Asylum Scheme for Coal Layer Workers

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Abstract— **This project presents a wearable ultra low protection system for coal mine workers to increase the occupational safety and to protect the workers effectively in the hazardous air polluted coal mine environment. This protection system consists of a gas sensor array, fire, temperature and humidity sensors, plunge detector and LDR to sense the catastrophe causing parameters and multiple toxic gas concentrations in the mine area. The ARM 7 microcontroller (LPC 2148) sends all sensed parameter values from the underground mine to the control station located in ground in a preset manner with consistency and high precision. The observed parameter values will be displayed in PC in the control station and in the LCD display placed in the wearable miner module. Upon detecting decisive issues, the microcontroller starts alerting the mine workers by alarming and the alert messages are transmitted to the control station by RF module and to the ambulance and fire service stations through GSM module, so that the essential rescue actions can be taken easily to make the workers stay away from pitfalls.**

Index Terms— **MOS sensors, low power.**

I. INTRODUCTION

  The coal mining has been extremely insecure bustle which fallouts in a number of risky effects on the environment such as suffocation, roof collapse, gas poisoning, gas explosions [1]. The air pollution and explosive gas emissions horror the human health, occupational safety and even causes demise in the coalmines [2]. The real time monitoring of the coal mines pave way for the safety of the miners. But the real time monitoring of process parameters inside the open shed mines in a reliable manner is a technical dare for the mine industry. The presented viable multiple gas detectors are not suitable for broad individual use due to their high cost, large size and large power consumption. In count, the regular maintenance required by some of the sensors raises their operating cost and lowers their achievability. Considerable energy has been committed to the research and development of gas sensing systems [3].

A wireless gas monitoring scheme have been designed, but it has the ability to detect only one gas [4]. A handy gas recognition structure has been offered [5]. But it can quantify only explosive organic compounds and not the toxic gases. Single-chip gas detection systems have been developed [6, 7]. But these plans can detect the gases and cannot determine gas

concentrations. Consequently, a new wearable system is needed right away to measure all the crisis causing parameters in the mine area including the concentrations of several explosive and toxic gases [8].

II. PROPOSED SOLUTION

The proposed system exhibits an ultra low power ARM based wearable protection system. It is based on RF communication at 2.4 GHz for alerting ground station and GSM communication for sending SMS to fire and ambulance service stations. This real time monitoring system provides accurate information about different critical mining parameters like humidity and temperature, presence of dangerous gases and its concentrations, fire and light, position of workers and paves way for the safety of the miners. It also has an ability to find the shortest exit path for the workers in case of decisive issues in the underground mines. If fire accidents or some other problems like toxic gases emission occur even in any one of the underground units, the miner modules fixed with the workers identifies it and alerts the ground station. Then the supervisor in the ground station alerts all the workers in the different underground mine about the problems. And also he guides the workers to move away in the shortest and safest exit path using the data stored in the PC. The messages sent from the supervisor in ground station will be displayed in the LCD display which helps the workers to save their lives. RF module will be used for this communication [9, 10].

The anticipated rescue system is separated into two segments namely the miner unit and ground unit. The wearable miner unit is attached with the body of the employers working in the underground [11] and the ground unit will be in the ground. The miner unit consists of sensors, ARM 7 (LPC 2148) microcontroller, RF transmitter (2.4 GHz) and GSM modem (SIM 900 A) for communicating with the ground unit. It also has buzzer and LCD display for alerting the workers in the mine. The ground unit has a control station consisting of RF receiver and a PC to monitor the conditions in coal mine. Two service stations namely fire and ambulance service stations are located near the control station in the ground unit. These service stations are used to help the workers in risky situations like fire explosions and gas emissions. The sensor module consists of some sensors that measure the parameters like temperature, humidity, light, fire and position of worker. Gas sensors are used to measure toxic gas concentrations like Methane, Carbon-monoxide, Propane and Hydrogen.
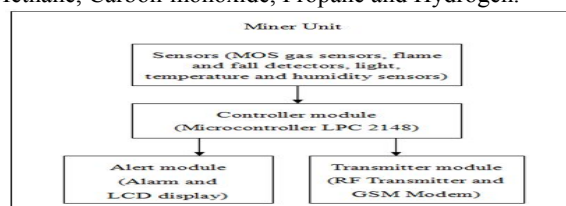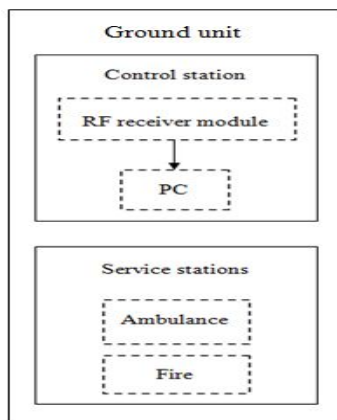

