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Department of Instrumentation and Automation
Engineering

Bachelor Work

Accident Avoidance of Vehicles using Multiple Sensors

2021

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Declaration

I declare that I have worked out this thesis independently assuming that the results of the thesis can also be used at the discretion of the supervisor of the thesis as its co-author. I also agree with the potential publication of the results of the thesis or of its substantial part, provided I will be listed as the co-author.

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ABSTRACT

Security in travel is the primary concern for everyone. Accidents occur in the blink of an eye. This project describes the design of an effective information system that can monitor an automotive / car condition in traveling. This project is designed to inform about the location of the vehicle, the accident that is occurred of a vehicle to the family members of the traveling people and other circumstances which in turn causes accidents.

The system contains sensors like Alcohol Sensor (It detects if the driver is driving under the influence), Smoke Sensor (It senses if there is any smoke inside the engine of the vehicle), Ultrasonic Sensor (It continuously monitors the nearby obstacles to the vehicle and alerts the driver during fog condition and varies its speed according to the distance), MEMS Accelerometer Sensor (It can detect the unevenness of vehicle and if the accident has occurred), Eye Blink Sensor (Detects if the driver is asleep while driving).

The monitoring system is composed of a GPS receiver, Arduino, and a GSM Modem. GPS Receiver gets the geo satellite information in the form of latitude and longitude. The Arduino receives the latitude, longitude and altitude from the GPS and then processes the information sent by the GPS. This processed information is sent to the user/owner using GSM modem via SMS about the location of the accident or if there is any other casualty is detected.

Abstract

Bezpečnost na cestách je prvořadým zájmem každého. K nehodám dochází velmi často. Tato práce popisuje návrh efektivního informačního systému, který dokáže monitorovat stav automobilu. Tento projekt je určen k informování o poloze vozidla, nehodě, ke které došlo u vozidla rodinným příslušníkům cestujících, a dalších okolnostech, které následně způsobují nehody.

Systém obsahuje senzory, jako je senzor alkoholu (detekuje, zda řidič jede pod vlivem alkoholu), senzor kouře (detekuje, zda je uvnitř motoru vozidla kouř), ultrazvukový senzor (nepřetržitě monitoruje překážky v blízkosti vozidla a upozorňuje řidiče při mlze a mění jeho rychlost podle vzdálenosti), senzor akcelerometru MEMS (dokáže detekovat nerovnosti vozidla a pokud došlo k nehodě), snímač mrknutí očí (detekuje, zda řidič za jízdy spí).

Monitorovací systém se skládá z přijímače GPS, Arduina a GSM modemu. Přijímač GPS získává informace o zeměpisném satelitu ve formě zeměpisné šířky a délky. Arduino přijímá zeměpisnou šířku, délku a nadmořskou výšku z GPS a poté zpracovává informace zaslané GPS. Tyto zpracované informace jsou odeslány uživateli/majiteli pomocí GSM modemu prostřednictvím SMS o místě nehody nebo v případě zjištění jiné oběti.

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List of Abbreviations

MEMS	Micro electro-mechanical system	(1)
LED	Light Emitting diode	(3)
PWM	Pulse width Modulation	(3)
UART	Universal asynchronous receiver-transmitter	(3)
USB	Universal serial bus	(3)
ICSP	In-circuit serial Programming	(3)
SDA	Serial Data	(3)
SCL	Serial clock	(3)
AREF	Analog Reference	(3)
IOREF	Voltage Reference	(3)
I/O	Input/Output	(4)
MIDI	Musical Instrument Digital Interface	(4)
PCB	Printed Circuit Board	(5)
GSM	Global System for Mobile communication	(6)
TDMA	Time Multiple division access	(6)
SIP	Session Initiation Protocol	(9)
TTL	Transistor-Transistor Logic	(10)
LPG	Liquified Petroleum Gas	(11)
ARM	Advanced RISC Machine	(13)
PIC	Peripheral Interface Controllers	(13)
MCU/MPU	Micro Controllers/Processors	(14)
GND	Ground	(16)
VDC	Video domain controller	(18)
SCK	Serial Clock line.	(25)

Chapter 1

Introduction

1.1 The Rationale for taking up the project

Major deaths occur due to road accidents in all over the world. Every year around 1.25 million die in a road accident across the globe. 20-50 million people are injured or disabled each year. Which narrows down to 3287 death per day. Many times, people die because the emergency departments were not informed on time about the accident and its location.[1] These can be reduced by proper implementation of the Arduino and IoT based systems. The core principle of the project is to reduce the number of deaths caused due to lack of proper treatment at the right time. The Arduino-based collision detection system is a kind of system that is the fastest growing safety feature in the automotive industries. Such a system enables vehicles to identify the chances of collision and give visual and audio warnings to the driver so that the driver can take necessary action to avoid a collision.

1.2 Description of the project

The project is designed to avoid accidents that occur due to reckless and irresponsible drivers who not only put their lives in danger but others as well. Maximum accidents occur because of drinking and driving, falling asleep while driving, breaking down of the car due to smoke coming out the engine and not so effective braking because of sudden interaction with another vehicle or no indication of the frontal vehicle during fog. These accidents could be prevented if certain safety features including these could be added to our cars. Sensors such as Alcohol, Eye-blink, Smoke, Ultrasonic and MEMS accelerometer could prevail the accidents to even occur in the first place. If it the value of sensors is above the threshold value (Set by the law enforcement department) then it would stop the car, then send a message of the location of the car to a relative and the information that the driver is not in a good condition to drive and could also help the emergency department to find those drivers and their location for assistance.

1.3 Methodology

To design an Accident-Avoidance system using multiple sensors with the help of Arduino to anticipate any mishap. To receive the information and location of the driver in case of any casualty. To alert the driver if there is any possibility of an accident. The proposed system will help us detect any plausibility of the accident by providing us information about:

It is designed to inform: -

1) Location of the car.
2) Accident of the vehicle to the family member.
3) If the driver is asleep or not.
4) To determine if driver's drunk while driving.
5) If there is smoke detected in the car.

Chapter 2

Arduino

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards can read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on processing.[3]

Figure 2.1: Arduino [XIX]

2.1 Arduino Mega

The Arduino Mega is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. Never fear for accidental electrical discharge, either since the Mega also includes a plastic base plate to protect it! The Mega 2560 R3 also adds SDA and SCL pins next to the AREF. Also, there are two new pins placed near the RESET pin. One is the IOREF that allow the shields to adapt to the voltage provided from the board. The other is not connected and is reserved for future purposes. The Mega 2560 R3 works with all existing shields but can adapt to new shields that use these additional pins.[2]

2.2 Applications

They are as follows: -

1) Multiple DIY Projects.
2) Easy to use for beginner level DIYers and makers.
3) Projects requiring Multiple I/O interfaces and communications.
4) Arduboy, a handheld game console based on Arduino.
5) Arduinome, a MIDI controller device that mimics the Monome.
6) Ardupilot, drone software and hardware.
7) ArduSat, a CubeSat based on Arduino.
8) C-STEM Studio, a platform for hands-on integrated learning of computing, science, technology, engineering, and mathematics (C-STEM) with robotics.
9) Data loggers for scientific research.
10) OBDuino, a trip computer that uses the on-board diagnostics interface found in most modern cars.
11) OpenEVSE an open-source electric vehicle charger.
12) XOD, a visual programming language for Arduino.[4]

2.3 Advantages and Disadvantages

Advantages:

1) Inexpensive.
2) Open source in hardware.
3) Don't need to external programmer (Burner).
4) Programming ease.
5) Open source in software.
6) IDE Software operate on any operating system.[5]

Disadvantages:

1) Processing power is weaker than the microcontroller.

2) The structure of Arduino is its disadvantage as well. During building a project you must make its size as small as possible. But with the big structures of Arduino, we must stick with big sized PCB's. If you are working on a small micro-controller like ATmega8 you can easily make your PCB as small as possible.

3) The most important factor which you cannot deny is cost. This is the problem that every hobbyist, Engineer or Professional must face. Now, we must consider that the Arduino is cost-effective or not.[5]

2.4 Specifications of Arduino

The Arduino Mega is a microcontroller board based on the ATmega2560.

Microcontroller	AT mega 2560
Operating voltage	5 V
Recommended input voltage	7-12 V
Input voltage limits	6-20 V
Analog input Pins	16
Digital I/O Pins	54(Out of which 14 provide PWM output)
DC current on I/O Pins	40mA
DC current on 3.3V pin	50mA
Flash memory	256 KB (8 KB is used for Boot loader)
SRAM	8 KB
EEPROM	4 KB
Frequency (Clock Speed)	16MHz

Table 2.2: Specifications of Arduino

Chapter 3

DESIGN PLATFORMS

The project can be implemented using 2 different points of views:

- The GSM approach.
- The Internet of Things approach.

