Smart Helment for Miners Using WSN

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ABSTRACT:
Safety plays an important role in mines. A number of parameters need to be monitored in coal mines as it can be hazardous for human life. Few such are the exposure to temperature, humidity, free oxygen and methane gas in that atmosphere.

The paper produces an idea in which the helmets are used as monitoring devices. The wireless sensor networks are used for communication between the node and the base station. The methane sensor (MQ-4), the temperature sensor (TMP102) and the humidity sensor (SHT11) are used for sensing methane content, temperature and humidity respectively. The sensed signals are then sent to the base station using wireless sensor networks.

WSN has a dynamic topology. The sensor nodes convey the necessary information about the parameters to the base station. A gateway node is used in delivering the information from the sensor nodes to the base station. A hybrid protocol is used for routing purpose. This protocol combines advantages of both the proactive and reactive protocols.

A sensor node has a microcontroller (AT89C52) connected to the sensors, transmitter. In addition, it also gives an indication to the workers if the values exceed the safety limit. This shall further be simulated with MATLAB.

KEYWORDS:
Wireless sensor networks (WSN), Microcontroller , Dynamic routing, Sensors, Transmitter ,Hybrid Protocol , APTEEN

1. INTRODUCTION

At present, in INDIA we use traditional helmets which do not have any special features embedded to it. Though there are vast developments in communication sector, underground mine communication is under rated. In our country we use live wire for communication. The major problem in developing coal mine communication is signals don't propagate completely in the desired direction due to diffraction. The coal mines don't expand vertically rather they are expanded in all directions. This can be overcome by using Wireless sensor networks propagate completely in the desired direction due to diffraction. The coal mines don't expand vertically rather they are expanded in all directions.

This can be overcome by using Wireless sensor networks (WSN).A WSN is spatially distributed autonomous sensors network to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and pass their data through the network to a main location. The more modern networks are bi-directional, also enabling control of sensor activity.

The WSN is a combination of "nodes". A few to several hundreds or even thousands form a network. Each node is connected to one or more sensors. These nodes are classified into Sensor and gateway nodes. Each such sensor network node has parts like a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source. A sensor node might vary in size and cost, depending on the complexity of the individual sensor nodes.[2]

The WSN are either static or dynamic. Dynamic WSN are adaptable to various topologies. Hence it can be used in because of the limited range of a particular node. Source shall communicate with an intermediate within its range which will further communicate with the next thus establishing a path between the source and the base receiver.

WSN protocols are used for routing purposes. Based on mode of functioning and type of target it is classified into proactive, reactive and hybrid.[2] Here a hybrid protocol like APTEEN is being used.[`1]

The paper has five sections. It starts with an introduction followed by the underground designed wireless network. In this section the dynamic property of the WSN is explained. It also contains information about the WSN routing protocols. The third section is the proposed work it explains the main idea of the paper. It deals with both the selection of routing protocols and the hardware design.

UNDERGROUND WIRELESS NETWORK DESIGN

2.1. DYNAMIC WIRELESS SENSOR NETWORKS

A number of sensors are connected to a node. This node is called cluster node. If a number of cluster nodes are connected, they communicate with the base via cluster head. The data from each cluster node is sent via the cluster head. A relay node is nothing but an antenna which helps in propagation of signals to a large extent. Two relay nodes can communicate with each other and also send the signal to the base station. These cluster nodes are called as gateway nodes. [4].

2.2. WSN ROUTING PROTOCOLS

The routing is done with the help of protocols. Based on the purpose a number of classifications are made. Based on mode of functioning and target it is classified into proactive, reactive and hybrid. In proactive protocol the nodes switch on their sensors sense the environment and transmit the data to a base station in a predefined route.

