APPLICATION OF INFRARED RADAR SYSTEM FOR ACCIDENT PREVENTION

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DEDICATION

This project work is dedicated to the Almighty God, the giver of wisdom, knowledge and understanding and to the Amakor Family.

DECLARATION

I, Amakor Udochukwu John declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology, Minna.

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ABSTRACT

This Infrared RADAR system is the implementation of an idea to reduce the rate of accident on the road by reducing the rate of collision (both forward and rear-end collision).It system aims at improving the level of consciousness and alert level of the driver by detecting obstacle ahead and behind the vehicle and alerting the driver through a continuous Alarm system whose frequency varies with the distance of the obstacle. It uses an infrared RADAR system to detect obstacle. This project comprises of six (6) different circuit modules which includes: two infrared transmitter and receiver modules for both the front and rear of the vehicle, a microcontroller unit, a signal conditioning unit, a display unit, an alarm circuit module. The microcontroller pulses the transmitters for 50ms at an interval of 950ms and it check its interrupt pin to which the receivers are connected-to for any reception of reflected signal. It uses the time difference between transmission and reception to calculate the distance of the reflecting obstacle. This approximate distance is use to drive the alarm if it is with certain range (FRSC ssafety distance). The brake lights are also triggered if an approaching vehicle from behind get to a critical distance (20m).

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CHAPTER ONE

INTRODUCTION

1.0 Background

This accident prevention mechanism is a system that is developed to prevent collision between vehicles on the highway and hence preventing accidents. It uses a simple infrared RADAR system to measure the distance between the vehicle and the obstacle (which can be another vehicle, a house, a tree, a person etc) ahead and behind it and alert the driver through an alarm system.

The intensity of the alarm is inversely proportional to the distance between the vehicle and the object. That is, the shorter the distance between the vehicle and the object, the higher the intensity of the alarm.

The alarm system is activated when the vehicle is moving at a speed of 80km/hr. This is to prevent the alarm from triggering when the vehicle is being driven within the city or in a go slow (traffic jams) situations.

There are five major components used in this design. They include infrared sensor, the circuit modules, BSII microcontroller, the alarm system and the speedometer of the vehicle. There are five different circuit modules that were used, the voltage regulator module, an oscillator module, the transmitter module, the receiver module and the analog to digital converter module.

This system measures the distance between the vehicle and the object by transmitting an infrared signal using an infrared sensor (infrared transmitter) and the reflected signal is detected using an infrared detector (infrared receiver). The micro-controller records the transmitting time and the time of reception and produces an output frequency proportional to the time difference between transmitting and receiving time. The distance between the two vehicles (objects) is proportional to the difference between the transmit time and reception time. This output voltage is used to drive the alarm system. They alarm system is a continuous alarm in which the intensity is proportional to the distance between the vehicle and the object. The alarm system is designed such that the intensity of the alarm is a function of the speed of the vehicle and the distance between the two vehicles.

It is triggered when the object within the range specified by the Federal Road Safety Commission (stopping distance).

The system is also expected to trigger the brake light when a vehicle approaching from the rear is within twenty (20) metres (critical distance) to alert the driver of the approaching vehicle.

1.0.1 Stopping Distance:- Never get too close to the vehicle in front. Leave enough space between you and the vehicle in front so that you can stop safely if the vehicle in front slows down or stops suddenly. According to federal road safety commission of Nigeria, the safe rule is never to get closer than the overall stopping distance as shown in the table below. On wet roads the gap should be much more. Slow down if an overtaking vehicle fills the gap in front of you.

Table 1.0 Stopping distance table

Stopping Distance			
Speed	**Thinking distance**	**Braking distance**	**Overall stopping distance**
Km/h	**Metre**	**Metre**	**Metre**
20	5	5	10
40	10	12	22
60	16	30	46
80	22	50	72

100	27	65	92

NOTE:

Stopping distance increases greatly with wet and slippery road, poor brake, bad tyres and tired drivers with low speed reacting time. (Distances given above are approximate). [1].

1.1 Aims and Objectives

1.1.1 Overall aim of the project

This project aims at reducing the rate of automobile accident on the highway.

1.1.2 Specific aims of the project

The specific aims of this project includes, to:

- reduce rear end collision on the highway
- reduce the number of death on the highway
- keep the driver alert and conscious of any obstacle while driving
- give the driver at least a10second head-off time before any collision.

1.1.3 Objectives of the project

The objectives of this project include, to design a system that will:

- detect obstacle (e.g. vehicle, tree, animal) within the safe driving distance of the vehicle.
- estimate the approximate distance between the vehicle and the obstacle.
- alert the driver through a continuous alarm of the obstacle if it's within the safe driving distance.
- ensure that the intensity of the alarm is proportional the distance between vehicle and the obstacle and also proportional to the speed of the vehicle.

1.2 Methodology

A review of existing system was first conducted and documented. The system was then segmented into modules which include the power supply unit, the infrared transmitter module, the infrared receiver module, the microcontroller module, the alert unit the display unit. The various units were then designed, simulated and bread boarded before it was finally constructed on a Vero-board. After construction, the various modules were coupled together into a single unit. They general performance of the system was then tested and the result was documented.

1.3 Scope

This system is expected to measure only the approximate distance between the vehicle and the object in front and behind it through the transmission and reception of an infrared signal with which the driver of the vehicle is then alerted through an alarm system, if the measured distance is within the safe distance specified by the regulatory body (Federal Road Safety Commission).

1.4 Source of material

The materials for this project were sourced from various sources which include: the Internet, text books, government agency (FRSC), private consultants etc.

CHAPTER TWO

LITERATURE REVIEW

2.1 Theoretical background

In view of the increasing number of automobile accidents on Nigeria highways in recent years, traffic accident has assumed the dimension of a serious social problem in the country. A vehicle traffic collision (motor vehicle collision, motor vehicle accident, car accident, or car crash) is said to occur when a road vehicle collides with another vehicle, pedestrian, animal, road debris, or other geographical or architectural obstacle [2]. This can be attributed to bad road networks, increase in the number of vehicle flocking into the country without the expansion of existing infrastructure, advancement in technology which has made cars available and affordable, poor vehicle maintenance culture and also the lack of necessary driving skill, carelessness, low sensitivity level and the high level of stress experienced by drivers in the country. This has lead to the loss of thousands of lives, properties and destruction of infrastructures. It is reported that the major cause of accident on the road are the drivers [1]. Due to the complexity of the situation, it has been concluded that not much can be done to improve the driver's skill, level of attentiveness or to appreciably reduce the level of stress experienced by the drivers. However, it is considered plausible to provide assistance to the driver in the form of non-human supplemental means to complement the driver's natural capabilities and reflexive response [3].

A very common traffic collision is the rear-end collision. A rear-end collision is said to take place when two vehicles travelling in the same direction and the second vehicle run's into they rear-end of the first vehicle in front of it when the vehicle suddenly slows down or stops. This kind of accident accounts for about 25% of all traffic accident. This is as a result of the vehicle not maintaining a safe driving distance (stopping distance) which is a summation of both the drivers' reaction time (thinking distance) and the braking distance. Another common traffic accident is the forward collision which involves a vehicle running into a stationary obstacle such as a stationary car, a tree, an animal, a structure e.t.c. This is majorly dependent on the level of consciousness and alertness of the driver while driving. Hence it is imperative that an electronic system be installed in vehicle to monitor the safe driving distance or the distance of the vehicle from any obstacle and to alert the driver to take necessary action to prevent collision and thereby improving the consciousness and the alert level of the drivers. Various systems have been put in place by some car manufacturer to assist driver in sensing, decision making and controlling of their vehicles with the ultimate aim of making driving safer and below is a review of some of such systems.[3]

2.1.1 Automated safety enhancement system

This system was designed to prevent accident or minimize force and damage of rear-end collision in case of an accident. They system scans and monitor the rear direct environment of the vehicle for potential danger. When any potential danger is detected, the system takes action by giving a visual or audio alert to the driver. This system incorporates two other subsystems which include an Intelligent Night-time Alert System which is designed for the purpose of car safety during night time parking and an Intelligent Third Brake Light which will blink when an emergency brake is applied.[4]

2.1.2 Volvo Cars' Collision Warning System with Brake Support System

This system continuously monitors space ahead of the car with the aid of a radar sensor. They system is activated in different phases throughout the whole course of the events. If the car approaches another moving car from behind and the driver does not react, a red warning light will flashes on the windscreen. At the same time an audible signal can be heard. If the driver does not react and the risk of collision increases despite the warning, the brake support is activated. This system is evident in the Volvo S80 model.[5]

2.1.3 Adaptive Safe Distance Control System

This is a forward looking collision avoidance system which aims at preventing rear-end collision. It monitors the zone in front of the host vehicle while driving. Base on the distance detected, the system controls and adjust the speed of the vehicle to establish a safe driving distance. It uses an ultrasonic sensor to transmit pulse signal and the reflected signal from the obstacle is detected by the ultrasonic receiver. A PIC microcontroller uses the output of the ultrasonic sensor to estimate the distance and to control the speed of the vehicle.[6]

2.1.4 Paroto Infrared and Radar data fusion for collision avoidance system

This system uses RADAR and infrared camera to detect obstacle. This system focuses on data fusion, which it uses to build a precise map of the obstacle ahead of the vehicle. They radar system uses 77GHz millimeter wave and a frame work of a Pulse Doppler Radar with Doppler priority. Also the radar uses only one antenna for emission and reception which provide a 3.3 degree field of view. It is expensive and is still an experimental system.[7]

2.1.5 Toyota pre-crash safety system

This system uses millimeter-wave radar to detect vehicles and obstacles ahead of the vehicle on the road and help reduce the severity of collision. It also uses stereo camera to detect pedestrians and support evasion maneuver by the driver. A rear millimeter-wave is used to detect vehicles approaching from behind and also an infrared projector located in the headlights supports night-time detection. The system retracts the seatbelts and warns the driver when it determines a high possibility of collision. If the driver does not react, the pre-crash brakes will be applied to reduce collision speed. If the rear radar detects vehicles approaching quickly from behind, it flashes the hazard light to warn the other driver. This system is evident in the Lexus LS460 model of Toyota.[8]

2.1.6 Mercedes PRE-SAFE braking system

This is a self braking system that helps drivers avoid collision by partially engaging the brake when the vehicle approaches another vehicle. It also provides a visual and audible warning when the vehicle is about to run into another vehicle and automatically calculate the brake force required to prevent collision. This system operates base on a near range RADAR sensors and it was found to reduce the severity of collision by approximately 40%. This system is an available option in the Mercedes S-Class and CL-Class model of cars.

