HYBRID WIRELESS COMMUNICATION SYSTEM BASED ON ARM9 FOR COALMINE MONITORING

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Abstract:
The most important aspect of the MINER Act is providing reliable communication for miners before and after tragic accidents. Reliable communication has always been a challenge in underground mines due to changing topologies and harsh environment. In addition, disasters disable electricity and communications cables, block tunnels and cause fire. These may damage the communication infrastructure which hampers rescue efforts and endangering lives. Therefore, durable wireless solutions using advanced communication and sensor network technologies have been investigated to provide reliable communications in underground mines. In this paper, it designs a monitoring system for coal mine safety based on Wi-Fi, Zigbee modules with sensors. In this system it consists of two main modules, Wi-Fi and zigbee based device which would cooperate together in order to transport disaster information. This system provides efficient, faster and reliable communication even when disaster occurred. The designed coal mine safety monitoring system based on wireless sensor network, Wi-Fi and zigbee will improve the level of monitoring production safety and reduce accident in the coal mine. ARM9 processor being used in zigbee coordinator and ARM7 used in zigbee end device in order to speed up the processing of data.

Keywords: Wi-Fi, Zigbee coordinator, Zigbee end device, Zigbee router, Coal mine monitoring system, WSN.

I .INTRODUCTION

Safety is the most vital part of any type of industry. In any hazardous work environment mines, safety of human life is an important concern, Negligence in the safety part may cause damaging of high quality equipment hampering of production or may cause loss of human life also in extreme cases. In the mining industry safety and security is a fundamental aspect of all. To avoid any types of unwanted phenomena all mining industry follows some basic precaution and phenomena [1]. Communication is the most vital key factor today, to monitor different parameters continuously and to take necessary actions accordingly to avoid any types of hazards related to production, security, managing of human resources. To avoid loss of material and damaging of human health, security and safety system as well as reliable continuous faithful communication system is essential in the interior of the underground mines. To enhance security, safety and productivity in underground mines, a reliable communication system must be established between workers, moving in the mine, and a fixed base station. It is very difficult to reinstall the wired communication system inside mines after a landslide or damage due to any reason. If due to some reason any wire of the communication network damages, it may cause temporary interruption of the continuous process or may cause a long term break down of the system. To improve life safety, many systems have been designed, and have even been implemented in some countries today.

II. RELATED WORK:

Because of the rapid development of sensors, microcontrollers, and network technology, a reliable technological condition has been provided for our automatic real-time monitoring of coal mine. Plenty of researches were done in developing different applications among them are listed below:

If we look to [2, 4] in [2] monitoring system has a sensor module consisting of some MEMS based sensors that measures real-time underground

parameters like temperature, humidity concentration of different gases, vibration inside mines etc. A microcontroller is used with the sensors to receive the sensor outputs and to take the necessary decision. When gas concentration crosses the safety level, microcontroller decodes siren alarms. In all such cases, this will send an alarm through an urgent message and alarm sound to the ground control terminal through zigbee. The microcontroller used here is PIC 16F877A with 20MHz operating frequency. It has five I/O ports, eight A/D input channels and 368 bytes data memory. Digimake XBEE24 product is used here for transmitting and receiving data wirelessly. Microcontroller MC9s08GT60, zigbee MC13193 and GPRS are used in [3] for coal monitoring. A robot equipped with sensors for detecting various poisonous gases and a wireless zigbee transceiver. It can navigate through a mine and send back information to the person monitoring its movement from a safe place outside, all that is happening inside the mine and even warn the workers regarding the places that may actually be life threatening. PIC controller PIC16f877A, ultrasonic sensor for collision avoidance, gas sensors and zigbee for data transmission are implemented in [4].

III. HARDWARE DESIGN SCHEME

The hardware platform of wireless gateway is made up of two parts: the LPC2148 ARM7 processor that integrates a 2.4 GHz, Zigbee IEEE 802.15.4-compliant transceiver and harmful gas detecting sensors based on application.

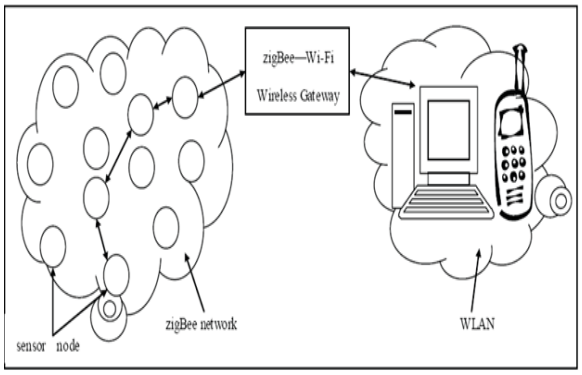

Figure 1. The communication model between ZigBee network and WLAN.