1) **The GSM approach: -** GSM stands for Global System for Mobile Communication. It is a digital cellular technology used for transmitting mobile voice and data services. GSM is a circuit-switched system that divides each 200 kHz channel into eight 25 kHz timeslots. GSM operates on the mobile communication bands 900 MHz and 1800 MHz in most parts of the world. In the US, GSM operates in the bands 850 MHz and 1900 MHz GSM is a circuit-switched system that divides each 200 kHz channel into eight 25 kHz timeslots. GSM makes use of the narrowband Time Division Multiple Access (TDMA) technique for transmitting signals. GSM was developed using digital technology. It can carry 64 kbps to 120 Mbps of data rates.[7]

2) **The Internet of Things approach**: - It is an interrelated system of computing devices, mechanical and digital machines. The objects or people who are equipped with unique identifiers (UIDs) and the ability to transfer data over a network without interaction between human-to-human or human-to-computer. An object in the internet of things can be an automobile that has built-in sensors to alert the driver when tire pressure is low, can be a person with a heart monitor implant or any other natural or man-made object that can be assigned an IP address and is enabled to transfer data over a network.[7]

For the best results and efficient outputs, this project aims at employing the Global System for Mobile Communication. The GSM network does not require internet access. Thus, the end-user can receive information without any internet supportive devices. Also, this approach is highly reliable and clubbed with greater security and better performance which proves to be a better choice. In addition to this, GSM is an old system and so it is widely adopted across the globe with its hardware available at low cost.

The features of GSM are as follows: -

1) Improved spectrum efficiency.

2) International roaming.

3) Low-cost mobile sets and base stations (BSs).

4) High-quality speech.

5) Compatibility with Integrated Services Digital Network (ISDN) and other telephone company services.

6) Support for new services. [7]

Chapter 4

COMPONENTS

4.1 Alcohol Sensor

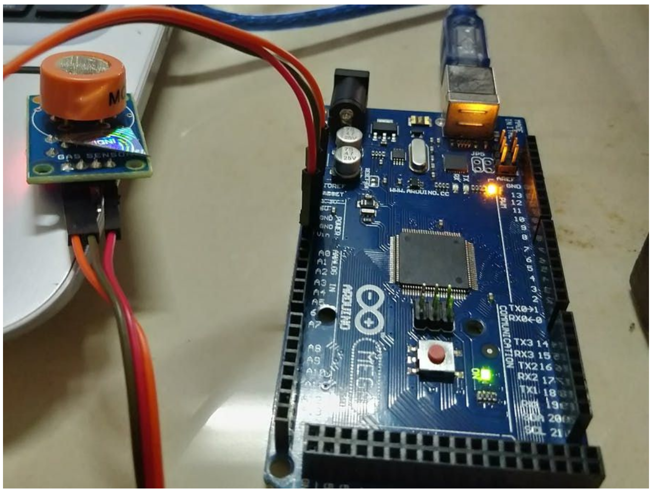

Figure 4.1: Alcohol sensor [XX]

This module is made using Alcohol Gas Sensor MQ3. It is a low-cost semiconductor sensor which can detect the presence of alcohol gases at concentrations from 0.05 mg/L to 10 mg/L. The sensitive material used for this sensor is SnO_2, whose conductivity is lower in clean air. Its conductivity increases as the concentration of alcohol gases increases. It has a high sensitivity to alcohol and has good resistance to disturbances due to smoke, vapor, and gasoline. This module provides both digital and analog outputs. MQ3 alcohol sensor module can be easily interfaced with Microcontrollers, Arduino Boards, Raspberry Pi, etc. This alcohol sensor is suitable for detecting alcohol concentration on your breath, just like your common breathalyzer. It has high sensitivity and fast response time. The sensor provides an analog resistive output based on alcohol concentration. The drive circuit is very simple, all it needs is one resistor. A simple interface could be a 0-3.3V ADC. [8]

4.1.1 Pin Description

Pin No:	Pin Name:	Description
For Module		
1	Vcc	This pin powers the module, typically the operating voltage is +5V
2	Ground	Used to connect the module to system ground
3	Digital Out	You can also use this sensor to get digital output from this pin, by setting a threshold value using the potentiometer
4	Analog Out	This pin outputs 0-5V analog voltage based on the intensity of the gas

Figure 4.2: Alcohol Sensor-Pin Description [XX]

4.1.2 Features

1) Sensor Type – Semiconductor
2) 5 V operation
3) Easy SIP header interface
4) Compatible with most of the microcontrollers
5) Low-Power standby mode
6) Requires high voltage
7) Good sensitivity to Alcohol Gas
8) Quick response to high sensitivity
9) Long life and low cost
10) Require simple drive circuit
11) LEDs for output and power.
12) Output sensitivity adjustable
13) Analog output 0 V to 5 V
14) Digital Output

4.1.3 Specifications:

1) Power requirements: 5 VDC @ 165 mA (heater on) / 60 mA (heater o_).

2) Current consumption: 150 mA

3) DO output: TTL digital 0 to 1 (0.1 and 5 V)

4) AO output: 0.1 – 0.3 V (relative to pollution), the maximum concentration of voltage is about 4 V

5) Detecting concentration: 0.05-10 mg/L Alcohol.

6) Interface: 1TTL compatible input (HSW), 1TTL compatible output (ALR).

7) Heater consumption: less than 750 mW

8) Operating temperature: 14 to 122 °F (-10 to 50) °C.

9) Load resistance: 200k ohm

10) Sensing resistance Rs: 2K ohm – 20K ohm (in 0.4mg/1 alcohol)

11) Dimensions: 32*22*16 mm. [9]

4.1.4 Application:

1) Gas level over-limit alarm.

2) Breathalyzer.

3) Portable alcohol detector.

4) Stand-alone/background sensing device.

5) Environmental monitoring equipment.

6) Vehicle Alcohol Detector.

7) Portable Alcohol Detector.[9]

4.2 Smoke Sensor

MQ2 is one of the commonly used gas sensors in the MQ sensor series. It is a Metal Oxide Semiconductor (MOS) type Gas Sensor also known as Chemiresistors as the detection is based upon the change of resistance of the sensing material when the Gas meets the material. Using a simple voltage divider network, concentrations of the gas can be detected. MQ2 Gas sensor works on 5 V DC and draws around 800mW. [9]

FIGURE 4.3: Smoke Sensor [XXI]

The MQ-2 Gas sensor can detect or measure gasses like LPG, Alcohol, Propane, Hydrogen, CO and even methane. The module version of this sensor comes with a Digital Pin which makes this sensor to operate even without a microcontroller and that comes in handy when you are only trying to detect one gas. When it comes to measuring the gas in ppm the analog pin must be used, the analog pin also TTL driven and works on 5 V and hence can be used with most common microcontrollers. [9]

4.2.1 Features

1) Preheat duration 20 seconds.
2) Can be used as a Digital or analog sensor.
3) The Sensitivity of Digital pin can be varied using the potentiometer.
4) Can be used to Measure or detect LPG, Alcohol, Propane, Hydrogen, CO and even methane.
5) Analog output voltage: 0V to 5 V.
6) Digital Output Voltage: 0V or 5 V (TTL Logic). [9]

4.2.2 Specifications:

1) Operating voltage: - 5 V.
2) Load resistance: - 20 K ohm.
3) Heater resistance: - 33 ohm.
4) Heating consumption: - ¡800mw.
5) Sensing Resistance: - 10 K ohm - 60 K ohm.
6) Concentration Scope: - 200 – 10000ppm.
7) Preheat Time: - 20 seconds. [9]

4.2.3 Applications:

1) Detects or measure Gases like LPG, Alcohol, Propane, Hydrogen, CO and even methane.
2) Air quality monitor.
3) Gas leak alarm.
4) Safety standard maintenance.
5) Maintaining environment standards in hospitals. [9]

4.3 Ultrasonic Sensor

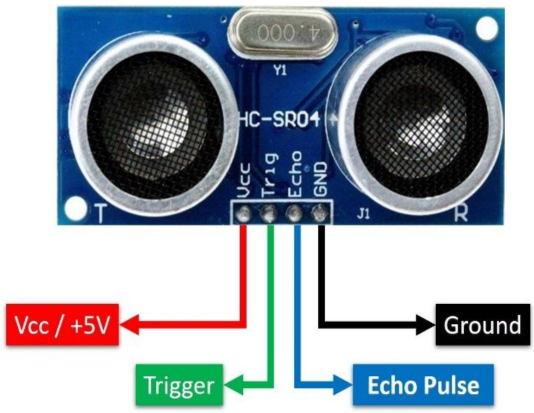

Figure 4.4: Ultrasonic Sensor [XXII]

An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e., the sound that humans can hear). Ultrasonic sensors have two main components: the transmitter (which emits the sound using piezoelectric crystals) and the receiver (which encounters the sound after it has traveled to and from the target). To calculate the distance between the sensor and the object, the sensor measures the time it takes between the emission of the sound by the transmitter to its contact with the receiver. The formula for this calculation is shown below. [9]

$$\boldsymbol{D = \frac{1}{2}(T \times C)} \quad \textbf{(1)}$$

(where D is the distance (m), T is the time (s), and C is the speed of sound 343 m/s)

The Ultrasonic transmitter transmits an ultrasonic wave, this wave travels in air and when it gets objected by any material it gets reflected toward the sensor this reflected wave is observed by the Ultrasonic receiver module. HC-SR04 distance sensor is commonly used with both microcontroller and microprocessor platforms like Arduino, ARM, PIC, Raspberry Pie etc. The following guide is universally since it must be followed irrespective of the type of computational device used.[9]

4.3.1 Pin Description:

Pin Number	Pin Name	Description
1	Vcc	The Vcc pin powers the sensor, typically with +5V
2	Trigger	Trigger pin is an Input pin. This pin has to be kept high for 10us to initialize measurement by sending US wave.
3	Echo	Echo pin is an Output pin. This pin goes high for a period of time which will be equal to the time taken for the US wave to return back to the sensor.
4	Ground	This pin is connected to the Ground of the system.

