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ABSTRACT

Today safety of miners is a major challenge. Miner's health and life is vulnerable to several critical issues, which includes not only the working environment, but also the after effect of it. Mining activities release harmful and toxic gases in turn exposing the associated workers into the danger of survival. This puts a lot of pressure on the mining industry. To increase the productivity and reduce the cost of mining along with consideration of the safety of workers, an innovative approach is required. An intelligent Mine Safety System Monitoring and Alerting based on Wireless Network is developed. This system monitors surrounding environmental parameters such as temperature, humidity and multiple toxic gases. A microcontroller is used for controlling these operations. This system also provides an early warning, which will be helpful to all miners present inside the mine to save their life before any casualty occurs. 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 or control room. 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. A good communication system must be set between mine workers and Remote Control room, for this wired network communication is inefficient in underground mining areas. For the successfully wireless data transmission, RF module can be properly utilized. This wireless communication system is going to be design by considering all the environmental parameters inside underground mines. It can sense temperature, smoke, fire, gas as well as vibration inside mines. Therefore the proposed system will be giving a very good solution for most of the problems faced in mine accidents. Wireless system is cost effective and useful than wired safety system.

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LIST OF FIGURES

LIST OF ABBREVIATIONS

S.NO	ABBREVIATION	EXPANSION
1	WSN	Wireless sensor network
2	PC	Personal computer
3	RF	Radio frequency
4	MEMS	Micro Electro Mechanical Systems
5	ANSI	American National Standards Institute
6	USB	Universal Serial Bus
7	LCD	Liquid Crystal Display
8	IDE	Integrated Development Environment
9	PWM	Pulse Width Modulation
10	ICSP	In Circuit Serial Programming
11	DC	Direct Current
12	AC	Alternating Current
13	UART	Universal Asynchronous Receiver/Transmitter
14	LPG	Liquefied Petroleum Gas
15	ADL	Architecture Description Language
16	UML	Unified Modeling Language
17	ADC	Analog to Digital Converter
18	GUI	Graphical User Interface
19	RTD	Resistance Temperature Detector

PROFOMA FOR APPROVAL OF PROJECT WORK PROPOSAL

Proposed Project Work by:

Reg. No	Name of the Student	Semester	Branch
13171056020	EMILIANA B. SHAYO	VIII	ISNE
13171056038	NEEMA H. MPEMBENI	VIII	ISNE
14173056071	MUUMIN NGUDE	VIII	ISNE

Title of the project	**INTELLIGENT MINE SAFETY SYSTEM MONITORING AND ALERTING BASED ON WIRELESS NETWORK**
Subject Area	Embedded Systems and Networking
Name of the Guide	Mr. S. Karthikeyan
Designation	Assistant Lecturer

Signature of the Student

…………………………..
(Ms. Emiliana B. Shayo)

…………………………..
(Neema H. Mpembeni)

…………………………..
(Muumin Ngude)

Signature of the Guide with date

……………………………………..
(Mr. S. Karthikeyan)

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SYNOPSIS	APPROVED		NOT APPROVED	
GUIDE	APPROVED		NOT APPROVED	

SIGNATURE OF THE HOD

………………………………...

Date……………………………

BIO-DATA OF THE PROPOSED GUIDE FOR PROJECT WORK

1.PERSONAL INFORMATION

Name	:MR. S. KARTHIKEYAN
Date of Birth & Age	:28/05/1985
Sex	:Male
Academic Qualification	:M.E
Official Address	:ISNE Block, 2nd floor, Room Number R-86 ISNE department staff room St. Joseph College of Engineering and Technology PO.BOX:11007, Dar Es Salaam, Tanzania
Phone No. and Fax.	:+255(0)659297456
Residential Address	:Staff Quarters, 1st Floor, Room Number 2 St. Joseph College of Engineering and Technology PO.BOX:11007, Dar Es Salaam, Tanzania
Phone No. and Email id	:+255625488254,karthickbism@yahoo.com

2.DETAILS OF EMPLOYMENT

Designation	:Assistant Lecturer
Field of Specialization	:Networking
Teaching Experience(years)	:5years
Industrial Experience(years)	:2years
Particulars of contribution experiencing the field of specialization	10(years)
No. of Projects Guided	:20

I **Mr. S. Karthikeyan** do hereby accept to guide **Ms Emiliana B. Shayo, Ms Neema H. Mpembeni, Mr Muumin Ngude** the students of Information Systems and Network Engineering Program of the St. Joseph College Of Engineering and Technology, Tanzania.

Signature of the Guide

………………………
(Mr S Karthikeyan)

ST.JOSEPH UNIVERSITY IN TANZANIA

CERTIFICATE OF THE GUIDE

Certified that this project report **"INTELLIGENT MINE SAFETY SYSTEM MONITORING AND ALERTING BASED ON WIRELESS NETWORK"** is the bonafide work of **Ms. Emiliana B. Shayo (13171056020), Ms. Neema H. Mpembeni (13171056038) and Mr. Muumin Ngude (14173056071)** who carried out the project work under my supervision. This thesis work is original one and not submitted earlier for the award of any degree / diploma elsewhere.

SIGNATURE	**SIGNATURE**
…………………………………..	**………………………………**
HEAD OFTHE DEPARTMENT	**PROJECT GUIDE**

INTERNAL EXAMINER	**EXTERNAL EXAMINER**
NAME:	**NAME:**
SIGNATURE	**SIGNATURE**
…………………………………	**……………..………………...**

DECLARATION BY THE CANDIDATE

We **MS. EMILIANA B. SHAYO (13171056020), NEEMA H. MPEMBENI (13171056038), and MR. MUUMIN NGUDE (14173056071)** declare that that this project report **“INTELLIGENT MINE SAFETY SYSTEM MONITORING AND ALERTING BASED ON WIRELESS NETWORK”** submitted to **St. Joseph college of Engineering and Technology, Tanzania ,**is the partial fulfillment of requirements for the award of Degree in **Information Systems and Network Engineering** is a record of the original work done by ourselves under the supervision of **MR. S. KARTHIKEYAN.** This thesis work is original one and not submitted earlier for the award of any degree/diploma elsewhere.

SIGNATURE OF THE STUDENTS

…………..………………

(Ms Emiliana B. Shayo)

…………………………..

(Ms. Neema H. Mpembeni)

……………………………

(Mr. Muumin Ngude)

CHAPTER ONE

INTRODUCTION

1.1 SYSTEM OVERVIEW

Underground mining operations prove to be a risky venture as far as the safety and health of workers are concerned. These risks are due to different techniques used for extracting different minerals. The deeper the mine, the greater is the risk. These safety issues are of grave concern especially in case of minerals industries. Thus, safety of workers should always be of major consideration in any form of mining, whether it is coal or any other minerals.

Underground mining involves a higher risk than open pit mining due to the problems of ventilation and potential for collapse. However, the utilization of heavy machinery and the methods performed during excavations result into safety risks in all types of mining.

Modern mines often implement several safety procedures, education and training for workers, health and safety standards, which lead to substantial changes and improvements of safety level in opencast and underground mining.

Minerals have always been the primary resource of energy in most of the countries, which has significantly contributed to the rapid industrial development of the country. About 70% of the power generation is dependent on it thus, the importance of minerals in energy sector is indispensable. But the production brings with it the other by products, which proves to be a potential threat to the environment and the people associated with it. Instead of that the present work is a sincere attempt in analyzing the graveness and designing a real time monitoring system of detection by using the wireless technology.

1.2 PROJECT OBJECTIVES

Mining environment often has hidden dangers within such as toxic gases, which may present severe health exposures to the people working within mining. These gases need to be detected at times and informed the dangerous situation in right time for the safety of miners. Wired network monitoring systems have assisted the mine safety significantly, but it is not idea for all types of mining environment.

An intelligent mine monitoring systems may assist in monitoring and control over the mining environment. Wireless technology offers its most of the advantages ideal for the real-time monitoring system. Thus, the primary objective of this project is decided to design an efficient intelligent mine monitoring system so that various leaked mine gases could be identified at times and preventive measures could be devised accordingly. The research investigations to be carried out with the following objectives:

1. Detection of different toxic gases within mining environment

2. Communication establishment between sensors and RF module

3. Establishment of Wireless Sensor Network

4. Design of intelligent mine monitoring system

1.3 BACKGROUND AND MOTIVATION

In underground mine, ventilation systems are critical to supply adequate oxygen, keeping up non-dangerous and non-lethal environments and an effective working mine. Monitoring underground mine can help killing high hazard environments. Primitive procedures of monitoring a mine's air can be followed back to the utilization of canaries and different creatures to ready diggers when the climate gets to be lethal. Incorporating ventilation monitoring systems empowers a mine to insightfully roll out ventilation improvements in view of the far reaching information given by the monitoring systems. Sudden changes in the ventilation system are identified by the monitoring system, permitting quick move to be made. New and creating correspondence and following systems can be used to monitor mines more proficiently and transfer the information to the surface.

The progression of technology has allowed mine monitoring techniques to become more sophisticated, yet explosions in underground mines still occur. The safety issues of mines have gradually turned into a major concern for the society and nation. The occurrence of disasters in mines is mainly due to the harsh environment and variability of working conditions. So, it makes the implementation of mine monitoring systems essential for the safety purpose. Wired network systems used to be a trend for traditional coal mines, which have really played a significant role in safely production in mines. With the continuous enlargement of exploiting areas and depth expansion, laneways have become blind zones, where numerous unseen dangers are hidden out. Moreover, it is not possible there to lay expensive cables, which is also time consuming. So, it is essential to have a wireless sensor network mine monitoring system, which can be disposed in such mines in order to have a safe production within.

Wireless sensor networks (WSNs) have earned a significant worldwide attention in current scenario. A WSN is a special ad-hoc, multi-hop and self-organizing network that consists of a large number of nodes arranged in a wide area in order to monitor the phenomena of interest. It can be useful for medical, environmental, scientific and military applications. Wireless sensor networks mainly consist of sensor nodes or motes responsible for sensing a phenomenon and base nodes, which are responsible for managing the network and collecting data from remote nodes. The design of the sensor network is influenced by many factors, including scalability, operation system, fault tolerance, sensor network topology, hardware constraints, transmission media and power consumption.

It has three major advantages over wired monitoring network systems:

1. There is no need of cables to lay and easy installation in blind areas, reducing cost of the monitoring system. The number of nodes can be increased to eliminate blind areas. Also, it offers a general communication and allocation of the goal.

2. The dense nodes ensure the data acquisition with high accuracy and optimum data transmission, and further realization of real-time monitoring system for mine environment.

3. A little computing ability, storage capacity with data fusion of sensor nodes make them suitable for the remote monitoring system.

The above mentioned advantages make wireless sensor network ideal for monitoring of safely production of coal mines.

1.4 EXISTING SYSTEM

In underground mining, ventilation systems are crucial to supply sufficient oxygen, maintaining non-explosive and non-toxic atmospheres and operating an efficient mine. Mine ventilation system can help in eliminating high risk atmosphere. Primitive techniques to monitor the mining atmosphere can be traced back to the use of canaries and other animals to alert miners, when the atmosphere becomes toxic. Integrating ventilation monitoring system enables mine to intelligently make ventilation changes based on the extensive data, the monitoring system provides. Unexpected changes in the ventilation system are noticed by the monitoring arrangement, allowing prompt action to be considered. New and developing communication and tracking systems can be utilized to monitor mines more efficiently and relay the data to the surface.

