An Event Reporting and Monitoring in Underground Coal Mine Environment using Wireless Sensor Networks

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Abstract:- **In the mining environment, the coal miners death rate is double compared to previous year, every year miners lives and worthy infrastructure get lose due to accident and disasters in underground coal mine environment. Wireless Sensor Networks (WSNs) are used in many applications like mining environment, animal monitoring and etc. WSN are used to monitoring that environment and frequently reporting the situation of the environment to the worker can reduce the disaster. This Proposal is focused on underground coal mine monitoring and an event reporting of that environment using Wireless Sensor Network. Our system measures various parameters such as temperature level, methane gas level, vibrating level of mine environment, pulse rate of miner, all data are stored in database, by using data mining algorithm, we compare the parameter level (because dynamic nature of coal mining environment) with correct data level, if any change occurs, our system alert the coal miner and overall controller of coal mine environment. The HC12 transceiver is used send and receive the monitored information. Hazardous condition information and frequently what happen in mine environment reporting employed for early warning to coal mines worker by the mobile node which is along with them.**

The vibration level of environment is sensed by stationary node. We use microcontroller for connecting the server to the different sensors like methane sensor, temperature sensor, vibration sensor, carbon mono -oxide health sensor.

I. INTRODUCTION

Wireless sensor networks areorganizational structure containing computing, sensing and communication element that try to give its organizer the ability to compute, collect and react to occurrence in monitored environment.WSN are used in several fields such as wild life monitoring, health care monitoring, industry monitoring, etc.. This research proposal is basically for underground coal mine environment and an event reporting using wireless sensor networks. Lot of coal miners lose their lives due to roof collapse,rock burst, gas poisoning and gas explosion in underground coal environment. In underground mine the monitoring of proper ventilation and poisoning gases is emphasized to avoid .The are more danger occur in underground coal mines ,they are Firedamp, Blackdamp ,Afterdamp, Stink damp , White damp. These dangers occur due to some poisonous gases present are high in underground mine that poisonous gases are follow methane , carbon mono- oxide, nitrogen , carbon dioxide. These gases affect the lungs of coal miners,so in this research we monitor the poisonous gas level as well as coal miners health. The mine environment are dynamic suddenly roof collapse may happen so it is very important to monitor the condition of roof ,in this paper we also monitor the roof of mine environment.In this proposal we particularly concentrate the life of coal miners, here we use three nodes mobile node, stationary node . If any poisonous gas level increases or oxygen level decreases the mobile node alert the miner to get out from that place and send the message to server through stationary node. Forwireless communication HC12 are used. The HC-12 is a half-duplex wireless serial communication module with 100 channels in the 433.4-473.0 MHz range that is capable of transmitting up to 2 km.**The HC12** maximum transmitting power is 100mW 20dBm, the receiving sensitivity is -117dBm at baud rate 5000bps in the air, communication distance up to 1000m on open space. Using HC12 transceiver send the collected information to the server.HC12 range is also high compare to some protocols. Here stationary node also act as gateway node to transmit the data.

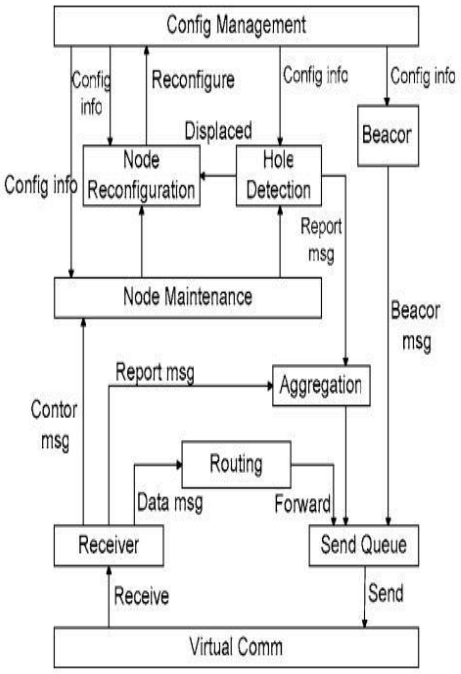
II. RELATED WORK

Title : Underground Coal Mine Monitoring with Wireless Sensor Networks

Authour:Pournima S. Sawai, C. Satyanarayana

Concept :

In this project, they discuss the design of a Structure-Aware Self-Adaptive WSN system, SASA. By regulating the mesh sensor network deployment and formulating a collaborative mechanism based on a regular beacon strategy, SASA is able to rapidly detect structure variations caused by underground collapses in underground coal mine environment.



Title: Real Time Monitoring System for Mine Safety Using Wireless Sensor Network

Author: Sumit Kumar Srivastava

Concept:
A real time monitoring system using wireless sensor network, which includes multiple sensors, is developed. This system monitors surrounding environmental parameters such as temperature, humidity and multiple toxic gases. 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 to establish wireless sensor network. It is wireless networking standard IEEE 802.15.4, which is suitable for operation in harsh environment.