Figure4.5: Ultrasonic Sensor-Pin Description [XXII]

4.3.2 Working

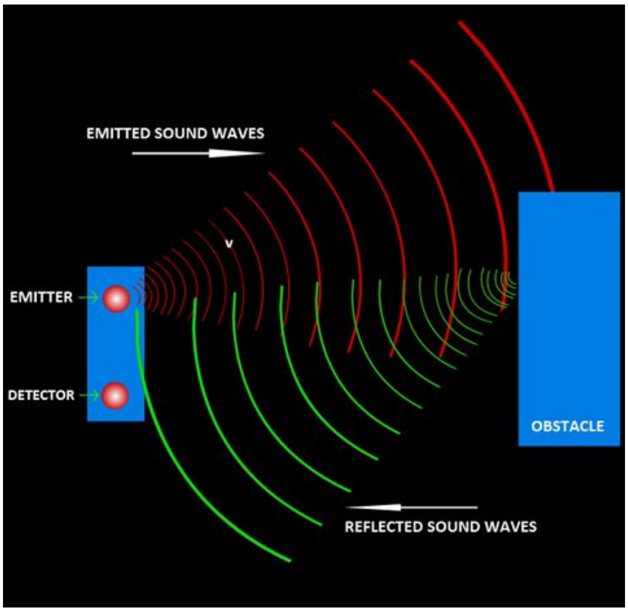

Figure 4.6: Ultrasonic Sensor Working [XXII]

Power the Sensor using a regulated +5 V through the Vcc ad Ground pins of the sensor. The current consumed by the sensor is less than 15mA and hence can be directly powered by the onboard 5 V pins (If available). The Trigger and the Echo pins are both I/O pins and hence they can be connected to I/O pins of the microcontroller. To start the measurement, the trigger pin must be made high for 10uS and then turned off. This action will trigger an ultrasonic wave at a frequency of 40Hz from the transmitter and the receiver will wait for the wave to return. Once the wave is returned after it is getting reflected by any object the Echo pin goes high for a particular amount of time which will be equal to the time taken for the wave to return to the sensor. The amount of time during which the Echo pin stays high is measured by the MCU/MPU as it gives the information about the time taken for the wave to return to the Sensor. Using this information, the distance is measured as explained in the above heading.[9] The microcontroller interprets the time signal into distance using the following functions: -

$$\boldsymbol{d\ (inch) = \frac{e}{148}} \quad \textbf{(2)}$$

$$\boldsymbol{d\ (cm) = \frac{e}{58}} \quad \textbf{(3)}$$

$$\boldsymbol{d = \frac{t \times c}{2}} \quad \textbf{(4)}$$

where, d………………. Distance (m)

e………. echo pulse width (µs)

t………..……. time taken (s)

c…...……. speed of sound (m/s)

4.3.3 Features:

1) Power consumption of 20 mA.
2) Pulse in/out communication.
3) Narrow acceptance angle.
4) Provides exact, non-contact separation estimations within 2 cm to 3 m.
5) The explosion point LED shows estimations in the advancement.
6) 3-pin header makes it simple to connect utilizing a servo development link.[9]

4.3.4 Specifications:

1) Operating voltage: - +5 V.
2) Theoretical Measuring Distance: - 2 cm to 450 cm.
3) Practical Measuring Distance: - 2 cm to 80 cm.
4) Accuracy: - 3 mm.

5) Measuring angle covered: - < 15°.
6) Operating Current: - < 15 mA.
7) Operating Frequency: - 40 Hz.
8) Output cycle: - 50 ms. [9]

4.3.5 Applications:

1) Used to avoid and detect obstacles with robots like biped robot, obstacle avoider robot, path finding robot etc.
2) Used to measure the distance within a wide range of 2 cm to 400 cm
3) Can be used to map the objects surrounding the sensor by rotating it
4) Depth of certain places like wells, pits etc can be measured since the waves can penetrate through water.[9]

4.4 Eye Blink Sensor

Figure 4.7: Eye Blink Sensor [XXIII]

The eye-blink sensor works by illuminating the eye and eyelid area with infrared light, then monitoring the changes in the reflected light using a phototransistor and differentiator circuit. The exact functionality depends greatly on the positioning and aiming of the emitter and detector concerning the eye. The Variation Across the eye will vary as per eye blink. If the eye is closed means the output is high otherwise output is low. This to know the eye is closing or opening position. This output is given to the logic circuit to indicate the alarm. This can be used for a project involves controlling accidents due to the unconscious through Eye blink.[11]

4.4.1 Pin Description

Pin Name	Description
VCC	Power Supply Input
GND	Power Supply Ground
OUT	Active High Output

Figure 4.8: Eye blink sensor PIN description [XXIII]

4.4.2 Working

Connect regulated DC power supply of 5 Volts. The black wire is Ground, Next middle wire is Brown which is output, and Red wire is positive supply. These wires are also marked on PCB. To test the sensor, you only need power the sensor by connecting two wires +5 V and GND. You can leave the output wire as it is. When Eye closed, LED is off and the output is at 0V. Put Eye blink sensor glass on the face within 15mm distance, and you can view the LED blinking on each Eyeblink. The output is active high for Eye close and can be given directly to the microcontroller for interfacing applications.[9]

EYE BLINK OUTPUT: -

- 5 V (High) → LED ON When Eye is close.
- 0V (Low) → LED OFF when Eye is open.

4.4.3 Features

1) EYE BLINK indication by LED
2) Instant output digital signal for directly connecting to the microcontroller.
3) Compact Size.
4) Working Voltage +5 V DC.[9]

4.4.4 Specifications

1) Operating Voltage: - +5 V DC regulated.
2) Operating Current: - 100 mA.
3) Output Data Level: - TTL Level.
4) Eye Blink Indicated by LED and Output High Pulse.[9]

4.4.5 Applications

Digital Eye Blink monitor for Vehicle Accident prevention and suitable for real time driving applications.

4.5 MEMS Accelerometer Sensor

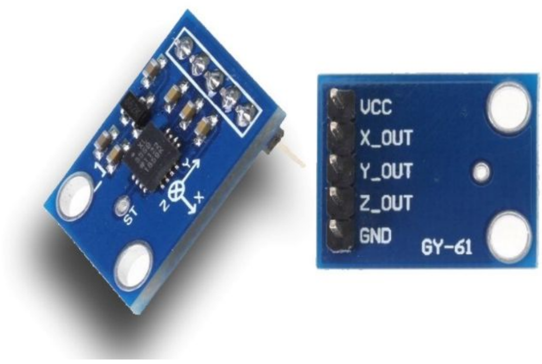

Figure 4.9: MEMS Accelerometer Sensor [XXIV]

The term MEMS stands for micro-electro-mechanical systems. These are a set of devices, and the characterization of these devices can be done by their tiny size and the designing mode. The designing of these sensors can be done with the 1- 100-micrometer components. These devices can differ from small structures to very difficult electromechanical systems with numerous moving elements beneath the control of incorporated micro-electronics. Usually, these sensors include mechanical micro-actuators, micro-structures, micro-electronics, and micro-sensors in one package.[9]

4.5.1 Pin Description

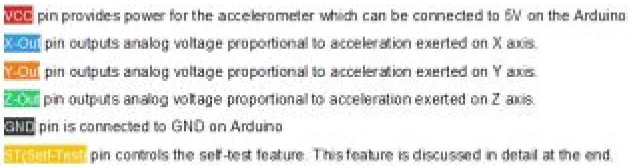

Figure 4.10: MEMS Pin description [XXIV]

4.5.2 MEMS Sensor Working Principle

Whenever the tilt is applied to the MEMS sensor, then a balanced mass makes a difference within the electric potential. This can be measured like a change within capacitance. Then that signal can be changed to create a stable output signal in digital, 4-20 mA or VDC. These sensors are fine solutions to some applications which do not demand the maximum accuracy like industrial automation, position control, roll, and pitch measurement, and platform leveling. [11]

4.5.3 Working

It is a chip-based technology, known as a Micro-Electro-Mechanical System, that is composed of a suspended mass between a pair of capacitive plates. When the tilt is applied to the sensor, the suspended mass creates a difference in electric potential which is measured as a change in capacitance. When the tilt is applied to the sensor, the suspended mass creates a difference in electric potential which is measured as a change in capacitance.[11]

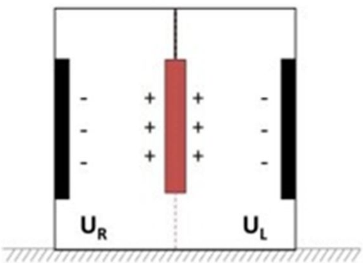

Figure 4.11 MEMS Accelerometer sensor working [XXV]

AIS2IH, a three-axis linear accelerometer from STMicroelectronics brings enhanced resolution, temperature stability, and mechanical robustness to non-safety automotive applications such as anti-theft, telematics, infotainment, tilt/inclination measurement, and vehicle navigation. The new device offers market-leading reliability and high-performance motion sensing at a wide operating temperature range of -40°C to +115°C. [9]

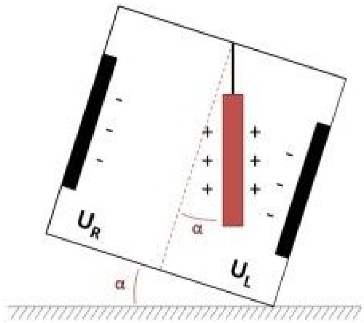

Figure 4.12: MEMS Accelerometer Sensor Working [XXV]

