Design and Construction of an Anti – Collision Prototype for Vehicles

BY

OFODU ANTHONY MELVIN
2001/12065EE

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE BACHELORS OF ENGINEERING DEGREE IN THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING.
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA
NIGER STATE

NOVEMBER, 2007.

DECLARATION

I, OFODU ANTHONY MELVIN hereby declare that this project [Anti-collision detection device] was constructed by me under the care of Engr.BALA SALIHU,a lecturer in the department of Electrical and Computer Engineering, Federal University of Technology, Minna.

OFODU ANTHONY MELVIN

(Name of Student)

04/12/07

....

(Signature and Date)

Engr. BALA SALIHU

(Name of supervisor)

04/12/07

....

(Signature and Date)

Engr. MUSA D. ABDULLAHI

(Name of H.O.D)

....

(Signature and Date)

....

(Name of External Exerminer)

....

(Signature and Date)

CERTIFICATION

This is actually to certify that this project (Anti-Collision detection device) was designed and constructed by OFODU ANTHONY MELVIN for the partial fulfillment of the award of bachelors degree in Electrical and computer engineering.

DEDICATION

Through the mercy of Almighty God, this project work is dedicated to my parents, Mr. & Mrs. ANTHONY OFODU

ACKNOWLEDGEMENT

My profound and indelible gratitude goes to God Almighty whom in His infinite mercy directed, protected and led me to the right people and places during this master piece and also throughout my stay in the university.

Thanks to my parents Mr. & Mrs. ANTHONY OFODU for their unending support and affection. To my supervisor Engr Bala Salihu with deep appreciation, for making the whole process a lot easier, the H. O. D. Engr M.D Abdullahi, Lecturers and other staff of Electrical and computer Engineering department.

Big thanks to my sisters and close relations for immense support and encouragement.

Finally to all my very good friends Ozo Nmuomu,Umar zakari who have been supportive in so many ways. Thank you and God bless you all. Amen!

- Melvin.

ABSTRACT

The Anti – Collision device is a detection device meant to be incorporated into cars for the purpose of safety. As opposed to the anti – collision devices present in the market today, this one is not designed to control the vehicle. Instead, it serves as an alert in the face of imminent collision.

The device is made up of an infrared transmitter and receiver. Also incorporated into it is an audio visual alarm to work in with the receiver and effectively alert the driver and/or the passengers.To achieve this design, 555 timers coupled both as astable and monostable circuits were used and a 38KHz Square – Pulse generator too.

The device works by sending out streams of infrared radiation and when these rays are seen by the other equipped vehicle, both are meant to take the necessary precaution to avert a collision. The device would still sound an alarm even though it is not receiving infrared beams from the oncoming vehicle. This is due to reflection of its own infrared beams.

TABLE OF CONTENT

LIST OF FIGURES

CHAPTER ONE

1.0 INTRODUCTION

All around us in the 21st century are the products of great minds. The human desire to live life with ease is an age long one and over the years, innovations have come up to make life easier. Interestingly, these innovations have been the reason for more innovations to exist. So that when an engineer invents a device to do a certain task, or number of tasks, there is reason to make something else that would handle the difficulties that naturally comes with the pre-existing one. An example is the TV- VCR- Video Cassette rewinder link. Each succeeding one coming to being because of the previous. A more closely related example would be military aircrafts- missiles- radar for detecting both.

Similarly, a major area of concern of an engineer should be safety, as it concerns the use of his inventions and the accompanying dangers due to human limitations.

When it comes to the use of a motor vehicle, accidents that have occurred over the years tell us that something needs to be done about them from an engineering point of view.

According to the September 19, 2006 edition of the Nigerian newspaper, Daily Triumph; a total of 231 persons lost their lives between January and August, just this year, in road accidents which occurred within the Federal Capital Territory (FCT). The statistics shows that 274 vehicular accidents occurred this period. 596 persons were injured in the same period under review [1].

Suffice to say that the implementation of certain highway codes like speed restrictions, among others, has done a lot in reducing the rates of these accidents. The issue here is that policies of conduct alone would not eradicate this, the engineer has a role to play, afterall, we are speaking of an engineering product here (the motor vehicle).

Many motorists have had to travel through areas with little light under much fatigue, yet compelled to undertake the journey out of necessity. It is not always irresponsible to do this. There have been cases where the driver sleeps off while driving, only to wake up moments later to find that he/she is about to have a head-on collision. Not many have had the fortune to quickly avert this. It is therefore imperative to consider the advantages of an early warning system where the driver is alerted of a possible collision some considerable amount of time before it occurs.

Some cars come factory fitted with such a design in mind.

The idea of incorporating radar systems into vehicles to improve road traffic safety dates back to the 1970s. Such systems are now reaching the market as recent advances in technology have allowed the signal processing requirements and the high angular resolution requirements from physically small antennas to be realised. Automotive radar systems have the potential for a number of different applications including adaptive cruise control (ACC) and anti-collision devices [2].

The problem with this brand of cars is that they are expensive. This becomes an even bigger challenge when you consider a developing country like Nigeria.

The Infrared Anti-Collision Device is made out of relatively inexpensive for easy purchase and incorporation. This project aims at the design of a prototype showing how this could function.

1.1 OBJECTIVE

The objective of this project is safety. To find a way to implement a minimum spacing for cars in traffic in an affordable way.

It would also achieve safety for the passengers of a moving car.

1.2 METHODOLOGY

1.2.1 CONCEPTUALIZATION

At this stage the whole concept underlying the project was viewed. First was the consideration of the problem at hand and next was to consider a possible means to solve this problem. The possible challenges were considered and the necessity of this particular work considered.

1.2.2 CONSULTATIONS

Here, some students who had some technical expertise were sought for advice on how to go about this work. This played an important role in knowing exactly what books to look at and what topics to be considered, the materials needed and the availability of these materials.

1.2.3 ECONOMIC CONSIDERATIONS

A fixed limit was put as to how much exactly would be spent doing this project. This was necessary since shortage of finances in the middle of a project would cause major delays. That could not be risked here in one which is time tagged.

