IoT-based Intelligent Embedded Vehicle Monitoring System

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering of the University of Asia Pacific

by

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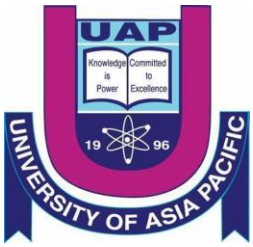

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
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DECLARATION

We hereby declare that this project is based on the original except for source material explicitly acknowledged. We have completed the project on the topic entitled "**IoT based Intelligent Embedded Vehicle Monitoring System**" as well as we prepared to the Department of Computer Science and Engineering of University of Asia Pacific in partial fulfillment of the requirement for the degree of B.Sc. in Computer Science and Engineering under the supervision of Shammi Akhtar, Assistant Professor, Computer Science and Engineering, University of Asia Pacific. The piece of work or a part of the piece of work has not been submitted for more than one purpose. We also acknowledge that we are aware of University policy and regulations on honesty in academic work, and of the disciplinary guidelines and procedures applicable to breaches of such policy and regulations.

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Abstract

Nowadays the number of using private vehicles is increasing day by day. To make life easier and faster one place to another private vehicle plays a vital role. However, the increasing number of using vehicles also costs some problems as if a thief can take control or there can occur any small or big accident. To solve this kind of problem we came out with some features of an IoT-based intelligent embedded vehicle monitoring system.

In this independent system, if anyone tries to get access to the vehicle a message goes to the owner's mobile, an alarm rings and without a password, the vehicle will not start. Secondly, if there is any leakage of gas or any smoke it detects and sends a message to the owner and rings an alarm. Now for the vehicle, it also measures the distance from the vehicle to the vehicle in the road and parking place.

In this thesis, we try to counter this problem and try to give a solution to protect the vehicle. Because our system is independent it can be implement in any kind of vehicle at a cheap rate and the user can monitor his/her vehicle.

ACKNOWLEDGEMENT

At first, we are very thankful to Almighty ALLAH. Without His help, we couldn't complete it. Then gradually come the names of our parents, teachers, family, friends, and mentors.

Especially, please allow us to dedicate our acknowledgement of gratitude toward the following significant advisors and contributors: First and foremost, we would like to thank Shammi Akhtar for her most support and encouragement.

We are also thankful to our teachers who helped us in a number of ways by providing various resources and moral support. We would like to extend our thanks to the laboratory staff for their fast response and cooperation with us to get some materials we need for our case.

Finally, we sincerely thank my parents, teachers, family, and friends, who provide the advice and financial support. The product of this report would not be possible without all of them.

Last of all, we are grateful to our family, who are always with us in every step of life.

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Chapter 1

1.1 Motivation and Objectives

Currently, many people own their vehicles, theft is occurring in parking and safe driving in public transportations, vehicle safety, and accident prevention have become more challenging. Therefore, many new techniques, such as IoT technique, Wireless communication procedure, embedded mode, and so on, have been combined into vehicle security systems. At the same time, the amount of accidents in vehicles remains high, particularly. So, one usable vehicle preservation system should be effective, sturdy, and secure.
Here we are building a system that aims to monitor full vehicles and prevent intelligence.

1.2 Problem

There is a big problem stealing vehicles. Vehicles are frequently stolen on several factors and mostly occur in sensitive areas. Precisely, the security systems in older vehicles may not be updated to the same standard as present vehicles. Thieves also have longer to learn their shortcomings. The Vehicle stolen rate in Bangladesh is around 60.68% [1].

Beside this for some technical fault, the vehicle can burn with fire, this can happen because of gas leakage, electrical error and also fuel tank leakage.

Since 2005, the RPGCL has published information on accidents caused by gas cylinder explosions in vehicles. The report shows that two accidents appeared due to cylinder explosions in 2005, seven accidents in 2006, seven accidents in 2007, eight accidents in 2008, five accidents in 2009, five accidents in 2010, six accidents in 2011, five in 2012, ten in 2014, four accidents in 2016 and one accident in 2017 [2].

1.3 Objective

Our system's main features are,

1. Security layer (External)
2. Security layer (Internal)
3. Safety distance and safety parking
4. Gas leakage detection
5. Motion detection with unauthorized access prevent

All are equipped with cellular text alerts to users.

1.4 Our Proposed system Architecture

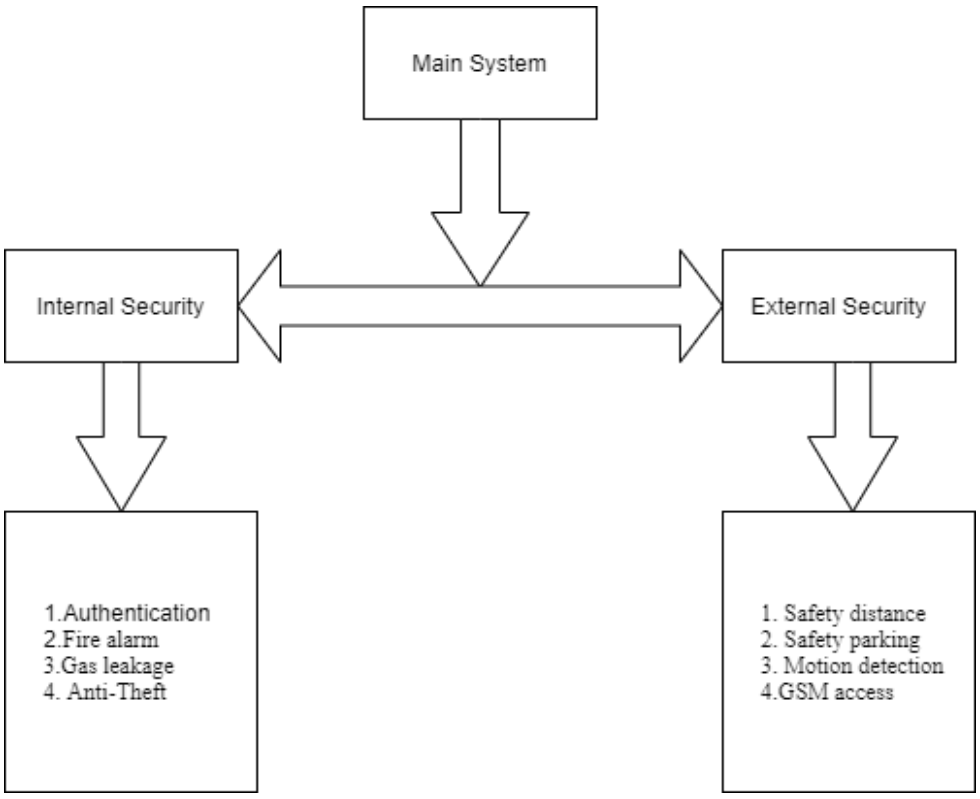

Fig 1 : System Architecture.