4.5.4 Features

1) Excellent temperature stability.
2) BW adjustment with a single capacitor per axis.
3) RoHS/WEEE lead-free compliant.
4) Operating Voltage: 3 V to 6 V DC.
5) Operating Current: 350 Microamp.
6) Sensing Range: 3g.
7) 3-axis sensing.
8) High Sensitivity for small movements.
9) Needs no external components.
10) Easy to use with Microcontrollers or even with normal Digital/Analog IC.
11) Small, cheap, and easily available.[12]

4.5.5 Specifications

1) 3-axis sensing.
2) Small, low-profile package.
3) 4 mm Ö 4 mm Ö 1.45 mm LFCSP.
4) Low power - 350 Microamp (typical).
5) Single-supply operation: - 1.8 V to 3.6 V.
6) 10,000 g shock survival.[12]

4.5.6 Applications

1) Cost-sensitive, low power, motion- and tilt-sensing applications.
2) Mobile devices.
3) Gaming systems.
4) Disk drive protection.
5) Image stabilization.
6) Sports and health device [12]

4.6 GSM

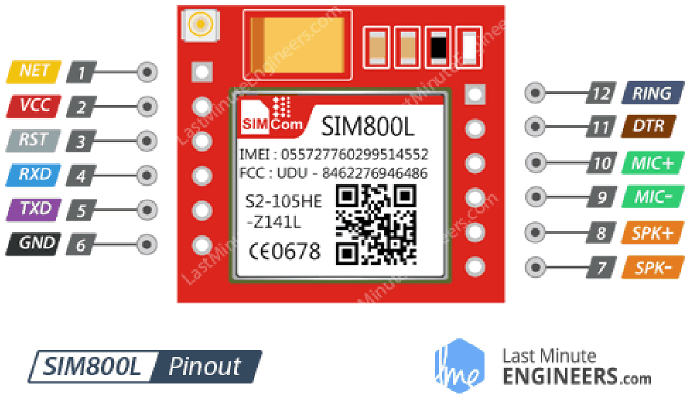

Figure 4.13: GSM [XXVI]

GSM is a mobile communication modem; it stands for global system for mobile communication (GSM). The idea of GSM was developed at Bell Laboratories in 1970. It is a widely used mobile communication system in the world. GSM is an open and digital cellular technology used for transmitting mobile voice and data services operate at the 850MHz, 900MHz, 1800MHz and 1900MHz frequency bands. GSM system was developed as a digital system using time division multiple access (TDMA) technique for communication purposes. A GSM digitizes and reduces the data, then sends it down through a channel with two different streams of client data, each in its time slot. The digital system can carry 64 kbps to 120 Mbps of data rates. There are various cell sizes in a GSM system such as macro, micro, Pico and umbrella cells. Each cell varies as per the implementation domain. There are five different cell sizes in a GSM network macro, micro, Pico, and umbrella cells. The coverage area of each cell varies according to the implementation environment.[9]

Time Division Multiple Access: - TDMA technique relies on assigning different time slots to each user on the same frequency. It can easily adapt to data transmission and voice communication and can carry 64kbps to 120Mbps of data rate.[13]

4.6.1 Pin description

NET is a pin where you can solder Helical Antenna provided along with the module.

VCC supplies power for the module. This can be anywhere from 3.4V to 4.4 volts. Remember connecting it to 5V pin will likely destroy your module! It doesn't even run on 3.3 V! An external power source like Li-Po battery or DC-DC buck converters rated 3.7V 2A would work.

RST (Reset) is a hard reset pin. If you absolutely got the module in a bad space, pull this pin low for 100ms to perform a hard reset.

RxD (Receiver) pin is used for serial communication.

TxD (Transmitter) pin is used for serial communication.

GND is the Ground Pin and needs to be connected to GND pin on the Arduino.

RING pin acts as a Ring Indicator. It is basically the 'interrupt' out pin from the module. It is by default high and will pulse low for 120ms when a call is received. It can also be configured to pulse when an SMS is received.

DTR pin activates/deactivates sleep mode. Pulling it HIGH will put module in sleep mode, disabling serial communication. Pulling it LOW will wake the module up.

MIC± is a differential microphone input. The two microphone pins can be connected directly to these pins.

SPK± is a differential speaker interface. The two pins of a speaker can be tied directly to these two pins.

Figure 4.14: GSM Pin description [XXVI]

4.6.2 Working

From the below circuit, a GSM modem duly interfaced to the MC through the level shifter IC Max232. The SIM card mounted GSM modem upon receiving digit command by SMS from any cell phone sends that data to the MC through serial communication. While the program is executed, the GSM modem receives command 'STOP' to develop an output at the MC, the contact point of which is used to disable the ignition switch. The command so sent by the user is based on an intimation received by him through the GSM modem 'ALERT' a programmed message only if the input is driven low. The complete operation is displayed over a 16x2 LCD.[13]

4.6.3 Features

1) Improved spectrum efficiency.
2) International roaming.
3) Compatibility with integrated services digital network (ISDN).
4) Support for new services.

5) SIM phonebook management.
6) Fixed dialing number (FDN).
7) Real-time clock with alarm management.
8) High-quality speech.
9) Uses encryption to make phone calls more secure.
10) Short message service (SMS).[13]

4.6.4 Applications

1) Cell Broadcast.
2) Voice Mail.
3) Fax Mail.
4) Call forwarding.
5) Barring of outgoing and incoming calls.
6) The closed user group (CUG).[13]

4.7 GPS

Figure 4.15: GPS [XXVIII]

Global Positioning System (GPS) is a satellite-based system that uses satellites and ground stations to measure and compute its position on Earth. GPS is also known as Navigation System with Time and Ranging (NAVSTAR) GPS. GPS receiver needs to receive data from at least 4 satellites for accuracy purpose. GPS receiver does not transmit any information to the satellites. This GPS receiver is used in many applications like smartphones, Cabs, Fleet management etc.

4.7.1 Pin description

1) VCC: Power Supply 3.3 – 6 V.
2) GND: Ground
3) TX: Transmit data serially which gives information about location, time etc.
4) RX: Receive Data serially. It is required when we want to configure GPS module.

4.7.2 Working

GPS receiver uses a constellation of satellites and ground stations to calculate accurate location wherever it is located. These GPS satellites transmit information signals over radio frequency (1.1 to 1.5 GHz) to the receiver. With the help of this received information, a ground station or GPS module can compute its position and time.

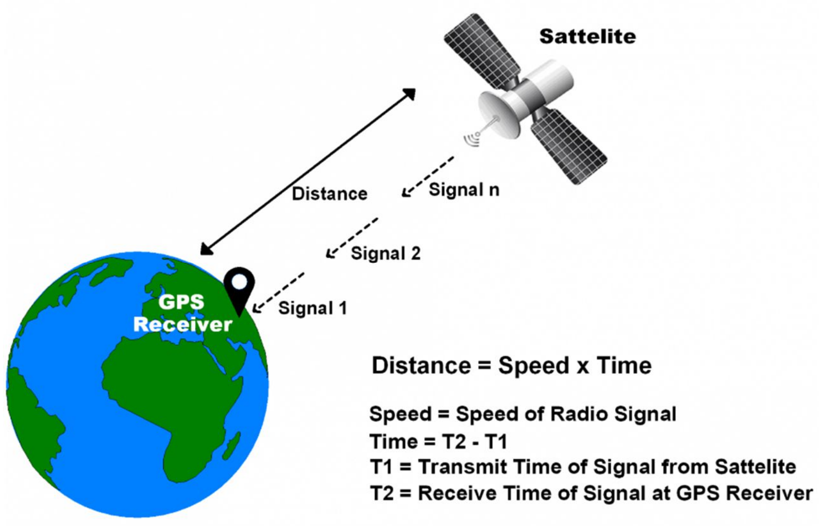

Figure 4.16: GPS Working [XXIX]

4.7.3 Features

1) Real-Time Tracking.
2) Trip History.
3) Alerts.
4) Anytime Anywhere Access.
5) Geo-Fencing.
6) Historical Reports and Dashboard summary.[15]

4.7.4 Applications

1) Aviation.
2) Farming.
3) Military.
4) Marine.
5) Science.
6) Surveying.[15]

4.8 I2C Liquid Crystal display

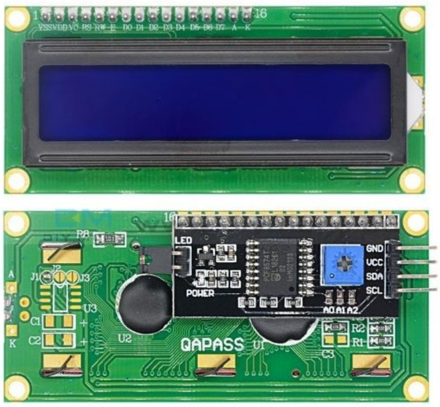

Figure 4.17: I2C LCD [XXVII]

I2C Module has an inbuilt PCF8574 I2C chip that changes over I2C sequential information to resemble information for the LCD. These modules are at present provided with a default I2C address of either 0x27 or 0x3F. To figure out which variant you have checked the dark I2C connector board on the underside of the module. On the off chance that there 3 arrangements of cushions named A0, A1, and A2 then the default address will be 0x3F. If there are no cushions the default address will be 0x27. The module has a difference change pot on the underside of the presentation. This may require changing for the screen to show message effectively. [16]

1) The I2C 16Ö2 Arduino LCD Screen is utilizing an I2C correspondence interface. It can show 16x2 characters on 2 lines, white characters on a blue foundation. This showcase conquers the downside of LCD

1602 Parallel LCD Display in which you'll squander around 8 Pins on your Arduino for the presentation to get working. Fortunately, in this item, an I2C connector is legitimately bound right onto the pins of the showcase. So, all you have to interface are the I2C pins, which shows a decent library and little coding.