1.2.4 RESEARCH AND DESIGN

This included searching recommended websites for relevant information like circuit diagrams and related projects done before. For this, books were read and drawings were made on paper to map out a sequence of work to be done. This was for orderliness and ease of completion of work.

1.2.5 CONSTRUCTION

This was the actual hardware fabrication part of the project. The components had to be tested first on a veroboard before transfers were made to the breadboard. The smallness of the device was considered, and its packaging. Here aesthetics were also considered in the packaging in order to present a clean work.

1.3 LIMITATIONS AND CONSTRAINTS

Being a prototype, this device could not be tested with an actual vehicle so that it has a different principle of operation from what it would have had if it was incorporated in a real car. Secondly, there were inconsistencies with devices which were meant to have similar ratings. This was due to manufacturer's error as they were substandard.

1.4 SIGNIFICANCE OF WORK

The anti-collision device, when wired into the circuitry of a vehicle would help in the reduction of road mishaps. Though not every kind can be helped by this.
It must be stated here that no allusion is being made that technology is the best line of action to take. This is just one of the aspects that are very important. It should be further noted that some already existing laws make use of technologies like the street lights and traffic lights. This would be a supplementation and not a replacement.

BLOCK DIAGRAM

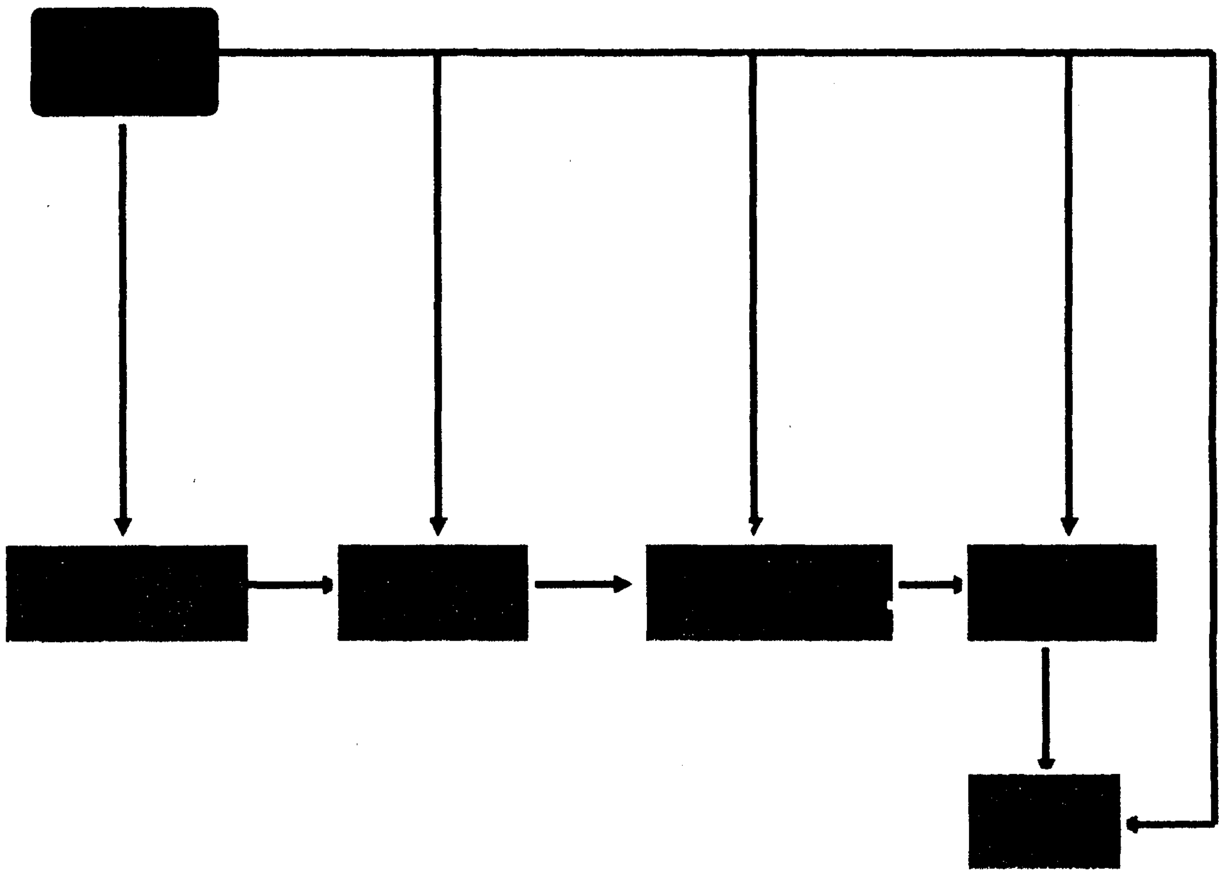

Fig.1.0 General Block Diagram of an Anti-collision Device

CHAPTER TWO

2.0 LITERATURE REVIEW

The anti – collision device prototype designed here is a detection device, sensitive to solid objects in its pathway. To achieve this sensitivity, some of the basic components used for its realize are discussed below.

2.1 THEORETICAL BACKGROUND

A basic makeup of the device is an infrared transmitter/receiver and an audio/visual alarm using two different colours of LED and a speaker. Each was duplicated for better demonstration. The project was designed around three basic modules:

i) High Frequency 30Khz square-wave oscillator

ii) Monostable multivibrators

iii) D.C. Battery power supply

These are thus discussed in further detail.

2.1.1 HIGH FREQUENCY SQUARE – WAVE OSCILLATOR

The infrared sensor type used demands that a modulated infrared source be used for the sensing circuits to effectively respond as required.

Infrared sensors are specified for three different modes of operation, and these are explained overleaf:

MODE 1

The amplitude and carrier frequencies are constant here. The sensor output goes momentarily low, as illustrated below, and this happens just once. For the output to again go low, the continuous carrier wave will have to be removed; else, the detector goes blind leaving its output on a high.

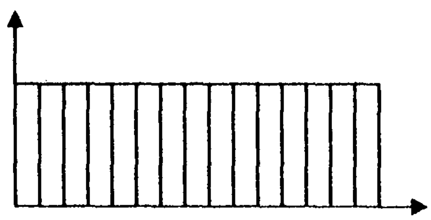

Figure 2.1 Oscillator Output for 40KHz Carrier.

