Underground Mine Workers Safety Monitoring System

Nishyanth Varun Reddy Somagattu
Guidance: Prof Longwei Wang
Dept-Computer Science, University of South Dakota,SD,USA

Anantha Reddy Pingili
Guidance: Prof Longwei Wang
Dept-Computer Science, University of South Dakota,SD,USA

Srinivasa Aditya Preetham Nidadavolu
Guidance: Prof Longwei Wang
Dept-Computer Science, University of South Dakota,SD,USA

Siva Shanth Reddy Nalla
Guidance: Prof Longwei Wang
Dept-Computer Science, University of South Dakota,SD,USA

Abstract- ***Mining activities release harmful and toxic gases in turn exposing the associated workers into the danger of survival. This puts a lot of pressure on the mining industry. To increase the productivity and reduce the cost of mining along with consideration of the safety of workers, an innovative approach is required. Miner's health is in danger mainly because of the toxic gases which are very often released in underground mines. These gases cannot be detected easily by human senses. In view of the problems of explosive, corrosion and accidents in underground coal mine production, this project designs a monitoring system based on Gas sensors and DHT sensor, Fire sensor and wireless sensor network, which can monitor the gas concentration, temperature and humidity parameters, and alarm when the parameters exceed the fixed value and simultaneously displayed on LCD. Experiments show that the system is stable in performance, accurate in measurement, and helpful to improve mine safety and reduce accidents.***

Keywords: Mining Industry , Sensors , LCD

INTRODUCTION

Mining

An underground mining operation proves to be a risky venture as far as the safety and health of workers are concerned. These risks are due to different techniques used for extracting different minerals. The deeper the mine, the greater is the risk.

These safety issues are of grave concern especially in case of coal industries.

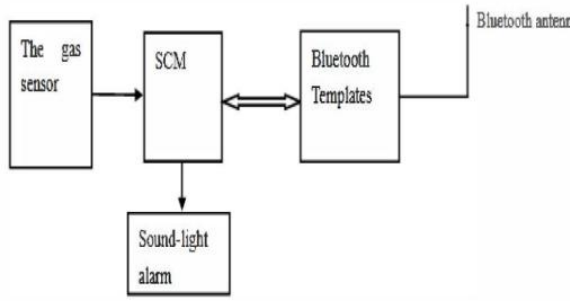
Thus, safety of workers should always be of major consideration in any form of mining, whether it is coal or any other minerals. Underground coal mining involves a higher risk than open pit mining due to the problems of ventilation and potential for collapse. However, the utilization of heavy machinery and the methods performed during excavations result into safety risks in all types of mining. Modern mines often implement several safety procedures, education and training for workers, health and safety standards, which lead to substantial improvements in safety, level both in opencast and underground mining

To ensure the safety of the workers, we will build a monitoring system which consists of both software and hardware.

Existing System

In existing system the coal mine monitoring using the Bluetooth wireless transmission system. As a standard of unified global short-range wireless communication, Bluetooth technology is to establish a common low-power, low-cost wireless air interface and controlling software opening system. This paper describes the development background, technical features and the structure of the protocol stack of Bluetooth technology, and proposed the solutions of the Bluetooth host controller interface (HCI) wireless communication for the complexity of its development. At the same time, the system uses CAN bus technology

maturely, has realized the combination of wired and wireless data transmission system



DISADVANTAGES: The Bluetooth is short distance wireless technology and use of cabling is difficult.

Proposed System

In this project we are implementing different gas sensors and temperature humidity sensors in coal mines. By this if any harmful gases are detected. These are communicated by using Zigbee protocol. The application for the overall system is developed using Arduino. Hardware modules used on transmitter side Two gas sensors to measure CO2, CO and DHT sensor to measure the Temperature and Humidity, Zigbee wireless module and LCD module for monitoring. Hardware modules used on receiver side is Zigbee e wireless module to receive the data and LCD module for monitoring and Buzzer for alerting.

Literature survey

I-Implementation of smart safety helmets for coal mine workers - Pranjal Hazarika

This paper presents implementation of safety helmet for coal mine workers. This helmet is equipped with methane and carbon monoxide gas sensor. This sensor sense the gas and the data is transmitted to the control room wirelessly, through a wireless module called X-Bee connected with the helmet. When the methane or carbon-monoxide gas concentration is beyond the critical level, controller in the control room triggers an alarm and keeps the plant and the workers safe by preventing an upcoming accident.

