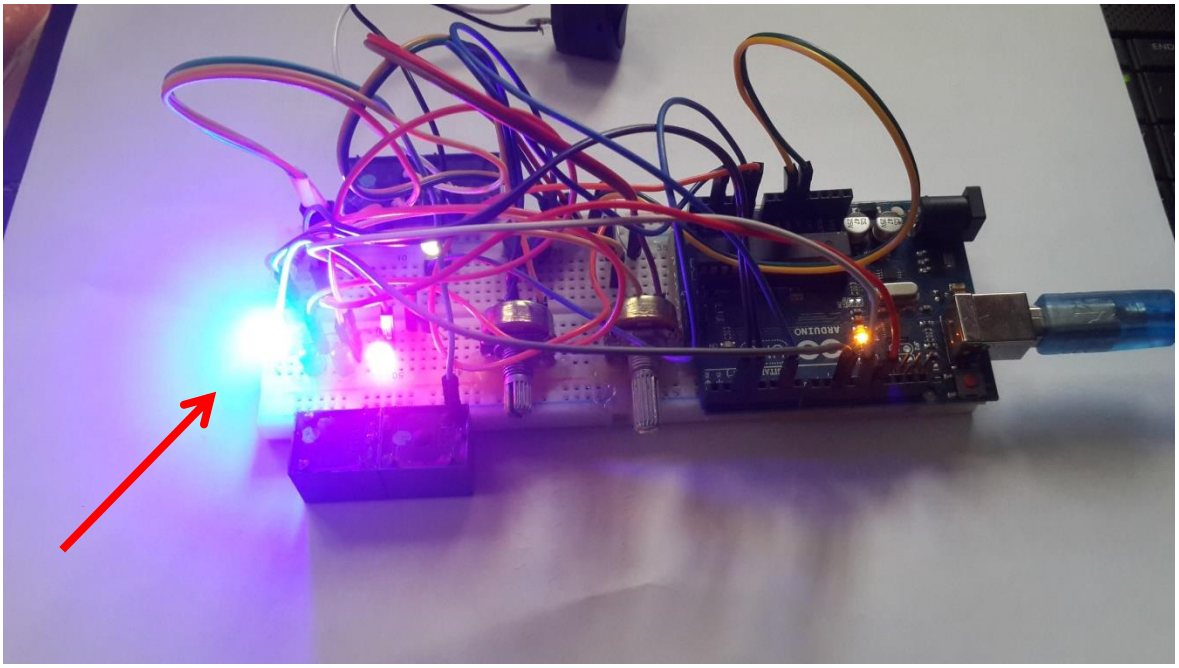

Figure 4. 18. High beam light switch ON with low beam

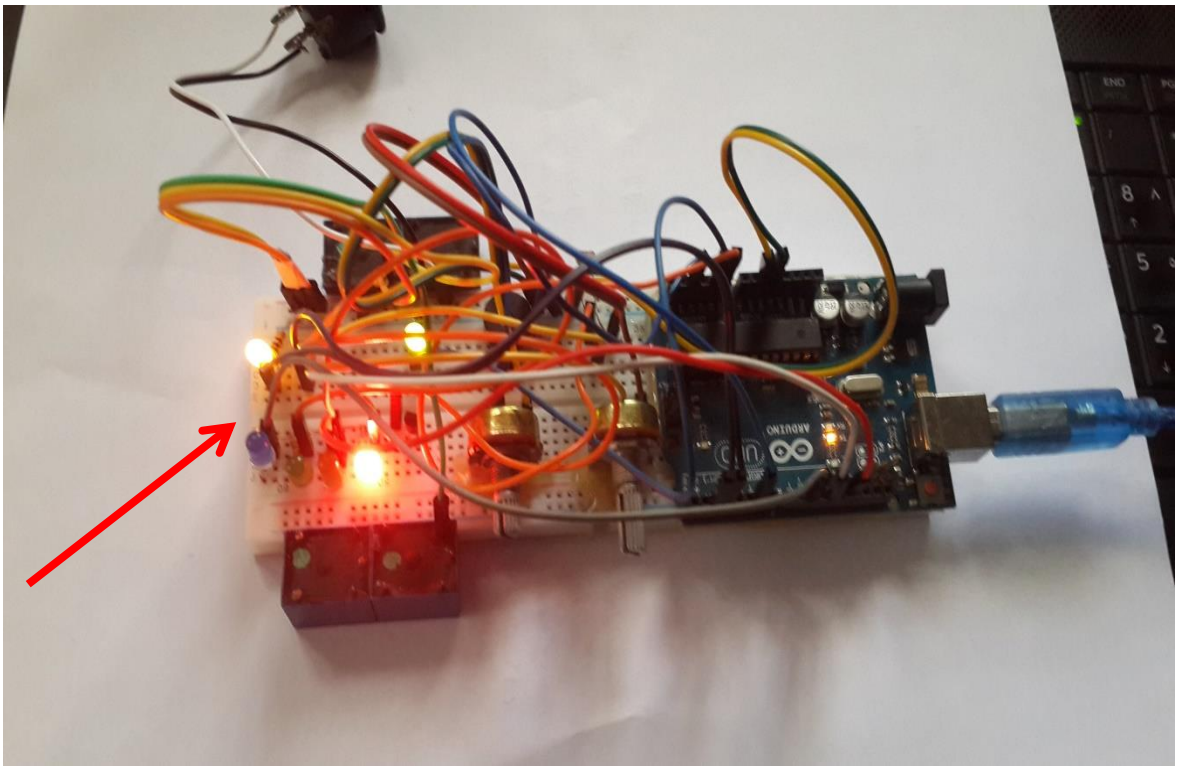

Figure 4. 19. Warning light switch ON with low beam

4.15. Summary

This high beam reduction system can counteract the frequent participants of road traffic accidents during night time which are freight vehicles especially Isuzu NPR 75-190 by excessive use of high beam. Since the design of the High beam reduction system automatically makes warning signal to the driver by sensing the opposite coming vehicle light intensity. If the driver will not reduce his/ her high beam light the newly designed high beam reduction system automatically de-energizes the high beam relay and reduce high beam light to low beam headlight up to the opposite coming vehicle pass. When the opposite coming vehicle passes each other the system returns to the original position of high beam.

The designed high beam reduction system also warns the opposite coming vehicle with high-intensity light by giving different colored light. When the opposite coming vehicle at a far distance the light intensity low and the yellow color light will be switch on and when the opposite coming vehicle more approaches its light intensity increase may it can cause glare for the front coming so to show this red color light switch on with yellow light. When the two-vehicle pass each other the system goes to normal function.

CHAPTER FIVE

CONCLUSION, AND RECOMMENDATION

5.1. Conclusion

A high beam reduction system controller had been designed using the LDR sensing technique. Thus, the system device automatically switches the headlight high beam to low beam when it senses the opposite coming vehicle approaching Light Dependent Resistor (LDR) sensor. Glare during driving is a serious problem for drivers and therefore caused by the sudden exposure of our eyes to a very bright light of the headlights of vehicles. This causes temporary blindness called the Troxler effect. Eventually, this has become the reason for accidents occurring at night.

The design performs more traditional road traffic accident remedies for high beam glare at night time; change light like high-low beam light, reduce speed, stop on the roadside, use CD and mirror for reflection, install additional power full light which is vehicle technology and enforcement. It was observed that:

- The high beam reduction system measured the opposite coming vehicles' light intensity which makes it easier for installation because it doesn’t need the manufacturers ECU data high beam light detection.
- The buzzer warns the driver when opposite coming vehicle light intensity in lux.
- The new system integrates with the existing old system and attaches in front of the driver's left side of the windshield.
- The design can warn the opposite coming vehicle with the per set of light intensity in lux.
- The lighting system passes through the new design computer-controlled system.

