CSE360: Computer Interfacing

Project Report

Project Name: FlameGuard: Fire Detection and Suppression Robot

Members:

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Introduction: Flameguard is a compact, innovative fire detection and suppression robot intended to improve fire and gas safety with autonomous technology in households, small companies, industrial areas, and public spaces. With the increase in electrical and kitchen fires, there is an obvious need for more responsive and adaptive fire protection measures. Flameguard is the solution to this challenge, intended to identify and immediately respond to fire and gas dangers promptly and effectively before they turn into big tragedies. It is equipped with advanced flame and gas sensors. Flameguard is designed to detect potential gas and fire hazards in its surroundings. When it detects a fire, it initiates an immediate response mechanism, informing the users via SMS and phone calls while simultaneously extinguishing the flame with its built-in water pump and servo-controlled nozzle. FlameGuard offers an effective and innovative solution for enhancing fire and gas safety in various environments, from homes to industrial facilities, by combining real-time monitoring with automated firefighting capabilities.

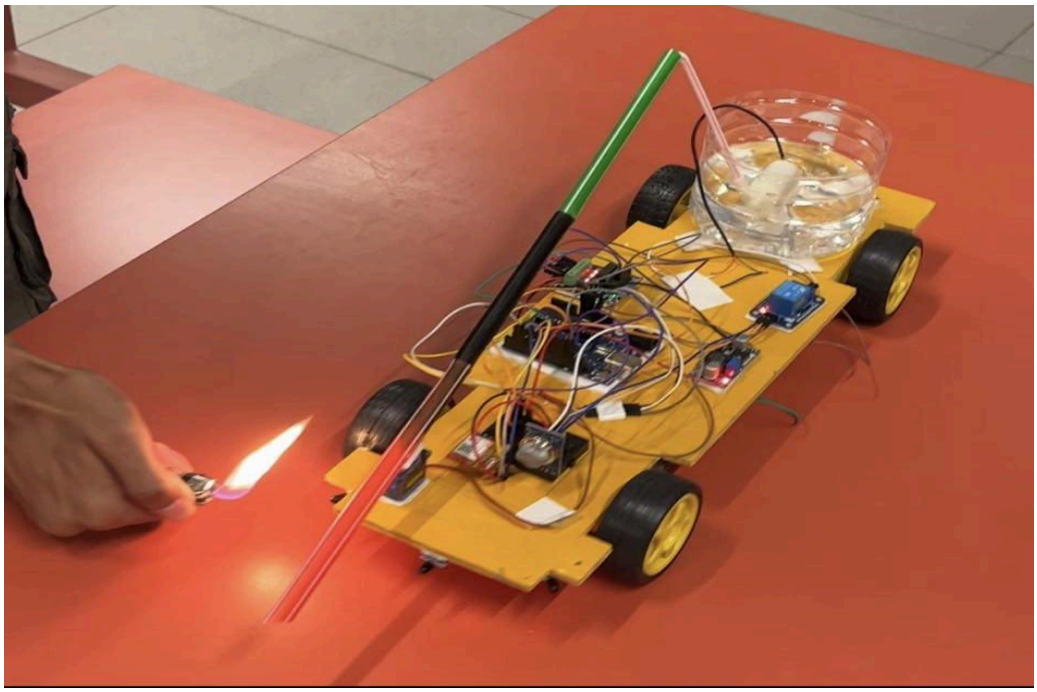

Figure-1: FlameGuard: Fire Detection and Suppression Robot

Application Area: Our Flameguard will serve the Security and Defense System. In the field of security and defense, the necessity for modern technology solutions to identify and respond to risks such as fires and gas leaks is crucial. These dangers endanger not just infrastructure but also human lives, especially in high-security, high-risk sites like military bases, ammunition depots, and defense production plants. Our robot, an autonomous alert system capable of identifying and responding to these hazards, plays a critical role in improving the safety and security standards in such areas.

Importance in Security and Defense System: Defense installations frequently include sensitive materials that might react strongly to fire and chemical exposure. The presence of explosives, hazardous chemicals, and essential equipment necessitates strict safety precautions. Traditional fire alarm systems and human supervision may be insufficient due to the possibility of fast escalation and the significant danger of human injury. Our robot overcomes these restrictions by offering a first-response solution that does not require human interaction to control the problem.

