Coal Mining Safety System Using WUSN and Lora

Mrs.C.Anitha[1],K.S.Prakadish[2], D.Surya[3]
[1]*Assistant Professor, Department of Electronics and Communication Engineering, Jeppiaar Engineering College, Chennai*
[2,3]*Student, Department of Electronics and Communication Engineering, Jeppiaar Engineering College, Chennai*

***Abstract*—Generally, people working in mining areas, face many risk factors like variation in temperature, pressure and leakage of hazardous and harmful gases like Fire damp a flammable gas found in coal mines. It is particularly found in areas where the coal is bituminous. The gas accumulates in pockets in the coal and adjacent strata, and when they are penetrated, the release can trigger explosions. In order to avoid such huge catastrophic disasters this multi monitoring system should be used, to safe guard the people working inside the mine and its environmental parameters should also need to be monitored. The hardware consists of electronic circuitry where a microcontroller is the principal processing unit with a graphical user interface. Using that a number of qualification tests are carried out. The existing system uses a single monitoring system were only a single parameter can be monitored at a time, but the proposed system can analyze different parameters like temperature, humidity and gas. Natural calamities like landslides occur due to soil erosion and heavy rainfall. MEMS Sensor and Vibration Sensor are used to monitor natural disaster.**

Keywords: Wireless, Ground sensor & safety monitoring

I. INTRODUCTION

Communication plays an important role in surveillance and safety for all industries. Generally, communication system is nothing but a transmitting and receiving of information from one end to other ends. It can be wire, wireless and both types. Structure and environment behaviour of underground mines is not easy to other industries. Therefore, Infrastructure of communication system is very complex and critical in underground mines. Environment monitoring and proper communication had been a crucial task to ensure safe working conditions and increased productivity in underground mines. The gassy underground atmosphere is potentially hazardous and may come across various factors due to which fire or explosion may take place.

CABLE BASED SYSTEM MONITORING

Current communication and monitoring systems in underground mines are cable based or discrete in nature. Cable based communication and monitoring has limitations like that

- Susceptible to failure during any type of cable breakage at the time of disaster.
- Possibility of sparks or flames because of any wrong design.
- Communication is only available from point to point, and cannot be Established from anywhere else. Thus, there is an inability to communicate with immovable men.
- With the working surface expanded, a blind area for monitoring appears, and then new installation and maintenance is needed.

RELIABLE SYSTEM

The development of cost-effective, reliable, maintenance-free, continuous monitoring and safety solution of underground mine workers is a burning need today. There is a need to develop a wireless network system to quickly detect the environment conditions and accurately provide location references to evacuate workers from the dangerous zone. The underground coal mines have some inherent challenges in wireless communication and some of them are the EMI, multipath fading, signal attenuation in turning or corner. Though, most of the researches in wireless monitoring systems have focused on the design of hardware and software in the sensor units and wireless communication capability of radio modules, these types of work face more challenging environments, where the system is expected to work against larger structure variations possibly caused by collapses or explosions. Wireless

monitoring system is also expected to be more flexible and easy to be deployed and removed, as the progress of coal mine digging requires frequent movement of the system. Although many protocols and algorithms have been proposed for traditional wireless ad-hoc networks, they are not well suited for the unique
features and application requirements of underground sensor networks. The real challenge is not only to find a good topology for wireless devices, but also a combination of techniques that can be efficient for location in coal mine galleries. The data for the location of workers and the mobile equipment are required to be taken from each section of mine corridor and will be routing to the host PC located preferably on the surface.

This report presents a comprehensive survey of number of technologies proposed so far for application of suitable wireless communication, environment monitoring in potentially passive underground mines. The objective of the survey is to provide awareness to the researchers about the recent developments and to invest knowledge towards more efficient and reliable research needs in this interdisciplinary area .In general, a module of sensors are used for monitoring underground
parameters as per the requirement and automating sequence of measuring data through digital wireless communication system. Wireless sensor network (WSN) technology is projected consisting of spatially distributed autonomous sensors to monitor physical or environmental conditions and to pass their data through the network. Automated systems have less