There are three types of devices has been developed, they are Zigbee end device (ZED), Zigbee Coordinator (ZC), Zigbee router (ZR). ZED is meant for manager, mining sardar, overman, assistant manager who are responsible for monitoring the area, manages the worker and tests the site weather it is safe to continue work or evacuate the area. This ZED module consists ARM7 processor, zigbee transceiver and sensors. ARM7 processor in ZED receives data from sensor nodes and interacts with them see figure 2. When methane gas detected, if exceeds the normal level then processor will send an encrypted data to ZC via ZR fitted in helmet of worker which is carried by all low cadre coalmine workers, labors, electricians, fitters etc.,. ZR is responsible for carrying data to ZC.

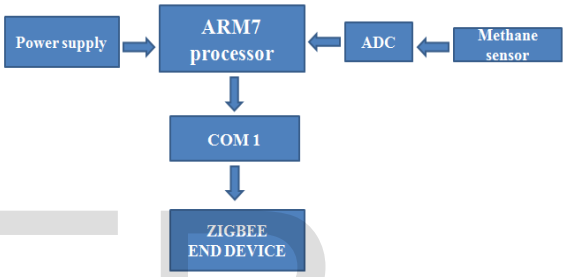

Figure 2. Block diagram of ZED.

The data received by ZC see figure 3 will be processed by ARM9 processor, if level of methane exceeds then ARM9 processor will display a message on touch screen like evacuate the sector or area, at the same time sends data to nearby ZC until it covers entire underground network thus we can establish a continuous communication and safety monitoring system. Each ZC consists of FRIENDLY ARM board which has Samsung s3c2440a ARM9 processor, resistive touch screen board, zigbee transceiver, Wi-Fi. ZC will be placed to cover certain sector, there will be numerous sectors each sector has its own ZC. Through ZC one can send a message or make a voice call to nearby ZC. Thus a reliable network is established, even a ZR is weak or not participating in network we had other ZR to carry the data.

The hardware setup after installation under the ground is shown in the figure.5 from this monitoring system tracking underground heavy

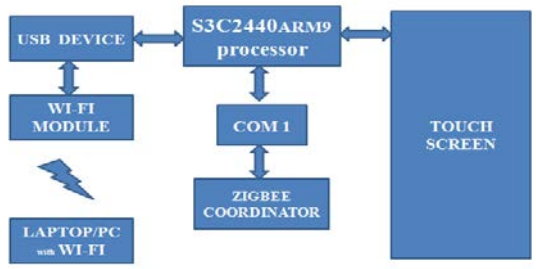

Figure 3. The ZigBee Coordinator.

vehicles, coalmine workers, voice and message based communication can also established between ZC's. One ZED device cannot communicate directly with other ZED, ZC is responsible for whole communication. Micro-controller is responsible for collecting environmental information (such as temperature, carbon monoxide, methane, wind speed, etc.) and do some data conversion, responsible for controlling and managing the entire nodes; the power module provides the necessary power for the nodes separately to run the various parts.

Sensor nodes are the basis unit of wireless sensor network; node stable running ensures the reliability of the whole network. Sensor node is comprised of data acquisition module, data processing module, wireless communication module, alarm module and the power module. Node hardware connection is shown in Fig.4. The data acquisition module is used for sensing, collecting information and converting to digital signals. According to the need for monitoring parameters of coal mine, the processor module is connected to gas sensor, pressure sensor, temperature sensor, and other kinds of sensor module, which is in charge of processing the data and coordinating the whole system.

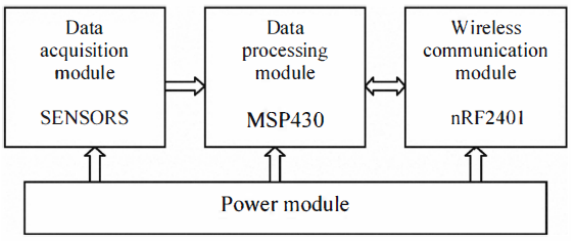

Figure 4. The data acquisition module WSN.

