

# Rescue System for Coal Mine Workers using Different Sensors Based on GSM and RF-PRO

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**Abstract**— In this paper we are implementing surveillance, safety measures for mine workers which is most essential in underground mining areas/sections. Here we are presenting MEMS based sensors network used to monitor the environment parameters of underground mine area and sends all sensed parameters/data to ARM7 processor. ARM7 processor is used to build a fully automated measuring system with reliability, high accuracy and smooth control. Upon detecting critical conditions/issues alert system starts and the same information is transmitted/passed to remote location by initiating modules based on GSM and RF-Pro (CC2500) communication Methods. The observed changes in the parameters will also be displayed in pc which makes easier for the underground control center to monitor and to take necessary immediate action to avoid damages and alerts through a mobile message.

**Index Terms**— Sensors Network, MEMS, GSM, RF-PRO, PC.

## I. INTRODUCTION

Safety of person is primary concern/aspect in any industry, especially in underground mining industry. To avoid any type of unwanted phenomena, all mining industry follows some basic precaution and phenomena. In underground coal mine major of accidents occurred are based on fire and natural gas and overheating of surroundings. We are also considering the health condition of a person using Fall-Detector, made of MEMS-Accelerometer (ADXL335).

Coal mine safety monitoring system based on wireless sensor network can timely and accurately reflect dynamic situation of staff in the underground regions to ground computer system. The hybrid underpass radio propagation model comprising of the free space propagation and the modified waveguide propagation is proposed. However, using popular radio communication inside underground mines has some drawbacks. While radio signals are transmitted, attenuation, diffraction, multi-path and scattering are frequently very serious. Thus, wireless communication is the important need today for the fast, flexible safety, accurate and production method in underground mines.

There are different other research ideas proposed by different people on wireless communication. In a network called chain-type wireless underground mine sensor network

(CWUMSN) is recently proposed which consists of three kinds of sensor nodes: sensing nodes, cluster head nodes, and a base station deployed on both sides of the tunnel at regular intervals to monitor the underground environment and locate the miners. A new decision-making approach to coal and gas outburst prediction with multisensory information fusion is proposed.

This system is design by considering all these parameters i.e. it can sense temperature, pressure, humidity, Fire, Gas as well as Persons Fall. Therefore the designed system is giving a very good solution for most of the problems faced in mine accidents.

A good communication system must be set between mine workers and Remote Base Station For this wired network communication is inefficient in underground mining areas. So we are choosing a wireless network system based on RF communication at 2.4 GHz (CC2500 RF Module is a Trans-Receiver module which provides easy to use RF communication at 2.4 GHz.) And GSM networks for sending SMS to fire and Ambulance.

## II. DESCRIPTION OF THE SCENARIO

The proposed system is divided into two segments. First is a hardware circuit that will be attached with the body of the Mine Workers. It may be preferably fitted with the safety helmet of the workers also.

