Application of the wireless sensor network based on ZigBee technology in monitoring system for coal mine safety

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Abstract— **Wireless sensor networks have become one of the important research fields with a wide-range application background. With the continuous development of technology, a new type of system of Coal Mine Safety Based on ZigBee technology is designed. Using the characteristics of wireless sensor networks , it implements real-time monitoring and intelligent warning for underground environment and production parameters. The system cosisted with a low power ARM processor as the control of the core and ZigBee as a communications platform of wireless sensor networks.after several tests, a lot of valuable data are collected from the actual environment for example communication quality, communication length and power consumption and so on.Finally experiment result confirms the feasibility of the system design and its good stability. Article describes a wireless sensor network based ZigBee technology. Mostly used for transferring and collecting the various monitoring information about the coal mine underground.after that the data is analysed and processed outside the monitoring system.To ensure the safety of the coal production and effectiveness better.**

Index Terms— **Monitoring andTracking intelligent sensor network, Zigbee device, Visual basics 6.**

I. INTRODUCTION

Safety of the human life is most important concern in any type of industry. In mining industries specifically in coal mines, due to the environmental condition, there are chances of disasters of constantly lives are lost and many countless miners are injured. To avoid any type of unwanted phenomenon all the mining industry should follow the basic precautionary measures. To avoid any loses to the production and damaging of human health, reliable and continuous communication system is required [1]. The present monitoring system of the coal mines mostly use cable networks in many places which are still incapable of saving lives of those workers which are working in this professional. Another disadvantage of wired communication is if it is damaged due to land slide or explosion, it is very difficult and expensive to reinstall it again.
Our proposed system is based on wired as well as wireless communication which are developed for fast and reliable communication without any interruption. Not only monitoring

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of wireless and cable network can complement each other, implementing safety monitoring but also it can solve key issue of communication bandwidth, data transmission, staff orientation, synchronised monitoring is possible [6].

II. WIRELESS SENSOR NETWORK

Wireless Sensor Networks (WSNs) consist of small node with computation and sensing wireless network capabilities.A wireless sensor network **(WSN)** consists of partially distributed as well as autonomous sensors to monitor physical conditions such as temperature, gas, humidity, light etc. A sensor network is as being composed of a large number of nodes which are deployed densely in close proximity to the phenomenon to be monitored.All nodes collects data and its purpose is to route this information back to a sink. Today such networks are used in many industrial and consumer applications such as industrial process control and monitoring, machine health monitoring and so on.
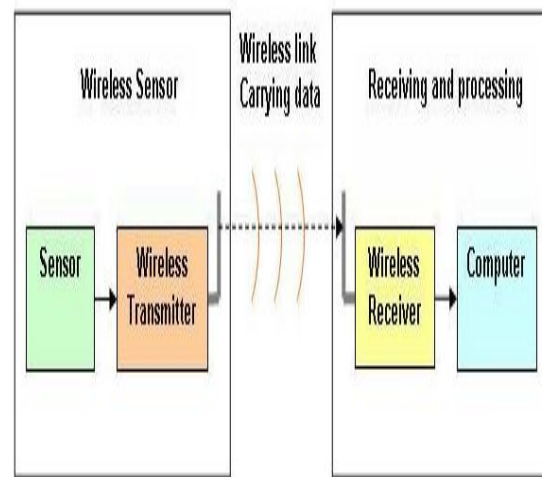
III. SYSTEM DESIGN STRUCTURE

The system structure is developed using two wireless sensor nodes, one is a fixed node and another is mobile data acquisition sensor node. These nodes are used to monitor the different environmental parameters inside the underground coal mine. The structure diagram of this system is shown in following figure 1 and figure 2.
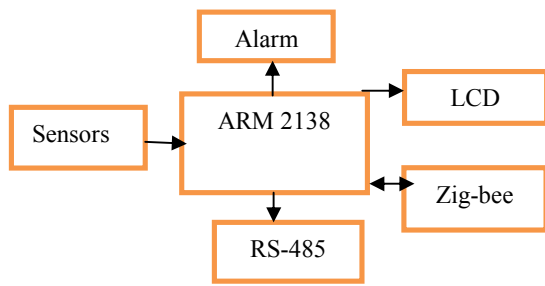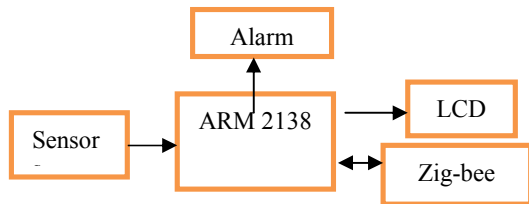
Fig 1.Fixed data acquisition sensor node

Fig 2. Mobile data acquisition sensor node

The data acquisition through fixed sensor node uses two types of communication technology, wired and wireless [3]. Here four different sensors are used in this node they are temperature, light, gas, humidity These Parameters are monitor by the sensors continuously and then data is sent to base station. When it is found that the parameter received at base station have exceed the set limit, then the miners are informed through the alarm buzzer to ring in time for safety measures.

Another mobile sensor node (moving node) will be attached with the body of miner. This node has a sensors module which is mainly battery-powered [4]. In particular mine excavation area, these module is placed to the worker that not only facilitates the data collection, but also it can trace the location of miner from the base station using our system software.

IV.   TECHNOLOGY OF ZIGBEE

A wireless network used for building,industrial control and home. It is the IEEE 802.15.4 wireless standard for low data rate and for maximum speed of 250 Kbps at 2.4 GHz, Zig-bee is slower than Wi-Fi and Bluetooth,but it requires low power so that batteries can last for months and years[5].The typical ZigBee transmission range is roughly few 100's of meters, but that can vary greatly depending on temperature, humidity and air quality.. It can communicate upto 254 controlled network nodes at a time.