II. LITERATURE SURVEY

1. COAL MINE SAFETY MONITORING ANDALERTING SYSTEM.

Authors:S. R. Deokar et al

Miner's health and life is vulnerable to several critical issues, which includes not only the working environment, but also the after effect of it. To increase the productivity and reduce the cost of mining along with consideration of the safety of workers, an innovative approach is required. 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 and mobile unit. The air pollution from coal mines is mainly due to emissions of particulate matter and gases include sulphur dioxide (SO2), nitrogen dioxide (NO2), carbon monoxide (CO) etc. To monitor the concentration level of harmful gases, semiconductor gas sensors are used. Due to any reason, if a miner falls down also proper treatment is not provided to them at that time, so many number of miners would die. To overcome this problem the system provides an emergency alert to the supervisor if a person falls down by any reason. Some workers are not aware of safety and they do not 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.The Underground Mining Area WSN Localization Algorithm**.**

Authors:Shailendra Kumar Rawat et al

The main aim or goal of our research work is to localize the workers working in mining area exactly or with minimum localization error. Network formation in mining area is always very crucial. Laborers working in mining area need strong availability of network so that when they go down or deep in a mining area they can be rescued easily. It can only be possible when we know the exact location of the worker working in the particular area. For this, we need better localization scheme. Many recent developments have been made in the field of mining area. Random forest scheme, SVM based regressive localization, Wi-Fi based localization, and these are some schemes developed so far. RSSI and Trilateration works for both indoor and outdoor localization.

III. PROPOSED SYSTEM

Existing System

In existing system zigbee network has implemented for transferring the measured parameters. This system measures the parameters like temperature sensor and moisture sensor. The measured sensor details are transferred based on zigbee network. Thereceived details are displayed on LCD. In many realistic cases,

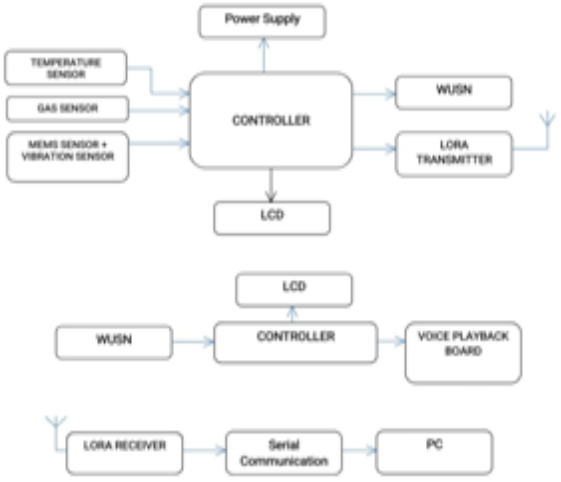
traditional wireless signal propagation techniques using EM waves can only be applied for very small transmission distances due to a large path loss and vulnerability to changes of soil moisture.

Drawback of Existing System
• Manual Operation.
• Traditionally, coal mine safety monitoring and automation systems were typically designed to meet the requirements of a single monitoring application.
• Person tracking is very difficult.
• Applied only for very small transmission distances.

Proposed System
The system consists of gas sensor, vibration sensor, temperature sensor, humidity sensor. The gas sensor is used to monitor whether there is leakage of gas or not. The temperature sensor is used to monitor whether the temperature is high or not. The humidity sensor is used to monitor the humidity at the particular region. They are being connected to wireless underground sensor network (WUSN) transmitter and receiver in which there is flow of data from one part to the other part. Finally the values that are being predicted can be viewed through personal computer for further rescue operations. The block diagram of the proposed system is given in figure 3.1.

Benefit of Proposed System
• Avoid accidents
• Person tracking is easy.
• MEMS sensor are used to monitor natural disaster.

Block Diagram



ARDUNO UNO
Arduino is an open-source project that created microcontroller-based kits for building digital devices and interactive objects that can sense and control physical devices. The project is based on microcontroller board designs, produced by several vendors, using various microcontrollers. These systems provide sets of digital and analog input/output (I/O) pins that can interface to various expansion boards (termed shields) and othercircuits. The boards feature serial communication interfaces, including Universal Serial Bus (USB) on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino project provides an integrated development environment (IDE) based on a programming language named Processing, which also supports the languages C and C++.

Temperature Sensor
The Temperature sensor has arrangement of exactness coordinated circuit temperature sensors have a yield voltage that is directly relative to the temperature in Celsius. The sensor is more precise than a thermistor at measuring temperature.

