

SMART SENSOR SUITE FOR COAL MINE SAFETY WORKERS

A Project Report Phase – II

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering degree in Electronics and Communication Engineering

by

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SCHOOL OF ELECTRICAL AND ELECTRONICS

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with Grade “A” by NAAC

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APRIL – 2023



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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **A.CHAITANYA (39130031), B.SUMANTH KALYAN (39130056)** who carried out the project entitled "**SMART SENSOR SUITE FOR COAL MINE SAFETY WORKERS**" under the supervision from November 2022 to April 2023.

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We, **A.CHAITANYA (39130031)**, **B.SUMANTH KALYAN (39130056)** hereby declare that the Project Report on “**SMART SENSOR SUITE FOR COAL MINE SAFETY WORKERS**” done by us under the guidance of **Dr.M.R.EBENEZAR JEBARANI** is submitted in partial fulfillment of the requirements of the award of Bachelor of Engineering degree in Electronics and Communication Engineering.

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ABSTRACT

Loss of mobility due to an injury is usually accompanied by a loss of self-confidence. For many individuals, independent mobility is an important aspect of self-esteem. Quadriplegics are limited in their motion due to damage to their spinal cord. The main goal of our project is to help quadriplegic patients to move independently from one place to another by the tilt movement of their head which in turn moves the wheelchair without the assistance of another person.

The head-controlled wheelchair is designed such that the wheelchair moves in accordance with the movement of the patient's head. A patient monitoring system consisting of heartbeat and temperature monitoring modules is provided such that it can constantly monitor these two important parameters and if any changes are seen, send a message immediately to the doctor or the nearest nursing home through the GSM.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Mining is the extraction of valuable minerals like solid, liquid and gas from the earth. The mining continues to supply all the basic resources like oil and gas used by modern civilization. The materials recovered by mining include aluminum, copper, lead, Zink, gold, silver, diamond, metal, coal etc. The large amount of coal required for electricity generation. Globally, coal resources have been estimated at over 861 billion tons. While India accounts for 286 billion tons of coal resources (as on 31 March 2011), other countries with major chunk of resources are USA, China, Australia, Indonesia, South Africa and Mozambique [1]. Coal meets around 30.3% of the global primary energy needs and generates 42% of the world's electricity. India is the third largest coal producing country after China and USA.

Coal is a prime source of energy in India. Coal is the key contributor to the Indian energy scenario 51% of the current total commercial energy needs is made by coal. There are mainly two methods for extracting the coal from earth- surface mine and underground mine. Most of surface mines are open pit or open cast mine. The surface mine is entirely open and operated from the surface of the earth. The advantages of surface mines are high productivity, low operating cost and good safety condition. Most of the coal is extracted using surface method. In case coal is very deep from surface underground method is used. The underground mines are supported or unsupported mines. In supported method used artificial pillars for support of the opening. Supported mining methods are often used in mines with weak rock structure.

The artificial supports are does not available for unsupported mining method. Unsupported methods are used in those areas where strong rock structure available. Underground coal mining involves a higher risk than surface mining due to the problems of ventilation and potential for collapse. The maximum accident

occurs in underground mines. In mining industry worker safety is very important issue. Every year, thousands of miners die in accidents and many more get injured, especially in the processes of coal mining and hard rock mining. The main reasons of accidents are gas or dust explosions, gas intoxications, improper use of explosives, electrical burn, fires, collapsing of mine structures, rock falls from roofs and side walls, flooding, workers stumbling/slipping/falling, or errors from malfunctioning or improperly used mining equipment. In coal mine use of personal protective equipment like helmet, shoes etc. are not proper and proper arrangements were not there to check if the person is wearing personal protective equipment or not.

The proper supervision for worker wear the protective equipment is very important factor for consideration. Underground mines are very dark so any miners are fall unconscious because of suffocation or falling of structure, supervisor don't know about her health condition and proper treatment is not provided her in time. The main reason for miner death is harmful gases explosions. In coal mines carbon monoxide, methane, LPG gases are existing and they are very harmful for human body. The proper supervision and proper communication is very important requirement of mining industry. The smart helmet provides a real time monitoring of harmful gases, person fall detection and miner wear the helmet or not. The harmful gases like carbon monoxide, LPG, Methane and also temperature are monitor using this system. The wired communication network is not so effective because when natural calamity or a roof fall occurred, wired network is damages, so it is very difficult and costly to reinstall the entire system. In wired network technology installation and maintenance cost is very high. The effective solution for communication from base station to underground mine is Wi Fi wireless network. In Wi Fi technology mesh topology provide a long distance wireless communication network.

1.2 Organization of Project Report

The Project Report is organized into five chapters including the chapter of the introduction. Each chapter is different from the others and is described along with the necessary theory required to comprehend it.

Chapter 1 Deals with the basic introduction and objective of thesis and the problem statement were discussed.

Chapter 2 Deals with the Literature Survey of the project.

Chapter 3 Deals with the Existing system of the project and the problem identification.

Chapter 4 Deals with the proposed system and the Proteus Software which is used.

Chapter 5 Deals with the Results and Discussions

Chapter 6 Deals with the Conclusion and its Future scope.

1.3 Problem Identification

In this project we had faced the problem like, In some cases such as very deep underground or in some closed area it is difficult to get the locations each and every time so far that we may need to use the real life GPS sensor during the working which helps in getting the location coordinates. And we had found some difficulty in code implementation.

