EEE499B (Section 5)

Final Report (CO5)

Project Title: Smart Safety System for Office & Industry.

Submitted To

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Date: 28/05/2021

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Agreement Form

We take great pleasure in submitting our senior design project report on "Smart Safety System for Office & Industry". This report is prepared as a senior design project EEE/CSE 499. This course involves a team of students who build and test custom designed systems, components or engineering processes. We would like to request you to accept this report as a partial fulfillment of Bachelor of Science degree under Electrical and Computer Engineering Department of North South University.

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Acknowledgement

By mercy of the Almighty we have completed our senior design project entitled “Smart Safety System for Office & Industry.”

Foremost, we would like to express our sincere gratitude to our advisor Dr. Shazzad Hosain for his continuous support in our project progress throughout the whole semester for his patience, motivation, enthusiasm, and immense knowledge. His guidance helped us in all the time of research, writing and completing of this project.

Our sincere thanks also goes to North South University, Dhaka, Bangladesh for providing an opportunity in our curriculum which enabled us to have an industrial level experience as part of our academics.

Last but not the least, we would like to thank our family as their inspiration and guidance kept us focused and motivated.

Abstract

As technology advances, it can be used to protect our lives. The main goal of this project is to create an automation framework for office and industrial safety and security.

There are many employees in an industry or workplace, but they are all focused on their own duties. There is always the possibility of an accident due to mechanical failure. Furthermore, any accident will result in the loss of many lives.

With this in mind, we built the device to sound the alarm as soon as an accident happens in the workplace, such as a fire, smoke, gas leak, or vibration. It will also send a message to the protection management.

The RFID scanning device is another function of our system. Such that only workers can punch their ID cards to gain access to the workplace.

It’s an Arduino-based system, and all four sensors will be combined in the system so that we don't have to create a separate system for each danger.

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Chapter 1 – Introduction

There are many people in an industry, such as employees and other staff members. There are some common accidents which are occurring in industry such as gas leakage, fire hazard and covering by smoke. We know industry is a combination of many kinds of machine. People in an industry are actually preoccupied with their jobs. They are unable to pay attention first when an accident occurs. When the accident becomes dangerous, people should warn the authorities. So the main purpose of this system is making a notification at starting time for accident.

Another aspect of an industry is that employees and workers are licensed for their jobs and are going about their everyday routines. There is a chance that an outsider will come in and join. As a result, we considered installing an automatic door lock system for registered users.

1.1 OBJECTIVE:

- To make a smart door lock system for registered staffs using RFID card so they can punch their card in door and pass that gate.
- To make a safety system using smoke, fire, gas and vibration sensor and this system will give us notification for any warning situation in that industry.

1.2 PROJECT DEFINITION:

This system's implementation would ensure the protection of a specific industry. The main goal of this system is to send out alerts in the event of an emergency, such as a gas leak, a fire danger, or smoke inhalation. This device will also provide warning if any industrial machine is functioning unnaturally.

There is another feature of our system and which is automatic door lock system using RFID scanning device. All stuffs and workers of an industry can punch their RFID card by this device and thy can enter into the industry.

Chapter 2 – System Design

For the implementation of the system we used different types of equipment. For choosing different types of component we have to think about some factors such as availability in market, usability, performance and reliability. After choosing components we successfully had done our final implementation. We made a list of component of our system. Here's the list of the component and the description of the vital components of our system.

2.1 Component list:

- ARDUINO UNO
- RFID RC522 Module
- Really Module
- 12V solenoid lock
- Hall effect sensor
- 10K resistance
- Buzzer
- RFID card
- smoke sensor
- gas sensor
- fire detector
- vibration detector
- display
- PCB board
- cork sheet
- jumper wire

2.2 Component description:

1. **Arduino Uno:** The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type BUSB cable. It can be powered by the USB cable or by an external9-volt battery, though it accepts voltages between 7 and 20 volts.

   In our system we used Arduino as a microcontroller and we used Arduino language for controlling our system.

Figure 1: Arduino Uno.

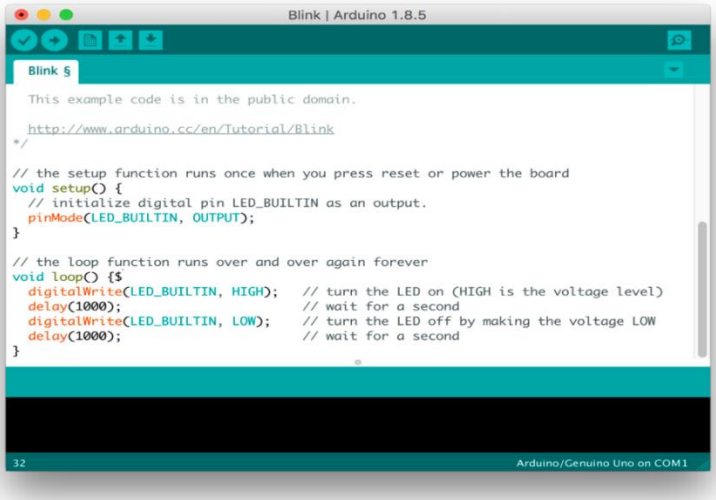

Figure 2: Arduino software user's interface.

2. **RFID RC522 Module:** RFID or Radio Frequency Identification system consists of two main components, a transponder/tag attached to an object to be identified, and a Transceiver also known as interrogator/Reader. A Reader consists of a Radio Frequency module and an antenna which generates high frequency electromagnetic field.

