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Coal Mine Safety Monitoring System Using ARM9

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Abstract: ***Coal is mined in every country which is mainly used to generate electricity. Thousands of mine workers were killed every year due to many disasters takes place inside coal mine. These accidents are caused mainly due to the leakage of poisonous gas [2] present in the mine. Especially developing countries face a poor safety system for mine workers. Hence it requires a safety monitoring system [1] provides safety factors and good decision making basis for underground environment. This paper provides a wireless monitoring system which provides a reliable communication even during disaster. The system has a underground system which collects temperature, humidity, methane gas and CO gas values and transmits it to the base station through Wi-Fi with a ARM9 core. Also this system provides online monitoring [3] by updating the values into a web server.***

Keywords: Coal mine, Monitoring system, Wi-Fi, ARM9, Web Server

1. Introduction

Coal plays a major role in electricity generation worldwide. Currently 40% of global electricity is powered by coal. Billions of tons of coal is mined every year and the need is increasing day by day. Coals are mined in underground and opencast pits where underground mining involves higher risk due to leakage of gases and mind collapse. Most of the accidents go unreported as mines mainly consist of random passages and branch tunnels. This structure makes it difficult for the deployment of any network. So safety is the important factor to be considered in mining industry [4]. Developing countries face a great challenge in proving safety measures. Communication is the key factor for any environment to continuously monitor and control the environment in case of occurrence of any hazards. There should be a reliable communication system between miners and the control room to avoid loss of human lives. The existing systems provides coal mine monitoring uses cabled network which is not reliable and damaged totally in case of any disaster and mine collapse. When an accident takes place both cables and sensors are damaged which cannot provide information in rescuing the miners and save them. Also it is more costly in reconstructing the cable. Some research has been done on using wireless sensor networks but it was not efficient in providing details of number of persons inside mines [5], communication bandwidth, real-time monitoring environment. And the sensor nodes have limited storage capacity, limited range and cannot transmit data in case of any collapse. Power requirement is also another challenge as those networks should consume very less power. Therefore we can make use of the wireless sensor network to monitor production safety of coal mine. So, wireless communication is the burning need today for the fast, accurate, flexible safety and production process in underground mines. The proposed system consists of an underground section and a base station. The sensors in the underground section will send the collected data to the ARM controller. Then the controller receives the data and sends them to the ground PC by the use of Wi-Fi protocol. The sensor values are also updated to the web server for online monitoring. Wi-Fi replaces Ethernet directly with wireless technology and they can be connected to a router and accessed across the internet.

2. Objective

1) To check the presence of methane gas inside the mine
2) To check the temperature and humidity values
3) To check heart beat of the miner
4) To save the life of worker who may die by numerous explosion taking place inside the mine
5) To provide whole interconnection, Wirelessly using Wi-Fi topology
6) To control and monitor using web server

3. Hardware Description

3.1 Power supply

In this system we are using 3.3V power supply for microcontroller of Transmitter section as well as receiver section. We use rectifiers for converting the A.C. into D.C and a step down transformer to step down the voltage.

3.2 Arm9 LPC3131

ARM [6] stands for Advanced RISC Machines. LPC3131 operates at 180 MHz. It has 192 kB RAM along with a NAND flash controller with 8-bit ECC. It also consist of high-speed USB 2.0 (OTG, Host, Device) with on-chip PHY, two I2S-bus interfaces Integrated master/slave SPI Two master/slave I2C-bus interfaces Fast UART Memory Card Interface (MCI): MMC/SD/SDIO/CE-ATA Four-channel 10-bit ADC for digital conversion.

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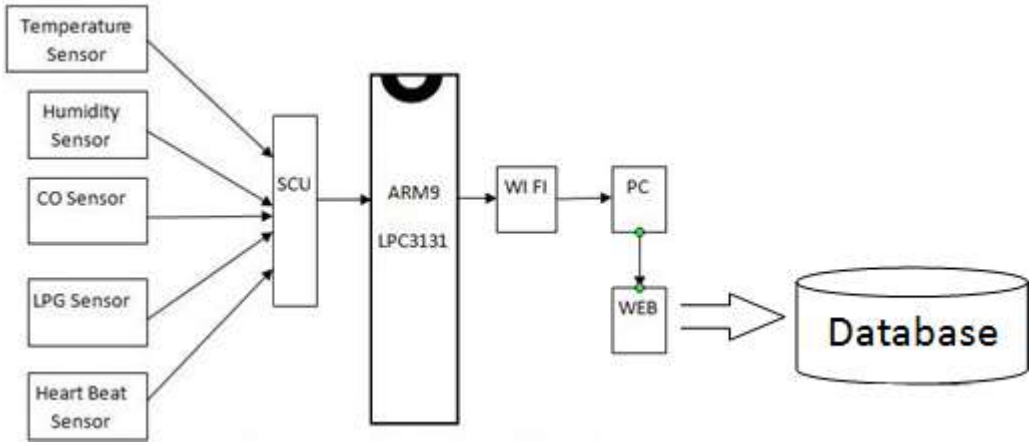


Figure 1: Block diagram of base station

3.3 CO Sensor

Carbon monoxide detectors trigger an alarm based on an accumulation of carbon monoxide over time. Detectors may be based on a chemical reaction causing a color change, an electrochemical reaction that produces current to trigger an alarm, or a semiconductor sensor that changes its electrical resistance in the presence of CO. Fig 2,Most carbon monoxide detectors require a continuous power supply, so if the power cuts off then the alarm becomes ineffective.