MODE 2

The sensor output goes briefly low each time a 40 KHz pulse is received. The duration of The output pulse is shorter than that of the 40 KHz signal.

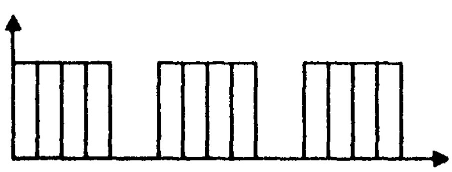

Figure 2.2 40KHz Carrier Pulsed at 7Hz.

MODE 3

Here the output from the detector produces 833 Hz pulses at a frequency rate of 7 Hz.

The 833 Hz pulses represent the data would be sending to the receiver.

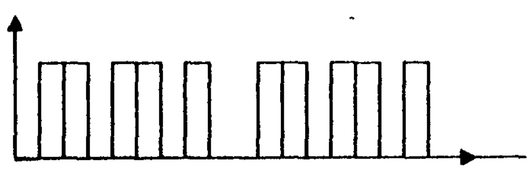

Figure 2.3 40KHz Carrier, Modulated at 833Hz and Pulsed at 7Hz.

2.1.2 MONOSTABLE MULTIVIBRATOR

It is also called a "single – shot", "single – swing" or "one – shot" multivibrator.

It has one absolutely stable state and one quasi – stable state. It can be switched to the quasi – stable state by an external trigger pulse but it returns to the stable condition after a time delay determined by value of circuit components. It has one capacitor with which it stores charges[3].

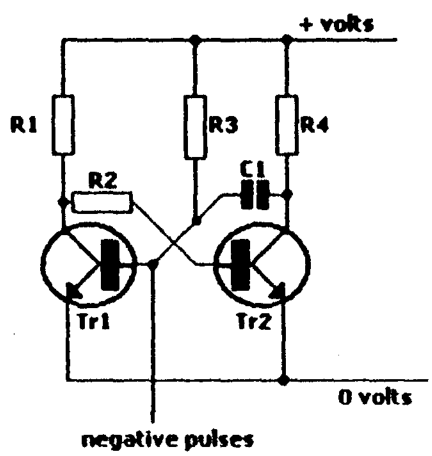

Figure 2.4 A Monostable Multivibrator

OPERATION

At switch on, Tr1 is forward biased by R3. This turns Tr1 hard on, giving it a high collector current and a low collector voltage. This low collector voltage is cross connected to the base of Tr2, turning Tr2 off. This is the stable state.

A negative pulse to the base of Tr1 turns Tr1 off. The collector voltage of Tr1 goes high and turns Tr2 on. The circuit is now in the unstable state.

C1 now charges from the supply rail via R3. Eventually the voltage on the left hand side of C1 will be high enough to turn Tr1 back on, which in turn switches Tr2 off.

The circuit is now back in its stable state. The monostable can be used as a short duration timer or a pulse width stretcher [4].

The monostable is also called a "One – Shot". One – shots are available in integrated circuit form even though they can be built from general – purpose op – amps[ref]. It is triggered by a rising or falling edge at the appropriate input. The only requirement on the triggering signal is that it have some minimum width. The pulse width can be longer or shorter than the output pulse.

Most monostables can be retriggered, beginning a new timing cycle, if the input does the retriggering in the duration of the output pulse. These are termed Retriggerable Monostables.

Some monostables are non – retriggerable; they ignore input transitions during the output pulse. An example is the 555 Timer device which is used in this work.

The 555 chip is configured in the monostable timer mode when wired as indicated below:

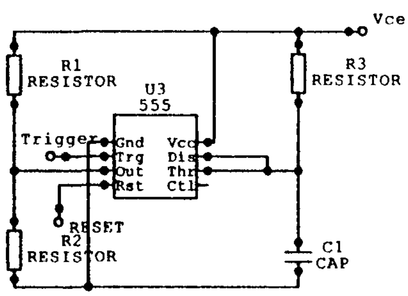

Figure 2.5 A 555 Monostable

The external capacitor, C_T, is initially held discharged by a transistor inside the timer. Upon application of a negative trigger pulse of less than 1/3 V_{CC} to Pin 2, a flip – flop is set. This both releases the short – circuit across the capacitor C_T and drives the output high. The voltage across the capacitor then increases exponentially for a period of time;

$t = 1.1\ R_TC_T$, at the end of which the voltage becomes equal to 2/3 V_{CC}. An external capacitor then resets the flip – flop, which in turn discharges the capacitor and drives the output to its low state.

Since the charge and the threshold level of the capacitor are both directly proportional to supply voltages, the timing interval is independent of supply.

During the timing cycle when the output is high, further application of a trigger will not affect the circuit so long as the trigger input is returned high at least 10 microseconds before the end of the timing interval. However, the circuit can be reset during this time by the application of a negative pulse to the reset interval (Pin 4).

The output will then remain in the low state until a trigger pulse is applied.

The timing delay generated using a 555 monostable is:

$Td = 1.1\ R_TC_T$

Where R_T is the resistance between the supply and pins 6 and 7; and C_T is the capacitance between Pins 6 and 7 and ground.

The IR sensor output are OR'ed and used at the enable input of a 555 oscillator (de - asserting RESET), GENERATING A 250 Hz audio tone. The output from the monostable independently controls visual LED indicators that show the origin of distance violation [5].

2.1.3 ASTABLE

It is a free – running relaxation oscillator. It has no stable state but only two quasi – stable (half – stable) between which it keeps oscillating of its own accord without external excitation.

In this circuit, neither of the transistors reaches à stable state, their frequency of change between the ON/OFF state is determined by the RC time constant in the circuit.

Two outputs (180^0 out of phase)are available[6].