The existing system does not have emergence counter measure to an emergence situation that occurs when mining. Let say in case methane gas which is harmful to human being, so miners will have to move and stop working activities. Same way in case of other environmental parameters such as carbondioxide, temperature, humidity etc.

1.5 PROPOSED SYSTEM

The proposed monitoring and safety system of underground mine will be divided into two section. Transmitter section will be in underground mine mounted on a wireless and with the help of wireless communication protocol, it will send the necessary data to the receiver section which will be in control room where we analyze the data and take necessary action according to it. Transmitter section consists of sensor network which senses the respective environmental parameter and gives to microcontroller for further operation. This sensing operation can be made in a specific time intervals according to need. Proper sensor need to be selected which are favourable to the environment inside underground mine. Such as, temperature sensor should be selected, which is capable of sensing temperature variation from 0°C to 50°C, which is a general temperature range present inside underground coal mine.

Receiver section is in control room which consists of microcontroller, tranreceiver, PC for output and wireless camera receiver. Environmental parameter data from transmitter side z is received by receiver side, will send this data to microcontroller through which it will give to PC for display of data.

CHAPTER TWO

REQUIREMENTS ANALYSIS AND SPECIFICATION

2.1 REQUIREMENTS

The developed system can be divided into two sections. First is a hardware circuit that will be attached with the body of the mine workers. This may be preferably fitted with the safety helmet of the workers also. The circuit has a sensor module consisting of some MEMS based sensors that measures real-time underground parameters like temperature, humidity and gas concentration. Gas concentration is meant for the harmful gases like methane and carbon-monoxide. A microcontroller is used with the sensors to receive the sensor outputs and to take the necessary decision. Once temperature is more than the safety level preprogrammed at microcontroller, it decodes

2.2 SOFTWARE REQUIREMENTS

2.2.1 PROTEUS 8

Proteus is a software technology that allows creating clinical executable decision support guidelines with little effort.Indeed, it should be fun creating your own guidelines.Once a guideline for a condition has been created, it can be executed to provide stepwise advice for any patient having that condition.

This site is dedicated to the Proteus executable guidelines model, tools based on the Proteus approach and the automated guidelines created using those tools.

A software tool that allows creating and executing clinical decision support guidelines using the Proteus approach is available. The tool called Protean may be downloaded from here. Protean allows creating new guidelines or editing existing ones very easily. Much of the editing is done by dragging and dropping.

2.2.2 MICRO C LANGUAGE

MICRO C is the powerful C compiler integrated in SUPER-FLASH which produces programs which can be run not only by SUPER-FLASH applications, but others as well. MICRO C supports a simplified sub-set of the ANSI C standard. It implements the syntax and the typical operators of C, interprets the control structures, but does not manage pointers. By means of the virtual type, it is easy to access the mixed database of the SUPER-FLASH variables. The programs compiled with MICRO C operate under the strict control of the runtime engine. This means only correct instructions are carried out, keeping the high level of reliability peculiar to SUPER-FLASH. Since it does not produce a machine code, the programs do not have to be recompiled to be used on other platforms.

Below are some of the possibilities offered by MICRO C:

- Execution of calculations in floating point
- Execution of calculations which involve trigonometric functions
- Development of communication protocols
- Runtime modification of the characteristics of the Variables
- Deferred recording of Trends
- Deferred recording of Alarms
- Importation, processing, exportation of the data generated by the applications (Trend, Alarms, Recipes, etc.)
- Carrying out management of fully customized files
- Carrying out completely free control functions
- Implementation of control functions for the input data
- Implementation of general control functions of data coherence
- Reduction in the SUPER-FLASH Variables needed for an application
- Possibility of protecting your know-how
- Making processing drivers seen by the system as a normal peripheral
- Interaction with the Event Management
- Interaction with SMART DB

2.3 HARDWARE REQUIREMENTS

This monitoring system contains several components like boards (Arduino board, RF module and USB interfacing board), LCD (Liquid crystal display), different sensors and other small electronic components. This chapter gives a detailed review of each of this part along with its working principle.

2.3.1 ARDUINO

Arduino is an open source hardware and software based on microcontroller which is very easy to use. Arduino is an inexpensive control board that's easy to program and can hook up to a wide variety of hardware. It is intended for anyone making project. Arduino senses the environment by receiving input from many sensors and affects its surroundings. In the market, various types of Arduino board are available such as Arduino UNO, Arduino Leonardo, Arduino due, Arduino Yun, Arduino Mega etc. But we are using Arduino UNO for this system. Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (*shields*) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus(USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

The Arduino project started in 2005 as a program for students at the Interaction Design Institute Ivrea in Ivrea, Italy,[2] aiming to provide a low-cost and easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors.

Arduino Uno

Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.. You can tinker with your UNO without worring too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

The Arduino board is a specially designed circuit board for programming and prototyping with Atmel microcontrollers. The microcontroller on the board is programmed using the Arduino Programming Language (based on Wiring) and the Arduino development environment (based on Processing). It is relatively cheap and plug straight to computer's USB port or power it with an AC-to-DC adapter or battery to get started. Arduino UNO has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. The Atmega328 has 32 KB of flash memory for storing code (of which 0.5 KB is used for the bootloader). Each of the 14 digital pins can be used as input or output and these operate at 5V.

The functions of these digital pins are predefined like 0 and 1 pins wok for receiving and transmitting data, 2 and 3 pins act as external interrupts which can be configured to trigger an interrupt on a low value and a rising or falling edge, 3, 5, 6, 9, 10, and 11 pins provide 8-bit PWM output, 10, 11, 12 and 13 pins support SPI communication.

Each of 6 analog pins can be used as analog input, which provides 10 bits of resolution (1024 different value). These pins measure from ground to 5V.

Arduino UNO can communicate with a computer or other Arduino or other microcontrollers. It communicates via serial communication (UART TTL). This serial communication appears as a virtual com port to software on the computer.

Figure 2.1 Arduino board

2.3.2 GAS SENSOR

A sensor is a device that detects and responds to some type of input from the physical environment. The specific input could be light, heat, motion, moisture, pressure, or any one of a great number of other environmental phenomena. The output is generally a signal that is converted to human-readable display at the sensor location or transmitted electronically over a network for reading or further processing.

Sensitive material of MQ-3 gas sensor is SnO_2, which with lower conductivity in clean air. When the target LPG (Liquefied Petroleum Gas) exist, the sensor's conductivity is higher along with the gas concentration rising. MQ-3 gas sensor has high sensitivity to LPG, and has good re sistance to disturb of gasoline, smoke and vapour. The sensor could be used to detect LPG with different concentrations; it is with low cost and suitable for different applications.

Sensors are used in everyday objects such as touch-sensitive elevator buttons (tactile sensor) and lamps which dim or brighten by touching the base, besides innumerable applications of which most people are never aware. With advances in micromachinery and easy-to-use microcontroller platforms, the uses of sensors have expanded beyond the traditional fields of temperature, pressure or flow measurement,[1] for example into MARG sensors. Moreover, analog sensors such as potentiometers and force-sensing resistors are still widely used. Applications include manufacturing and machinery, airplanes and aerospace, cars, medicine, robotics and many other aspects of our day-to-day life.

A sensor's sensitivity indicates how much the sensor's output changes when the input quantity being measured changes. For instance, if the mercury in a thermometer moves 1 cm when the temperature changes by 1 °C, the sensitivity is 1 cm/°C (it is basically the slope Dy/Dx assuming a linear characteristic). Some sensors can also affect what they measure; for instance, a room temperature thermometer inserted into a hot cup of liquid cools the liquid while the liquid heats the thermometer. Sensors are usually designed to have a small effect on what is measured; making the sensor smaller often improves this and may introduce other advantages.[*citation needed*] Technological progress allows more and more sensors to be manufactured on a microscopic scale as microsensors using MEMS technology. In most cases, a microsensor reaches a significantly higher speed and sensitivity compared with macroscopic approaches.

Fig2.2 Gas sensor

2.3.3 TEMPERATURE SENSOR

In general, a temperature sensor is a device which is designed specifically to measure the hotness or coldness of an object.LM35 is a precision IC temperature sensor with its output proportional to the temperature (in °C).With LM35,the temperature can be measured more accurately than with a thermistor. It also possess low self heating and does not cause more than 0.1 °C temperature rise in still air. The operating temperature range is from -55°C to 150°C.The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It has find its applications on power supplies, battery management, appliances, etc

The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in °C).It can measure temperature more accurately than a using a thermistor. The sensor circuitry is sealed and not subject to oxidation. The LM35 generates a higher output voltage than thermocouples and may not require that the output voltage be amplified. The LM35 has an output voltage that is proportional to the Celsius temperature. The scale factor is .01V/°C.

The LM35 does not require any external calibration or trimming and maintains an accuracy of +/-0.4°C at room temperature and +/-0.8°C over a range of 0°C to +100°C.Another important characteristic of the LM35 is that it draws only 60 micro amps from its supply and possesses a low self-heating capability. The LM35 comes in many different packages such as TO-92 plastic transistor-like package,T0-46 metal can transistor-like package,8-lead surface mount SO-8 small outline package.

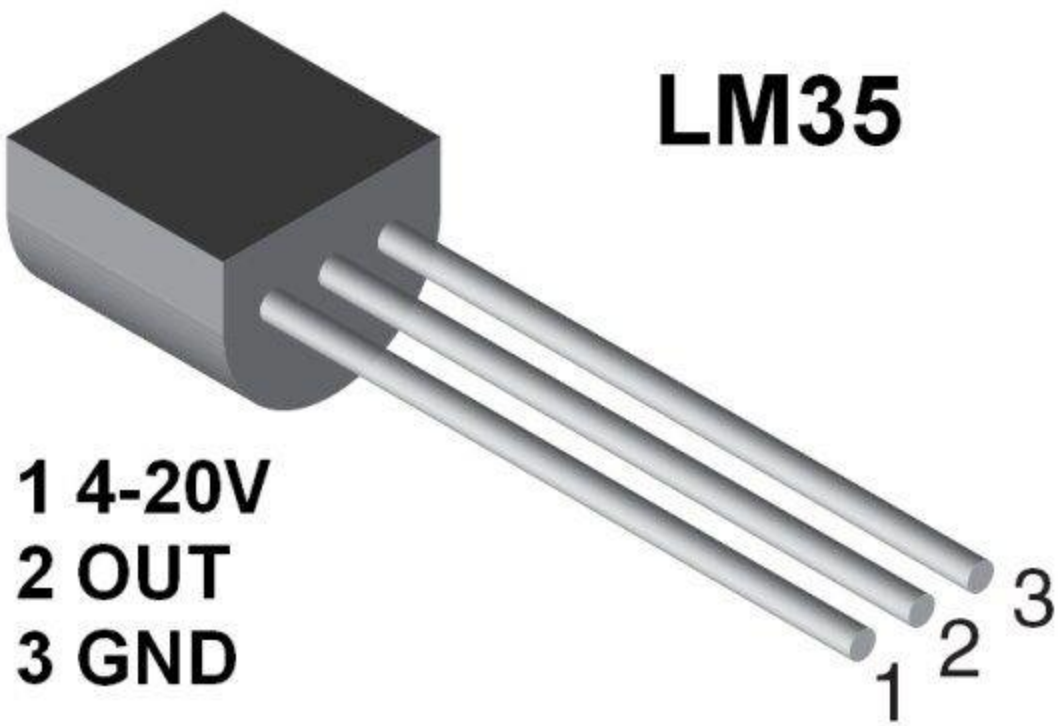

Fig 2.3 LM35 temperature sensor

Working principle of LM35

There are two transistors in the center of the drawing. One has ten times the emitter area of the other. This means it has one tenth of the current density, since the same current is going through both transistors. This causes a voltage across the resistor R1 that is proportional to the absolute temperature, and is almost linear across the range. The "almost" part is taken care of by a special circuit that straightens out the slightly curved graph of voltage versus temperature.

