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Coal Mine Safety System Using Wireless Sensor Networks and RFID Technology

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Abstract:

This paper designs a monitoring system for mine safety based on Radio Frequency Identification (RFID) wireless sensor network. In this project, there are two sections. The first section is underground section another section is ground section. In the underground section the sensor will sense the environment conditions such as temperature, humidity, gas, noise, tilt and this information is sent to the micro controller. Micro controller sends the information through RFID transmitter. In ground section RFID receiver takes that information and sends to the controller and the controller sends the information to Global System for Mobile communication (GSM) modem as well as displays on the LCD. Here GSM modem sends the message to mobile whenever the sensor senses the data above threshold level. Also, a buzzer rings whenever there is danger.

Keywords: RFID, Transmitter, GSM, microcontroller.

1.Introduction

We know that mining is the one of the major sector for the economic growth of the country. More number of people are employed in the mining department but there is a larger probability of occurrence of accidents inside the mining area. So, a system must be placed to reduce the probability of accidents. Several systems are designed to reduce the number of accidents. Day-by-day with the increase in the new technologies and analysing different types of accidents which are occurring inside the mining more systems with advanced technology are implemented. Various types of sensors are also used to reduce the occurrence of accidents. Now a day's wireless sensor networks are used everywhere because they are reliable, easy to maintain and the communication which plays a major role is easy. The communication between the sensor nodes is very fast and reliable. So, we can use this technology in various applications so that the count in the number of accidents decreases.

2. Literature survey

In designing the coal mine safety system, various systems have been proposed, in which the first system was developed using wired network. In 2005 YU et al proposed a real-time forest fire detection system based on wireless sensor network [1]. They designed the monitoring and detecting sensor networks using neural network. Some systems were designed to provide alert system and provided necessary strategies for the selection and installation of ideal fire alarm system. Some systems were designed based on wireless sensor networks for monitoring the dangerous gases concentration [2] in the under-ground mine.in our proposed system, all the probabilities of occurrence of accidents in the mining area are considered and different sensors are placed to reduce the accidents inside the mining.

3. Methodology

The existing monitoring systems include a wired network. This kind of network has poor performance of expansion. The cables are easy to ageing and have high possibilities of failures. When an accident occurs, especially explosion, the sensors and cables usually are damaged and couldn't provide information for rescue search and detection events. Wireless sensor network can solve the key issue of communication bandwidth, mobile data transmission, working on real time monitoring [1] and having synchronisation while monitoring. This project is mainly a monitoring system based on RFID technology to build wireless sensor network. The sensor nodes will send the collected data to the micro controller. The micro controller that we are using is ATMega328p and then the controller receives the data and sends it to the RFID receiver through which danger signal is sent to GSM modem as well as displayed on the LCD. Here GSM modem

sends the message to mobile when the sensor senses a value greater than the threshold level. In this project, various types of sensors are used. They are temperature, humidity, gas, noise, tilt sensor. All these sensors sense different parameters in the mining area.

Architecture:

The architecture consists of a microcontroller which is a main processing unit for signal processing [2]. The micro controller we are using is AT Mega 328p. Different types of sensors such as temperature, humidity, title, gas are used. On the other side, RFID, which is used for the communication and to give specifications about the area where there is information is collected. An LCD is placed to give the warning indication to the people working in the mining environment and GSM is used to give the form of message to a mobile phone about the accident to take necessary action about the incident.

Humidity Sensor (DHT 11):

Humidity sensor is mainly used for checking the moisture level in the environment. The sensor that we are using is DHT11 which is a combination of both humidity and temperature sensor. DHT11 is a low-cost sensor which provides high reliability and long term stability. The DHT11 comes in two variations: just the sensor or the module. The main difference is that the module consists of the pull-up resistor and may also include a power ON LED. We have used a module in this project and if you wish to use the sensor itself, you need to connect a 5KΩ pull-up resistor additionally. Coming to the design, the data pin of the pin 11 of Arduino A 16 x 2 LCD display is used for the result.