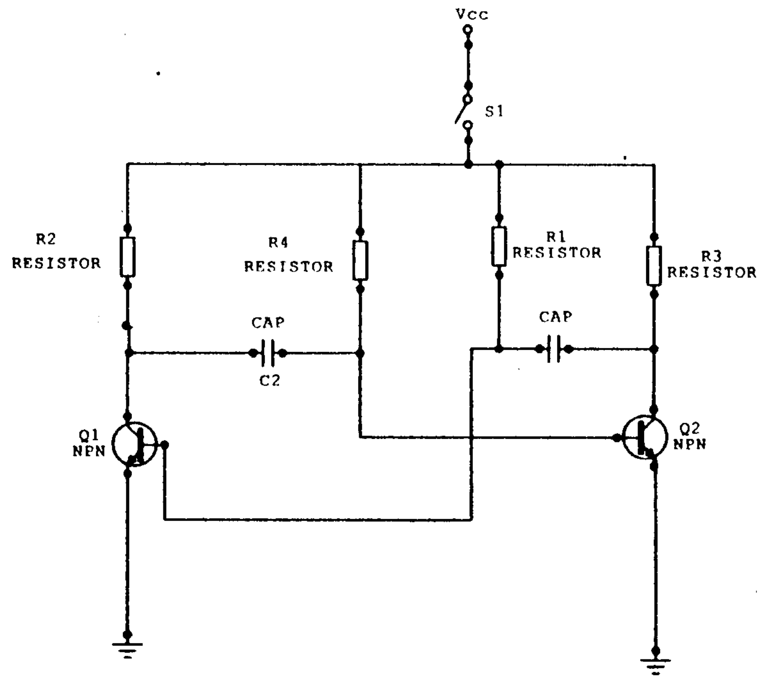

Figure 2.6 Astable mulitvibrator

The 555 Astable Oscillator is a form of relaxation oscillator in which a current source changes a capacitor, then discharging it rapidly when the voltage reaches some threshold, beginning the cycle anew.

The operation of the 555 Astable Oscillator is explained below:

The output pin (3), goes high when the 555 receives a trigger input, on Pin 2, and it stays there until the threshold (Pin 6) is driven, at which time the output goes low and the discharge transistor (collector on Pin 7) is turned on. The trigger input is activated by an input level below 1/3 V_{CC}, and the threshold is activated by that above 2/3 V_{CC}.

When power is applied to a 555 Astable, the capacitor is discharged, so the 555 is triggered causing the output to go high, the discharge transistor to turn off, and the capacitor to begin charging towards 2/3 V_{CC} through $R_A + R_B$. When it reaches this value, the threshold input is triggered, causing the constant to go low and the discharge transistor to turn on, discharging Ç towards ground through R_B.

The operation is now cyclic, with the voltage at C going between 1/3 V_{CC} and 2/3 V_{CC}, with period $T = 0.693 (R_A + 2R_B) C$.

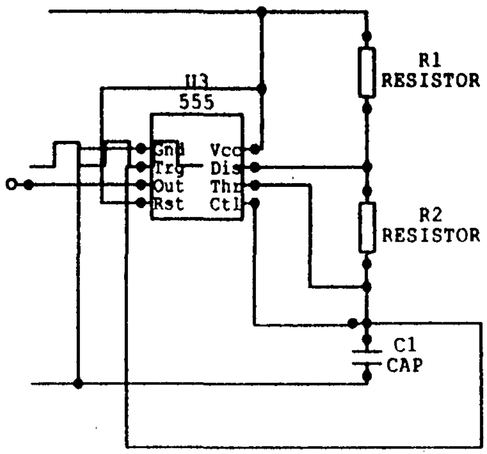

Figure 2.7 555 Astable

2.1.4 POWER SUPPLY

This is supplied by 6F22 9V primary cell batteries.

2.2 A BRIEF HISTORY

Due to the devastation caused by car accidents as far back as the 1950s, engineers since then had dreamed about a day when cars would come with automatic devices that would avert these accidents.

2.2.1 A FORECAST ABOUT ANTI-COLLISION CARS

Hugo Gernsback, the editor of a website in the year 1960, made the following remarks regarding the need for smart Anti-collision cars. Here he also forecasts the possible technology, the problems that would come with such an invention:

'In the U.S. in 1959, over 35,000 people were killed and some 1.2 million were injured in automobile accidents. This appalling situation-the killing and injuring of more of our people than in a major shooting war of a similar period--has become the grave concern of every auto maker, just as it has been the concern of society at large.

Benson Ford, vice-president of Ford Motor Company, on October 1, 1951, in a talk before the Detroit section of the Society of Automotive Engineers, called for "better automobile safety devices, including an electronic control that would apply brakes when collision is imminent.

"By means of photoelectric cells, and capacitance-effect devices it should not be a difficult problem for radio engineers, in conjunction with automobile technicians, to evolve ways and means to make automobiles safer--far safer than they are today. To mention a few ideas on the subject, all of which are possible even today: Many accidents are caused today by cars colliding, by one car running into another, by one car being bumped in the rear of another etc. Authorities have long agreed that cars, even when stopping, should not come closer than two or three feet of each other. If a capacitance device were installed on the front fenders of all cars, then as soon as a body having a large capacitance (such as an automobile, truck, pedestrian) came within two feet of it, a relay would automatically cause the brakes to be applied. This would obviate a great many collisions, and while it would not stop all of them, it would certainly minimize their effects. It is better to stop a car suddenly without hitting another car, even if slight injuries result, than to have a serious collision, killing the driver or passengers outright when the cars crash or having them die in fire which often breaks out.

While it is true that such an automatic capacitance operated device would not be very effective when a car going at 40 miles an hour (12.19m) suddenly came within two feet of a pedestrian, the chances are that the damage done might not be as great as if the progress of the car had not been halted. It is one thing to strike a human being with a car going 40 miles an hour and quite a different thing if the car strikes at the speed of 8 to 10 miles an hour (2.44m – 3.05m). The difference may be one of life or death to the person struck."

Sixteen years ago, electronic science perhaps was not sufficiently advanced to cope with the problem as effectively as we can today, but now there is no valid reason for not equipping cars with anti-collision electronic devices, if auto makers sincerely demand them.

I can visualize an electronic system which embodies a combination of simplified, special radar, plus a capacitance-effect device--both acting together. Such a system should give us a greater margin of safety to prevent or minify collisions.

True, such improved cars will be more expensive than present day ones, but it is a certainty that the public will want such safety equipped cars, at almost any price.

Moreover, the first automobile manufacturer to pioneer in the electronic anticollision device will create a world-wide sensation. Other manufacturers will then have to follow suit if they wish to compete.