1.5 Why do we propose this system?

In this project, we try to build a system which is not only secure but also cheapest. Our system is platform independent so any one can use it on any kind of vehicle. In the previous security system, we found some problems so we try to develop our system.

Chapter 2

2.1 Literature Review

2.1.1 This kind of project previously try by M. Debajyoti, G. Megha, C. Prajakta, A. Tahesin and P. Vidhi "An Attempt to Develop an IOT Based Vehicle Security System"

In this system for security issues a keypad is installed to unlock the door. Here once 3 time passwords can be interred if the password is incorrect the door will be locked. To fix the system there is also a reset option. If the user wears the seat belt and the password is correct then he can operate the vehicle. If the vehicle is towed by anyone, it sends a message through Bluetooth module and with the help of GSM module. If someone try on inter with door the IR sensor sends command to controller to dashboard through Bluetooth module and send a SMS to mobile with GSM module [3].

2.1.2 Advantages

Here all 3 features try to cover all possible things. And here try to build a cheap but effect full system

2.1.3 Problem with this model

Here the door lock system is in the door and can be noticed by anyone. Here after 3 times a reset button can be used to boot it up. So here the thief gets a bug and time to recover and no message sent to the owner. Second, when someone is towed by someone it sends a message but with the help of Bluetooth and we all know the range of Bluetooth is small so after a certain distance it becomes useless. Third, when someone tries to break the glass of the window it

sends a message. Nowadays the thief doesn't break glass because they can be noticeable to any one. So this model has some problems in real life.

2.2 This kind of similar project also made by P. Boominathan and A. Rajatabh, "Vehicle Security System Using IoT Application"

Another work is to make a system where someone tries to steal the vehicles it helps to find it out. Its system alerts the car owner when he is at nearest distance as well as when he is far position [4].

2.2.1 Problems

No doubt, it sends message to the owner but if the thief took the vehicles and try to dismantle then this feature is useless. Moreover, it doesn't alarm before breaking the security system so it has become more complex after cracking the system.

2.3 Another similar project is try to made by Sabiya Sultana and Sadaf Ahmed "Smart Car Parking System using Arduino UNO"

Now in this system some controllers such as Arduino and no sonar sensor are used. If there is any slot remaining the system allows the vehicle to enter. And give a slot. It's very handy to find a location [5].

2.3.1 Problem

In automated parking areas the computer already knows about the area so before interns it can give an idea. Second when a small area becomes thought to park it doesn't provide any feature. Now trying to implement it in every parking slot is costly so the system will become easier if it's implemented on vehicles.

Chapter 3

3.1 HARDWARE COMPONENTS

3.1.1 Introduction

This project provides a guideline to the students who are new in the world of Arduino and help them to understand about the PIR sensor, flame sensor, gas sensor keypad, sonar sensor, GSM module, Pump, Buzzer, breadboard and how to make a security system using these components. By this component, a fully automated system will be active and the user can control it as far as he/she chooses.

3.1.2 Components that used in this system

The designed system consists of the following components

1. Arduino Mega,
2. PIR Sensor,
3. Arduino Sketch Software,
4. Breadboard,
5. Display with i2c adapter,
6. Keypad,
7. Flame Sensor,
8. Gas Sensor,
9. Sonar Sensor,
10. GSM Module,
11. Buzzer,
12. Pump,
13. Wires (Male to Male/ Male to Female Connectors) etc.

3.2 “Arduino” What does it mean and why are going to use it

Arduino is an open source development platform for which include both hardware and software. It can take inputs like light on a sensor , fingerprint or finger on a sensor, Twitter message and shows output on a display, activating motor, Led. As it is open source it is used world wide. It's run on different platforms like Windows, Mac and Linux. In 2005 it was invented in Italy so that small kinds of projects can be made on it. Arduino programs are written in (IDE) Integrated Development Environment and the programming language is based on simple hardware programming language. This kind of language is similar to the C language. As its language is close to C & C + + it has become easy for the beginner. Today development of robotics , design and architects' small prototype, music instruments has become easier for an ex part or a beginner. It provides some advantage which are given below,

- Inexpensive
- Cross-platform
- Simple, clear programming environment
- Open source and extensible software
- Open source and extensible hardware

3.3 Types of Arduino

There are mainly four types of Arduino [6],

Table 1 : About “Arduino”

Major types are given below:

- Entry Level
- Enhanced Features
- Internet of Things
- Wearable
- Retired

All Arduino's Information:

Features	Arduino Uno	Arduino Due	Arduino Mega	Arduino Leonardo
Processor	16Mhz ATmega328	84MHz AT91SAM3X8E	16MHz ATmega2560	16MHz ATmega32u4
Memory	2KB SRAM, 32KB flash	96KB SRAM, 512KB flash	8KB SRAM, 256KB flash	2.5KB SRAM, 32KB flash
Digital I/O	14	54	54	20
Analogue I/O	6 input, 0 output	12 input, 2 output	16 input, 0 output	12 input, 0 output

Table 2: About configuration

***For our system we are using "The Arduino Mega". Here are some details about The ArduinoMega.**

3.4 The Arduino Mega

The Arduino Mega is an open-source development board. This one has the Microchip that is developed ATmega2560P by Atmel.

This arduino mega has 54 digital input/output pins where,

1. 16 pins have analog input pins
2. 14 PWM pin
3. 6 hardware serial ports (UARTs).

This micro-controller also has a crystal oscillator-16 MHz alongside a power jack, and also a ICSP header, including USB-B port, and a RESET button.

However, this also has a programmable USB host chip installed. This uses the same 5V power connector as the Uno [7].

Fig 2.1: Arduino Mega

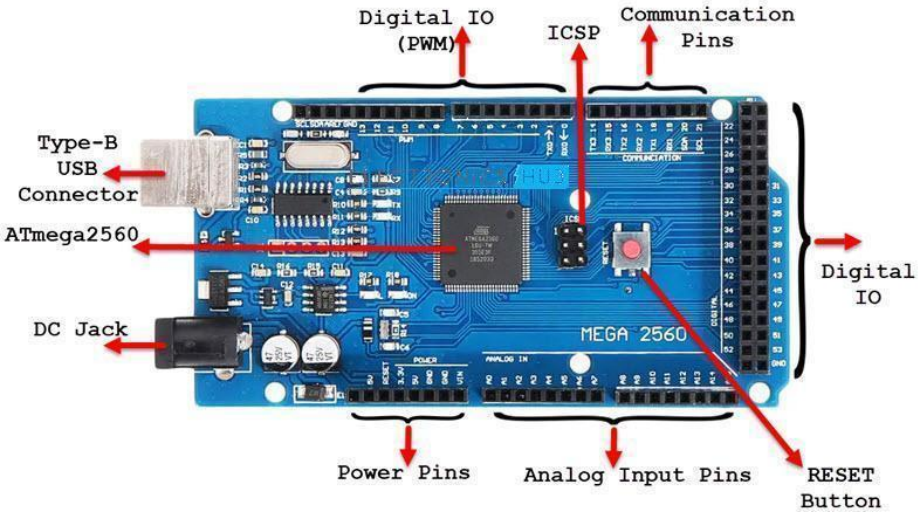

Fig 2.2: Diagram of Arduino Mega (Pinout) [8]