   RFID module works of some registered ID card. There is a specific code for every ID card and RFID module can detect the code. If ID's internal code and RFID module's code which saved in previous match with each other than RFID module will work.

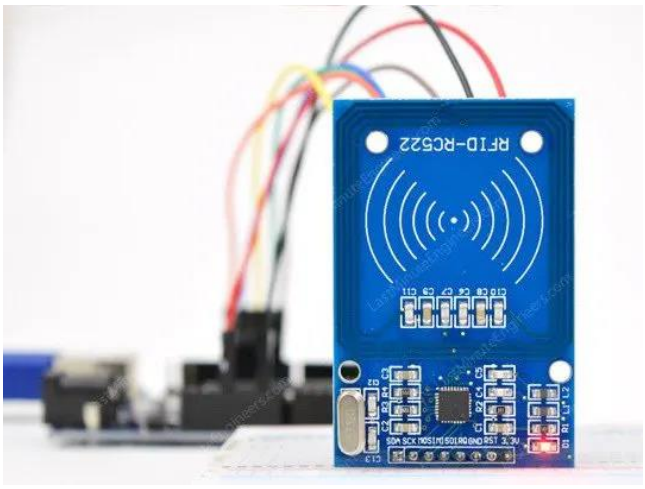

Figure 3: RFID module.

3. **Really Module:** The relay module is a separate hardware device used for remote device switching. With it anyone can remotely control devices over a network or the Internet. Devices can be remotely powered on or off with commands coming from Clock Watch Enterprise delivered over a local or wide area network. Anyone can control computers, peripherals or other powered devices from across the office or across the world.

Figure 4: RFID module.

4. **Solenoid lock:** A solenoid bolt is a type of electronic-mechanical locking mechanism. This type of lock is characterized by the use of a solenoid to throw the bolt. Sophisticated solenoid bolt locks may use microprocessors to perform voltage regulation, reduce power consumption, and/or provide access control. A solenoid bolt can be designed either to fail open (the lock opens on power loss) or to fail closed (the device is locked upon power loss). Some models may be suitable for high-security sites.

Figure 5: Solenoid lock.

5. **RFID card:** Radio-frequency identification (RFID) uses electromagnetic fields to automatically identify and track tags attached to objects. An RFID tag consists of a tiny radio transponder; a radio receiver and transmitter. When triggered by an electromagnetic interrogation pulse from a nearby RFID reader device, the tag transmits digital data, usually an identifying inventory number, back to the reader. This number

can be used to inventory goods. There are two types. Passive tags are powered by energy from the RFID reader's interrogating radio waves. Active tags are powered by a battery and thus can be read at a greater range from the RFID reader; up to hundreds of meters.

Figure 6: RFID card.

6. **Smoke sensor:** Smoke detector is a device that senses smoke, typically as an indicator of fire. Commercial security devices issue a signal to a fire alarm control panel as part of a fire alarm system, while household smoke detectors, also known as smoke alarms, generally issue a local audible or visual alarm from the detector itself or several detectors if there are multiple smoke detectors interlinked.

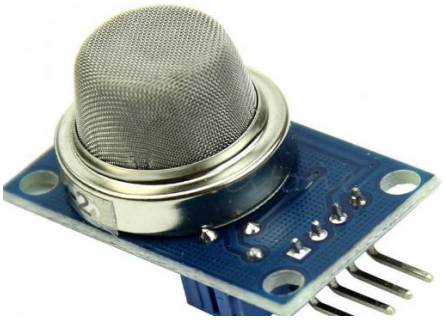

Figure 7: Smoke sensor.

7. **Gas sensor:** Gas sensors (also known as gas detectors) are electronic devices that detect and identify different types of gasses. They are commonly used to detect toxic or explosive gasses and measure gas concentration. Gas sensors are employed in factories and manufacturing facilities to identify gas leaks, and to detect smoke and carbon monoxide in homes. Gas sensors vary widely in size (portable and fixed), range, and sensing ability. They are often part of a larger embedded system, such as hazmat and security systems, and they are normally connected to an audible alarm or interface. Because gas sensors are constantly interacting with air and other gasses, they have to be calibrated more often than many other types of sensors.

Figure 8: Gas sensor.

8. **Fire detector:** A flame detector is a sensor designed to detect and respond to the presence of a flame or fire, allowing flame detection. Responses to a detected flame depend on the installation, but can include sounding an alarm, deactivating a fuel line (such as a propane or a natural gas line), and activating a fire suppression system.

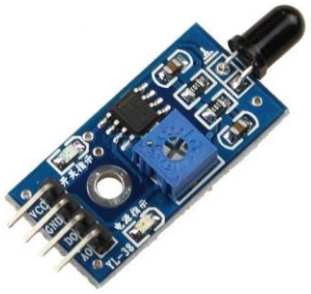

Figure 9: flame sensor.

9. **Vibration Detector:** The vibration sensor is also called a piezoelectric sensor. These sensors are flexible devices which are used for measuring various processes. This sensor uses the piezoelectric effects while measuring the changes within acceleration, pressure, temperature, force otherwise strain by changing to an electrical charge. This sensor is also used for deciding fragrances within the air by immediately measuring capacitance as well as quality.

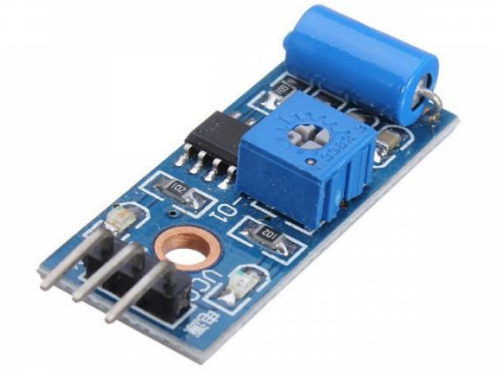

Figure 10: vibration sensor.

