

Continuous Monitoring and Protection System for Underground Mine Workers using Arduino

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Abstract

In any type of industry one of the most vital parts is the safety. Negligence in the safety may cause loss of human life or may cause damaging of high quality equipments. So, this paper discusses the continuous monitoring of underground coal mine parameters like temperature, gases and humidity. Sensors are used to collect and send all these parameters information to monitoring section. Mine workers are informed through buzzer. The hardware section includes the Arduino Galileo from Intel, Temperature, Gas and Humidity sensors, GSM shield.

Keywords

Arduino Galileo from Intel, Temperature, Gas and Humidity Sensors, GSM Shield

I. Introduction

One of the biggest problems is the environmental care in almost every country from the last few years. In the last decades, there is a massive increase of industrial accidents. So for monitoring and controlling of environment, the industries are demanding for instrumentations. So that there will be no loss of human life and losses of property.

The disasters happening in the coal mines are due to the complexity environment so it is very important to monitor continuously the mine working environment. The gases released from the mine environment are methane, carbon monoxide, and other toxic gases. Methane is the major emission. Coal Mine Methane (CMM) is the methane released during and after mining operations. If this methane is passed through a oxygen it can ignite easily and create a violent explosion. Hence, mine workers should be continuously monitored. If the situation is unfavorable for working then workers will be alerted to leave the place.

II. System Overview

The Proposed System consists of Arduino Galileo Gen2 board, Buzzer, Temperature, Humidity and Gas Sensors, GSM Shield. This system has three sensors that will goes as the input to the Arduino Galileo gen2 board. The administrator will set the threshold values for each sensor. If the values exceeds the threshold then immediately buzzer will ON and LED will glow, at the same the Simple Message System(SMS) / Call will be sent to the high authorities.

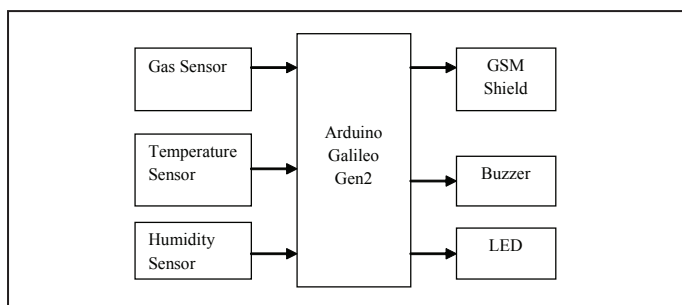


Fig. 1: Block Diagram

III. Hardware System Components

A. Arduino Galileo Gen2

There are different types of embedded processors hardware boards among them the most famous are Raspberry pi, Arduino Galileo. The devices like Raspberry pi are designed in such a way that they are integrated with things like RAM, unlimited storage, Ethernet but the only thing is that device doesn't have the analog - to - digital converter, because of this analog sensors would not work on Raspberry pi board.

On other side Arduino Galileo Gen2 board based on the Intel Quark SOC X1000 is a 32-bit Intel Pentium processor, operating at speed up to 400MHz and it supports analog sensors. In this project we used a new version of arduino i.e. Arduino Galileo Gen2 board which is integrated. The board is integrated with Ethernet, micro SD slot, 20 digital input/output pins out of which 6 can be used as PWM outputs and 6 as analog inputs. It operates at a voltage of 3.3V or 5V.