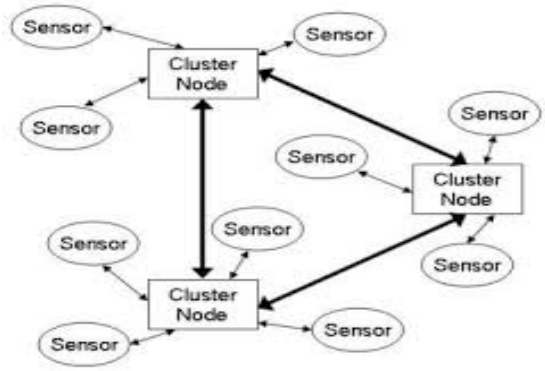

FIG1. Communication among cluster nodes

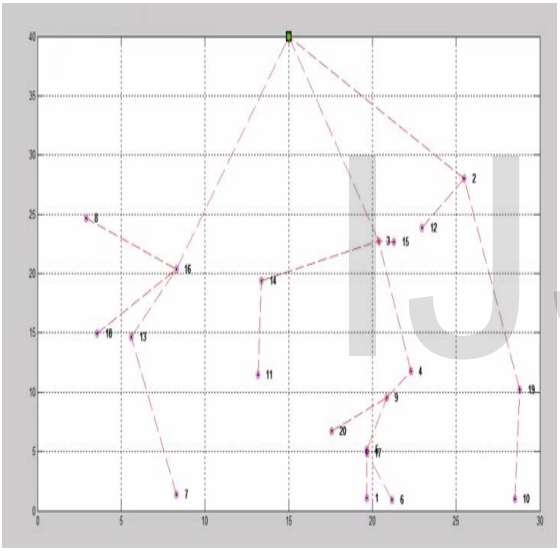

FIG 2. Cluster tree structure using MATLAB

E.g. LEACH. The reactive notes the sudden changes, if it is beyond the threshold value the nodes instantly react. E.g.TEEN .A hybrid incorporates both proactive and reactive concepts. Generally the routes are computed first and then improve them. E.g. APTEEN. In our usage a hybrid is preferred because it saves power and also reports the changes.

3 .PROPOSED WORK

Sensors are connected and send data to the transmitter. This data is further sent from the transmitter to the receiver with the help of intermediate nodes and relay nodes.

3.1 COMMUNICATION

Each sensor communicates to the transmitter. The sensors indicate the worker if the content rises maximum limit. This indication is done with the help of LEDS. The corresponding LED glows when it raises the limit. The data from the transmitter is updated at regular intervals. Routing protocols are available which helps the purpose. If data can't reach the receiver directly it uses relay nodes for communication. The relay nodes have are antennas external or internal which helps in propagation of the signal. The data is transmitted via a number of relay nodes within the range and then a path is established.

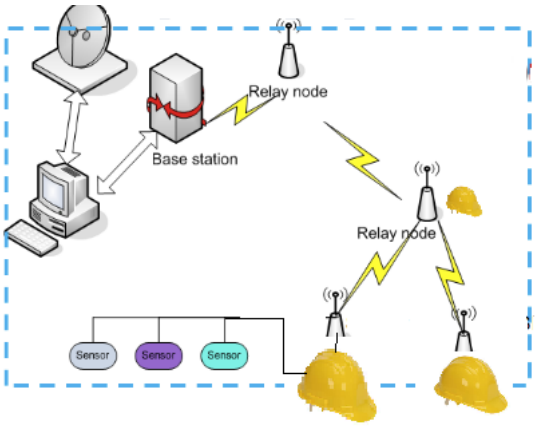

FIG 3. UNDRGROUND COMMUNICATION

3.2. ROUTING PROTOCOL

Nodes in the network should be dynamic and must consume less power. These are advantages of a proactive and a reactive protocol. A hybrid protocol which combines both features is used-Adaptive Periodic Threshold-sensitive Energy Efficient sensor Network protocol (APTEEN) [4]. It is a hybrid protocol that changes the periodicity or threshold values used in the TEEN protocol according to the user needs and the type of the application. Here, the cluster-heads broadcasts the following parameters

1. Attributes (A): This is a set of physical parameters about which information is needed.
2. Thresholds: this parameter consists of the Hard Threshold (HT) and the Soft Threshold (ST).
3. Schedule: A TDMA schedule, assigning a slot to each node.
4. Count Time (CT): It is the maximum time period between two successive reports sent by a node.

