Design and Simulation of Circuits and Embedded Systems

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LTTS GLOBAL ENGINEERING ACADEMY

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Chapter 1. Passive Safety Systems for Bike via Helmet

1.1 Abstract

The main purpose of this project to safeguard lives of riders thus making helmets compulsory for speeds above 30 kmph.

1.2 Introduction

- The design consists of "helmet holder" where helmet can be placed when vehicle is at rest. This ensures helmet is always with bike and rider does not fail to forget wearing it.
- There are different sensors used to detect speed of vehicle, check helmet and state of person riding vehicle. If any such conditions are found then ignition is turned off. Thus not allowing rider to ride bike and be prone to accidents.

1.3 Requirements

- <u>High Level Requirements</u>

  1.0) Rider should compulsorily wear helmet after attending speed of 30kmph.

  2.0) System will not support drink and drive condition.

  3.0) Establish Communication link throughout system.

  4.0) Maintenance

- <u>Low Level Requirements</u>

  1.0) Rider should compulsorily wear helmet after attending speed of 30kmph.

    1.1) Use of force sensing register (FSR) to send data to board.

    1.2) Receive information from speed sensor and account for speed greater than 30kmph.

    1.3) If helmet is worn turn ON relay.

    1.4) Turn OFF relay if helmet is not worn.

  2.0) System will not support drink and drive condition.

    2.1) Use of MQ-3 gas sensor to detect state of rider.

2.2) Send information of sensor to board.

2.3) If person is drunk turn off relay.

3.0) Establish Communication link throughout system.

3.1) Initiate RF communication between bike and helmet.

4.0) Maintenance

4.1) Check health of sensors.

4.2) Check battery state.

1.4 Block diagram

- Helmet unit

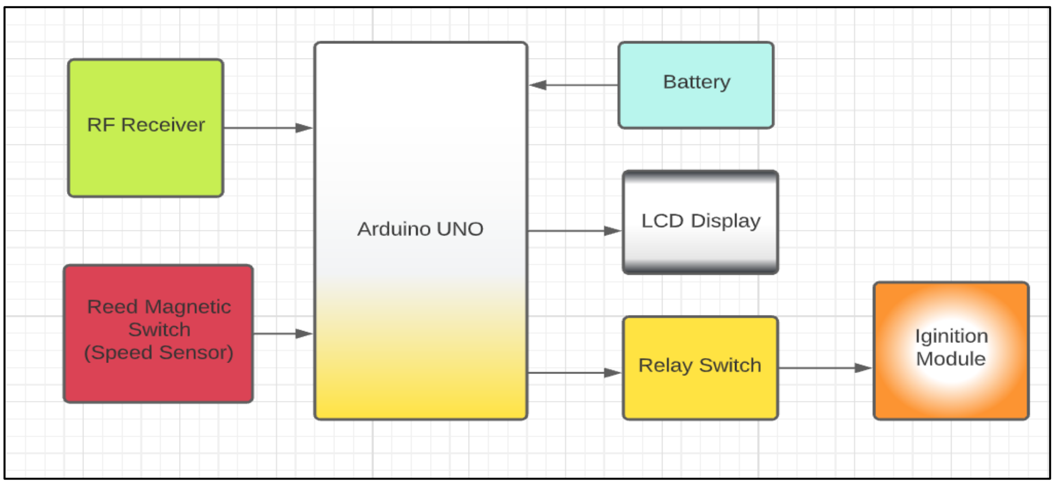

Fig 1.1. Block diagram of helmet unit

- Control unit

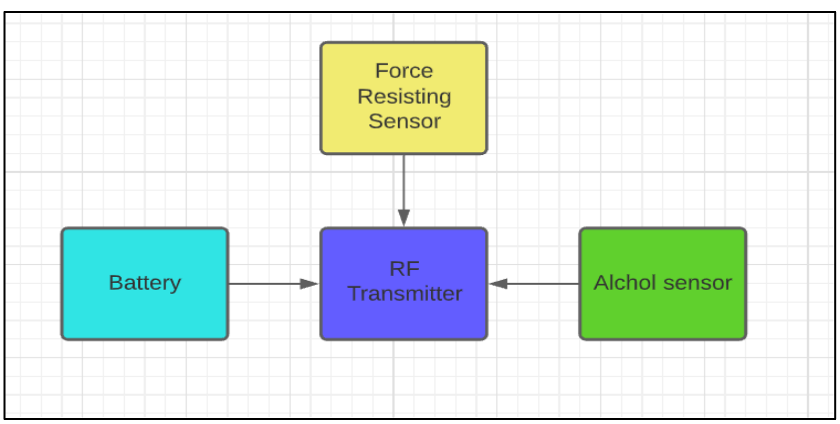

Fig 1.2. Block diagram of Control unit

1.5 Components

1) Force Sensitive Resistor (FSR) Sensor

When pressure is applied to the sensing area, the resistance of the sensor changes. The greater the pressure, the lower the resistance. At the same time, it will cause the output voltage to change, the greater the pressure, the greater the output voltage. This type of sensor is mainly used to measure the pressure change trend and the pressure distribution in a region (pressure map).

