E-NEJAT: EARLY WARNING SYSTEM FOR MINER'S SAFETY

[1]NAJIBA HUSSAINI, [2]HISATO SHIMA, [3]KABERA MARIE GORETTI, [4]NASRATULLAH GHAFOORI

[1,2,3,4]Kobe Institute of Computing
E-mail: [1]najibah20@gmail.com, [2]shima@kic.ac.jp, [3]kaberamarie@gmail.com, [4]nasrat.sellab@gmail.com

Abstract— Unavailability of safety system is a challenge in mining industry of Afghanistan. The safety level is not satisfactory in mines. In coalmine the number of death and injuries are increasingevery year due to gas explosion. It is important to control the accidents. This paper designs an early warning system for the miner's safety. The system is to monitor the critical parameter in coalmine by using wireless sensor network to control the level of Methane and Carbon monoxide gases. The system will improve the safety of miners and reduces the number of accidents and causality of miners. The system will provide the communication pathway between miners and up ground monitoring staffs. Meanwhile, the miners could receive warning in case of danger because of gas level inside mines.

Index Terms— Wireless Sensor Network, Safety of Miners, Methane and Carbon Monoxide Gas Sensors.

I. INTRODUCTION

Coalmine is a major natural resource and an important source of income for economic growth of Afghanistan. The safety levels in coalmines are considered poor. Mining safety is the main aspect and need to be focused to prevent unwanted incidents. It is necessary to prevent the occurrence of any incident inside of coal mine.

To prevent incidents in coalmine, Afghanistan mining industries use some basic equipment like hat, glass, gloves and gas detector devices. These kinds of devices had poor result. The result is not accurate for the miners when the devices are analyzing the level of gases inside the tunnels. The devices have expiration date and need to be reprogramed on time. As Afghanistan is facing with lack of specialist persons in those specific fields, it's needed to program the devices back in their factories, however the expense and cost will be more than their efficiency. The accidents are happening frequently and loss lots of materials and humans life.

To avoid the incidents it is necessary to have safe communication among miners and up ground staffs during their activities. The safety system should monitor all parameters inside coalmine, analyze the dangerous parameters inside the tunnels and pass alert sound to the miners on time to prevent the damage.
To increase the safety in mining industries this paper recommend an early warning system that can solve the key issues of the miners and increase safety level in coalmines. These devices are easy to be carried by each miners, the device will have two gas sensor, Methane and Carbon monoxide gases sensors, Arduino Uno, Wi-Fi shield, buzzer and three different color of LED light to show different moment of gases level in tunnel.

II. LITERATURE REVIEW

The integration of different type of technology brought many changes in human lives in both developed and developing countries and the usage of technology is increasing day by day. Mining industries have tried to use these technologies and increase the safety system of mining. Technologies like sensors technology, GSM technologies; RF and ZEGBEE were applied by researchers in different ways. The gas detectors, wearable jacket were another types of technologies, which were used by miners to increase their safety during their work. Researchers developed and proposed different type of system instead of using wired system to reduce the incident inside coalmines [3]. In this paper our proposed system is focusing on designing a monitoring center with wireless sensor network in Afghanistan coalmines. There are some proposed systems with other different concepts.

A. Combination of wired and wireless system

In this paper they used the combination of both wired and wireless monitoring systems [2]. Some part of the tunnel is hidden and the wired monitoring system is not sufficient to guarantee the monitoring requirement of whole tunnel. The wired system is effective in some part of the tunnel but its inconvenient to dispose wire monitoring system in all parts of the coal mine. So this paper claim that using both wired and wireless monitoring system is usable and efficient.

B. ZIGBEE wireless sensor networks

In this paper, the ZIGBEE technology is proposed to use for communication between underground section and ground sections. The two main ZIGBEEs in both ground section and underground sections are communicating. The sensed data is transferred to microcontroller and will be displayed in some LCD screens and send it by ZIGBEE transmitter. The

ground ZIGBEE receiver will get information and then will pass it to the controller and then to GSM modem and will display it on LCD in ground sections. GSM is responsible to send message to mobile. There is connection between controller and PC; the collected information is passed to PC for monitoring and will be kept for the future use [1].

C. The Issues with Current and Proposed Systems

With the consideration of Afghanistan ICT infrastructure, mobile communication facilities are not available in the remote areas where mainly the mines are located. So it's difficult to use mobile and GSM systems.

The mining infrastructure is not standard, however the system called gases detector is used and it is fixed with a limited time to work. The mentioned devices also need reprogramming after specific period of time. The efficiency of the existence system is low and it does not meet the requirement of Afghanistan coalmines condition.