1.4 Objective of the work

Designing a sensor suite with various sensors, once the abnormality in various levels of the sensor is reached, the sensor will allow the message notification with live location to the rescue department.

1.5 Summary

The above chapter gives the information regarding the basic information about the effects and inconvenience of the coal mine workers and the problems which are facing by them. Here we have given the introduction regarding the smart sensor suite which was used in real time and helps the coal mine workers in their daily works followed by problem identification and the objective of the work. Apart from this, chapter1 gives us information how the thesis is organized.

CHAPTER 2

LITERATURE SURVEY

XueGONG, et.al., (2022) has proposed Coal Mine Fire Prediction Based on Long Short-Term Memory Network. The fire caused by coal seam spontaneous combustion is one of the most difficult fires in coal mines, endangering coal mine production and worker safety. The LSTM neural network timing memory, self-learning, and adaptive ability are used to accurately analyze the spontaneous combustion gas in a coal mine. The multiple gas factors and historical data factors of coal mine spontaneous combustion are thoroughly considered, and the potential relationship between the data is explored, to identify the nonlinear influence of each gas factor on coal mine fire over a long time range and to solve the problem of single traditional prediction gas factor and low prediction accuracy. In this paper, the LSTM neural network model is built and the model's time step length and depth are analyzed. The super parameters of the model are optimized, and the accuracy and reliability of coal mine fire prediction and early warning are improved.

A.V. Prabu, et.al., (2022) had developed Smart Coal Mine Safety & Monitoring System. The safety of mining workers is a major issue in today's generation. The use of coal is gradually increasing as time passes. As a result, the demand for coal mining workers rises. The mining safety system should be designed to provide a risk-free working environment. There is no early warning system to detect and alert the dangerous cause of coal mine accidents. This venture primarily ensures that workers will have better working conditions and that accidents will be reduced. This paper proposes connecting various sensors to create a monitoring system for the safety of miners. This can identify various boundaries such as dampness, temperature, noxious gas level noticeable all around, and the vibrations delivered in the functioning region. For these boundaries, various sorts of sensors which at that point, are associated with the Arduino are utilized. The values collected by the sensors are transmitted to the Arduino computing environment. The sensor-based alert system works in terms of the threshold value. Consequently, the mobile

phone's GSM module raises an alert to workers that can follow precautions and be careful, and also if the sensors exceed the threshold, then a buzzer and red led will be in an active state. Through this, the workers can understand that there is some problem ahead. Through this, the smart coal mine protection and surveillance system are designed for the mining workers. This project is not only useful for the coal mine workers but also will be very useful for everyone who is working in the mining industry.

T. Porselvi, et.al., (2021) has done IoT-Based Coal Mine Safety and Health Monitoring System using LoRaWAN. The safety of mining workers is a major issue in today's generation. The use of coal is gradually increasing as time passes. As a result, the demand for coal mining workers rises. The mining safety system should be designed to provide a risk-free working environment. There is no early warning system to detect and alert the dangerous cause of coal mine accidents. This venture primarily ensures that workers will have better working conditions and that accidents will be reduced. This paper proposes connecting various sensors to create a monitoring system for the safety of miners. This can identify various boundaries such as dampness, temperature, noxious gas level noticeable all around, and the vibrations delivered in the functioning region. For these boundaries, various sorts of sensors which at that point, are associated with the Arduino are utilized. The values collected by the sensors are transmitted to the Arduino computing environment. The sensor-based alert system works in terms of the threshold value. Consequently, the mobile phone's GSM module raises an alert to workers that can follow precautions and be careful, and also if the sensors exceed the threshold, then a buzzer and red led will be in an active state. Through this, the workers can understand that there is some problem ahead. Through this, the smart coal mine protection and surveillance system are designed for the mining workers. This project is not only useful for the coal mine workers but also will be very useful for everyone who is working in the mining industry.

Rohan Paul, et.al., (2022) had developed an Smart Helmet For Coal Miners. A traditional model of the smart helmet has been produced to assist miners operating in the mining industry. Many risky incidents commonly occur in the mining sector, many of which result in life-threatening injuries or death. A miner's helmet is one of the most regularly used safety equipment for mine workers hence it must be loaded with some more advanced features. With the use of different sensors, the smart helmet will be able to identify catastrophic situations such as harmful gases like Carbon-Monoxide, CH₄, LPG, and natural gases. Whether the miner is wearing his helmet or not is detected by an infrared sensor. Each sensor has a critical value that, if exceeded, causes the buzzer to activate and the LEDs to illuminate, signaling the miners and Supervisors. The GPS module fitted in the miners' helmets allows the mining officials to readily track their locations. Furthermore, a Panic Button has been implemented, which, when pressed, sends an emergency signal via mail to higher authorities outside the mines. A mobile application has also been created to display all of the data supplied wirelessly from the sensors. As a result, the proposed smart helmet protects miners from any upcoming accidents.

Ashok Kumar S.R, et.al., (2022) has done an Implementation of Coal Mining Safety and Alerting System Using Internet of Things. Coal mining is a vital process of extracting coal from the ground, whereas cement industries and steel industries used coal as a fuel for extracting iron from iron ore. The proposed research with alerting and safety monitoring system helps to protect the mine workers by alerting with the use of the individual kit. The proposed research work implemented with Arduino hardware kit and C compiler with WIFI modules, various sensors, etc., are used to simulate the design for better execution. The designed kit will monitor the detection of gas, carbon dioxide, high temperature, etc., and transfer the recorded data to the mine workers and higher officials for early protection of workers. Future work is about avoiding the disconnection of signals to transfer the observed data from the sensors for better communication using WSN.