Fig 1.3. FSR sensor

Specifications:

- Range: up to 150 Kg (depend on the type)
- Response Time:<1.2msec
- Repeatability: ~±2.5% (of full scale)
- Drift: >7%
- Consumption: ~0.4mA

2) MQ-3 Gas Sensor

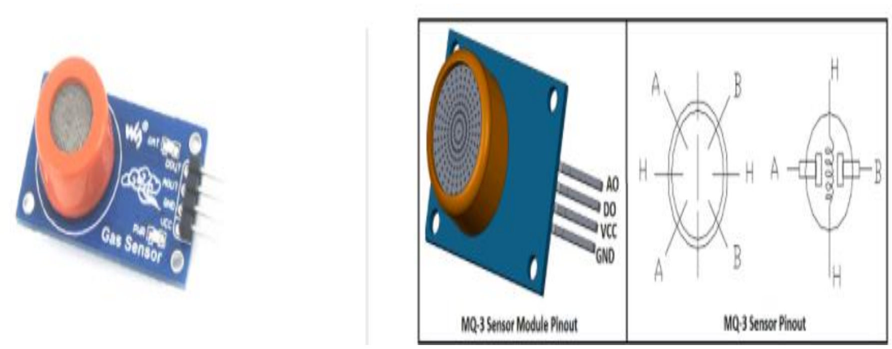

Fig 1.4. MQ- 3 Gas sensor

Specifications

- Power requirements: 5 VDC @ ~165 mA (heater on) / ~60 mA (heater off)
- Current Consumption: 150mA
- DO output: TTL digital 0 and 1 (0.1 and 5V)
- AO output: 0.1- 0.3 V (relative to pollution), the maximum concentration of a voltage of about 4V
- Detecting Concentration: 0.05-10mg/L Alcohol
- Interface: 1 TTL compatible input (HSW), 1 TTL compatible output (ALR)
- Heater consumption: less than 750mW
- Operating temperature: 14 to 122 °F (-10 to 50°C)
- Load resistance: 200kΩ
- Sensitivity S: Rs(in air)/Rs(0.4mg/L Alcohol)≥5
- Sensing Resistance Rs: 2KΩ-20KΩ(in 0.4mg/l alcohol)
- Dimensions: 32 x 22 x 16 mm

3) ARDUINO UNO

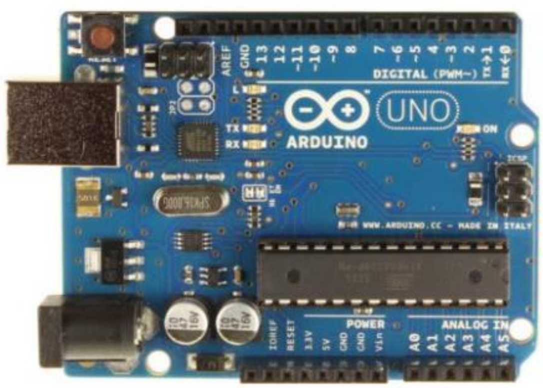

Fig 1.5. Arduino UNO Board

Specifications:

- Microcontroller: ATmega328
- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V

- Input Voltage (limits) 6-20V
- Digital I/O Pins 14 (of which 6 provide PWM output)
- Analog Input Pins 6
- DC Current per I/O Pin 40 mA
- DC Current for 3.3V Pin 50 Ma
- Flash Memory 32 KB (ATmega328) of which 0.5 KB used by bootloader
- SRAM 2 KB (ATmega328)
- EEPROM 1 KB (ATmega328)
- Clock Speed 16 MHz