The amplifier at the top ensures that the voltage at the base of the left transistor (Q1) is proportional to absolute temperature (PTAT) by comparing the output of the two transistors.

The amplifier at the right converts absolute temperature (measured in Kelvin) into either Fahrenheit or Celsius, depending on the part (LM34 or LM35).The little circle with the "i" in it is a constant current source circuit.

The two resistors are calibrated in the factory to produce a highly accurate temperature sensor.

The integrated circuit has many transistors in it -- two in the middle, some in each amplifier, some in the constant current source, and some in the curvature compensation circuit. All of that is fit into the tiny package with three leads.

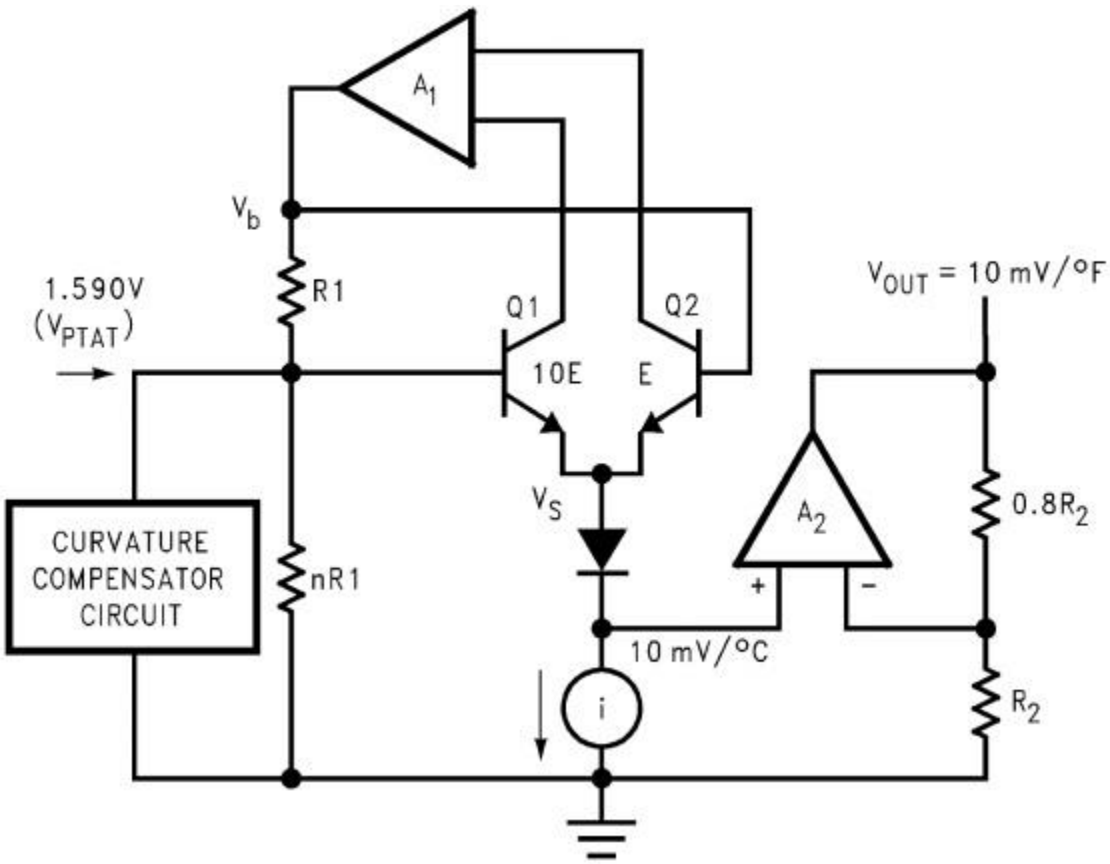

Fig 2.4 Working principle of LM35

How to connect temperature sensor to Arduino UNo

The LM35 IC has 3 pins-2 for the power supply and one for the analog output.It is a low voltage IC which uses approximately +5VDC of power.The output pin provides an analog voltage output that is linearly proportional to the Celsius (centigrade) temperature. Pin 2 gives an output of 1 millivolt per 0.1°C (10mV per degree).So to get the degree value in Celsius, all that must be done is to take the voltage output and divide it by 10-this give out the value degrees in Celsius.

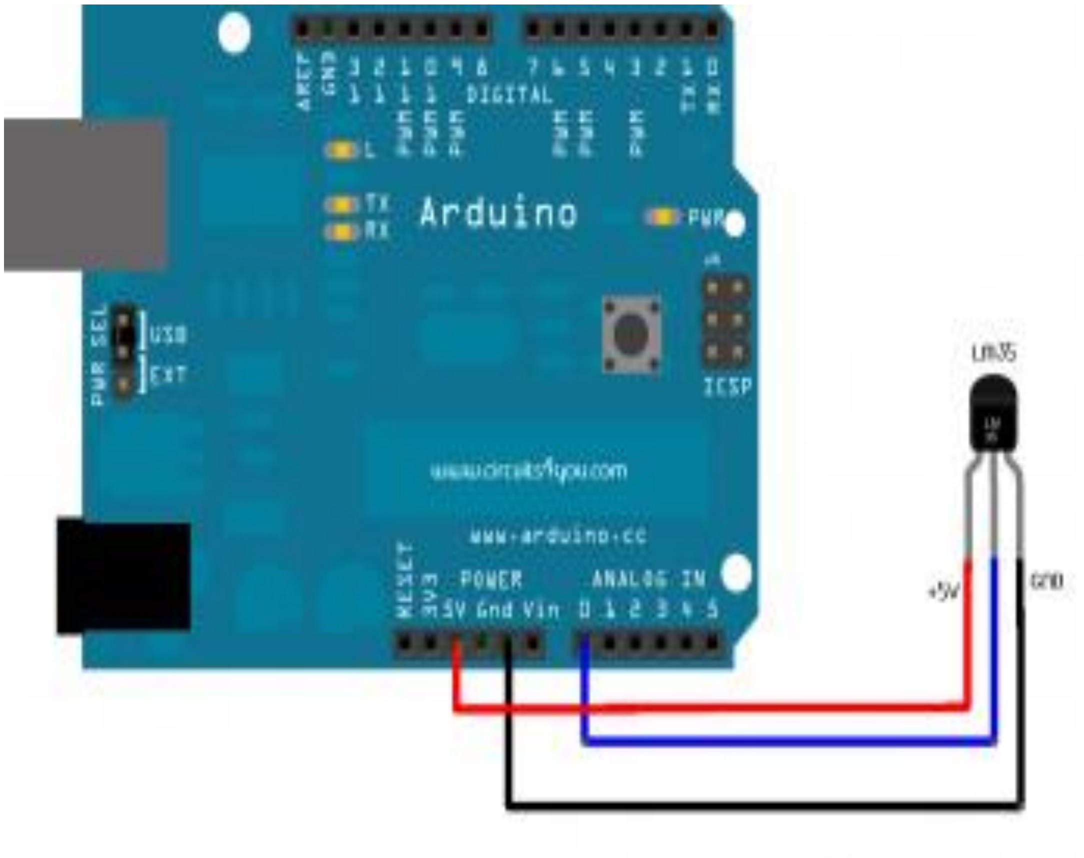

Fig 2.5 LM35 sensor connected to Arduino Uno

The circuit connections are made as follows:

- Pin 1 of the LM35 goes into +5V of the arduino
- Pin 2 of the LM35 goes into analog pin A0 of the arduino
- Pin 3 of the LM35 goes into ground (GND) of the arduino

Program for temperature sensor circuit

Before getting a Celsius reading of the temperature, the analog output voltage must first be read. This will be the raw value divided by 1024 times 5000. It is divided by 1024 because a span of 1024 occupies 5V. Here we get the ratio of the raw value to the full span of 1024 and then multiply it by 5000 to get the millivolt value. Since the output pin can give out a maximum of 5 volts (1024), 1024 represents the possible range it can give out. The raw voltage over this 1024 (value) therefore represents the ratio of how much power the output pin is outputting against this full range. Once we have this ratio, we then multiply it by 5000 to give the millivolt value. This is because there is 5000 millivolts in 5 volts. Refer here for more about analog voltage calculations. Once this analog voltage in millivolts is calculated, we then can find the temperature in Fahrenheit by the equation: ((Celsius * 9)/5 + 32).At the end of this program, a delay of 5000ms is included to take the temperature reading every 5 seconds.

2.3.4 BUZZER

Whenever the toxic gases , temperature, humidity and vibration crosses its threshold level then buzzers ON for alerting the people present in coal mines.

There are several kinds; the most basic is a piezoelectric buzzer, which is just a flat piece of piezoelectric material with two electrodes. This type of buzzer requires some kind of oscillator (or something more complicated like a microcontroller) to drive it—if you apply a DC voltage you will just get a click. They are used in places where you need something that emits an audible tone, but don’t care about high-fidelity sound reproduction, like microwave ovens, smoke alarms, and electronic toys. They are cheap and can be very loud without using very much power. They are also very thin, so they can be used in flat objects like “singing” greeting cards.

A piezoelectric element also produces a voltage in response to pressure, so piezoelectric buzzers can also be used as crude pressure sensors or microphones. A similar device, thecrystal earpiece, can be used in unpowered crystal radios (now mainly built by hobbyists), because its very high sensitivity means it can be powered by the radio signal itself.

More complex buzzers include the oscillator circuit and the piezoelectric element or speaker in a single package, so all you need to do is apply a voltage and you will get an annoying beeping or buzzing sound. Sonalert is a common brand name for these devices, and sometimes you will hear the word “Sonalert” used generically to refer to any kind of modular buzzer or siren.

Fig 2.6 Buzzer

2.3.5 RF TRANSMITTER

The RF transmitter is ideal for remote control applications where low cost and longer range is required. The transmitter operates from a 1.5 to 12V supply, making it ideal for battery-powered applications. The transmitter employs a SAW stabilized oscillator, ensuring accurate frequency control for best range performance. Output power and harmonic emissions are easy to control. The manufacturing friendly SMT (Surface-Mount Technology) style package and low cost make the RF module make it suitable for high volume applications

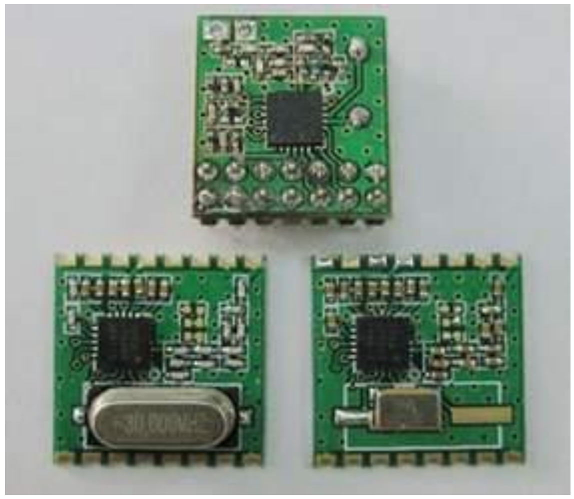

Fig 2.7 RF Transmitter

2.3.6 RF RECEIVER

RF receivers are ideal for short-range remote control applications where cost is a primary concern. The receiver module requires no external RF components except for the antenna. It generates virtually no emissions. The super regenerative design exhibits exceptional sensitivity at a very low cost. A SAW filter can be added to the antenna input to improve selectivity for applications that require robust performance. The friendly SIP (Single in-line pin) style package and low-cost make it suitable for high volume applications.

