

# A Cost Benefit Analysis of Communication to Wireless Sensor Network in Underground Hard Rock Mines

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**Abstract:** A portion of the significant mishaps like discharging of toxic gases, fire mishances which prompts genuine impacts in the mining business bringing about loss of human life, or causing dangerous sicknesses. These issues can be lessened when the parameters were under legitimate observation. A financially savvy ZigBee-based remote mine regulating framework is introduced in this article. This plan utilized savvy caps as ultra-low-control hubs of remote sensor arrange. The program embraced ZigBee remote innovation to fabricate remote sensor systems. ZigBee based remote sensor systems are as of late examined because of their remote condition checking abilities. Such a system can without much of a stretch gather information recognized by the sensor and transmit them by radio recurrence. Joining these two points of interest we outline a brilliant new head protector, which empowers the cap as a versatile hub of ZigBee remote sensor systems, gathering parameters from underground auspicious and rapidly. Besides excavators can likewise trade data from control focus through remote correspondence. It is helpful for brought together administration to assemble ongoing observation on condition parameters, so potential wellbeing issues can be recognized rapidly by early-cautioning insight.

**Keywords:** *IoT, wireless sensor network, ZigBee, underground hard rock.*

## I. INTRODUCTION

Mining is the extraction of important minerals like strong, fluid and gas from the earth. The mining keep on supplying all the essential assets like oil and gas utilized by present day development. The materials recouped by mining incorporate aluminum, copper, lead, Zink, gold, silver, jewel, metal, coal and so forth. The extensive measure of coal required for power age. Internationally, coal assets have been assessed at more than 861 billion ton. While India represents 286 billion ton of coal assets (as on 31 March 2011), different nations with real lump of assets are USA, China. Coal is the key supporter of the Indian vitality situation 51% of the present aggregate business vitality needs is made by coal. There are for the most part two strategies for separating the coal from earth-surface mine and underground mine. INDIA is the third one of next china and USA for coal. The vast majority of surface mines are open pit or open cast mine. The surface mine are completely open and worked from the surface of the earth. The benefits of surface mines are high efficiency, low working expense and great security condition. A large

portion of the coal is separated utilizing surface strategy. In the event that coal is profound from surface underground technique is utilized. The underground mines are upheld or unsupported mines. In upheld technique utilized counterfeit columns for help of the opening. Bolstered mining strategies are frequently utilized as a part of mines with frail shake structure. The counterfeit backings are does not accessible for unsupported mining strategy. Unsupported strategies are utilized as a part of those regions where solid shake structure accessible. Underground coal mining includes a higher hazard than surface mining because of the issues of ventilation and potential for fall. The most extreme mischance happens in underground mines. In mining industry laborer security is imperative issue. Consistently, a huge number of diggers bite the dust in mishances and numerous more get harmed, particularly in the procedures of coal mining and hard shake mining. The primary reasons of mishances are gas or tidy blasts, gas inebriations, dishonorable utilization of explosives, electrical consume, fires, crumbling of mine structures, shake tumbles from rooftops and side dividers, flooding, laborers bumping/slipping/falling, or blunders from failing or disgracefully utilized mining hardware. In coal mine utilization of individual defensive gear like cap, shoes and so on are not legitimate and appropriate courses of action were not there to check if the individual is wearing individual defensive hardware or not [2]. The correct supervision for laborer wear the defensive gear is imperative factor for thought. Underground mines are exceptionally dull so any excavators are fall oblivious due to suffocation or falling of structure, chief don't thought about her wellbeing condition and legitimate treatment isn't given her in time. The fundamental purpose behind excavator demise is unsafe gases blasts. In coal mines carbon monoxide, methane, LPG gases are existing and they are exceptionally destructive for human body.

The best possible supervision and legitimate correspondence is imperative prerequisite of mining industry. The keen head protector gives a constant checking of unsafe gases, individual fall identification and excavator wear the cap or not. The destructive gases like carbon monoxide, LPG, Methane and furthermore temperature are screen utilizing this framework. The wired correspondence organize isn't so viable on the grounds that when normal disaster or a rooftop fall happened, wired

system is harms, so it is exceptionally troublesome and exorbitant to reinstall the whole framework. In wired system innovation establishment and support cost is high. The successful answer for correspondence from base station to underground mine is Zigbee remote system. In Zigbee innovation work topology give a long separation remote correspondence arrange.