5.2. Recommendation

- In our country, there is no abiding law that regulates the intensity of lights in the vehicle, even though illuminating light is a major cause of road traffic accidents.
- For making the full circuit in a single PCB the full design should be sent to PCB makers and get the current designed PCB for the system instead of the breadboard that was used in the project.

- For making the design be implemented large quantity industries should participate in manufacturing this high beam reduction system for the mass production needed for implementing in all vehicles.
- Further researches would be very useful in solving additional problems successfully.
- This research could be used as a resource full of information for future researches and if funded it could solve a lot of RTAs during night time.
- I strongly recommended this device install for all vehicles when came to annual inspection.
- Finally, for better functionality, the sensor will be attached to the base of the windscreen.

REFERENCE

Al-Subhi, B., Hasoon, F. N., Fadhil, H. A., Manic, S., & Biju, R. (2019). Smart vehicle headlights control system. *AIP Conference Proceedings*, *2137*(August). https://doi.org/10.1063/1.5120994

Applications, A., & Applications, D. (n.d.). *Light Dependent Resistor - LDR*.

Arpita, K., Jain, A. M., & R, A. K. (2018). *Automated Headlight Intensity Control and Obstacle Alerting System*. *6*(13), 1–6.

Asaduzzaman, A. S. M., Islam, M. M., Paul, S., Alam, F., & Rahman, M. (2013). *Automatic High Beam Controller for Vehicles*. *4*(April 2013), 1–5.

Beam, L., & Beam, H. (n.d.). *Photometric Specification of Automotive Headlamp Photometric Specification of Automotive Headlamp*.

Bhatia, I. A. (2012). *Electrical Fundamentals - Introduction to Batteries*. *233*.

Boyce, P. R. (2019). The benefits of light at night. *Building and Environment*, *151*(December 2018), 356–367. https://doi.org/10.1016/j.buildenv.2019.01.020

Bullough, J. D. (2015). *High-Beam Intensity , Visual Performance and Safety-Related Impacts*. (October), 1–12.

Chen, Y. S., & Chiu, S. C. (2018). New method of automatic control for vehicle headlights. *Optik*, *157*, 718–723. https://doi.org/10.1016/j.ijleo.2017.11.137

Chenani, S. B., Vaaja, M. T., & Kurkela, M. (2017). *Target detection distances under different road lighting intensities*. https://doi.org/10.1007/s12544-017-0234-z

Chrysler, S. T., Carlson, P. J., & Hawkins, H. G. (2003). *HEADLAMP ILLUMINATION PROVIDED TO SIGN POSITIONS*. *7*(2).

Ciffee, R., Sudha, G., Saranya, S., & Karthick Thyagesh, G. (2021). Zigbee based automation systems for homes with the deployment of smart sensors. *Materials Today: Proceedings*, (xxxx). https://doi.org/10.1016/j.matpr.2021.01.043

Data, R. U. S. A., Nigro, A. M., & Plains, W. (2007). *(12) Patent Application Publication (10) Pub. No.: US 2007/0008093 A1*. *1*(19).

De Santos-Berbel, C., & Castro, M. (2019). Effect of vehicle swiveling headlamps and highway geometric design on nighttime sight distance. *Mathematics and*

Computers in Simulation, (xxxx). https://doi.org/10.1016/j.matcom.2019.08.012

Denton, T. (2007). Automobile Electrical and Electronic Systems. *Automobile Electrical and Electronic Systems*. https://doi.org/10.4324/9780080492490

Friedland, H. T. (2012). *The Effectiveness of Glare-Obscuring Glasses on Nighttime Driving Performance*.

Hwang, A. D., & Peli, E. (2013). Development of a headlight glare simulator for a driving simulator. *Transportation Research Part C*, *32*, 129–143. https://doi.org/10.1016/j.trc.2012.09.003

Information, T. (n.d.). *LIGHTING THE FUTURE STANDARD AND HIGH PERFORMANCE AUTOMOTIVE HALOGEN BULBS Standard and High Performance*.

Journal, I., & Special, T. (2016). *Automatic Headlight Dipper with Respect to Upcoming Vehicles Response*. *7*(2), 169–172.

kumar Jayam, Y., Tunuguntla, V., Sreehari, J. B., & Harinarayanan, S. (2021). Artificial photosynthesis using LDR controlled solar relay circuit. *Materials Today: Proceedings*, (xxxx). https://doi.org/10.1016/j.matpr.2020.11.1020

Lakshmi, K., Nevetha, R., Ilakkiya, S. N., & Ganesan, R. (2019). *Automatic Vehicle Headlight Management System to Prevent Accidents Due To Headlight Glare*. (9), 757–760. https://doi.org/10.35940/ijitee.G5807.078919

Madupoju, S. K., Satya, V., Teja, S., Thangadurai, N., Basavaraj, H., Sure, A. S., & Eda, A. R. (2021). Materials Today : Proceedings Diode Modelling of Rectifier for Mobile Charging Unit with Emission Coefficient Analysis. *Materials Today: Proceedings*, (xxxx). https://doi.org/10.1016/j.matpr.2021.01.505

Methods, S. (2013). *Lecture 14 两因素方差分析*. 1–20.

Mikoski, P., Zlupko, G., & Owens, D. A. (2019a). Drivers' assessments of the risks of distraction, poor visibility at night, and safety-related behaviors of themselves and other drivers. *Transportation Research Part F: Traffic Psychology and Behaviour*, *62*, 416–434. https://doi.org/10.1016/j.trf.2019.01.011

Mikoski, P., Zlupko, G., & Owens, D. A. (2019b). Drivers ' assessments of the risks of distraction , poor visibility at night , and safety-related behaviors of themselves

and other drivers. *Transportation Research Part F: Psychology and Behaviour*, *62*, 416–434. https://doi.org/10.1016/j.trf.2019.01.011

Prasetijo, J., Jawi, Z. M., Mustafa, M. A., Zadie, Z., Majid, H. A., & Roslan, M. H. (2018). *Impacts of Various High Beam Headlight Intensities on Driver Visibility and Road Safety*. *2*(3), 306–314.

ROAD TRANSPORT LIGHTING FOR DEVELOPING COUNTRIES. (2007).

S, K. U. (2016). Raspberry Pi and Wifi Based Home Automation Server. *International Journal of Advance Engineering and Research Development*, *3*(02), 25–30. https://doi.org/10.21090/ijaerd.030217

Sataloff, R. T., Johns, M. M., & Kost, K. M. (n.d.). *No 主観的健康感を中心とした在宅高齢者における 健康関連指標に関する共分散構造分析Title*.

Service, V. (n.d.). *Lighting Systems*.

Sharma, A., Kumar, R., & Mansotra, V. (2016). Proposed Stemming Algorithm for Hindi Information Retrieval. *International Journal of Innovative Research in Computer and Communication Engineering (An ISO Certified Organization)*, *3297*(6), 11449–11455. https://doi.org/10.15680/IJIRCCE.2016

Sourav, C. P., Karthika, K. A., Saju, A., & Gayathri, T. (2019). *Automatic Headlight Intensity Controller*. *7*(V), 1592–1595.