3.5 Advantages of Using Arduino

Using an Arduino simplifies the number of hardware and software development you need to do in order to receive a system running. The Arduino hardware platform already has the potential and reset circuitry setup as well as circuitry to program and interact with the microcontroller over USB. The I/O pins of the microcontroller are typically already fed out to the chamber for easy access. On the development side, Arduino provides a huge number of libraries to compose the programming and the microcontroller simple. The effortless functions

is to control and read the I/O pins rather than handel the bust masks typically and used to interface with the Atmega I/O . More useful are stuffs such as being capable to set I/O pins to PWM at a certain duty period using a single command or doing Serial communication [9].

- Ready to Use.
- Examples of codes.
- Effortless functions.
- Large community.

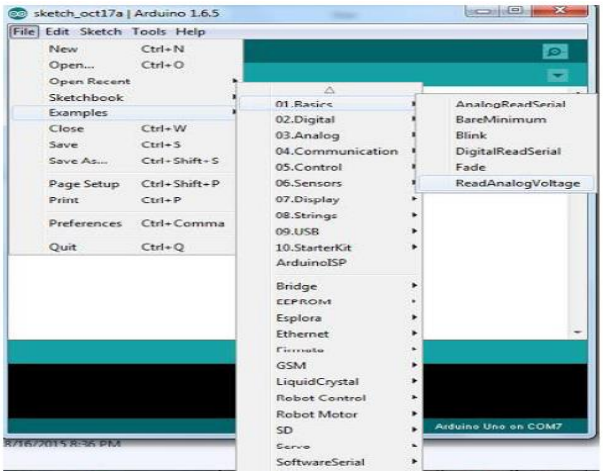

Fig 2.3 : Arduino IDE [10]

3.6 Passive Infrared Sensors (PIR sensor)

PIR sensors are able to sense motion and are used to detect whether a human has moved or not inside the sensor's range. They are commonly found in gadgets and devices that are used at home or for businesses [11].

Following are the advantages of PIR Sensors:

- ❖ Small in size
- ❖ Wide lens range
- ❖ Easy to interface
- ❖ Inexpensive

- Low-power
- Easy to use
- Do not wear out

Fig 2.4: PIR Sensor

PIR sensors are made of pyroelectric sensors, a round metal can with a rectangular crystal in the center, which is able to detect everything that emits low-level radiation (infrared radiation) alongside it and the hotter this is, the more radiation is detected by it. The sensor in a motion detector is splitted in two halves. This is to detect motion and not like average IR levels. PIR sensors have adjustable settings [12].

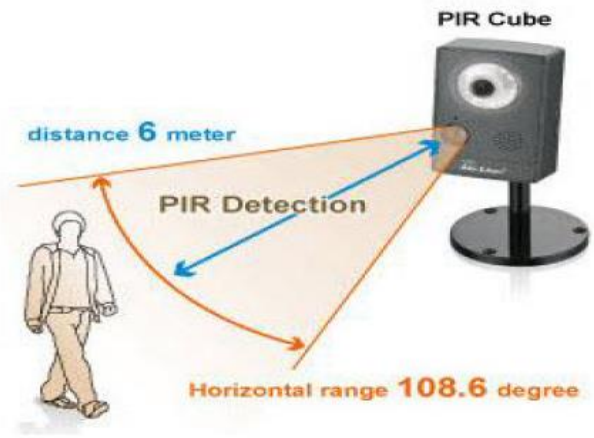

Fig 2.5: PIR Range

To begin explanation how a basic PIR sensor works, we'll use this rather nice diagram [13].

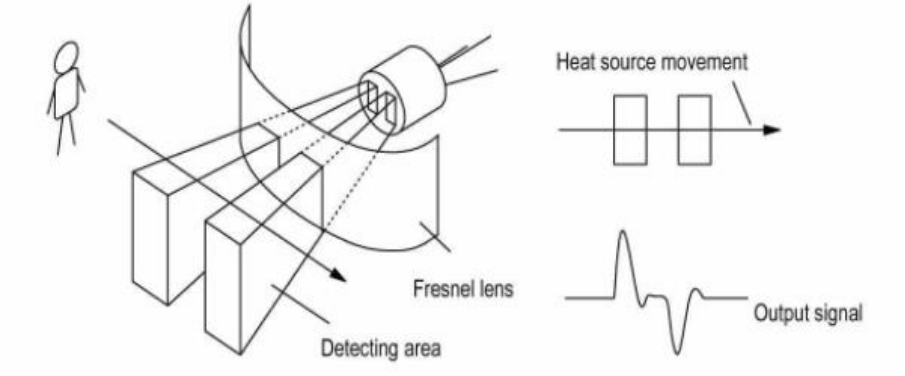

Fig 2.6: PIR Detection

3.6.1 How PIR Works and Configuration

The aim of the PIR sensor is to detect motion of any object in a specific area. As seen in Figure, "PIR Detection" these sensors contain two parts which are sensitive to IR. To increase the performance we can increase the IR sensitive area. This can be done in two ways,

- Increasing the number of sensors
- Using a Fresnel lens.

The latter method is highly recommended because it is inexpensive and improves IR reception by the sensor. It multiplies the area which is visible to the sensor and it focuses reception of IR with the sensor [14].

In below we can see the configuration (fig 3.8),

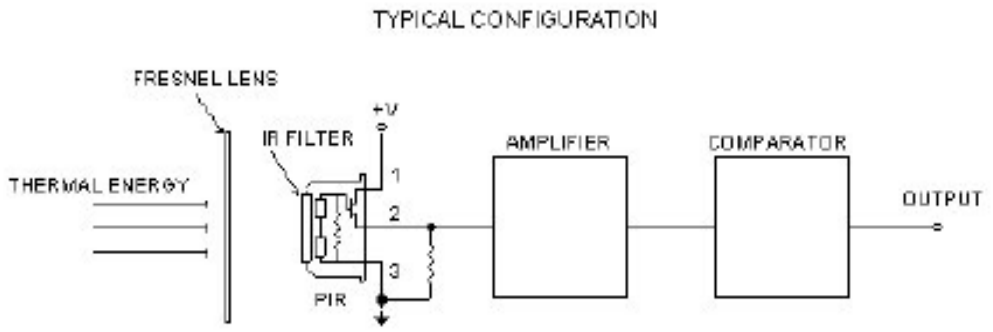

Fig 2.7: Configuration of the PIR sensor

3.6.2 The sensor signal

When a body, with a condition different to ambient, moves into the detection field of a PIR sensor, the sensor provides a small AC signal. Usually the signal range is in 1 mVpp. This small voltage is about a DC signal that may undoubtedly vary from one sensor to another. For this reason, it is essential to cancel the DC part of the signal and to amplify the AC part. As the environment interrupts the signal, a noise filter is convenient.