10. **LCD Display:** A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals combined with polarizers. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome.

Figure 11: LCD display

11. GSM Module (SIM 800L):

SIM800L is a miniature cellular module which allows for GPRS transmission, sending and receiving SMS and making and receiving voice calls. Low cost and small footprint and quad band frequency support make this module perfect solution for any project that require long range connectivity. After connecting power module boots up, searches for cellular network and login automatically. On board LED displays connection state (no network coverage - fast blinking, logged in - slow blinking).

This module has two antennas included. First is made of wire (which solders directly to NET pin on PCB) - very useful in narrow places. Second - PCB antenna - with double sided tape and attached pigtail cable with IPX connector. This one has better performance and allows putting your module inside a metal case - as long the antenna is outside.

Specification

- Supply voltage: 3.8V - 4.2V
- Recommended supply voltage: 4V

- Power consumption:
    - sleep mode < 2.0mA
    - idle mode < 7.0mA
    - GSM transmission (avg): 350 mA
    - GSM transmission (peek): 2000mA
- Module size: 25 x 23 mm
- Interface: UART (max. 2.8V) and AT commands
- SIM card socket: microSIM (bottom side)
- Supported frequencies: Quad Band (850 / 950 / 1800 /1900 MHz)
- Antenna connector: IPX
- Status signaling: LED
- Working temperature range: -40 do + 85 ° C

Set have

1. SIM800L module
2. goldpin headers
3. wire antenna
4. PCB antenna with pigtail and IPX connector

Pinout (bottom side - left):

- RING (not marked on PBC, first from top, square) - LOW state while receiving call
- DTR - sleep mode. Default in HIGH state (module in sleep mode, serial communication disabled). After setting it in LOW the module will wake up.
- MICP, MICN - microphone (P + / N -)
- SPKP, SPKN - speaker (P + / N -)

Pinout (bottom side - right):

- NET - antenna

- VCC - supply voltage
- RESET - reset
- RXD - serial communication
- TXD - serial communication
- GND – ground

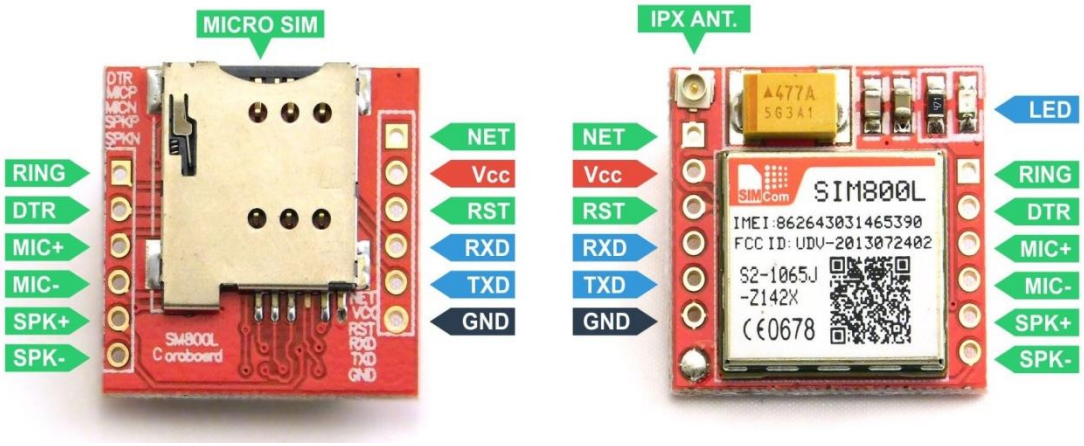

Figure 12: Sim800L GSM Module

Chapter 3 – Impacts and Constraints

3.1 Impact:

Industrial safety is important as it safeguards human life, especially in high risk areas such as nuclear, aircraft, chemical, oil and gases, and mining industries, where a fatal mistake can be catastrophic. Industrial Safety reduces risks to people, and processes. Process control and safety systems are usually merged. Maintaining a safe and healthy working environment is not only an important human resources issue, it's the law. Whether they're entry-level workers, seasoned veterans, supervisors, or plant managers, the employees need to understand health and safety risks, the steps they need to take to minimize those risks, and common safety standards and compliance procedures.

Another part of our system is RFID scanning device. RFID applications can automate the collection of information about the movement and location of assets, components, stock or other items; doing this more quickly, whilst reducing costs and with greater accuracy and reliability than is possible with manual methods and with more detail than can be obtained from techniques such as bar-coding. Data collection can be a by-product of other activities, eliminating the need for effort in form filling. Identifying products using RFID is quicker than barcode scanning or manual entry of product details.

Because RFID allows data to be captured in real-time as stock or assets are moved detailed, up-to-date, management information is available for planning and operational management purposes.

3.2 Limitations:

In this system it only can make an alarm at accidental situation for take attention. But this can’t take the necessary steps to avoid an accident.

3.3 Further development:

Taking a path into the future is often a difficult task. To survive in the market, every product must contend with the competitive force. Research and development, combined with constant redesigning of the same product, makes it better and more marketable over a longer period of time.

We are committed to the future modification of the product to make it a selling product across the globe. Here are some initial thoughts punched through the mind of our team.