Below is a list of various model of cars with similar system in place to prevent accident by reduce the rate of automobile collision.[9]

2005 Acura RL, MDX, ZDX

Audi A4, A5, Q5, A6, A8 (with GPS and front camera input), Q7

BMW 7 Series, 5 series, 6 series, 3 series (Active Cruise Control)

2004 Cadillac XLR, 2005 STS, 2006 DTS

2007 Chrysler 300C

2006 Ford Mondeo, S-Max, Galaxy, 2010 Taurus

2003 Honda Inspire, Legend

Hyundai Genesis (Smart Cruise Control, delayed)

Infiniti M, Q45, QX56, G35, FX35/45/50 and G37

1999 Jaguar XK-R, S-Type, XJ, XF

2000 Lexus LS430/460 (laser and radar), RX (laser and radar), GS, IS, ES 350, and LX 570

Lincoln MKS, MKT

1998 Nissan Cima, Nissan Primera T-Spec Models (Intelligent Cruise Control)

1998 Mercedes-Benz S-Class, E-Class, CLS-Class, SL-Class, CL-Class, M-Class, GL-Class, CLK-Class

2010 Porsche Panamera, 2011 Porsche Cayenne

Range Rover Sport

Renault Vel Satis

Subaru Legacy & Outback Japan-spec called SI-Cruise

1997 Toyota Celsior, Sienna (XLE Limited Edition), Avalon, Sequoia (Platinum Edition), Avensis, 2009 Corolla (Japan), 2010 Prius

Volkswagen Passat, 2003 Phaeton, Touareg, 2009 Golf

Volvo S80, V70, XC70, XC60, S60.[10]

2.2 Techniques for Obstacle Detection

Various techniques have been used by the automobile systems above to detect obstacle and be able to take necessary action and below is a brief review of some of such techniques.

2.2.1 Optical techniques -: This includes the use of passive infrared, laser radar and vision sensors.

- Passive infrared -: these sensors measure the thermal energy emitted by an object within the vicinity of the sensor. Their main advantage is that they are relatively cheap and small in size, but they are unable to determine the precise distance from the detected object and also they have slow response time.
- Laser radar -: two techniques exist, one of which uses a high-power pulse beam of infrared light. While the other uses the amplitude of light which is modulated with sine wave. The pulse technique offer long range, high directionality and fast response time. It has the limitation of high cost, sensibility to external conditions (mud, poor visibility, and so on) and the need to keep the laser power with safe level.

- Vision system -: this technique is base on the use of video cameras and image processing software's. Their high cost and high sensitivity to environmental effect makes their use unlikely in most vehicle applications. Another problem associated with this technique is the large power required to process the images.

2.2.2 Electromagnetic techniques -: this include the use of FMCW (frequency modulated carrier wave) radar, impulse radar and capacitive sensors.

- FMCW radar -: this radar technique uses modulated high frequencies (typically of microwave frequencies), so that the frequency difference between the transmitted and reflected signal is proportional to the distance of the object ahead. In addition the Doppler shift on the reflected signal can be used to determine the relative speed between the vehicle and the object ahead. Despite the high cost, this technique has the merit of being insensitive to mud and poor visibility conditions and allows beam width to be modified depending on the particular application.
- Impulse radar -: this radar uses a short pulse instead of a continuous wave and it performs as well as the FMCW radar. It is susceptible to external electromagnetic interference.
- Capacitive sensors -: these sensor are able to detect close object (within the range of 2 meter), using the capacitance variation between electrodes excited at low frequencies, typically 5 kHz. Despite their limited range, they are relatively cheap and are robust to external environmental conditions. They may be useful in low speed collision warming such as obstacle detection during backing-up maneuvers.

2.2.3 Acoustic technique (Ultrasonic) -: this sensor works by measuring the Time-to-flight of a short burst of sound energy. The time taken for the ultrasonic waves to return from the obstacle is directly proportional to the distance between the obstacle and the reference object. The headway distance is obtained by measuring the time between transmitting a pulse and receiving a reflection. They have the merit of being relatively cheap but certain objects are likely to go undetected due to their poor reflection ability.

2.3 Benefit of this project

They system in this project has several benefits above other available systems. Some of such benefits are listed below.

- This project seeks to develop a system which is independent of the vehicle manufacturer, vehicle model or weather conditions but will function properly in any vehicle when properly installed.
- It incorporate a system to prevent both forward and rear-end collision with the ingenuity of triggering the brake light when a vehicle approaching from behind get to the critical distance (20 meter).
- Also the alarm system is a continuous alarm which varies as a function of the distance between the vehicle and the obstacle.
- This project uses low cost sensors and components to achieve safety in driving on the highway, hence it can be produced in large scale and it is also marketable.
- They radiation from the system has no lethal medical or environmental consequences and it is easily applicable on all roads independent of geographical location.

A block diagram of this system is shown in figure 2.0 below.

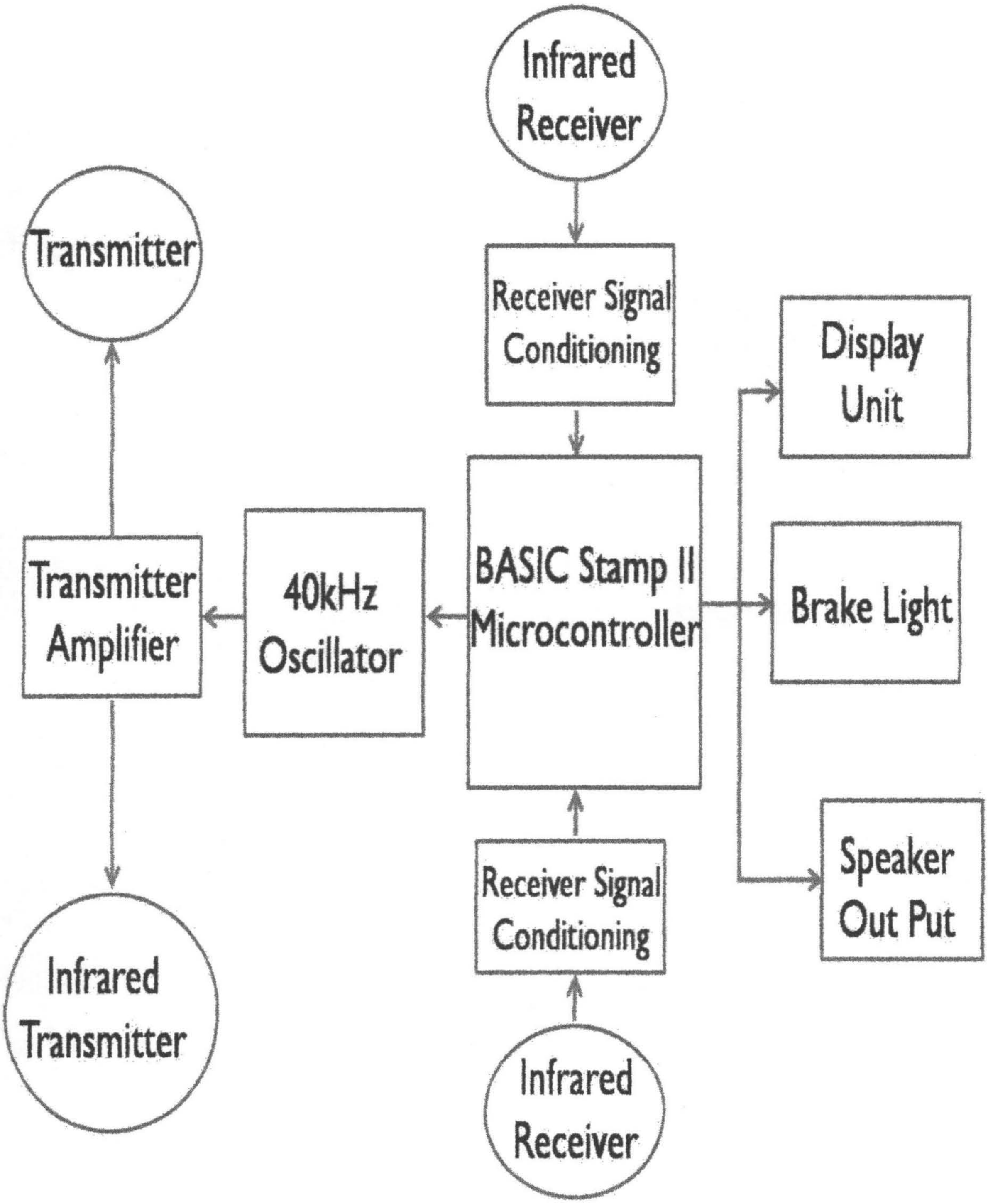


Fig2.0 Block diagram of a simple infrared radar system for accident prevention.