2) The I2C is a sort of sequential transport created by Philips, which utilizes two bidirectional lines, called SDA (Serial Data Line) and SCL (Serial Clock Line). Both must be associated by means of pulled-up resistors. The utilization voltages are standard as 5 V and 3.3V. [16]

On the off chance that you as of now have the I2C connector welded onto the board like in this item, the wiring is very simple. You ought to for the most part have just four pins to attach. VCC and GND obviously. The LCD works with 5 Volts. So, we go for the 5 V Pin.[16]

4.8.1 Pin description

1) GND – Ground
2) VCC – 5 V Power Supply
3) SDA – Data Line
4) SCK – Clock Line

4.8.2 Features

1) Operating Voltage: - 5 V.
2) Backlight and Contrast is adjusted by potentiometer.
3) Serial I2C control of LCD using PCF8574.
4) Come with 2 IIC interface, which can be connected by Dupont Line or IIC
5) dedicated cable.
6) Compatible for 16x2 LCD.
7) This is another great IIC/I2C/TWI/SPI Serial Interface.
8) With this I2C interface module, you will be able to realize data display via only 2 wires.

4.8.3 Specifications

1) Compatible with Arduino/Genuino UNO, Mega, Micro, Nano, Mini.

2) I2C Address: 0x20-0x27(0x20 default).
3) Back lit (Blue with white char color).
4) Supply voltage: 5 V.
5) Interface: I2C/TWI x1, Gadgeteer interface x2.
6) Adjustable contrast.
7) Size: 82 x 35 x 18 mm (3.2Ö1.4Ö0.7 in).
8) White text on the Blue background.
9) Interface Address: 0x27.
10) Character Color: White.
11) Backlight: Blue.
12) Supply voltage: 5 V. [16]

4.8.4 Applications

1) LCD televisions.
2) computer monitors.
3) instrument panels.
4) aircraft cockpit displays.
5) consumer electronics.
6) video game devices. [16]

Chapter 5

Working

1.1 Block Diagram

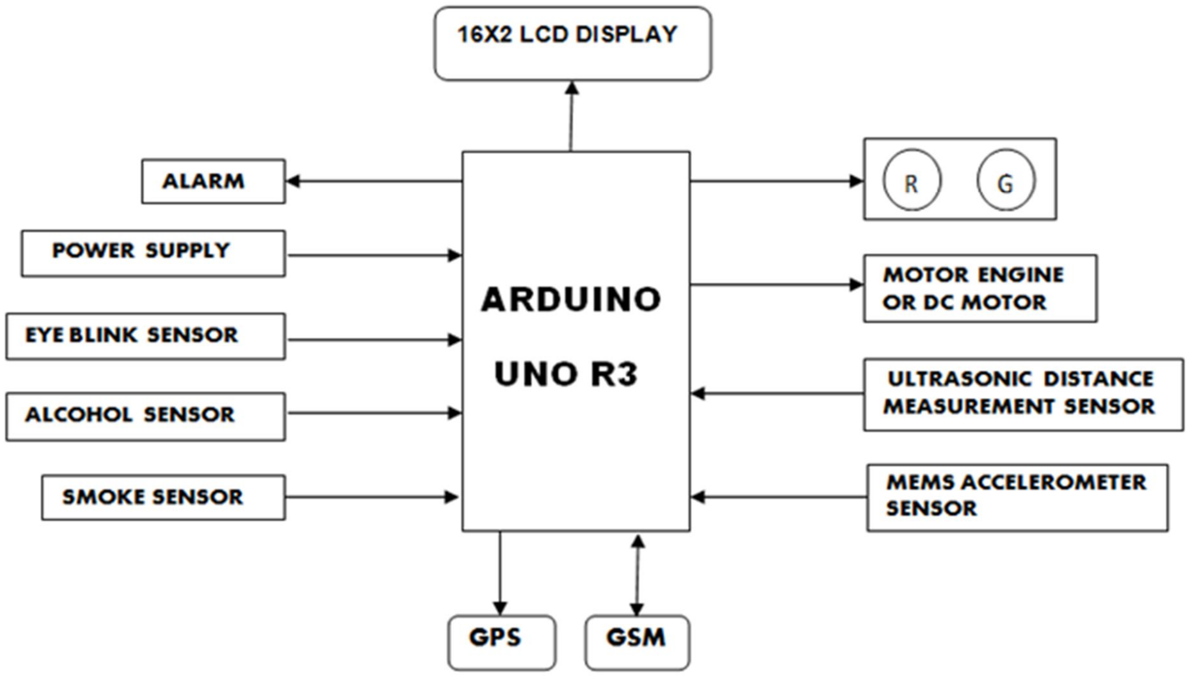

Figure 5.1: Block Diagram

This diagram explains us the basic working of this system and this experiment which gives us a primary sketch about how the system looks like after an initial setup. I will explain the system and its working in the following topic where I will cover all the parts and sensors and their connectivity to the Mega Arduino board.

1.2 Flow chart

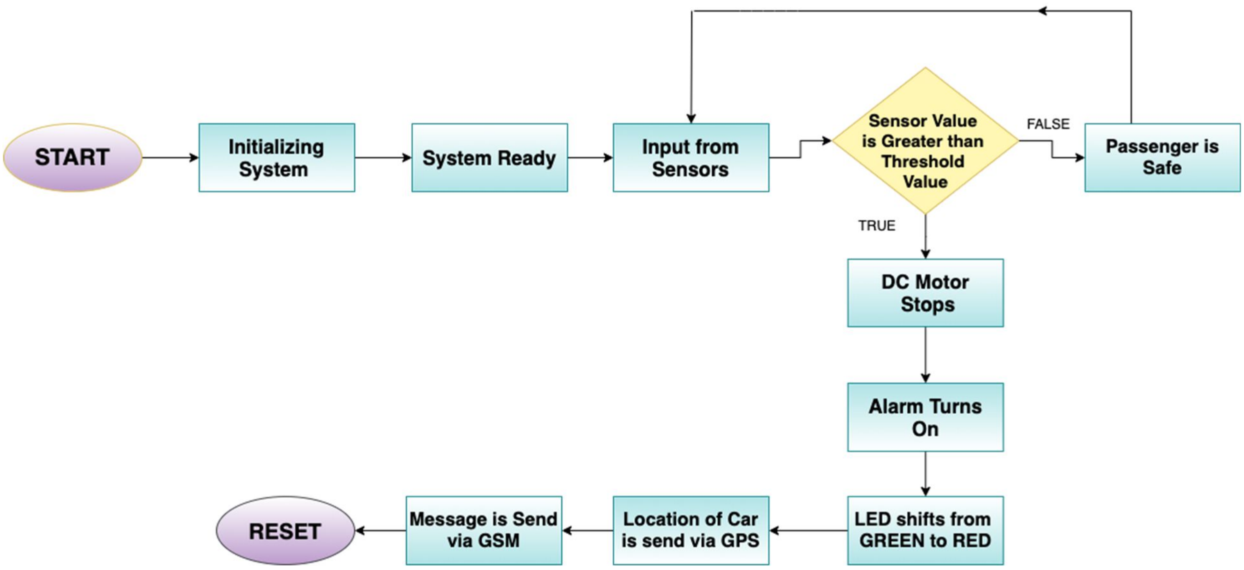

Figure 5.2: Flow Chart

1) The system is designed in such a way to avoid accident under conditions. The system is assembled with multiple sensors that include Ultrasonic Sensor, Alcohol Sensor, MEMS Sensor, Smoke Sensor, Eye-Blink Sensor, GPS, and GSM.

2) In the beginning the system will check all the connections and then initialize the input pins, output pins and the variables of the sensors that will be used to store data at different intermediate steps. After the initialization phase is over, the system is ready to go and thus there will be a message displayed on the LCD screen that the system is ready as well as the green LED also turns ON.

3) Then the system starts reading data from the sensors. The data reading from the sensors is done using the polling technique. Polling Technique is technique in which the highest priority sensor is checked first. If the value of the sensor is greater than the threshold value or not. If not, then it goes to next sensor. This way the value keeps on getting verified and if there are no issues then the car keeps on moving.

4) After fetching the input from the sensors, it will check if the value received from the sensor is above or below the threshold value.

5) If the value is a above the threshold value provided from any sensor during the motion of the car it follow through certain procedure for safety.

6) It would stop the car or slow it down, then the alarm turns on, LED’s which switch from Green to Red as sign of danger and LCD shows warning on the display.

7) Then it would send the location of the car to a family member via GSM and GPS.

8) If the value is less, then threshold value then the system will check that the passenger is safe and then would go to back to reset mode.

9) Example-1 (Alcohol sensor) :- If the value of the sensor is greater than the threshold value defined the (Law Enforcement Department) then the vehicle would stop down, the Alarm turns ON and so does the LED’ which switch from Red to Green and the LCD would show warning signal on the display so as to indicate the driver that the vehicle would not start until the condition is resolved. Furthermore, the GPS would determine the location of the car and is send via GSM this location would be send to a relative or a family member that “THE DRIVER NEED’s HELP”. In this the the system would prevail the chances of accident to even occur.

10) Example-1 (Ultrasonic sensor): - In this sensor if the value is greater than threshold value i.e. The distance between is too close then the system is designed in such a way that it would automatically assist the driver in braking. As the distance decreases the speed of the car decreases accordingly and if it crosses the inner most threshold value then the engine would stop immediately. The system doesn’t use GPS or GSM in this case, it only uses Alarm and LED’s and LCD to provide the driver with indications.