- We used RFID scanning device. Staffs can punch their ID to enter the gate. In future we can take attendance by improving the scanning device.
- We used four sensors and fire detector is one of them. Now in our system if detector can detect fire then it can give notification. In future we can improve the device so that after detecting fire device can take necessary steps to put out the fire.
- When a machine's frequency is higher than average, our device's vibration detector will detect it. We should upgrade the system in the future so that it can automatically shut down the computer after detecting an irregular condition.

Chapter 4 – Methodologies

According to the findings of related research in this project, while developed countries are developing their industrial safety systems, Bangladesh is lagging far behind.

So, we decided to keep our system as low-cost as possible while still performing well. We designed several methods to accomplish this.

4.1 Budget

To begin, we studied all of the data associated with the project.

We wanted to know which parts are needed to put the device together. Those detectors may be made in a variety of ways (fire, gas, smoke, vibration).

We devised a preliminary budget for the project. We also wanted to keep the costs down, so we went to various markets and online websites to find out how much the equipment cost.

NUMBER	EQUPMENT	quantity	PRICE
1	ARIDUINO UNO	2	800
2	RFID RC522 Module	1	170
3	Really Module	1	129
4	12V solenoid lock	1	750
5	Hall effect sensor	1	70
6	10K resistance	2	5
7	Buzzer	3	45
8	RFID card	3	105
9	smoke sensor	1	155
10	gas sensor	1	190
11	fire detector	1	130
12	vibration detector	1	85
13	sonic sensor	4	360
14	display	1	273
15	PCB board	2	30
16	Jumper wire		100
17	Sim800L	1	500
		total	3897

This was the first list we created for the project. However, during the project's implementation, it changed.

4.2 Virtual design

Ours project is mostly a hardware project. All of the detector circuits were designed with hardware, and the commands were written in Arduino code.

We put our circuit to the test with fire, smoke, vibration, and gas to determine whether it is working or not. For the RFID lock, we entered two RFIDs into our system to see how it worked.

Since we coded with Arduino, we can see the circuit's result in the Arduino. We used the arduino program to implement the arduino code. When we put fire, smoke, or gas in the arduino, the arduino will output that there is smoke or fire.

Figure 13: Arduino software

So, we can see the result in Arduino before sending the warning message to the owners and security authorities.

Fritzing was testing software we used for our project. We drew the circuit and test the code in the system to see whether it works or not.

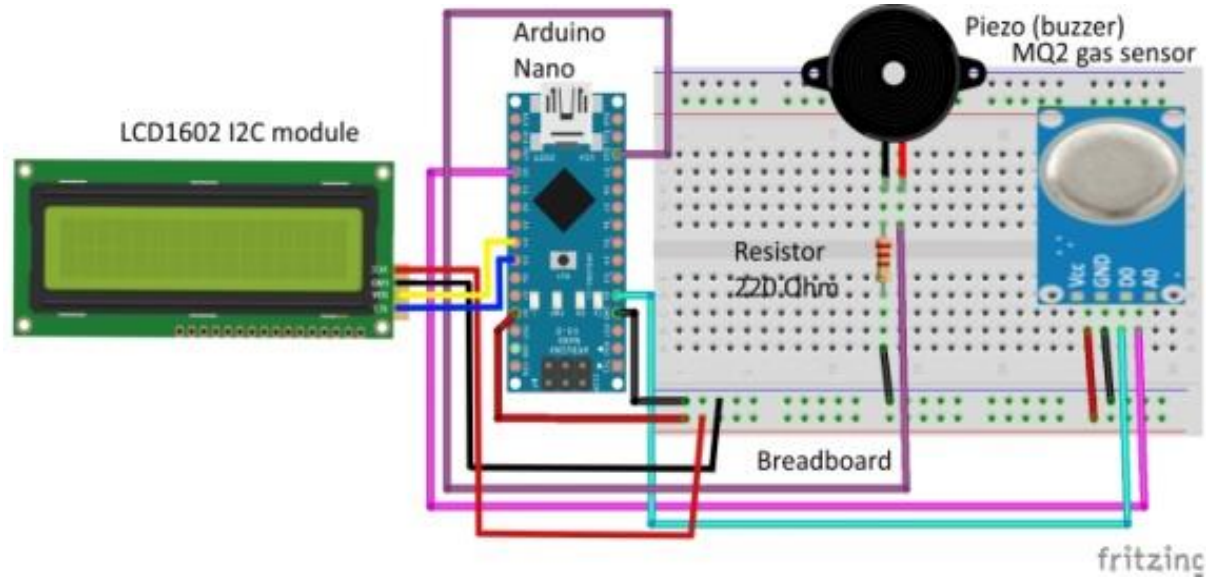

Figure 14: Circuit design in fritzing

There are numerous hardware tools installed in the software that we need for our project. So, before physically implementing the circuit, we saw how it should be done. We looked at the circuit from fritzing to see what hardware would be more effective for the system.

We also made a UX design for the whole project body.