Title:A WSN for Monitoring and Event Reporting in Underground Mine Environments

Author:Umar Ibrahim Minhas, Ijaz Haider Naqvi

Concept:
This paper proposes a WSN-based system, which is capable of detecting and identifying events of interest (with 90% success rate) and localization of miners (2–4 m) and roof falls (10–12m). Finally, for intelligent processing of gathered data, a spatio-temporal and attribute-correlated event detection mechanism suitable for the highly unreliable mine environment is described.

Title: A Novel Routing Protocol Providing Good Transmission Reliability in Underwater Sensor Networks

Author :J. Shen

Concept:

As the network communications technology developing, a new type of networks has appeared in the daily life which is named underwater sensor networks (UWSNs). UWSNs are a class of emerging networks that experience variable and high propagation delays and limited available bandwidth.In this paper,they proposed a routing protocol named LARP for UWSNs, which utilizes the location information of nodes to transmit a message.

Title: The design and evaluation of a wireless sensor network for mine safety monitoring.

Author : X.Niu

Concept:

This paper proposes a middleware to achieve remote monitoring and control automation ofunderground physical sensor devices used in mines.

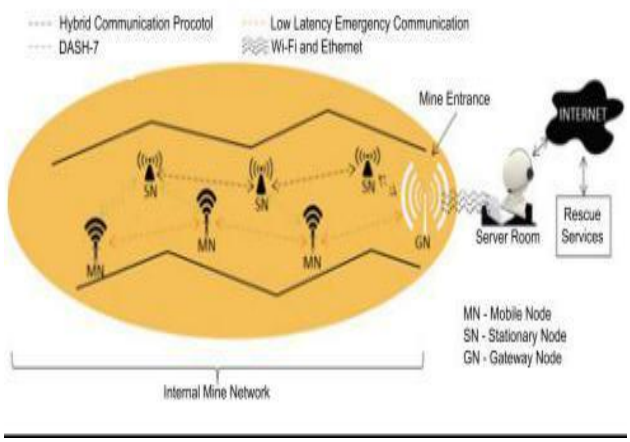
Comparison Study

Previous work	Basic monitoring	Event forecasting	Miner's health& Miner's localization	Rooffall detection
1	Yes			Yes
2	Yes	Partial		
3	Yes	Yes		Yes
4	Yes			
5	Yes			
Our proposed system	Yes	Yes	Yes	Yes

III. PROPOSED SYSTEM

The overall system architecture is shown in Fig.

1. The system consists of three types of devices: mobile node (MN), stationary node (SN), and gateway node (GN). Each type of device runs its specific firmware and communicates, via set communication protocol. Hardware design as well as power requirements alsovary for each type of device as described in subsequent sections.

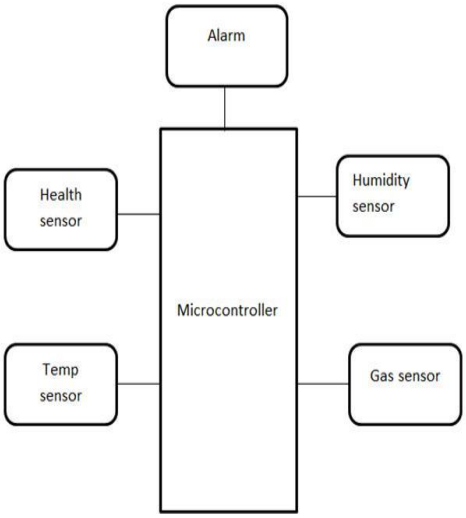


3.1 Mobile Nodes

It is moving node. we planned to this node always with individual coal miner.This frequently monitor the gases level, health condition of miner .If any gases level is high it alert the coal mine and send the information to stationary node and also emergency control room(Base station) through stationary node.MNs are carried by the miners. The nodes are capable of monitoring miner activity, sense parameters critical for miner's survival inside the mine (e.g. temperature, humidity, and oxygenlevels) and convey information to the nearest SN. Miners can also send distress signal(s) to the gateway as well as run miner localization algorithm. MNs are charged by Li-Po batteries (2200 mAh, 62 × 50 ×5 mm3) and are designed with a view that they can be recharged easily, just like cell phones, every few days. This fact allows for less stringent power constraints and flexibility when communicating with SNs. MNs use DASH-7 protocol for communication, which is further explained in Section V-C. Dimensions of an MN are 2.5 × 2.75 in2 and itweighs about 220 g with battery contributing a large chunk of the weight (150 g).