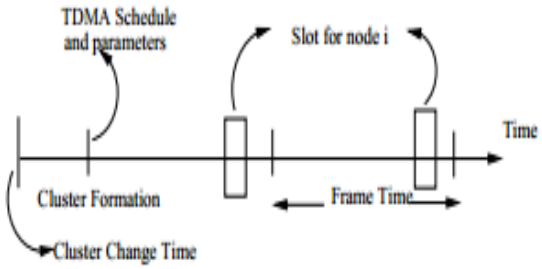

Fig 4. Operation of APTEEN

The node senses the environment continuously. Those nodes which sense a data value at or
beyond the hard threshold transmit the information. Once a node senses a value beyond HT, it transmits data only when the value of that attributes changes by an amount equal to or greater than the ST. If a node doesn't send information for a time period equal to CT, it is forced to sense and retransmit the information. A TDMA schedule is used and each node in the cluster is assigned a transmission slot. APTEEN uses a modified TDMA schedule convenient to implement the hybrid network. [5]

3.3. HARDWARE DESIGN

3.2.1. Temperature Sensor

In temperature sensor module we use TMP102. It's a two-wire, serial output sensor. It has a high resolution of 0.0625°C. It has a temperature range of -40° C to +125°C. The resolution is 12 bits. It has a low power consumption. The supply range varies from 1.4 V to 3.6V.It offers low quiescent current. It is used in notebook computers, powered battery and power supply temperature monitoring.[6]

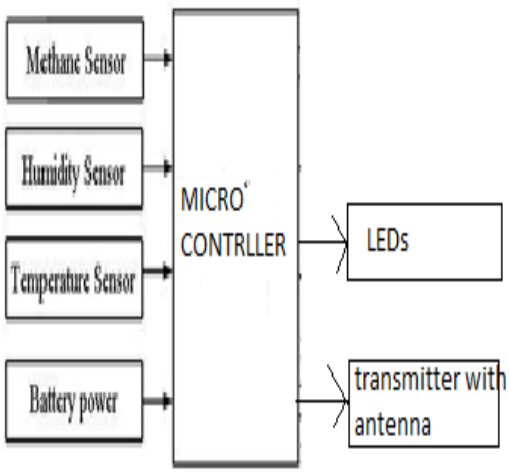

Fig 5. Block Diagram

3.2.2. Humidity Sensor

SHT11 is a digital sensor designed for. SHT11's main features: temperature range of -40℃ ~ +85℃, relative humidity range of 0% ~ 100% RH; low-power ,short response time, completely submerged, temperature measurement accuracy ± 0.4℃ , humidity measurement accuracy of ± 3.0% RH. SHT11 can store factors in OTP memory preliminarily, after 14-bit A/D converter done, then send temperature.[9]

3.2.3. Gas Sensor Unit

In Gas module we choose MQ-4 as a methane sensor. It has high sensitivity to Natural gas. It has a fast response and a stable long life. They are used in detecting leakages of CH_4. .MQ-4 has a high precision, low heating consumption less than 750mw. Its circuit voltage is 5V±0.1 and heating voltage is 5V±0.1.It uses sensitivity Resistance of 10KΩ. It has a standard detection condition of Temp: 20℃±2℃, Vc:5V±0.1 and Humidity: 65%±5% , Vh: 5V±0.1 .[8]

3.2.3.Microcontroller

Atmel **89C52** is an 8-bit microcontroller and belongs to Atmel's 8051 family. AT89C52 has 8KB of Flash programmable and erasable read only memory (PEROM) and 256 bytes of RAM. AT89C52 has an endurance of 1000 Write/Erase cycles which means that it can be erased and programmed to a maximum of 1000 times.AT89C51 and AT89C52 have been tabulated below.

*The **pin configuration of AT89C52** is exactly similar to that of AT89C51 except that the first two pins, P1.0 and P1.1 are multiplexed to correspond to Timer2 operations as given in the following table.

Existing	Alternate	Function
P1.0	**T2**	Timer/counter 2 External Count input
P1.1	**T2 EX**	Timer/counter 2 Trigger input

While AT89C51 has two timers (Timer0 & Timer1), AT89C52 also has Timer2. Corresponding to Timer2, there are extra SFRs (Special Function Registers) T2CON & T2MOD. Also there are registers RCAP2H & RCAP2L to configure 16 bit Capture & Auto-reload modes of Timer2.

4. ADVANTAGES

- It is cost efficient
- The power efficient time is low
- It has short response time

5. CONCLUSION

It is cost efficient. This helps the base station to receive accurate information and helps them to be monitoring the

current status. WSN is used specially for its dynamic topology and power control.

6. FUTRESCOPE

Adding on features will help better safety and communication. Cameras could be embedded in different parts of the safety suite and helmet. GSM can also be used this will help people to track the path of the miners. It reduces confusion and complexity.

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