11) If the value of all sensors is below the threshold value, then system would display that “ALL IS WELL” and goes back to input stage for new values.

Sr. No.	Sensors	Threshold Value (Vth)	LED-R/G If Value > Vth	GPS	GSM	Buzzer ON/OFF
1.	ALCOHOL	300	R-ON	G-OFF	ON	ON
2.	SMOKE	200	R-ON	G-OFF	ON	ON
3.	MEMS	400<X>500 400<Y>500 500<Z>600	R-ON	G-OFF	ON	ON
4.	ULTRSSONIC	150	R-ON	G-OFF	OFF	ON
5.	EYE BLINK	1	R-ON	G-OFF	ON	ON
Note: If value is greater than the threshold value then RED Led is ON & GREEN is OFF						

Figure 5.3: Table

Chapter 6

LIMITATIONS AND FUTURE WORK

Limitations: -

1) The message and location of the driver might be unavailable if there are network issues.
2) Cars coming from blind spots might not be detected.
3) The power supply might not be adequate.

Future Work: -

1) Audio Control System.
2) Blind-Spot Warning System.
3) Cross-Traffic Alert System.
4) Night Vision System.
5) Pedal Travel Sensor.
6) Active Kinematics Control System

Chapter 7

INTERMEDIATE RESULT

7.1 Alcohol Sensor

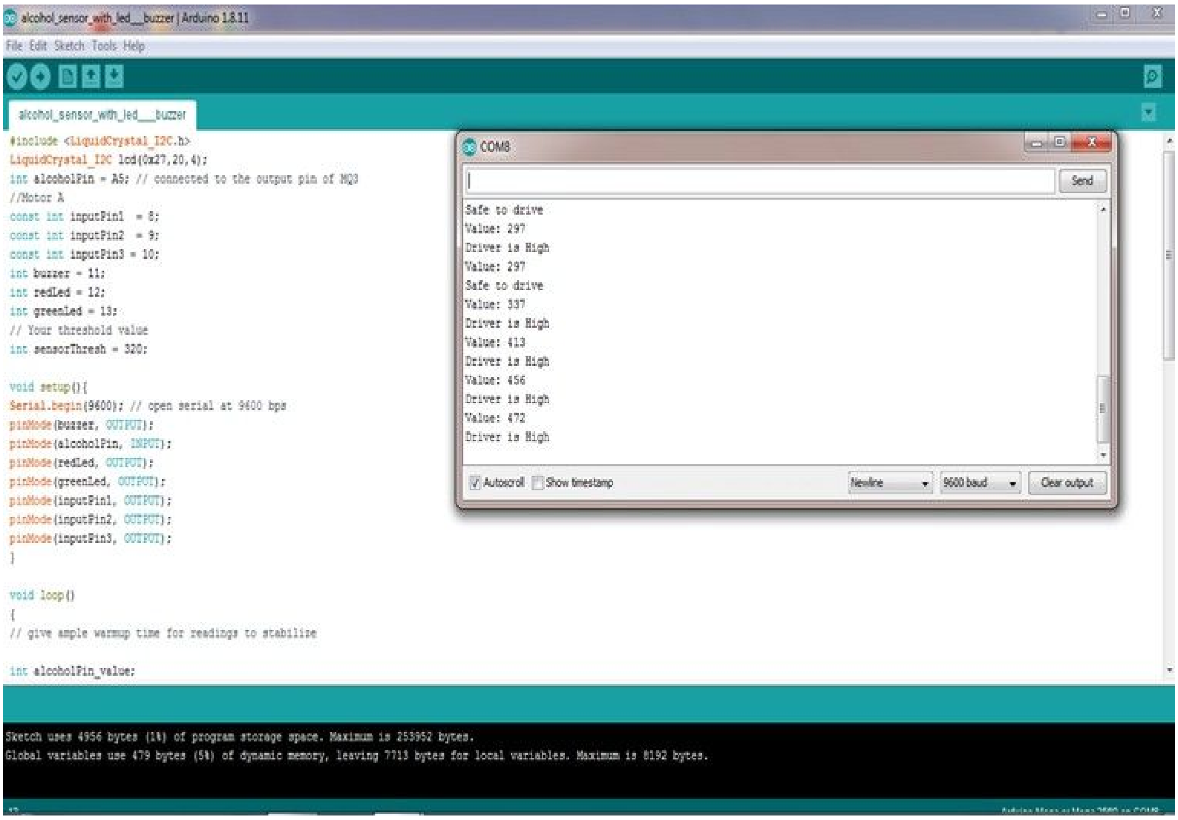

Figure 7.1: Alcohol Sensor

