

“Microcontroller Based Smart Helmet for Coal Miners Safety”

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Abstract— In this paper main focus on the miners supervising system, which is based on the cost effective wireless network. Real time monitoring with initial warning intelligence on harmful gases, helmet removal, collision detection in mining area and RF module used for information transfer to reduce safety problems in coal mining area for this purpose we develop smart helmet. All these parameters are detected continuously by gas sensor, collision sensor, and helmet remover sensor and if they cross the pre-defined limit, then the remote device gets alert as the buzzer will automatically turn on with LCD display shows the status. As the system consisting of microcontroller transmitter and receiver the system can be easily extended. The values of different sensors are continuously transmitted by RF transmitter to the remote monitoring unit which is received by RF receiver module.

Index Terms— Sensors, RF transmitter, RF receiver.

1) INTRODUCTION

The most important part of any type of industry is safety. In the mining industry safety and security is a first aspect of all. To avoid any types of unwanted conditions, every mining industry follows some basic precaution. Communication is the most vital key factor today, to monitor different parameters such as collision, gas, and helmet remover continuously using sensors such as collision sensor, gas sensor MQ5 and Helmet sensor to take necessary actions accordingly to avoid any types of hazardous

conditions and gives an alert using buzzer. To achieve safety in underground mines, a suitable communication system must be created between workers, moving in the mine, and a fixed base station. The wired communication network technology system will be not so effective. Under the mines due to uncomfortable situation the installation cost as well as maintenance cost is high for wired communication networks. For the successfully wireless data transmission, in this work a low cost RF transmitter and receiver. A cost effective based wireless mine supervising system with early-warning security.

2) WORKING

The intelligent security system consists of a helmet, which is mounted with the sensor circuits. The transmitter section has a microcontroller which receives input from various sections like gas sensor, collision sensor, and helmet remover sensor and in certain case when dangerous event occurred then helmet transfer alert towards RF receiver via. RF transmitter. RF (Radio Frequency) receiver receives RF signals produced by RF transmitters fixed on various spots in the coal mine to identify the location of miner. These RF transmitters will emit RF signals containing corresponding location information. These signals are received by the RF receiver placed in the helmet and it will decide this location information

and fed into the microcontroller. For the simplicity to demonstrate, here in this project, four different locations are chosen and corresponding information is given through a single RF transmitter with the help of switch. Four switch positions are predetermined for four locations. On receiving a signal corresponding to a particular location, the microcontroller will be able to identify the position of the coal miner. The collision sensor, helmet remover and gas sensors will sense the corresponding parameters [2].

3) SYSTEM ARCHITECTURE

Block Diagram

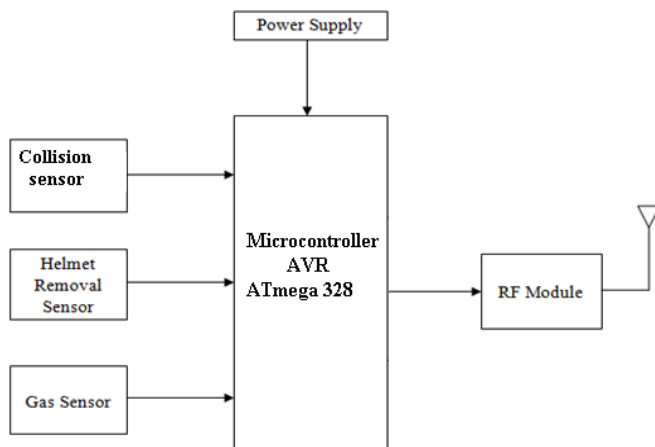


Fig.1. Block Diagram of Transmitter

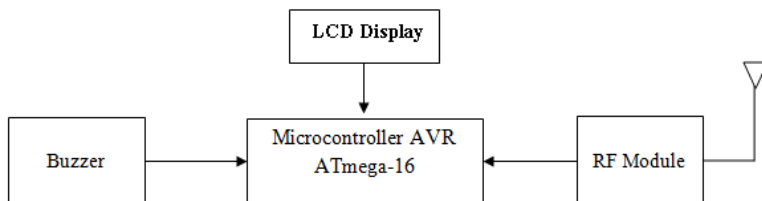


Fig.2. Block Diagram of Receiver

The helmet section consists of gas, Collision and helmet removal sensors, RF transmitter for communication and microcontroller AVR ATmega-328 [1]. Inputs to the microcontroller are from gas, collision sensor, helmet removal sensors outputs, RF Module. Fig.1. MQ-5 is the gas sensor which is able to detect the level of CO, LPG, CH₄ gases.