When the new tunnel is built, miners have to move from the existing tunnel to the new tunnel. Installing the device and system in new tunnel is one of the other issues to be considered more.

Where and which tunnel is suppose to be effected with accident. In the studiedpapers the systems are focused just on the sending alert for miners, howeverthose systemsdid not mention who and where the alerts will be received. In this paper our proposed system has focusedon the location of both tunnels and miners where they would receive the alert before the incident occurs. The proposed system devices are transferable by miners in all location and tunnels of coalmines.

III. PROBLEM STATEMENTS

Afghanistan mining industries facilitates are low. Coalmines are among those industries, which face many issues including explosions. Methane gas explosions are the main and biggest issues in both destroying the mine tunnels and increase the causalities of miners every year.

The unavailability of safety systems including modern warning system, poor infrastructure, lack of measurement system to monitor the gases level and pass a warning message to the miners when it is needed. Miners are using a basic and common system in coal mine industries in Afghanistan. Based on non-standard ventilation system in Afghanistan coalmine, unavailability of fresh air to balance all components like dust, gases in tunnel. With the existence of technology issues, human resource issues are another factor in mining causalities. Many companies hire under age worker with no experience that naturally increase the threat inside coalmines as shown in Fig.1

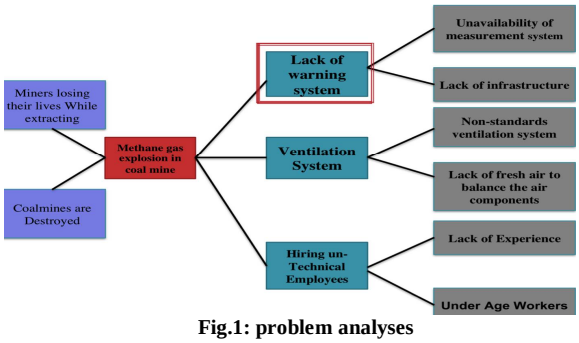


Fig.1: problem analyses

IV. FIELD RESEARCH

A filed research is done to identify the existence situation of miners and mine In Afghanistan's coalmines. Questionnaires were used to identify how and which types of safety system have been used so far. The findings of the research shows that there are many challenges in coalmine, however mainly collapse, explosion and high level of gases are measurable shown in Fig.2.

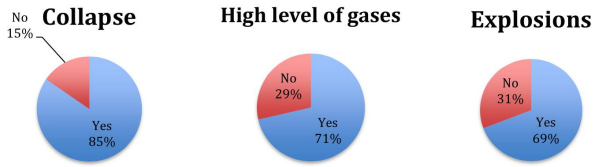


Fig.2: Death reason of the miners

In coalmine industries the existence of different type of gases like Hydrogen, Nitrogen, Methane, carbon monoxide and etc. are measurable. Fig.3 shows in Afghanistan coalmines the miners are mostly the victims of Methane gas explosion and as well as Carbon monoxide.The coalmine disaster has left death of dozens miners in every explosion and collapse.

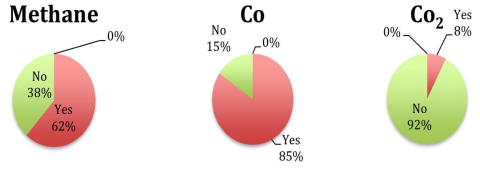


Fig.3: dangerous and harmful gases

Afghanistan coalmine industries already used a system called gases detectors that is already described in other parts.

V. PROPOSED SYSTEM

The proposed system, which is found for the listed problems in coalmine, is early warning system; the proposed system is divided into two main parts underground and ground section.

Fig3. Shows how the underground devices are connected to monitoring center in ground section. Both monitoring staff and miners are aware of every changes and worse case inside of the tunnels.

The system consisted of monitoring center to analyze and monitor the collected data from underground. The monitoring center is also in communication with provincial branch and ministry of mines and petroleum to pass and get the information