Fig 2.8 RF Receiver

2.3.7 LIQUID-CRYSTAL DISPLAY

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and 7-segment displays, as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements.

LCDs are used in a wide range of applications including monitors, televisions, instrument panels, aircraft cockpit displays, and indoor and outdoor signage. Small LCD screens are common in portable consumer devices such asdigital cameras, watches, calculators, and mobile telephones, including smartphones. LCD screens are also used on consumer electronics products such as DVD players, video game devices and clocks. LCD screens have replaced heavy, bulky cathode ray tube (CRT) displays in nearly all applications. LCD screens are available in a wider range of screen sizes than CRT and plasma displays, with LCD screens available in sizes ranging from tiny digital watches to huge, big-screen television set.

Since LCD screens do not use phosphors, they do not suffer image burn-in when a static image is displayed on a screen for a long time (e.g., the table frame for an aircraft schedule on an indoor sign). LCDs are, however, susceptible to image persistence.[2] The LCD screen is more energy-efficient and can be disposed of more safely than a CRT can. Its low electrical power consumption enables it to be used inbattery-powered electronic equipment more efficiently than CRTs can be. By 2008, annual sales of televisions with LCD screens exceeded sales of CRT units worldwide, and the CRT became obsolete for most purposes

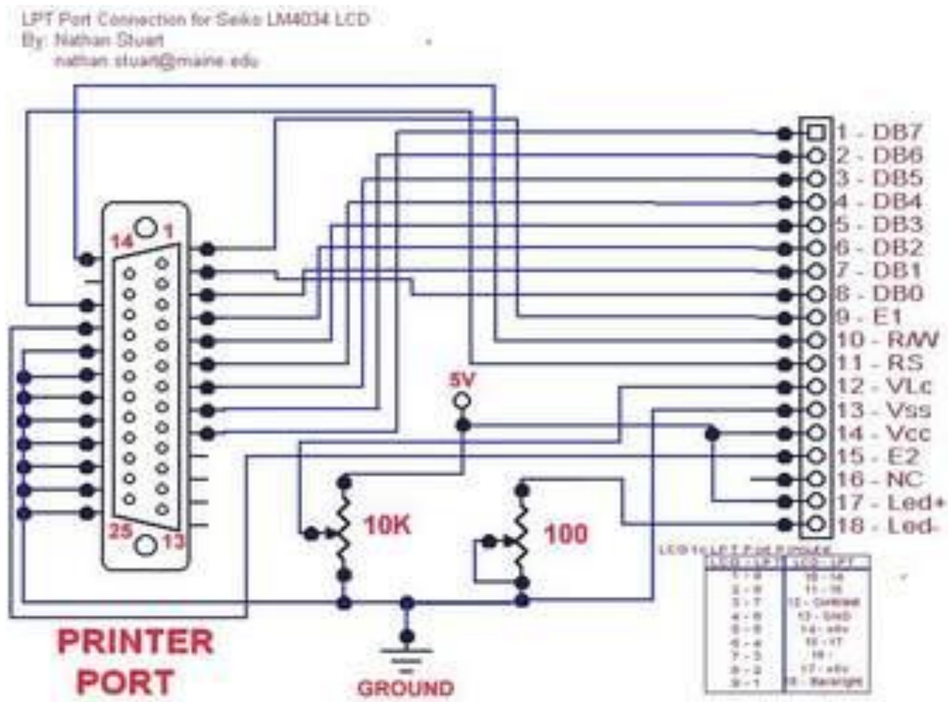

Fig 2.9 LCD Circuit

2.3.8 RESISTORS

A Resistor is a heat-dissipating element and in the electronic circuits it is mostly used for either controlling the current in the circuit or developing a voltage drop across it, which could be utilized for many applications or a resistor is a two-terminal electronic designed to oppose an electric current by producing a voltage drop between its terminals in proportion to the current, that is, in accordance with Ohm's law: V = IR. The resistance R equals to the voltage drop V across the resistor divided by the current I through the resistor.

Resistors are characterized primarily by their resistance and the power they can dissipate. Other characteristics include temperature coefficient, noise, and inductance. Practical resistors can be made of resistive wire, and various compounds and films, and they can be integrated into hybrid and printed circuits. Size, and position of leads are relevant to equipment designers; resistors must be physically large enough not to overheat when dissipating their power. Variable resistors, adjustable by changing the position of a tapping on the resistive element, and resistors with a movable tap ("potentiometers"), either adjustable by the user of equipment or contained within, are also used. Resistors are used as part of electrical networks and electronic circuits. The ohm (symbol: Ω) is the SI unit of electrical resistance

Resistors are classified as:-

- Variable resistor
- Fixed resistors

Variable resistor

A potentiometer is a three-terminal resistor with a sliding contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat. A potentiometer measuring instrument is essentially a voltage divider used for measuring electric potential (voltage); the component is an implementation of the same principle, hence its name.

Potentiometers are commonly used to control electrical devices such as volume controls on audio equipment. Potentiometers operated by a mechanism can be used as position transducers, for example, in a joystick. Potentiometers are rarely used to directly control significant power (more than a watt), since the power dissipated in the potentiometer would be comparable to the power in the controlled load. Variable resistors consist of a resistance track with connections at both ends and a wiper which moves along the track as you turn the spindle.

Variable resistors consist of a resistance track with connections at both ends and a wiper which moves along the track as you turn the spindle. The track may be made from carbon, cermet (ceramic and metal mixture) or a coil of wire (for low resistances). The track is usually rotary but straight track versions, usually called sliders, are also available.

Variable resistors may be used as a rheostat with two connections (the wiper and just one end of the track) or as a potentiometer with all three connections in use. Miniature versions called presets are made for setting up circuits which will not require further adjustment.

Fig 2.10 Variable resistor

Fixed resistor

Fixed value resistors have a defined ohmic resistance and are not adjustable. Fixed resistors are the most commonly used resistors and in general one of the most used electronic components. Fixed resistors are available in axial leaded and surface mount packages as well as more customized packages depending on their application.

In an ideal world a perfect resistor would have a constant ohmic resistance under all circumstances. This resistance would be independent of for example frequency, voltage or temperature. In practice no resistor is perfect and all resistors have a certain stray capacitance and inductance, resulting in an impedance value different from the nominal resistance value. The resistor materials have a certain temperature coefficient, resulting in a temperature dependency of the resistor value. The different resistor types and materials determine the dependency of the resistance value on these external factors. Depending on e.g. the required accuracy, power dissipation and noise requirements, the type and material of resistor are selected.

Fig 2.11 Fixed resistor

The electronic color code is used to indicate the values or ratings of electronic components, very commonly for resistors. Resistor values are always coded in ohms, capacitors in Pico farads (pF), inductors in micro henries (μH), and transformers in volts.

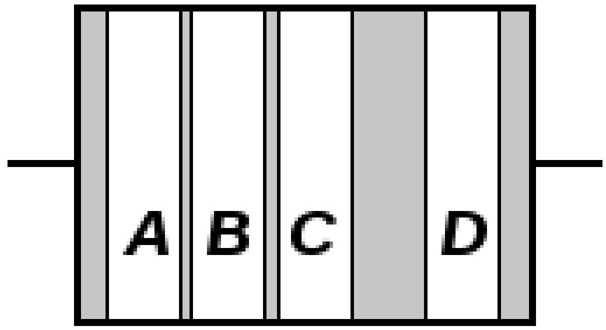

Fig 2.12 Resistor color bands

Where;

Band A is first significant figure of component value

Band B is the second significant figure

Band C is the decimal multiplier

Band D if present, indicates tolerance of value in percent (no color means 20%)

Resistor values are normally shown using colored bands. Each color represents a number as shown in the table.

Most resistors have four bands.

- The first band gives the first digit.
- The second band gives the second digit.
- The third band indicates the number of zeros.
- The fourth band is used to shows the tolerance (precision) of the resistor

2.3.9 CAPACITOR

A device used to store charge in an electrical circuit. A capacitor functions much like a battery, but charges and discharges much more efficiently (batteries, though, can store much more charge).

A basic capacitor is made up of two conductors separated by an insulator, or dielectric. The dielectric can be made of paper, plastic, mica, ceramic, glass, a vacuum or nearly any other nonconductive material. Some capacitors are called electrolytic, meaning that their dielectric is made up of a thin layer of oxide formed on a aluminum or tantalum foil conductor.

Capacitor storing ability (called capacitance) is measured in Farads. One Farad is actually a huge amount of charge (6,280,000,000,000,000,000 electrons to be exact), so we usually rate capacitors in microfarads (uF) and picofarads (pF). Capacitors are also graded by their breakdown voltage. Capacitors rated for lower voltages are generally smaller in size and weight; you don't want to use too low a voltage rating, though, unless you enjoy replacing burnt-out capacitors in your creation.

Non-polarized fixed capacitor

A non-polarized ("non polar") capacitor is a type of capacitor that has no implicit polarity -- it can be connected either way in a circuit. Ceramic, mica and some electrolytic capacitors are non-polarized. Mostly known as “bipolar” capacitors

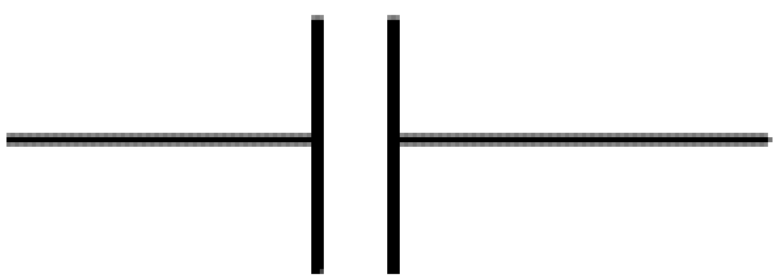

Fig 2.13 Non-polarized capacitors

Polarized fixed capacitor

A polarized ("polar") capacitor is a type of capacitor that has implicit polarity -- it can only be connected one way in a circuit. The positive lead is shown on the schematic (and often on the capacitor) with a little "+" symbol. The negative lead is generally not shown on the schematic, but may be marked on the capacitor with a bar or "-" symbol. Polarized capacitors are generally electrolytic

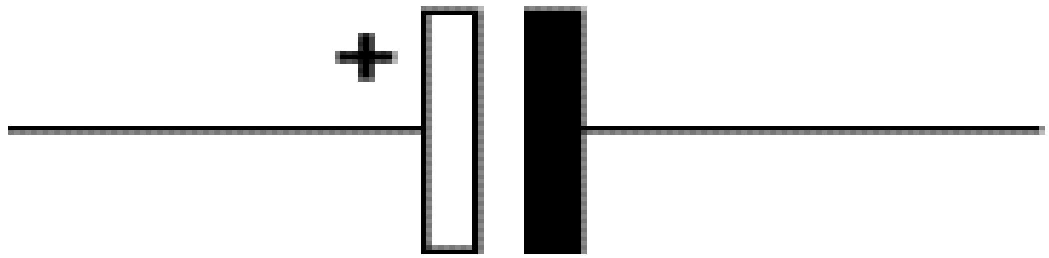

Fig2.14 Polarized capacitors

CHAPTER THREE

SYSTEM ARCHITECTURE AND DESIGN

3.1 SYSTEM ARCHITECTURE

System architecture is a conceptual model that defines the structure, behavior, and more views of a system. An architecture description is a formal description and representation of a system, organized in a way that supports reasoning about the structures and behaviors of the system.