4) RF Communication Circuit

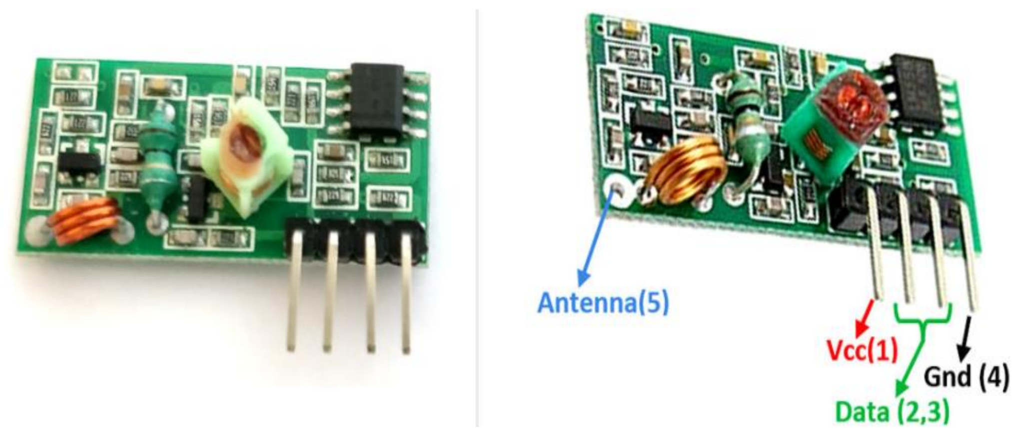

Fig 1.6. Circuit of RF module

Specifications:

- Wireless (RF) Simplex Transmitter and Receiver
- Receiver Operating Voltage: 3V to 12V
- Receiver Operating current: 5.5mA
- Operating frequency: 433 MHz
- Transmission Distance: 3 meters (without antenna) to 100 meters (maximum)
- Modulating Technique: ASK (Amplitude shift keying)
- Data Transmission speed: 10Kbps