MdRakibul, et.al., (2021) has developed Web Socket Based IoT Temperature and Humidity Monitoring System for Underground Coal Mine. In underground coal mines safety of the workers always has been a concern and challenging task. Excessive humidity and high temperature can easily be formed in the underground environment which can affect the health and safety of the workers significantly. Typically, the temperature ranges from 27°C to 30°C in underground coal mines, and humidity is spanned from 70% to 75% which is considered the maximum limit for the survival of any human being. Temperature and humidity can rise for various reasons, resulting in occurring serious accidents in the underground mine. And the situation becomes more severe because electronic devices hardly function properly at that high temperature and humidity level. To address this issue many manual systems are used in underground coal mines to measure and monitor temperature and humidity. But in the recent era with the advancement of communication technologies, we can design more efficient systems instead of the former manual ones. So, this paper suggests a way to invent a monitoring device to prevent these accidents associated with humidity and temperature by developing a robust, sustainable, and cost-efficient electronic measurement system using state-of-the-art communication techniques. This paper aims for paving the way to construct a portable device using the Internet of Things (IoT) technique along with many other advanced techniques and services, such as embedded data mining, distributed storage, and alarm services at the edge of the network. Event triggering-based data transmission methodology is adopted to process the mine's real-time data. Moreover, decision-making based on real-time data further enhances the utility of the proposed system.

Sayan Sarkar, et.al., (2020) has done the Study of Cardio respiratory and Sweat Monitoring Wearable Architecture for Coal Mine Workers. In an industrial environment, there is always a surging demand for wearable devices to cope with the increasing degree of automation and reduced manual intervention. The requirement of the wearable is related to the employee's health and well-being. Safety remains a prime concern despite other large-scale availability of personal protective equipment (PPE) and the adoption of strict safety measures. The wearable can be an essential component of the worker's toolkit, as its application is increasingly demanding. We have developed an integrated cardio respiratory & sweat monitoring wearable and performed extensive experiments in an operational underground mine in different conditions. The appearance of a wearable platform with biochemical analysis, physiological parameters monitoring along with ambient environment sensors has enabled the observation of critical indicators of performance as well as the stress of mineworkers.

Sunny Sanyal, et.al., (2020) had developed a Fog-Enabled Prediction Platform For Underground Coal Mines. The underground mining industry observes enormous losses in terms of human lives and infrastructure every year due to fatal fire hazards and blasts caused due to methane accumulation. When the methane levels are high, the methane monitoring systems deployed inside the mines don't provide sufficient time to remove the accumulated methane gas and thus remain the only option for halting the work and evacuation of the workers. Therefore, the mining industry suffers a loss of productivity due to frequent evacuations, power terminations, and false alarms caused by conventional monitoring systems. This paper advocates an alternate paradigm of forecasting rather than detection, which ensures that the system gets sufficient time to take necessary measures to remove the accumulated methane gas without completely halting the work. The paper presents a fog computing-enabled IoT data aggregation and accident prediction framework for high-stress underground mining scenarios that predict fatal accidents due to high methane accumulation using Deep LSTM encoder-decoder architecture.

The experimental results show that the proposed solution can classify accidental scenarios at an accuracy of 94.23 percent along with a satisfactory long-duration future time series prediction.

Abhishek Srivastav, et.al., (2022) has done the Coal Mine Safety Monitoring and Alerting System. The most crucial component of every industry is security. The only factor in the mining business is safety and security. The mining industry takes many safeguards to prevent accidents of any kind, including steel accidents. Temperature increases cause methane gas leaks and an increase in water levels in underground mines. Here, we give workers protection. When the danger can be suppressed by the worker, we alert the panic switch protection. To improve safety between employees in underground mines and 10 between the stationary landmine system, a dependable communication system should be implemented. There should never be a break in the communication network. This project suggests a Zimbi best wireless supervision system with early warning intelligence. On IoT, the worker status can be followed.

Suwama Kama, et.al., (2022) has proposed an IoT-based Smart Helmet for Automated and Multi parametric Monitoring of Underground Miners. Safety has always been a concern for underground miners or construction site workers in general. The recent growth of the Internet of Things (IoT) and its applications has paved the way to monitor and track the safety of workers in real-time. This paper reports the design and development of an IoT-based smart helmet for real-time monitoring of the health and safety of workers in underground mines. The smart helmet was comprised of an array of ambient and flexible body sensors, which were wirelessly connected to the cloud via the LoRaWAN protocol, thereby establishing communication with the control room. The effectiveness and performance of this smart helmet were tested and analyzed.

Ashok kumar S.R, et.al., (2022) has proposed an Coal Mining Safety and Alerting System Using Internet of Things. Coal mining is a vital process of extracting coal from the ground, whereas cement industries and steel industries used coal as a fuel for extracting iron from iron ore. The proposed research with alerting and safety monitoring system helps to protect the mineworkers by alerting with the use of individual kits. The proposed research work implemented with Arduino hardware kit and C compiler with WIFI modules, various sensors, etc., are used to simulate the design for better execution. The designed kit will monitor the detection of gas, carbon dioxide, high temperature, etc., and transfer the recorded data to the mine workers and higher officials for early protection of workers. Future work is about avoiding the disconnection of signals to transfer the observed data from the sensors for better communication using WSN.