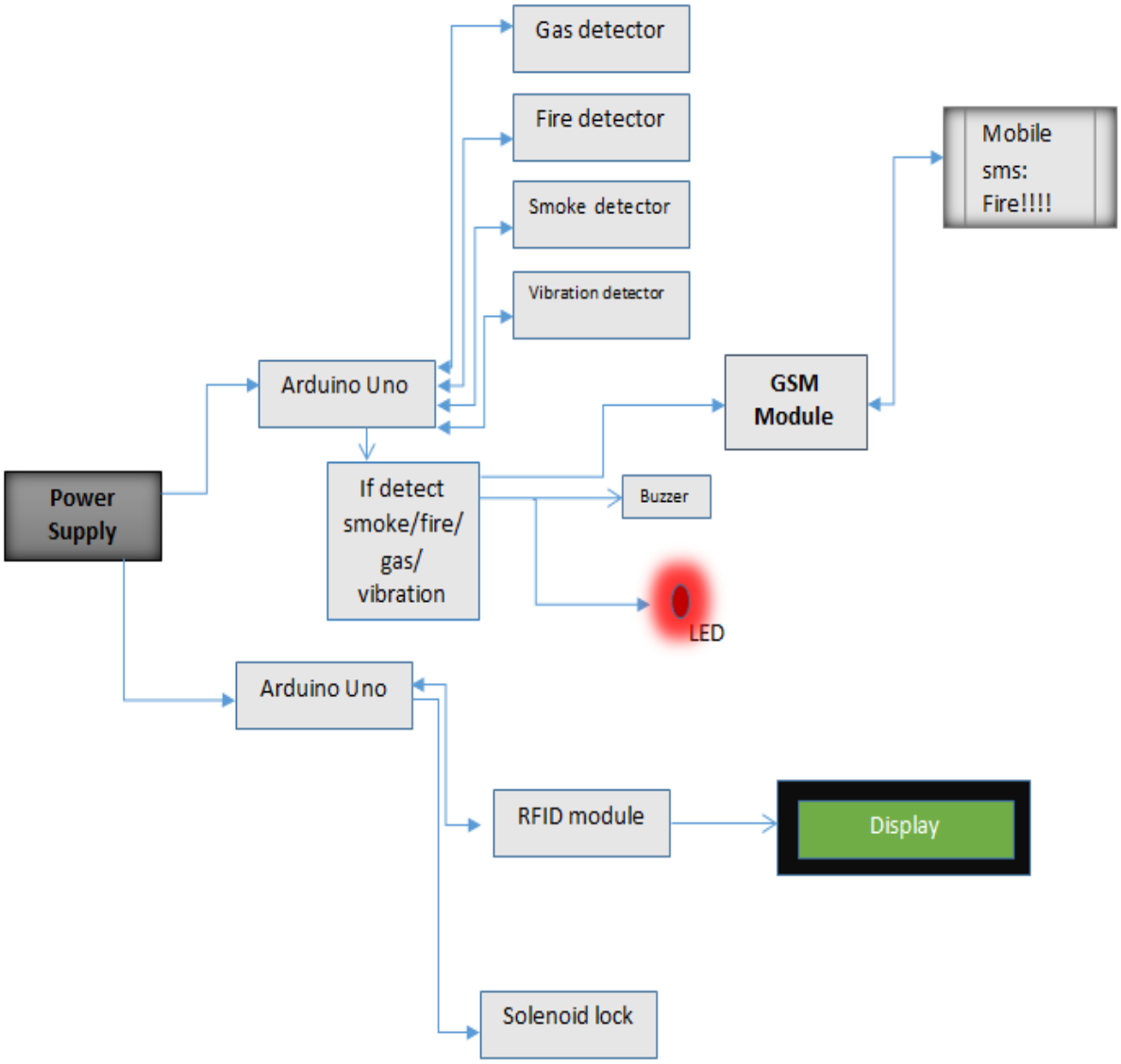

Figure 15: UX design of the system

4.3 Circuit implementation

To begin, we created a circuit for each detector as well as a circuit for the RFID lock. Then, in a single circuit, we combined all of the detectors.

For our RFID lock system, we produced two test entries. The gate will be unlocked when these two cards are placed on the test surface. Then, to show the names of the entries in the display, we added a display for RFID. The display will show “valid card only” if the individual is not currently employed by the company.

When any danger will (fire, smoke, gas leakage, vibration) occur, the combined circuit of detectors will sound an alarm. A Gsm module was added to send an alert message to a specific phone number (security controller).

4.4 Arduino Code

We used C++ code in the Arduino to set up and control our circuit for this project. Before the physical implementation, we wrote the code. We tested the code in the Fritzing app to see how it worked. However, during the physical installation of the circuit, we had to update the code on a regular basis.