2.4 The microcontroller

A microcontroller is combination of a piece of microprocessor based hardware and the suitable software to undertake a specific task. There are several microcontrollers in the market from different manufacturers and with different specifications. The microcontroller used in this project is the AT89C52 which is a low power, high performance CMOS 8-bit microcontroller and it has the following features:

- 8k bytes of flash programmable and erasable read only memory (PEROM).
- 256 bytes of RAM
- 32 input/output lines
- Three 16-bit timer/counters
- A six-vector two-level interrupt architecture
- A full-duplex serial port
- An on–chip oscillator and
- Clock circuitry

In addition, the AT89C52 is designed with static logic for operation down to zero frequency and supports two software selectable power saver modes. The idle mode stops the CPU while allowing the RAM, timer/counter, serial port and the interrupt system to continue functioning. The power-down mode saves the RAM's contents and freezes the oscillator, thereby disabling all other chip functions until the next hardware reset. Below is the diagram of the microcontroller and its pin functions.[11]

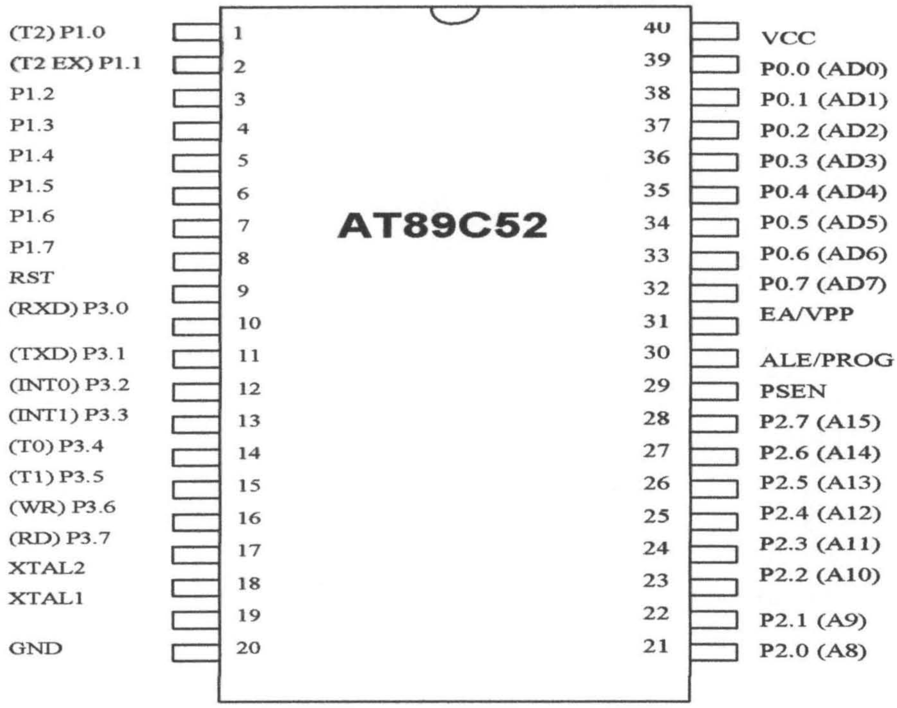


Fig 2.1 Top view of AT89C52

2.4.1 Pin Description

Vcc

Supply voltage.

GND

Ground

Port 0

Port 0 is an 8-bit open drain bi-directional I/O port. As an output port, each pin can sink eight TTL inputs. When 1s are written to port 0 pins, the pins can be used as high impedance inputs. Port 0 can also be configured to be the multiplexed low order address/data bus during accesses to external program and data memory. In this mode, P0 has internal pull-ups. Port 0 also receives the code bytes during Flash programming and outputs the code bytes during program verification. External pull-ups are required during program verification.

Port 1

Port 1 is an 8-bit bi-directional I/O port with internal pull-ups. The Port 1 output buffers can sink/source four TTL inputs. When 1s are written to Port 1 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 1 pins that are externally being pulled low will source current (IIL) because of the internal pull-ups. In addition, P1.0 and P1.1 can be configured to be the timer/counter 2 external count input (P1.0/T2) and the timer/counter 2 trigger input (P1.1/T2EX), respectively, as shown in the following table. Port 1 also receives the low-order address bytes during Flash programming and verification.

Port Pin Alternate Functions

P1.0 T2 (external count input to Timer/Counter 2), clock-out

P1.1 T2EX (Timer/Counter 2 capture/reload trigger and direction control)

Port 2

Port 2 is an 8-bit bi-directional I/O port with internal pull-ups. The Port 2 output buffers can sink/source four TTL inputs. When 1s are written to Port 2 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 2 pins that are externally being pulled low will source current (IIL) because of the internal pull-ups. Port 2 emits the high-order address byte during fetches from external program memory and during accesses to external data memory that uses 16-bit addresses (MOVX @ DPTR). In this application, Port 2 uses strong internal pull-ups when emitting 1s. During accesses to external data memory that uses 8-bit addresses (MOVX @ RI), Port 2 emits the contents of the P2 Special Function Register. Port 2 also receives the high-order address bits and some control signals during Flash programming and verification.

Port 3

Port 3 is an 8-bit bi-directional I/O port with internal pull-ups. The Port 3 output buffers can sink/source four TTL inputs. When 1s are written to Port 3 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (IIL) because of the pull-ups. Port 3 also serves the functions of various special features of the AT89C51, as shown in the following table. Port 3 also receives some control signals for Flash programming and verification.

Port Pin Alternate Functions

P3.0 RXD (serial input port)

P3.1 TXD (serial output port)

P3.2 INT0 (external interrupt 0)

P3.3 INT1 (external interrupt 1)

P3.4 T0 (timer 0 external input)

P3.5 T1 (timer 1 external input)

P3.6 WR (external data memory write strobe)

P3.7 RD (external data memory read strobe

RST

Reset input. A high on this pin for two machine cycles while the oscillator is running resets the device.

ALE/PROG

Address Latch Enable is an output pulse for latching the low byte of the address during accesses to external memory. This pin is also the program pulse input (PROG) during Flash programming.

In normal operation, ALE is emitted at a constant rate of 1/6 the oscillator frequency and may be used for external timing or clocking purposes. If desired, ALE operation can be disabled by setting bit 0 of SFR location 8EH. With the bit set, ALE is active only during a MOVX or MOVC instruction. Otherwise, the pin is weakly pulled high. Setting the ALE-disable bit has no effect if the microcontroller is in external execution mode.

PSEN

Program Store Enable is the read strobe to external program memory. When the AT89C52 is executing code from external program memory, PSEN is activated twice each machine cycle, except that two PSEN activations are skipped during each access to external data memory.

EA/VPP

External Access Enable. EA must be strapped to GND in order to enable the device to fetch code from external program memory locations starting at 0000H up to FFFFH. Note, however, that if lock bit 1 is programmed, EA will be internally latched on reset. EA should be strapped to VCC for internal program executions. This pin also receives the 12-volt programming enable voltage

(VPP) during Flash programming when 12-volt programming is selected.

XTAL1

Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

XTAL2

Output from the inverting oscillator amplifier.

2.5 CD4047B IC

This is a low power monostable/ astable multivibrator IC. It requires capacitor (between pins 1 and 3) and an external resistor (between pins 2 and 3) to determine the output pulse width in monostable mode and the output frequency in the astable mode. The astable operation is enabled by a level on the astable input or a low level on the astable input. The monostable operation is obtained the device is triggered by low-to-high transition at positive (+) trigger input or high-to-low transition at the negative (-) trigger. A high level on Reset input resets the outputs Q to low, Q to high. Below is a diagram of the IC and its pins function.[12]

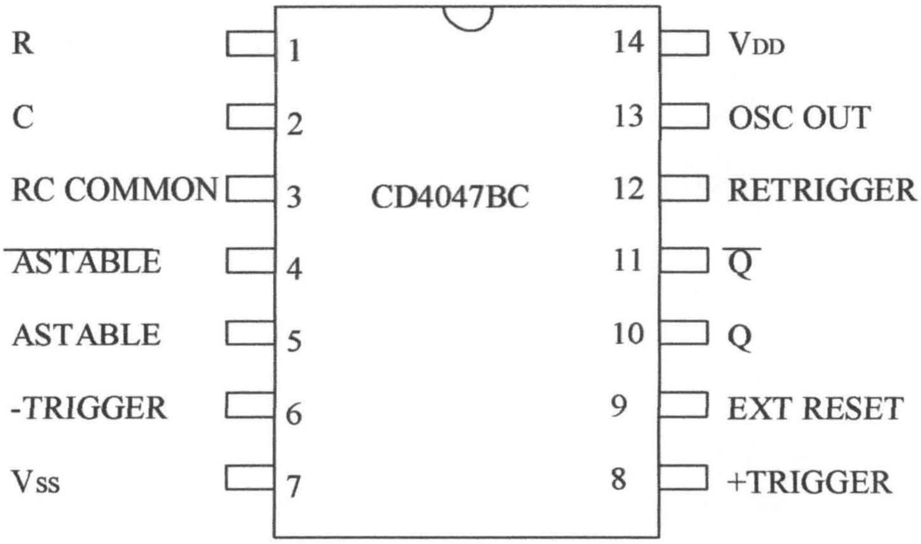


Fig2.2 Top view of CD4047BC

2.5.1 Features

- Wide supply voltage range 3.0V to 15V
- High noise immunity 0.45 VDD (typ.)
- Low power TTL Fan out of 2 driving 74L compatibility or 1 driving 74LS

2.5.2 Special features

- Low power consumption: special CMOS oscillator configuration
- Monostable (one-shot) or astable (free-running) operation
- True and complemented buffered outputs
- Only one external R and C required

2.5.3 Applications

- Frequency discriminators
- Timing circuits

- Time-delay applications
- Envelope detection
- Frequency multiplication
- Frequency division

2.6 TSOP1738 IC

This is a 38 kHz infrared receiver IC. It has three pins; Pin 1 is ground (GND), Pin 2 is Vs and Pin 3 is the output. The demodulated output signal can directly be decoded by a microprocessor. The diagram of the IC and its pins function is shown below.[13]

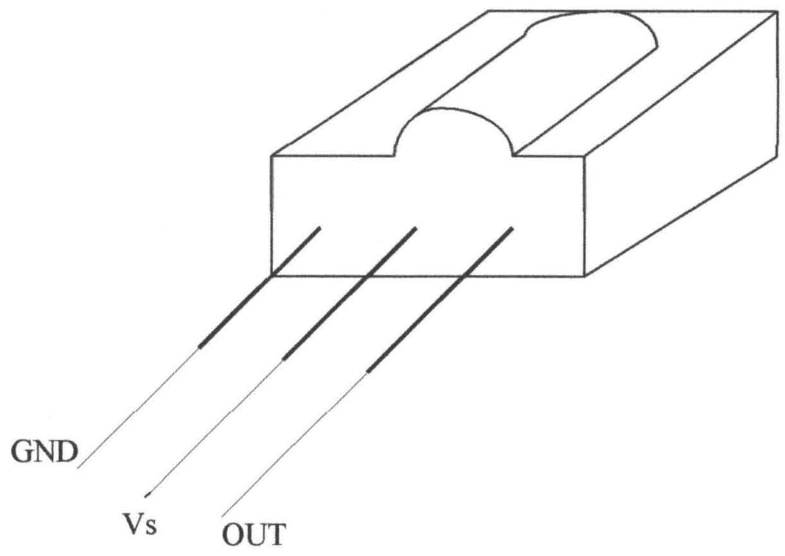


Fig2.3 Top view of TSOP1738

2.6.1 Features

- Photo detector and preamplifier in one package
- Internal filter for PCM frequency
- Improved shielding against electrical field disturbance
- TTL and CMOS compatibility
- Output active low
- Low power consumption

- High immunity against ambient light
- Continuous data transmission possible (up to 2400 bps)
- Suitable burst length of 10 cycles/burst

CHAPTER THREE

DESIGN AND IMPLEMENTATION

3.0 System Analysis

The design of this accident prevention mechanism is broken down into six different modules which include the power supply unit, the infrared transmitter module, the infrared receiver module, the oscillator circuit module, the microcontroller module and the alarm circuit module.