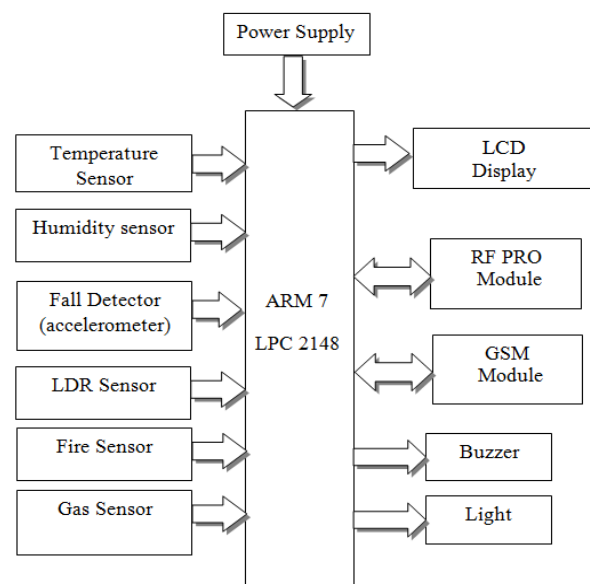


Fig 1 Block diagram Representation of Mine Section



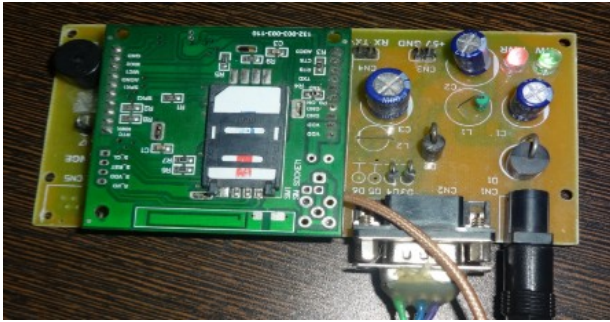


Fig 4 GSM Module

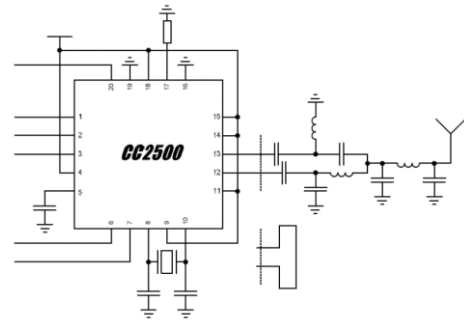


Fig 6 CC2500 Basic circuit representation

### C. RF-PRO (CC2500 MODULE)

#### 1) RF module

RF module providing easy and flexible wireless data transmission between devices. This is based on AVR Atmega8 with serial output which can be interfaced directly to PC.

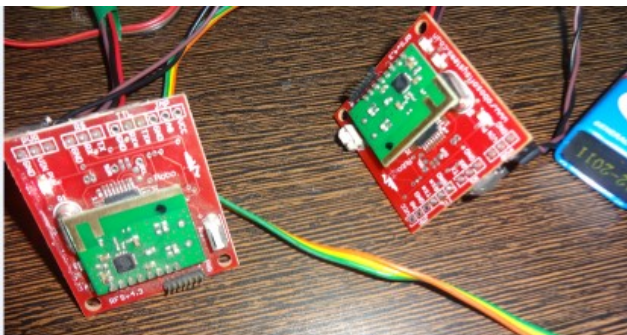


Fig 5 RF-Pro Trans-Receivers

When Powered ON RF module will send “ok” via serial port at 9600 baud. The default operation mode is “Transceiver” and the default sender and receiver address is 0. When we have two RF modules any data sent to RF\_A from serial port the same data will be received by RF\_B and displayed on the serial port.

#### 2) Low-Cost Low-Power 2.4 GHz RF Transceiver:

The CC2500 is a low-cost 2.4 GHz transceiver designed for very low-power wireless applications purpose. The circuit is intended for the 2400- 2483.5 MHz SRD (Short Range Device) and ISM (Industrial, Scientific and Medical) frequency band. RF transceiver is integrated with a highly configurable baseband modem. This modem supports various modulation formats and has a configurable data rate up to 500 k Baud. The CC2500 provides extensive hardware support for packet handling, burst transmissions, data buffering, link quality indication, wake-on-radio, and clear channel assessment. The main operating parameters and the 64- byte transmit/receive FIFOs of CC2500 can be controlled via an SPI interface. In any typical system, the CC2500 will be used together with a microcontroller and a few additional passive components.

### D. LCD INTERFACING

Here we have interfaced a character based 16x2 LCD for displaying information regarding different parameters like Temperature, Humidity etc.



Fig 7 LCD with Sensor Information

## IV. SOFTWARE DESCRIPTION

As this system is based on embedded systems, the firmware development is done using Embedded C language. We have use various software tools in deploying the developed system. The most important among these tools are Keil IDE, Flash Magic and HyperTerminal

### A. About Keil IDE

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

### B. About HyperTerminal

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

## V. RESULTS

The Overall system’s results are given in this section. The LPC2148 Evolution Board which is shown in below figure is heart of all functionalities in miner module i.e. Monitoring, Processing collected data and taking necessary action based on the limits given for individual sensors.



Fig 8 LPC2148 Evolution Board

In the following Figure all sensors and modules are connected to form the first prototype of our proposed system.

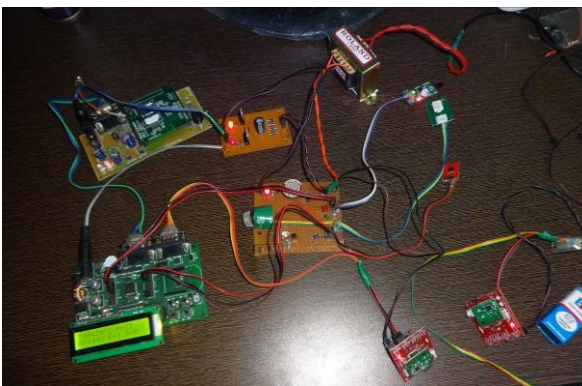


Fig 9 Overall Miners Module Hardware Setup

On detection of Abnormal activity at miner module the core system alerts and sends SMS to either Fire station or Ambulance based on the Interrupt source. SMS is sent to Fire station when Fire accident occurred in the underground area. Similarly SMS is sent to Ambulance if Person is fallen down. The Below figures show message received in both cases.