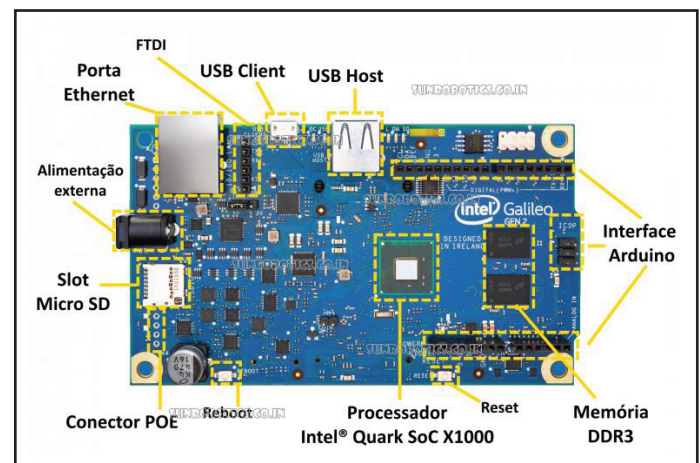


Fig. 2: Arduino Galileo Gen2 Board

B. Temperature Sensor

Temperature sensor is used to measure the ambient temperature. It has three pins positive, ground and signal. LM35 can measure the temperature more accurately than the Thermistor. The Celsius temperature ($^{\circ}\text{C}$) is the output voltage for LM35 temperature sensor. Low self heating capability is the another advantage of this sensor and it draws $60\mu\text{A}$ from its power supply. By simple conversion the output voltage is converted to temperature. The general equation is given below

$$\text{Temperature } (^{\circ}\text{C}) = V_{\text{out}} * (100^{\circ}\text{C}/\text{V}) \quad (1)$$

For example, if V_{out} is 1V then temperature = 100°C

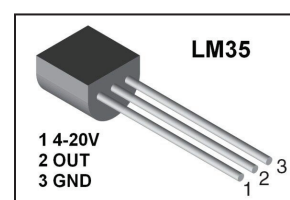


Fig. 3: Temperature Sensor

C. Gas Sensor

In today's lifestyle monitoring of gases plays a vital role. From home appliances to industries monitoring of gases is very important. The methane gas sensor, senses gases that is produced from the methane. When the gas interacts with the sensor it is absorbed by the sensing element and it conveyed through the processor through output pins in the form of current. This changes the resistance values, as the resistance values changes it alters the current.



Fig. 4: Gas Sensor

D. Moisture Sensor

Moisture sensor is used to detect the water content in the underground. To measure the dielectric permittivity of the surroundings it use the capacitance. The advantage of moisture sensor it has high sensitivity and response time is fast.

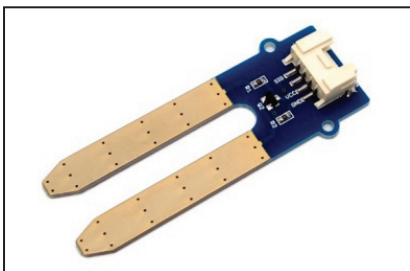


Fig. 5: Moisture Sensor

E. Buzzer

It is an electronic signaling device. The principle of the buzzer is it consists of piezo crystals between the two conductors. When a voltage is applied across these crystals, they push one conductor and pull the other conductor due this action it creates the sound. Mostly the buzzers generates sound in the frequency range of 2 to 4 KHz. Buzzer will have two pins one is connected to the input and the other is connected to the ground. Applications of the buzzer are it can be used in alarm devices, Household applications.



Fig. 6: Buzzer

F. GSM Shield

GSM stands for Global System for Mobile Communications. The Arduino GSM shield connects your board to the internet

using GPRS. Just you need to insert the GSM shield onto the Arduino board and insert the sim card. You can make the phone calls, receive the phone calls and can send the simple message system(SMS). GSM shield contains a bunch of LED's which will be ON when it gets power. It blinks when it is communicating with the radio network. It has an input pins that can be used to connect the microphone and output pins to connect speaker. So, in order to speak to and hear you need to add a speaker and a microphone.



Fig. 7: GSM Shield

G. LED

LED stands for Light Emitting Diode. In LED's electrical energy is converted to optical energy. In present days they are most widely used because of low power consumption. The ON/OFF of an LED is quick and the life time of a light emitting diode is long. The efficiency of a light emitting diode is nearly 80% whereas for the traditional lamps it's about 20% and remaining 80% is radiated as heat.

