BLUETOOTH CONNECTED ROBOT WITH FIRE AND HAZARDOUS GAS DETECTION

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1. INTRODUCTION

In the current era, rising global temperatures and increasing pollution levels have led to numerous health issues affecting people worldwide. One specific vulnerable group is underground mining workers, who face significant risks due to hazardous gases present in mining environments. Exposure to these dangerous gases, coupled with extreme temperature fluctuations, poses a severe threat to their health and well-being.

To address this critical concern, our project aims to develop an advanced gas and temperature monitoring system. This system is based on an AVR microcontroller and will serve as a crucial tool for detecting combustible and hazardous gases, as well as monitoring the ambient temperature in underground mining operations. The primary objective is to ensure the safety and health of workers by providing real-time gas and temperature data, along with immediate alerts in case of any potential danger.

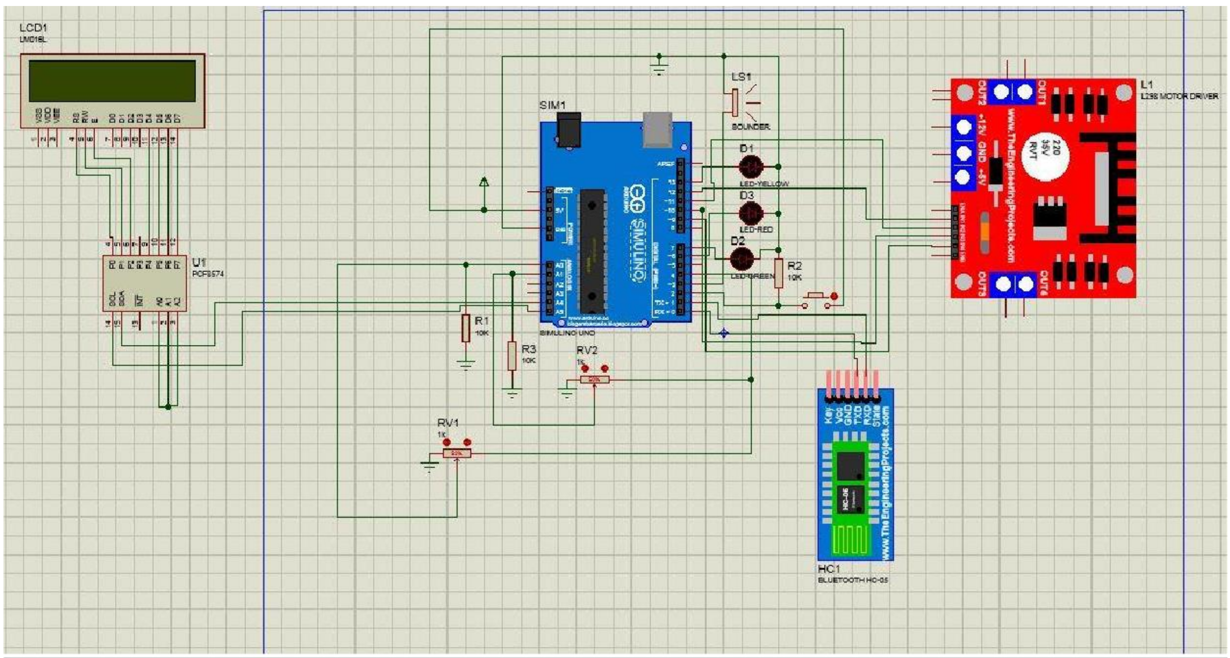
The proposed system will be equipped with gas sensors capable of detecting various hazardous gases prevalent in underground mining environments, such as coal mines, chemical plants, waste treatment facilities, and recycling sites. Additionally, the system will incorporate a temperature sensor to monitor and regulate the ambient temperature within safe limits.

Through a combination of smart technology and user-friendly interfaces, the system will alert workers to hazardous gas levels and temperature extremes using a buzzer for audible warnings and LED lights for visual indicators. Furthermore, the system will be designed to enable remote monitoring and control through a smartphone app utilizing Bluetooth technology.

By providing timely and accurate information, this smart gas and temperature monitoring system will play a pivotal role in enhancing the safety and well-being of underground workers in high-risk industrial settings. The real-time data and alerts will empower workers to take precautionary measures and respond effectively to any potential threats, ultimately reducing the prevalence of health issues associated with hazardous gas exposure and extreme temperatures.