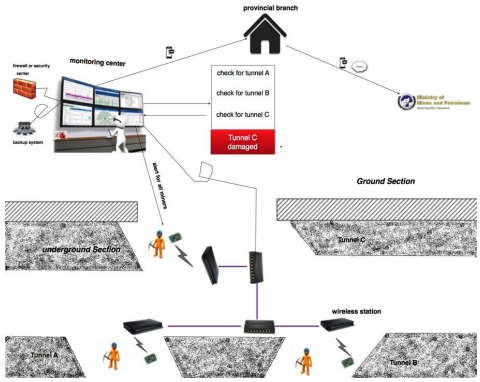


Fig.3: general diagram of e-Nejat system

A. System Functions

Fig4. Shows the block diagram of entire system in underground section the miners would carry the devices and the devices will measure the underground parameters like Methane and Carbon Monoxide gases. An Arduino micro controller will receive the data and will pass it through wireless access point to the monitoring center for monitoring and analyzing. Whenever the collected data is analyzed and monitored the result will be shown trough different LED light in the device. The analyzed data is divided in three different levels like low, medium and high level. Whenever the harmful gases to the miners are in low level the LED light yellow will be switched on. The other lights would be off, for medium level the green LED will be on and for high level LED red light will be on as shown in Figure 4. However in worse case the device will automatically produce the alert sound to inform the miners from any expected incident. Using LED light is easy and understandable for all miners. Miners are mostly illiterate. Instead of reading the information on LCD display, memorizing the three different LED lights, which shows three different information of gas is easy and understandable.

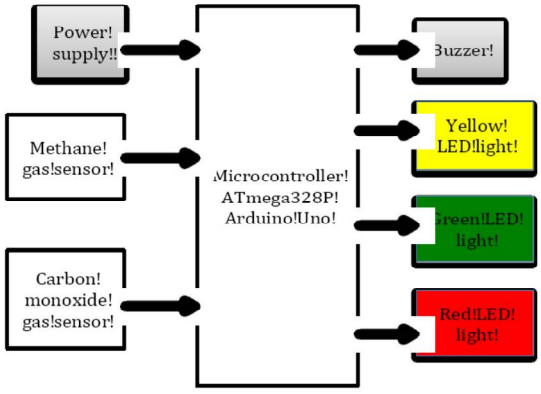


Fig.4: block diagram of underground device

B. How monitoring center works

Monitoring center monitor and analyzes the collected data from underground devices. The data will be passed using access point in underground section to the monitoring system. The monitoring center is able to recognize the tagged tunnel while the levels of gases are increased or the incident is about to happen Fig.3. An automatic alert sound will be passed to miners and it inform them from upcoming incident and ask them to get out of mine from the target tunnel. In Fig.3 monitoring center have communication with provincial branch and provincial branch with ministry of mines and petroleum (MOMP) to share the information of miners and mine by using mobile and Internet. Using mobile and Internet is acceptable only for the places, whichare covered by telecommunication coverage.

VI. EXPECTED RESULT

By implementing the proposed system the Methane and Carbon Monoxide gases level will be continuously monitored and analyzed. In monitoring center the collected data will be stored on the PCs. The casualties of miners will be decreased during mines extraction. If the level of Methane and Carbon Monoxide gases increase an alarm will be sent to miners the fig.3 showing the practical design of both ground and underground sections respectively.

CONCLUSION

The described system is proposed and the system is called e-Nejat. The e-Nejat system is monitoring and analyzing the values of the gases parameters, whichexist in coal mine. The monitored and analyzed data can be used and helpful to detect the incidents before they happen. As the system will give information to the miners through passing signal. The signal will be generated based on analyzeddata. It would help to decrease the causalities and increase the effectiveness of rescue system in coalmines in Afghanistan.

REFERENCES

[1] [1]. S.Vandana,? V.B.Sundheep?, Development of Coalmine Safety System Using Wireless Sensor Network , Department of Electronics and Communications Engineering Sri Vasavi Engineering College, Tadepalligudem Andhra Pradesh, India, International Journal on Computer Science and Engineering (IJCSE), ISSN : 0975-3397 Vol. 3 No. 5 May 2011

[2] [2]. Wei Yang, Ying Huang, Wireless Sensor Network Based Coal Mine Wireless and Integrated Security Monitoring Information System, 1. State Key Laboratory of Fire Science, University of Science and Technology of China, Hefei 230027, China?2. Geo-detection Laboratory, Ministry of Education of China, China University of Geosciences, Beijing 100083, China 3. School of Electronics and Information Engineering, Beijing Jiaotong University, Beijing 100044, China, Proceedings of the Sixth International

Conference on Networking (ICN'07) 0-7695-2805-8/07 $20.00 © 2007 IEEE.

[3] [3]. RAJKUMAR BODDU, P.BALANAGU & N.SURESH BABU, Department of Electronics and Communication Engineering, Chirala Engineering College, Chirala, ZIGBEE Based Mine Safety Monitoring System With GSM, International Journal of Computer & Communication Technology ISSN (PRINT), Volume-3, Issue-5, 2012.

★★★