'It must be realized that such an anticollision device will never prevent every type of collision.'

Side swipes, oblique collisions, and other unusual types of auto accidents, it is true, are much more difficult to prevent, although not impossible to avert in the future, with more advanced and refined electronic devices.

'With constantly increasing car speeds, no human can be trusted always to stop a car quickly enough to avoid accident. Human reactions are too slow. With a car moving at 65 miles an hour (104.59 Km/hr)--let us picture a common situation: From a shrubbery obscured side street another car moves across the main road. The driver of the first car going 65 mph sees the other car 75 feet away (22.86m). But it takes about 3.75th of a second before he can apply the brakes. In that time his car has traveled 77.5 feet (23.62m). Then the car's momentum will cause if to cover, say at least 100 feet before it can be brought to a dead stop. Thus the first car will have traveled 171.5 feet (52.27m) from the moment it sighted the second car till it was stopped. Result--unless both cars swerve--a bad crash!

The electronic control is better in accident detection though they can not replace human in totality. the human reactions are not instantaneous, in emergency he rarely has sufficient time to put on his power brakes--but electronics can do it instantly when the car gets in the danger zone. True, not all collisións will be prevented, but the force of the impact will be greatly reduced. It will be the difference between death and injury.

The electronic anticollision device need not be very large nor cumbersome, perhaps not much larger than a medium table radio. It will have a rudimentary radio brain that will also make certain decisions as to when and where NOT to put on the brakes. For instance, when another car travels in the same direction in close city traffic and comes within 6 inches of the anticollision equipped car, or when you wish to park your car in the street.

The electronic device can be designed to differentiate between such situations and those involving danger'. [7]

2.3 OTHER TYPES OF DETECTORS

These are an example of other types of detection objects:

2.3.1 RADAR DETECTORS

One kind of detector is a radar type detector. Radar being an acronym for Radio Detection and Ranging.

Is use as a speed gun is considered. A basic speed gun is a radio transmitter and receiver combined into one unit. A radio transmitter is a device that oscillates an electric current so the voltage goes up and down at a certain frequency. This electricity generates electromagnetic energy, and when the current is oscillated, the energy travels through the air as an electromagnetic wave. A transmitter also has an amplifier that increases the intensity of the electromagnetic energy and an antenna that broadcasts it into the air.

A radio receiver picks up electromagnetic waves with an antenna and converts them back into an electric current.

Radar make use of radio waves to detect and monitor various objects. The simplest function of radar is to tell you how far away an object is. To do this, the radar device emits a concentrated radio wave and listens for any echo. If there is an object in the path of the radio wave, it will reflect some of the electromagnetic energy, and the radio wave will bounce back to the radar device. Radio waves move through the air at a infrared laser bursts in a short period of time to collect multiple distances. By comparing these different distance samples, the system can calculate how fast the car is moving. These guns may take several hundred samples in less than half a second, so they are extremely accurate.

Police may use handheld lidar systems, just like conventional radar guns, but in many areas, the lidar system is completely automated. The gun shines the laser beam at an angle across the road and registers the speed of any car that passes by (the system makes a mathematical adjustment to account for the angle of view). [9]

2.4 ABOUT INFRARED RADIATION

Infrared Radiation, emission of energy as electromagnetic waves in the portion of the spectrum just beyond the limit of the red portion of visible radiation. The wavelengths of infrared radiation are shorter than those of radio waves and longer than those of light waves. They range between approximately 10^{-6} and 10^{-3} (about 0.0004 and 0.04 in). Infrared radiation may be detected as heat, and instruments such as bolometers are used to detect it.

Infrared radiation is used to obtain pictures of distant objects obscured by atmospheric haze, because visible light is scattered by haze but infrared radiation is not. The detection of infrared radiation is used by astronomers to observe stars and nebulas that are invisible in ordinary light or that emit radiation in the infrared portion of the spectrum.

An opaque filter that admits only infrared radiation is used for very precise infrared photographs, but an ordinary orange or light-red filter, which will absorb blue and violet light, is usually sufficient for most infrared pictures. Developed about 1880, infrared photography has today become an important diagnostic tool in medical science as well as in agriculture and industry. Use of infrared techniques reveals pathogenic conditions that are not visible to the eye or recorded on X-ray plates. Remote sensing by means of aerial and orbital infrared photography has been used to monitor crop conditions and insect and disease damage to large agricultural areas, and to locate mineral deposits. In industry, infrared spectroscopy forms an increasingly important part of metal and alloy research, and infrared photography is used to monitor the quality of products.

Infrared devices such as those used during World War II enable sharpshooters to see their targets in total visual darkness. These instruments consist essentially of an infrared lamp that sends out a beam of infrared radiation, often referred to as black light, and a telescope receiver that picks up returned radiation from the object and converts it to a visible image. [10]

2.5 PRESENT IMPLEMENTATION OF PROXIMITY VIOLATION SYSTEM

2.5.1 KONKAN RAILWAY CORPORATION LIMITED (AN UNDERTAKING BY THE INDIAN GOVERNMENT)

Due to the gruesome nature of accidents involving trains, the loss of lives and property when these accidents occur, mishaps that come when a train crew member becomes inactive for a while and the other human factors that cannot be helped, the Indian Government is undertaking a project to fit trains with anti-collision devices (ACD).

ACDs fitted on a Locomotive and Guard's SLR/Brake Van continuously monitor the 'emergency' situations that may lead to 'collision-like' situations, while the train is either stationary or on the move. They also detect presence of other trains, Level Crossing Gates, Stations etc., en-route, in their vicinity, by exchanging information with ACDs fitted on them.

Based on the 'relevant' train working rules programmed in it, the 'Loco ACD' analyses the situation on 'real-time basis and applies brakes 'automatically', either to reduce train speed to a 'pre-determined' level or to a STOP, as the case may be. It releases the control on braking mechanism for the driver, as soon as the task is accomplished.

If brakes do not apply 'adequately' in time, automatically by the 'Loco ACD', it will immediately give Audio-Visual indication to the driver to take urgent necessary action, as deemed fit.

However, the ACD System does not give any 'positive' indication to staff to take any action or steps, over-riding existing procedures or safety rules for train operations.