Although ZigBee networks can be configured in mesh, peer-to-peer and star topologies, ZigBee was named by mesh network. A ZigBee mesh provides multiple pathways from device to device (like the Internet) and eliminates a single point of failure. If nodes go down or if removed, ZigBee devices can "zig" and "zag" through the network to their destination like a bumblebee [5]. ZigBee uses two types of devices. Reduced-function devices (RFDs) are sensors that communicate with full-function devices (FFDs). FFDs are complex nodes that conform to the full 802.15.4 standard which serve as routers. It currently operates in 868MHz band at a data rate of 20Kbps in Europe, 914MHz band at 40kbps in USA, and the 2.4GHz ISM bands in India at a data-rate of 250Kbps. Table shows a comparison of different transmission media [5].

TABLE I. Comparison of Different Transmission Media

PARAMETER	BLUETOOTH	RF MODULE	ZIGBEE
Power consumption	Medium	Medium	Low
Units	7	1	254
Distance	10m	50m	Few 100m
Transfer Rate	1Mbps	4.8Kbps	256Kbps

V.   RS 485 [75176]

As we know that RS 232 cable provides the limited distance of communication between PC and microcontroller that's why we are using this RS 485 cable. The RS 485 cable transfers data to the longer distance. Here we are using RS 485 driver IC to communicate between the Slaves (µC's) and the Master (PC).

When a network needs to transfer small blocks of information over long distances, RS-485 is often used for the interface. The network nodes can be microcontrollers, PC or devices which are capable of asynchronous serial communications.In comparison with Ethernet and other interfaces RS-485's hardware and protocol requirements are cheaper and simpler. The RS-485 standard is flexible to provide a choice of receivers, drivers and other components depending on the cable length, data rate, number of nodes and the need to conserve power. The interface popularly known as RS- 485 is an electrical specification for multipoint systems that use balanced lines. RS-485 is similar to RS-422 but RS-422 allows just one driver with multiple receivers whereas S-485 supports multiple drivers and receivers.

VI.   SYSTEM SOFTWARE DESIGN

The system software is developed using visual Basic 6 under Windows OS® as front end tool which is an object oriented based software package. A software developed here is to Display different environmental parameter inside the coal mine and systematic miner movement path is plotted.

The module allows design of Fail Safe communication technique to make sure that the slave can send the data to master even if one of the transmission technique fails. The paper mainly completes the software design of system with wired and wireless parts as we are using two transmission technique, one Zig-bee trans-receiver (wireless) & other RS-485 (wired). Initially the slave will send their data via Zig-bee. And if Zig-bee fails due to any reason's the slave will automatically switch to wired RS-485 communication. In this way data collection is done without any interruption.
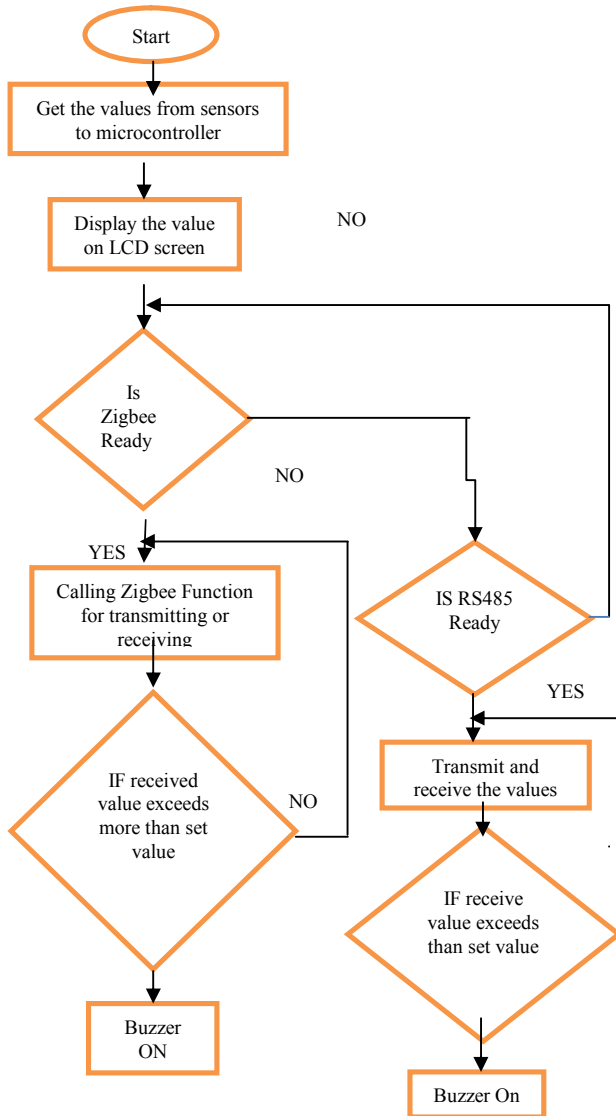
VII. FLOWCHART

Fig 3.Systematic flowchart

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CONCLUSION

In this application monitoring of the underground coal mine system based on wired as well as wireless network so the key issue of communication bandwidth , continuous monitoring & safety has been solved before the hazards happens [7]. In case of disaster, the system will help to locate the miner's which are trapped inside underground coal mine. This will solve the time taken for rescue work since it is automated increase life safety of rescuers and coal mine workers.