4.4(i) Combine circuit code:

```
#include "gsm_config.h"
#include <Arduino.h>
#include <TinyGsmClient.h>
#include <SoftwareSerial.h>

class Gsm
{
private:
   SoftwareSerial SerialAT = SoftwareSerial(10, 11);
   TinyGsm modem = TinyGsm(SerialAT);


public:
   void init_gsm();
   bool send_sms(const String &sms_to, const String &sms_body);
};


#include <Arduino.h>
#include "gsm.hpp"
#include <Wire.h>

// Pin declarations
#define mq5 A0
```

```
#define ir A1
#define vib A2
#define buzzer A3

const String owner_number = "01751194974";

// Sensor delay in ms
const int sensor_delay = 1000;

// Send SMS delay in ms
const int SMS_delay = 60000;

#define SerialMon Serial

// Instantiate global gsm_module object
Gsm gsm_module;
#include "global_config.hpp"

// function prototypes
void print_sensor_values(int mq5_value, int ir_value, int vib_value);

// global variable to count sms delaye
int sms_delay_count = 0;

void setup()
{
        sms_delay_count = 0;
```

```
	SerialMon.begin(115200);
	SerialMon.println("Booting up device");
	delay(1000);

	gsm_module.init_gsm();
	gsm_module.send_sms(owner_number, "Your device has turned on.");

	SerialMon.println("Initializing Sensors...");
	// Initializing input pin modes
	pinMode(mq5, INPUT);
	pinMode(ir, INPUT);
	pinMode(vib, INPUT);

	// Initializing buzzer pin modes
	pinMode(buzzer, OUTPUT);
}

void loop()
{
	int mq5_value = !digitalRead(mq5);
	int ir_value = !digitalRead(ir);
	int vib_value = !digitalRead(vib);

	// Printing digital sensor values to Serial Monitor
	print_sensor_values(mq5_value, ir_value, vib_value);

	if (mq5_value || ir_value || vib_value){
		// Check if predefined sms delay has passed
```

```
        if (sms_delay_count >= SMS_delay){

                // Constructing SMS body
                String SMS_body = "Hazard Alert!!! \r\nSensors:";

                // Concating sensor information to the SMS body
                if (mq5_value){
                        SMS_body += " Gas ";
                }

                if (ir_value){
                        SMS_body += " Fire ";
                }

                if (vib_value){
                        SMS_body += " Vibration ";
                }
                SMS_body += "\r\n";
                SMS_body += "Please call 999.";

                // Send sms to the owner
                if (gsm_module.send_sms(owner_number, SMS_body)){
                        // Reset sms delay counter
                        sms_delay_count = 0;
                }
        }
}
```

```
        // Delaying sensor reading
        delay(sensor_delay);

        // Incrementing sensor delay count
        sms_delay_count +=      sensor_delay;
}

// Function to print sensor values to Serial Monitor
void print_sensor_values(int mq5_value, int ir_value, int vib_value)
{
        SerialMon.print("MQ Sensor: ");
        SerialMon.print(mq5_value);
        SerialMon.print("\t");

        SerialMon.print("IR Sensor: ");
        SerialMon.print(ir_value);
        SerialMon.print("\t");

        SerialMon.print("Vibration Sensor: ");
        SerialMon.println(vib_value);
}
```

4.4 (ii) RFID code:

```
#include <LiquidCrystal.h>
#include <SPI.h>
#include <MFRC522.h>

#define SS_PIN 10
#define RST_PIN 9
//#define LED_G 5 //define green LED pin
//#define LED_R 4 //define red LED
#define RELAY 6 //relay pin
#define BUZZER 2 //buzzer pin
#define ACCESS_DELAY 2000
#define DENIED_DELAY 1000
MFRC522 mfrc522(SS_PIN, RST_PIN);   // Create MFRC522 instance.

// display
const int rs = 8, en = 7, d4 = 5, d5 = 4, d6 = 3, d7 = 2;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);

void setup()
{
  //display
// set up the LCD's number of columns and rows:
  lcd.begin(16, 2);
  // Print a message to the LCD.
```

```
  //lcd.print("hello, world!");



  Serial.begin(9600);   // Initiate a serial communication
  SPI.begin();          // Initiate  SPI bus
  mfrc522.PCD_Init();   // Initiate MFRC522
  //pinMode(LED_G, OUTPUT);
  //pinMode(LED_R, OUTPUT);
  pinMode(RELAY, OUTPUT);
  pinMode(BUZZER, OUTPUT);
  noTone(BUZZER);
  digitalWrite(RELAY, HIGH);
  Serial.println("Put your card to the reader...");
  Serial.println();

}
void loop()
{

  // display
  // Turn off the blinking cursor:
  lcd.noBlink();
  delay(100);
  // Turn on the blinking cursor:
  lcd.blink();
```

```
// Look for new cards
if ( ! mfrc522.PICC_IsNewCardPresent())
{
  return;
}
// Select one of the cards
if ( ! mfrc522.PICC_ReadCardSerial())
{
  return;
}
//Show UID on serial monitor
Serial.print("UID tag :");
String content= "";
byte letter;
for (byte i = 0; i < mfrc522.uid.size; i++)
{
   Serial.print(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " ");
   Serial.print(mfrc522.uid.uidByte[i], HEX);
   content.concat(String(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " "));
   content.concat(String(mfrc522.uid.uidByte[i], HEX));
}
Serial.println();
Serial.print("Message : ");
```

```
  content.toUpperCase();
  if (content.substring(1) == "07 21 78 1C") //change here the UID of the card/cards that you want to give access
  {
    Serial.println("Authorized access");
    Serial.println();
    lcd.print("Welcome Abdur Rouf");
    delay(100);
    digitalWrite(RELAY, LOW);
    //digitalWrite(LED_G, HIGH);
    delay(ACCESS_DELAY);
    digitalWrite(RELAY, HIGH);
    //digitalWrite(LED_G, LOW);
  }

 else   {
    Serial.println(" Access denied");
    lcd.print("valid card only");
    //digitalWrite(LED_R, HIGH);
    tone(BUZZER, 300);
    delay(DENIED_DELAY);
    //digitalWrite(LED_R, LOW);
    noTone(BUZZER);
  }
}
```

4.5 Extra equipment

We experienced a lot of backlash during the physical implementation. During the circuit's construction, some sensors and other components were destroyed. Some of the equipment was not suitable for the circuit, so we had to purchase new equipment. We had to buy new batteries when the battery's capacity was drained. Also, since we updated the code regularly to work perfectly, we had to buy new equipment for work.

Chapter 5 – Result

We checked the circuit several times after it was completed to see how it worked. We make certain that we receive the most effective and timely response possible.

Here's the result of our system.