Furthermore, it does not unilaterally create any 'Un-safe' condition additionally, in the event of its failure.

What the ACD system basically does is to act as 'watch-dog' to ensure safer train operations. In addition it monitors 'specific' events related to 'collision-like' situations and communicate the same to each other within their 'radio-zones' of influence. [11]

2.5.2 THE MERCEDES S-CLASS, 2007 MODEL

Secondly, the Mercedes S-Class, 2007 model is equipped with radar sensors that can prepare the car if an accident is inevitable. The system uses two different radar frequencies to scan traffic in front of the car. Short-range radar covers the first 30 metres in a fan-shaped 80-degree pattern, working in tandem with a narrower beam of longer-range radar used with the DISTRONIC cruise control feature. The two radar frequencies complement each other to cover a full range of more than 146 metres.

First, the S-Class's audible warning sounds to indicate a potential collision. If the brakes are applied quickly, the Brake Assist Plus system recognizes the emergency application and adds as much braking as necessary based on the rate at which the two vehicles are coming together—up to 100 percent braking power. [12]

CHAPTER THREE

3.0 DESIGN AND IMPLEMENTATION

A basic makeup of the device is an infrared transmitter/receiver and an audio/visual alarm using two different colours of LED and a speaker. Each was duplicated for better demonstration. The project was designed around three basic modules:

i) High Frequency 30Khz square-wave oscillator

ii)555 Monostable

iii) D.C. Battery power supply

3.1 HIGH FREQUENCY SQUARE – WAVE OSCILLATOR

Since most commercially available three – terminal infrared sensors are most sensitive in the 38Khz region, particularly the TSOP 1738 used, a stable 38Khz source is mandatory.

A critical examination of the various configurations shows that only mode 2 or mode 3 type of operation is applicable in the implementation of the desired system.

The mode 2 type of operation is employed here, as this gives the basic implementation of the infrared (IR) link among vehicles.

A 38 KHz square – wave oscillator is modulated by a low frequency 7 Hz source to generate a pulsed output at the sensor's end. This low modulating frequency allows for easy visual observation as indicator Light Emitting Diodes (LEDs) blink in response to the received IR radiation.

The charge time (output high) is given by:

$t_1 = 0.693 (R_A + R_B) C$;

and the discharge time (output low) is given by:

$t_2 = 0.693 (R_B) C$;

thus the period is:

$T = t_1 + t_2$

$T = 0.693 (R_A + 2R_B) C$,

The frequency of oscillation is; $f = 1/T = 1/[0.693 (R_A + 2R_B) C]$

Therefore $f = 1.44/[(R_A + 2R_B) C]$

The duty cycle is: $D = R_B/(R_A + 2R_B)$

Since the frequency of operation of the three – terminal IR sensor used lies between 32 – 40 KHz, the oscillator frequency must therefore lie in this range. Most sensors are optimally responsive at 38 KHz as such this frequency is more often used in IR systems.

Since modulation is also desired, a means of generating a modulated signal is required. The 555 device has an extra input pin (Pin 5 – modulation input) which allows an input wave form to directly modulate the free running 38 KHz astable frequency.

This frequency modulation produces a 38 KHz IR carrier modulated at 7 Hz. This effectively puts the transmitter – sensor interface in mode 2.

Using $f = 1.44/[(R_A + 2R_B) C]$ and an output frequency of 38 KHz;

$38000 = 1.44/[(R_A + 2R_B) C]$;

A standard capacitance value of 0.0015μF was chosen and R_A = 2.2 KHz. Substituting both values in the equation above yields 11.53 KΩ.

This was achieved using a variable potentiometer of 20 KΩ.

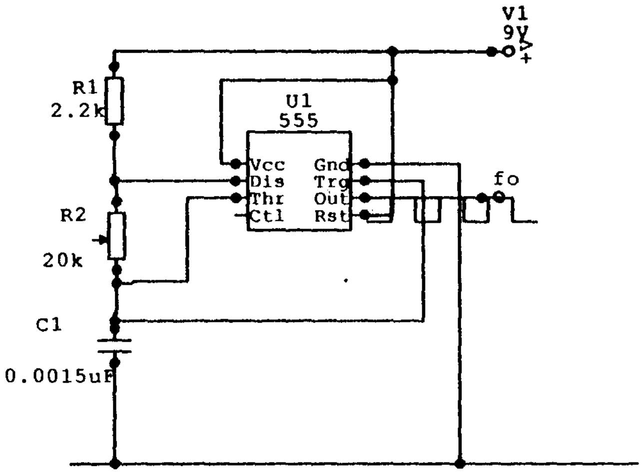

Figure 3.1 Oscillator A

The modulation source is coupled as shown below:

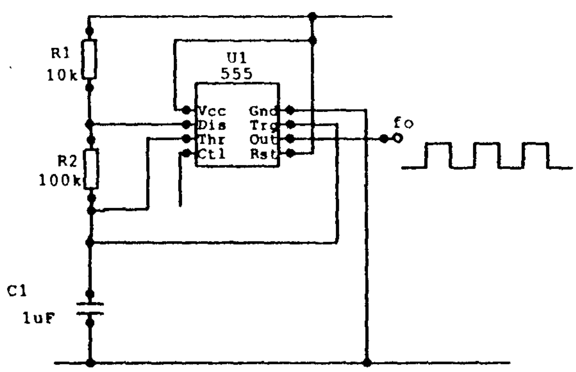

Figure 3.2 Oscillator B

Both oscillators are shown wired together as below:

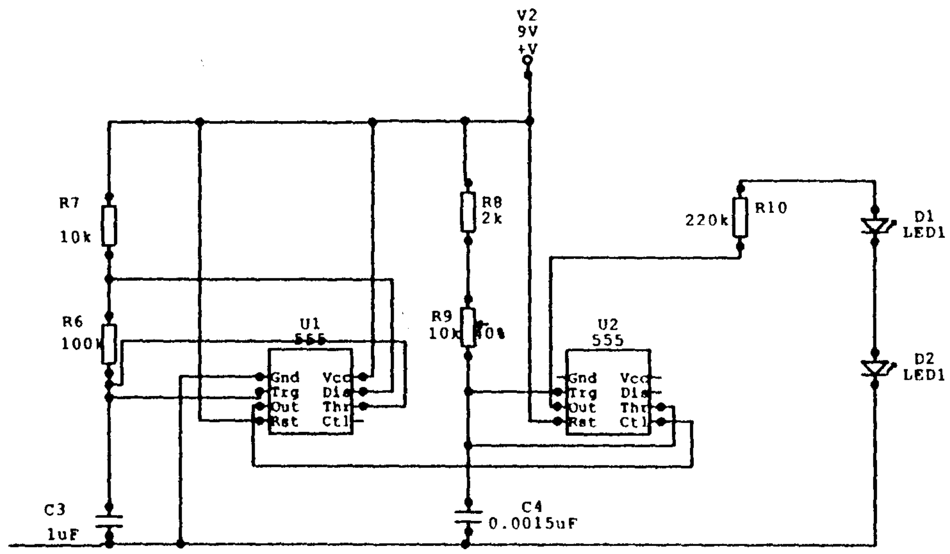

Figure 3.3 Coupling of Both Oscillators

The modulated 38 KHz carrier signal drives two series connected IR LED through a 200Ω resistance in series with the diodes.

R_S is deduced from the equation; $R_S = (V_{CC} - V_{LED}) / I_{LED}$

Since the diodes are connected in series, the same current, I_{LED}, flows through them.

$V_{CC} = 9V$, and $V_{LED} = 1.7V$ (measured), I_{LED} has a maximum 0.5A for the diodes used.

Using these values,

$R_{S(min)} = [9\text{-}2(1.7)]/0.5 = (9 - 3.4)/0.5$

Reducing I_{LED} ensures diode longevity. A 220Ω resistance was used to yield a low I_{LED}, and a low power IR carrier since the distance of travel of the generated carrier is a direct function of the diode forward current.

3.2 THE RECEIVER CIRCUIT

The receiver circuit comprises two monostables, as explained earlier on, and a low frequency audio oscillator designed around the 555 timer IC. Two IR sensors connected to two different monostables produce a common output logic that enables/disables the audio frequency oscillator. Each monostable responds to the IR beam sent in its direction by generating a pulsed 1 second square – wave output. This output forms the input to the transistor equivalent.

3.3 ANALYSIS

The two monostables provide a one second output that Gates ON or OFF the audio oscillator. Besides the gating action, each monostable also drives a visual indicator that shows the origin of the minimum inter – car distance violation.

When the minimum spacing distance is breached from either direction, front or rear, the appropriate sensor picks up the IR beam transmitted from the offending car, turns the appropriate visual indicator on to reflect the direction of violation. At the same time, it enables the audio frequency oscillator that provides enough power to drive a loudspeaker. Since this is merely a detection device, the occupants of both cars will be notified of the need to adjust to a safer distance apart.

Two SC 1815GR NPN transistors are wired in parallel with their collectors commoned and pulled to +9V via a 10KΩ resistance. This 10KΩ resistance is also the R_B for a common – emitter NPN transistor whose collector load is a 10KΩ resistance as depicted below.

With transistors Q_1 and Q_2 off, R_3 sources current into the base emitter direction of Q_3. This current is high enough to saturate the transistor, putting its collector at a potential that is just a few tenths of a volt above the emitter potential, 0V.

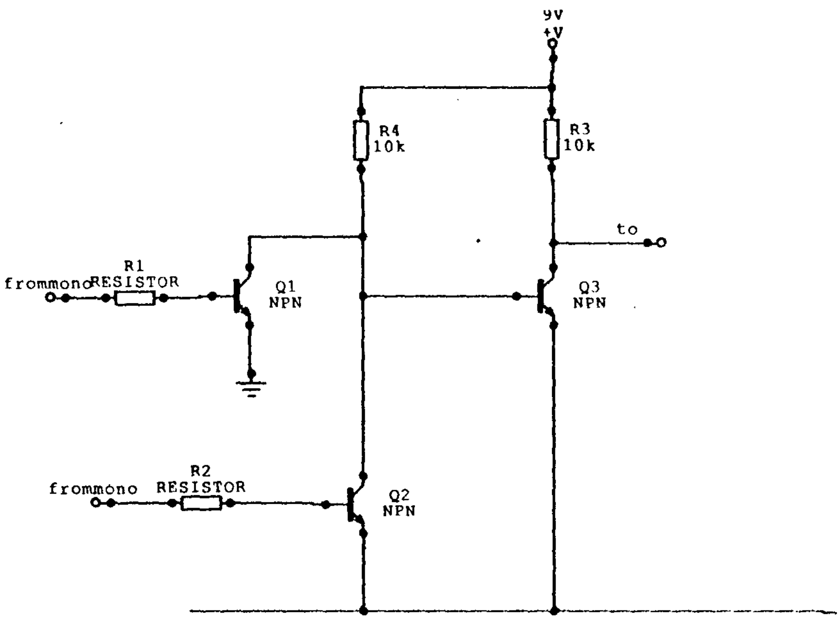

Figure 3.4 Oscillator connection With Receiver

Since Q_3's collector is connected to RESET on the audio oscillator, and with Q_3 saturated, RESET is active. Correspondingly, the oscillator is disabled and no tone is generated.

If either Q_1 or Q_2 is on (driven by the associated monostable), the base Q_3 of is shorted to ground, forcing it off. Q_3's collector voltage rises to approximately V_{CC} de – asserting RESET. The audio oscillator is now enabled and it generates a frequency,

$F = 1.44/[(R_A + 2R_B) C]$ Hz.

