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WIRELESS UNDER GROUND SENSOR NETWORKS (WUSN) BASED COAL MINE SAFETY MONITORING

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ABSTRACT

Wireless underground sensor networks (WUSNs) can enable many important applications such as intelligent agriculture, pipeline fault diagnosis, mine disaster rescue, concealed border patrol, and crude oil exploration. The key challenge to realize WUSNs is the wireless communication in underground environments. The frequent coal mine safety accidents have caused serious casualties and huge economic losses. It is urgent for the global mining industry to increase operational efficiency and improve overall mining safety. This paper proposes a WUSN based coal mining safety monitoring. This system also provides an early warning, which will be helpful to all miners present inside the mine to save their life before any casualty occurs.

Keywords: Wireless, Ground sensor & safety monitoring

1. INTRODUCTION

1.1 INTRODUCTION OF COAL MINE

India is a large country with rich coals. However, the current safe production level of coal mine is still low, especially in recent years, disasters in coal mine occur frequently, which lead to great loss of possession and life. The safety problems of coal mine have gradually become to the focus that the nation and society concern on. The disasters happening in coal mine are due to the complexity of mine environment and the variety of work condition of coal mine, so it is very necessary to monitor mine working environment. Traditional coal mine monitoring systems tend to be wired network systems, which play an important role in coal mine safe production. With continuous enlarging of exploiting areas and extension of depth in coal mine, many lanew2ays become blind areas, where in there are lots of hidden dangers.

Moreover, it is inconvenient to lay cables which are expensive and consume time. In order to solve the problems, we will design a coal mine safety monitoring system based on wireless underground sensor network(WUSN), which can improve the level of monitoring production safety and reduce accident in the coal mines Wireless sensor networks is composed of a large number of micro-sensor nodes which have small volume and low cost. It possesses self-organized capability by wireless Communication. Underground mines are usually extensive labyrinths, of which the tunnels are

generally long and narrow with a few kilometers in length and a few meters in width. Thousands of mining personnel are needed to work under extreme conditions according to the construction requirements, and hundreds of miners die from mining accidents every year. It is now widely approved that the underground mining operations are of high risk. In view of this, a monitoring and control system needs to be deployed as one important infrastructure in order to ensure the mining safety and coordinate various tasks.

However, underground coal mines mainly consist of random passages and branch tunnels, and this disorganized structure makes it very difficult to deploy any networking skeleton. In such a case, the utilization of a wireless underground sensor network (WUSN) and other sensing devices may have special advantages for realizing the automation of underground monitoring and control due to the rapid and flexible deployment. In addition, the multi-hop transmitting method can well adapt to the tunnel structure and thus provide enough scalability for the construction of a mining system, and it is very suitable to the comprehensive monitoring and control in coal mines, which can effectively compensate the deficiencies of the exiting underground cable monitoring system. The progression of technology has allowed mine monitoring techniques to become more sophisticated, yet explosions in underground coal mines still occur. The safety issues of coal mines have gradually turned into a major concern for the society and nation. The occurrence of disasters in coal mines is mainly due to the harsh environment and variability of working conditions. So, it makes the implementation of mine monitoring systems essential for the safety purpose.

Wired network systems used to be a trend for traditional coal mines, which have really played a significant role in safely production in coal mines. With the continuous enlargement of exploiting areas and depth expansion, laneways have become blind zones, where numerous unseen dangers are hidden out. Moreover, it is not possible there to lay expensive cables, which is also time consuming. So, it is essential to have a wireless sensor network mine monitoring system, which can be disposed in such mines in order to have a safe production within.

1.2 EMBDDED SYSTEM

A system is an arrangement in which all its unit assemble work together according to a set of rules. It can also be defined as a way of working, organizing or doing one or many tasks according to a fixed plan. For example, a watch is a time displaying system. Its components follow a set of rules to show time. If one of its parts fails, the watch will stop working. So we can say, in a system, all its subcomponents depend on each other.