Tilt sensor:

A tilt sensor [4] is an instrument that is used for measuring the tilt in multiple axes of a reference plane. Tilt sensors measure the tilting position regarding the gravity, and are used in numerous applications. They enable the easy detection of orientation or inclination. These instruments are being used in the bigger applications. For example, the sensor provides valuable information about both the vertical and horizontal inclination of an airplane, which helps the pilot to understand how the current orientation of the plane and the angle at which the plane is inclined to the earth's surface, an also can be placed in stunt planes. Tilt sensors are an essential decision making tool for the pilots. In this project the tilt sensor is used to check the inclination of the land inside the mine so that when the upper surface inside danger.

Noise sensor:

Noise sensor is sensitive to the sound in the environment, generally to be used to detect the intensity of the ambient sound. If the data collected by the sensor is greater than the threshold level, then the output is high and the signal is sent to the micro controller for processing and if the sensed data is less than the threshold value then there is no change in the output. The threshold level is calculated by the environment inside the mine. This indicates that there are some disturbances inside the mining area.

Gas Sensor(MQ6):

This is a gas sensor, suitable for sensing LPG, methane and other dangerous gases (composed of mostly propane and butane) concentrations in air. The MQ-6 can detect gas concentrations anywhere from 200-1000ppm.this sensor has a high sensitivity and fast response time. The sensor's output is an analog resistance. The drive current is very simple; all we need to do is power the heated coil with 5V, add a load resistance, and connect the output to an ADC. The ADC is nothing but analog to digital converter. The output of ADC is given to the micro controller.

Microcontroller (ATmega328p):

The high performance Microchip Pico power 8-bit AVR RISC-based microcontroller[3] combines 32KB ISP flash memory wit read-while-write capabilities,1024B EEPROM,2KB SRAM,23 general purpose I/O lines,32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, a 6-channel 10-bit A/D converter(8-channels in TQFP and QFN/MLF packages),programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates

between 1.8-5.5 volts. By executing powerful instructions in a single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed.

RFID:

RFID tagging is an ID system that uses small radio frequency identification devices for identification and tracking purposes. An RFID tagging system includes the tag itself, a read/write device, and a host system for data collection, processing, and transmission. An RFID tag (sometimes called an RFID transponder consists of a chip, some memory and an antenna. RFID tags that contain their own power source are known as active tags. Those without a power source are known as passive tags. A passive tag is briefly activated by the radio frequency scan of the reader. The electrical current is small –generally just enough for transmission of an ID number. Active tags have more memory and can be read at greater ranges. Increasingly RFID tagging is used in a supply chain management as an alternative barcode technology. Although more expensive use than the bar code stickers, RFID tags don't get dirty or fall off or require an unobstructed line-of-sight between the tag and the reader.

There are almost endless possible uses for RFID tagging. Injectable ID chips have been used to track wildlife and livestock for over a decade. An injectable RFID tag called the verichip can be used to help medical personnel identify a patient who is unable to speak and even provides access to the person's medical records. The RFID tags are mainly used for locating the specific area. The specific area can be designed by programming.

LCD:

The liquid crystal display is a flat panel display or electronic liquid crystal display do not emit the light directly and uses the property of light monitoring display. The 16x2 liquid crystal display contains two horizontal lines and they are used for compressing the space of 16 display characters. LCD has two registers. One is command register and another one is data register. The command register is used to insert a special command in the LCD. The data register is used to enter the line in the LCD. The interfacing with the Arduino module is done by connecting the RS pin of the LCD to the pin 12 of the Arduino. The R/W pin is connected to the ground. The pin 11 of the Arduino is connected to the enable signal pin of LCD module. The LCD module and Arduino module are interfaced with the 4 -bit mode in this project. So, the 4 input lines which are used are DB4 to DB7. These pins are interfaced with 5-2 pins of Arduino.