- Circuit type: Saw resonator
- Low cost and small package

1.6 Flowchart

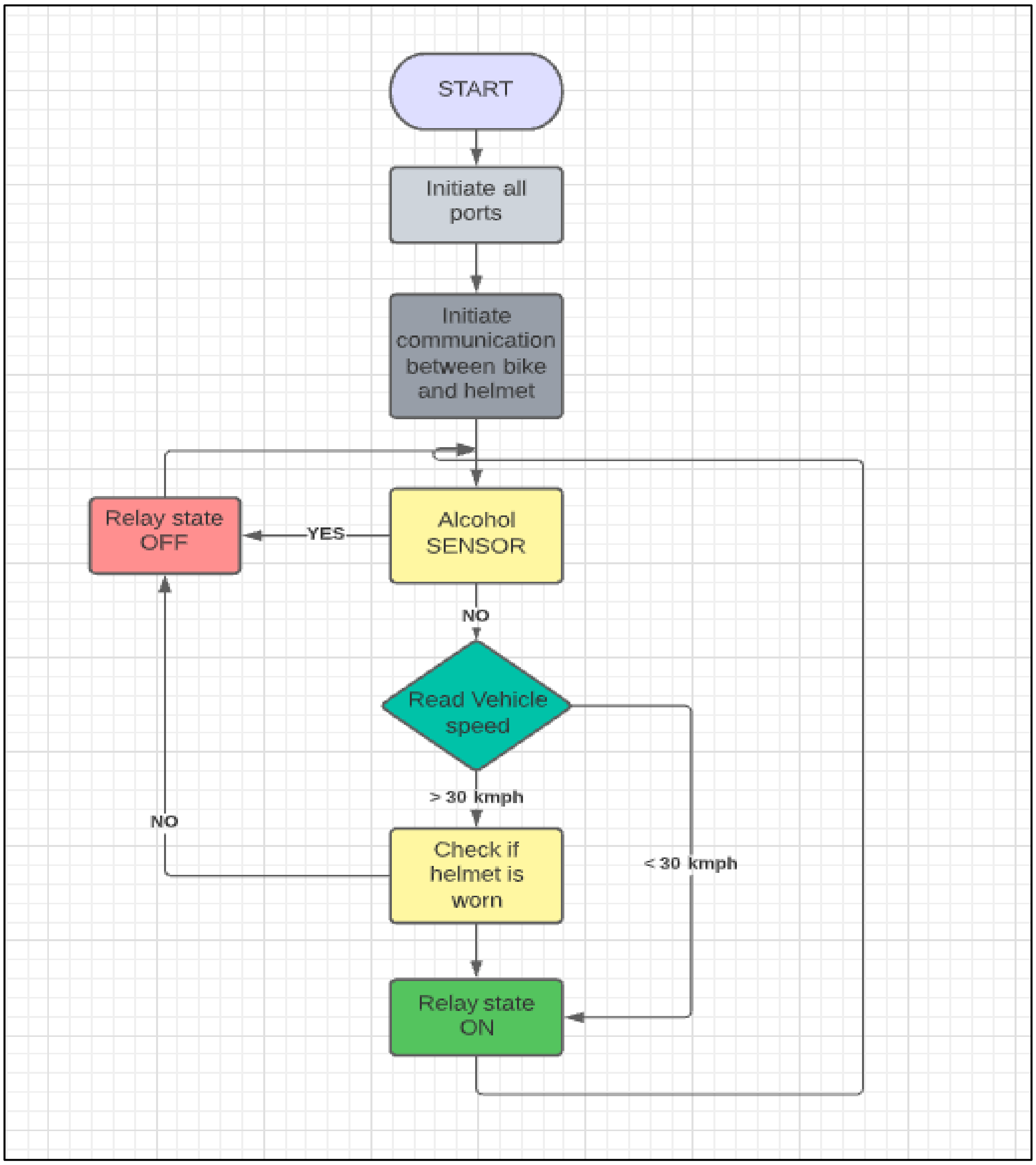

Fig 1.7. Flowchart of complete system

1.7 Test Cases

1) When the vehicle starts, the bike will check for alcohol sensor and then display "VEHICLE SPEED" and "IGNITION: ON".
2) When the vehicle is running below 30kmph with or without helmet it displays "VEHICLE SPEED" and "IGNITION: ON".
3) When the vehicle is running above 30kmph without helmet it displays "VEHICLE SPEED" and "IGNITION: OFF".
4) When the vehicle is running above 30kmph with helmet it displays "VEHICLE SPEED" and "IGNITION: ON".
5) When the helmet is worn and the rider is drunk it displays "DRIVER DRUNK" and "IGINITION: OFF".

1.8 Advantages

- Prevention of series injuries during high-speed accident.
- Option to avoid the helmets while riding less than 30kmph
- Customizable on running solar power also.
- Helmet holder will serve the purpose of a convenient helmet lock
- If helmet is stolen or lost, we can easily customize new helmet with required RF signal.

1.9 Application

- Automobile industry.
- Bicycle helmet

1.10 References

[1]. Smart Helmet with Sensors for Accident Prevention Mohd Khairul Afiq Mohd Rasli, Nina Korlina Madzhi, Juliana Johari Faculty of Electrical Engineering University Tecnology MARA40450 Shah Alam Selangor, MALAYSIAjulia893@salam.uitm.edu.my)

[2]. Vijay J, Saritha B, Priyadharshini B,Deepeka S and Laxmi R î´TTTÖ, DzDrunken Drive Protection Systemdz,)International Journal of Scientific & Engineering Research, Vol. 2, No. 12, ISSN: 2229-5518.

Chapter 2. Embedded Controller for Vehicle In-Front Obstacle Detection and Cabin Safety Alert System

2.1 Abstract

- The following system monitors the level of the toxic gases such as CO, LPG and alcohol inside the vehicle and provides alert information in the form of alarm during the critical situations. And also send SMS to the authorized person through the GSM.
- An IR Sensor is used to detect the static obstacle in front of the vehicle and the vehicle gets stopped if any obstacle is detected. This may avoid accidents due to collision of vehicles with any static obstacles.

2.2 Introduction

An embedded system designed to make the journey of the passengers inside a vehicle safe and secure with various recently found safety and security measures.

2.3 Requirements

- High Level Requirements

  1.0) Sense toxic gases like CO, LPG, alcohol within cabinet area.

  2.0) Obstacle sensing.

  3.0) SMS sending.

  4.0) Maintenance

- Low Level Requirements

  1.0) Sense toxic gases like CO, LPG, alcohol within cabinet area.

    1.1) Detect if any toxic gases are present in cabinet using MQ-7 gas sensor.

    1.2) Inform microcontroller if the level of toxic gases (CO>20ppm, LPG>1000ppm, alcohol) increases.

    1.3) Alert driver and passengers with an alarm.

1.4) Send message to authorized person through GSM.

2.0) Obstacle sensing.

2.1) Detect static object within distance of 3ft from vehicle using ultrasonic sensors.

2.2) Send information of sensor to board.

2.3) Alert driver if any object is present.

3.0) SMS sending.

3.1) Use of GSM interface to send SMS to authorized person.

4.0) Maintenance

4.1) Check health of sensors.

4.2) Check battery state.