- A system architecture can comprise system components that will work together to implement the overall system. There have been efforts to formalize languages to describe system architecture, collectively these are called architecture description languages (ADLs). Prior to the advent of digital computers, the electronics and other engineering disciplines used the term "system" as it is still commonly used today. However, with the arrival of digital computers and the development of software engineering as a separate discipline, it was often necessary to distinguish among engineered hardware artifacts, software artifacts, and the combined artifacts. A programmable hardware artifact, or computing machine, that lacks its computer program is impotent; even as a software artifact, or program, is equally impotent unless it can be used to alter the sequential states of a suitable (hardware) machine. However, a hardware machine and its programming can be designed to perform an almost illimitable number of abstract and physical tasks. Within the computer and software engineering disciplines (and, often, other engineering disciplines, such as communications), then, the term system came to be defined as containing all of the elements necessary (which generally includes both hardware and software) to perform a useful function.
- A systems architecture makes use of elements of both software and hardware and is used to enable design of such a composite system. A good architecture may be viewed as a 'partitioning scheme,' or algorithm, which partitions all of the system's present and foreseeable requirements into a workable set of cleanly bounded subsystems with nothing left over. That is, it is a partitioning scheme which is exclusive, inclusive, and exhaustive. A major purpose of the partitioning is to arrange the elements in the sub systems so that there is a minimum of interdependencies needed among them. In both software and hardware, a good

sub system tends to be seen to be a meaningful "object". Moreover, a good architecture provides for an easy mapping to the user's requirements and the validation tests of the user's requirements. Ideally, a mapping also exists from every least element to every requirement and test.

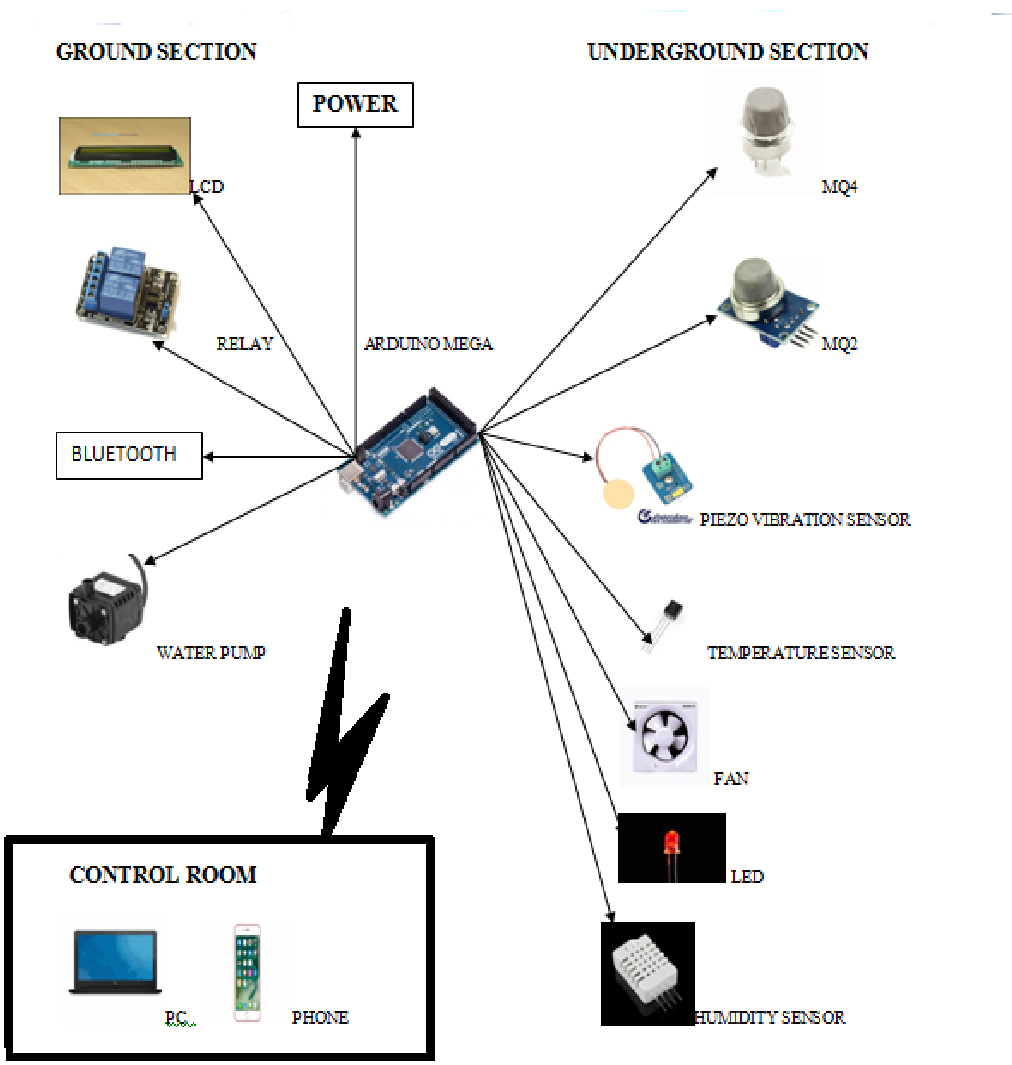

Fig 3.1 Architecture diagram

3.2 BLOCK DIAGRAM

A block diagram is a diagram of a system in which the principal parts or functions are represented by blocks connected by lines that show the relationships of the blocks. They are heavily used in engineering

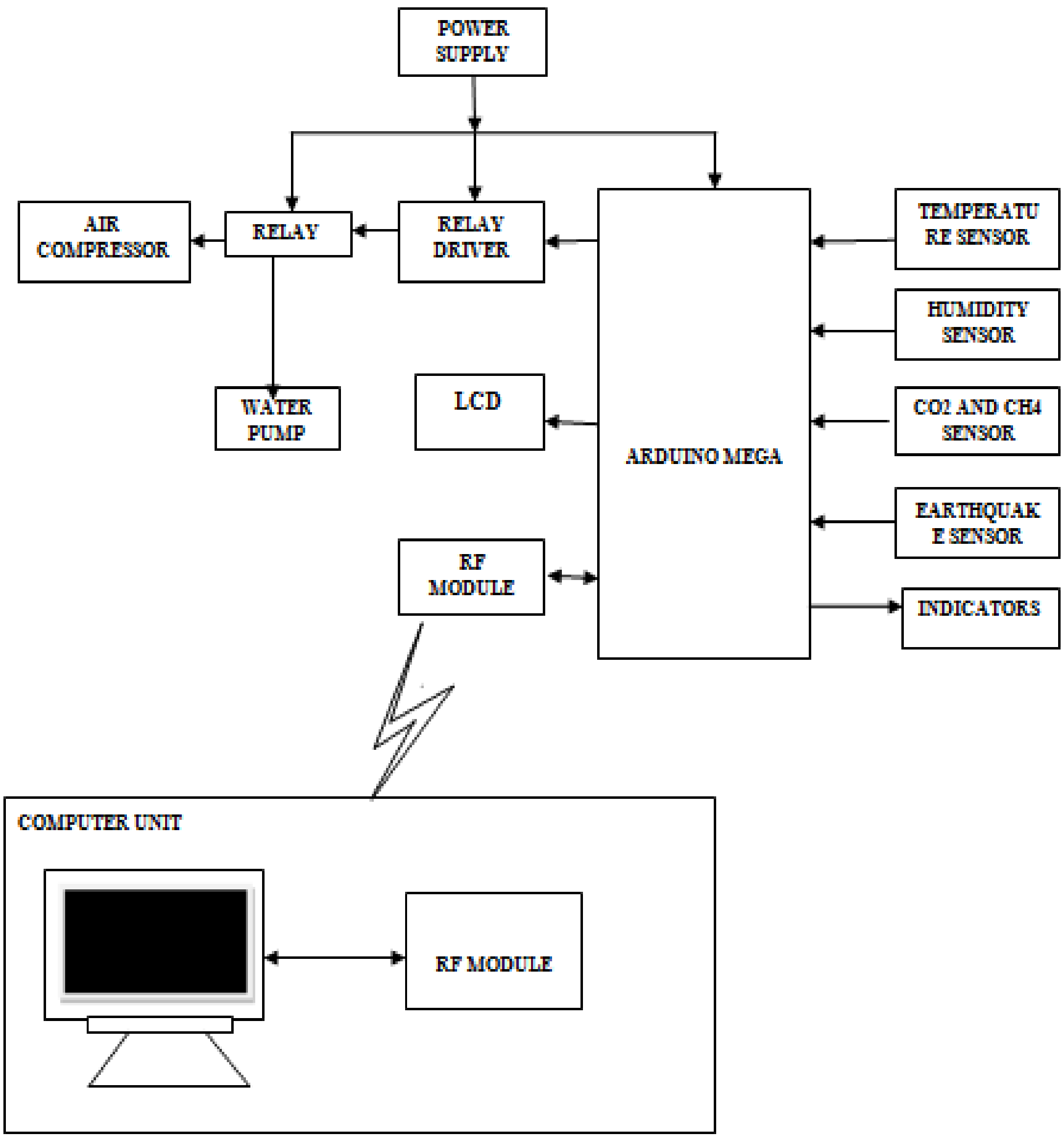

Fig. 3.2 Block diagram

3.3 USECASE DIAGRAM

A use case diagram is a graphic depiction of the interactions among the elements of a system.

A use case is a methodology used in system analysis to identify, clarify, and organize system requirements. In this context, the term "system" refers to something being developed or operated, such as a mail-order product sales and service Web site. Use case diagrams are employed in UML (Unified Modeling Language), a standard notation for the modeling of real-world objects and systems.

System objectives can include planning overall requirements, validating a hardware design, testing and debugging a software product under development, creating an online help reference, or performing a consumer-service-oriented task. For example, use cases in a product sales environment would include item ordering, catalog updating, payment processing, and customer relations. A use case diagram contains four components.

- The boundary, which defines the system of interest in relation to the world around it.
- The actors, usually individuals involved with the system defined according to their roles.
- The use cases, which are the specific roles played by the actors within and around the system.
- The relationships between and among the actors and the use cases.

A use case diagram looks something like a flowchart. Intuitive symbols represent the system elements.