There is two potentiometers is on the board that helps to adjust parameters:

1. Sensitivity: This helps to the maximum range that motion is able to detect. It has a range of about 3 meters to approximately 7 meters.
2. Time: This sets how long the output will remain HIGH after detection. The minimum range is 3 seconds to maximum 5 minutes or 300 seconds.

Finally, the board also has a jumper that depends on the models. It has two settings:

- H: Hold/Retriggering In this position of the HC-SR501. PIR Sensor Retriggering Repeat Mode Jumper Setting. From fig 3.9 we know the details,

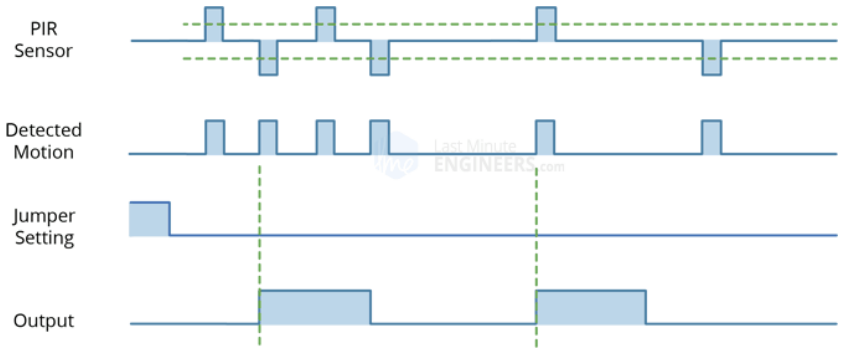

Fig 2.8: PIR detection Mode

- L: Intermittent or No-Repeat/Non-Retriggering. PIR Sensor Non-Retriggering No-Repeat Mode Jumper Setting. From fig 3.10 we know the details [15],

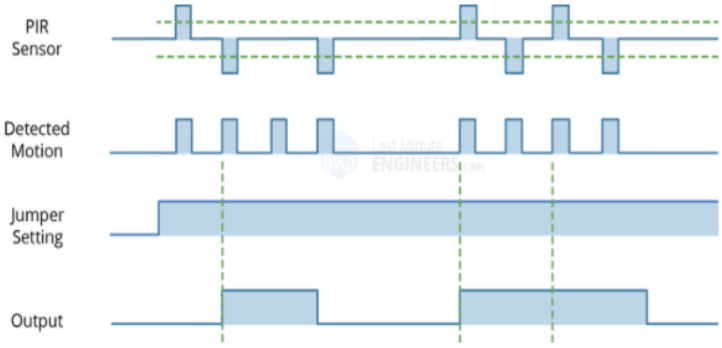

Fig 2.9: PIR detection Mode

3.7 Display

The display module that we have used has a i2c adapter that has a 8-Bit I/O Expander chip PCF8574. This i2c chip converts the i2c data from an arduino into the parallel data which is required by the LCD panel [16].

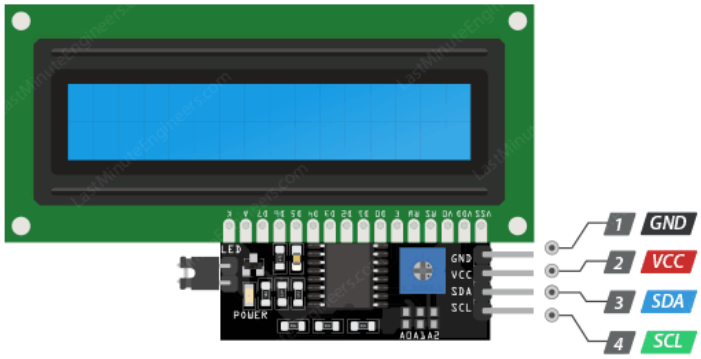

Fig 2.10: diagram for display

3.8 Keypad

16-button membrane keyboard with interface components for microcontroller projects. Available holding provides a simple way to mount the keypad in a variety of projects. Here this is used for security systems that include authentication [17].

Fig 2.11: diagram for keypad.

3.8.1 How it Works

Matrix keypads use a 4x4 combination. Each and every key has a push button under it. Here one end is connected to one row, and the other one is connected to one column. These connections are shown here:

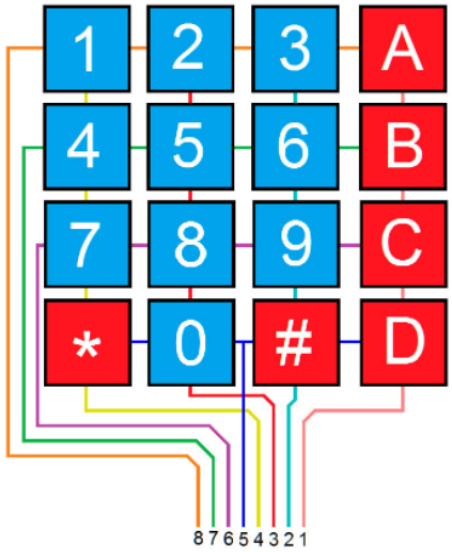

Fig 2.12: Keypad

In order to the microcontroller that can determine which button is pressed, at first this needs to pull all the each of the four columns that is pin 1-4 and that can either low or high one at a time and then poll the states all the four rows that is in pin 5-8.

3.9 Flame Sensor

A flame sensor is designed to detect fire and respond to the presence of fire. It responds to a detection of flame. By including a buzzer with flame sensor it is able to sound an alarm, deactivate a fuel line and activate a fire suppression system.

Fig 2.13: diagram for the Flame Sensor

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When the fire burns the sensor can sense the small amount of Infrared light, this light will receive the signal by the IR receiver that is in the sensor [18].

3.10 Gas Sensor

Gas sensors are electronic devices that detect and identify different types of gases. They are commonly used to detect any kind of toxic or explosive gasses. It also measures gas concentration in various situations.

Fig 2.14: diagram for the Gas Sensor.

Gas sensors can detect widely in size, range and sensing ability. They are often part of a larger embedded project like this project for security systems [19].