3.4 OVERVIEW OF TRANSMITTER AND RECEIVER CIRCUIT

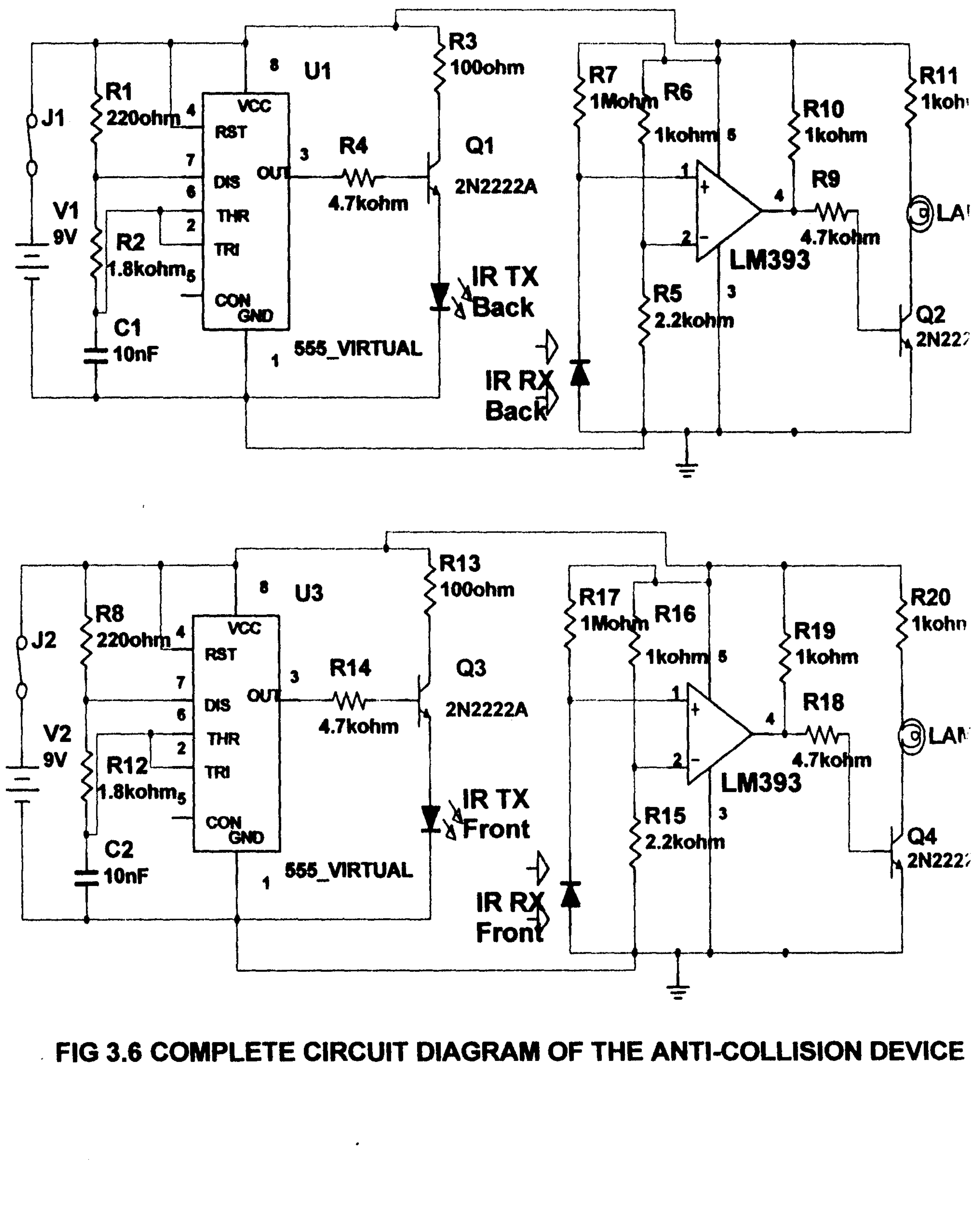

FIG 3.6 COMPLETE CIRCUIT DIAGRAM OF THE ANTI-COLLISION DEVICE

CHAPTER FOUR

4.0 TEST, RESULTS AND DISCUSSIONS

Tests were carried out on the prototype device to see its effectiveness as to what degree it meets its expected performance.

4.1 TESTS

At first both devices are made to face each other to see if they would respond to the closeness.

Then the distance between them was further increased to see the minimum within which it would still be effective as an anti – collision device.

4.2 RESULTS

As they were brought close together it was noted that both devices had both LEDs on and their respective audio alerts came off.

When they were brought to 0.4m of each other, the alarm ceased indicating that the circuits were working desirably. Although only one stopped sounding as the other had to be manually shut – down to keep it from draining the battery.

4.3 DISCUSSIONS

During the tests, it was noted that one of the devices kept signaling an alarm even when it had gone beyond the safe range (0.4m). This was due to the nature of the transmitter bought. There was a problem with purchasing a good one, as it was hard to tell from the point of purchase, which one would work and which would not.

There was also a power supply problem as the speaker actually drained a lot of power from the battery, causing instability in the system thereby. Much of the testing was done with the speaker disconnected.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

The device constructed achieved its set objectives as it pertains to cost and functionality. However, it should be stated here that the device this project was aimed at fabricating was a prototype, a replica of the actual thing. It is economically viable to undertake certain projects this way since testing would not cost so much.

Any desire to implement this design into a vehicle would require a laser detector. The problem of power supply would not arise due to the amount of battery power form the car battery.

5.1 RECOMMENDATIONS FOR FURTHER WORK

I recommend that to further improve on this design, the Radar option should be considered. In this case only a screen display would be used in place of LEDs. It would actually show the actual position of an on coming vehicle.

I suggest also that for the above recommendation, would be economical to have the work undertaken by two people.

REFERENCES

1. [http://www.triumphnewspapers.com/auto1992006.htm]
2. [http://journals.cambridge.org/action/displayAbstract]
3. B.L. Theraja, A.K. Theraja, A textbook of electrical technology, S. Chand and company, New delhi, India,1999, pp 1956
4. [http://www.hobbyprojects.com/multivibrators.html]
5. Paul Horowitz and Winfield Hill, Art of electronics, 2nd Edition, ISBN 0-672-21932-8 (pp 517 – 518)
6. [http://journals.cambridge.org/action/displayAbstract]
7. [http://www.twd.net/ird/forecast.html]
8. [http://electronics.howstuffworks.com/radar-detector.htm]
9. [http://electronics.howstuffworks.com/lidar.htm]
10. Microsoft Encarta 2006 Premium
11. [http://www.konkanrailway.com/website/ehtm.htm]
12. [http://autos.msn.com/research/vip/overview.aspx?year=2007&make=Mercedes-Benz & model=S-Class]