3.2 Stationary Nodes

It is fixed node.It may be fixed in roof. This node monitor the roof condition as well as it also used to receive a data from mobile and sent it to server.Sometimes it is act as gateway node, if gateway node is failed.SNs are deployed throughout the mine at an appropriate distance from each other. SNs sense different parameters critical to structural integrity of the mine (e.g. roof fall, temperature, humidity,and concentration of toxic gases such as carbon monoxide (CO)). Based on readings of different attributes, SNs run local event detection and identification algorithm. This distributed processing is one of the key features of the proposed system.This means that in case a node or certain number of nodes are disconnected from server, they can still use the gathered data (of that particular region) for localized event detection and localized alarm generation. Finally, SN is responsible for dataaggregation and routing to GNs. Each SN acts as a cluster head and forward the received data to the GN. SNs communicate with MNs using DASH-7 (see Section V-C) and with other SNs using customized protocol (see Section V-C1). SNs are powered withlow-cost maintenance free-sealed lead-acid batteries. They, unlike MNs, cannot be monitored on daily basis for wear and tear and have a higher probability to come under tremendous stress after a roof fall. Hence, Li-Po batteries are avoided for fixed nodes since they can explode if mistreated. The system wastested with 10 Ah batteries (151 × 51 × 100 mm3) for SNs.



Block Diagram

VI. PERFORMANCE EVALUATION AND ANALYSIS

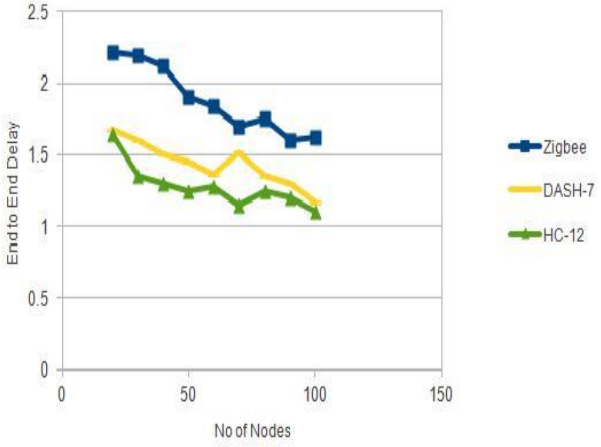
Blue represents Zigbee, Yellow represents DASH-7 and Green represents HC-12. In phase3, the performance is evaluated based on end to end delay, life time, energy, packet delivery ratio and throughput for Zigbee, DASH-7 and HC-12.

End to end delay Vs No of nodes:

When node gets increased, the performance of Zigbee gets decreased and the performance of DASH-7 and HC-12value gets minute changes. In this result,HC-12 is better than Zigbee, DASH-7

Nodes	Zigbee	DASH-7	HC-12
20	2.22	1.68	1.65
30	2.2	1.6	1.35
40	2.12	1.5	1.3
50	1.9	1.45	1.25
60	1.84	1.36	1.28
70	1.7	1.52	1.15
80	1.75	1.35	1.25
90	1.6	1.3	1.2
100	1.62	1.17	1.1

Table 4.1End to End Delay Vs No of nodes

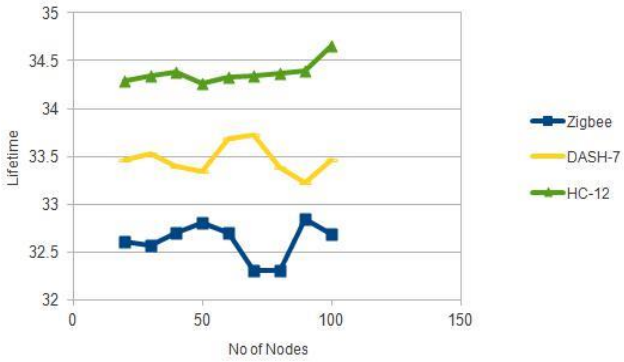


Lifetime Vs No of nodes:

When node gets increased, the performance of HC-12 gets increased and the performance of Zigbee value gets increased, DASH-7 value gets increased. In this result, HC-12 is better than Zigbee, DASH-7.

Nodes	Zigbee	DASH-7	HC-12
20	32.604	33.46	34.284
30	32.567	33.52	34.336
40	32.7	33.4	34.386
50	32.8	33.34	34.26
60	32.7	33.68	34.325
70	32.3	33.72	34.347
80	32.304	33.38	34.367
90	32.843	33.23	34.395
100	32.69	33.46	34.661

Table 4.2 Lifetime Vs No of nodes



CONCLUSION

The mining industry suffers frequent loss of lives. WSNs based monitoring of environment can help to save human lives and costly infrastructure.In this paper, the system level aspects of a control and monitoring system for mining industry have been empirically investigated. This paper has addressed three design considerations for WSN being used for underground mine environments. The system successfully detected and identified the events in all tested cases providing a comprehensive control and monitoring mechanism and tracked location of miners and events required for rescue operations.

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