3.1 The power supply unit

This system is power from the car battery which is 12 volts, 60A DC supply. This is fed to the system through a 9 volts voltage regulator (7809) IC. This is because the system requires a 9 volts supply to operate. The circuit diagram of the voltage regulator is shown below.

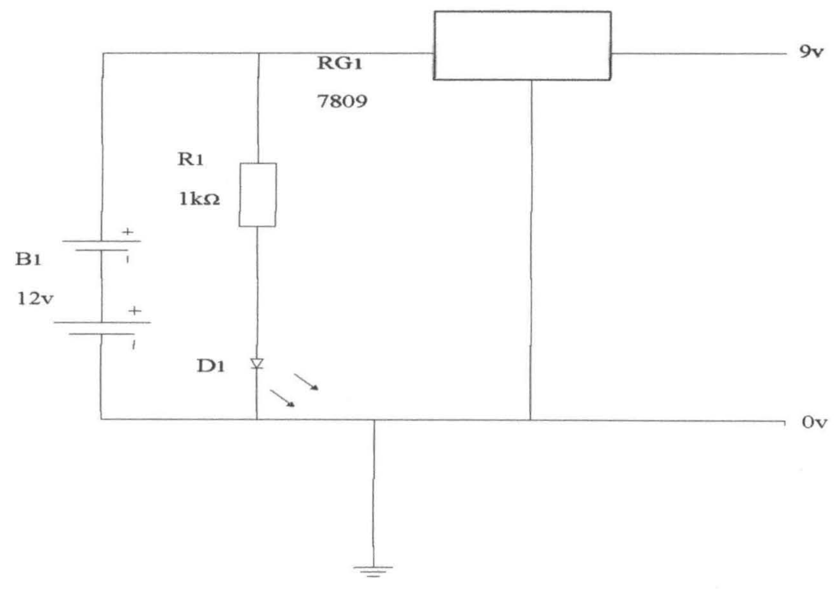


Fig3.1 9V Regulator Circuit

This voltage is further regulated to 5 volts using the 7805 voltage regulator IC, so that the microcontroller unit will be supplied with the appropriate voltage and below is the circuit diagram.

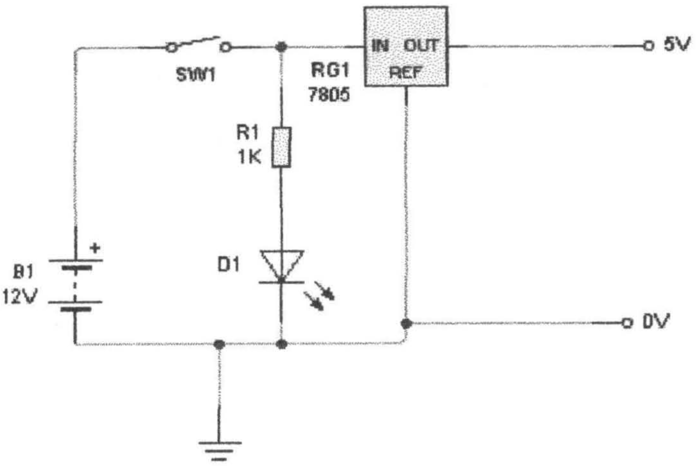


Fig 3.1 5V Regulator Circuit

Diode D1 is a power supply indicator LED and normally draws a current of about 10mA and comes ON at a voltage of about 1.7 volts. Hence,

$12 = 1.7 + IR1 = 1.7 + (10mA)*R1$

$R1 = (12 - 1.7)/ 10mA$

$R1=1030\Omega$

For this design $1k\Omega$ resistor will be used.

3.2 Infrared transmitter circuit module

The infrared transmitter used in this system design has a range of about 10 meter but a laser pointer may also be used to achieve a longer range of distance. However, with a very narrow beam from the laser pointer, extra care has to be taken, lest a small jerk to the gadget may change the beam orientation and cause loss of contact. This system uses three infrared transmitting LEDs (IR1 through IR3) in series to increase the radiated power. To increase the directivity and so also the power density, the infrared LEDs are assembled inside the reflector of a torch. For increasing the circuit efficiency, a MOSFET (BS170) has been used, which acts as a switch and to avoid any dip during its turn on/turn off operations, a 100μF reservoir capacitor C2 is used across the supply. The circuit diagram is shown below.cc

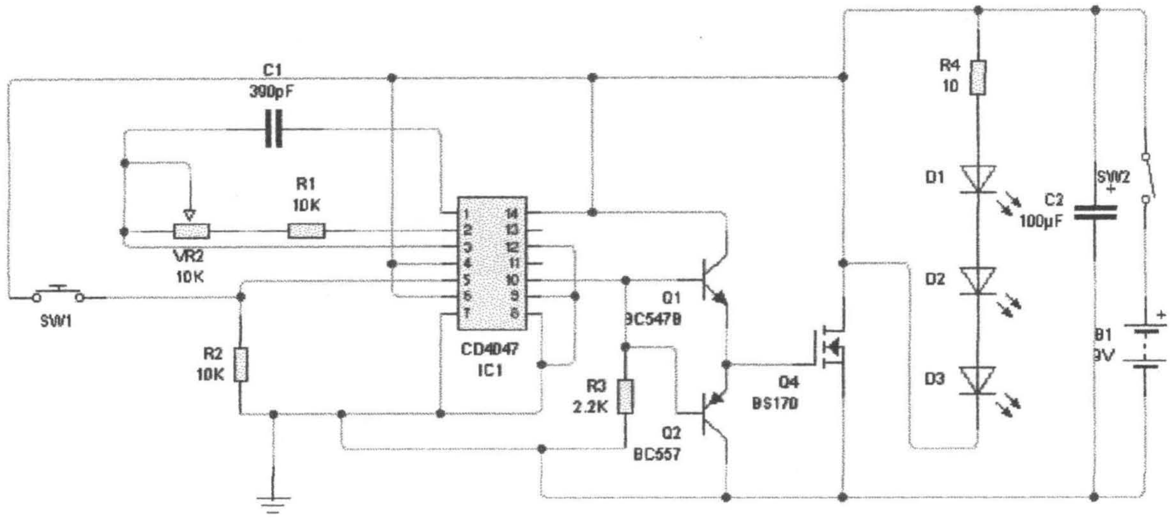


Fig3.2 Infrared Transmitter Circuit

Capacitor C2 supplies extra charge during 'switching on' operations. As the MOSFET exhibits large capacitance across gate-source terminals, a special drive arrangement has been made using npn-pnp Darlington pair of BC547 and BC557 (as emitter followers), to avoid distortion of the gate drive input. The CD4047 IC is a pulse width modulator and generates a 38kHz frequency which is used to drive the infrared transmitter. The microcontroller modulates the transmission of infrared signal through the switch SW1 which is connected to pin 5 of the IC. Two of these transmitter circuit modules will be used in this system design for both the front and the rear of the vehicle.

For a frequency of 38kHz, period $t = 1/38kHz = 2.6316 \times 10^{-5}s$.

$t = 4.40R_1 \times C_1$

$C_1 = 390pF$

$R_1 = t/4.40C_1 = 2.6316 \times 10^{-5}/ (4.40 \times 390 \times 10^{-12})$

$R_1 = 15335.5\ \Omega$

A combination of a 10kΩ resistor and a 10kΩ variable resistor will be used.

The infrared LED D1, D2 and D3 normally draw a current 10mA and have an individual ON voltage of 1.7V dc. Hence,

$9V = 3(1.7) + IR_4 = 5.1 + R_4\,(10 \times 10^{-3})$

$R_4 = (9 - 5.1) / 10 \times 10^{-3} = 390\Omega$

For convenience, a 470Ω resistor will be used.

3.3 Infrared receiver circuit module

The infrared receiver module used in this design is TSOP1738 module which is a 38kHz receiver with three pins. Pin 1 is connected to the ground; Pin 2 is connected to Vs while Pin 3 is the output. The receiver module is supplied through the 5 volts voltage regulator IC. Below is the circuit diagram of the infrared receiver circuit module.

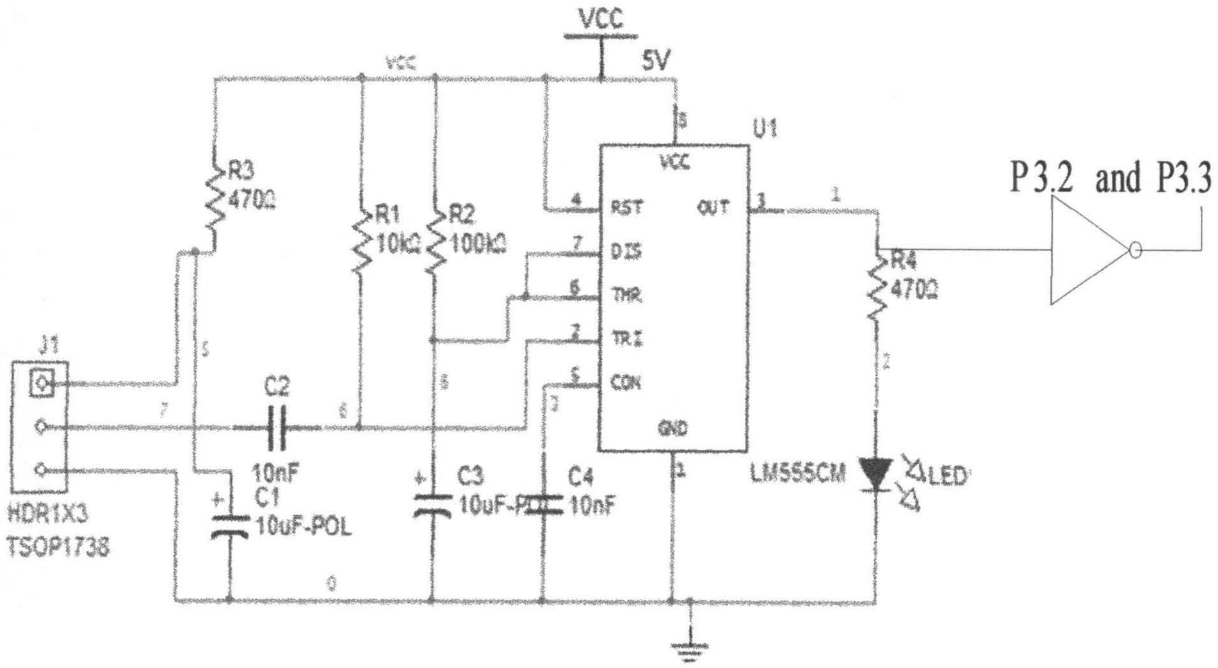


Fig3.3 Infrared Receiver Circuit

The output of the infrared receiver is used to trigger the LM555CM such that LED1 which serve as a reception indicator is lighted up once the TSOP1738 pick up an infrared signal. The output of the TSOP1738 serves as a trigger to the 555 timer which is connected in monostable mode.