Sudhan, R. H., Kumar, M. G., Prakash, A. U., Devi, S. A. R., & P., S. (2015). Arduino Atmega-328 Microcontroller. *Ijireeice*, *3*(4), 27–29. https://doi.org/10.17148/ijireeice.2015.3406

Varudharajulu, A. K., & Ma, Y. (2018). A Survey on Big Data Process Models for E-Business, E-Management, E-Learning, and E-Education. *International Journal of Innovative Research in Computer and Communication Engineering*, 8825–8828. https://doi.org/10.15680/IJIRCCE.2018

Verifikasi, D. A. N., Jari, C. A. P., & Sulong, G. B. I. N. (2005). *Design and Development of an Automatic Fingerprint Verification System*. (8), 107–112.

You, A., Be, M. A. Y., & In, I. (2018). *Analysis of battery consumption of Gentayu electric car on different types of headlight Analysis of Battery Consumption of Gentayu Electric Car on Different Types of Headlight*. *060009*(June).

Appendix I; Questionnaire

Adama University Of Science And Technology

School Of Mechanical, Material And Chemical Engineering

Department Of Mechanical System And Vehicle Engineering (MSc in Automotive engineering)

Questionnaire to be answered by Vehicle drivers

Dear Respondents:

The information in this questionnaire is for educational purposes only and I respectfully request that you place the answer in the box next to the options "√" and in the space provided.

Thank you in advance for taking the time to complete this questionnaire.

Background information of respondent

1) Gender：male ☐ female ☐

2) Age：20-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐ 61> ☐

3) Marital status: Are you married? Yes ☐ No ☐

If yes, how many families do you have? 2-3 ☐ 4-5 ☐ ≥6 ☐

4) What kind of vehicle driver are you?

1) Heavy-duty vehicle ☐

2) Lightweight vehicle ☐

5) Road length status

A) Long-distance driver not per kilometer (km)?

100 -150 ☐ 151-200 ☐ 251-300 ☐ 350≥ ☐

B) Short-distance driver not per kilometer (km)?

20 -50 51-80 81-100

6) How long did you spend working as a driver? ----------

7) Do you drive at night? If so, how many hours do you drive? ----------

8) What do you do to avoid falling asleep while driving at night?

A) Do you pick khat? Yes ☐ no ☐

If yes, why? 1-2 ☐ 3-4 ☐ 5-6 ☐

B) Do you drink alcohol? Yes ☐ no ☐

Occasionally ☐ regularly ☐

C) Do you get enough sleep? Yes ☐ no ☐

If yes, for what range? 1 hrs ☐ 2hrs ☐ 3 hrs ☐ 4 hrs ☐ ≥ 5 hrs ☐

9) Do you find it difficult to see at night when driving in the opposite direction?

Yes ☐ no ☐

If your answer is yes, how do you handle the long light coming in the opposite direction (what kind of solution)?

---

10) Do you have a problem with this High beam?

Appendix II; Timestamp (ms) VS Illuminance (Lux)

S.N	Timestamp (ms)	Illuminance (Lux)	S.N	Timestamp (ms)	Illuminance (Lux)
1	1620577618206	3.75	41	1620577619974	6.116
2	1620577618207	3.75	42	1620577619976	6.116
3	1620577618208	3.75	43	1620577619981	6.116
4	1620577618209	3.75	44	1620577619983	6.116
5	1620577618354	3.7252	45	1620577620151	6.6312
6	1620577618355	3.7252	46	1620577620152	6.6312
7	1620577618356	3.7252	47	1620577620160	6.6312
8	1620577618357	3.7252	48	1620577620161	6.6312
9	1620577618534	3.6538	49	1620577620332	6.1904
10	1620577618535	3.6538	50	1620577620334	6.1904
11	1620577618537	3.6538	51	1620577620339	6.1904
12	1620577618537	3.6538	52	1620577620342	6.1904
13	1620577618717	3.688	53	1620577620511	6.6188
14	1620577618719	3.688	54	1620577620513	6.6188
15	1620577618725	3.688	55	1620577620517	6.6188
16	1620577618727	3.688	56	1620577620518	6.6188
17	1620577618898	2.7444	57	1620577620689	6.1532
18	1620577618901	2.7444	58	1620577620691	6.1532
19	1620577618906	2.7444	59	1620577620694	6.1532
20	1620577618908	2.7444	60	1620577620695	6.1532
21	1620577619078	3.1852	61	1620577620871	6.5816
22	1620577619081	3.1852	62	1620577620874	6.5816
23	1620577619085	3.1852	63	1620577620880	6.5816
24	1620577619088	3.1852	64	1620577620882	6.5816
25	1620577619255	5.045	65	1620577621051	6.1874
26	1620577619259	5.045	66	1620577621055	6.1874
27	1620577619264	5.045	67	1620577621060	6.1874
28	1620577619265	5.045	68	1620577621062	6.1874
29	1620577619435	6.6436	69	1620577621230	5.88
30	1620577619438	6.6436	70	1620577621234	5.88
31	1620577619444	6.6436	71	1620577621239	5.88
32	1620577619445	6.6436	72	1620577621240	5.88
33	1620577619614	6.1408	73	1620577621410	3.6854
34	1620577619617	6.1408	74	1620577621414	3.6854
35	1620577619622	6.1408	75	1620577621419	3.6854
36	1620577619624	6.1408	76	162057762142	3.6854
37	1620577619794	6.594	77	1620577621588	3.614
38	1620577619797	6.594	78	1620577621592	3.614
39	1620577619802	6.594	79	1620577621597	3.614
40	1620577619804	6.594	80	1620577621598	3.614

81	1620577621767	5.3678	121	1620577623564	7.7706
82	1620577621769	5.3678	122	1620577623568	7.7706
83	1620577621773	5.3678	123	1620577623574	7.7706
84	1620577621774	5.3678	124	1620577623576	7.7706
85	1620577621947	3.3438	125	1620577623744	7.7954
86	1620577621949	3.3438	126	1620577623748	7.7954
87	1620577621953	3.3438	127	1620577623753	7.7954
88	1620577621954	3.3438	128	1620577623754	7.7954
89	1620577622127	3.4802	129	1620577623924	7.3422
90	1620577622130	3.4802	130	1620577623928	7.3422
91	1620577622133	3.4802	131	1620577623934	7.3422
92	1620577622134	3.4802	132	1620577623935	7.3422
93	1620577622308	3.4554	133	1620577624098	7.7736
94	1620577622312	3.4554	134	1620577624099	7.7736
95	1620577622317	3.4554	135	1620577624101	7.7736
96	1620577622318	3.4554	136	1620577624101	7.7736
97	1620577622487	3.3438	137	1620577624278	7.305
98	1620577622491	3.3438	138	1620577624279	7.305
99	1620577622495	3.3438	139	1620577624280	7.305
100	1620577622497	3.3438	140	1620577624280	7.305
101	1620577622667	3.2694	141	1620577624458	7.0472
102	1620577622671	3.2694	142	1620577624458	7.0472
103	1620577622677	3.2694	143	1620577624459	7.0472
104	1620577622678	3.2694	144	1620577624460	7.0472
105	1620577622846	5.2934	145	1620577624642	6.2122
106	1620577622850	5.2934	146	1620577624645	6.2122
107	1620577622856	5.2934	147	1620577624650	6.2122
108	1620577622857	5.2934	148	1620577624652	6.2122
109	1620577623027	6.8518	149	1620577624818	6.2122
110	1620577623032	6.8518	150	1620577624819	6.2122
111	1620577623037	6.8518	151	1620577624824	6.2122
112	1620577623038	6.8518	152	1620577624825	6.2122
113	1620577623203	6.8518	153	1620577625002	4.4118
114	1620577623205	6.8518	154	1620577625005	4.4118
115	1620577623207	6.8518	155	1620577625011	4.4118
116	1620577623207	6.8518	156	1620577625013	4.4118
117	1620577623385	7.7458	157	1620577625181	4.03
118	1620577623389	7.7458	158	1620577625185	4.03
119	1620577623394	7.7458	159	1620577625190	4.03
120	1620577623396	7.7458	160	1620577625192	4.03
161	1620577625360	4.8278	201	1620577627160	6.948