A.V. Prabu, et.al., (2022) had developed an Smart Coal Mine Safety & Monitoring System. In the present generation, the safety of mining workers is a major challenge. As days pass by, the use of coal is expanding step by step. Therefore, the number of workers in coal mining also increases. The mining safety system should be in such a way that it can provide a hazard-free working environment. There is no early warning system in place to detect the dangerous cause of coal mine accidents and give an alert system. This venture chiefly guarantees that it can give better working conditions to the laborers and lessen the mishap rate. This paper proposes interfacing different sensors to make a monitoring system for the laborers' safety in the mining industry. This can identify the different boundaries like dampness, temperature, noxious gas level noticeable all around, and the vibrations delivered in the functioning region. For these boundaries, various sorts of sensors which at that point, are associated with the Arduino are utilized. The values collected by the sensors are transmitted to the Arduino computing environment. The sensor-based alert system works in terms of the threshold value. Consequently, the mobile phone's GSM module raises an alert to workers that can follow precautions and be careful, and also if the sensors exceed the threshold, then a buzzer and red led will

be in an active state. Through this, the workers can understand that there is some problem ahead. Through this, the smart coal mine protection and surveillance system are designed for the mining workers. This project is not only useful for the coal mine workers but also will be very useful for everyone who is working in the mining industry.

Ashwini J, et.al. (2017) had developed an Alerting System using LabVIEW. Coal is one of the important fuels used for electricity generation, steel production, cement manufacturing, and as a liquid fuel, also to produce syngas by gasification process. So to extract this coal, which results in great importance to the coal mining industry. A large population in the world depends on these coal mine industries for its livelihood. For this, they have to work in various dangerous conditions in the coal mine. A single, small accident can cause the death of the mine worker/workers. So it is important to have a warning system that is capable of detecting the non-safety condition in coal and generating an alarm. A research work deals with the design and development of a LabVIEW and micro-controller-based coal mine monitoring system using wireless technologies like ZigBee and GSM(Global System for Mobile Communication). Different types of sensors are used for sensing the physical condition parameters in coal mines like temperature, gas, humidity temperature, fire, etc.

These parameter signals from the sensors are continuously collected by the base station situated underground in the mine and sent to the ground station on the ground level. A ZigBee wireless communication system is used for communication between the underground mine base station and the ground station. These signals are fed to LabVIEW which works as a signal processor and monitoring system. Being a signal processor LabVIEW continuously compares the sensed value with the predefined critical safety values and then gives the alert indication signal accordingly to the GSM system through the micro-controller for calling and sending

the message to the safety division. Working as a monitoring and data acquisition system it acquires the data from all the sensors in the form of an excel sheet.

Qingming Sang, et.al. (2022) has proposed an algorithm on Incremental Extreme Learning Machine. Safety is the most important part of coal industry production. The existing safety monitoring for coal mines mainly adopts the hard division of the values collected by sensors, the analysis, and processing means of related information are single, and the overall scheme of intelligent mining of risk situation is lacking. Based on the temporal and spatial distribution law of coal mine production big data, this paper constructs a coal mine safety risk assessment model and combines the incremental extreme learning machine to predict the coal mine production safety risk. This method fully selects the optimal time granularity of the time window characteristics before the accident, focuses on the impact of recent sample characteristics on the risk development trend, and dynamically selects more appropriate characteristics, which can effectively meet the parameter update of coal mine safety risk model under the condition of incremental data. Experiments on multi-class monitoring data from several mines show that this method has better accuracy than other similar methods.

ZhibinMeng, et.al. (2020) has done the research on “The real-time monitoring system based on a low-power wide area network (LPWAN)” is built for the poor environment, as the high labor intensity, the heavy physical load, and the poor health of the coal mineworkers. The prediction method of miners' health status is proposed based on the long-term and short-term memory network (LSTM), and an intelligent sensing node with an edge computing function is designed. The system can master the physical and working conditions of miners in real-time, and provide a guarantee for the health of miners and the safety production of the coal mine.

Ivan Alfonso, et.al. (2018) had developed an algorithm on Monitoring the concentration of gases in under- ground coal mines is a mandatory process that may save lives. Wireless Sensor Networks (WSNs) can alert mine personnel when dangerous levels of gases are detected, such as methane and carbon monoxide that may cause explosions or poisoning of workers. WSNs must be designed to cover all active mining areas throughout a specified time horizon, thus, posing a trade-off between the cost of installation (i.e., sensors) and operation (i.e., energy consumption). While most literature on node deployment for WSNs in mines focuses on single objective functions, we propose a novel two-stage approach that allows users to address both the cost of installation and the WSN lifetime: in the first stage, our model provides the lowest-cost solution that satisfies a user-specified minimum lifetime; in the second stage, the configuration of the WSN is modified to maximize its lifetime, subject to maintaining the number of nodes(and, hence, installation costs) from the first stage. Illustrative examples are presented regarding two real coal mines in Boyaca (Colombia).