The pulse width $t_p = 1.1 \times R_3C_3 = 1.1 \times 100 \times 10^3 \times 10 \times 10^{-6} = 1.1\text{sec}$

Hence, the output pulse of the receiver will last for 1.1sec when it is triggered by a 38kHz infrared signal.

This output serves as the input to the to the external interrupt pin of the microcontroller (P3.2 and P3.3) through a NOT gate since the interrupt of AT89C52 is a falling edge interrupt.

In this system design, two infrared receiver circuit modules will be used for the front and rear of the vehicle. One is connected to P3.2 and the other to P3.3.

3.4 The alarm circuit module

The alarm system is design such that the output frequency varied from the output frequency of the microcontroller. A buzzer is used. Two of such alarm is used in this system for the front (P1.0) and rear (P1.1) of the vehicle. Below is the circuit diagram of the alarm circuit module.

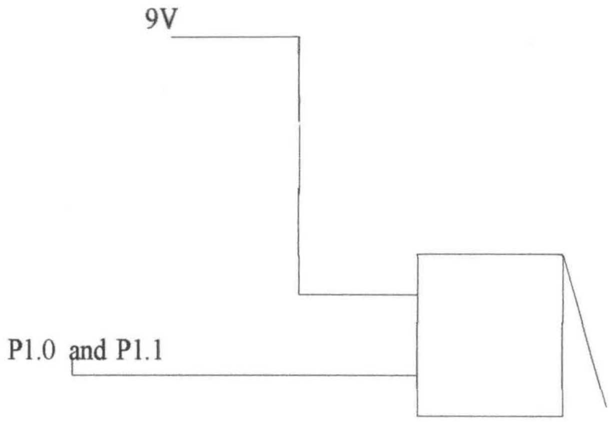


Fig3.4 Alarm circuit

3.5 The display unit

This unit displays the approximate distance between the vehicle and the obstacle ahead and behind it. A liquid crystal display (lcd 1602) is used in this unit. It is connected to the port two (P2) of the microcontroller and it is connected in the 4 bit mode. The first line of the lcd displays the front distance while the second line displays the back distance. The connection of the display unit is shown below.

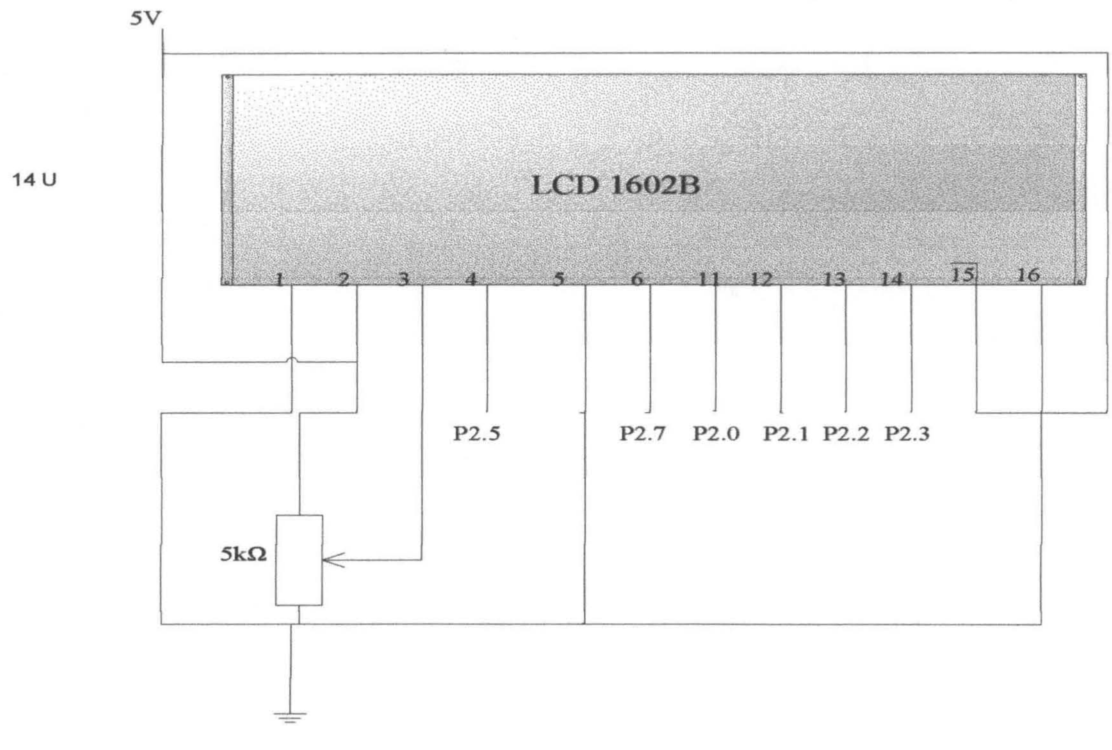


Fig3.5 Display unit

3.5 The microcontroller circuit module

This unit controls all the other units of the system. An AT89C52 microcontroller is used in this design. The infrared transmitters, infrared receivers, alarm circuit and brake light are all connected to this unit. The microcontroller is programmed to pulse the infrared transmitters for 10ms at an interval of 90ms. It is expected that any reflection from any object will be detected by the infrared receiver within this interval.

Taking the speed of infrared light as

$$C = f\lambda = 3.8 \times 10^4\, Hz \times 10\, m = 3.8 \times 10^5\, ms^{-1}$$

Where f = frequency of transmission of the infrared transmitter = 38 kHz, and

λ = wave length of infrared light = 10m, in 90ms the distance x travelled by the infrared light and reflect back to the point of transmission will be given by:

$$x = \frac{C \times t}{2} = \frac{3.8 \times 10^5 \times 90 \times 10^{-3}}{2} = 34200m$$

This implies that within the interval of 90ms, an object within this distance could be detected.

Below are the pins of the microcontroller that will be used and their functions.

Table 3.1 AT89C52 microcontroller pin function

Pin	Function
P1.0 T2	External count input to Timer, clock-out
P1.1 T2EX	Timer/Counter 2 capture/reload trigger
P1.3	Bi-directional input
XTAL 1	Input to the inverting oscillator amplifier and input to the internal clock operating circuit
XTAL 2	Output from the inverting oscillator amplifier
VCC	Supply voltage
P 2 (A8 – A15)	Bi-directional I/O port
P3.2(INT0)	external interrupt 0
P3.3(INT1)	external interrupt 1

P3.4(T0)	timer 0 external input
P1.6	Bi-directional input
P1.7	Bi-directional input
RST	Reset Pin
GND	Ground

3.5.1 Connections of the microcontroller unit

- P 1.0 Front Alarm
- P 1.1 Back Alarm
- P 1.3 Brake light
- P 1.6 Front Infrared Transmitter
- P 1.7 Back Infrared Transmitter
- P 3.2 Front Infrared Receiver
- P 3.3 Back Infrared Receiver
- P 2 Liquid Crystal Display (LCD)

3.6.2 Microcontroller programming

The microcontroller is programmed to pulse the front transmitter for 100ms at an interval of 900ms. Within this interval, the back transmitter is then pulse for the same time and interval. This is to avoid the receivers from detecting infrared signal at the same time and causing a double interrupt thereby forcing the microcontroller to mask one of the interrupt. Hence the system will not function properly since only one of the interrupt subroutine (ISR) will be executed.

Upon detecting an infrared signal (at 38 kHz) the interrupt pin of the microcontroller is asserted and this will force the microcontroller to save it current state and jump to the address of the ISR and execute its instructions, and in this case, it will calculate the distance of the obstacle that reflected the infrared signal from the time difference between the time of transmission and the time of reception. This distance is then displayed on the LCD and also the microcontroller triggers the front or back alarm depending on which receiver interrupt was triggered. The frequency of the alarm is varied by the microcontroller according to the calculated distance. The programming of the microcontroller was done using embedded C programming language.

See appendix for detailed program code.

The complete circuit diagram of the entire system and the flow chart are shown the pages that follow.