5.1 RFID door lock system:

Figure 16: The RFID door

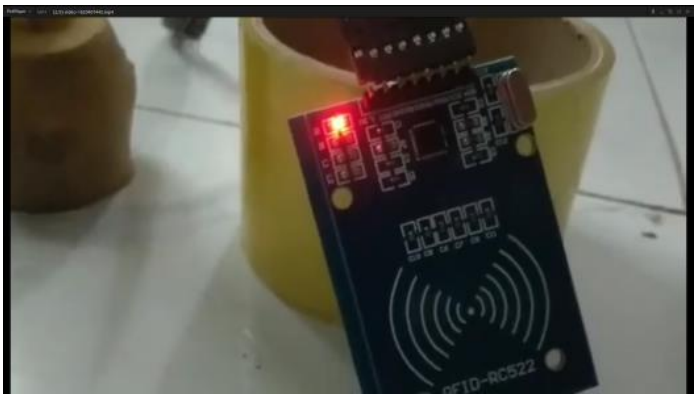

Figure 17: RFID scan surface

Figure 18: Valid entry card

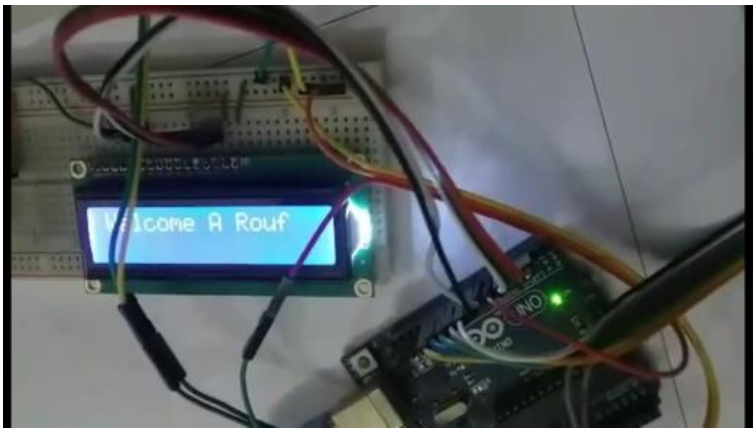

Figure 19: Display after valid entry

After scanning a valid entry card the display shows the name of the employer.

Figure 20: Display after invalid entry

When the card is not valid it shows “valid card only” means the card is not valid.

5.2 Combine detectors:

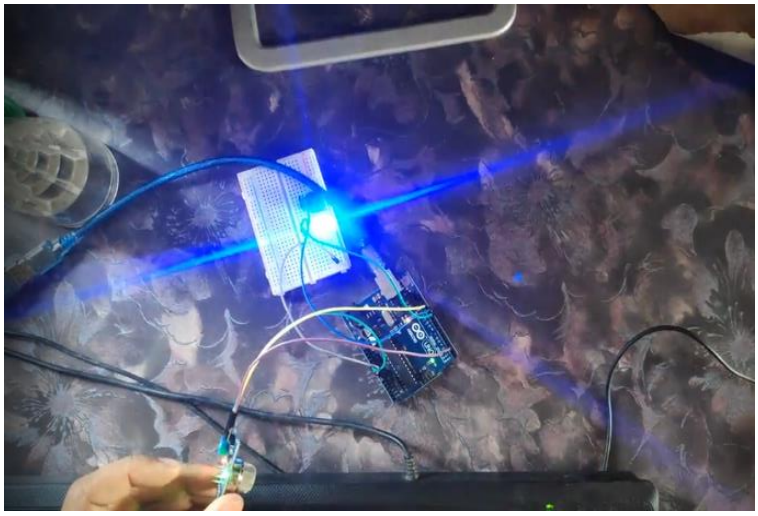

Figure 21: Gas detecting

The circuit is lighted up and giving an alarm when sensed gas leakage.

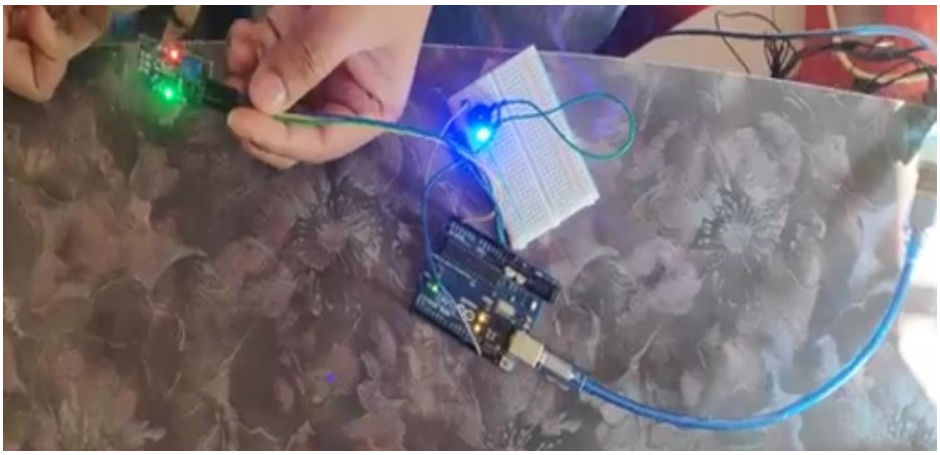

Figure 22: smoke detecting

The circuit is lighted up and giving an alarm when sensed smoke.