CHAPTER 3

EXISTING SYSTEM

3.1 Existing System

Industrial safety is one of the main aspects of industry specially coal mine industry. Underground mining hazards include suffocation, gas poisoning, object fall, roof collapse and gas explosion. So air quality and hazardous event detection is very important factor in mining industry. This system provides a wireless sensor network for monitoring real time situation of underground mines from base station. It provides real time monitoring of harmful gases like Heart Sensor and Respiratory Sensor and also location. The main reason for death of miners is that, due to any reason miners falls down and loses consciousness also proper treatment is not provided them at that time.

To overcome this problem the system provide emergency alert to the supervisor if person fall down by any reason. Some workers are not aware for safety and they are not wear helmet. A Limit switch was then used to successfully determine whether a miner has removed his helmet or not. The system uses Wi-Fi technology for transmission of data from underground mine to base station. There is alert switch at mines and base station for emergency purpose.

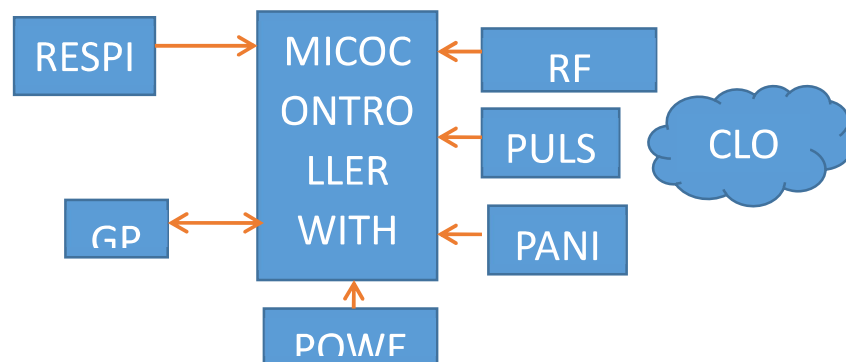


Figure 3.1 – Block diagram

3.2 Hardware Implementation

The overall block diagrams of the transmitter and receiver sections of the real-time coal mine monitoring system.

The gas sensor measures the concentration of gas in its vicinity. A gas sensor interacts with a gas to measure its concentration. Each gas has a unique breakdown voltage i.e., the electric field at which it is ionized. The sensor identifies gases by measuring these voltages. The concentration of the gas can be determined by measuring the current discharge in the device. MQ-6 gas sensor has been used in this work which has a high sensitivity to Propane, Butane, and LPG, also response to Natural gas. The sensor could be used to detect different combustible gas, especially Methane, it is low-cost and suitable for different applications.

The Fire sensor is used to detect fire flames. The module makes use of the Fire sensor and comparator to detect fire up to a range of 1 meter. The typical Maximum Range is 1 m and the input is +5V DC. It consists of LED with 3 pins easy interface connector.

Buzzer is considered to be an indicator, which indicates something is happening in the circuit, it is quite useful to identify problems in any system. If a detector detects fire or gas, or some abnormal changes occur in the temperature, then alarm sounders operate to warn the people in the coal mine of the possible danger and that they need to evacuate.

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, 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 an AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2(Atmega8U2 up to version R2) programmed as a USB-to-serial converter. Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to the ground, making it easier to put into DFU mode.

A relay is an electromagnetic switch operated by a relatively small electric current that can turn on or off a much larger electric current. The heart of a relay is an electromagnet (a coil of wire that becomes a temporary magnet when electricity flows through it). Relay is a switch on with a tiny current and it switches on another appliance using a much bigger current. As the name suggests, many sensors are incredibly sensitive pieces of electronic equipment and produce only small electric currents. But often we need them to drive bigger pieces of apparatus that use bigger currents. Relays bridge the gap, making it possible for small currents to activate larger ones. That means relays can work either as switches (turning things on and off) or as amplifiers (converting small currents into larger ones). Relays are also used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal.

ZigBee is a specification for a suite of high-level communication protocols using small, low-power digital radios based on the IEEE 802.15.4-2003 standard for Low Rate Wireless Personal Area Networks (LR-WPANs), such as wireless light switches with lamps, electrical meters with in-home displays, consumer electronics

equipment via short-range radio needing low rates of data transfer. The technology defined by the ZigBee specification is intended to be simpler and less expensive than other WPANs, such as Bluetooth. ZigBee is targeted at radio-frequency (RF). Applications that require a low data rate, long battery life, and secure networking. ZigBee is a low-cost, low-power, wireless networking standard. First, the low cost allows the technology to be widely deployed in wireless control and monitoring applications. Second, low power usage allows longer life with smaller batteries. Third, mesh networking provides high reliability and a more extensive range.

Disasters are common in coal mines due to the complexity of their natural Environment.

These frequent disasters bring huge loss of possession and life. Therefore, the safe production of coal in the mine is inevitable. The system adopted a ZIGBEE wireless technology to build wireless sensor networks and realized real-time surveillance with early-warning intelligence on methane, temperature, and humidity in the mining areas to reduce potential safety problems in coal production.

CHAPTER 4

PROPOSED SYSTEM

4.1 Introduction

Today, the safety of miner workers is a significant challenge. Miner's health and life are helpless against a few basic issues, which incorporates the working environment, yet in addition its delayed consequence. To extent profitability and diminish the expense of mining alongside the thought of the safety of miners, a creative and innovative methodology is required. The proposed system comprises of two sections one to monitor the mineworker status and another one is the total monitoring section. In the mine laborer area, air contamination is primarily due to the outflows.