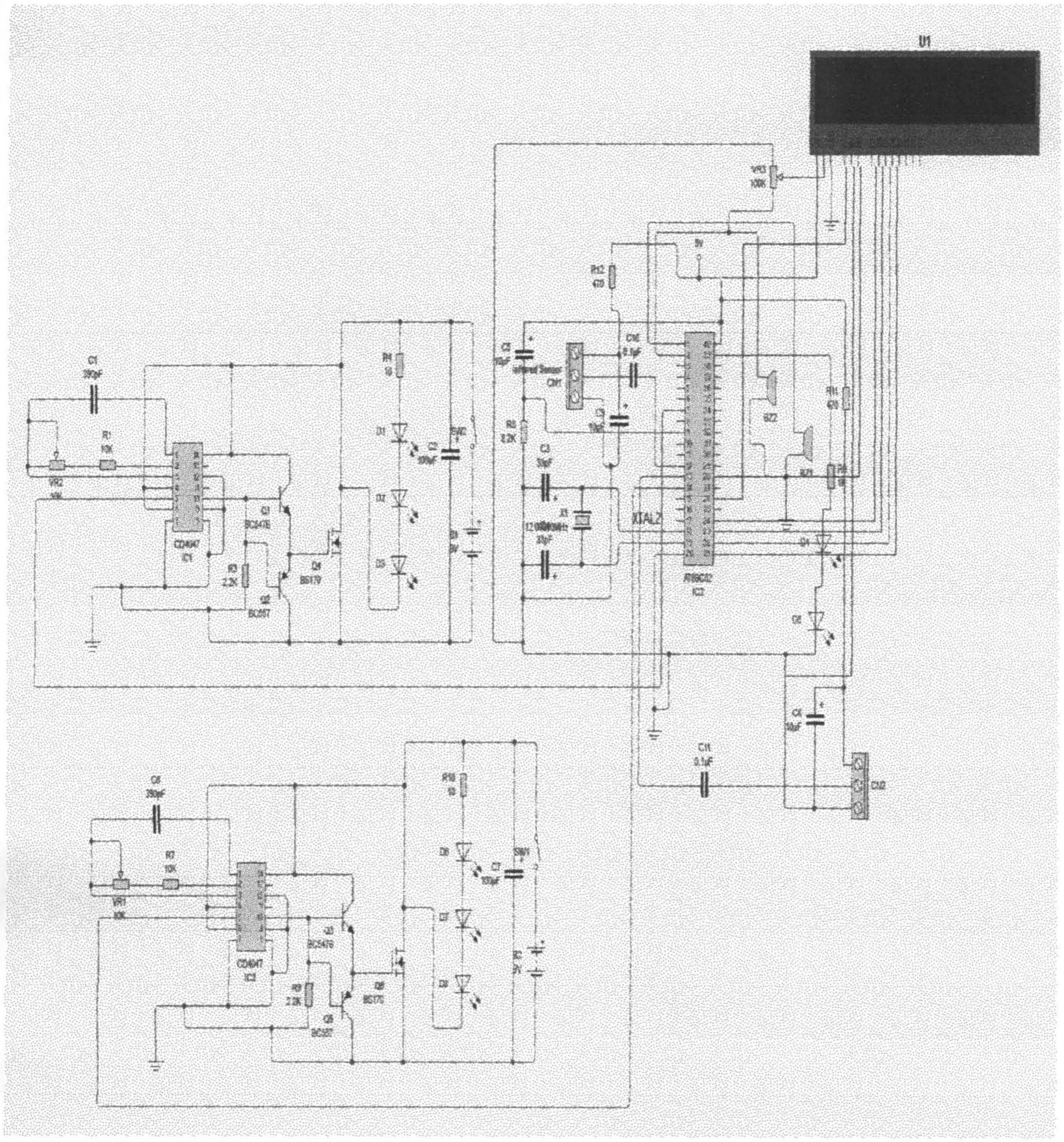
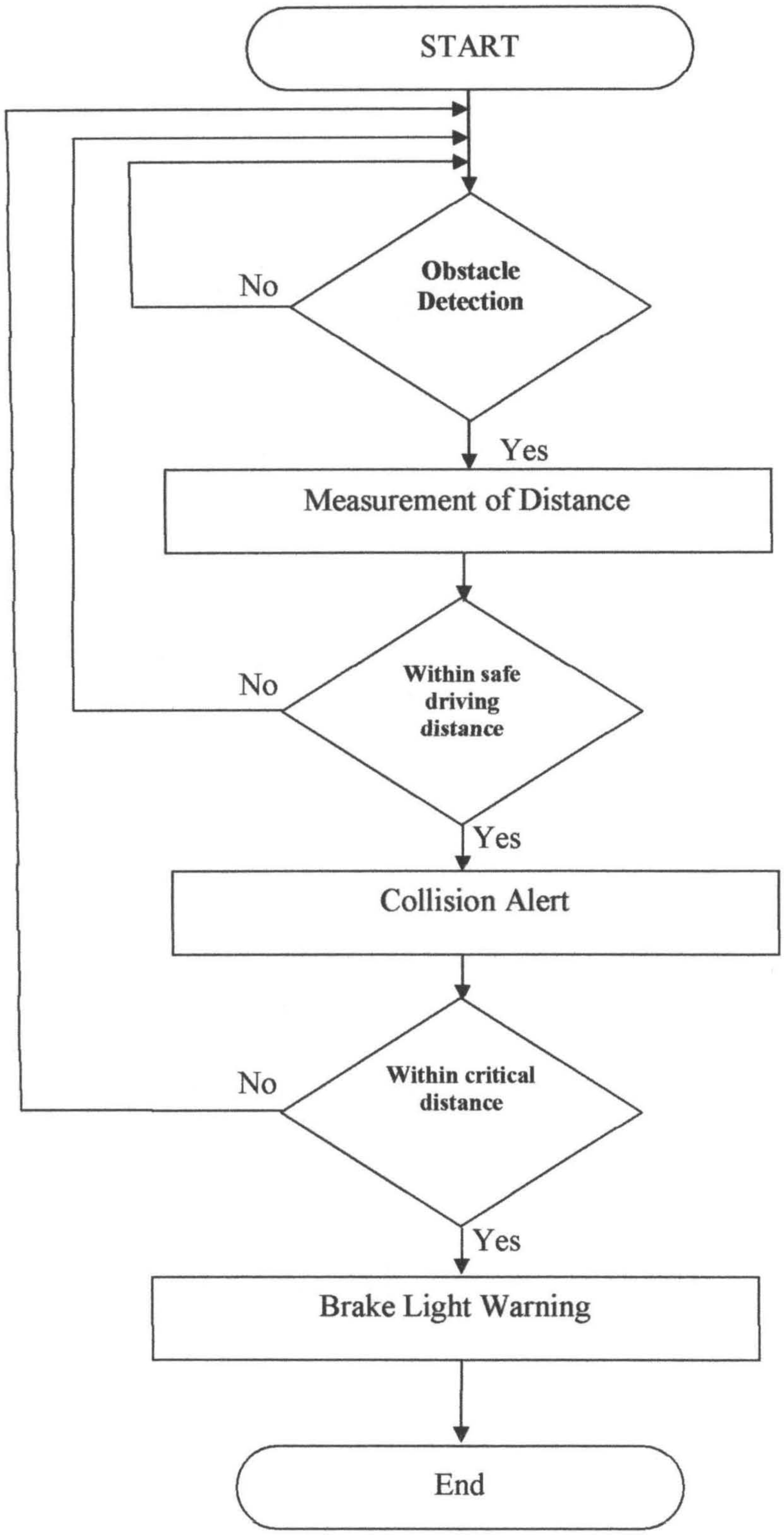
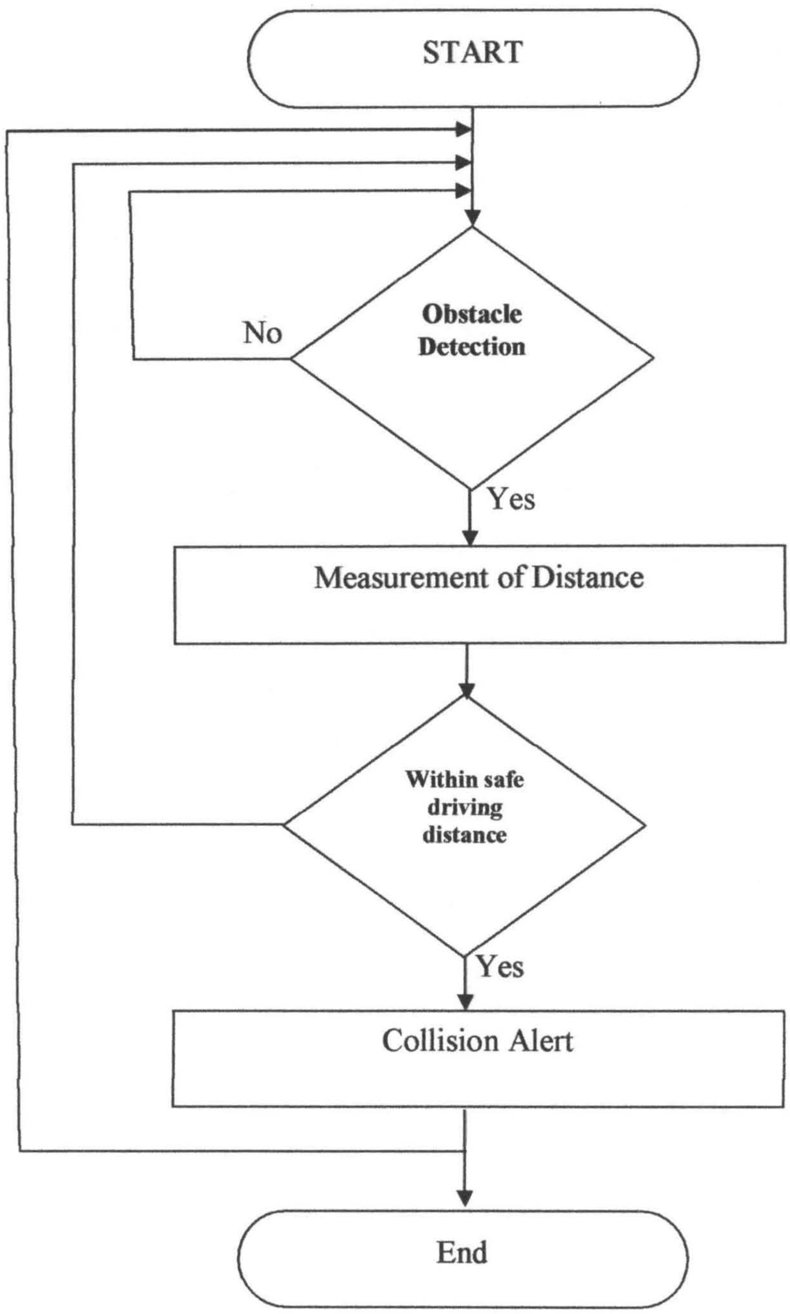


Fig3.6 Complete circuit

Flow Chart



Rear end of vehicle



Front End of vehicle

CHAPTER FOUR

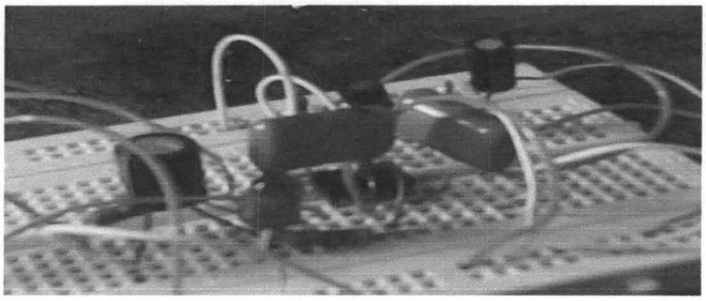
TEST, RESULT AND DISCUSSION OF RESULT

4.0 Component test

They various components which includes; Resistors, Capacitors, Transistors, Infrared transmitter LEDs, TSOP1738, Buzzers, 555 timer ICs, Voltage regulator ICs(7805 and 7809), Oscillator IC, Liquid Crystal Display, LED indicators and the microcontroller IC(AT89C52) that makes up the different circuit modules were all tested using a digital multi-meter to confirm their rated values and that they are functioning properly.