Functionality and Response:

- **Detection:** The robot is equipped with high-sensitivity sensors that continuously check the environment for indicators of fire or dangerous gasses. In defense contexts, such hazards must be detected quickly and accurately to avoid an escalation that could result in catastrophic outcomes. The MQ-2 gas sensor detects a range of flammable gasses that are frequently encountered in defense manufacturing processes. The flame sensor, which is sensitive to IR wavelengths associated with flames, ensures early detection of fire outbreaks.

- **Alert System:** When the robot detects a threat, it quickly activates an integrated alert system. This system sends real-time notifications to the control center and the appropriate workers via SMS or a communication network. In defense scenarios, timely communication is critical for mobilizing emergency response teams and evacuating personnel from damaged locations.

- **Suppression Capability:** One of our robot's distinguishing qualities is its capacity to perform initial fire suppression operations. When a flame is spotted, the robot moves automatically towards the source. Using an inbuilt water reservoir and pump system, it begins to spray water to contain and possibly extinguish the fire. This fast intervention can keep the fire from spreading to locations with more sensitive or explosive materials.

Advantages in Security and Defense: Autonomous Operation: The robot operates without direct human supervision. This capability is especially useful in dangerous situations when human presence could result in injury or fatalities.

- **Rapid Response:** By combining detection, communication, and initial suppression into a single unit, the response time from detection to action is significantly reduced.

- **24/7 Monitoring:** Unlike human guards, who require shifts and can experience lapses in attention, our robot provides continuous surveillance, ensuring around-the-clock security.

- **Integration with Existing Systems:** Our robot is intended to work smoothly with existing security and safety systems in defense infrastructure. It can be linked to central monitoring systems, allowing for coordinated emergency response and other security measures. The ability to communicate with these systems improves the entire security architecture, allowing for a strong reaction to any detected threats.

Equipment/ tools used:

1. Flame Sensor (x3)
2. MQ-2 Flammable Gas & Smoke Sensor
3. L293D Motor Driver
4. Relay Module (5V)
5. LM 2596 Buck Converter
6. Servo sg 90
7. Mini Water Pump (5V)
8. BO Motor, Wheel (x4)
9. 18650 Battery (x3)
10. Mini Breadboard
11. Jumper Wire
12. Multimeter
13. A Water Pot
14. Arduino Uno R3

Sensors:

Gas Sensor (MQ-2): This sensor detects flammable gasses and smoke by measuring the conductivity of a tin oxide-based sensitive material that changes with exposure to gasses.

Figure-2: Gas Sensor (MQ-2)

Flame Sensor: Works on the principle of infrared (IR) detection to recognize the presence of fire. Explain how the sensor detects wavelengths typical of flames and the significance of its response time and accuracy.

Figure-3: Flame Sensor

Circuit Diagram:

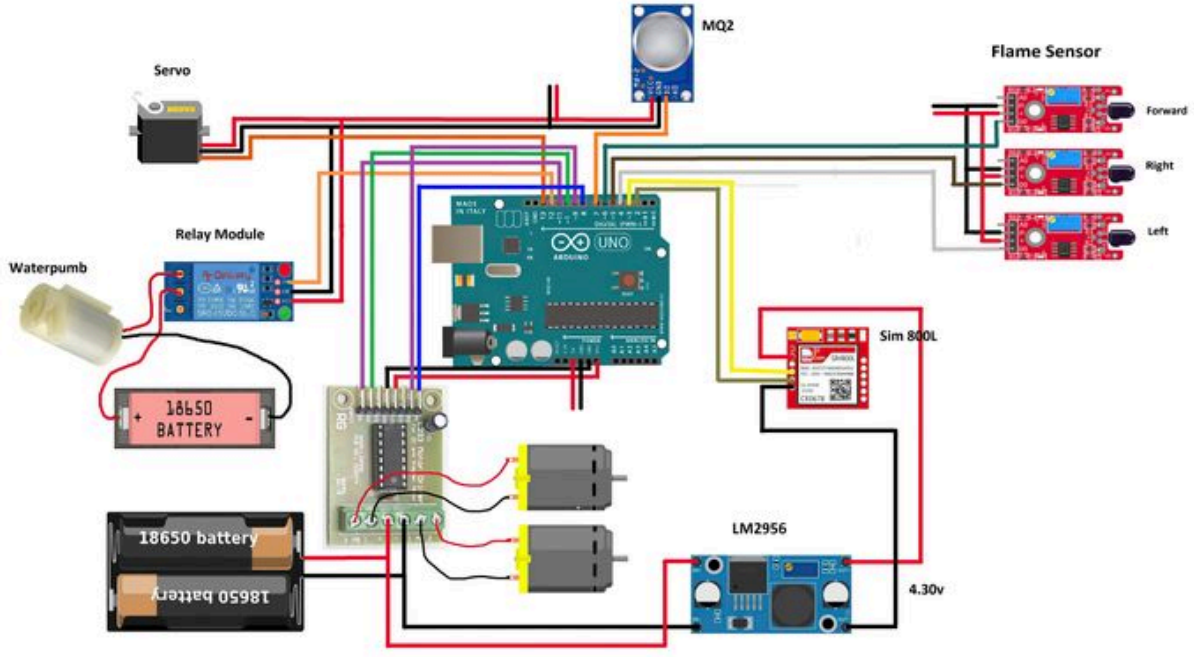

Figure-4: Circuit Diagram

Protocols:

The FlameGuard project primarily uses the UART (Universal Asynchronous Receiver-Transmitter) communication protocol for serial communication with the GSM module. UART is a standard communication protocol for asynchronous serial communication between devices, where data is transmitted sequentially, one bit at a time, over two wires: one for transmitting data (TX) and one for receiving data (RX).

- Sensor Detection: Sensors detect flame or gas and send a digital signal to the Arduino.
- Processing and Decision Making: Arduino processes these inputs, and decides the course of action (e.g., move towards the fire, start the pump, send SMS, or make a call).
- Motor Control: Commands are sent to motor drivers to move the robot or operate the pump.
- Servo Control: PWM signals control the servo to aim the water spray.
- GSM Communication: SMS alerts or calls are initiated via UART communication to inform about gas detection or ongoing fire suppression.
- Feedback and Monitoring: The Arduino continuously monitors the status of its tasks and sensors, adjusting its actions based on dynamic environmental feedback.

Code:

```
#include <Servo.h>
#include <SoftwareSerial.h>

Servo myservo;

int pos = 0;
boolean fire = false;


const String PHONE = "+880**********";

#define rxPin 2
#define txPin 3
SoftwareSerial sim800L(rxPin,txPin);
#define Left 4          // left sensor
#define Right 5         // right sensor
#define Forward 6       //front sensor
#define GAS_SENSOR 7    //Gas sensor
```

```
#define LM1 8          // left motor
#define LM2 9          // left motor
#define RM1 10          // right motor
#define RM2 11          // right motor
#define pump 12         //water pumb



void setup()
{

  Serial.begin(9600);

  sim800L.begin(9600);

  sim800L.println("AT");
  delay(1000);
  sim800L.println("AT+CMGF=1");
  delay(1000);

  pinMode(Left, INPUT);
  pinMode(Right, INPUT);
  pinMode(Forward, INPUT);
  pinMode(GAS_SENSOR, INPUT);
  pinMode(LM1, OUTPUT);
  pinMode(LM2, OUTPUT);
  pinMode(RM1, OUTPUT);
  pinMode(RM2, OUTPUT);
  pinMode(pump, OUTPUT);

  myservo.attach(13);
  myservo.write(90);

   while(sim800L.available()){
  Serial.println(sim800L.readString());
  }

}

void put_off_fire()
```

```
{



   digitalWrite(LM1, HIGH);
   digitalWrite(LM2, HIGH);
   digitalWrite(RM1, HIGH);
   digitalWrite(RM2, HIGH);
   digitalWrite(pump,HIGH);
   delay(500);


   for (pos = 50; pos <= 110; pos += 1) {
   myservo.write(pos);
   delay(10);
  }
  for (pos = 110; pos >= 50; pos -= 1) {
   myservo.write(pos);
   delay(10);
  }
  digitalWrite(pump,LOW);
  myservo.write(90);
  fire=false;
}

void loop()
{


  myservo.write(90); //Sweep_Servo();

  if (digitalRead(Left) ==1 && digitalRead(Right)==1 && digitalRead(Forward) ==1)
    {
   delay(500);
   digitalWrite(LM1, HIGH);
   digitalWrite(LM2, HIGH);
   digitalWrite(RM1, HIGH);
   digitalWrite(RM2, HIGH);
    }
    else if (digitalRead(Forward) ==0)
```

```
  {
  digitalWrite(LM1, LOW);
  digitalWrite(LM2, HIGH);
  digitalWrite(RM1, LOW);
  digitalWrite(RM2, HIGH);
  fire = true;

  }

  else if (digitalRead(Left) ==0)
  {
  digitalWrite(LM1, LOW);
  digitalWrite(LM2, HIGH);
  digitalWrite(RM1, HIGH);
  digitalWrite(RM2, HIGH);
  }

  else if (digitalRead(Right) ==0)
  {
  digitalWrite(LM1, HIGH);
  digitalWrite(LM2, HIGH);
  digitalWrite(RM1, LOW);
  digitalWrite(RM2, HIGH);
  }
  delay(400);//change this value to change the distance

   if(digitalRead(GAS_SENSOR)== 0)
  {
   Serial.println("Gas is Detected.");
    send_sms();
  }

   while (fire == true)
   {
    put_off_fire();
    Serial.println("Fire Detected.");
    make_call();
   }}
   void make_call()
{
```

```
  Serial.println("calling....");
  sim800L.println("ATD"+PHONE+";");
  delay(1000); //1 sec delay
  sim800L.println("ATH");
  delay(1000); //1 sec delay
}

void send_sms()
{
  Serial.println("sending sms....");
  delay(50);
  sim800L.print("AT+CMGF=1\r");
  delay(1000);
  sim800L.print("AT+CMGS=\""+PHONE+"\"\r");
  delay(1000);
  sim800L.print("Gas Detected");
  delay(100);
  sim800L.write(0x1A);
  delay(1000);
}
```