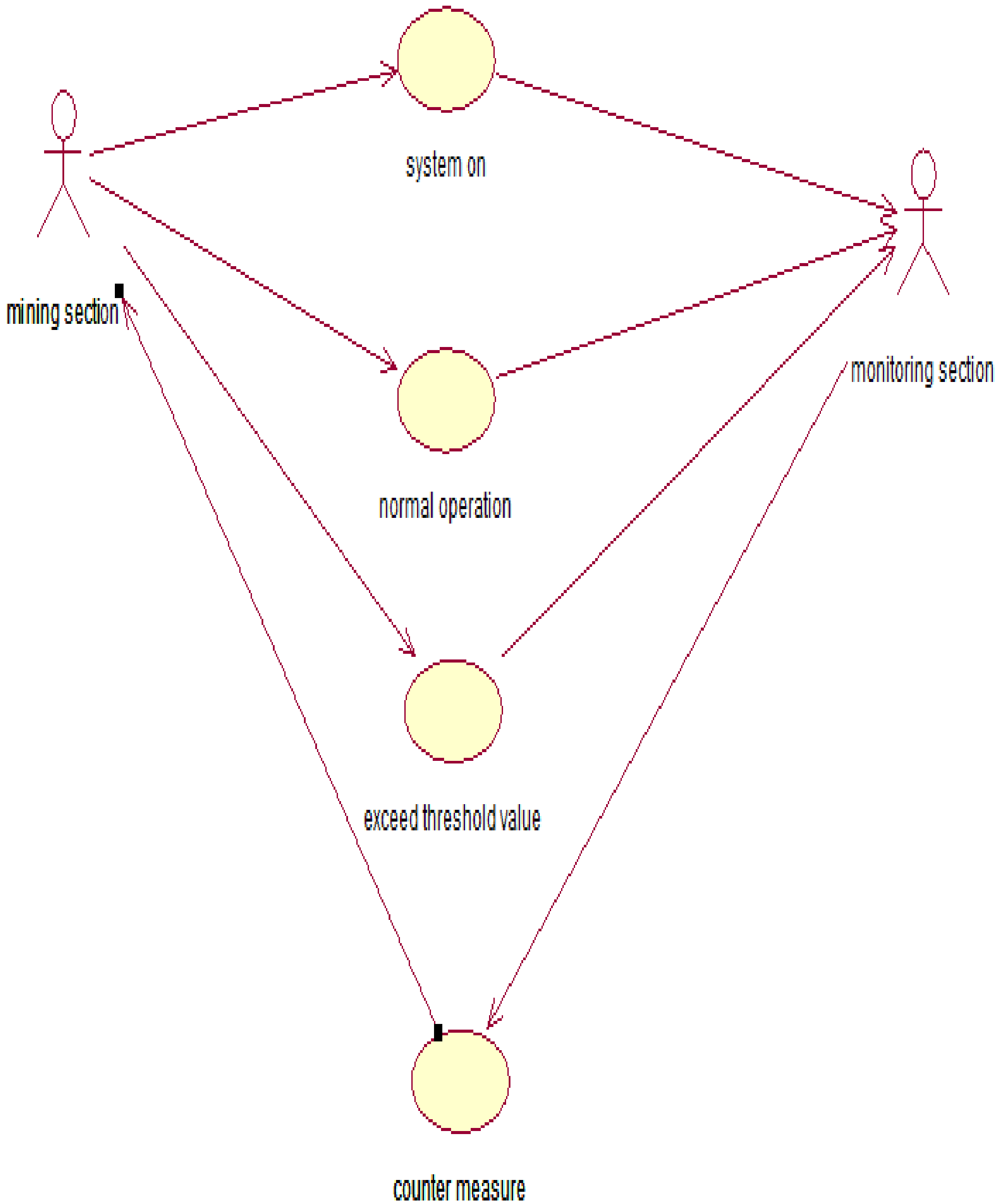

Fig 3.3 Use case diagram

3.4 CLASS DIAGRAM

A class diagram in the Unified Modeling Language (UML) is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among objects.

The class diagram is the main building block of object-oriented modelling. It is used both for general conceptual modelling of the systematics of the application, and for detailed modelling translating the models into programming code. Class diagrams can also be used for data modeling.[1] The classes in a class diagram represent both the main elements, interactions in the application, and the classes to be programmed.

A class with three compartments.

In the diagram, classes are represented with boxes that contain three compartments:

- The top compartment contains the name of the class. It is printed in bold and centered, and the first letter is capitalized.
- The middle compartment contains the attributes of the class. They are left-aligned and the first letter is lowercase.
- The bottom compartment contains the operations the class can execute. They are also left-aligned and the first letter is lowercase.

In the design of a system, a number of classes are identified and grouped together in a class diagram that helps to determine the static relations between them. With detailed modelling, the classes of the conceptual design are often split into a number of subclasses.

In order to further describe the behaviour of systems, these class diagrams can be complemented by a state diagram or UML state machine.[

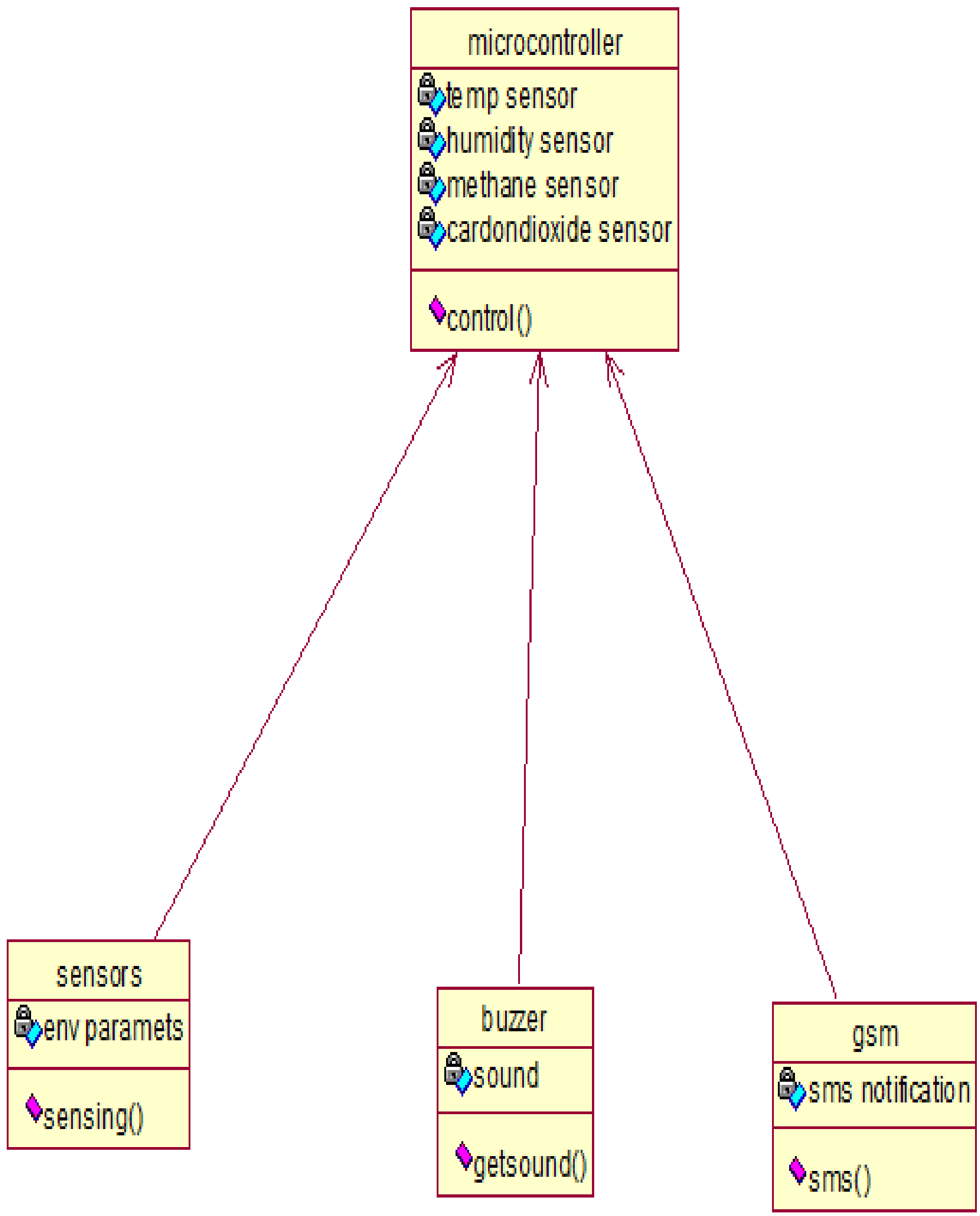

Fig 3.4 Class diagram

3.5 FLOW DIAGRAM

Flow diagram is a collective term for a diagram representing a flow or set of dynamic relationships in a system. The term flow diagram is also used as a synonym for flowchart and sometimes as a counterpart of the flowchart.

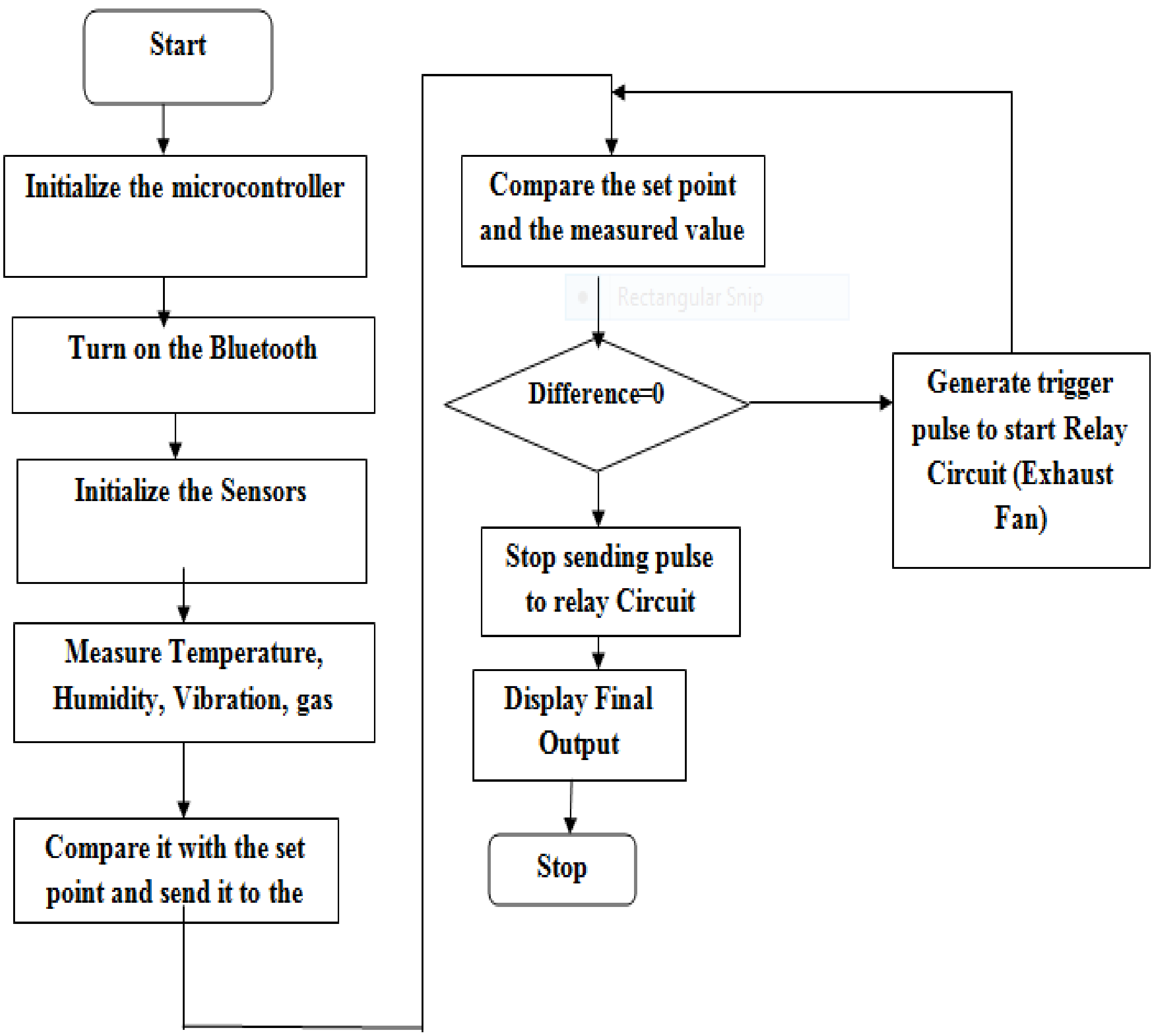

Fig 3.5 Flow diagram

CHAPTER FOUR

DEVELOPMENT AND IMPLEMENTATIONS

In this paper we have proposed improved wireless communication system for mines specially to update the underground section in minerals mines to the ground section and send the message to the Administrator that is authorized person immediately. Here the system is divided into the mining section and monitoring section. The Mining section includes controller, the number of sensors that includes humidity sensor, temperature sensor, vibration sensor and gas sensor. This also includes the device driver, Buzzer and motor, RF module transceiver. The monitoring section includes administrator PC which acts as a server.