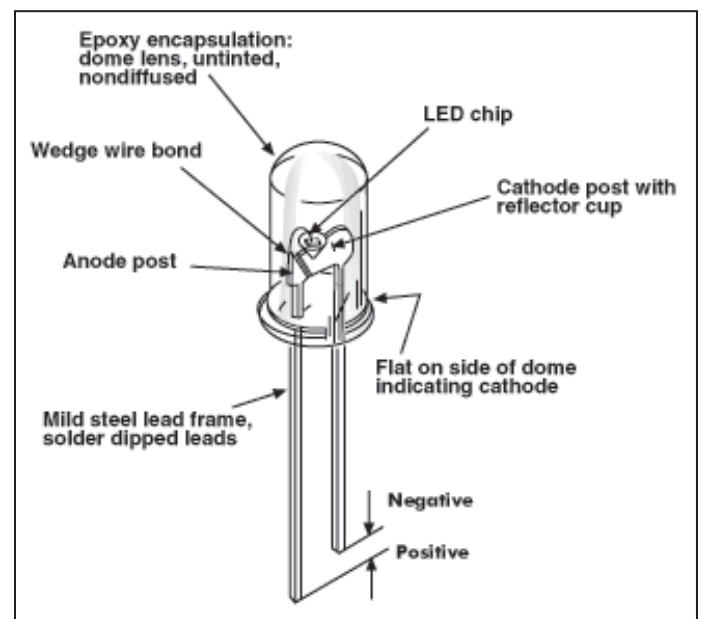


Fig. 8: LED

IV. Advantages

1. System continuously monitors the environmental parameters.
2. It provides security for workers.

V. Design Flow

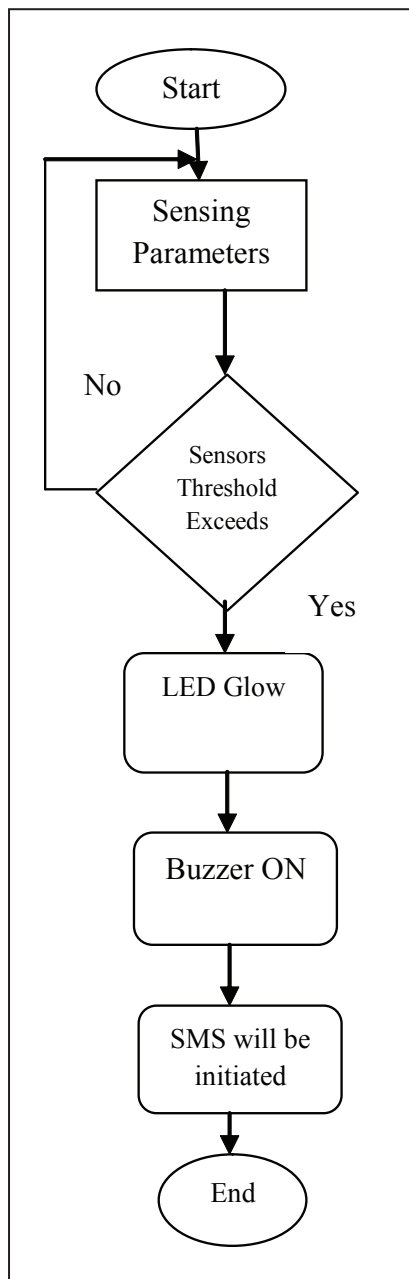


Fig. 9: Flow Chart

VI. Results

Table 1: Results for Normal Conditions

S.No	Name of the sensor	Threshold value	Actual value	Activated
1	Temperature sensor	50	45	Buzzer OFF
2	Gas sensor	137	70	Buzzer OFF
3	Moisture sensor	137	70	Buzzer OFF

Table 2: Results for Abnormal Conditions

S.No	Name of the sensor	Threshold value	Actual value	Activated
1	Temperature sensor	50	70	Buzzer ON
2	Gas sensor	137	167	Buzzer ON
3	Moisture sensor	137	500	Buzzer ON