4.1 Bread board Test

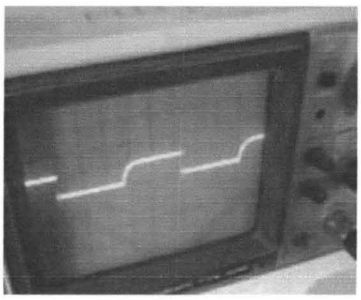
They various circuit modules were first constructed on a bread board to confirm the feasibility of the circuit diagram. This includes the transmitter circuit, receiver circuit, the display unit, and the microcontroller unit.



4.2 Transmitter circuit test

After the construction of the infrared transmitter on the bread board, various tests were carried out on it and this includes:

Transmission frequency test: - The output of the infrared transmitter was connected to an oscilloscope and the transmission frequency was set to about 38 kHz by varying the variable resistorVR_2.



$\frac{t}{div} = 5\mu s, \qquad number\ of\ division = 5.2$

$period\ t = 5 \times 10^{-6} \times 5.2 = 26\mu s,$

Hence the frequency of transmission $f = \frac{1}{t} = \frac{1}{26 \times 10^{-6}} = 38461\ Hz$

Resistance of the variable resistor at this frequency was measured using a digital multimeter and VR_2 was found to be 5.82 kΩ.

Voltage before pulsing: - The output voltage (voltage across infrared LEDs) before the infrared transmitter is pulsed was measured using a digital multimeter and it was equal to 4.48V dc.

Voltage during pulsing (V): - The output voltage when the transmitter is pulsed was also measured using a digital multimeter and was found to be 8.86V.

Voltage after pulsing: - The output voltage of the transmitter after the pulse was equal to the voltage before pulse.

Current drawn by the infrared LEDs (I): - The current drawn by the infrared LEDs was measured and found to be equal to 0.01A.

Power output of infrared transmitter: - $P_0 = IV = 8.86 \times 0.01 = 88.6\ mW$

4.3 Receiver circuit test

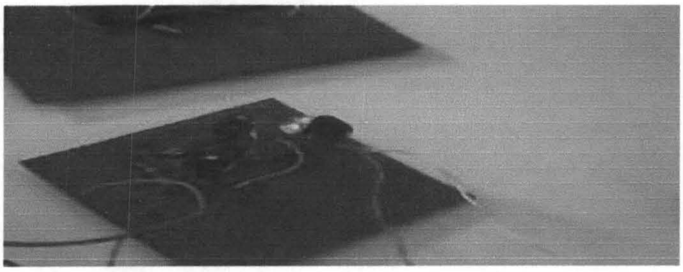
Voltage across the infrared receiver before reception of infrared signal (38kHz) = 4.48V dc

Voltage across the receiver upon reception of signal =0.02V dc

Output voltage of the 555 timer before the receiver detected a signal = 0.00V

Output voltage of the 555 timer when the receiver detects a signal = 4.48V dc

This indicates that the infrared receiver circuit is functioning properly since the infrared receiver IC (TSOP1738) operates in the active low state and since the output of the IC serves as the trigger of the timer circuit which is connected in monostable mode, the output of the timer will go high for 1.1s once the IC detects any infrared signal at its operating frequency.



4.4 Programming test

After the program was written according to the flow chart using embedded C programming language, it was burned into the microcontroller through a programmer. It was then use to drive the functions of the various circuits and this includes: pulsing the transmitters at the right interval, checking the receiver circuit for any reception, calculating the approximate distance of the object reflecting the infrared signal, displaying this distance on the lcd and driving the alarm at three different frequencies. It continues to loop this process for both the front and the rear of the vehicle at a second interval. The program was found to function properly.

4.4 Alert system test

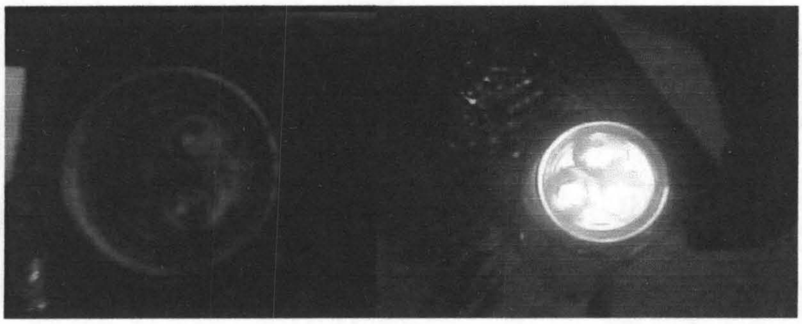
The alarms were tested to verify if the output frequency changes with distance and they were found to function properly. The brake light is trigger when an obstacle from the rear is within the critical distance.

After construction of the various modules on the Vero board, they were retested before combination into a single unit and cased in a plastic casing. The final testing of the prototype of the system was done using a remote controlled toy car on a cleared path with obstacles placed at different distances or locations. The system was found to function but not with certain limitations.

4.5 Limitations

This system as in every other system experienced certain limitation and below is a list of some of such limitations.

- Multiple reflections from the dispersion of the infrared light and this occur due to the inability of the torch reflector to properly focus the infrared light.

  Hence it is advisable that infrared laser of control power should be carefully used. This is to avoid the danger of laser beam which includes burns and damage of the eyes.
- Fading of the infrared signal in the presence of sunlight or ultra-violet light and the effect of this could be drastically reduced by improving on the sensitivity of the infrared receiver.
- Relative velocity of the infrared signal since the vehicle is also in motion and this was not accounted for in this system.
- Noise signal from other infrared source that modulate in the bandwidth of which the frequency of transmission and reception (38kHz) is within its range. An example of such source is the SHARP remote controls.
- Simulation of vehicle speed was not possible

See appendix and appendix for user manual and troubleshooting techniques and also appendix for cost analysis of the system.

CHAPTER FIVE

CONCLUSION

5.0 Conclusion

This project is the implementation of an idea to enhance safety on the road using infrared RADAR. The various modules of this system were constructed and tested to function properly. But due to the various limitations of the system, most especially the dispersion of the infrared signal, the overall performance of the system was inaccurate. The distance measurement of the system was found to be imprecise and the triggering of the alert by the microcontroller was hence uncoordinated. If these limitations are properly tackled and this system is implemented and properly installed, the aims of the project will be gracefully achieved. The functionality of this system is independent of car manufacturer or car model once properly installed.

Also in this system, the parameter for collision alert was only the approximate distance between the vehicle and the obstacle. Further work can also be done on including the speed of the vehicle as a parameter.

Also in this system, the switching circuit was not implemented since it was dependent on the speed of the vehicle.