3.11 Sonar Sensor

Sonar Sensors as known as ultrasonic sensors work by sending sound waves at a frequency too high for us that we humans are able to hear. Then it waits for the sound to be reflected back. By calculating distance based on the time required.

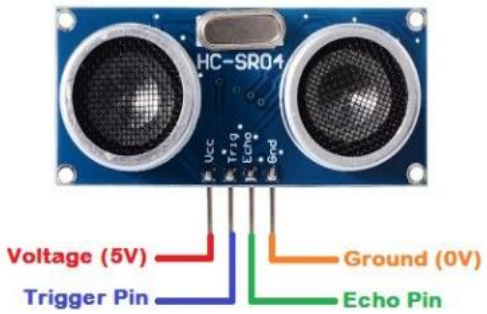


Fig 2.15: diagram for the Sonar Sensor.

This is almost similar to the radar system that measures the time it takes a radio wave that to return after hitting an object [20].

3.12 GSM Module

GSM module is used to establish a cellular network between sender and receiver and this is an easy to use system. It can be sent from anywhere. In this project, GSM modules are used for a cost-effective solution for sending and receiving alarm or threat notifications.

Fig 2.16: diagram for the GSM Module.

It offers connectivity along with cellular data communication. These devices have special feature as if light and easy to use, low power consumption for the amount of work they can do.

A GSM module is a specialized type of device which needs a SIM card, and operates through a mobile operator for a special subscription, just like a cell phone or pager. A GSM modem

looks just like a phone but the difference between a cell phone and a module is the flexibility in applications [21].

3.13 Buzzer

Buzzers can be found both fun and useful in electronic circuits. This consists of an outside case with two pins into it which is known as power and ground.

Fig 2.17: diagram for the Buzzer.

When current is applied to the buzzer it causes the ceramic disk to bond or increase. Changing this causes the surrounding disc to vibrate. That's the sound is able to hear. If we change the frequency of the buzzer, the speed of the vibrations changes and it changes the sound according to value [22].

3.14 Pump

This is high a performance (no brush) DC pump with a long-life, small in size, high efficiency, low noise and low power consumption and adopt high performance stainless steel shaft. Very easy to use, just connect the red wire to 5V and black wire to ground.

Fig 2.18: diagram for the Pump.

This pump is waterproof (IP68) and the axis is enclosed with static sealing not dynamic which can helps to avoid leaking problem [23].

3.15 Wires (types of)

- Arduino Cable
- Male to Male
- Male to Female etc [24].

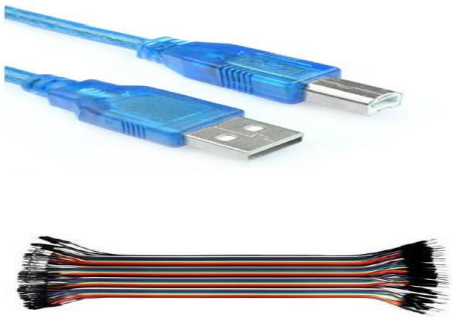


Fig 2.19: diagram of Arduino Cable and Wires

3.16 Breadboard

This helps make a temporary circuit and helps to test and try an idea. This one doesn't need soldering and it is very easy to change wire connections [25].

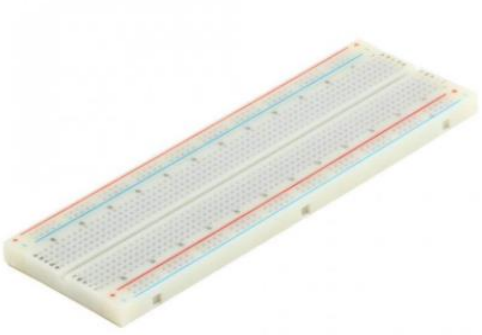


Fig 2.20: diagram for the Breadboard

3.17 Conclusion

Here we know about different kinds of microcontroller use and the advantages of it. We also know the working principle of different kinds of sensors like the GSM module, PIR, Flame, Gas sensor, Buzzer other equipment and how it works with microcontrollers. We also know the working principle and the sensor signal, how it takes input and shows output on display also with the sensor details.

Chapter 4

4.1 Implementation And Results

4.1.1 Expected Result (Considering Real time scenarios)

1. Security layer (External)

After installation of the system if someone tries to get closer to the vehicle, first a security alarm will be run which will be operated by PIR sensor with the help of Arduino mega and at the same time a message goes to the mobile of the client with the help of GSM module. Therefore, there will be sufficient time for taking any step. If someone breaks this system at any cost when he/she tries to start the engine, he/she fails because there comes the 2nd layer of security which is keypad lock. To start up the engine he/she will have to put a password. This password is directly connected to the fuel so there will be no supply of fuel to the engine without a password.

2. Security layer (Internal)

In most cases, fire occurs in vehicles not for overheating issues. Most of the time this occurs for electrical components problems. Mobile charging or use of other electrical products is also a major problem for fire. Therefore, if accidentally there occurs an emergency at the primary stage flame sensor took the value and show on display and rang the buzzer. If the owner of the vehicle is not close to the vehicle, there is another feature that is sending a message to the owner's mobile with the help of a GSM module so he or she takes necessary steps before it's too late.

Safety distance and safety parking

Now in the first two features we can protect our vehicle but if the vehicle is damaged during parking or in driving condition or it hits something. So to reduce the loss of life's and vehicle we introduced a feature is safety distance and safety parking. In both cases, the main function is similar but they are used for different scenarios. For this the sonar sensor took_the responsibility if it detected any objects at a certain range with the help of Arduino mega. After taking the reading, it will respond with buzzers. So if it finds any object it will ring. It will work for safety parking. In the same way at running conditions if a vehicle slows down immediately and the driver doesn't notice this scenario there will also be a buzzer rang which will work a safety distance

Gas leakage detection

In a vehicle there might be two sources of gas one is internal which is Methane and other is external source. However, the main thing is that all kinds of gas are similar. So if there is any leakage of gas for extreme pressure or any other source the gas sensor takes the help of Arduino mega and detects it and shows it on display. It also sends a message to the owner with the help of the GSM module and rings the buzzer before it's too late. Our aim was to give security to vehicles from external and internal threads. For the external threat of a thief we build a security alarm and message system and also provide a keypad lock engine system. For internal threads like fire and gas leakage, we built a security alarm and message to the owner. And to reduce accident we built safety parking and safety distance feature which will give an alarm from a safe distance if it find any object

Motion detection with unauthorized access prevent

If any unauthorized person wants to access the system it will alert the authorized person with a text message and also start an alarm that is installed in the system, by that user can prevent access to the vehicle of an unauthorized user.

4.2 Implementation

After all this hard work, all the parts are connected according to circuit design. Then we upload the programming code as we compiled in the Arduino IDE and we get positive results. We can see that it works properly according to our system design and system architecture that we developed for the project.