II-The study on coal mine using the bluetooth wireless transmission - Yongping Wu, Guo Feng, Zhang Meng

During the process of mine development, it is very important to measure the gas concentration in mines. For the present of situation of gas concentration monitoring system, this paper proposes a Bluetooth-based coal mine gas concentration monitoring system design, describes the ideas and specific methods software and hardware design. As a standard of unified global short-range wireless communication, Bluetooth technology is to establish a common low-power, low-cost wireless air interface and controlling software opening system. This paper describes the development background, technical features and the structure of the protocol stack of Bluetooth technology

III-Feasibility of Intelligent Monitoring of Construction Workers for Carbon Monoxide Poisoning - Jason B . Forsyth

This paper presents a feasibility study of a wearable computing system to protect construction workers from carbon monoxide poisoning. A pulse oximetry sensor has been integrated into a typical construction helmet to allow continuous and noninvasive monitoring of workers' blood gas saturation levels. To show the feasibility of monitoring for carbon monoxide poisoning without subjecting users to dangerous conditions, a prototype for monitoring blood 2 saturation was constructed and tested during a user study involving typical construction tasks to determine its reliability while undergoing motion. As monitoring for O2 and CO simply differ in the number of wavelengths of light employed, if monitoring O2 is feasible, then monitoring for CO will be feasible as well.

IV-Productivity, safety, and regulation in underground coal mining: evidence from disasters and fatalities - Gautam Gowrishankankaran and Charles He

Underground coal mining is a dangerous industry where the regulatory state may impose tradeoffs between productivity and safety. We recover the marginal tradeoffs using disasters near a mine as shocks that increase future accident costs. We find that in the second year after a disaster, productivity decreases 11% and accident rates decrease 18-80% for mines in the same state, with some evidence that the number of managers increases. Using published "value of statistical life" and injury cost estimates, we find that the productivity loss following a disaster in the same state costs 2.51 times the value of the safety increases.

V-An Intelligent Ultrasonic Helmet system for Miner - Chandrasekhar S

This project primarily focuses on navigation through underground ways in the Mining Industries and aroundlarge objects without sight, through the use of an ultrasonicrangefinder that haptically interfaces with the user via tinyvibrating motors mounted on the user's head. These features areachieved with the help of a microcontroller. The MCU (MicroController Unit) is interfaced via Darlington array to loadvibrators, which vibrate in varying intensities individuallyindicating direction based on the ultrasonic sensor output. Theultrasonic sensor is directly interfaced to MCU, which rotates 0°and 360o with aid of stepper motor. In navigation when obstacleis sensed by sensor, the vibrators indicate obstacle to userindicating the obstacle distance through ZigBee transmitter. Thevibrators intensify as obstacle nears. The entire process can beobserved in nearest computer unit with aid ZigBee receiving unit

Challenges and Constraints:

- The main concern is to ensure the safety and well-being of miners who are exposed to harmful gasses while working in underground mines. The inability to detect these gasses readily puts miners at risk of major health consequences, even death.
- Apart from poisonous gasses, temperature and humidity levels have an impact on working conditions in mines. Extreme temperatures and humidity can increase health risks and limit productivity.
- Traditional gas detection methods may be insufficient to precisely monitor gas concentrations in real time or to detect chemicals present at low quantities but still dangerous.
- The implementation of safety measures and monitoring systems should not place an undue financial burden on mining operations. Solutions must be cost-effective to assure practicality and acceptance by mining corporations.
- Integrating different sensors, such as gas, temperature, humidity, and fire sensors, into a unified monitoring system poses technological problems in terms of sensor compatibility, data gathering, and communication protocols.
- The monitoring system must offer consistent and accurate data in order to efficiently identify potential safety issues and issue timely alerts. Any system faults or false alerts can erode confidence in the system and jeopardize safety.

Working

In software it is required to install the libraries for DHT Sensor in Arduino IDE to start to work with application code. Hardware modules used on transmitter side Two gas sensors to measure CO2, CO and DHT sensor to measure the Temperature and Humidity, a fire sensor to detect fire accidents Zigbee wireless module and LCD module for monitoring. Once the power is ON, LCD shows the title of the project. Whenever the temperature is >34 degree celcious then the Transmitter sends

data to Receiver using Zigbee module, then receiver LCD shows the “Over

temperature detected” and Buzzer should ring. Similarly Gas sensors data also crossed the threshold values then receiver LCD shows the Over CO2 or CO detected respectively and simultaneously send the same message to registered mobile number using GSM.