2. PROJECT DESIGN AND IMPLEMENTATION

2.1 Hardware Design Including Block Diagrams And Schematics



2.2 Interfacing

This robot is equipped with two types of interfaces.

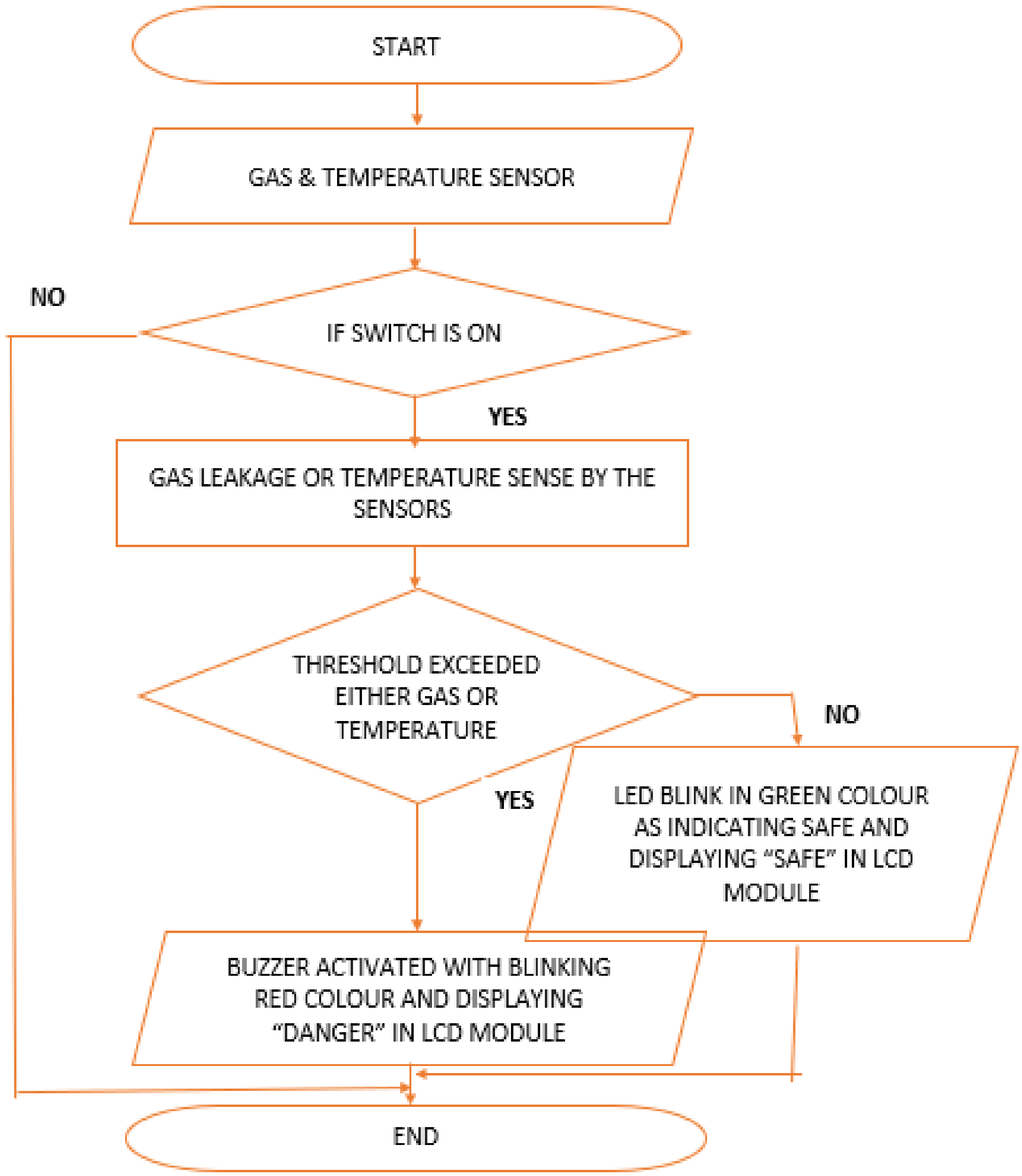
1. On-Board Communication Interface:

The on-board communication interface allows different components within the embedded product to communicate with each other. For the first function, which is to alert when hazardous gas is detected or when the temperature exceeds a threshold value, the mining robot utilizes this on-board communication interface. The primary protocol used for this communication is the I2C (Inter-Integrated Circuit) bus. The I2C bus enables the gas sensors and temperature sensors to share data with the AVR microcontroller. When a hazardous gas is detected by the gas sensors or when the temperature surpasses a predefined threshold value, the respective sensor communicates this information to the microcontroller via the I2C bus. The microcontroller then processes this data and triggers the alerting mechanisms, such as the buzzer for audible warnings and the LED lights for visual indicators.

2. External Communication Interface:

The external communication interface enables the mining robot to interact with external devices, such as a readily usable mobile app. This interface is specifically employed for the second function of the mining robot, which is to be a Bluetooth-controlled car. Through Bluetooth communication, the mining robot establishes a connection with a mobile app, which allows users to control the robot remotely. The mobile app serves as a convenient and user-friendly control interface, enabling users to steer the robot, initiate movement commands, and stop it as desired. The mobile app sends control signals via Bluetooth to the mining robot, and the robot's AVR microcontroller interprets these signals to execute the corresponding actions, such as moving forward, backward, turning left, or turning right.

2.3 Software Design Including Possible Diagrams



2.4 Implementation

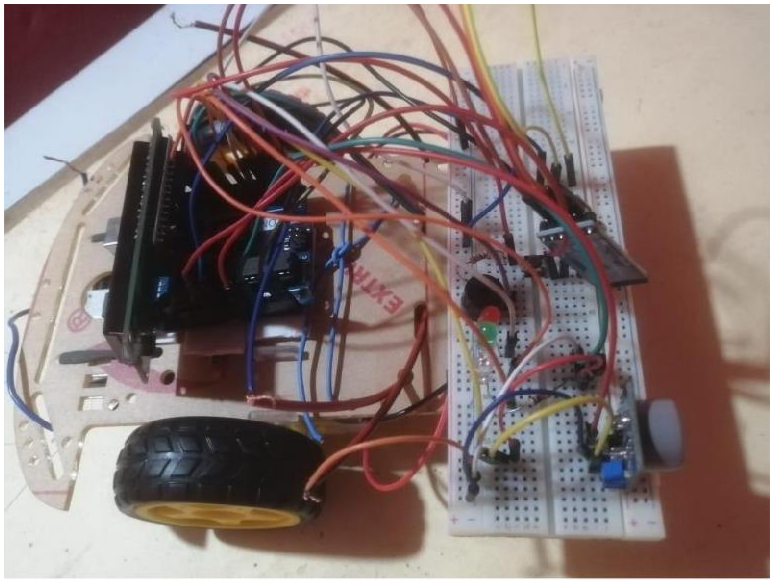


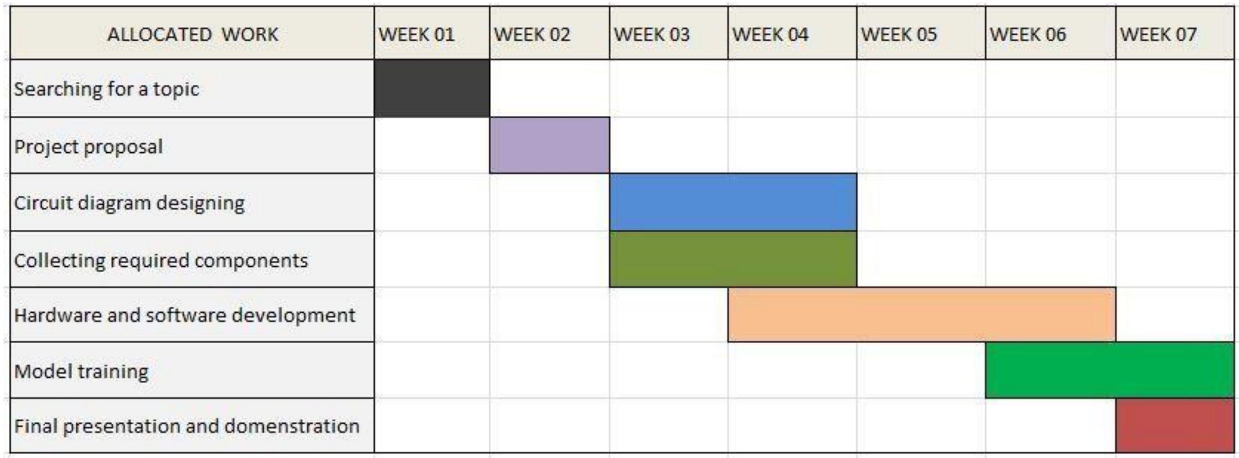
FIGURE 01:CIRCUIT WITH BOTH TEMPERATURE AND GAS SENSORS

FIGURE 02 : WORKING OF LCD DISPLAY

3. CHALLENGES OR PROBLEMS FACED AND SOLUTIONS OR WORKAROUNDS FOUND

Problem	Solution
• Difficult to get the accurate reading in LM35	• Calibration
• The exact power for the sensors couldn’t be identified	• By changing the battery level , can get the approximate values.

4. Timeline


ALLOCATED WORK
WEEK 01
WEEK 02
WEEK 03
WEEK 04
WEEK 05
WEEK 06
WEEK 07
Searching for a topic
Project proposal
Circuit diagram designing
Collecting required components
Hardware and software development
Model training
Final presentation and domenstration

5. COMPONENTS AND COST

Component	Quantity	Cost (in Rs)
2WD smart car kit	1	1,380
3.7V battery	2	1,000
LM 35 temperature sensor	1	250
MQ-7 carbon monoxide sensor	1	480
Bluetooth module	1	510
LCD display	1	420
I2C module	1	250
Motor controller	1	700
Other power component		1,500
Total		6,490

6. REFLECTION ON APPLIED KNOWLEDGE FROM THINGS LEARNED IN THE COURSE