4.2.1 System in Idle Mode (Full mode in image)

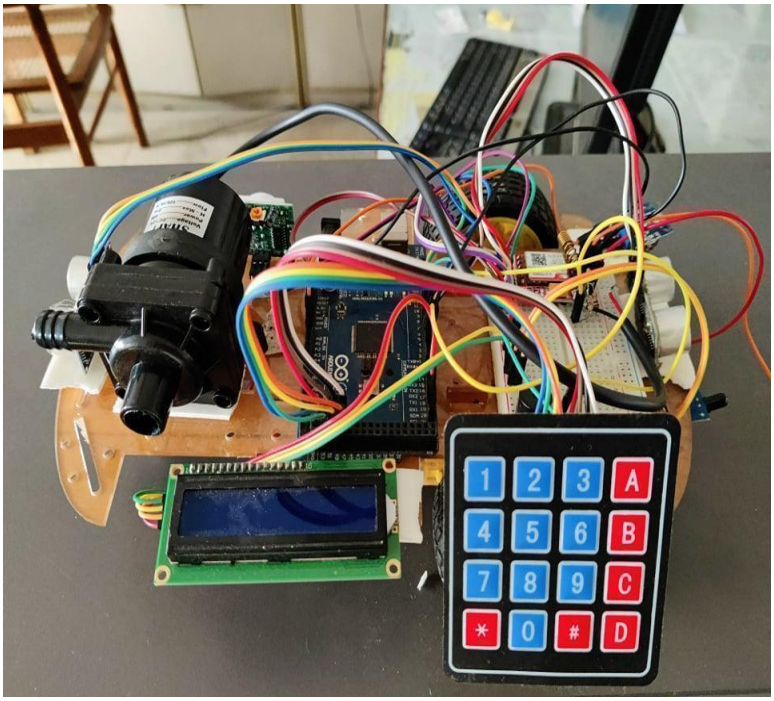


Fig 3.1: Image of our system (1)

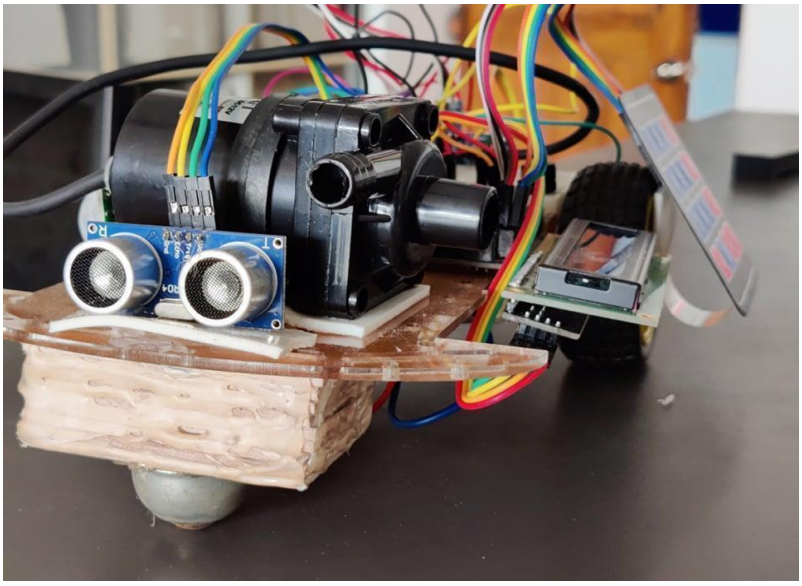


Fig 3.2: Image of our system (2)

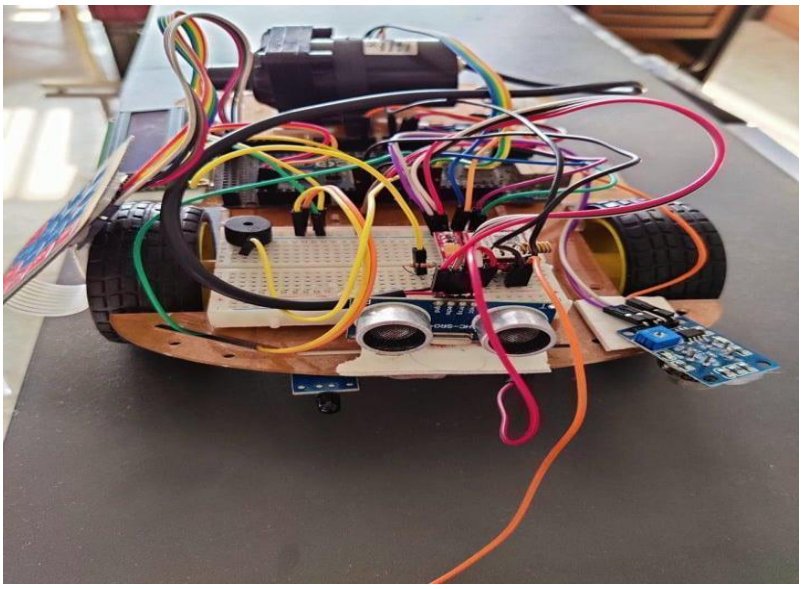


Fig 3.3: Image of our system (3)