7.2 MEMS Sensor

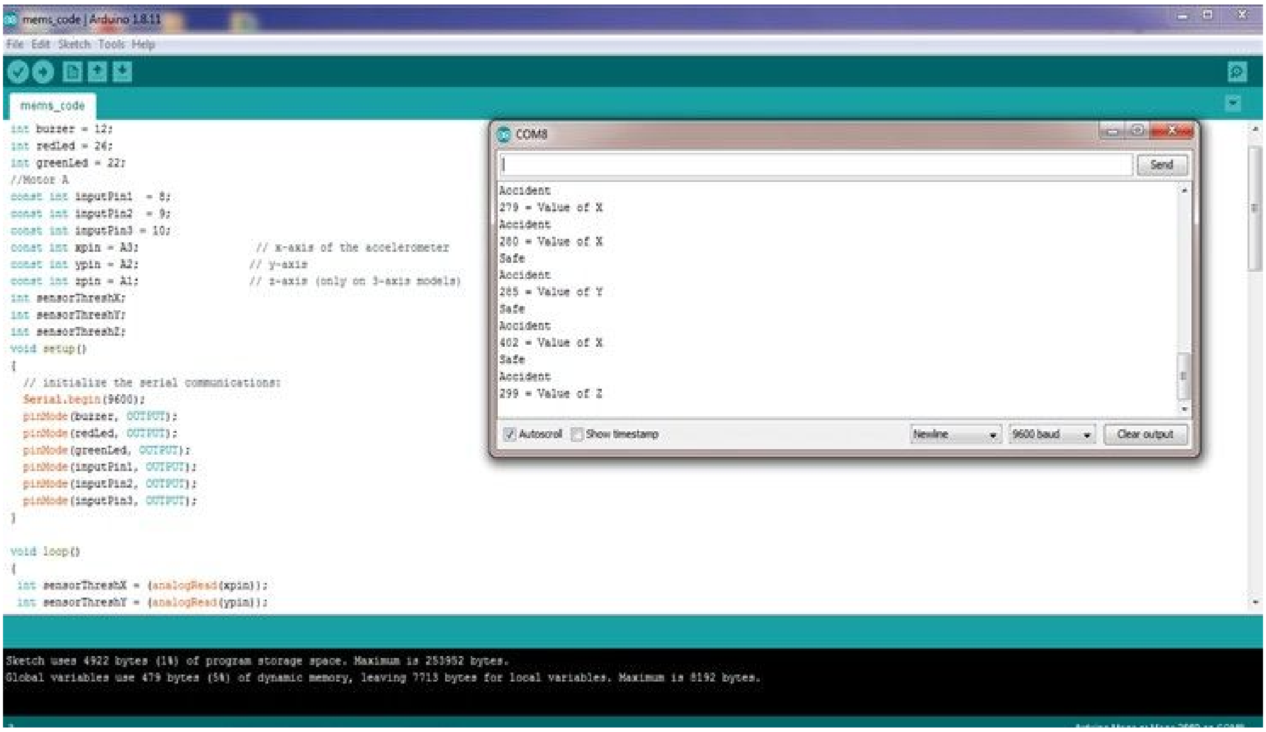

Figure 7.2: MEMS Sensor

7.3 Ultrasonic Sensor

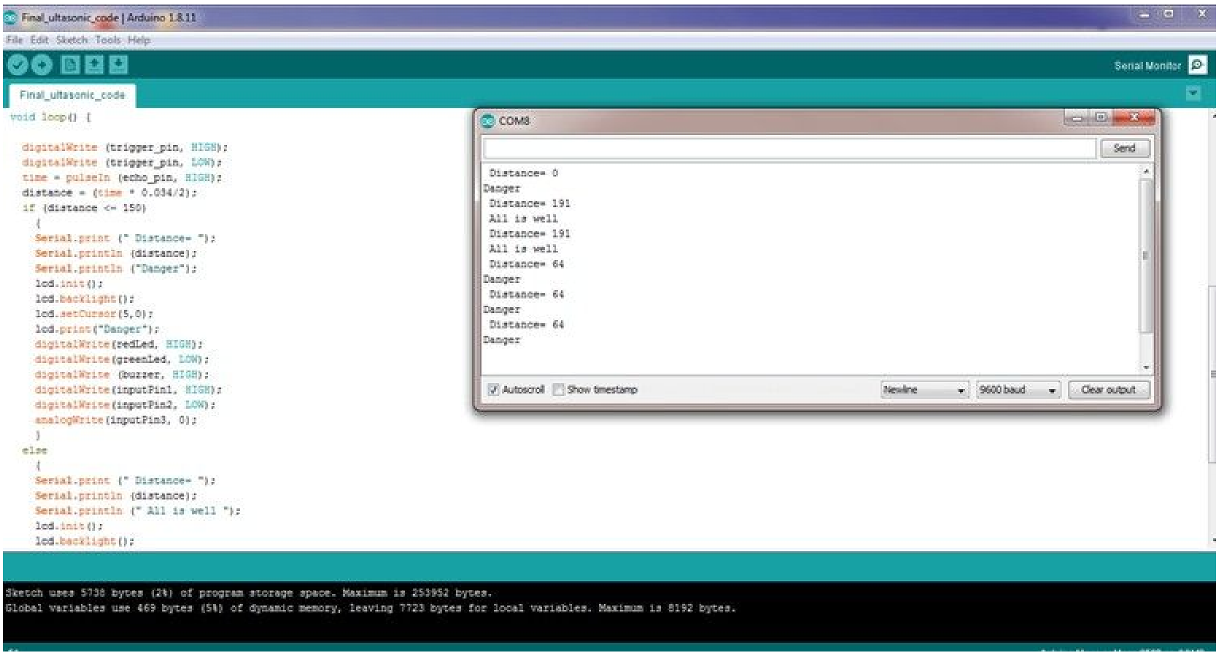

Figure 7.3: Ultrasonic Sensor

7.4 Smoke Sensors

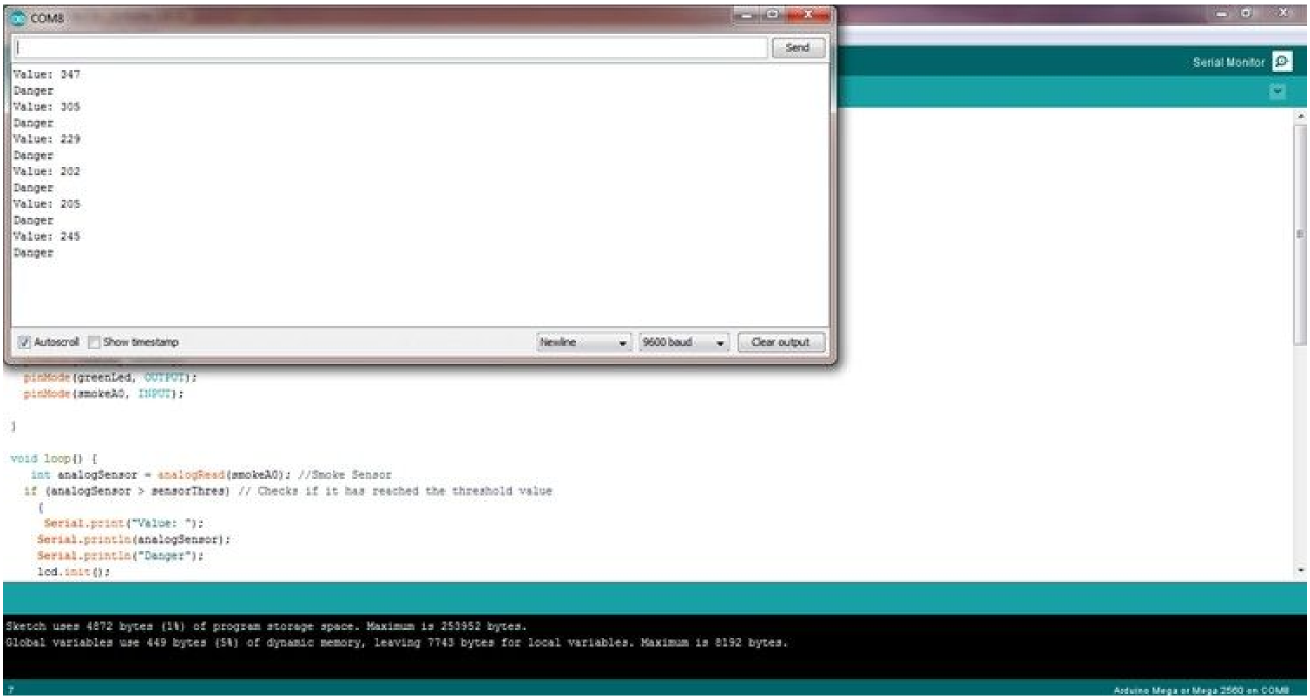

Figure 7.4: Smoke Sensor

Chapter 8

RESULT

8.1 SMS

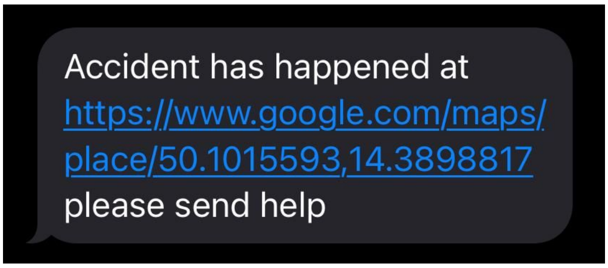

Figure 8.1: SMS via GSM

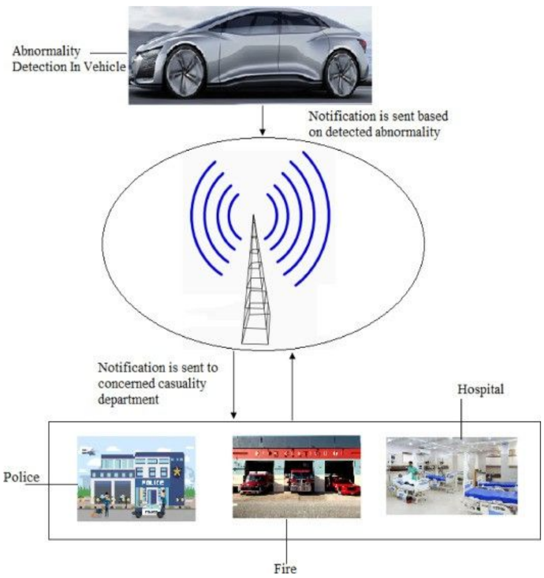

Figure 8.2: SMS via GSM

Here, as we can see in the figures above. The GPS signal and the location can be sent to the registered phone number or the last contacted number on the phone. This is just an example of how the message looks like when a real time accident happened.

8.2 Location

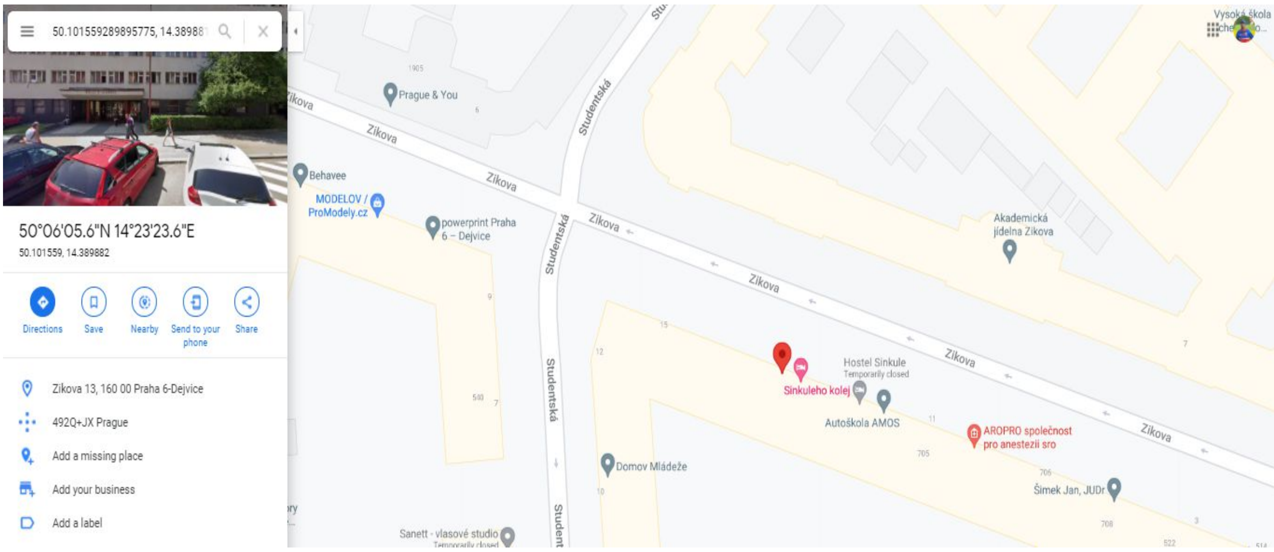

Figure 8.3: Location via GPS

GPS calculate the Latitude and Longitude and transmits this information to the receiver which allows the person using the location to locate and travel to destination of accident as shown in figure. In this case we have allocate the phone number of the person to the Arduino tool in case of emergency.