Estimated Cost Analysis:

In order to ensure the feasibility and financial sustainability of the Flameguard robot, a comprehensive cost analysis has been conducted. This analysis only focuses on the development part of the project.

1. Sensors:
   Flame Sensor (x3) - 207TK
   MQ-2 Flammable Gas & Smoke Sensor-129TK

2. L293D Motor Driver- 215TK
3. Relay Module (5V)-75TK
4. LM 2596 Buck Converter- 99TK
5. Servo sg 90- 170TK
6. Mini Water Pump (5V)- 160 TK

7. BO Motor, Wheel (x4) - 660 TK
8. 18650 Battery (x3)- 252TK
9. Mini Breadboard- 45TK
10. Jumper Wire-150TK
11. Arduino UNO R3 - 789 TK

Our total cost would be **3545TK**.

Brief Description: Our robot, which is built as an alert and response system, plays an important role in threat detection and early fire suppression. The robot is equipped with sensors (Flame Sensor, Gas Sensor) that detect the presence of gas and flames and activate its alert mechanisms instantly when they are detected. If gas is discovered, it sends an SMS alert to a predetermined user's phone number and if fire is detected, it sends a call to that number, providing immediate warning of potential risk. In the event of a flame detection, the robot launches a phone call to notify the user immediately.

In addition, the robot serves as both a passive detector and an active responder. When it detects a flame, it automatically navigates to the source of the flame. When it arrives at the area, it installs a water pump system. This device is controlled by a servo motor, which allows for accurate aiming of the water spray to successfully suppress the fire at its early stages. The robot's dual detection and response capabilities make it a useful tool for early fire safety intervention, dramatically reducing risks and providing a rapid reaction solution.

Conclusion: In conclusion, the autonomous fire and gas detection robot is an important addition to security and defense systems, especially in areas where the risk of fire and gas occurrences is high. By improving detection capabilities, assuring timely communication, and performing first suppression operations, the robot dramatically improves safety protocols in high-risk regions, potentially saving lives and preventing damage to important infrastructure.

Reference:

1. S. V. Nagirnyak and T. A. Dontsova, "Gas sensor device creation," 2017 IEEE 7th International Conference Nanomaterials: Application & Properties (NAP), Odessa, UKraine, 2017, pp. 01NNPT13-1-01NNPT13-4, doi: 10.1109/NAP.2017.8190193

2. B. U. Toreyin, E. B. Soyer, O. Urfalioglu and A. E. Cetin, "Flame detection using PIR sensors," 2008 IEEE 16th Signal Processing, Communication and Applications Conference, Aydin, Turkey, 2008, pp. 1-4, doi: 10.1109/SIU.2008.4632660

3. M. R. Habib et al., "Quick Fire Sensing Model and Extinguishing by Using an Arduino Based Fire Protection Device," 2019 5th International Conference on Advances in Electrical Engineering (ICAEE), Dhaka, Bangladesh, 2019, pp. 435-439, doi: 10.1109/ICAEE48663.2019.8975538.

Responsibilities:

Name	Responsibilities
Al Shahriar Him	Bot Assembling and Report writing
Rubaba Rashid	Bot Assembling and Report writing
Rantu Das	Circuit building and Report writing
Dipta Dipayan Kar	Circuit building and Report writing