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Appendix

Program Code

```
#include <reg52.h>
#define lcd_port P2
 #define LCD_en  0x80
 #define LCD_rs  0x20
 sbit ir_tx2   = P3^4;
 sbit ir_tx1   = P1^6;
 unsigned int count;
 unsigned char diff1;
 unsigned char diff2;
double dist_front;
double dist_back;
unsigned int count2;
sbit alarm1 = P1^0;
sbit alarm2 = P1^1;
bit john;
sbit led = P1^2;



 const double speed_light = 3.8e-1;
 unsigned char *val[] = {"0","1","2","3","4","5","6","7","8","9","10","11","12","13","14","15"};
 void wait_second()
   {
              unsigned int x;
                     for(x = 0; x < 33000; x++);
          }
  void LCD_busy()
{
       unsigned char i,j;
       for(i=0;i<50;i++)        //A simple for loop for delay
         for(j=0;j<255;j++);
}
void  reset_LCD()
   {
              lcd_port = 0xFF;
      LCD_busy();
      lcd_port = 0x03+LCD_en;
      lcd_port = 0x03;
      LCD_busy();
      lcd_port = 0x03+LCD_en;
      lcd_port = 0x03;
      LCD_busy();
      lcd_port = 0x03+LCD_en;
      lcd_port = 0x03;
      LCD_busy();
      lcd_port = 0x02+LCD_en;
      lcd_port = 0x02;
      LCD_busy();
          }

void lcd_cmd(unsigned char ch)
   {
             lcd_port = ((ch >> 4)&0x0F)|LCD_en;
```

```
        lcd_port = ((ch >> 4)&0x0F);

        lcd_port = (ch &0x0F)|LCD_en;
        lcd_port = (ch &0x0F);
                LCD_busy();
                LCD_busy();
          }
void send_data(unsigned char info)
  {
          lcd_port = (((info >> 4)&0x0F)|LCD_en|LCD_rs);
        lcd_port = (((info >> 4)&0x0F)|LCD_rs);

        lcd_port = ((info&0x0F)|LCD_en|LCD_rs);
        lcd_port = ((info&0x0F)|LCD_rs);

        LCD_busy();
                LCD_busy();
          }

void send_string(unsigned char *ch)
  {
          while(*ch)
                send_data(*ch++);
          }
void LCD_init()
  {
                reset_LCD();       // Call LCD reset
        lcd_cmd(0x28);      // 4-bit mode - 2 line - 5x7 font.
        lcd_cmd(0x0C);      // Display no cursor - no blink.
        lcd_cmd(0x06);      // Automatic Increment - No Display shift.
        lcd_cmd(0x80);      // Address DDRAM with 0 offset 80h.
          }

          void init_timer1()
          {
              ET1   = 1;
              TMOD  = 0x10;          // 50ms delay
                  TL1   = 0xB0;
              TH1   = 0x3C;
                  EX1 = 1;
                  EA    = 1;
                  ir_tx2 = 1;
                  TR1   = 1;


          }

          void init_timer0()
          {
              ET0   = 1;
              TMOD  = 0x01;
                  TL0   = 0xB0;
              TH0   = 0x3C;
                  EX0 = 1;
                  EA    = 1;
                  ir_tx1 = 1;
                  TR0   = 1;


          }
```

```
void convert(double value)
{
		unsigned int first,second; //,third,fourth,n;
		  value *= 100;
		  first = (int) value/10;
			second = value - 10*first;
			//second = n/100;
			//n = n - 100*second;
			//third = n/10;
			//fourth = n - 10*third;
			lcd_cmd(0x01);
			lcd_cmd(0x80);
			send_string("0.");
			lcd_cmd(0x82);
			send_string(val[first]);
		  lcd_cmd(0x83);
			send_string(val[second]);
			lcd_cmd(0x85);
			//send_string(val[third]);
			//lcd_cmd(0x83);
			//send_string(val[fourth]);
			//lcd_cmd(0x86);
			send_string("metre");
			alarm1 = 0;
}

void convert_2(double value)
 {
	unsigned int first,second, third, n;
		value *= 100;
		first = (int)value/100;
		n = value - 100*first;
		second = n/10;
		third = n - 10*second;
		lcd_cmd(0x01);
		lcd_cmd(0x80);
		send_string(val[first]);
		lcd_cmd(0x82);
		send_string(".");
		lcd_cmd(0x83);
		send_string(val[second]);
		lcd_cmd(0x84);
		send_string(val[third]);
		lcd_cmd(0x86);
		send_string("metre");
		if(value > 0 && value < 300)
		   alarm1 = 0;
 }
void convert2(double value)
{
		unsigned int first,second; //,third,fourth,n;
		  value *= 100;
		  first = (int)value/10;
			second = value - 10*first;
			//second = n/100;
			//n = n - 100*second;
			//third = n/10;
			//fourth = n - 10*third;
			lcd_cmd(0x01);
```

```
                lcd_cmd(0xc0);
                send_string("0.");
                lcd_cmd(0xc2);
                send_string(val[first]);
            lcd_cmd(0xc3);
                send_string(val[second]);
                //lcd_cmd(0xc2);
                //send_string(val[third]);
                //lcd_cmd(0xc3);
                //send_string(val[fourth]);
                lcd_cmd(0xc5);
                send_string("metre");
                alarm2 = 0;
                led  = 1;
}

void convert2_2(double value)
 {
    unsigned int first,second, third, n;
        value *= 100;
        first = (int)value/100;
        n = value - 100*first;
        second = n/10;
        third = n - 10*second;
        lcd_cmd(0x01);
        lcd_cmd(0xc0);
        send_string(val[first]);
        lcd_cmd(0xc2);
        send_string(".");
        lcd_cmd(0xc3);
        send_string(val[second]);
        lcd_cmd(0xc4);
        send_string(val[third]);
        lcd_cmd(0xc6);
        send_string("metre");
        if(value > 0 && value < 300)
            alarm2 = 0;
 }
void receive_ir0() interrupt 0
{

                diff1 = 0xB0 - TL1;
                TR1 = 0;
                ir_tx2 = 0;
                dist_front = (diff1*speed_light)/2;
                if(diff1 < 6)
                 {
                   convert(dist_front);
             }
                else
                 {
                      convert_2(dist_front);
                    }
}

void receive_ir1() interrupt 2
{
                diff2 = 0xB0 - TL0;
                TR0 = 0;
                ir_tx1 = 0;
```

```
                dist_back = (diff2*speed_light)/2;
                if(diff2 < 6)
                  {
                    convert2(dist_back);
                        }
                else
                  {
                        convert2_2(dist_back);
                        }
}
void timer1_isr()    interrupt 3
 {


                  F0 = 1;
                        ir_tx2 = 0;
                        return;


 }
 void timer0_isr()    interrupt 1
 {


                  john = 1;
                        ir_tx1 = 0;
                        return;

 }


 void main()
{
            alarm1 = 1;
                  alarm2 = 1;
                  count = 0;
            ir_tx2 = 0;
                  count2 = 0;
                  ir_tx1 = 0;
            LCD_init();
                  send_string("WELCOME");
                  for(count = 0; count < 5; count++)
                      wait_second();
            lcd_cmd(0x01);
                  send_string("ACCIDENT PREVENT");
                  lcd_cmd(0xC3);
                  send_string("MECHANISM");
                  for(count = 0; count < 5; count++)
                      wait_second();
                  for(;;)
                    {
                        init_timer1();
                                    wait_second();
                                    init_timer0();
                                    wait_second();


                    }

}
```

\

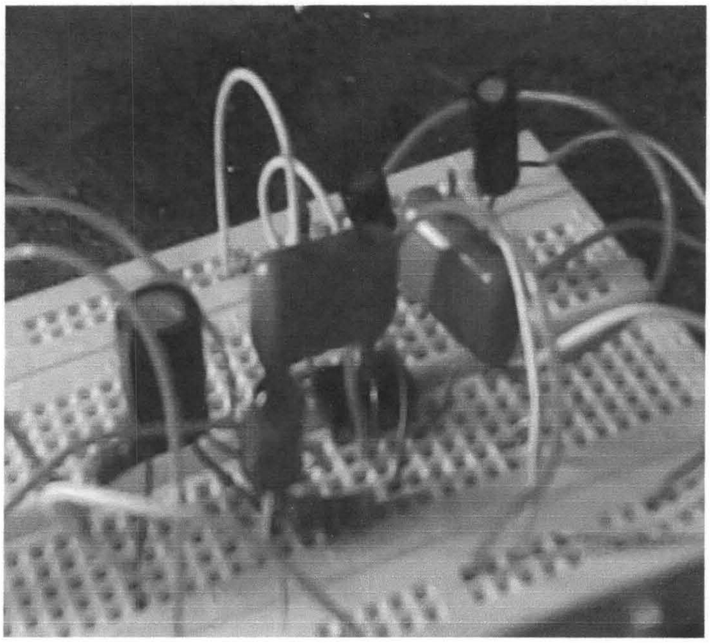
COST ANALYSIS

Components	Price (naira)
Vero-board	200
Connecting wires	100
Resistors	200
Infrared transmitter LEDs (6)	500
TSOP1738 (2)	300
Buzzer (2)	300
Voltage regulator ICs	100
Capacitors	300
LCD	1500
4069 IC	100
AT89S52	1000
Crystal oscillator	150
Battery (3)	150
LED	40
BS 170 IC	250
BC 557 (2)	50
BC 547 (2)	50
4047 IC (2)	50
Touch reflectors (2)	200
Total	**5540**

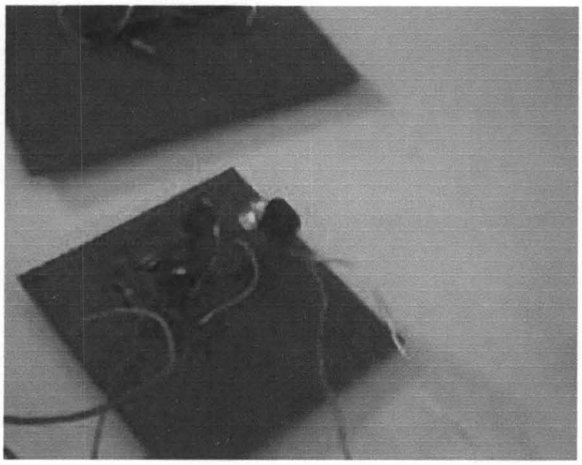
User Guide

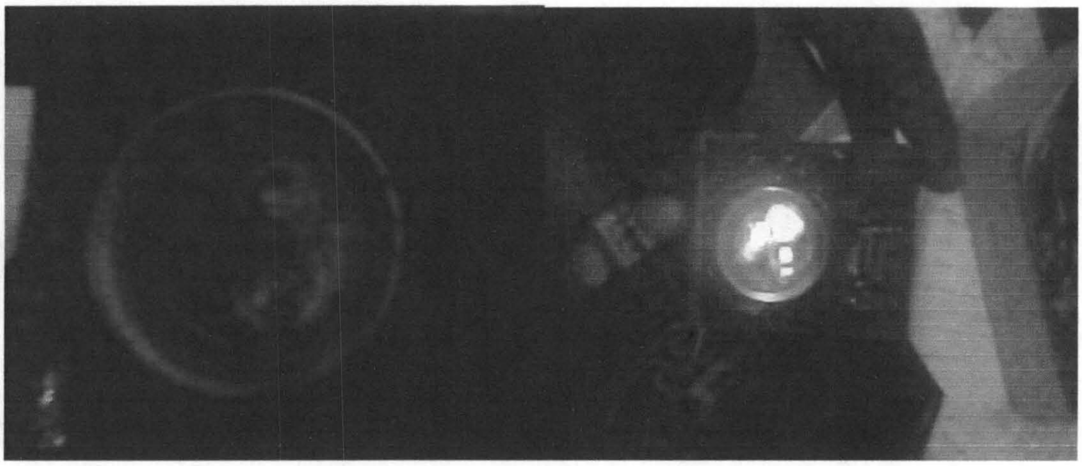
1. Connect the system to the 12v supply of the car battery.
2. Switch On the system from the power on switch.
3. Wait for 10 second for the system to initialize.
4. Listen to the front alarm as an indication of an obstacle ahead and the intensity as an indication of changing distance (increasing intensity mean the obstacle is getting closer and decreasing intensity is an indication of increasing distance from obstacles).
5. Similarly the back alarm is an indication of an obstacle from behind with similar intensity indication as the front alarm.
6. The upper part of the display shows the approximate front-distance to an obstacle and the lower part of the display shows the approximate back-distance to the obstacle.
7. The brake light comes on if an obstacle from rear is within a critical distance.

Project Photos



Bread-board stage





Vero-board stage

Complete Construction.