Gas Sensor
The Gas sensor has a high sensitivity as well as a quick response time. A sensor is used in gas detectors to determine the concentration of specific gases in the atmosphere. When a chemical reaction triggered by a particular gas occurs, the sensor acts as a reference point and scale, generating a measurable electric current.

Mems Sensor
Micro Electro Mechanical Systems a shortening for MEMS. It is a chip based technology where sensors are composed of a suspended mass between a pair of capacitive plates. When the sensor is tilted, a difference in electrical potential is created by this suspended mass. Thecreated difference is then measured as a change in capacitance. MEMS sensor are low- cost, high- precision inertial sensors.

LCD Display
A Liquid crystal display (LCD) is made up of two glass panels with liquid crystal content sandwiched between them. The materials used in LCDs combine

the properties of both liquids and crystals. Straightforward anodes are covered on the internal surface of the glass plates, characterizing the character images, or examples to be appeared. To keep a given direction, polymeric layers are available between terminals and the fluid precious stone atoms.

Single Voice Playback Modules

The single voice playback (), which is a single –chip, single message record/ playback device. Recordings are stored into on-chip non-volatile memory, providing zero-power message storage. This module having high quality voice recording and high quality replay. It can be used as a speaker module and can be controlled through microcontroller MCU.

Wireless Underground Sensor Network Module

Wireless Underground Sensor Networks (WUSNs), which consist of wireless sensors buried underground, are a natural extension of the wireless sensor network phenomenon and have been considered as a potential field that will enable a wide variety of novel applications that were not possible before. Wireless Underground Sensor Networks (WUSNs) constitute one of the most promising application areas of the recently developed wireless sensor networking techniques.

WUSN is a specialized kind of WSN that mainly focuses on the use of sensors at the subsurface region of the soil. For a long time, this region has been used to bury sensors, usually targeting irrigation and environment monitoring applications, although without wireless communication capability. WUSNs promise to fill this gap and to provide the infrastructure for novel applications.

LORA Module

LORA stands for Long Range Radio and is mainly targeted for M2M and IOT networks. This technology will enable public or multi-tenant networks to connect a number of applications running on the same network. LORA also features an adaptive data rate algorithm to help maximize the nodes battery life and network capacity.

Embedded C

High-level language programming has long been in use for embedded-systems development. However, assembly programming still prevails, particularly for digital-signal processor (DSP) based systems. DSPs are often programmed in assembly language by programmers who know the processor architecture inside out. The key motivation for this practice is performance, despite the disadvantages of assembly programming when compared to high-level language programming.

Embedded C is designed to bridge the performance mismatch between Standard C and the embedded hardware and application architecture. It extends the C language with the primitives that are needed 25 by signal-processing applications and that are commonly provided by DSP processors. The design of the support for fixed-point data types and named address spaces in Embedded C is based on DSP-C. DSP-C is an industry-designed extension of C with which experience was gained since 1998 by various DSP manufacturers in their compilers.

IV. RESULT AND DISCUSSION

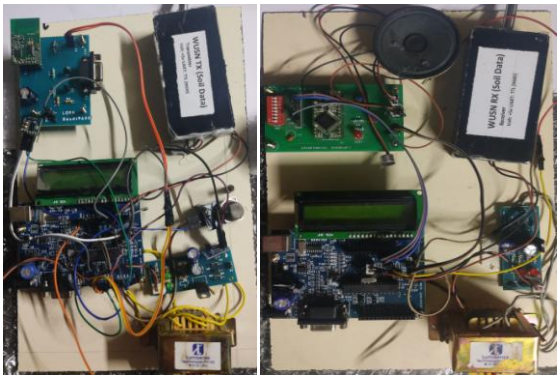
DISCUSSIONS

The sensors are integrated to the Arduino microcontroller and checked for its working. The mines are being tested and monitored on the basis of the mentioned parameters for the safety of workers. When the gas gets leaked it indicates that the gas is high through the voice playback mode.

The system indicates that the multi monitoring system for the safety of the workers. Similarly when the vibration is high in the particular region it indicates that the land slide can occur. After the temperature attained is high, it indicates that the temperature at the particular region is high through voice playback recorder. Now, finally using this multi monitoring system in which the safety of the mine workers is ensured in the coal mines and death of lives can be avoided.

RESULT ANALYSIS

The analysis made with the existing system against the proposed system shows that the proposed model gives better accuracy for efficient monitoring of various parameters.