In our project, we are utilizing embedded systems for two distinct, single-function applications, each designed to perform specialized operations. The first application focuses on hazardous gas and temperature detection, where the embedded system continuously monitors gas and temperature sensors. It reacts in real-time to any changes, instantly alerting the user to the presence of hazardous gases or if the ambient temperature exceeds a predefined threshold. This real-time responsiveness is critical for ensuring the safety of underground mining workers and industrial operations. Both applications exhibit tightly constrained design metrics, as is typical of embedded systems. Additionally, these systems are engineered to perform fast data processing in real-time while consuming minimal power, thus extending battery life.

The second application involves a Bluetooth-controlled robot, where users can remotely control the robot's path through a mobile app. The embedded system facilitates smooth and accurate control of the robot by promptly responding to user commands transmitted via Bluetooth. The system's compact size and low power consumption make it highly portable and even suitable for use as a wearable device, thus increasing its versatility.

By adopting embedded systems for these applications, our project benefits from their efficiency and effectiveness. The gas and temperature detection system ensures worker safety by providing real-time monitoring and alerting, while the Bluetooth-controlled robot delivers an intuitive and interactive control mechanism. Both applications exemplify the advantages of embedded systems in meeting specific requirements and delivering reliable and efficient solutions for our project.

7. CONCLUSION

Mining is still a dangerous and difficult job, with more fatalities and injuries occurring in this industry than in any other. Tragically, over 15,000 miners lose their lives annually, likely underestimating the actual figures. Uncertainty also surrounds the number of mining-related injuries, but it is believed to reach hundreds of thousands each year. Such alarming statistics underscore the urgent need for enhanced health and safety measures for mine personnel.

Our project's primary objective is to address these pressing concerns by developing a mining robot equipped with a critical alert system. The robot's pivotal function is to detect and promptly communicate the presence of hazardous gases and extreme temperatures to miners and the mining operation system before they enter mining areas. By providing advance warnings, our product aims to prevent potential disasters such as explosions, fires, and respiratory ailments caused by inhaling dust particles generated during mining activities.

The significance of our project lies in safeguarding the health and well-being of miners, mitigating the risks they face daily, and offering essential protection against life-threatening situations. Through the prototype's successful development and subsequent performance analysis, we have demonstrated that the mining robot effectively delivers alert messages without any interruptions. This crucial advancement represents a crucial step towards enhancing mine safety and ensuring that miners can work in a healthier and more secure environment.