162	1620577625364	4.8278	202	1620577627166	6.948
163	1620577625369	4.8278	203	1620577627168	6.948
164	1620577625370	4.8278	204	1620577627336	6.9604
165	1620577625540	3.4058	205	1620577627340	6.9604
166	1620577625543	3.4058	206	1620577627346	6.9604
167	1620577625548	3.4058	207	1620577627349	6.9604
168	1620577625550	3.4058	208	1620577627517	8.1152
169	1620577625720	3.4926	209	1620577627521	8.1152
170	1620577625724	3.4926	210	1620577627527	8.1152
171	1620577625729	3.4926	211	1620577627528	8.1152
172	1620577625730	3.4926	212	1620577627698	8.4722
173	1620577625899	3.8094	213	1620577627703	8.4722
174	1620577625903	3.8094	214	1620577627709	8.4722
175	1620577625908	3.8094	215	1620577627709	8.4722
176	1620577625910	3.8094	216	1620577627875	8.1742
177	1620577626078	3.3438	217	1620577627878	8.1742
178	1620577626081	3.3438	218	1620577627883	8.1742
179	1620577626086	3.3438	219	1620577627884	8.1742
180	1620577626087	3.3438	220	1620577628054	8.0656
181	1620577626258	3.4926	221	1620577628057	8.0656
182	1620577626261	3.4926	222	1620577628062	8.0656
183	1620577626265	3.4926	223	1620577628063	8.0656
184	1620577626267	3.4926	224	1620577628234	8.4598
185	1620577626438	3.4554	225	1620577628238	8.4598
186	1620577626442	3.4554	226	1620577628243	8.4598
187	1620577626447	3.4554	227	1620577628245	8.4598
188	1620577626619	5.2438	228	1620577628414	8.435
189	1620577626622	5.2438	229	1620577628417	8.435
190	1620577626627	5.2438	230	1620577628423	8.435
191	1620577626628	5.2438	231	1620577628425	8.435
192	1620577626798	5.697	232	1620577628593	8.9006
193	1620577626802	5.697	233	1620577628597	8.9006
194	1620577626807	5.697	234	1620577628602	8.9006
195	1620577626808	5.697	235	1620577628603	8.9006
196	1620577626977	6.532	236	1620577628772	8.9224
197	1620577626981	6.532	237	1620577628775	8.9224
198	1620577626985	6.532	238	1620577628780	8.9224
199	1620577626987	6.532	239	1620577628782	8.9224
200	1620577627157	6.948	240	1620577628952	8.9006
241	1620577628954	8.9006	281	1620577630753	10.0524
242	1620577628960	8.9006	282	1620577630758	10.0524
243	1620577628961	8.9006	283	1620577630759	10.0524
244	1620577629132	8.5188	284	1620577630927	10.3226
245	1620577629134	8.5188	285	1620577630931	10.3226
246	1620577629139	8.5188	286	1620577630936	10.3226

247	1620577629139	8.5188	287	1620577630938	10.3226
248	1620577629312	8.494	288	1620577631107	9.624
249	1620577629316	8.494	289	1620577631110	9.624
250	1620577629321	8.494	290	1620577631115	9.624
251	1620577629322	8.494	291	1620577631117	9.624
252	1620577629491	8.6274	292	1620577631284	10.3598
253	1620577629494	8.6274	293	1620577631287	10.3598
254	1620577629499	8.6274	294	1620577631292	10.3598
255	1620577629500	8.6274	295	1620577631293	10.3598
256	1620577629670	8.1618	296	1620577631464	10.4218
257	1620577629673	8.1618	297	1620577631466	10.4218
258	1620577629678	8.1618	298	1620577631470	10.4218
259	1620577629680	8.1618	299	1620577631471	10.4218
260	1620577629845	9.3414	300	1620577631643	10.8284
261	1620577629846	9.3414	301	1620577631645	10.8284
262	1620577629848	9.3414	302	1620577631649	10.8284
263	1620577629848	9.3414	303	1620577631650	10.8284
264	1620577630029	7.659	304	1620577631823	11.2568
265	1620577630033	7.659	305	1620577631825	11.2568
266	1620577630038	7.659	306	1620577631829	11.2568
267	1620577630039	7.659	307	1620577631831	11.2568
268	1620577630209	6.765	308	1620577632004	11.2196
269	1620577630213	6.765	309	1620577632011	11.2196
270	1620577630218	6.765	310	1620577632015	11.2196
271	1620577630220	6.765	311	1620577632017	11.2196
272	1620577630389	9.2794	312	1620577632185	10.4188
273	1620577630392	9.2794	313	1620577632189	10.4188
274	1620577630397	9.2794	314	1620577632194	10.4188
275	1620577630399	9.2794	315	1620577632195	10.4188
276	1620577630569	9.2174	316	1620577632361	10.518
277	1620577630574	9.2174	317	1620577632364	10.518
278	1620577630579	9.2174	318	1620577632369	10.518
279	1620577630580	9.2174	319	1620577632369	10.518
280	1620577630750	10.0524	320	1620577632543	10.5056
321	1620577632546	10.5056	361	1620577634336	6.52
322	1620577632551	10.5056	362	1620577634338	6.52
323	1620577632553	10.5056	363	1620577634339	6.52
324	1620577632718	10.518	364	1620577634519	9.0096
325	1620577632719	10.518	365	1620577634522	9.0096
326	1620577632721	10.518	366	1620577634528	9.0096
327	1620577632722	10.518	367	1620577634529	9.0096
328	1620577632903	10.813	368	1620577634699	11.94
329	1620577632907	10.813	369	1620577634703	11.94
330	1620577632913	10.813	370	1620577634708	11.94
331	1620577632915	10.813	371	1620577634709	11.94

332	1620577633082	11.1452	372	1620577635068	12.4428
333	1620577633087	11.1452	373	1620577634878	11.288
334	1620577633092	11.1452	374	1620577634882	11.288
335	1620577633094	11.1452	375	1620577634887	11.288
336	1620577633262	10.9464	376	1620577634889	11.288
337	1620577633266	10.9464	377	1620577635057	12.4428
338	1620577633271	10.9464	378	1620577635061	12.4428
339	1620577633272	10.9464	379	1620577635066	12.4428
340	1620577633438	10.4932	380	1620577635068	12.4428
341	1620577633440	10.4932	381	1620577635237	12.6044
342	1620577633442	10.4932	382	1620577635242	12.6044
343	1620577633443	10.4932	383	1620577635247	12.6044
344	1620577633620	10.8968	384	1620577635248	12.6044
345	1620577633624	10.8968	385	1620577635416	12.949
346	1620577633629	10.8968	386	1620577635420	12.949
347	1620577633630	10.8968	387	1620577635425	12.949
348	1620577633800	10.4684	388	1620577635426	12.949
349	1620577633803	10.4684	389	1620577635596	13.8926
350	1620577633809	10.4684	390	1620577635599	13.8926
351	1620577633810	10.4684	391	1620577635604	13.8926
352	1620577633982	10.4312	392	1620577635605	13.8926
353	1620577633985	10.4312	393	1620577635776	13.8708
354	1620577633991	10.4312	394	1620577635779	13.8708
355	1620577633992	10.4312	395	1620577635784	13.8708
356	1620577634160	11.6822	396	1620577635786	13.8708
357	1620577634167	11.6822	397	1620577635955	14.3458
358	1620577634178	11.6822	398	1620577635959	14.3458
359	1620577634179	11.6822	399	1620577635964	14.3458
360	1620577634335	6.52	400	1620577635965	14.3458
401	1620577636134	14.262	441	1620577637928	14.4668
402	1620577636137	14.262	442	1620577637931	14.4668
403	1620577636143	14.262	443	1620577637934	14.4668
404	1620577636144	14.262	444	1620577637935	14.4668
405	1620577636314	13.4642	445	1620577638108	14.1098
406	1620577636318	13.4642	446	1620577638110	14.1098
407	1620577636323	13.4642	447	1620577638115	14.1098
408	1620577636324	13.4642	448	1620577638116	14.1098
409	1620577636494	13.7934	449	1620577638288	13.9952
410	1620577636499	13.7934	450	1620577638290	13.9952
411	1620577636503	13.7934	451	1620577638294	13.9952
412	1620577636504	13.7934	452	1620577638295	13.9952
413	1620577636673	14.138	453	1620577638467	9.2768
414	1620577636677	14.138	454	1620577638470	9.2768
415	1620577636682	14.138	455	1620577638473	9.2768
416	1620577636683	14.138	456	1620577638474	9.2768