V. CONCLUSION AND FUTURE SCOPE

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. MEMS, Gas and temperature level isalways sensed and if changes in those values from threshold level then it monitored by the monitoring center. From this proposed system, we can give immediate treatment for workers in case of emergency situation.

FUTURE SCOPE

With the developing developments future work of this experimentation may incorporate, greater improvement of the framework by utilizing other progressed sensors for checking the underground Dangers. Likewise, every one of the underground tasks can be completed from the beginning. New creating correspondence advancements can be utilized for fast information move in mix with keen sensors for detecting the mine conditions. Additionally, In future, we will develop this project with vibration sensor for measuring linear velocity and acceleration.

REFERENCE

[1] Abdulrahman A, Abdulmalik A S , Mansour A , et al , May (2016). Ultra Wideband Indoor Positioning Technologies : Analysis and Recent Advances[J]. Sensors, vol.16, no.5, pp.707-743.

[2] Al-Haija Q A, Alfarran I, Alabdullah A, et al, Sep (2019). Design and on-field testing of wireless sensor network-based air quality monitoring system[J]. JITCE (Journal of Information Technology and Computer Engineering), vol.3, no.2, pp.54-59.

[3] Akkas M A, Jun (2018). Using wireless underground sensornetworks for mine and miner safety[J]. WirelessNetworks, vol.24, no.1, pp.17-26.

[4] Cheng B, Cheng X, Chen J, Jan (2015). Lightweight monitoring and control system for coal mine safety using REST style[J]. Is a Transactions, vol.54, pp.229-239.

[5] Cheng B, Zhao S, Wang S, et al, Jan (2017). Lightweight Mashup Middleware for Coal Mine Safety Monitoring and Control Automation[J]. IEEE Transactions on Automation and Engineering, vol.14, no.2, pp.1-11.

[6] Guan Z, Miao Q, Si W, et al, Feb (2018). Research on Highway Intelligent Monitoring and Warning System Based on Wireless Sensor Network[J]. Applied Mechanics &Materials, vol.876, pp.173-176.

[7] IlhanAydın, Mehmet Karaköse& Erhan Akın, Aug (2015).Combined intelligent methods based on wireless sensor networks for condition monitoring and fault diagnosis[J]. Journal of Intelligent Manufacturing, vol.26, no.4,pp.717-729.

[8] Li Z D, Feng G H, Feng X, May (2015). Design of Gas Density Monitor System Based on Wireless Sensor Network[J]. Applied Mechanics & Materials, vol.716, no.717,pp.888-891.

[9] Ma C, Zhao D, Wang J, et al, Jun (2015). Intelligent monitoring system for aquaculture dissolved oxygen in pond based on wireless sensor network[J]. NongyeGongchengXuebao /Transactions of the Chinese Society of Agricultural Engineering, vol.31, no.7, pp.193-200.

[10] MuduliL, Mislira D P, Jana P K, Mar (2017). Application of wireless sensor network for environmental monitoring in underground coal mines: A systematic review[J]. Journal of Network and Computer Applications, vol.106, pp.48-67.

[11] Peng C, Yonghong X, Pei J, et al, May (2018). A wireless sensor data-based coal mine gas monitoring algorithm with least squares support vector machines optimized by swarm intelligence techniques[J]. International Journal

of Distributed Sensor Networks, vol.14, no.5, pp.155014-155044.

[12] Wang K, Xu D, July (2016). Connectivity Node Set Generation Algorithm of Mine WSN Based on the Maximum Distance[J]. International Journal of Distributed Sensor Networks, vol.12, no.7, pp.1654521-1654521.

[13] Wu Q, Jun (2015). Application of the Downhole Monitoring Based on Zigbee Wireless Communication Technology[J]. Open Automation & Control Systems Journal, vol.7, no.1,pp.1460-1464.

[14] Zhang H, Wang X, Jia C, Mar (2017). False Data Filtering Strategy in Wireless Sensor Network Based on Neighbor Node Monitoring[J]. International Journal of Online Engineering (iJOE), vol.13, no.3, pp.174-187.

[15] Zhao XQ, Cui YP, Gao CY, et al, Jan (2020). Energy-Efficient Coverage Enhancement Strategy for 3-D Wireless Sensor Networks Based on a Vampire Bat Optimizer[J]. IEEE Internet of Things Journal, vol.7, no.1, pp.325-338.