8. REFERENCES

Bhattacharjee, S., Roy, P., Ghosh, S., Misra, S. and Obaidat, M.S., 2012. Wireless sensor network-based fire detection, alarming, monitoring and prevention system for Bord-and-Pillar coal mines. *Journal of Systems and Software*, *85*(3), pp.571-581.

Adjiski, V., Despodov, Z. and Serafimovski, D., 2017. Prototype model for fire safety system in underground mining. *American Journal of Mining and Metallurgy*, *4*(1), pp.62-67.

Wang, H., Fang, X., Li, Y., Zheng, Z. and Shen, J., 2021. Research and application of the underground fire detection technology based on multi-dimensional data fusion. *Tunnelling and Underground Space Technology*, *109*, p.103753.

Litton, C.D., 1979. *Fire Detectors in Underground Mines* (Vol. 8786). Department of the Interior, Bureau of Mines.

www.alldatasheet.com. (n.d.). *LM35 Datasheet, PDF - Alldatasheet*. [online] Available at: https://www.alldatasheet.com/view.jsp?Searchword=Lm35&gclid=Cj0KCQjwwvilBhCFARIsADvYi7Jf7dBEku1NBuy8l8eH-1MkXl-lsBQUONlqxLcn8SK6JXxx8mrRAnkaAv7rEALw

www.sciencedirect.com. (n.d.). *Gas Sensor - an overview | ScienceDirect Topics*. [online] Available at: https://www.sciencedirect.com/topics/chemistry/gas-sensor#:~:text=Gas%20sensors%20are%20devices%20that.

StudySmarter UK. (n.d.). *Environmental Impact of Mining: An Overview | StudySmarter*. [online] Available at: https://www.studysmarter.co.uk/explanations/environmental-science/physical-environment/environmental-impact-of-mining/#:~:text=Many%20negative%20impacts%20can%20result.

9. APPENDIX

9.1 Code

```
#include <LiquidCrystal_I2C.h> // Include the LiquidCrystal_I2C library

LiquidCrystal_I2C lcd(0x27, 16, 2); // Set the LCD I2C address and dimensions (change the address if necessary)

int Buttonpin = 2;
int outPin1 = 4;

 // Starting of Program
int m1a = 9;
int m1b = 10;
int m2a = 11;
int m2b = 12;
char val;

int sensorPin1 = A0;
int lm35_pin = A1;
int sensorValue1 = 0;
int sensorValue2 = 0;

int greenLED1 = 7;
int redLED1 = 6;
int buzzar = 3;

int ONValue1 = 450;
int ONValue2 = 200;

boolean buttonState;
boolean lastState;
boolean state = LOW;

void setup() {
  analogReference(DEFAULT);
  lcd.init(); // Initialize the LCD
  lcd.backlight();
  //lcd.print("Safety System"); // Display initial message
 delay(2000);
 lcd.clear(); // Clear the LCD

  pinMode(Buttonpin, INPUT);
  pinMode(outPin1, OUTPUT);
  pinMode(13, OUTPUT); // Power on indicator