2.4 Block diagram

- Whole system

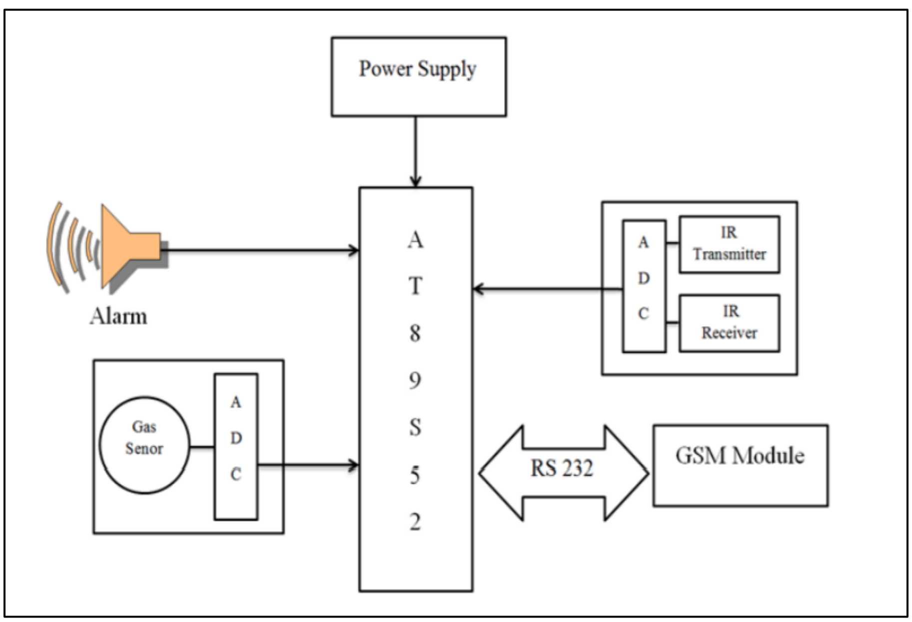

Fig 2.1. Block diagram of proposed unit

- The Gas Sensing Module

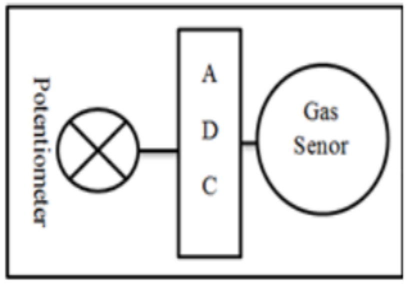

Fig 2.2. Block diagram of gas sensing module

- . Obstacle Sensing Module

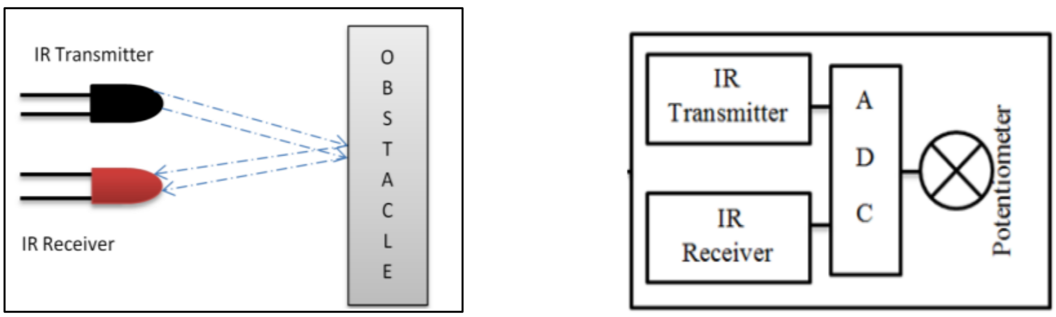

Fig 2.3. Block diagram of obstacle sensing module

2.5 Components

1) <u>MQ-7- Gas Sensor</u>

   MQ-7 is a highly sensitive gas sensor which is capable of detecting 10 to 10,000 ppm carbon monoxide concentrations in the air.

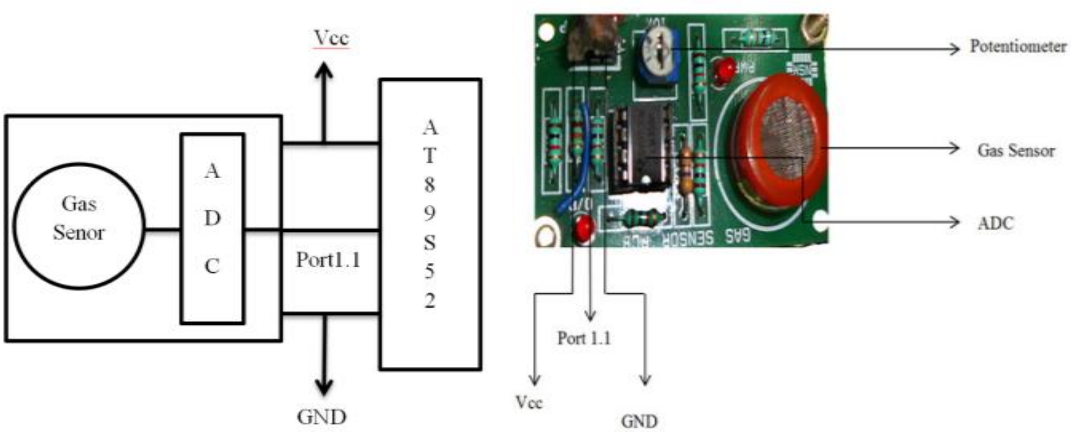

Fig 2.4. Gas sensor MQ-7

Specifications

- Voltage: 5 V
- Current: 150 mA
- Concentration detection: 10 to 10,000 ppm
- Temperature: -10 to +50 ° C

2) IR sensor

The IR sensor module consists mainly of the IR Transmitter and Receiver, Op-amp, Variable Resistor (Trimmer pot), output LED along with few resistors.