4.2.2 Project block diagram

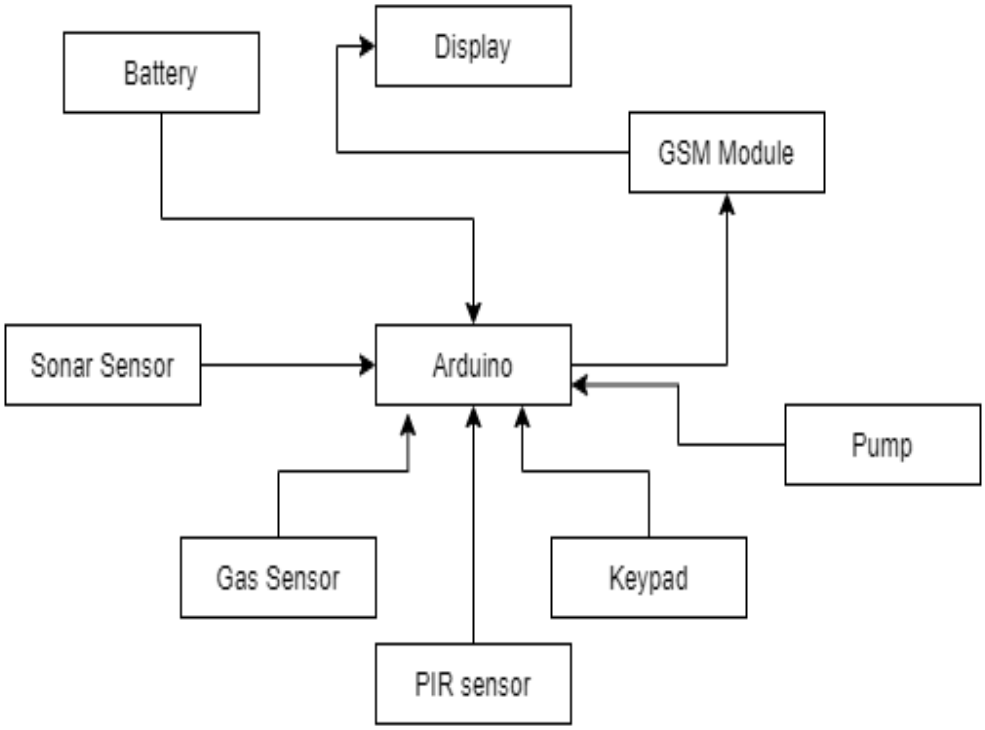
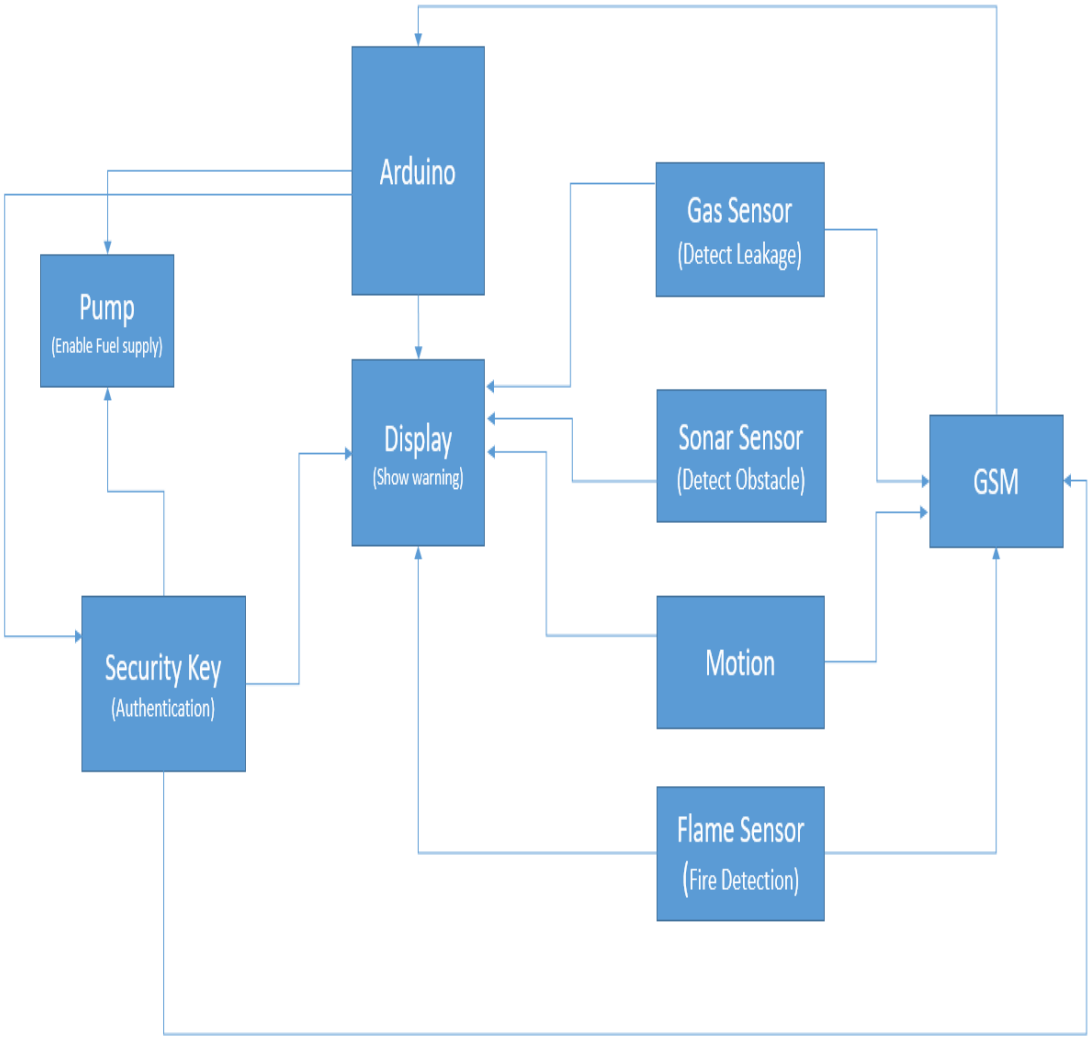


Fig 3.4: Block diagram for the project.

4.2.3 Flow Control

In below, we can see the flow control of our system that shows the relation of the internal components.