## II. RELATED WORK

**Yongping Wu and Guo Feng** actualize coal mine checking utilizing the Bluetooth remote transmission framework. As a standard of brought together worldwide short-run remote correspondence, Bluetooth innovation is to build up a typical low-control, minimal effort remote air interface and controlling programming opening framework [3]. In the meantime, the framework uses CAN transport innovation maturely, has understood the blend of wired and remote information transmission framework. The primary trouble of this framework is that the Bluetooth is short separation remote innovation and utilization of cabling is troublesome. At the point when a characteristic cataclysm or a rooftop fall happened, the cabling is harm. So the unwavering quality and long existence of regular correspondence framework is poor. Because of the brutal condition inside the mine, the establishment and support of the wired correspondence is exceptionally troublesome.

**Jingjiang Song, Yingli Zhu** proposed programmed observing framework for coal mine wellbeing in view of remote sensor arrange. The sensor gatherings of the framework seriously screen temperature, mugginess and different parameters in the underground mine, parameters estimated are sent to remote correspondence module by the miniaturized scale controller. The gathered data is sent to long-remove checking focus by link [4]. The issue of this usage is that equipment is set inside the coal mines, when a characteristic cataclysm or a rooftop fall happened, the framework is harm. So the dependability and long existence of ordinary correspondence framework is poor. The another issue is that the working state of coal mine is exceptionally boisterous and if the separation of digger and framework is long, excavator not get legitimate message. **Pranjal Hazarika** presents execution of wellbeing head protector for coal diggers. This cap is outfitted with methane and carbon monoxide gas sensor. This sensor sense the gas and the information is transmitted to the control room remotely, through a remote module called Zigbee associated with the protective cap [5]. This framework does not distinguishing tumble down of the individual and whether the miner's wear the protective cap or not.

**D. Kock, et al.** figured robotization for the coal mining industry in South Africa thinking about that of efficiency, wellbeing and security [6]. They conjointly explored the coal interface discovery (CID); to do this they utilized two surely understood strategies, for example, vibration investigation and characteristic gamma radiation. Correspondence channels-they likewise thought to be infrared, control line transporter, radio and optical fiber

correspondence channels for transmission of information in the coal mines. Here it should be all the more altogether investigated to achieve the prosperous execution of modernized frameworks in underground mines. Individuals resolve to take responsibility for activity. Something else, the framework, regardless of how fine it works, is bound to decrease in the long spurt.

**Hongjiang** author has proposed a keen cap for coal mines in light of ZigBee remote correspondence, their principle thought is to distinguish the stickiness level, methane fixation and the temperature of the mining territory. These detected information will be transmitted to the ground station remotely through ZigBee. The individual who is observing in the ground station alarms the digger through voice correspondence about the occasion happened. The issue in this execution is that it is unrealistic to caution digger through voice correspondence since he will work in a boisterous domain and there a man should be assigned at the observing space to screen and alarm the excavator

**Pranjal Hazarika** presents usage of wellbeing cap for coal diggers. This protective cap is furnished with methane and carbon monoxide gas sensor. This sensor sense the gas and the information is transmitted to the control room remotely, through a remote module called Zigbee associated with the cap. At the point when the methane or carbon-monoxide gas fixation is past the basic level, controller in the control room triggers an alert and guards the plant and the laborers by keeping an up and coming mischance [8]. This framework does not identifying tumble down of the individual and whether the digger's wear the protective cap or not.

**Tanmoy Maity and Partha Sarathi Das** execute a remote observation and security framework for excavators in view of Zigbee. This framework tends to a savvy, adaptable arrangement of underground diggers' wellbeing. A module of MEMS based sensors are utilized for underground condition observing and computerizing movement of estimation information through advanced remote is proposed with the, smooth control and unwavering quality, high precision. A microcontroller is utilized for gathering information and settling on choice, in light of which the excavator is educated through caution and additionally voice framework. The voice framework with both amplifier and speaker changes into advanced flag and viably discuss remotely with the ground control focus PC for this short separation. Zigbee is a short separation remote correspondence organize so it isn't conceivable to close to dependable experts who are at long separation.

## III EXISITNG SYSTEM

The present remote sensor organize observing framework utilizes the robots as the portable hubs. It screens working condition by utilizing three hubs called as versatile hub (mn),stationary hub (sn),gateway hub (gn). This robot will screen the exercises experiencing in the mines,the checked data is sent to the stationary hub and

from the stationary hub the data is then sent to the reconnaissance room.

#### IV PROPOSED SYSTEM

A financially savvy ZigBee-based remote mine administering framework is introduced in this task. This plan utilized smart protective caps as ultra-low-control hubs of remote sensor organize. The program embraced ZigBee remote innovation to construct remote sensor systems, acknowledged ongoing observation with early-cautioning knowledge on GAS, FIRE in mining zone to decrease potential wellbeing issues in coal generation.