```

```
  pinMode(greenLED1, OUTPUT);
  pinMode(redLED1, OUTPUT);
  pinMode(buzzar, OUTPUT);

  pinMode(m1a, OUTPUT);  // Digital pin 9 set as output Pin
  pinMode(m1b, OUTPUT);  // Digital pin 10 set as output Pin
  pinMode(m2a, OUTPUT);  // Digital pin 11 set as output Pin
  pinMode(m2b, OUTPUT);  // Digital pin 12 set as output Pin

  Serial.begin(9600);
}

void loop() {
  while (Serial.available() > 0) {
    val = Serial.read();
    Serial.println(val);
 }

  if (val == 'F') // Forward
  {
    digitalWrite(m1a, HIGH);
    digitalWrite(m1b, LOW);
    digitalWrite(m2b, HIGH);
    digitalWrite(m2a, LOW);
  }
  else if (val == 'B') // Backward
  {
    digitalWrite(m1a, LOW);
    digitalWrite(m1b, HIGH);
    digitalWrite(m2b, LOW);
    digitalWrite(m2a, HIGH);
 }

  else if (val == 'L') //Left
  {
    digitalWrite(m1a, LOW);
    digitalWrite(m1b, HIGH);
    digitalWrite(m2a, LOW);
    digitalWrite(m2b, LOW);
  }
  else if (val == 'R') //Right
  {
    digitalWrite(m1a, LOW);
    digitalWrite(m1b, LOW);
    digitalWrite(m2a, LOW);
```

```
    digitalWrite(m2b, HIGH);
}

        else if (val == 'S') //Stop
        {
          digitalWrite(m1a, LOW);
          digitalWrite(m1b, LOW);
          digitalWrite(m2a, LOW);
          digitalWrite(m2b, LOW);
        }
        else if (val == 'I') //Forward Right
        {
          digitalWrite(m1a, HIGH);
          digitalWrite(m1b, LOW);
          digitalWrite(m2a, LOW);
          digitalWrite(m2b, LOW);
        }
        else if (val == 'J') //Backward Right
        {
          digitalWrite(m1a, LOW);
          digitalWrite(m1b, HIGH);
          digitalWrite(m2a, LOW);
          digitalWrite(m2b, LOW);
        }
        else if (val == 'G') //Forward Left
        {
          digitalWrite(m1a, LOW);
          digitalWrite(m1b, LOW);
          digitalWrite(m2a, HIGH);
          digitalWrite(m2b, LOW);
        }
        else if (val == 'H') //Backward Left
        {
          digitalWrite(m1a, LOW);
          digitalWrite(m1b, LOW);
          digitalWrite(m2a, LOW);
          digitalWrite(m2b, HIGH);
        }

        int reading = digitalRead(Buttonpin);
        if (reading == LOW && lastState == HIGH) {
          delay(10);
          if (digitalRead(Buttonpin) == LOW)
            state = !state;
        }
```

```
    digitalWrite(outPin1, state);

    if (state == HIGH) {
      digitalWrite(13, HIGH);
      delay(10);

      int sensorValue1 = analogRead(A0);
      int sensorValue2 = analogRead(A1);
      Serial.print("SensorValue1 =  ");
      Serial.print(sensorValue1);

      float temp_val;
      sensorValue2 = analogRead(lm35_pin); /* Read Temperature */
      temp_val = (sensorValue2 * 4.8828125); /* Convert adc value to equivalent voltage */
      temp_val = (temp_val / 10); /* LM35 gives output of 10mv/°C */
      //temp_val = temp_val - 170;
      Serial.print("     Temperature = ");
      Serial.print(temp_val);
      Serial.print(" Degree Celsius\n");
      delay(1000);

      if ((sensorValue1 < ONValue1) && (temp_val < ONValue2)) {
        digitalWrite(greenLED1, HIGH);
        digitalWrite(redLED1, LOW);
        digitalWrite(buzzar, LOW);
        Serial.println("Safe");

        // Display safe message on the LCD
        lcd.setCursor(0, 0);
        //lcd.print(temp_val);
        lcd.print("     Safe");
      } else {
        digitalWrite(greenLED1, LOW);
        digitalWrite(redLED1, HIGH);
        digitalWrite(buzzar, HIGH);
        delay(300);
        digitalWrite(buzzar, LOW);
        delay(300);
        digitalWrite(buzzar, HIGH);
        delay(300);
        digitalWrite(buzzar, LOW);
        delay(1000);

        Serial.println("Danger");
```

```

      // Display danger message on the LCD
      lcd.setCursor(0, 0);
      //lcd.print(temp_val);
      lcd.print("    Danger");
    }
  }

  if (state == LOW) {
    Serial.println("Off");
    digitalWrite(13, LOW);
    digitalWrite(greenLED1, LOW);
    digitalWrite(redLED1, LOW);
    digitalWrite(buzzar, LOW);

    // Display off message on the LCD
    lcd.setCursor(0, 0);
    lcd.print("Off");
  }
  lastState = reading;
}
```

Minimized Version Of The Poster

Why this product………………

to alert the workers and send messages to the authority, when there is a temperature increment or hazardous gas release especially in underground mining areas.

It consists with,

- AVR microcontroller
- 2-wheel car kit
- Temperature Sensor(LM35)
- Gas Sensor(MQ7)
- Buzzer
- LCD display
- Bluetooth module
- Motor controller