Embedded means something that is attached to another thing. An embedded system can be thought of as a computer hardware system having software embedded in it. An embedded system can be an independent system or it can be a part of a large system. An embedded system is a microcontroller or microprocessor based system which is designed to perform a specific task. For example, a fire alarm is an embedded system; it will sense only smoke.

An embedded system has three components −

a) It has hardware.
b) It has application software.
c) It has Real Time Operating system (RTOS) that supervises the application software and provide mechanism to let the processor run a process as per scheduling by following a plan to control the latencies. RTOS defines the way the system works. It sets the rules during the execution of application program. A small scale embedded system may not have RTOS.

So we can define an embedded system as a Microcontroller based, software driven, reliable, real-time control system.

2. LITERATURE SURVEY

2.1 Reza Malekian, Bo Liu, and JinpengXu "Groundwater Mixing Process Identification in Deep Mines Based on Hydro-geochemical Property Analysis" Appl. Sci. 2017, 7, 42; doi:10.3390/app7010042

Karst collapse columns, as a potential water passageway for mine water inrush, are always considered a critical problem for the development of deep mining techniques. This study aims to identify the mixing process of groundwater deriving two different limestone karst-fissure aquifer systems. Based on analysis of mining groundwater hydro-geochemical properties, hydraulic connection between the karst-fissure objective aquifer systems was revealed. In this paper, piper diagram was used to calculate the mixing ratios at different sampling points in the aquifer systems, and PHREEQC Interactive model was applied to modify the mixing ratios and model the water–rock interactions during the mixing processes. The analysis results show that the highest mixing ratio is 0.905 in the C12 borehole that is located nearest to the karst collapse column, and the mixing ratio decreases with the increase of the distance from the karst collapse column. It demonstrated that groundwater of the two aquifers mixed through the passage of #2 karst collapse column. As a result, the proposed Piper-PHREEQC based method can provide accurate identification of karst collapse columns' water conductivity, and can be applied to practical applications.

2.2 Roopashree K, Srujana2 B K, Suma P, Suma G, Chaithanya "IoT based mine safety system Using wireless sensor network" Vol-2 Issue-5 2017 IJARIIE-ISSN(O)-2395-4396

Activities developed under hazardous conditions, such has mining, require an active investment from the industry to avoid serious injuries and even loss of lives. Mine Detection Robot can be substituted or partial substituted for emergency workers to enter the mine shaft disaster site and detect hazardous gas do some environmental exploration and surveying task. Safety measures taken to address this problem is to implement current sensor technologies and IoT based wireless communication system which uses cloud computing for transmission and storage of parameters obtained from wireless module with zigbee interface. Wireless sensor technology used in recently developed mine safety monitoring system is highlighted and compared with traditional wired monitoring system.

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

Due to any reason miner's falls down and lose consciousness also proper treatment is not provided them at that time, so number of miners are died. To overcome this problem, the system, provide emergency alert to the supervisor if person fall down by any reason. Some workers are not aware for safety and they are not wear helmet. A Limit switch was then used to successfully determine whether a miner has removed his helmet or not. This system also provides an early warning, which will be helpful to all miners present inside the mine to save their life before any casualty occurs. The system uses Zigbee technology and GSM for transmission of data. There is alert switch at receiver and transmitter side for emergency purpose.

2.4 Abdul Salam Mehmet C. Vuran "Smart Underground Antenna Arrays: A SoilMoisture Adaptive Beamforming Approach" IEEE INFOCOM 2017 - IEEE Conference on Computer Communications

In this paper, a novel framework for underground beamforming using adaptive antenna arrays is presented to extend communication distances for practical applications. Based on the analysis of propagation in wireless underground channel, a theoretical model is developed which uses soil moisture information to improve wireless underground communications performance. Array element in soil is analyzed empirically and impacts of soil

type and soil moisture on return loss (RL) and resonant frequency are investigated. Accordingly, beam patterns are analyzed to communicate with underground and above ground devices. Depending on the incident angle, refraction from soil-air interface has adverse effects in the UG communications. It is shown that beam steering improves UG communications by providing a high-gain lateral wave. To this end, the angle, which enhances lateral wave, is shown to be a function of dielectric properties of the soil, soil moisture, and soil texture. Evaluations show that this critical angle varies from 0◦ to 16◦ and decreases with soil moisture. Accordingly, a soil moisture adaptive beamforming (SMABF) algorithm is developed for planar array structures and evaluated with different optimization approaches to improve UG communication performance.