##### 4.1 ADVANTAGES PROPOSED SYSTEM

- Low control utilization
- Less cost
- Design is basic
- More productivity

#### V WORKING PRINCIPLE OF PROPOSED SYSETM

The created framework can be partitioned into two areas. To start with is an equipment circuit that will be appended with the body of the diggers. This might be ideally fitted with the security head protector of the specialists moreover. The circuit has a sensor module comprising of a few MEMS based sensors that measures constant underground parameters like temperature, mugginess and gas fixation. Gas fixation is implied for the destructive gases like methane and carbon-monoxide. A microcontroller is utilized with the sensors to get the sensor yields and to take the essential choice.

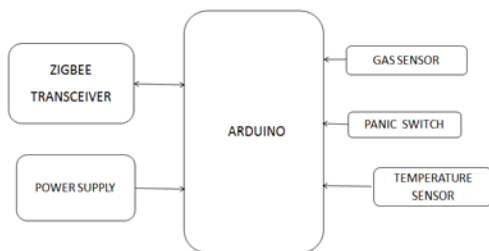


FIGURE 1 PROPOSED SYSTEM

When temperature is more than the wellbeing level prearranged at microcontroller, it interprets beep alerts through the headset speaker associated with controller. Once more, once the deliberate mugginess esteem is more than the wellbeing level prearranged at microcontroller, it deciphers distinctive kind of beep cautions. cases, this will send a caution through a pressing message and alert sound to the ground control terminal through zigbee. With its powerful and selectable coding calculations, 8kbps to 128kbps information/testing rates, bolstered interior clock signals makes it adaptable [1].

It has simple information interface with encoder that associates the receiver and microcontroller and

furthermore a simple yield Correspondence through these encoding and translating of voice and alert signs is adequately settled with the assistance of microcontroller.

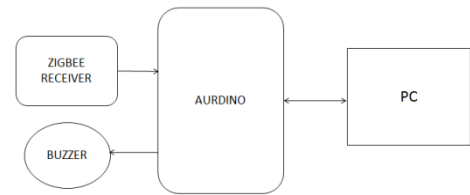


FIGURE 2 RECEIVER SIDE

This is the upside of PIC 16F877A .If the structure of UART (Universal Asynchronous Receiver Transmitter) framework is finished, sending and accepting sign is conceivable utilizing ZigBee, in the wake of introducing vital programming. The RESET stick of Zigbee is utilized to give a discretionary reset office of client through a reset catch. A transistor is utilized for this reason. The Zigbee Modules utilized as a part of the interfacing sheets, are designed to meet IEEE 802.15.4 guidelines. It is minimal effort, low-control, solid 20

In transmit mode serial data is gotten in the DI (data in) support and the data is secured in the DI Buffer until the point that the moment that it can be dealt with. Exactly when the DI bolster is 17 bytes from being full, obviously, the module de-states CTS (high) to movement to the host device to stop sending data CTS is reasserted after the DI Buffer has 34 bytes of memory available. More diminutive size data or low baud rate can be avoided this state of surge. In get mode substantial RF information is gotten through the radio wire. At the point when RF information is gotten, the information enters the DO (information out) cradle and is conveyed the serial port to a host gadget. Once the DO cushion achieves limit, any extra approaching RF information is lost. In the event that RTS (equipment stream control) is empowered for stream control, information won't be conveyed the DO cushion as long as RTS is de-declared. Rest Modes empower the RF module to enter conditions of low-control utilization when not being used parameter. To change or read RF Module parameters, the module should first go into Command Mode - a state in which approaching characters are translated as orders. The programming requires the establishment of X-CTU programming and a serial association with a PC. The detail of the product is given in the following area. At the point when correspondence happens between two arranged gadgets, every datum bundle contains a 'Source Address' and a 'Goal Address' field.

#### VI HARDWARE IMPLEMENTATION

ZigBee remote sensor hubs for the most part comprise the sensor unit, flag molding hardware, microcontroller (MCU), RF modules MC13193, clocks, memory and power administration module and different

segments appeared in Fig.3. Smaller scale controller is in charge of gathering ecological data, (for example, temperature, carbon monoxide, methane, wind speed, and so forth.) and do a few information transformation, in charge of controlling and dealing with the whole hubs; RF module MC13193 is in charge of the correspondence between hubs by a specific convention ; the power module gives the important energy to the hubs independently to run the different parts. Sensor hubs are the premise unit of remote sensor organize; hub stable running guarantees the unwavering quality of the entire system. Sensor hub is involved information procurement module, information preparing module, remote Correspondence module, caution module and the power module.