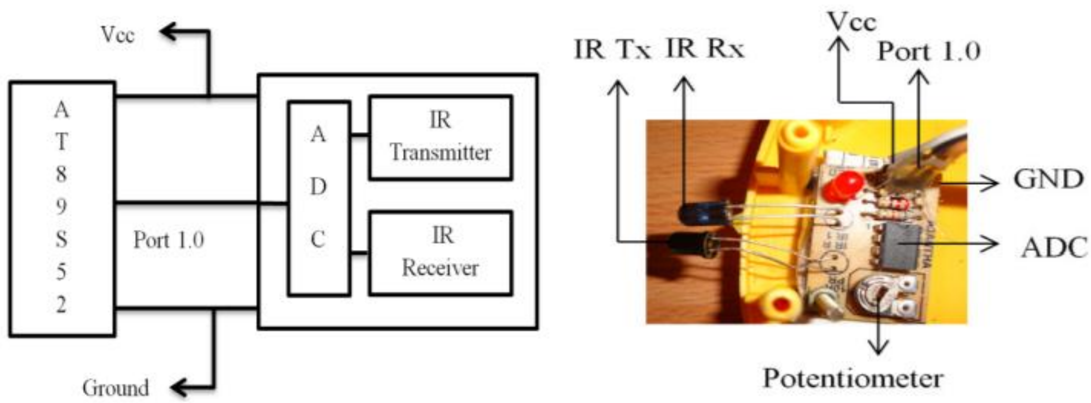

Fig 2.5. IR sensor with pin configration

Specifications

- 5VDC Operating voltage
- I/O pins are 5V and 3.3V compliant
- Range: Up to 20cm
- Adjustable Sensing range
- Built-in Ambient Light Sensor
- 20mA supply current
- Mounting hole

3) GSM Module

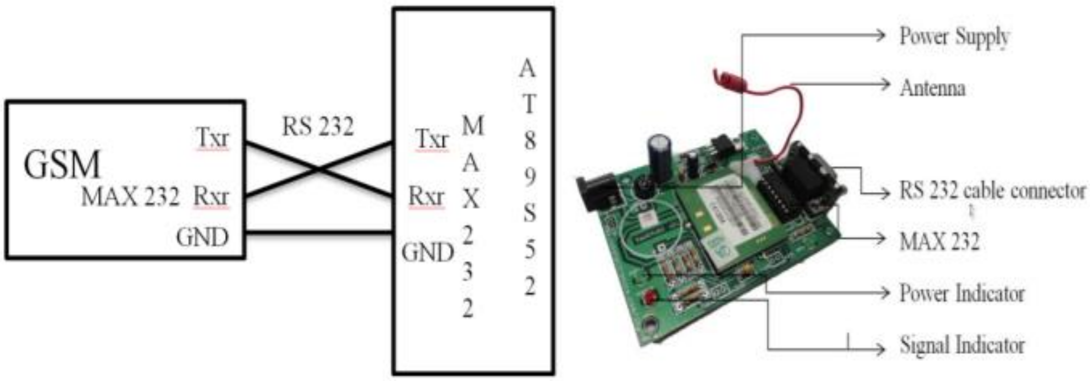

Fig 2.6. GSM module

Specifications

- Power supply: Single supply voltage 3.8V - 4.5V
- Frequency Bands: 850MHz, 900 MHz, 1800 MHz and 1900MHz.
- Supported protocols: Voice (2G)
- Standard size SIM card slot
- Power consumption: 0,7mA sleep. 2A peak
- Quad-band 850/900/1800/1900MHz
- GPRS multi-slot class 12/10
- Compliant to GSM phase 2/2+
- Operation temperature: -40℃ ~85℃
- Point to point MO and MT
  - SMS cell broadcast
  - Text and PDU mode

4) Microcontroller

The AT89S52 provides the following standard features:

- 8K bytes of Flash

- 256 bytes of RAM,
- 32 I/O lines,
- Watchdog timer
- two data pointers,
- three 16-bit timer/counters,
- six-vector two-level interrupt architecture
- full duplex serial port, on-chip oscillator, and clock circuitry.