4.3 System in Idle Mode (Circuit Diagram)

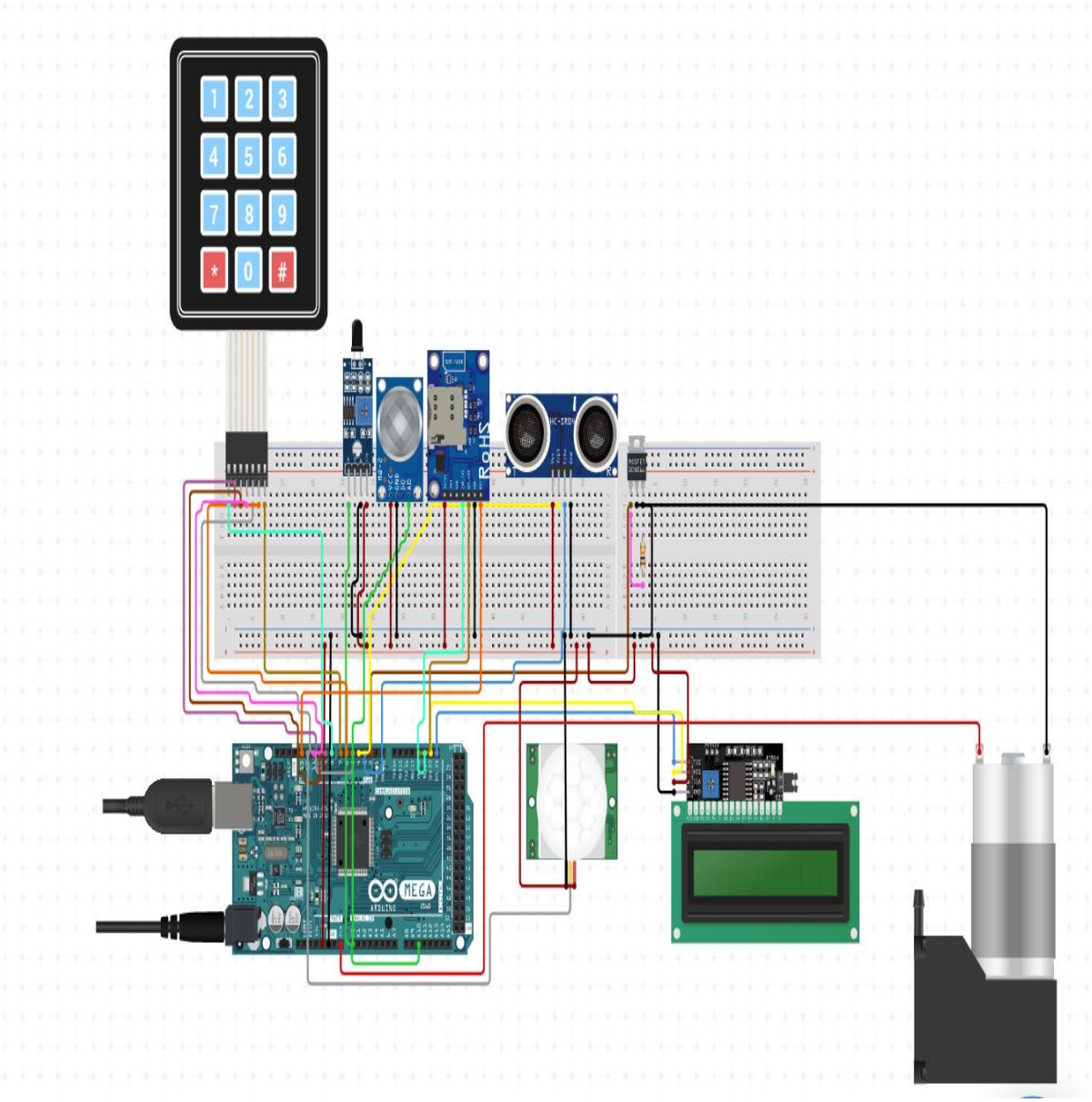


Fig 3.5: Circuit diagram for the system.

4.4 The real time result

As we mention in the sub-chapter 4.1, the outcome of our system is similar to this. We have the same result we expected before we developed it. But we can improve the system by developing it more efficiently by adding more features and re-consider the facilities provided by our system.

Our aim was to give security to vehicles from external and internal thread. For the external threat of thieves, we build a security alarm, message system, and also provide a keypad lock engine system.

For internal threads like fire and gas leakage, we built a security alarm and message to the owner. In addition, to reduce accidents we built a safety parking and safety distance feature that will give an alarm from a safe distance if it finds any object towards the vehicle.

Chapter 5

5.1 Conclusion and Future work

5.1.1 Conclusion

Technology nowadays has taken on a completely new meaning. A System using Keypad Lock has been designed and developed for making our life more easy and secure. We have used a 5v Arduino board and 5volt 2A power adapter to give power for running the machine. We also use a PIR sensor for detecting motion, also a sonar sensor to measure the safety distance from the obstacles. Use of flame sensor and gas sensor to prevent the fire attack and leakage of gas. We have also used the GSM module to alert the owner of the system.

We fix all the problems that come across during the design and testing of the system. The production cost is low. Hence, our product is suitable for commercial use.

5.2 Future works for our system

We developed our system for now with some small features. But we have big plans for our developed system with some big features which will transfer this to another level. The whole system will contain.

1. Location provides using GPS.
2. Installation of Graphical LCD panel.
3. Low fuel meter warning and suggest the nearest fuel station with the help of Map- API.
4. By including higher quality, sensors increase the stability also increasing more security.
5. Remove the password feature and include fingerprint to make the system more secure.

Source Code

```
#include "sonar.h"
#include "buzzer.h"
#include "pir.h"
#include "smoke.h"
#include "Display.h"
#include "key.h"
#include "fire.h"
#include "msg.h"
int t1=9,e1=10,t2=4,e2=5,p=6,b=7,g=A1,f=8,pir;
#include <Keypad.h>

const int ROW_NUM = 4; //four rows
const int COLUMN_NUM = 4; //three columns
char keys[ROW_NUM][COLUMN_NUM] = {
  {'1','2','3','A'},
  {'4','5','6','B'},
  {'7','8','9','C'},
  {'*','0','#','D'}
};
byte pin_rows[ROW_NUM] = {53, 51, 49, 47}; //connect to the row pinouts of the keypad
byte pin_column[COLUMN_NUM] = {52, 50, 48, 46}; //connect to the column pinouts of
the keypad
Keypad keypad = Keypad( makeKeymap(keys), pin_rows, pin_column, ROW_NUM,
COLUMN_NUM );

const String password = "1234"; // change your password here
String input_password;
void setup() {
  Serial.begin(9600);
```

```
  pinMode(t1,OUTPUT);pinMode(e1,INPUT);pinMode(t2,OUTPUT);pinMode(e2,INPUT);
  pinMode(p,OUTPUT);pinMode(b,OUTPUT);
  input_password.reserve(32); // maximum input characters is 33, change if needed
  lcd.begin();
  lcd.backlight();
  lcd.clear();
}
void loop() {
   char key = keypad.getKey();
  if (key){
    Serial.println(key);
    if(key == '*') {
      input_password = ""; // clear input password
    } else if(key == '#') {
      if(password == input_password) {
        Serial.println("password is correct");
//-------------------------Stat-----------------------
       int distance1=getDistance(t1,e1);int distance2=getDistance(t2,e2);
       int pir=getPIR(p);int gas=smoke(g);
      Serial.print("D1 ");Serial.print(distance1);Serial.print(" D2
");Serial.print(distance2);Serial.print(" ");Serial.print(gas);Serial.print(" ");Serial.print(pir);
      digitalWrite(p,HIGH);lcd.clear();lcd.setCursor(0,0);lcd.print("Engine
Started");delay(2000);lcd.clear();
      printDis(distance1,distance2);
      Serial.println(digitalRead(f));
      if(!fire(f)){
        lcd.clear();lcd.setCursor(0,0);lcd.print("Warning Flame");beep(7);sendMsg("Flame
Warning");
      }
      if(getPIR(pir)){
```

```
        lcd.clear();lcd.setCursor(0,0);lcd.print("An unknown person
detected");beep(7);sendMsg("An unknown person detected");
      }
      if(smoke(g)){
      gassWarning();beep(7);sendMsg("Smoke detected");
      }
      if(distance1<10){
        obstacleWarning('F');beep(7);sendMsg("Front obstacle");
      }
      if(distance2<10){
        obstacleWarning('B');beep(7);sendMsg("Back obstacle");
      }
      } else {
        Serial.println("password is incorrect, try again");
      }

      input_password = ""; // clear input password
    } else {
      input_password += key; // append new character to input password string
    }
  }

}
```

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