417	1620577636853	15.1064	457	1620577638647	8.9848
418	1620577636856	15.1064	458	1620577638649	8.9848
419	1620577636861	15.1064	459	1620577638653	8.9848
420	1620577636862	15.1064	460	1620577638655	8.9848
421	1620577637033	15.3766	461	1620577638828	9.9536
422	1620577637036	15.3766	462	1620577638832	9.9536
423	1620577637044	15.3766	463	1620577638837	9.9536
424	1620577637046	15.3766	464	1620577638838	9.9536
425	1620577637212	15.3146	465	1620577639008	12.0024
426	1620577637215	15.3146	466	1620577639011	12.0024
427	1620577637221	15.3146	467	1620577639016	12.0024
428	1620577637222	15.3146	468	1620577639017	12.0024
429	1620577637392	14.7742	469	1620577639188	15.1282
430	1620577637396	14.7742	470	1620577639191	15.1282
431	1620577637401	14.7742	471	1620577639197	15.1282
432	1620577637402	14.7742	472	1620577639198	15.1282
433	1620577637571	13.728	473	1620577639365	16.342
434	1620577637575	13.728	474	1620577639368	16.342
435	1620577637580	13.728	475	1620577639373	16.342
436	1620577637582	13.728	476	1620577639374	16.342
437	1620577637752	13.5976	477	1620577639547	10.0032
438	1620577637755	13.5976	478	1620577639550	10.0032
439	1620577637759	13.5976	479	1620577639557	10.0032
440	1620577637760	13.5976	480	1620577639558	10.0032
481	1620577639723	9.6462	521	1620577641522	11.4748
482	1620577639726	9.6462	522	1620577641525	11.4748
483	1620577639729	9.6462	523	1620577641530	11.4748
484	1620577639730	9.6462	524	1620577641531	11.4748
485	1620577639905	12.4556	525	1620577641702	13.6818
486	1620577639908	12.4556	526	1620577641705	13.6818
487	1620577639914	12.4556	527	1620577641710	13.6818
488	1620577639915	12.4556	528	1620577641712	13.6818
489	1620577640085	10.8322	529	1620577641881	17.4224
490	1620577640089	10.8322	530	1620577641885	17.4224
491	1620577640094	10.8322	531	1620577641891	17.4224
492	1620577640095	10.8322	532	1620577641893	17.4224
493	1620577640264	9.6432	533	1620577642060	11.9652
494	1620577640268	9.6432	534	1620577642065	11.9652
495	1620577640273	9.6432	535	1620577642070	11.9652
496	1620577640274	9.6432	536	1620577642073	11.9652
497	1620577640440	10.028	537	1620577642240	10.2264
498	1620577640443	10.028	538	1620577642244	10.2264
499	1620577640449	10.028	539	1620577642249	10.2264
500	1620577640451	10.028	540	1620577642250	10.2264
501	1620577640624	9.6116	541	1620577642417	10.707

502	1620577640628	9.6116	542	1620577642419	10.707
503	1620577640634	9.6116	543	1620577642422	10.707
504	1620577640635	9.6116	544	1620577642423	10.707
505	1620577640804	10.2978	545	1620577642598	10.5886
506	1620577640809	10.2978	546	1620577642602	10.5886
507	1620577640814	10.2978	547	1620577642608	10.5886
508	1620577640815	10.2978	548	1620577642609	10.5886
509	1620577640983	10.1614	549	1620577642779	9.3252
510	1620577640987	10.1614	550	1620577642782	9.3252
511	1620577640992	10.1614	551	1620577642788	9.3252
512	1620577640993	10.1614	552	1620577642789	9.3252
513	1620577641163	10.0528	553	1620577642959	10.1572
514	1620577641166	10.0528	554	1620577642968	10.1572
515	162057764117	10.0528	555	1620577642968	10.1572
516	1620577641172	10.0528	556	1620577642969	10.1572
517	1620577641342	9.966	557	1620577643134	11.1358
518	1620577641345	9.966	558	1620577643135	11.1358
519	1620577641350	9.966	559	1620577643136	11.1358
520	1620577641352	9.966	560	1620577643137	11.1358
561	1620577643315	13.1696	601	1620577645113	20.2292
562	1620577643317	13.1696	602	162057764511	20.2292
563	16205776433	13.1696	603	1620577645123	20.2292
564	1620577643322	13.1696	604	1620577645124	20.2292
565	1620577643495	19.8128	605	1620577645293	16.442
566	1620577643497	19.8128	606	1620577645296	16.442
567	1620577643500	19.8128	607	1620577645302	16.442
568	1620577643501	19.8128	608	1620577645303	16.442
569	1620577643674	22.4174	609	1620577645474	16.923
570	1620577643677	22.4174	610	1620577645478	16.923
571	1620577643681	22.4174	611	1620577645483	16.923
572	1620577643682	22.4174	612	1620577645483	16.923
573	1620577643854	21.1198	613	1620577645653	20.0684
574	1620577643856	21.1198	614	1620577645656	20.0684
575	1620577643860	21.1198	615	1620577645661	20.0684
576	1620577643861	21.1198	616	1620577645662	20.0684
577	1620577644035	20.5644	617	1620577645832	19.8978
578	1620577644038	20.5644	618	1620577645834	19.8978
579	1620577644044	20.5644	619	1620577645840	19.8978
580	1620577644045	20.5644	620	1620577645841	19.8978
581	1620577644215	20.7008	621	1620577646011	19.0616
582	1620577644218	20.7008	622	1620577646014	19.0616
583	1620577644223	20.7008	623	1620577646019	19.0616
584	1620577644224	20.7008	624	1620577646020	19.0616
585	1620577644394	20.7752	625	1620577646191	20.1142
586	1620577644399	20.7752	626	1620577646194	20.1142