The receiver section consists of RF module, microcontroller AVR ATmega16, LCD display screen and buzzer as shown in fig.2. The receiver section receives the data which is transfer from transmitter section and displays it on the LCD Display screen.

4) HARDWARE

A) Sensor Network

i) Air Quality Sensor:

In this project we used MQ5 gas sensor to identify the level of dangerous gases in air. The MQ5 gas sensor device is used to detect various types of gases such as hydrogen, carbon monoxide and methane. MQ5 gas sensor is a device which is highly sensitivity to detect LPG. The cast of MQ5 is low and it is suitable for different application.

ii) Collision Sensor:-

In order to identify collision on the miners head, a pressure sensor is used. In this project we used piezoelectric sensor to used measure pressure. A piezoelectric sensor is a device which used piezoelectric effect. Piezoelectric effect means the ability of material which converts mechanical stress into AC voltage or converts AC voltage into mechanical stress.

iii) Helmet removal Sensor:-

Helmet removal Sensors for coal miners is designed to be attached to the inside of a safety helmet. In this

project IR sensor is used as a helmet removal sensor. When miner remove the safety helmet then IR sensor is turn off and system detect helmet remove event

B] Arduino328

Arduino328 is a microcontroller, the central controller for the whole unit of transmitter section. Arduino328 is based on the ATmega328. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, and a reset button. The board can be programmed with Arduino Software (IDE). The board can operate on an external supply from 6 to 20 volts. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. The ATmega328 has 32 KB flash memory. It also has 2 KB of SRAM and 1 KB of EEPROM.

C] Microcontroller AVR ATmega-16

In this project we used microcontroller AVR ATmega16 in the receiver section. Microcontroller ATmega-16 is 40 pin IC, 8 bit microcontroller and it is base on CMOS technology. ATmega-16 consists of 16 KB flash memory, 512 bytes EEPROM and 1 KB of SRAM. It required 4.5 to 5.5 volts for its operation.

D] RF Module

In this project CC2500 RF module is used for wireless alert information transfer from transmitter to receiver section. The CC2500 is simple to use radio frequency communication at 2.4GHz. For data transmit and receive it use 9600 baud rate and this RF module does not required any extra hardware or coding for data transfer.

F] Buzzer

Buzzer is device which is used for audio indication. In this project buzzer is used to alert monitoring section when RF receiver receives alert information

and send towards buzzer through microcontroller. It required 5volts for its proper operation.

5) RESULTS AND DISCUSSION

Safety helmet removal test is done by using infrared sensor. When helmet is removing then helmet removal event is detected then transmitter section send “HELMET REMOVED” alert status towards monitoring section by using RF transmitter. In monitoring section LCD display shows the alert status and at the same time buzzer is turn on. This test give 100% satisfaction and the obtain result is shown in figure 3.