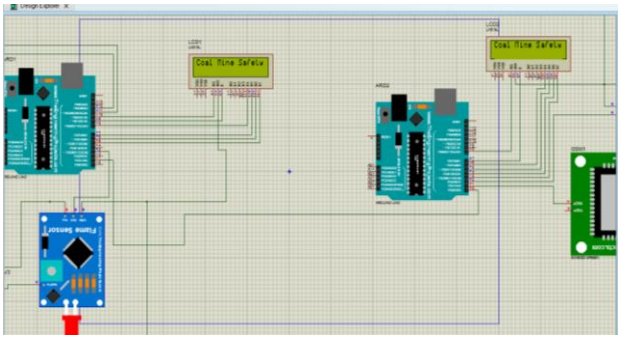


Image of the Circuit

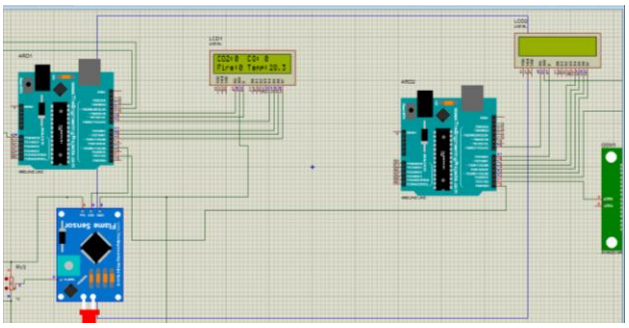
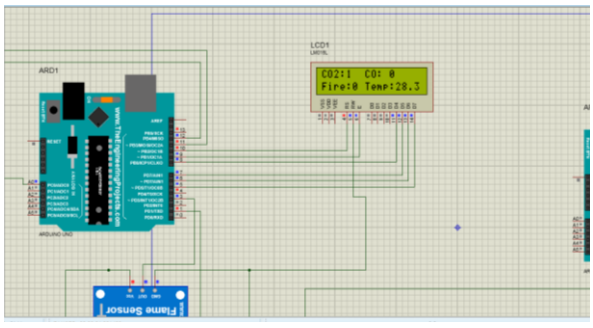
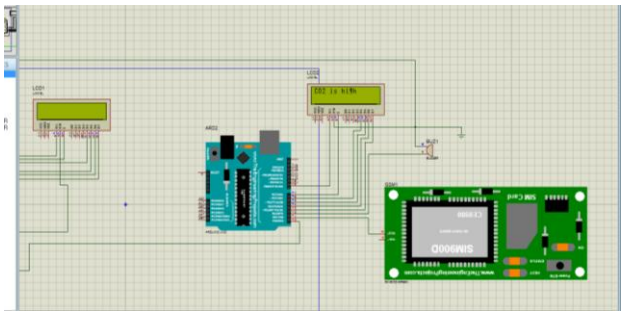


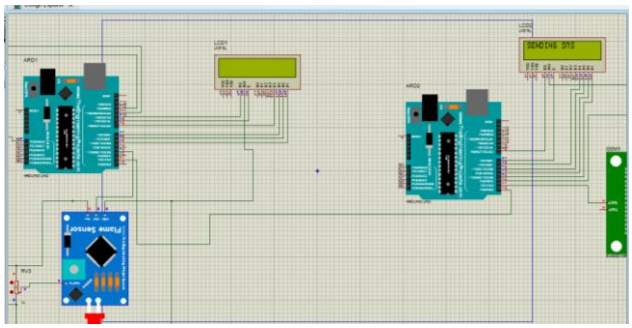
Image of values displaying



Changing values using potentiometer



Alert at receiver



Entered in sms sending process

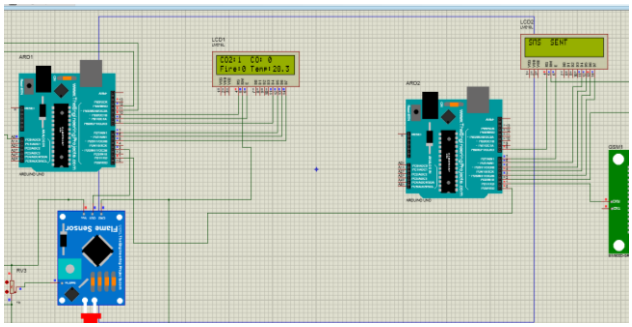
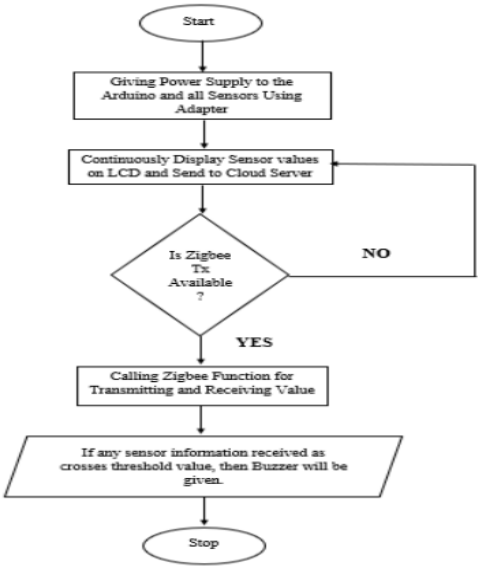


image of sms sent

Working Flowchart:

This chapter deals with the hardware implemented for the real time monitoring system. The details of each components used were described briefly based on its functionality and specifications. The flow chart and block diagram show the organization and working of the system. The above-mentioned hardware and design plan has been described in the subsequent chapter which

explains the implementation part



Conclusion

A real time monitoring system is developed to provide clearer and more point to point perspective of the underground mine. This system is displaying the parameters on the monitoring unit. It will be helpful to all miners present inside the mine to save their life before any casualty occurs. Alarm triggers when sensor values crosses the threshold level. This system also stores all the data in the computer for future inspection

FUTURE SCOPE

- Using additional sensors all possible safety issues could be monitored such as gases, dust, vibrations, fire etc.
- The other important data can be communicated through this system making it feasible where wired communication is a hindrance.