587	1620577644404	20.7752	627	1620577646199	20.1142
588	1620577644405	20.7752	628	1620577646200	20.1142
589	1620577644575	22.7466	629	1620577646370	20.1364
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591	162057764458	22.7466	631	1620577646379	20.1364
592	1620577644584	22.7466	632	1620577646380	20.1364
593	1620577644754	24.1126	633	1620577646550	20.617
594	1620577644757	24.1126	634	1620577646553	20.617
595	1620577644763	24.1126	635	1620577646559	20.617
596	1620577644764	24.1126	636	1620577646560	20.617
597	1620577644933	23.9758	637	1620577646729	20.7658
598	1620577644936	23.9758	638	1620577646733	20.7658
599	1620577644941	23.9758	639	1620577646738	20.7658
600	1620577644943	23.9758	640	1620577646740	20.7658
641	1620577646909	23.0266	681	1620577648705	27.8328
642	1620577646913	23.0266	682	1620577648709	27.8328
643	1620577646918	23.0266	683	1620577648714	27.8328
644	1620577646919	23.0266	684	1620577648717	27.8328
645	1620577647088	23.5418	685	1620577648884	27.8576
646	1620577647093	23.5418	686	1620577648888	27.8576
647	162057764709	23.5418	687	1620577648893	27.8576
648	1620577647099	23.5418	688	1620577648895	27.8576
649	1620577647268	22.9716	689	1620577649064	27.5532
650	1620577647272	23.9716	690	1620577649067	27.5532
651	1620577647278	22.9716	691	1620577649072	27.5532
652	1620577647279	22.9716	692	1620577649073	27.5532
653	1620577647449	23.907	693	1620577649244	25.3462
654	1620577647452	23.907	694	1620577649248	25.3462
655	1620577647457	23.907	695	1620577649253	25.3462
656	1620577647459	23.907	696	1620577649254	25.3462
657	1620577647628	24.804	697	1620577649423	26.5972
658	1620577647631	24.804	698	1620577649427	26.5972
659	1620577647636	24.804	699	1620577649432	26.5972
660	1620577647638	24.804	700	1620577649433	26.5972
661	1620577647809	26.2534	701	1620577649603	29.0962
662	1620577647811	26.2534	702	1620577649606	29.0962
663	1620577647816	26.2534	703	1620577649611	29.0962
664	1620577647817	26.2534	704	1620577649612	29.0962
665	1620577647987	26.409	705	1620577649782	31.148
666	1620577647992	26.409	706	1620577649785	31.148
667	1620577647996	26.409	707	1620577649790	31.148
668	1620577647997	26.409	708	1620577649791	31.148
669	1620577648166	27.0978	709	1620577649962	31.8328
670	1620577648169	27.0978	710	1620577649965	31.8328
671	1620577648174	27.0978	711	1620577649970	31.8328

672	1620577648175	27.0978	712	1620577649972	31.8328
673	1620577648345	24.781	713	1620577650141	36.4864
674	1620577648349	24.781	714	1620577650145	36.4864
675	1620577648354	24.781	715	1620577650150	36.4864
676	1620577648356	24.781	716	1620577650152	36.4864
677	1620577648525	27.6562	717	1620577650321	37.1008
678	1620577648528	27.6562	718	1620577650324	37.1008
679	1620577648533	27.6562	719	1620577650330	37.1008
680	1620577648534	27.6562	720	1620577650331	37.1008
801	1620577654092	97.5808	841	1620577655888	128.4152
802	1620577654095	97.5808	842	1620577655892	128.4152
803	1620577654101	97.5808	843	1620577655897	128.4152
804	1620577654102	97.5808	844	1620577655898	128.4152
805	1620577654271	99.32	845	1620577656065	132.8736
806	1620577654276	99.32	846	1620577656067	132.8736
807	1620577654284	99.32	847	1620577656071	132.8736
808	1620577654285	99.32	848	1620577656072	132.8736
809	1620577654450	86.1448	849	1620577656244	136.2512
810	1620577654454	86.1448	850	1620577656247	136.2512
811	1620577654459	86.1448	851	1620577656251	136.2512
812	1620577654460	86.1448	852	1620577656252	136.2512
813	1620577654631	97.656	853	1620577656424	125.8088
814	1620577654635	97.656	854	1620577656427	125.8088
815	1620577654640	97.656	855	1620577656431	125.8088
816	1620577654641	97.656	856	1620577656432	125.8088
817	1620577654811	113.128	857	1620577656603	135.2336
818	1620577654814	113.128	858	1620577656606	135.2336
819	1620577654819	113.128	859	1620577656610	135.2336
820	1620577654821	113.128	860	1620577656611	135.2336
821	1620577654991	116.7912	861	1620577656785	150.9056
822	1620577654994	116.7912	862	1620577656789	150.9056
823	1620577654999	116.7912	863	1620577656794	150.9056
824	1620577655001	116.7912	864	1620577656795	150.9056
825	1620577655170	128.3056	865	16205776569608	159.0888
826	1620577655173	128.3056	866	1620577656961	159.0888
827	1620577655178	128.3056	867	1620577656962	159.0888
828	1620577655179	128.3056	868	1620577656963	159.0888
829	1620577655350	118.8808	869	1620577657139	168.9752
830	1620577655354	118.8808	870	1620577657140	168.9752
831	1620577655360	118.8808	871	1620577657140	168.9752
832	1620577655361	118.8808	872	1620577657141	168.9752
833	1620577655529	113.976	873	1620577657324	180.6712
834	1620577655532	113.976	874	1620577657328	180.6712
835	1620577655537	113.976	875	1620577657333	180.6712
836	1620577655538	113.976	876	1620577657334	180.6712

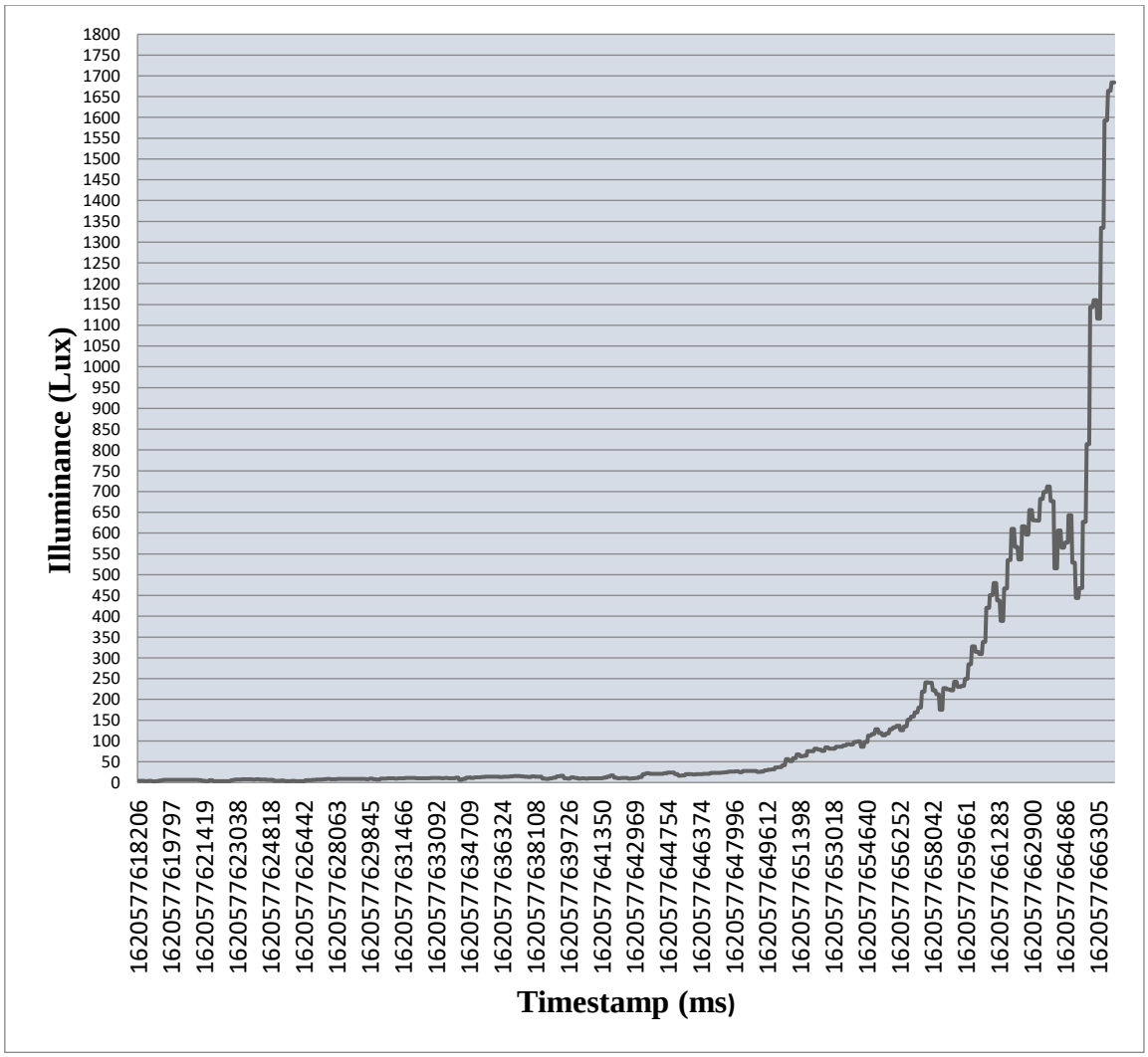
837	1620577655709	118.3576	877	1620577657503	218.3704
838	1620577655712	118.3576	878	1620577657507	218.3704
839	1620577655717	118.3576	879	1620577657511	218.3704
840	1620577655719	118.3576	880	1620577657513	218.3704

