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Coal Mining Safety Monitoring Using WSN

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ABSTRACT-

The main purpose was to provide an implementable design scenario for underground coal mines using wireless sensor networks (WSNs). The main reason being that given the intricacies in the physical structure of a coal mine, only low power WSN nodes can produce accurate surveillance and accident detection data. The work mainly concentrated on designing and simulating various alternate scenarios for a typical mine and comparing them based on the obtained results to arrive at a final design. In the Era of embedded technology, the GSM protocols are used in more and more applications. 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. The underground system collects temperature, humidity and methane values of coal mine through sensor nodes in the mine.

I. INTRODUCTION :

Industrial safety is one of the main aspects of industry specially mining industry. In the mining industry safety is a very vital factor. To avoid any types of unwanted phenomena all mining industry follows some basic precaution and phenomena. Communication is the main key factor for any industry today to monitor different parameters and take necessary actions accordingly to avoid any types of hazards. To avoid loss of material and damaging of human health, protection system as well as faithful communication system is necessary inside the underground mines. To increase both safety and productivity in mines, a reliable communication must be established between workers, moving in the mine, and a fixed base station. Inside mines, the wired communication system is not so effective. The Reliability and long life of conventional communications systems in harsh mining environments has always been a problem. Inside mines due to uncomfortable situation the installation cost as well as maintenance cost is high for wired communication networks. It is very difficult to reinstall the wired communication system inside mines after a landslide or damage due to any reason. Due to roof fall, if by any means some workers trapped inside mines, to\maintain the continuity of the communication system is very much important to know the actual position and condition of the trapped workers. To monitor other parameters during this condition it is very much necessary to maintain the communication system as usual. Accordingly, development of mine monitoring system to accurately detect temperature,

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pressure, flammable and poisonous gas and to track underground miners and vehicles on real-time has significant meaning to safety production and rescue of coal mine disaster. Generally, the coal miners are facing lot of problems in coal mines due to harmful emissions like CO2, LPG and methane gases, etc and fire accidents. Due to this, many of the people lost their lives and so much property (machinery) loss also arises. To overcome these problems, in olden days, sensor network was used for monitoring the harmful emissions as well as temperature. But this methodology having a drawback i.e., it just alerts the coal miners inside the coal mine.The existing monitoring systems underground of coal mine mostly use cable network and very often of them use wireless sensor networks but can't provide the details of the number of personnel in the mines. When an accident happened, especially explosion, the sensors and cables usually were damaged fatally, and couldn't provide information for rescue search and detection events .In this application, Wireless sensor network can solve the key issues of communication bandwidth, mobile data transmission, staff orientation, working surface real-time monitoring, synchronization monitoring and so on. The WSNs have been lately successfully employed in various applications ranging from area monitoring, landslide detection to health monitoring and other bio-medical applications.

Implementation:

ARM7

The ARM7 family includes the ARM7TDMI, ARM7TDMI-S, ARM720T, and ARM7EJ-S processors. The ARM7TDMI core is the industry's most widely used 32-bit embedded RISC microprocessor solution. Optimized for cost and power-sensitive applications, the ARM7TDMI solution provides the low power consumption, small size, and high performance needed in portable, embedded applications.

The ARM7EJ-S processor is a synthesizable core that provides all the benefits of the ARM7TDMI low power consumption, small size, and the thumb instruction set while also incorporating ARM's latest DSP extensions and enabling acceleration of java-based applications. Compatible with the ARM9™, ARM9E™, and ARM10™ families, and Strong-Arm® architecture software written for the ARM7TDMI processor is 100% binary-compatible with other members of the ARM7 family and forwards-compatible with the ARM9, ARM9E, and ARM10 families, as well as products in Intel's Strong ARM and x scale architectures. This gives designers a choice of software-compatible processors with strong price-performance points. Support for the ARM architecture today includes:

- Operating systems such as Windows CE, Linux, palm and SYMBIAN OS.
- More than 40 real-time operating systems, including qnx, Wind River's vxworks and mentor graphics' vrtx.
- Co simulation tools from leading eda vendors
- A variety of software development tools.

GSM Module

GSM (Global System for Mobile communications)is an open, digital cellular technology used fortransmitting mobile voice and data services. It is adigital mobile telephone system that is widely used inEurope and other parts of the world. GSM uses avariation of Time Division Multiple Access (TDMA)and is the

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most widely used of the three digital wirelesstelephone technologies (TDMA, GSM, and CDMA. Itoperates at either the 900 MHz or 1,800 MHzfrequency band. It supports voice calls and data transferspeeds of up to 9.6 kbps, together with the transmissionof SMS (Short Message Service) [9].The message sending module is SIM900, it is acomplete Quad-band GSM/GPRS module designed bySIMCom. SIM900 delivers GSM/GPRS850/900/1800/1900MHz performance for voice, SMS,Data and Fax in a small form factor and with lowpower consumption. SIM900 is designed as a DCE(Data Communication Equipment). It provides a fullmodem serial port, which is used for data transmissionand for sending AT commands. The SIM900 isintegrated with the TCP/IP protocol; extended TCP/IP

AT commands are developed for customers to use theTCP/IP protocol easily, which is very useful for thosedata transfer applications. Both GPS and GSM areinterfaced to the control unit using serialcommunication protocol [9].