Figure 2: CO Sensor

3.4 Smoke sensor

Smoke sensor Sensitive material of MQ-2 gas sensor is SnO2, which with lower conductivity in clean air. When the target combustible gas exist, the sensor's conductivity is higher along with the gas concentration rising. Fig 3, MQ-2 gas sensor has high sensitivity to LPG, Propane and Hydrogen, also could be used to Methane and other combustible steam, it is with low cost and suitable for different application.



Figure 3: Smoke sensor

3.5 Temperature sensor

Temperature sensors are those detect **Temperature** or heat as shown in the Fig 4. These types of temperature sensor vary from simple ON/OFF thermostatic devices which control a domestic hot water heating system to highly sensitive semiconductor types that can control complex process control furnace plants.

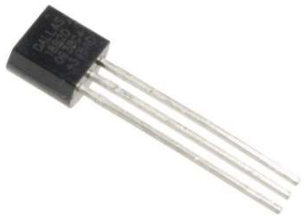


Figure 4: Temperature Sensor

3.6 Humidity sensor

Humidity is the presence of water in air. The amount of water vapor in air can affect human comfort as well as many manufacturing processes in industries as shown in the fig 5. The presence of water vapor also influences various physical, chemical, and biological processes. critical because it may affect the business cost of the product and the health and safety of the personnel. Hence, **humidity sensing** is very important, especially in the control systems for industrial processes and human comfort.



Figure 5: Humidity sensor

3.7 Wi-Fi module

Bluegiga's WF121 is a stand-alone Wi-Fi module providing fully integrated 2.4GHz 802.11 b/g/n radio, TCP/IP stack and a 32-bit micro controller (MCU) platform for embedded applications requiring simple, low-cost and low-power wireless IP connectivity as shown in the fig.6 . It also provides flexible peripheral interfaces such as SPI, I2C, ADC, GPIO, *Bluetooth* co-existence, and timers to connect various peripheral interfaces directly to the WF121 Wi-Fi module. These fully-certified surface mount Wi-Fi modules allow designers to quickly and seamlessly add internet

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connectivity to their applications. The modules' small form factor, rich features, and ultra-low power make them perfect for mobile wireless applications such as asset monitoring, sensors, and portable battery operated devices.

The WF121 Wi-Fi module also allows end-user applications to be embedded onto the on-board 32-bit MCU, using a simple Bluegiga BGScript™ scripting language and free-of-charge development tools. This eliminates need for and additional MCU and enables end users to develop smaller and lower cost Wi-Fi devices. The WF121 can also be used in modem-like mode in applications where the external MCU is needed. The 802.11 access point and HTTP server functionality is also included for easy configurations and direct connections with phones, tablets, and PCs.

With an integrated 802.11 radio, antenna, single power supply, and CE, FCC, and IC regulatory certifications, the WF121 provides low-risk and fast time-to-market for applications requiring Wi-Fi connectivity.

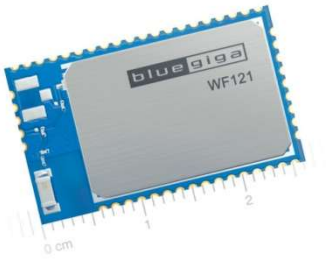


Figure 6: Wi-Fi module

4. Simulation

Software's used here are Keil software for C programming, Express PCB for lay out design and Express SCH for schematic design. After entering into Keil µ Vision i.e. after starting new project, the program can be written in C language or ASM, and then the program has to be run successfully. The computer stores the parameters in the hard disk and ground staff can [7] choose any of the parameters for recording and replaying. When it is found that the parameters received goes out of range the controller will ring the alarm and the computer at ground control centre also gives the alarm ring and the alarm pictures.

Step1: First we are initializing Wi-Fi and LCD to receive the parameter values and to display it for monitoring purpose.

Step2: Receiving the parameters such as Temperature, Humidity, gas values continuously from the underground section through Wi-Fi.

Step3: Uploading the received parameters into web server which makes monitoring can be done through online.

5. Conclusion

A safety system is developed for Cole mine workers using wireless sensor networks. A larger area and more depth inside hazardous underground mines are now can be covered and potential accidents can be controlled effectively. And also in this paper Wi-Fi repeaters are used instead of sensor nodes which can cover higher range and also more robust i.e., can transmit signals even during disasters.

Web server based wireless coal mine monitoring system proves to be very effective in monitoring the atmospheric conditions of underground places in coal mines. A step by step approach in designing the coal mine safety system for preventing hazardous gas or fire accidents will be identified through this system using sensors and will be updated in the base station through wireless technology i.e., Wi-Fi. In the base station we are updating the information of mining place to web server. In any emergency cases in the underground section we have alarms to indicate the emergency and from the base station through an GSM modem we send alert messages to the respective authorities. The system has successfully overcome some of the aspects existing with the present technologies, by the use of wireless technology for communication between underground section and base station regarding the emergency situations in coal mines.

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