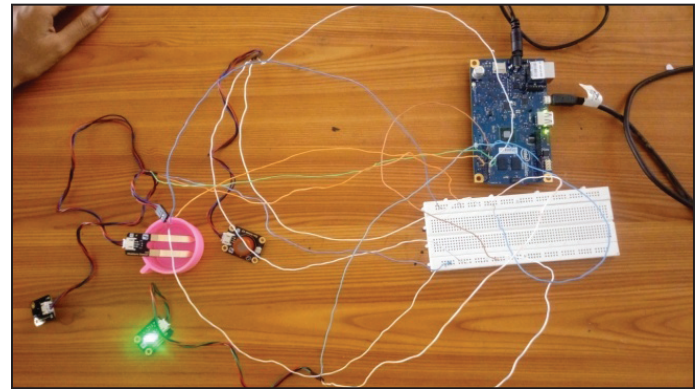


Fig. 10: Output During Abnormal Conditions

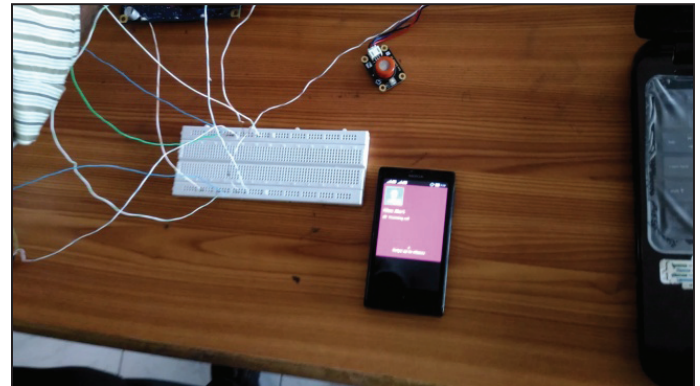


Fig. 11: Mine Alert through GSM Shield

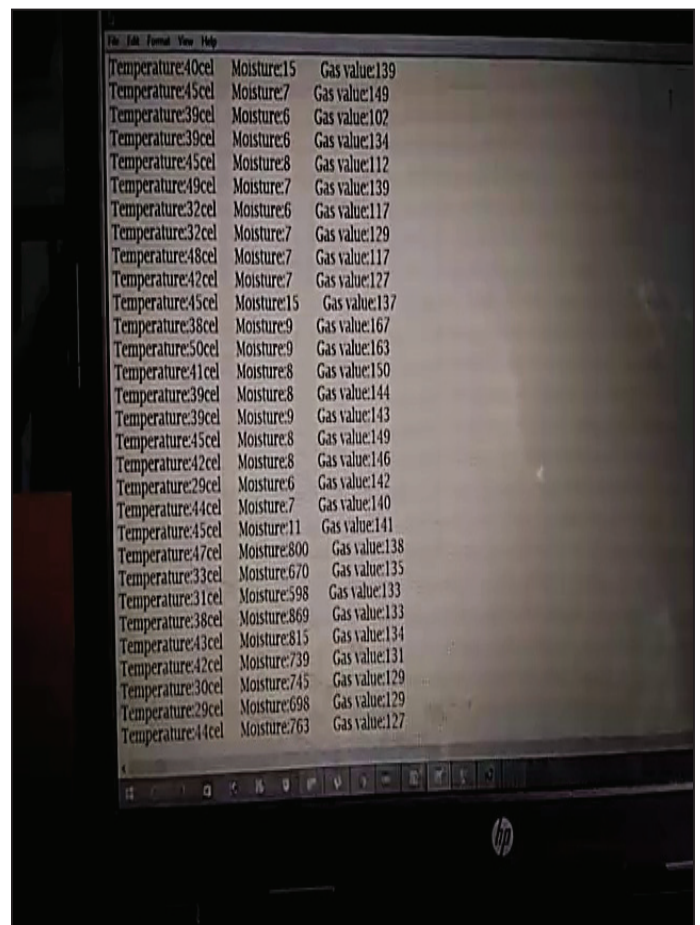


Fig. 12: Serial Monitor Output

VII. Conclusion

Continuous Monitoring and Protection System for Underground Mine Workers is eco – friendly and the best way to safety and

security of underground mines. The accidents can be controlled effectively because it covers the large area and more depth inside underground mines. This system not only monitors, but also indicate alarm automatically when the parameters are abnormal, which helps to reduce the accident in coal mine.

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