8.3 Structure

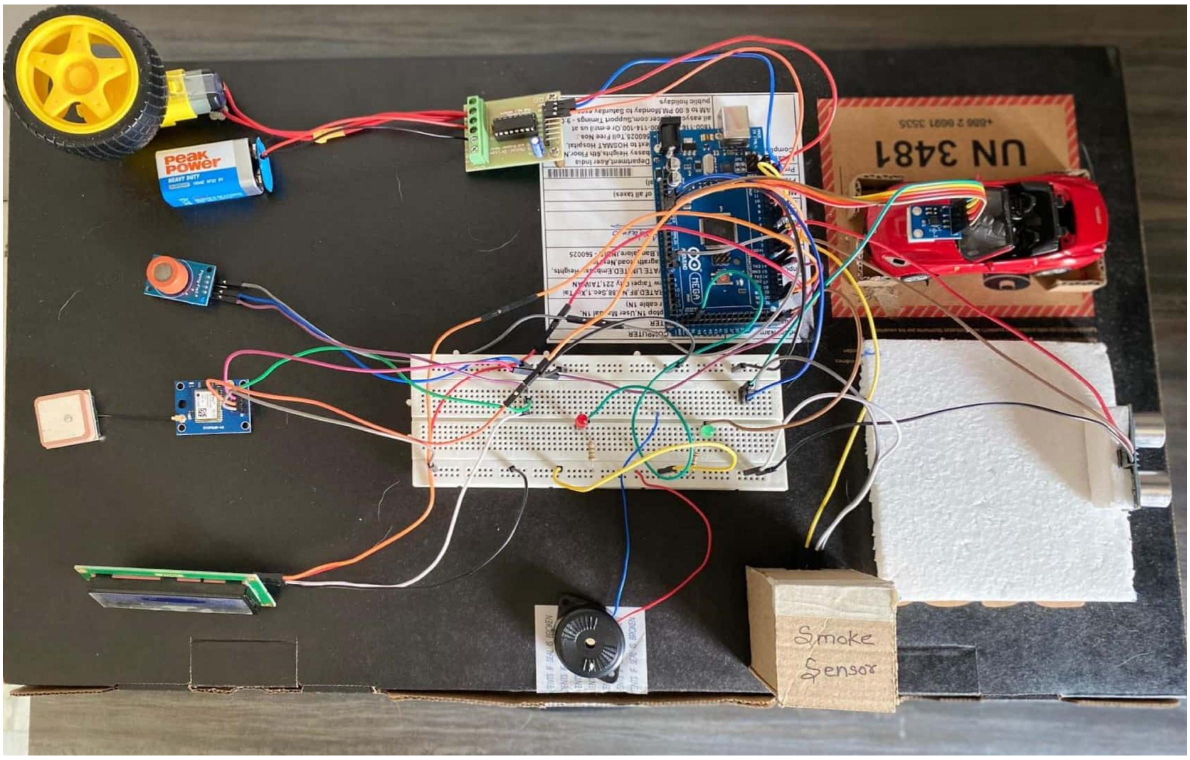

Figure 8.4: Structure

Chapter 9

CONCLUSION

The main objective of the proposed system is to design a smart vehicle system using Arduino. Here a prototype of the smart vehicle is developed which can be integrated to form an application for installing smart vehicles in the future. This system will help people receive emergency services on-time and will reduce the causes of road accidents. Since smart cars is the new trend, every working system is being upgraded to an automatic or smart system, then why not a smart vehicle system. In the proposed project we have taken up only five parameters, the system can further be modified by the addition of more sophisticated designs. All these parameters and the smart vehicle systems I described in this project are still work in progress and can be more user friendly possible to be used in daily life and in all the upcoming future smart Vehicles.

Working on this project has been very interesting and great knowledge curve for me. As there were so many positives from the project there were some negatives as well. At first for me the main challenge I faced was to gather all the equipment needed for the model. After which the part where I had to setup was not so troubling as I managed to do that comfortably. Then also gathering all the coding part to do for the Arduino to function all the sensors was also a bit of challenge just to understand at first. But also, it is very user-friendly if any non-technical person doing it for the first time can learn quickly enough. I was able to make the model work for only some of the sensors mentioned above in detail.

A big downturn and setback for me was to work with the GPS and get the location to any registered device. As I did not manage to make it work only through Arduino coding as it did not give me precise location. Then I found out a way to code through Python and make it work to send a text message of location to the number contacted the latest. Which did work but only for sending a text message to the last called Phone but also did not locate precisely. Since GPS did not work properly, I had to integrate it with Python for the coordinates. Hence, I can say that this idea is very useful and safe for the coming years, but it’s still work in progress to make it happen with very good effect to the real-life cars and situations.

Chapter 10

Bibliography

[1] *Road safety facts* [online]. [cit. 2021-8-18]. Available from: https://www.asirt.org/safe-travel/road-safety-facts/

[2] *Arduino* [online]. [cit. 2021-8-18]. Available from: https://www.arduino.cc/

[3] KAUR, Parveen, Manash BORAH, Animesh DAS and Smrit DEY. Smart Vehicle System using Arduino. *ADBU Journal of Electrical and Electronics Engineering (AJEEE)* . Volume 3. Assam, India: r Creative Commons Attribution 4.0 International License (CC-BY), 2019, p. 5. ISBN 2582-0257.

[4] *Introduction to Arduino mega 2560* [online]. [feeling. 2021-8-18]. Available from: https://www.theengineeringprojects.com/2018/06/introduction-to-arduino-mega-2560.html

[5] *Advantages and Disadvantages of Micro controllers.* [online]. [feeling. 2021-8-18]. Available from: https://www.researchgate.net/post/What-are-the-advantages-and-disadvantages-of-arduino-compared-to-microcontrollers

[6] *Micro controllers.* [online]. [feeling. 2021-8-18]. Available from: https://components101.com/microcontrollers/arduino-uno

[7] *GSM* [online]. [feeling. 2021-8-18]. Available from: https://www.tutorialspoint.com/gsm/gsm_overview.html

[8] *Alcohol sensor* [online]. [feeling. 2021-8-18]. Available from: https://lastminuteengineers.com/mq3-alcohol-sensor-arduino-tutorial/

[9] *All Components Specifications* [online]. [feeling. 2021-8-18]. Available from: https://components101.com/

[10] DAS, Pragyaditya and S. Pragadeesh. A Microcontroller Based Car-Safety System: Implementing Drowsiness Detection and VehicleVehicle Distance Detection in Parallel. *INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH*. 4. 2015, pp. 3. ISBN 2277-8616.

[11] *MEMS Sensor Working* [online]. [feeling. 2021-8-18]. Available from: https://jewellinstruments.com/support/how-does-a-mems-sensor-work/

[12] *MEMS Selection* [online]. [feeling. 2021-8-18]. Available from: http://www.eeherald.com/section/design-guide/mems_selection1.html

[13] *GSM Properties* [online]. [feeling. 2021-8-18]. Available from: https://www.elprocus.com/gsm-technology-architecture-its-applications/

[14] *GSM Working* [online]. [feeling. 2021-8-18]. Available from: https://www.geeksforgeeks.org/how-gsm-works/

[15] *GPS module* [online]. [feeling. 2021-8-18]. Available from: https://www.electronicwings.com/sensors-modules/gps-receiver-module

[16] *Microcontroller Interfacing* [online]. [feeling. 2021-8-18]. Available from: https://circuitdigest.com/microcontroller-projects/interfacing-16x2-lcd-with-esp32-using-i2c

[17] *GPS* [online]. [feeling. 2021-8-18]. Available from: https://www.geotab.com/blog/gps

[18] PATIL, Prof. Bhavna, Harsh AMRITE, Kailas GAIKWAS, Jagdish DIGHE and Sumit HIRLEKAR. SMART CAR MONITORING SYSTEM USING ARDUINO. *International Research Journal of Engineering and Technology (IRJET)*. 5. 2018, p. 4. ISBN 2395-0056.

[19] ACHARYA G., Pavan, Kailas GAIKWAS and Suthesh BHAT. SMART VEHICLE PROTECTING SYSTEM. *International Journal of Scientific Development and Research (IJSDR)* . 2. Udupi, India, 2017, p. 4. ISBN 2455-2631.

XIX. *Arduino Picture* [online]. [feeling. 2021-8-18]. Available from: https://www.laskarduino.cz/arduino-nano-r3--atmega328p-klon--pripajene-piny/?gclid=Cj0KCQjw5PGFBhC2ARIsAIFIMNc9YhAfNDjciD2-nfmlNja7Y1Iy-nFwktTt

XX. *Alcohol Detection Sensor* [online]. [feeling. 2021-8-18]. Available from: https://www.hackster.io/yashikibrahim/alcohol-detection-sensor-dc32cd

XXI. *Mq2 Gas sensor* [online]. [feeling. 2021-8-18]. Available from: https://www.electronicscomp.com/mq2-gas-sensor-price-in-india

Ultrasonic Sensor - distance measurement [online]. [feeling. 2021-8-18]. Available from: https://microcontrollerslab.com/hc-sr04-ultrasonic-sensor-interfacing-with-arduino-distance-measurement-example/

XXII. *Ultrasonic Sensor* [online]. [feeling. 2021-8-18]. Available from: https://www.fierceelectronics.com/sensors/what-ultrasonic-sensor

XXIII. *Eye Sensor* [online]. [feeling. 2021-8-18]. Available from: https://www.semanticscholar.org/paper/Arduino-based-Accident-Prevention-System-with-Eye-Upender-Reddy/

XXIV. *Accelerometer Module* [online]. [feeling. 2021-8-18]. Available from: https://www.electronicwings.com/sensors-modules/adxl335-accelerometer-module

XXV. *MEMS Sensor Working* [online]. [feeling. 2021-8-18]. Available from: https://jewellinstruments.com/support/how-does-a-mems-sensor-work/

XXVI. *GSM GPRS module* [online]. [feeling. 2021-8-18]. Available from: https://www.ecorobotics.com.na/products/sim800l-gsm-gprs-module

XXVII. *All Components Specifications* [online]. [feeling. 2021-8-18]. Available from: https://components101.com/

XXVIII. GPS MODULE [online]. [feeling. 2021-8-18]. Available from: https://www.circuituncle.com/product/gps-module-neo-6m/

XXIX. *GPS receiver Module* [online]. [feeling. 2021-8-18]. Available from: https://www.electronicwings.com/sensors-modules/gps-receiver-module