4.1 MINING SECTION MODULE

In the mining section the numbers of physical parameters are observed by the respective sensor. In the mining section there are gas sensor, humidity sensor, temperature sensor and vibration sensor. The output from this sensor is directly connected to the ADC of the ARM. There is no need of connecting signal conditioning circuit because output never exceeds from 5V. During the hazard all the information from sensor is sent to the ground section. Information related to the safety measure as wearing helmets of oxygen etc. will be given to the workers, so that they can save their life. If any of the received parameter is beyond the ultra limit then Buzzer is ON giving warning to the people. The output from sensor is converted into the digital format and sent to the ground section through RF module transceiver.

Fig 4.1 (a) Mining section

Fig 4.1 (b) Mining section

A. Temperature measurement

Suitable temperature is one of the most important condition inside underground mines. It is important for mine worker to have proper temperature to work safely and effectively inside the mines. During working hour due to drilling or blasting inside mines, new surfaces are get opened up which may cause increase or decrease in temperature, so it is very much important to monitor temperature inside the mines. Lots of technologies have been developed for temperature measurement .Thermocouple, RTD, Thermistor, LM series sensors etc. can be used to measure the temperature changes inside the mines.

B. Humidity Measurement

Humidity generally defined as the amount of water vapor present in the environment. Humidity is the presence of water in air. The amount of water vapour in air can affect human comfort as well as many manufacturing processes in industries. The presence of water vapour also influences various physical, chemical, and biological processes. Humidity sensors relying on this principle consists of a hygroscopic dielectric material sandwiched between a pair of electrodes forming a small capacitor. Most capacitive sensors use a plastic or polymer as the dielectric material, with a typical dielectric constant ranging from 2 to 15. In absence of moisture, the dielectric constant of the hygroscopic dielectric material and the sensor geometry determine the value of capacitance. At normal room temperature, the dielectric constant of water vapour has a value of about 80, a value much larger than the constant of the sensor dielectric material. Therefore, absorption of water vapour by the sensor results in an increase in sensor capacitance.. It is required to know the humidity inside the mines as it can affects chemical, physical and biological conditions of underground mines. The amount of water vapor in air can affect human comfort as well as physical processes inside the mines.so it is useful to have track on humidity inside the mines. Different sensors can be employed to measure humidity inside mines. There are sensors which are based on capacitive effect, some humidity sensors are polymer based. Sensors like SYSH220, HSM-20G etc. are good humidity sensors.

C. Gas Detection

Toxic and harmful gases like methane, carbon monoxide may be present in the surfaces of underground coal mines. During working hour, due digging or blasting of coal, methane or other harmful gas can explode and cause dangerous accidents. It is difficult to stop the emission of such harmful gases, but we can save the lives of coal worker by evacuating them, if such accidents occur. So it is important to detect these gases during digging of coal. Different sensors like MQ4, MQ5, TGS2611 etc. can be used to detect methane in underground coal mines. When the target LPG (Liquefied Petroleum Gas) exist, the sensor's conductivity is higher along with the gas concentration rising. MQ-3 gas sensor has high sensitivity to LPG, and has good resistance to disturb of gasoline, smoke and vapour. The sensor could be used to detect LPG with different concentrations; it is with low cost and suitable for different applications.

4.2 MONITORING SECTION MODULE

In the ground section the RF module transceiver receives the information and sends that information to the server. There is one Graphical user interface created by Neatbeans platform. On this we can set the threshold values and control the input sensor and output devices. There is another GUI running on android application of administrator created by eclipse software.

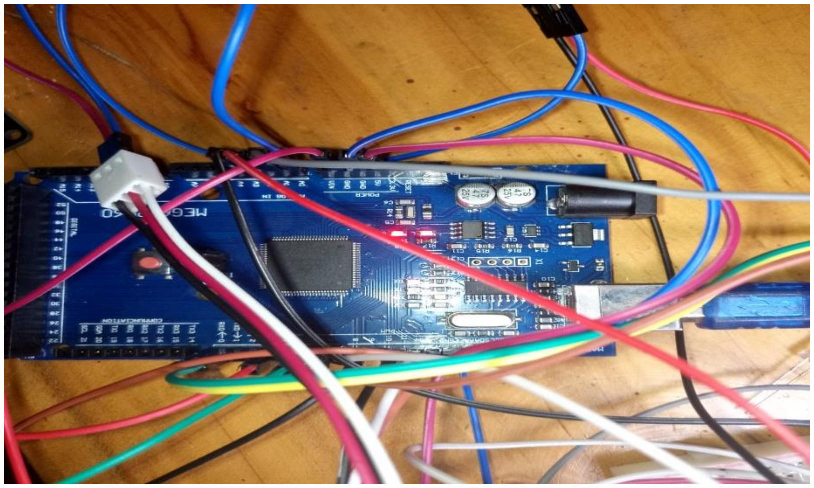

Fig4.2 (a) Monitoring section

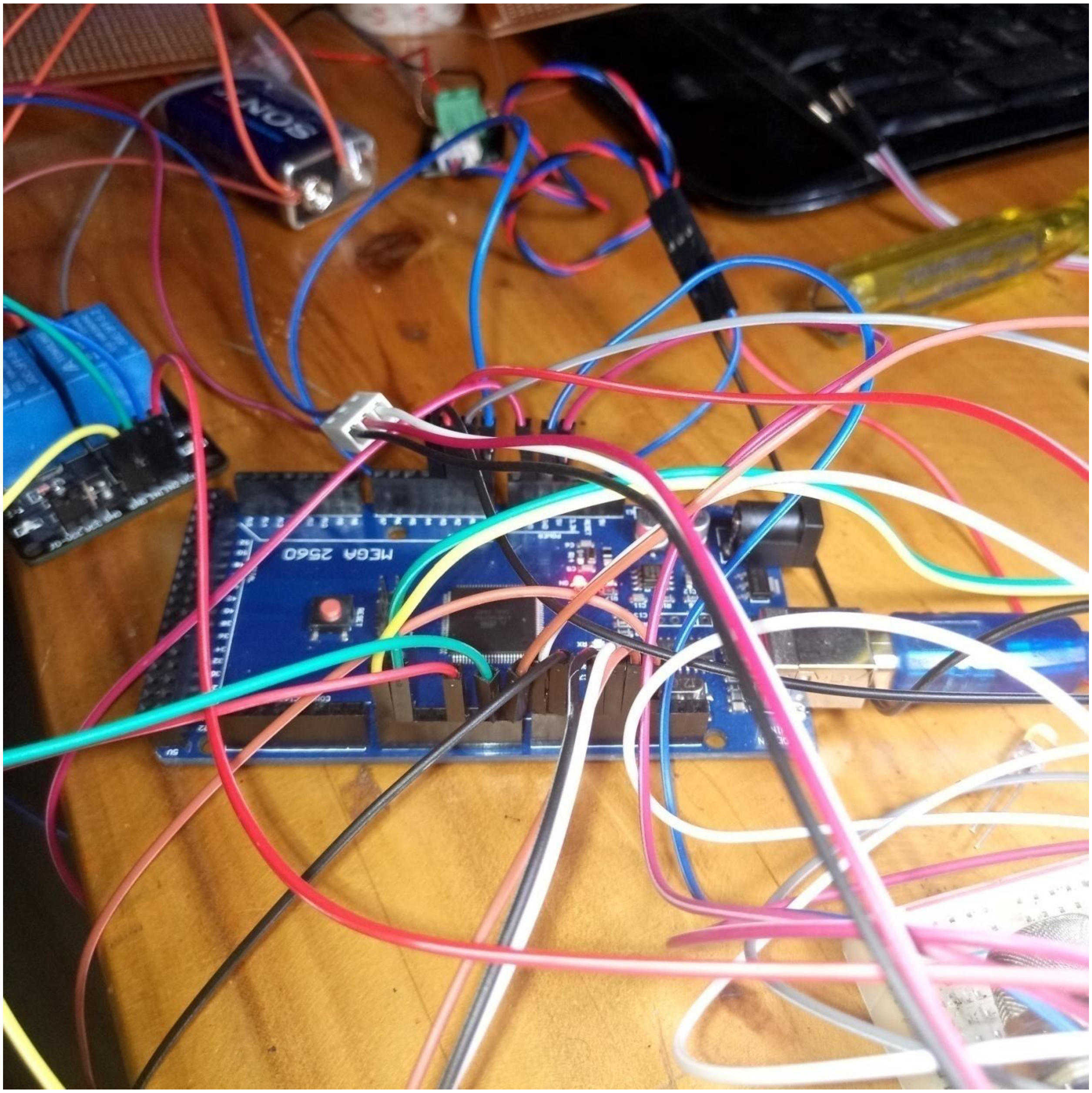

Fig 4.2(b) Monitoring section

4.2.1 TRANSMITTER SECTION

Transmitter section will be in underground mine mounted on a wireless and with the help of wireless communication protocol, it will send the necessary data to the receiver section which will be in control room where we analyze the data and take necessary action according to it. Transmitter section consists of sensor network which senses the respective environmental parameter and gives to microcontroller for further operation. This sensing operation can be made in a specific time intervals according to need. Proper sensor need to be selected which are favorable to the environment inside underground coal mine. Such as, temperature sensor should be selected, which is capable of sensing temperature variation from 0°C to 50°C, which is a general temperature range present inside underground coal mine. Transmitter section consists of microcontroller, temperature sensor, humidity sensor, methane sensor, tilt sensor, buzzer, LCD, Driver ICs and trans receiver. Environmental parameter data of underground coal mine is send to receiver side through RF module. Bulb is connected to the transmitter section through relay which is drive by ULN 2803.As transmitter section is mounted on wireless robot, DC motors are required drive by L2983D motor driver IC. On wireless robot, wireless camera transmitter is mounted nearby bulb. Wireless camera will give live view of underground coal mine.