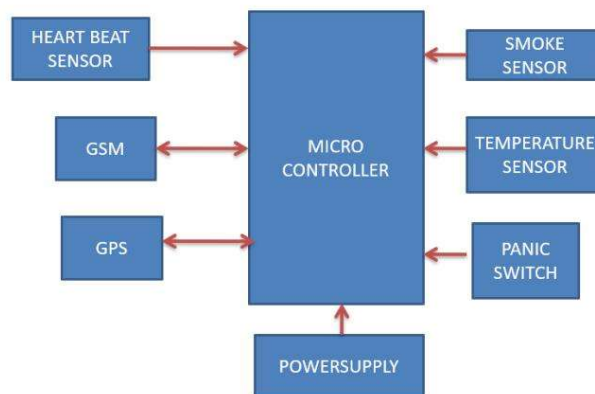


Figure 4.1
diagram

Block

4.2 Proteus Software

Computer Control Technology is a comprehensive and important technical course for university students in school of electrical engineering and automation. The course requires students to master control theory, computer control system analysis and design methods, and basic design skills to design a simple computer control system.

In the process of teaching the course, we find that students usually feel difficult in computer control system hardware design, which is abstract and difficult to image. Usually, in teaching practice, teachers first explain the theory and use theory to explain the relevant practical part, which makes the theory and practice teaching disjointed. Computer control system test box is used in experimental process of Computer Control Technology, whose internal structure is fixed.

So, students only do some simple connection during experimental process and then check and analyze the results system operation. Such experiments are unable to practice the abilities of students to design a computer control system. Obviously, current laboratory hardware is unable to meet existing experimental modern teaching needs. Fortunately, with the development of computer technology, simulation technology has become an important mean to aid circuit analysis and system design.

Particularly, Proteus simulation software from UK Lab Center Electronics Company, combines circuit simulation, PCB design and simulation of a virtual model together effectively to solve the problem of the design and co-simulation of microcontroller and peripheral circuits.

Many teachers have employed Proteus in relevant teaching. In this paper, we analysis in detail the application of Proteus in teaching through a teaching examples. We believe that software simulation of teaching examples will improve the overall design capabilities of computer control system of students.

4.2.1 Simulation Diagram

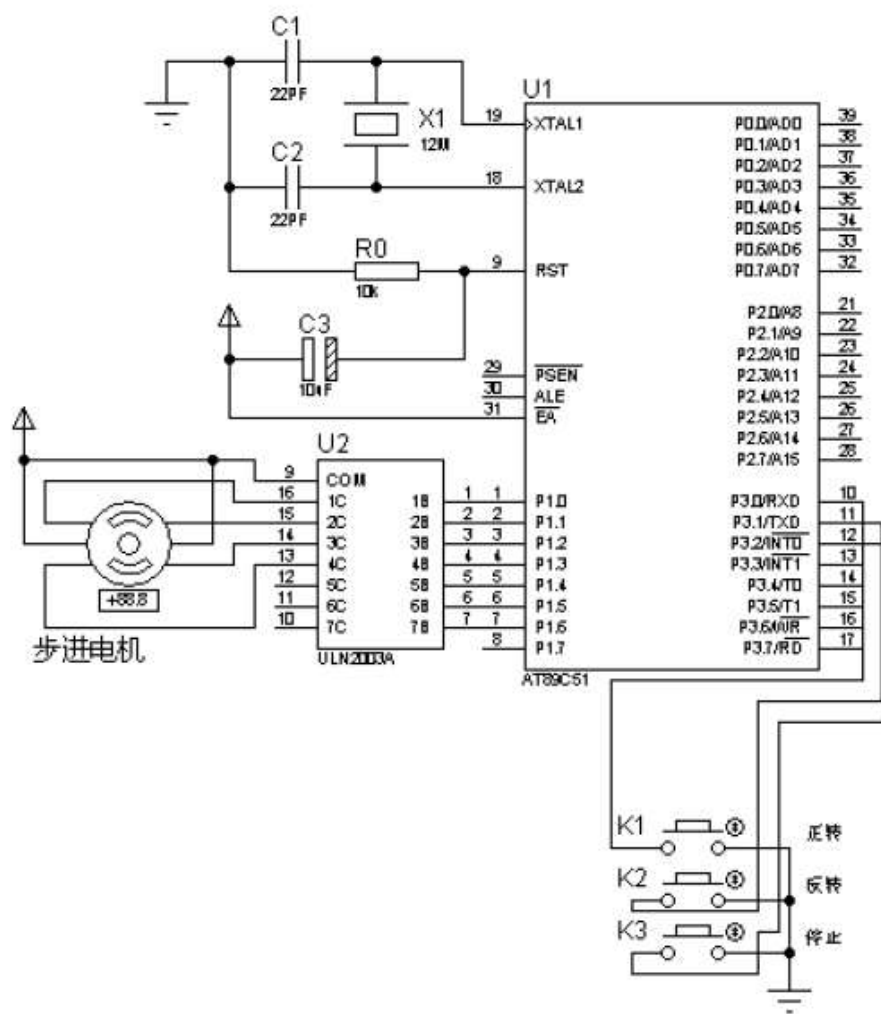


Figure 4.2 Simulation Diagram

In this we describe the process using Proteus for virtual simulation in the teaching of computer control technology based on AT89C51 stepper motor control.