GSM:

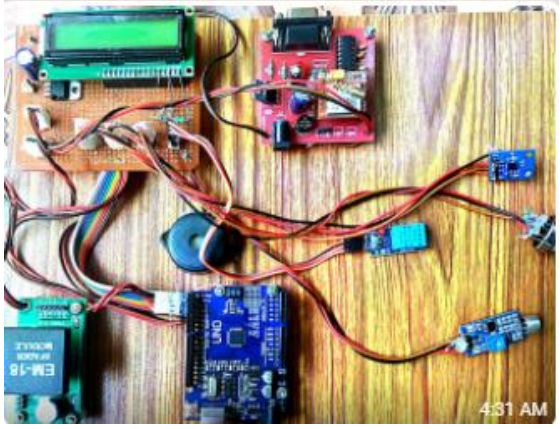
GSM (Global system for mobile communication) is a digital mobile telephone system that is widely used in many parts of the world**.** GSM has been dubbed the "wireless revolution" and it doesn't take much to realise why GSM provides a secure and confidential method of communication. GSM uses a Variation of Time Division Multiple accept(TDMA) and it is the most widely used of the three digital wireless telephone technologies (TDMA, GSM and CDMA). GSM digitizes and compresses data, then sends it down a channel with two their streams of user data, each in its own time slot. GSM operates in the 900MHz,1800MHz, or 1900 MHz frequency bands. GSM together with other technologies such as RFID is part of an evolution of wireless mobile telecommunication that includes high speed circuit-switched data(HCSD), General Packet Radio System(GPRS), Enhanced Data GSM Environment (EDGE), and Universal Mobile Telecommunication service (UMTS). GSM security such as theft of service, privacy, and legal interception continue to raise significant interest in the GSM community.

Simulation:

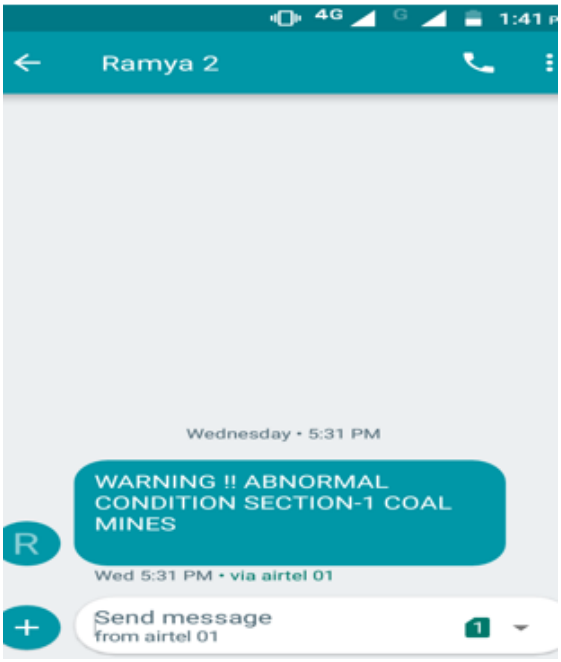
As we are using Arduino, we also require a program that has to be dumped inside the hardware.

Results:

The final project looks like the below figure



Whenever there is any abnormal condition inside the mining department, an alert message to the respected phone number which is done by using GSM module.



We also have a LCD screen to display the amount of temperature, humidity, gas, tilt in the mining area to give an alerting signal to the people working under the ground.

Conclusion:

The study on real time monitoring of toxic gases and other parameters present in underground mine has analysed using wireless Sensor network. A real-time monitoring system is developed to provide clearer and more point to point perspective of the underground mine. This system is displaying the parameters on the LCD at the underground section where sensor unit is installed as well as on the monitoring unit; it will be helpful to all minors present inside the mine to save their life before any casualty occurs. Alarm triggers when sensor values cross the threshold level. This system also stores all the data in the computer for future inspiration. From the experiments and observations, the following conclusion can be drawn:

(i) Each node in a frame work functions as the pioneer robot when all its parameters are configured properly.

(ii) Sensor nodes can reconfigure remotely over a wireless network and most of the processing done in software on computer side.

(iii) The calibration equations of gas sensors may have affected the accuracy of the ppm results.

Future Scope:

Using more number of sensors, we can monitor more data such as detection of dangerous gases, vibrations, fire and all other possibilities of occurrence of accidents. RFID can be used for surveillance of mining operation such as subsidence, water leakage etc.

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