REFERENCES

[1] Gautam Gowrishankankaran and Charles He, “Productivity, safety and regulation in underground coal mining: Evidence from diasters and fatalities,” Arizon education, March 2017.

[2] Valdo Henriques and Reza Malekian, “Mine safety system using wireless sensor network”, IEEE, pp. 1-12, 2016.

[3] P. Hazarika, "Implementation of smart safety helmet for coal mine workers," 2016 IEEE 1st International Conference on Power Electronics, Intelligent Control and Energy Systems (ICPEICES), Delhi, India, 2016, pp. 1-3, doi: 10.1109/ICPEICES.2016.7853311, 4-6 July 2016.

[4]. Y. Zhu and G. You, "Monitoring System for Coal Mine Safety Based on Wireless Sensor Network," 2019 Cross Strait Quad-Regional Radio Science and Wireless Technology Conference (CSQRWC), Taiyuan, China, 2019, pp. 1-2, doi: 10.1109/CSQRWC.2019.8799111 pp. 18-21 July 2019.

[5] Coal Mine Safety Monitoring and Alerting System , 2017, S. R. Deokar, J. S. Wakode, International Research Journal of Engineering and Technology (IRJET), Volume: 04 Issue: 03 | Mar -2017.

[6] Tanmoy Maity and Partha Sarathi, “A wireless surveillance and safety system for mine workers based on Zigbee”, 1st Int’l Conf. on Recent Advances in Information Technology RAIT-2012
[7] Yogendra S Dohare and Tanmoy Maity, “surveillance and safety system for underground coal mines based on Low Power WSN”, IEEE, pp.116-119, 2014.

[8] Jingjiang Song ,Yingli Zhu and Fuzhou DongK, “automatic monitoring system for coal mine safety based on wireless sensor network”, IEEE Radio Science and Wireless Technology Conference, pp.933-936, 2011.

[9] Yi-ming Tian, You-rui Huang, Yi-qing Huang, "Intelligent Information Processing of WSN Based on Vague Sets Theory and Applied in Control of Coal Mine Monitoring,"cccm, vol. 2, pp.649-652, 2008 ISECS International Colloquium on Computing, Communication, Control, and Management, 2008.

[10] Xiaolong Feng, Jiansheng Qian, Zhenzhen Sun, Xing Wang, "Wireless Mobile Monitoring System for Tram Rail Transport in Underground Coal Mine Based on WMN," cason, pp.452-455, 2010 International Conference on Computational Aspects of Social Networks, 2010.

[11] Yongping Wu and Guo Feng, “The study on coal mine monitoring using the Bluetooth wireless transmission system” , 2014 IEEE Workshop on Electronics, Computer and Applications, pp. 1016-1018, 2014.

[12] Prof A.H.Ansari , Pooja kadu , Karishma Shaik , Nikam Rishikesh“IOT Based Coal Mine Safety Monitoring and Alerting System” June 2021

[13] Xiaolong Feng, Jiansheng Qian, Zhenzhen Sun, Xing Wang, "Wireless Mobile Monitoring System for Tram Rail Transport in Underground Coal Mine Based on WMN," cason, pp.452-455, 2010 International Conference on Computational Aspects of Social Networks, 2010

[14] Yi-ming Tian, You-rui Huang, Yi-qing Huang, "Intelligent Information Processing of WSN Based on Vague Sets Theory and Applied in Control of Coal Mine Monitoring,"cccm, vol. 2, pp.649-652, 2008 ISECS International Colloquium on Computing, Communication, Control, and Management, 2008

[15] Huping Xu, Feng Li, Yancheng Ma, A ZigBee-based miner Localization System’, IEEE, 2012. 8 Shuo pang, Ricardo Trujillo, Indoor Localization Using Ultrasonic Time Difference of Arrival’, IEEE, 2013

[16] Yuping Zhang, Yinghui Zhang, Chen Li2, Research of Short Distance Wireless Communication Technology in the Mine Underground’,IEEE, 2014.

[17] Nisha Dube1, Prof. K.S.Ingle 2 PG Student, Dept. of ECE “Intelligent Mining: A Monitoring and Security System for Coal Mine Workers”,International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (An ISO 3297: 2007 Certified Organization) Vol. 5, Issue 1, January 2016