4.2.2 RECEIVER SECTION

Receiver section is in control room which consists of , RF module trans receiver, PC for output and wireless receiver. Environmental parameter data from transmitter side RF module is received by receiver side . And RF module will send this data to microcontroller through which it will give to PC for display of data. Wireless can be controlled by RF module from control room itself or by using RF module .For that one keypad for movement of environmental parameter is connected to the microcontroller in control room. The receiver section can be assemble on PCB. RF receivers are ideal for short-range remote control applications where cost is a primary concern. The receiver module requires no external RF components except for the antenna. It generates virtually no emissions. The super regenerative design exhibits exceptional sensitivity at a very low cost. A SAW filter can be added to the antenna input to improve selectivity for applications that require robust performance. The friendly SIP (Single in-line pin) style package and low-cost make it suitable for high volume applications.

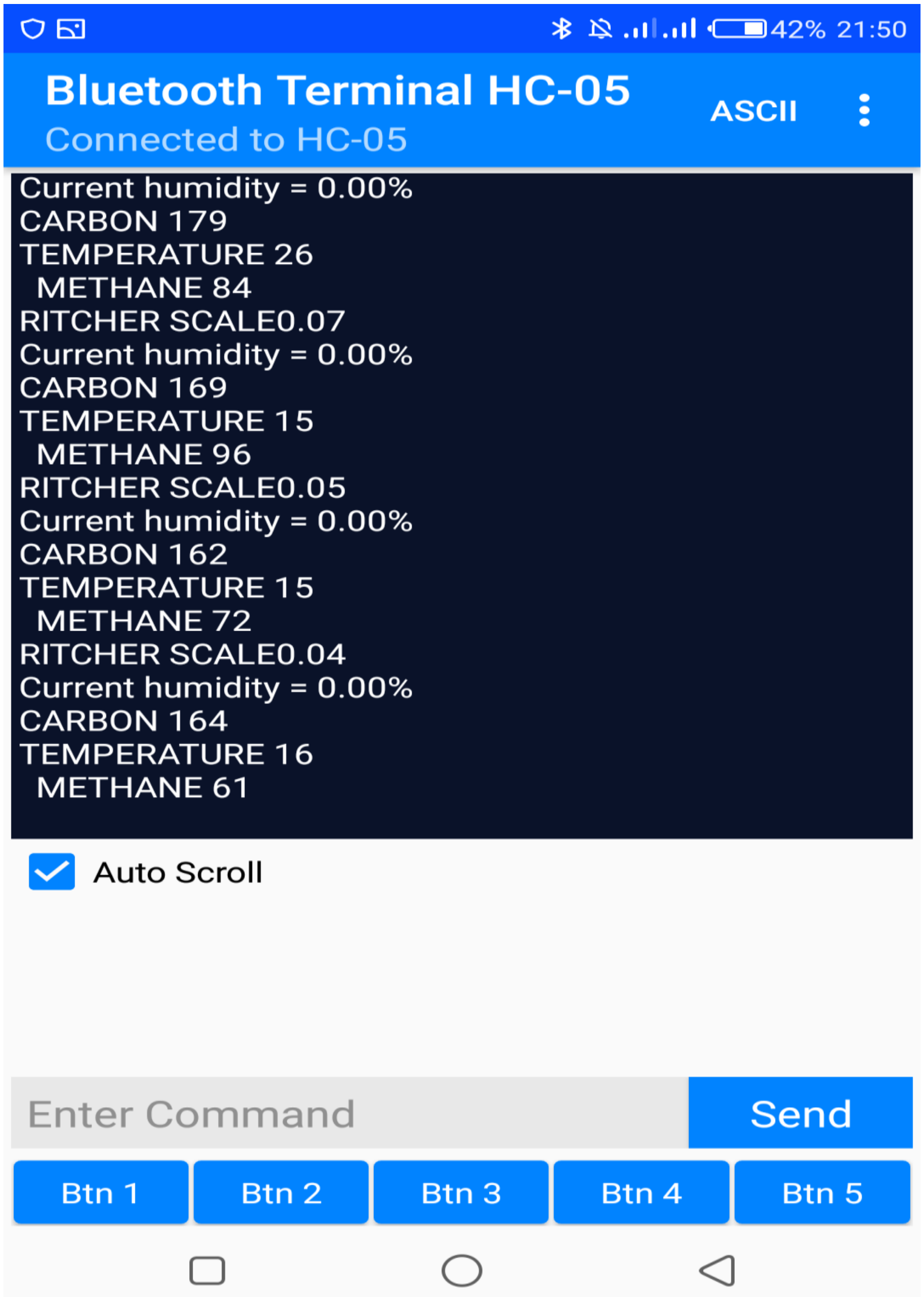

Fig 4.3 Receiver section

CHAPTER FIVE

RESULTS AND CONCLUSION

5.1 SAMPLE CODE

```
#include <SoftwareSerial.h>

#include <dht.h>

#include <LiquidCrystal.h>

#define dht_apin A1 // Analog Pin sensor is connected to

LiquidCrystal lcd(12, 11, 5, 4, 3, 2);

const int analogInPin = A0;

int tempPin = A2;

int methane = A4;

int meth_relay=9;

int val;

const int buzzer = 7;

int sensorValue = 0;

const int PIEZO_PIN = A3; // Piezo output

int led = 13;

dht DHT;

int fen = 8;

void setup() {

   lcd.begin(16, 2);

  Serial.begin(9600);
```

```
  pinMode(fen,OUTPUT);
  pinMode(led,OUTPUT);
  pinMode(meth_relay,OUTPUT);
   lcd.setCursor(0, 1);
  lcd.println("MINING SYSTEM");

  delay(6000);
 lcd.clear();
 //digitalWrite(meth_relay, HIGH);
}

void loop() {
  digitalWrite(led, LOW);
 lcd.setCursor(0, 2);
  // scroll 16 positions (display length + string length) to the left
  // to move it back to center:
  for (int positionCounter = 0; positionCounter < 10; positionCounter++) {
    // scroll one position left:
    lcd.scrollDisplayLeft();
    // wait a bit:
    delay(150);
  }

  // delay at the end of the full loop:
  delay(500);
```

```
earthquake();
 delay(500);
hummidity();
delay(500);
smoke();
delay(500);
temperature();
 delay(500);
 methane2();
 delay(500);
}

void earthquake()
{

  // Read Piezo ADC value in, and convert it to a voltage
  int piezoADC = analogRead(PIEZO_PIN);
  float piezoV = piezoADC / 1023.0 * 5.0;

   Serial.print("RITCHER SCALE");

  Serial.println(piezoV); // Print the voltage.

   lcd.print(" EARTH "); // Print the voltage.
 lcd.print(piezoV); // Print the voltage.
```

```
//lcd.print(" "); // Print the voltage.
  delay(500);
  if(piezoV > 0.15){
    int i;
for(i=0;i<=10;i++){

   digitalWrite(led, HIGH);
delay(500);
}

 Serial.println("EARTH QUAKE");
 Serial.println(piezoV); // Print the voltage.

 lcd.print("EARTH Q");
 lcd.print(piezoV); // Print the voltage.
 lcd.print(" "); // Print the voltage.
 delay(500);



      tone(buzzer,100);
```

```
}
 else
  {

  noTone(buzzer);
  }
}

 void hummidity()
 {

DHT.read11(dht_apin);

    Serial.print("Current humidity = ");
    Serial.print(DHT.humidity);
    Serial.println("%  ");
     lcd.print("  HUM ");
    lcd.print(DHT.humidity);
    lcd.print("% ");



    delay(500);

  }
```

```
 void smoke(){
  sensorValue = analogRead(analogInPin);
  lcd.print("CARBON ");
lcd.print(sensorValue);
 lcd.print(" "); // Print the voltage.
delay(500);
       Serial.print("CARBON ");


     Serial.println(sensorValue);
  delay(1000);




if (sensorValue >= 250)
  {


    tone(buzzer,100);


 Serial.println("carbon detected");


lcd.print("CARBON DETECTED");
lcd.print(sensorValue);
delay(500);
  }
```

```
}

void temperature()
{
val = analogRead(tempPin);
int mv = ( val/1024.0)*5000;
int cel = mv/10;
int farh = (cel*9)/5 + 32;

Serial.print("TEMPERATURE ");
Serial.println(cel - 13);
Serial.print("  ");
lcd.print("TEMP ");
lcd.println(cel-13);

delay(500);

if((cel-13)  >  30){
Serial.print("HIGH TEMPERATURE");
Serial.print("COOLING SYSTEM ACTIVATED");
   tone(buzzer,100);
   lcd.print("HIGH TEMPERATURE");
```

```
    digitalWrite(fen, LOW);



}
 else
  {
  digitalWrite(fen, HIGH);

  noTone(buzzer);
  }



}

void methane2(){
  sensorValue = analogRead(methane);
  lcd.print("METHANE =");
lcd.print(sensorValue);
 lcd.print(" "); // Print the voltage.
delay(500);
       Serial.print("METHANE ");

     Serial.println(sensorValue);
  delay(1000);
```

```
if (sensorValue >= 500)
  {

    tone(buzzer,100);
  digitalWrite(meth_relay,LOW);
 Serial.println("METHANE DETECTED");

lcd.print("METHANE DETECTED");
lcd.print(sensorValue);
delay(500);
  }
 else{

  digitalWrite(meth_relay,HIGH );
  }

}
```

5.2 RESULT

By implementing this paper, the temperature, humidity and gas values of the mine are continuously monitored at the underground and ground sections and stored in the PC. The numbers of personnel working inside the mine are also monitored. In case if any of the data is ultra-limit, it warns the personnel inside to come out by means of a Buzzer. The personnel, who remained inside the mine and can't come off the mines, will use the oxygen helmets. The related personnel of safety will take action to bring them out safely. This system also stores all the data in the computer for future inspection. From the experiments and observations, the following conclusion can be drawn:

(i) Each node in a particular framework functions as the pioneer 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.

This is a low cost and lifelong system.

5.3 FUTURE RECOMMENDATIONS

The system can be extended in order to determine or predict the occurrence of landslides. It will improve scalability of underground environment and accurate positions of miners.

5.4 CONCLUSION

As the accidents and hazards inside mines are increasing now a day, a mine safety system seems to be very useful and relevant. With the help of the miner's helmet itself, we could sense the undesirable environmental parameters like temperature, humidity and methane gas inside the coal mine and could communicate efficiently through a most reliable and cost effective wireless communication system. Sensing of different parameters and communication up to a length of 8 to 9 meters was observed in the final test. By properly fixing appropriate power ratings, this model is expected to fit for practical industrial applications. On time voice communication can also be provided with a microphone - loud speaker set. Alerts can be given along with alarming tones which will be more noticeable. By minimization of all the components, size and weight of the circuit can be reduced to a much comfortable level. Intelligent mine safety monitoring and alerting system based on wireless technology. This system integrates person locating system with gas concentration, humidity, and temperature parameters checking system effectively, and realizes functions of person attendance, distance measurement positioning, gas concentration detecting and data communication. This system is an open system, and it allows developing other applications on it. The old traditional wired and wireless underground coal mine security system can be effectively replace by this robot based wireless monitoring and safety system. This system is reliable and cost effective than wired safety system. This system also reduces the human intervention due to use of wireless robot operated from control room. This system is the best solution for complex mine environment as it will combined the low power ,low cost based high frequency data transmission technology with small size sensors. This system will provide proper communication between control room and underground workers and will reduces the accidents.

5.5 REFERENCE

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