This example mainly contains four steps as key input, interrupts, timers, stepper motor. After the system is running, we can use buttons to start, stop, forward and reverse the stepper motor. From this example, students can be very intuitive to see the process of hardware design, software programming and debugging, and the running states of the stepper motor. By this example, students can take deep understanding of the work mechanism of the stepper motor and some ways to operate hardware.

4.2.2 Working of Proteus Software

Proteus is an EDA tool which can simulate microcontroller and peripheral devices. Proteus can truly turn a complete design from concept into product. Proteus can program based on the virtual prototype directly. Together with display and output devices, input and output can be seen after running of programs. Proteus establishes a comprehensive electronic design and development environment.

Teaching content of Computer Control Technology course includes theoretical teaching and experimental teaching, which are mainly related to hardware design techniques such as bus technology, analog and digital input and output, digital control technology, practices and complex control technology, computer control system design and implementation.

A transformation, stepper motor control about the parallel interface chip 8255A, timer counter chip 8253, 8259, and interrupt controller chip. These chips work more complicated due to too many pins and complicated links. Consequently, it is difficult

for students to understand and grasp a lot of related knowledge. Now, after the introduction of Proteus software, we can directly show real-time running effects of these circuit chips, meanwhile dynamically change the parameters related to devices just in the classroom, which shows the advantages combination of virtual simulation and the theory.

Therefore, using Proteus in classroom can demonstrated corresponding examples to explain the theory of knowledge, which can greatly improve learning initiative of student. On the other hand, Proteus updates soon, so the latest relevant teaching device can be found in the new version of Proteus.

4.2.3 Applications

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards.

This software can be used for the designing of automation works related to electronics. **Proteus** is used to simulate, design and drawing of electronic circuits. It was invented by the Lab center electronic. By using proteus you can make two-dimensional circuits designs as well. With the use of this engineering software, you can construct and simulate different electrical and electronic circuits on your personal computers or laptops.

4.2.4 Advantages and Disadvantages

As software that integrates circuit simulation, PCB design, and single-chip simulation, Proteus not only contains a large number of components based on the real environment, supports many mainstream single-chip models and general

peripheral models, but also provides the best real-time display effects. Its dynamic simulation is based on frames and animation, so it provides better visual effects. Proteus supports the editing /compiling /source-level simulation of the assembly language of the microcontroller, with built-in assembly compilers of 8051, AVR, and PIC, and can also be combined with third-party integrated compilation environments (such as IAR, Keil, and Hi-tech) to perform source-level simulation of high-level languages Simulation and debugging.

Advantages

Proteus can provide all the resources needed for the test, directly evaluate the correctness of hardware circuit design, directly debug the software with hardware schematic diagram, verify the function of the whole design, and test controllable, easy to evaluate and easy to implement.

Disadvantages

The disadvantage of Proteus is that it is insufficient in data calculation of the circuit. It is difficult to debug software without system hardware. It is very costly and time-consuming to remake the board.

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4.3 Hardware Components

4.3.1 Arduino

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, 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.

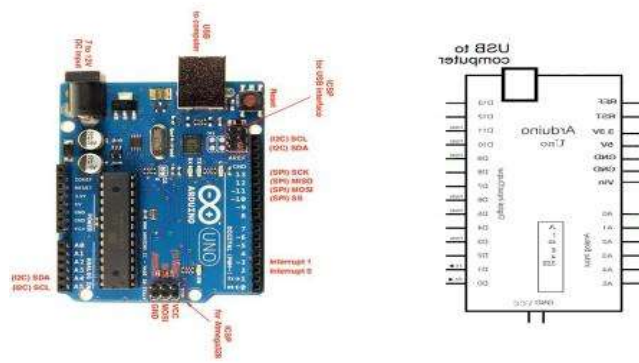


Figure 4.3 Arduino Uno

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode. Revision 3 of the board has the following new features

Pinout

Added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that use the AVR, which operate with 5V and with the Arduino Due that operate with 3.3V. The second one is a not connected pin, that is reserved for future purposes. Stronger RESET circuit. Atmega 16U2 replace the 8U2.

Uno means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

Schematic & Reference Design

EAGLE files: arduino-uno-Rev3-reference-design.zip (NOTE: works with Eagle 6.0 and newer) Schematic: arduino-uno-Rev3-schematic.pdf Note: The Arduino reference design can use an Atmega8, 168, or 328, Current models use an ATmega328, but an Atmega8 is shown in the schematic for reference. The pin configuration is identical on all three processors.

Power

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector. The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. The power pins are as follows

VIN.

The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.

Memory

The ATmega328 has 32 KB (with 0.5 KB used for the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using `pinMode()`, `digitalWrite()`, and `digitalRead()` functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions.

Serial

0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip. External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the `attachInterrupt()` function for details.

PWM

3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the `analogWrite()` function.

SPI

10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.

LED

13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analog Reference () function. Additionally, some pins have specialized functionality.

TWI

A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library.

There are a couple of other pins on the board:

Reset

Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board. See also the mapping between Arduino pins and ATmega328 ports. The mapping for the ATmega8, 168, and 328 is identical.

Communication

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Uno's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation for details. For SPI communication, use the SPI library.