881	1620577657683	241.0096	921	1620577659479	232.4176
882	1620577657687	241.0096	922	1620577659482	232.4176
883	1620577657691	241.0096	923	1620577659487	232.4176
884	1620577657693	241.0096	924	1620577659488	232.4176
885	1620577657863	239.8192	925	1620577659658	249.032
886	1620577657867	239.8192	926	1620577659661	249.032
887	1620577657872	239.8192	927	1620577659666	249.032
888	1620577657873	239.8192	928	1620577659667	249.032
889	1620577658042	221.3304	929	1620577659833	284.5488
890	1620577658045	221.3304	930	1620577659834	284.5488
891	1620577658051	221.3304	931	1620577659835	284.5488
892	1620577658052	221.3304	932	1620577659836	284.5488
893	1620577658222	212.292	933	1620577660018	327.4144
894	1620577658225	212.292	934	1620577660020	327.4144
895	1620577658230	212.292	935	1620577660025	327.4144
896	1620577658232	212.292	936	1620577660027	327.4144
897	1620577658401	175.0768	937	1620577660197	314.4456
898	1620577658405	175.0768	938	1620577660200	314.4456
899	1620577658411	175.0768	939	1620577660205	314.4456
900	1620577658412	175.0768	940	1620577660206	314.4456
901	1620577658581	226.8064	941	1620577660376	308.9696
902	1620577658585	226.8064	942	1620577660379	308.9696
903	1620577658591	226.8064	943	1620577660385	308.9696
904	1620577658592	226.8064	944	1620577660386	308.9696
905	162057765876	223.952	945	1620577660556	338.176
906	1620577658763	223.952	946	1620577660559	338.176
907	1620577658768	223.952	947	1620577660564	338.176
908	1620577658769	223.952	948	16205776605666	338.176
909	1620577658940	221.544	949	1620577660735	420.4392
910	1620577658943	221.544	950	1620577660738	420.4392
911	1620577658948	221.544	951	1620577660744	420.4392
912	1620577658949	221.544	952	1620577660745	420.4392
913	162057765912	242.5504	953	1620577660915	451.0512
914	1620577659123	242.5504	954	1620577660918	451.0512
915	1620577659128	242.5504	955	1620577660923	451.0512
916	1620577659129	242.5504	956	162057766092412	451.0512
917	1620577659299	229.876	957	1620577661094	479.8656
918	1620577659302	229.876	958	1620577661098	479.8656

919	1620577659307	229.876	959	1620577661103	479.8656
920	1620577659308	229.876	960	1620577661104	479.8656

961	1620577661274	437.6144	1001	1620577663068	630.9112
962	1620577661277	437.6144	1002	1620577663070	630.9112
963	1620577661283	437.6144	1003	1620577663074	630.9112
964	1620577661284	437.6144	1004	1620577663075	630.9112
965	1620577661454	388.948	1005	1620577663249	629.9096
966	1620577661457	388.948	1006	1620577663254	629.9096
967	1620577661462	388.948	1007	1620577663259	629.9096
968	1620577661464	388.948	1008	1620577663261	629.9096
969	1620577661634	467.2672	1009	1620577663429	682.636
970	1620577661638	467.2672	1010	1620577663436	682.636
971	1620577661643	467.2672	1011	1620577663442	682.636
972	1620577661644	467.2672	1012	1620577663443	682.636
973	1620577661813	534.884	1013	1620577663608	699.1512
974	1620577661817	534.884	1014	1620577663612	699.1512
975	1620577661823	534.884	1015	1620577663617	699.1512
976	1620577661824	534.884	1016	1620577663618	699.1512
977	1620577661993	610.5304	1017	1620577663788	712.0936
978	1620577661995	610.5304	1018	1620577663792	712.0936
979	1620577662001	610.5304	1019	1620577663799	712.0936
980	1620577662001	610.5304	1020	1620577663801	712.0936
981	1620577662172	566.6104	1021	1620577663968	677.1592
982	1620577662176	566.6104	1022	1620577663971	677.1592
983	1620577662181	566.6104	1023	1620577663980	677.1592
984	1620577662182	566.6104	1024	1620577663982	677.1592
985	1620577662352	536.3472	1025	1620577664148	515.0216
986	1620577662355	536.3472	1026	1620577664151	515.0216
987	1620577662360	536.3472	1027	1620577664156	515.0216
988	1620577662361	536.3472	1028	1620577664157	515.0216
989	1620577662530	616.3576	1029	1620577664327	606.1208
990	1620577662534	616.3576	1030	1620577664330	606.1208
991	1620577662538	616.3576	1031	1620577664335	606.1208
992	1620577662539	616.3576	1032	1620577664337	606.1208
993	1620577662711	596.3712	1033	1620577664506	564.9768
994	1620577662714	596.3712	1034	1620577664509	564.9768
995	1620577662719	596.3712	1035	1620577664514	564.9768
996	1620577662720	596.3712	1036	1620577664515	564.9768
997	1620577662890	655.3944	1037	1620577664686	577.2392
998	1620577662894	655.3944	1038	1620577664690	577.2392
999	1620577662899	655.3944	1039	1620577664695	577.2392
1000	1620577662900	655.3944	1040	1620577664696	577.2392