Figure 1: Miner unit

Figure 2: Ground unit

Microcontroller (LPC 2148) is used with the sensors to receive the sensor outputs and to take the necessary decision in vital issues. If temperature, humidity and gas concentrations in the underground mine are more than the safety point fixed at microcontroller, the controller decodes beep alarms in the miner module. It also gives alert to the control station through RF module and to service stations through GSM module. Light sensor senses the light intensity and turn on LED lights in darkness. A 2x16 character LCD module is interfaced with the miner module to show all the parameters like temperature, humidity etc..,
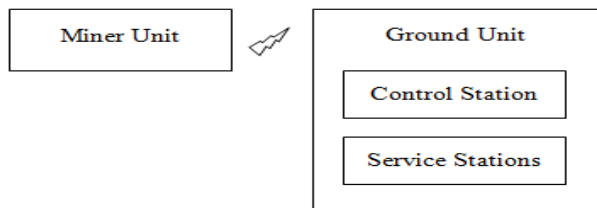

Figure 3: Communication between miner and ground units

This system uses wireless communication to monitor the critical parameters inside the mine and transmits the data in wireless manner for better monitoring and revelation [12, 13]. Also it guides the workers to exit quickly in a safest path from the perilous area. Thus gives a chance to miner to rescue his life from the hazards occurred in coal mines.

III. IMPLEMENTATION

A. Hardware implementation

1. Gas sensors

In the midst of gas sensor technologies, MOS sensors plunk away as applicant for wearable systems. Especially its structures are compatible with modern micro fabrication processes and are therefore suitable for low cost miniaturization. MOS sensors are of low power consumption and low cost with extremely long lifetimes and the ability to detect wide range of gases such as CH_4, NH_3, CO, NO_2, H_2, SO_2, CO_2, H_2S and O_2 over large concentration ranges. In this project, four MOS sensors namely MQ7, MQ4, MQ5, MQ6 are used to sense the gases carbon monoxide, methane, hydrogen and propane respectively.

2. Flame detector

Fire disaster is a great threat to lives and occupational safety. Fire detection is a crucial part in underground coal mines. The fire sensor used here works on the principle of IR rays or heat radiation detection for protection against fire. The output of this sensor will give interrupt signal to the microcontroller (LPC 2148) as soon as it detects fire in underground regions.

3. Light Sensor (LDR)
It is used to sense the darkness in underground mining section. Depending on the amount of light intensity the resistance of LDR increases or decreases. When the working area is dark then LDR will turn ON the LED lights present on miner's module. This pact provides convenience to the miner.

4. Temperature Sensor (LM35)
This sensor measures the amount of heat energy in the environment. LM 35 output will be electrical which is relative to the Centigrade temperature. The ADC of LPC 2148 will convert analog value into digital value and this digital value will be displayed on the LCD display interfaced to LPC 2148 in the miner module.

5. Humidity Sensor (HR-202)
Humidity is the quantity of water vapor in the atmosphere. HR202 is a new kind of humidity sensor made from organic macromolecule materials. The output will be analog voltage with respect to relative humidity and temperature and the value will be displayed on the LCD display.

6. Plunge detector (ADXL335)
The plunge detector is used to detect the position of the worker in the underground coal mine [14]. It is a cost-sensitive, low power consuming fall detector used in motion and tilt-sensing applications. It can measure the stationary acceleration of gravity in tilt sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration.

7. Microcontroller (LPC 2148)
It is an ARM 7 based 32-bit microprocessor with real-time emulation and embedded trace support. LPC2148 is used with the sensors to receive the sensor outputs. It will alert the control station through RF module and sends SMS to the fire service and ambulance service stations through GSM module in the hazardous situation.

8. GSM module (SIM 900A)

Figure 4: GSM Modem

Global system for mobile communication is a globally accepted standard for digital cellular communication. The GSM module with SIM 900 A is used in this protection system for sending messages to the service stations. Sending SMS through GSM modem when interfaced with microcontroller is uncomplicated.

9. RF(CC2500) module

RF module provides simple and pliable wireless data transmission. This modem supports various modulation formats and has a configurable data rate up to 500 k Baud. The CC2500 provides wide hardware bear for packet handling, burst transmissions, data buffering, link quality indication, and clear channel assessment. The RF transmitter in the miner unit sends all the data and alert messages to the RF receiver in the control station. The RF receiver displays and stores all the messages in the PC using serial communication.