6.1 ZIGBEE

Zigbee is an insignificant exertion, low-control, remote work mastermind standard centered at the wide headway of long battery life devices in remote control and checking applications. Zigbee works in the cutting edge, legitimate and therapeutic (ISM) radio gatherings: 2.4 GHz in many wards overall Data rates : 250 Kbps, 40 Kbps and 20 Kbps according to groups The radio outline utilized by Zigbee has been precisely upgraded for minimal effort in huge scale generation. It has couple of simple stages and uses advanced circuits wherever conceivable. Setting up the system is extremely straightforward and simple. It doesn't have focal controller and burdens are circulated uniformly over the system. It is anything but difficult to screen and control home machines from remote. It will replace existing Infrared innovation based gadgets. This will spare cost of battery substitution as zigbee utilizes lithium battery which keeps going long.



FIGURE 3 ZIGBEE

6.2 GAS SEBSOR

A gas sensor is a gadget that identifies the nearness of gases in a territory This can be utilized to distinguish the gas spills and can be interfaced with the control framework to know the gas which is released This gadget can identify the TOXIC gases discharged amid the underground mining process



FIGURE 4 GAS-SENSOR

This MQ arrangement gas sensor utilize a little radiator inside with an electro-concoction sensor The gas sensor module comprises of a steel exoskeleton under which a detecting component is housed. This distinguishing part is subjected to current through interfacing leads. This current is known as warming current through it, the gases moving toward the recognizing segment get ionized and are devoured by the identifying segment This movements the assurance of the distinguishing segment which changes the estimation of the present abandoning it.

6.3 BUZZER

A buzzer is an audio signalling device, which may be mechanical, electro mechanical, or piezoelectric.



FIGURE 5 BUZZER

6.4 TEMPERATURE SENSOR

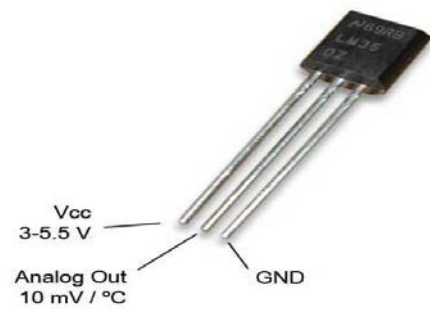


FIGURE 6 TEMPERATURE SENSOR

LM35- There are a wide variety of temperature sensor ICs that are available to simplify the broadest



possible range of temperature monitoring challenges. A temperature sensor IC can operate over the nominal IC temperature range of -55°C to +120°C. Above temperature sensor has three terminals and required Maximum of 5.5 V supply. This type of sensor consists of a material that performs the operation according to temperature to vary the resistance. This change of resistance is sensed by circuit and it calculates temperature. When the voltage increases then the temperature also rises. It can be stuck or establish to a surface and its temperature will be within around the range of 0.01°C of the surface temperature. This presumes that the ambient air temperature is just about the same as the surface temperature. If the air temperature were much higher or lower than the surface temperature, the actual temperature of the LM35 die would be at an intermediate temperature between the surface temperature and the air temperature.

6.5 ARDUINO UNO



FIGURE 7 ARDUINO UNO

Arduino is a computer hardware and software company, project, and user community that designs and manufactures microcontroller kits for building digital devices and interactive objects that can sense and control objects. Arduino is open source hardware. Arduino programs may be written in any programming language with a compiler that produces binary machine code.

VII RESULT AND DUSCUSSION



FIGURE 8a

Final output shows that output when gas goes beyond threshold value.



FIGURE 8b

Figure 7b shows that output when temperature goes beyond threshold value

VII CONCLUSIOIN

It has been introduced the first plan of the low power ZigBee remote sensor framework with a to a great degree lessened cost. It is solid framework with fast and simple establishment. The mining business endures visit loss of lives. WSNs based observing of condition can spare human lives and expensive foundation. In this paper, the framework level parts of a control and checking framework for mining industry have been experimentally examined. This paper has tended to three plan contemplations for WSN being utilized for underground mine surroundings. The framework may be effectively extended. With ZigBee remote situating gadgets, it will enhance framework versatility and broaden precise position of underground mineworkers in future. It is taken a toll effective. This causes the base station to get precise data and encourages them to screen the present status. WSN is utilized uncommonly for its dynamic topology and power control. The framework effectively will be recognized and distinguished the occasions in every single tried case giving an extensive control and observing instrument and followed area of diggers and occasions required for save activities.

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