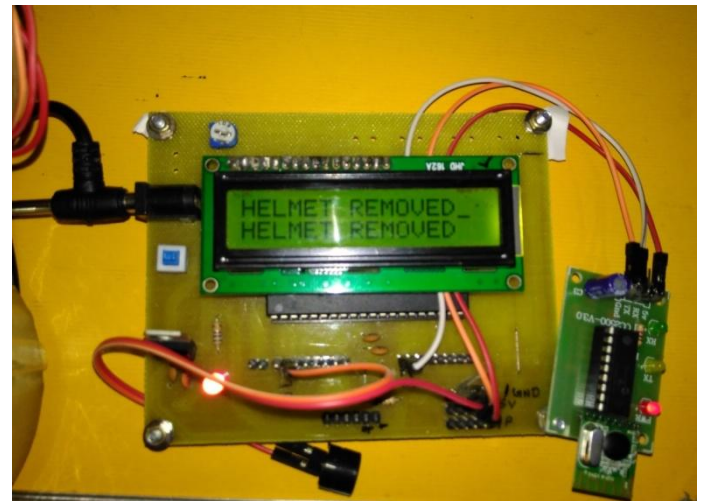


Figure No. 3 Helmet Removal Test Result

Air quality sensor test is done by using MQ5 gas sensor. When the gas sensor MQ5 is detect high level of toxic gases then transmitter section send “GAS DETECTED” alert status by using RF transmitter towards monitoring section and the alert status is show on LCD display, at the same time buzzer is turn on. The air quality sensor test result is show on LCD Display in fig. 4

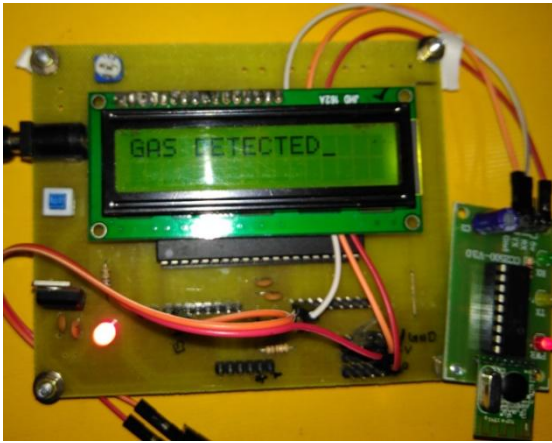


Figure No.4 Air Quality Sensor Test Result

Collision sensor test is done by using piezoelectric sensor. In this test when any object is fall on the

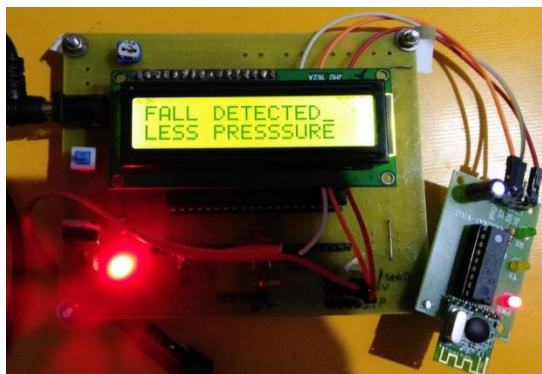
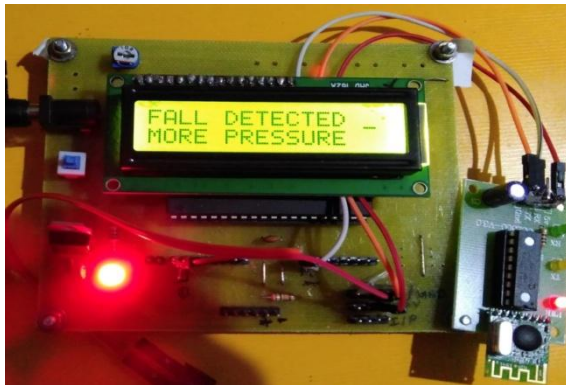


Figure No.5 Collision Sensor Test Result

helmet then pressure is detect and the transmitter section send “FALL DETECTED LESS/MORE PRESSURE” alert status by using RF transmitter towards monitoring section and the status is show on LCD display, at the same time buzzer is turn on. The

collision sensor test result is show on LCD display in fig. 5

6) CONCLUSIONS

A prototype of smart helmet is developed to detect various types of dangerous event such as air quality, miner removing the safety helmet and collision on miner head and send this dangerous event information towards the monitoring section which provides rescue operation for the miner. The present Mine security system can be effectively replaced by using this rescue safety system. This system covered the most Important and Primary necessity aspect of any mine workers safety. The monitoring of depth and dangerous mines is made easy with this paper. In this paper we used Low power RF transmission and receiver. All the sensors can be easily place on helmet that helps in continuous monitoring.

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