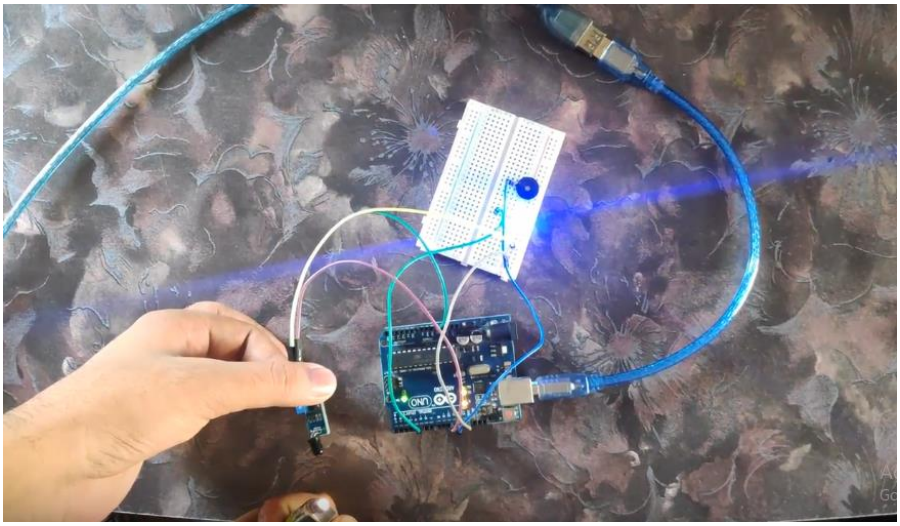

Figure 23: Fire detecting

The circuit is lighted up and giving an alarm when sensed fire.

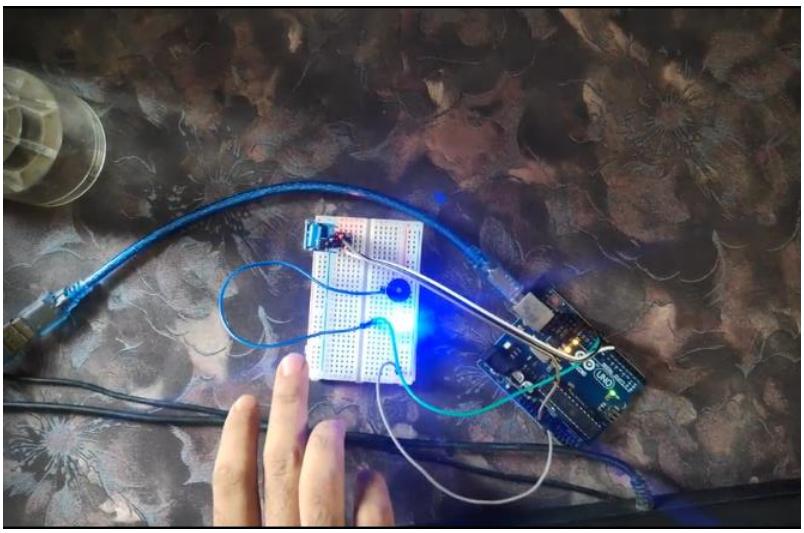

Figure 24: Vibration detecting

The circuit is lighted up and giving an alarm when sensed vibration.

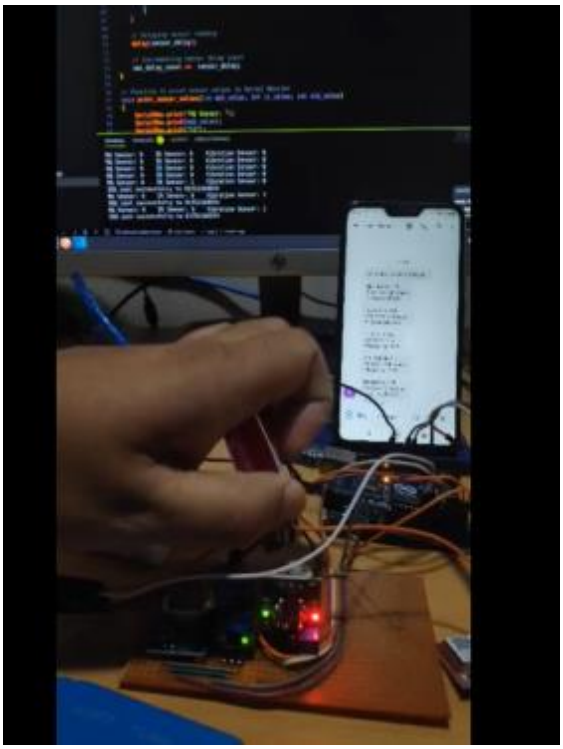

Figure 25: Sending alarm message

When the circuit detects any of the dangers, it sends a warning to the protection controller (gas, smoke, fire, vibration).

As we can see all the detectors and RFID lock work perfectly in our system. In this project, we achieved our goal of creating a low-cost safety and security system. Although, it can be improve with additional features.

Chapter 6 – Conclusion

The success of any group project requires a group of committed individuals who are eager to achieve the desired result. We were fortunate to have several group members who never missed a week's meeting because of a day off. The group meeting was part of our daily academic schedule during the semester, and we split the task down into several small parts, each of which we tackled one at a time.

We determined the number of meetings based on the importance of the task and held several emergency meetings. As a result, the workload could never be built on our shoulders.

The team required working freedom, which was a critical component in allowing us to thrive in our thought process. The supervisor never forced or pressured us to move in a certain direction.

As previously mentioned, this system is a very well idea for our country's current situation. We were tasked with creating a prototype that could assist the internal environment, which is currently unprotected. This project thus promises for a day that will help save many lives from accents and save lives.

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