2.5 Valdo Henriques, Reza Malekian "Mine Safety System Using Wireless Sensor Networks" MIPRO 2017, May 22- 26, 2017

In this paper, we designed wireless sensor networks consisting of temperature, air- flow, humidity, noise, dust, and gas sensors to improve the safety of mines considerably by eliminating the need for human testers inside the mines. Each of these characteristics can be solely or collectively responsible for incurring a risk to a mine worker. The wireless sensor network discussed in this research work considers star and mesh network topologies. We also take advantage of available wireless technologies, which will not only monitor the conditions inside the mine but also be used to provide a noise mapping feature which will output a noise protection scheme for the workers, and provide ventilation switching to regulate air in the mine. From the experimental results obtained, an accurate mine safety system is achieved by design of various sensors.

3.EXISTING SYSTEM

In existing system zigbee network has implemented for transferring the measured parameters. In this system the measures the parameters like temperature sensor and moisture sensor the measured sensor details are transferred based on zigbee network. The received details are displayed on LCD.In many realistic cases, traditional wireless signal propagation techniques using EM waves can only be applied for very small transmission distances due to a large path loss and vulnerability to changes of soil moisture.

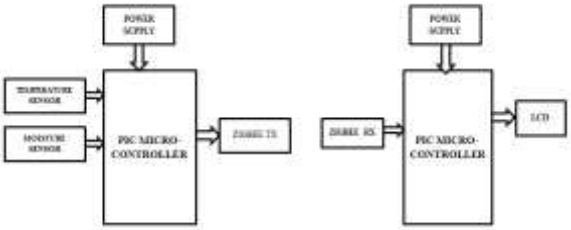


Fig 1: Existing block diagram

4. PROPOSED SYSTEM

A continuous monitoring is necessary which again requires some effective and accurate sensing system. Several techniques are adopted to sense the presence of these poisonous gas, among them use of semiconductor type gas sensor is very much effective. These sensors can be mounted in the coal mine area but some time these create some problems in mining too. Accidental damage of the sensor device often took place. Another technique is the use of robot. These robots are effective but cost of robot is very high. However, there is another way of getting effective and low cost solution of sensor implantation; The key to controlling coal mine accidents the prediction of outburst by implementing sensors and microcontrollers and to generate an alarm system before critical atmospheric level.

The key to controlling coal mine accidents the prediction of outburst by implementing sensors and microcontrollers and to generate an alarm system before critical atmospheric level. A continuous monitoring is necessary which again requires some effective and accurate

sensing system. Proposed system consists of temperature sensor, Pressure sensor and gas sensor for monitoring the parameter like temperature, Pressure condition and gas. The measured parameters are transferred WUSN.At receiver side, it receives the measured parameters display on LCD and Buzzer is used for the purpose of emergency indication.

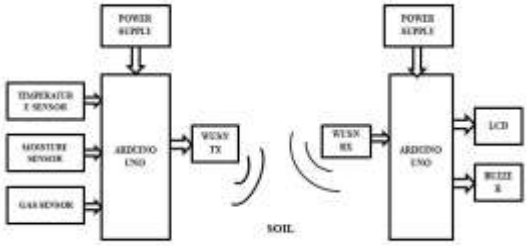


Fig 2: Proposed block diagram

In wusn transmitter side temperature sensor, moisture sensor and gas sensor are interfaced with the arduino uno micro controller. It picksup the measured sensor details. This measured sensor details transmitted using WUSN transmitter module based on magnetic induction approach. At receiver side the WUSN receiver module receives the information and it displayed on the LCD. If the measured sensor details goes high means buzzer is used to indicate.