10. LCD display

A character based 2x16 LCD is interfaced in the wearable miner's module. It displays different parameters like temperature, humidity, concentration of various toxic and explosive gases, presence of fire, and intensity of light to the mine workers.

Figure 5: LCD display

B. Software implementation

The firmware development of the projected system is done using Embedded C language. We have used software tools such as Keil IDE and HyperTerminal in deploying this industrial system.

1. About Keil IDE

Keil is free software that solves many of the pain points for an embedded programmer. This is integrated development environment software that integrates a text editor to write, a compiler to compile it and convert source code to hex files.

2. About HyperTerminal

The HyperTerminal tool is used to monitor Serial Ports in PC. Thus at the Remote station the collected data from RF receiver is displayed as shown in the results section.

IV. RESULTS

This is the overall setup of the wearable asylum scheme for coal layer workers which consist of miner unit and the ground unit.

Figure 6: Overall Setup

The following figure shows the miner unit. In this unit all sensors are connected to the microcontroller. On recognition of anomalous bustle at miner unit the controller alerts the workers by alarming and displaying the risks in LCD display.
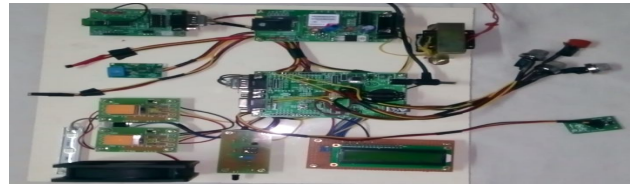

Figure 7: Miner unit

Figure 8: RF Transmitter

All the measured parameter values will be displayed in the LCD display to alert the workers in the underground mine area.

Figure 9: Displaying concentration of toxic and combustible gases

Figure 10: Warning for humidity abnormal

The below figure show the ground unit consisting of RF receiver module, PC and mobile phones for ambulance and fire service stations.
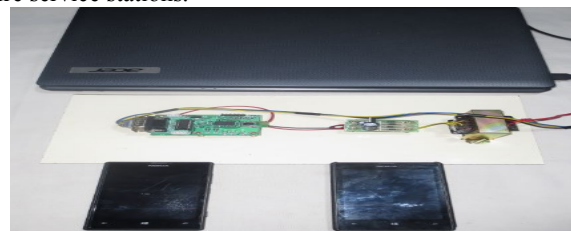

Figure 11: Ground Unit

In the control station we use a PC to monitor the data through RF Receiver. This data is displayed in PC, which provides the complete information of workers and statistics of all the parameters.
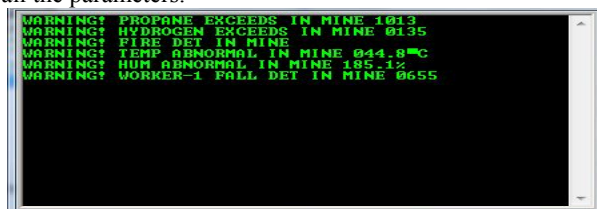

Figure 12: Alert messages displayed in PC in control station

SMS is sent to fire and ambulance service stations if any problem occurs in the underground mine. The below figures shows messages received in the service stations.
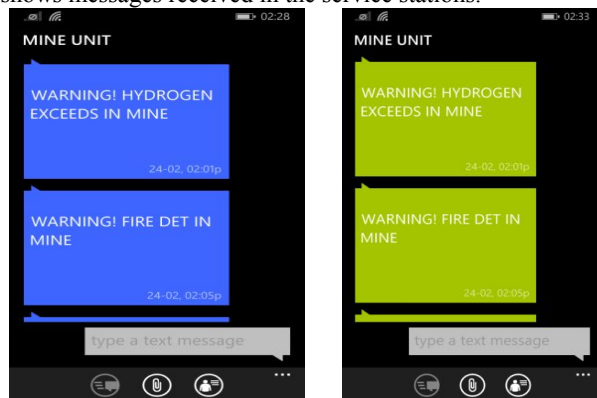

Figure 13: SMS to fire and ambulance stations

CONCLUSIONS

The current coalmine security systems can be effectively replaced by the safety system proposed here. This system covers the chief stipulation aspects of the safety of coalmine workers. The insightful and dangerous coalmines parameters can be monitored easily with the help of this system. As the low power components are used, lot of power utilization is reduced which is most important for any system that run on battery. Supplementary security is provided by GSM which is used to send messages to fire and ambulance service stations. This module can be easily sited on miner's helmet or body for continuous monitoring.

In future, this proposed system may be extended with an ability to guide the workers for shortest exit path by fixing the voice over IC in the miner module. It will make the rescue actions more effective. With this aspect the miners in different underground mine units can exit the risky region fast in a safest way.

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