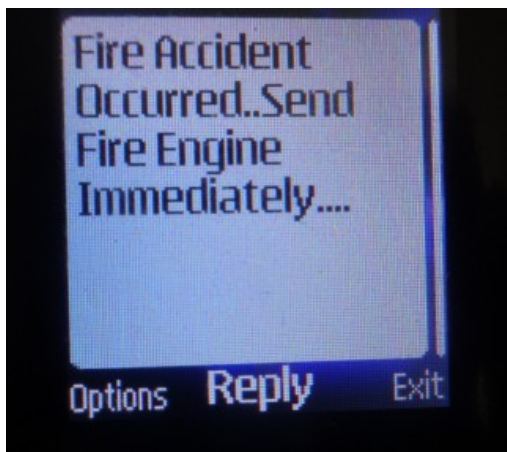


Fig 10 Fire Station Mobile Section



Fig 11 Ambulance Mobile Section

Here it goes the Monitor section i.e. Remote Base Station. In this 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.

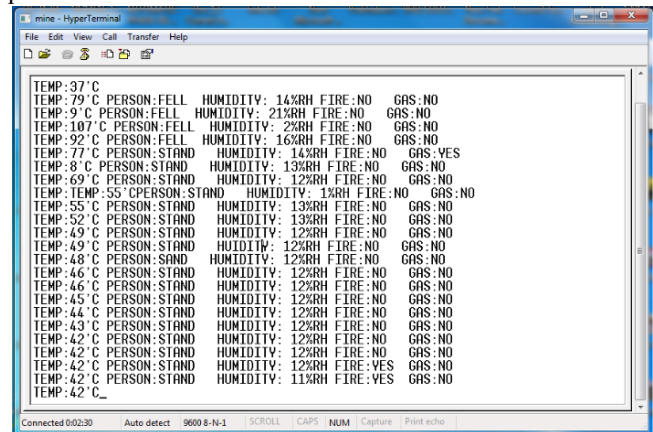


Fig 12 Remote Monitoring section Screen

## VI. CONCLUSIONS

The present Mine security system can be effectively replaced by this rescue safety system proposed in this paper. Our system covered the most Important and Primary necessity aspect of any mine workers safety. The monitoring of depth and dangerous mines is made easy with this paper. As we are using Low power RF transmission and lamp control circuit lot of power utilization is reduced, which is most important for any system that run on Battery. More security is provided by GSM, used to send message to fire and ambulance. All these sensors can be easily placed on Miner's Helmet that helps in continuous monitoring.

## REFERENCES

- [1] E. K. Stanek, "Mine Electrotechnology Research: The Past 17 Years", IEEE transactions on industry applications, vol. 24(5), pp 818-19, 1988.
- [2] S. Wei, L. Li-li, "Multi-parameter Monitoring System for Coal Mine based on Wireless Sensor Network Technology", Proc. International IEEE Conference on Industrial Mechatronics and Automation, pp 225-27, 2009.

- [3] Y.P. Zhang, G. X. Zheng, J. H. Sheng, "Radio Propagation at 900 MHz in Underground Coal Mines", IEEE transactions on antennas and propagation, vol.49(5), pp. 752-62, 2001.
- [4] S. Jin-ling, G. Heng-wei, S. Yu-jun, "Research on Transceiver System of WSN Based on V-MIMO Underground Coal Mines", Proc. International Conference on Communications and Mobile Computing, pp 374-378, 2010.
- [5] N. Chaamwe, W. Liu, H. Jiang, "Seismic Monitoring in Underground Mines: A case of Mufulira Mine in Zambia Using wireless Sensor Networks for Seismic Monitoring", Proc. IEEE international Conference on Electronics and Information Engineering, vol. 1(V1), pp 310-14, 2010.
- [6] X. Ma, Y. Miao, Z. Zhao, H. Zhang, J. Zhang, "A novel approach to Coal and Gas Outburst Prediction Based on Multi-sensor Information Fusion", Proc. IEEE international conference on automation and logistics, pp 1613-18, China 2008.
- [7] C. Qiang, S. J. Ping, Z. Zhe, Z. Fan, "ZigBee Based Intelligent Helmet for Coal Miners", Proc. IEEE World Congress on Computer Science and Information Engineering, pp. 433-35, 2009.
- [8] D. Koenig, M. S. Chiamonte, A. Balbinot, "Wireless Network for Measurement of Whole-Body Vibration", J. Sensors, vol. 8, pp. 3067-81, 2008. [11] <http://www.mxcom.com>, accessed June, 2011.
- [9] <http://www.citeseerx.ist.psu.edu/viewdoc/download>, accessed August 2010.
- [10] <http://www.MaxStream.net>, accessed June, 2011.

#### BIOGRAPHIES



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