4.1 CIRCUIT DIAGRAM

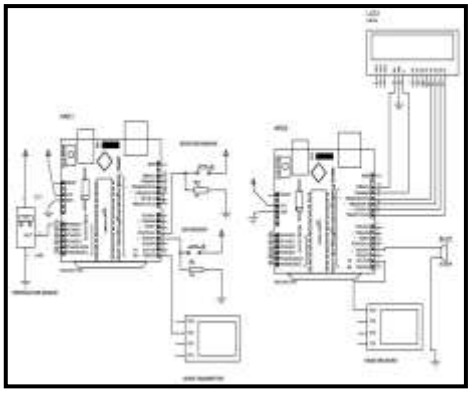
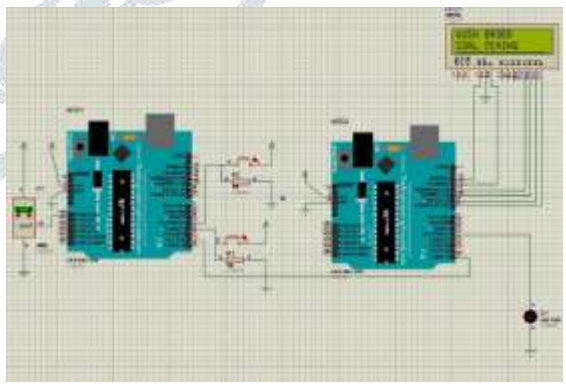


Fig 3: Circuit diagram

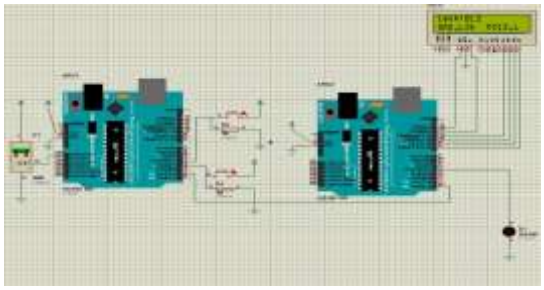
In this circuit, at WUSN transmitter side temperature sensor (LM35) Vout pin is connected to the Arduino uno A0, similarly moisture sensor Vout and gas sensor Vout connected to 3 and 4 of Arduino uno. The measured sensor details picks up by the Arduino uno controller then this measured signal transferred with the help of WUSN transmitter module. At the receiver side, WUSN receiver module receives measured details. LCD display (RS, EN, D4, D5, D6, D7) connected to Arduino uno (13,12,11,10,9,8). Buzzer is connected to 3 pin of Arduino. When the Arduino controller receives abnormal condition then buzzer pin goes high for indication purpose.

5. SYSTEM IMPLEMENTATION

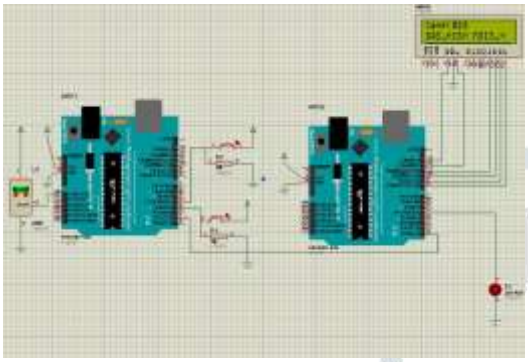


Simulation for this project implemented using Proteus software. Here temperature sensor connected to A0 of Arduino and moisture sensor and gas sensor are connected to 3 and 4 pin of Arduino. The sensor measured details are transferred serially to the receiver. In this simulation not able to show how transmitted in soil. So

instead of that we use serial transmission.



The measured condition about sensor are displayed on LCD display.



In this measured sensor details goes abnormal condition, so it indicated through LED.

6. CONCLUSION

Thus the coal mine safety monitoring system is implemented using wireless underground sensor network (WUSN). Based on magnetic induction approach the advances are related to various aspects of wireless communication and networking. Moisture, Gas and temperature level is always sensed and if changes in those values from threshold level then it monitored by the monitoring center. From this proposed we can able to give immediate treatment for workers in case of emergency situation.

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