The wireless communication module is mainly responsible for communicating with other nodes. In addition, the energy problem is the key problem, because once nodes exhaust the energy of the battery, which will drop out of the wireless sensor network, so power consumption of the wireless sensor network should be low as far as possible.

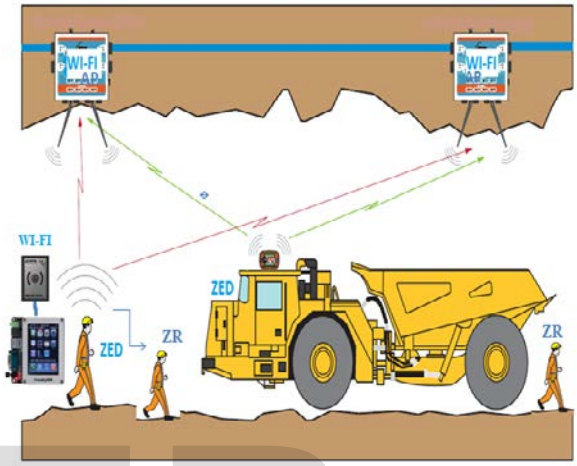

Figure 5. Tracking Methodology. The image above shows tracking movement and position using zigbee, Wi-Fi.

IV. SOFTWARE DESIGN SCHEME

In software design, communication protocol layers have the energy conservation for the center. Take the communication between the sensor nodes and the network coordinator as an example to introduce the flow of communication between the ZigBee modules. Before making communication, ZigBee module need effective initialization, the initialization process between ZigBee sensor nodes and the network coordinator shown in Figure 3. During initialization, the network coordinator issues an active signaling request to connect the sensor nodes. After the sensor nodes successfully receive and verify a data frame and MAC command frames. Return Acknowledgment frame to the sink node, the sensor node's ZigBee module is in sleep mode. After initialization, ZigBee module information processing as shown in Figure 4, the network coordinator is from the working mode to waiting for connection request signaling for the response of the sensor node, and on the regular time, the sensor nodes take the initiative request to connect the network coordinator and

report the detected security information inside the mine to the network coordinator.

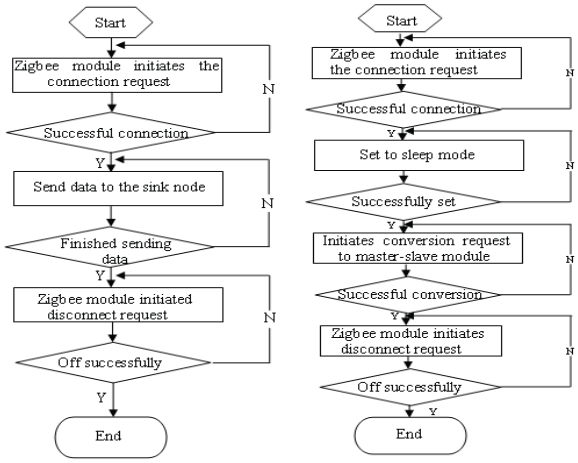

Figure 6.Design flow for initialization and processing.

The communication between sensor nodes and sink nodes, and exchange between sink nodes and networks coordination are similar. Software design mainly programmed with C language combining Lab view is responsible for the collected data display, analysis and storage etc.

The Present work, coal mine safety monitoring system based on wireless sensor networks, and hardware and software design of wireless sensor network are described in detail, this system can detect concentration of the gas, temperature, humidity, wind speed and trace the location of miners in underground mine tunnels. Wireless sensor networks applied in monitoring coal mine security breaks through the traditional methods and ideas, which improves the practical ability and flexibility of monitoring system.

V. CONCLUSIONS

This system not only can monitor all kinds of parameters under the coal mine, but also can alarm automatically when environment parameters are abnormal to exceed the limitation, which help improve the level of monitoring safety production and reduce accident in the coal mine. Therefore, the coal mine Safety Monitoring system put forward in this article quite meets the need of coal mine safety monitoring. Traditional mine safety can be effectively replaced by surveillance and safety system proposed in this paper. Along with Temperature and Humidity used get the alerts regarding moistures and hazardous gases if detected at the Site of the Sensor node. This System can extend for multiple tunnels by using sensor network and every worker; vehicle information can be monitored on base station through web page. Web based online monitoring and operation of vehicle can be further extended in future.

VI. ACKNOWLEDGMENT

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