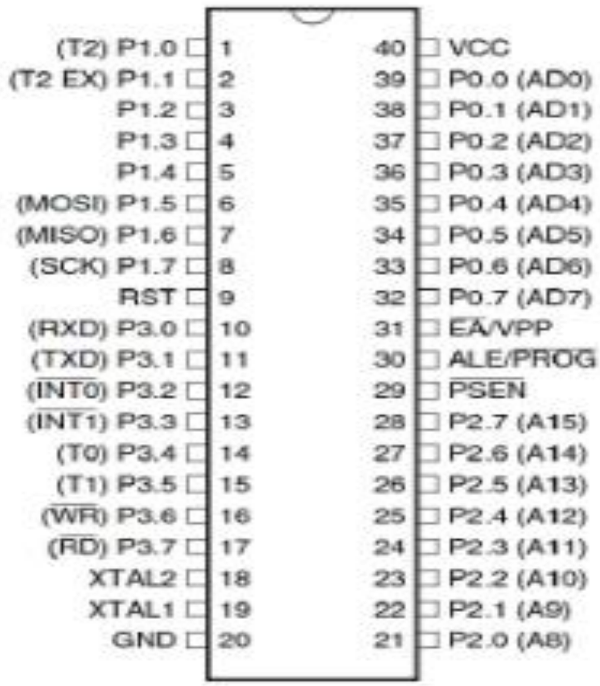

Fig 2.7. Pin description of AT8S52

2.6 Flowchart

- Obstacle Sensing module

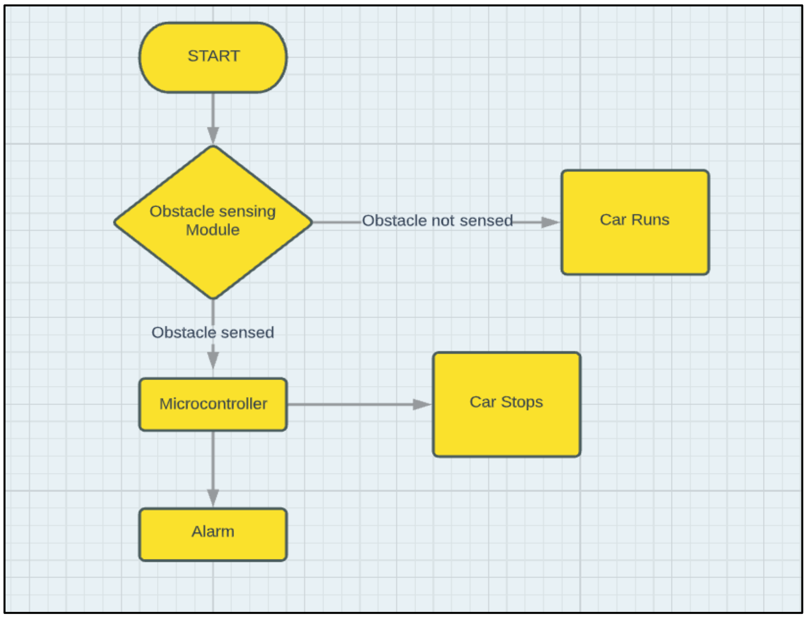

Fig 2.8. Flowchart of obstacle sensing module

- Gas sensing module

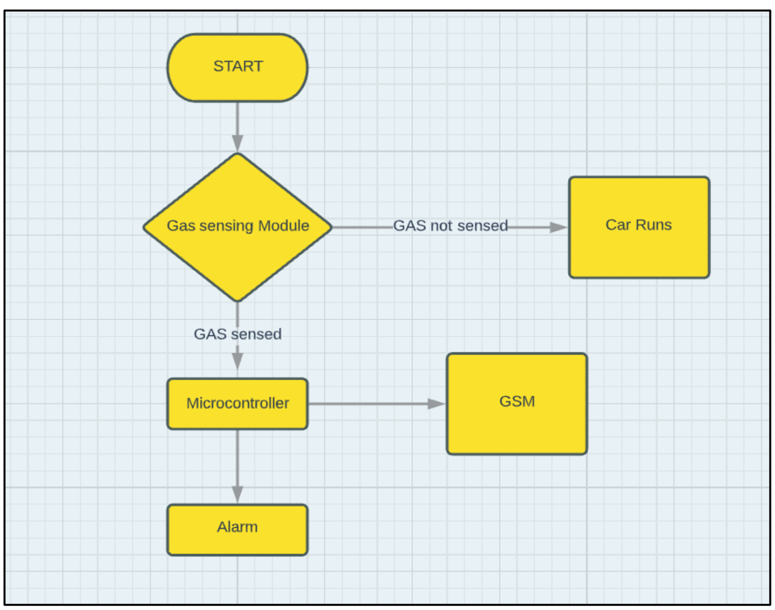

Fig 2.9. Flowchart of gas sensing module

- Overall System

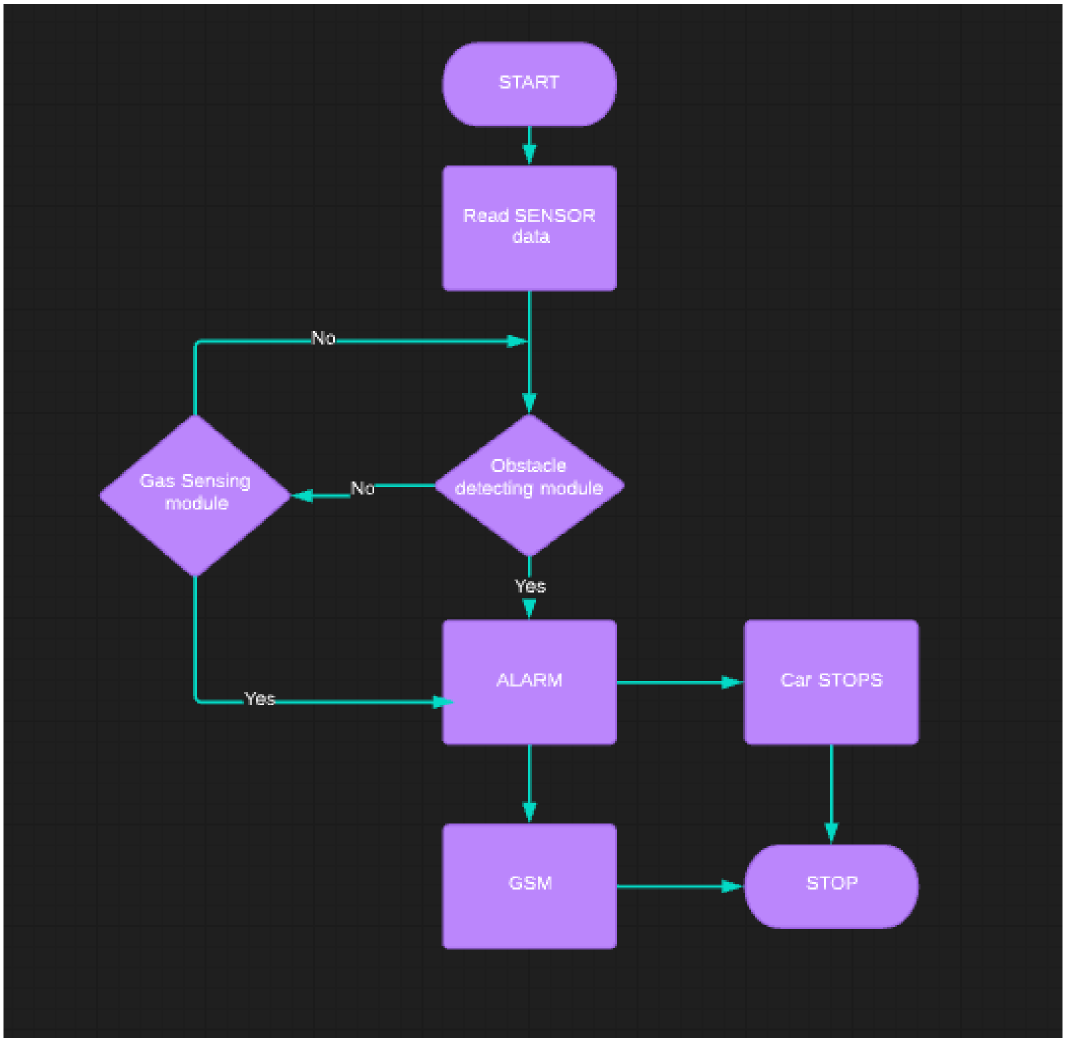

Fig 2.10. Flowchart of overall system

2.7Test Cases

1) When the vehicle starts, it will check for gas sensor and then display “VEHICLE ATMOSPHERE” , “NO OBSTACLE” and “IGNITION: ON”.
2) When the vehicle is running and if toxic gas level increase, then it displays “VEHICLE ATMOSPHERE ALERT”, “NO OBSTACLE” and “IGNITION: ON”. Sends SMS
3) When the vehicle is at rest and if toxic gas level increase, then it displays “VEHICLE ATMOSPHERE ALERT”, “NO OBSTACLE” and “IGNITION: OFF”. Sends SMS

4) When the vehicle is at rest and if static object is detected then it displays "VEHICLE ATMOSPHERE", "OBSTACLE ALERT" and "IGNITION: OFF". Sends SMS
5) When the vehicle is running and if static object is detected then it displays "VEHICLE ATMOSPHERE", "OBSTACLE ALERT" and "IGNITION: ON". Sends SMS

2.8 Application

- Automobile industry.

2.9 References

[1]. Da-Jeng Yao, "A gas sensing system for indoor air quality control and polluted environmental monitoring," pp. 11-14, 2009.

[2]. K. Galatsis, W. Wlodarsla, K. Kalantar-Zadeh and A. Trinchi, "Investigation of gas sensors for vehicle cabin air quality monitoring," vol. 42, pp. 167-175, 2002.

[3]. Raj Kamal, "Embedded system Architecture programming and design" TATA McGraw Hill.