GPS Module

The Global Positioning System (GPS) is a satellitebased navigation system that sends and receives radiosignals. A GPS receiver acquires these signals andprovides the user with information. Using GPStechnology, one can determine location, velocity andtime, 24 hours a day, in any weather conditionsanywhere in the world for free [7].There is a set of 24 satellites that are continuouslyorbiting the earth. These satellites are equipped withatomic clocks and send out radio signals as to the exacttime and their location. These radio signals from thesatellites are picked up by the GPS receiver. Once theGPS receiver locks on to four or more of thesesatellites, it can triangulate its location from the knownpositions of the satellites [7]. It is a high performance,low power satellite based model. It is a cost effectiveand portable system which accurately detects thelocation.A software standard for commercial GPS receiversis NMEA 0183. This is a serial protocol using ASCIIsentences to convey information from the GPSreceiver. According to NMEA-0183 protocol standardspecifications, GPS receiver transmits the position andspeed information to the PC and PDA etc. via the serialport. It is the most widely GPS receiver used protocolcurrently. The receiver sends multiple types ofstatements, only a few of letters in certain statements isvalid, so it needs to parse the received data, separatingout the required information.

MAX232

The MAX232 is an integrated circuit that converts signals from an RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits. The MAX232 is a dual driver/receiver and typically converts the RX, TX, CTS and RTS signals.

The drivers provide RS-232 voltage level outputs (approx. ± 7.5 V) from a single + 5 V supply via on-chip charge pumps and external capacitors. This makes it useful for implementing RS-232 in devices that otherwise do not need any voltages outside the 0 V to + 5 V range, as power supply design does not need to be made more complicated just for driving the RS-232 in this case.

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PIN DIAGRAM OF MAX232

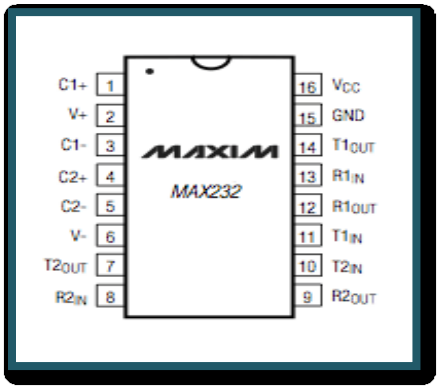

Fig 4.2: Pin Diagram of MAX232.

RS232 Interfaced to MAX 232

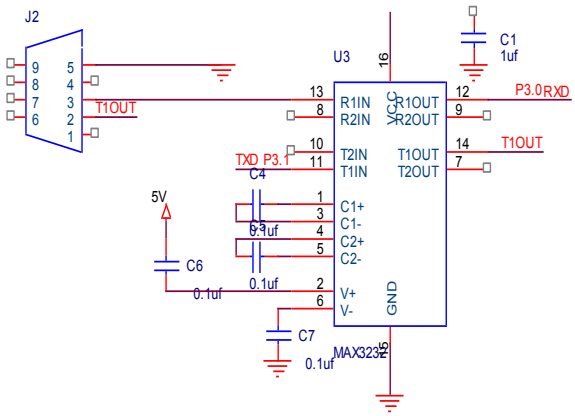

Fig 4.3: RS232 Interfaced to MAX232.

- RS232 is 9 pin db connector, only three pins of this are used ie 2,3,5 the transmit pin of RS232 is connected to Rx pin of MAX232.

3.3.2 VOLTAGE LEVELS

It is helpful to understand what occurs to the voltage levels. When a MAX232 IC receives a TTL level to convert, it changes a TTL Logic 0 to between +3 and +15V, and changes TTL Logic 1 to between -3 to -15V, and vice versa for converting from RS232 to TTL. This can be confusing when you realize that the RS232 Data Transmission voltages at a certain logic state are opposite from the RS232 Control Line voltages at the same logic state. To clarify the matter, see the table below.

Table 4.2: TTL Logic Levels

RS232 Line Type & Logic Level	RS232 Voltage	TTL Voltage to/from MAX232
Data Transmission (Rx/Tx) Logic 0	+3V to +15V	0V
Data Transmission (Rx/Tx) Logic 1	-3V to -15V	5V
Control Signals (RTS/CTS/DTR/DSR) Logic 0	-3V to -15V	5V
Control Signals (RTS/CTS/DTR/DSR) Logic 1	+3V to +15V	0V

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Temperature sensor:

For prototype, LM35 Temperature sensor was used for measuring temperature and to give analog value equivalent to the temperature to the controller. It has three pins. One is for supply (5 v DC), second pin is for analog output, and third pin is for ground. The maximum and minimum temperature limits of LM 35 are 150 and -55 degree Celsius.

Methane & CO sensors :

Methane sensor is used to measure the methane level inside the coal mine and CO sensor for measurement of CO gas level. CO sensor module gives an analog value proportional to CO level in the atmospheric air.

CONCLUSION :

This work solves the issues like prevention of second explosion caused if the amount of methane gas is high in air by early detection. Time taken for rescue work will be reduced since it is automated. Increase life safety of rescuers and coal mine workers, reduces the risk taken by rescuers and complexity.

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