1041	1620577664865	643.5608	1081	1620577666661	1592.404
1042	1620577664869	643.5608	1082	1620577666664	1592.404
1043	1620577664874	643.5608	1083	1620577666669	1592.404
1044	1620577664875	643.5608	1084	1620577666671	1592.404
1045	1620577665045	528.9632	1085	1620577666841	1664.1136
1046	1620577665048	528.9632	1086	1620577666844	1664.1136
1047	1620577665053	528.9632	1087	1620577666849	1664.1136
1048	1620577665054	528.9632	1088	1620577666850	1664.1136
1049	1620577665225	1444.22	1089	1620577667015	1684.1792
1050	1620577665228	1444.22	1090	1620577667015	1684.1792
1051	1620577665233	1444.22	1091	1620577667016	1684.1792
1052	1620577665234	1444.22	1092	1620577667016	1684.1792
1053	1620577665404	1467.8288			
1054	1620577665408	1467.8288			
1055	1620577665413	1467.8288			
1056	1620577665414	1467.8288			
1057	1620577665584	1627.036			
1058	1620577665588	1627.036			
1059	1620577665593	1627.036			
1060	1620577665594	627.036			
1061	1620577665764	813.8672			
1062	1620577665766	813.8672			
1063	1620577665771	813.8672			
1064	1620577665773	813.8672			
1065	1620577665943	1143.3503			
1066	1620577665946	1143.3503			
1067	1620577665951	1143.3503			
1068	1620577665952	1143.3503			
1069	1620577666123	1160.7968			
1070	1620577666125	1160.7968			
1071	1620577666130	1160.7968			
1072	1620577666132	1160.7968			
1073	1620577666302	1116.1425			
1074	1620577666305	1116.1425			
1075	1620577666312	1116.1425			
1076	1620577666313	1116.1425			
1077	1620577666482	1334.2625			
1078	1620577666485	1334.2625			
1079	1620577666490	1334.2625			
1080	1620577666492	1334.2625			


Illuminance (Lux)
1800
1750
1700
1650
1600
1550
1500
1450
1400
1350
1300
1250
1200
1150
1100
1050
1000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
1620577618206
1620577619797
1620577621419
1620577623038
1620577624818
1620577626442
1620577628063
1620577629845
1620577631466
1620577633092
1620577634709
1620577636324
1620577638108
1620577639726
1620577641350
1620577642969
1620577644754
1620577646374
1620577647996
1620577649612
1620577651398
1620577653018
1620577654640
1620577656252
1620577658042
1620577659661
1620577661283
1620577662900
1620577664686
1620577666305
Timestamp (ms)

Appendix III; Arduino sketch for High beam to low beam

```
/*This program sketch reads an interrupt pin from PIN number 1 which is a hardware interrupt
    pin from LDR and measures the time pulses which are used to calculate the voltage
    output of LDR With this reference the program compares the calculated light intensity
    vehicle headlight.
  *The first condition checks if the system is on or off
  * If the system is on it will check if there is any signal in the light detecting resistor
  * If the system detects an oncoming vehicle while the high beam is on it will enable the
    buffer for some time
  * if the driver does not respond it will change the light from high beam to low beam by
    activating relay1
  * If there is a vehicle incoming and high beam is one it will turn on the first led
  * If the incoming vehicle dose not responded it will flash yellow light.
   * If the incoming vehicle does not responded with yellow light  red light flash to warn
    the opposite coming vehicle.
bool state_lock =  true;
bool BLINK = false;
bool manual_mode = true;
bool state2 = true;
bool state3 = true;
bool state4 = true;
bool blink_state = false;
bool red_light = false;
bool buzzer_state = true;

int ldr_state = 1;
void setup() {
  Serial.begin(9600);
  pinMode(13,OUTPUT);
  pinMode(12,OUTPUT);
  pinMode(11,OUTPUT);
  pinMode(10,OUTPUT);
  pinMode(2,OUTPUT);
  pinMode(3,OUTPUT);
  pinMode(A1,INPUT);
}
```

```
void loop() {
  int power = digitalRead(A1);
  int temp = analogRead(A3);
  temp = map(temp,0,1023,0,90);
  bool LOW_BEAM = 0;
  bool HIGH_BEAM = 0;
  bool PARKING_LIGHT = 0;
  bool OFF = 1;

 if(temp >= 20 && temp <= 30){
    LOW_BEAM = 1;
 }else if(temp >= 30 && temp <= 60){
    PARKING_LIGHT = 1;
 }else if(temp >= 60 && temp <= 90){
    HIGH_BEAM = 1;
 }else{
     OFF =1;
 }

 if(LOW_BEAM == HIGH){
   analogWrite(6,0);
   buzzer_state = true;
  }else{
   if(buzzer_state == true){
      buzzer_state = false;
      state3 = true;
   }
  }

  if(power == HIGH ){
    state_lock = true;
    int ldr = analogRead(A0);
    Serial.println(ldr);
    if (ldr_state != ldr){
```

```
     ldr_state = ldr;
}
if(ldr <= 0.00802){
    digitalWrite(2,LOW);
    digitalWrite(3,LOW);
    analogWrite(6,0);
    blink_state = false;
    state3 = true;
}else if(ldr >= 0.00802 &&  ldr <= 0.667 ){
   manual_mode = true;
   state2 = true;
   state4 = true;
   red_light = false;
   if(state3 == true){
       state3 = false;
       blink_state = false;
           digitalWrite(3,LOW);
           Serial.println(ldr);
           delay(100);
           Serial.println("Car detected");
           Serial.println("Buzzer on");
           Serial.println(" ");
           analogWrite(6,120);

   }
}else if(ldr > 0.667  && ldr <= 1){
   manual_mode = false;
   red_light = false;
   digitalWrite(3,LOW);
   if(state2 == true){
       state2 = false;
       state3 = true;
       state4 = true;

       blink_state = true;
```

```
      Serial.println(ldr);
      delay(100);
      Serial.println("the car is close !!");
      Serial.println("The light system changed from high_beam to low_beam
  automaticaly !!");
      if(HIGH_BEAM == HIGH){
         digitalWrite(12,HIGH);
         digitalWrite(11,LOW);
         digitalWrite(10,LOW);
         digitalWrite(13,LOW);
      }
      Serial.println("warnning light on !!");
      Serial.println(" ");

  analogWrite(6,0);
  }
}else if(ldr > 1 ){
   if(state4 == true){
      state4 = false;
      Serial.println(ldr);
      delay(100);
      Serial.println("the car is very close !!");
      Serial.println("red light on..");
   }
    red_light = true;
}
if(blink_state == true){
     if(BLINK == true){
        BLINK = false;
        digitalWrite(2,HIGH);
        if(red_light == true){
          digitalWrite(3,HIGH);
        }
        delay(100);
      }else{
```

```
            BLINK = true;
            digitalWrite(2,LOW);
            if(red_light == true){
              digitalWrite(3,LOW);
            }
            delay(100);
          }
      }

if(manual_mode == true){

  if(LOW_BEAM == HIGH){
    digitalWrite(12,LOW);
    digitalWrite(11,LOW);
    digitalWrite(10,LOW);
    digitalWrite(13,HIGH);
  }else if(PARKING_LIGHT == HIGH){
     digitalWrite(13,LOW);
     digitalWrite(10,LOW);
     digitalWrite(12,HIGH);
     digitalWrite(11,HIGH);
  }else if(HIGH_BEAM == HIGH){
     digitalWrite(13,LOW);
     digitalWrite(10,HIGH);
     digitalWrite(12,HIGH);
     digitalWrite(11,LOW);
     digitalWrite(2,LOW);
     digitalWrite(3,LOW);
  }else if(OFF == HIGH){
     digitalWrite(13,LOW);
     digitalWrite(10,LOW);
     digitalWrite(12,LOW);
     digitalWrite(11,LOW);
     digitalWrite(2,LOW);
     digitalWrite(3,LOW);
```

```
  }
}
}else{
    if( state_lock){
        state_lock = false;
        Serial.println("the power is switch off");
        digitalWrite(13,LOW);
        digitalWrite(10,LOW);
        digitalWrite(12,LOW);
        digitalWrite(11,LOW);
        digitalWrite(2,LOW);
        digitalWrite(3,LOW);
    }
  }
}
```

Appendix IV; Circuit Diagram of Newly Developed System