Automatic (Software) Reset

Rather than requiring a physical press of the reset button before an upload, the Arduino Uno is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2/16U2 is connected to the reset line of the ATmega328 via a 100 Nano fara capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the boot loader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload. This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it

resets each time a connection is made to it from software (via USB). For the following half second or so, the bootloader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data. The Uno contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labeled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110-ohm resistor from 5V to the reset line; see this forum thread for details.

USB Overcurrent Protection

The Arduino Uno has a resettable polyfuse that protects your computer's USB ports from shorts and over current. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

Physical Characteristics

The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Four screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multiple of the 100 mil spacing of the other pins.

4.3.2 GSM Modem

Global system for mobile communication (GSM) is a globally accepted standard for digital cellular communication. GSM is the name of a standardization group established in 1982 to create a common European mobile telephone standard that would formulate specifications for a pan-European mobile cellular radio system operating at 900 MHz

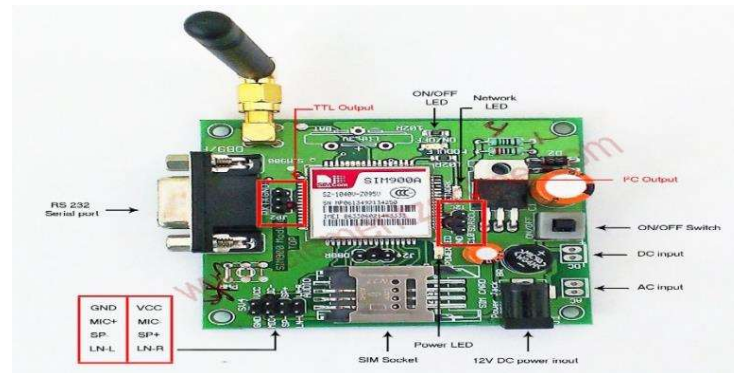


Figure 4.4 GSM Module

GSM provides recommendations, not requirements. The GSM specifications define the functions and interface requirements in detail but do not address the hardware. The reason for this is to limit the designers as little as possible but still to make it possible for the operators to buy equipment from different suppliers. The GSM network is divided into three major systems: the switching system (SS), the base station system (BSS), and the operation and support system (OSS). The basic GSM network elements are shown in below figure.

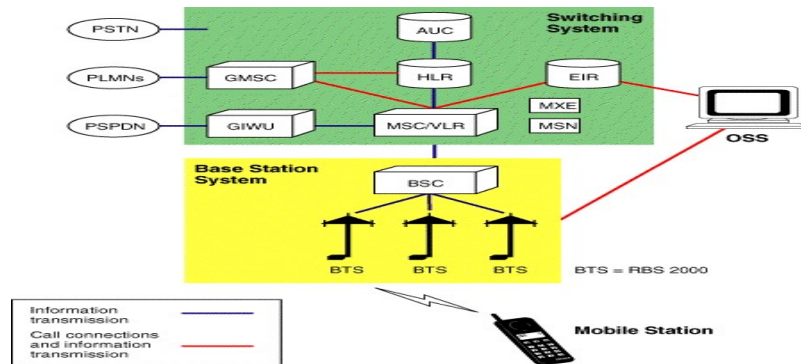


Figure 4.5 Gsm network elements

A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves.

GSM MODEM APPLICATIONS

A GSM modem can be an external device or a PC Card / PCMCIA Card. Typically, an external GSM modem is connected to a computer through a serial cable or a USB cable. A GSM modem in the form of a PC Card / PCMCIA Card is designed for use with a laptop computer. It should be inserted into one of the PC Card / PCMCIA Card slots of a laptop computer. Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier in order to operate.

As mentioned in earlier sections of this SMS tutorial, computers use AT commands to control modems. Both GSM modems and dial-up modems support a common set of standard AT commands. You can use a GSM modem just like a dial-up modem.

In addition to the standard AT commands, GSM modems support an extended set of AT commands. These extended AT commands are defined in the GSM standards. With the extended AT commands, you can do things like:

Reading, writing and deleting SMS messages.

Sending SMS messages.

Monitoring the signal strength.

Monitoring the charging status and charge level of the battery.

Reading, writing and searching phone book entries.

The number of SMS messages that can be processed by a GSM modem per minute is very low -- only about six to ten SMS messages per minute.



Figure

GSM Modem Applications

4.6

FACTS AND APPLICATIONS OF GSM/GPRS MODEM

The GSM/GPRS Modem comes with a serial interface through which the modem can be controlled using AT command interface. An antenna and a power adapter are provided. The basic segregation of working of the modem is as under

Voice calls

Voice calls are not an application area to be targeted. In future if interfaces like a microphone and speaker are provided for some applications then this can be considered.

SMS

SMS is an area where the modem can be used to provide features like:

Pre-stored SMS transmission

These SMS can be transmitted on certain trigger events in an automation system

SMS can also be used in areas where small text information has to be sent. The transmitter can be an automation system or machines like vending machines, collection machines or applications like positioning systems where, The navigator keeps on sending SMS at particular time intervals. SMS can be a solution where GSM data call or GPRS services are not available.

4.3.3GPS MODULE

This article demonstrates how to play with the u-blox NEO-6M global positioning system (GPS) module, a very popular, cost-effective, high-performance GPS module with a ceramic patch antenna, an on-board memory chip, and a backup battery that can be conveniently integrated with a broad range of microcontrollers. Nowadays, two NEO-6M GPS modules are extremely popular — the GY-GPS6MV2 and the GY-GPSV3-NEO.

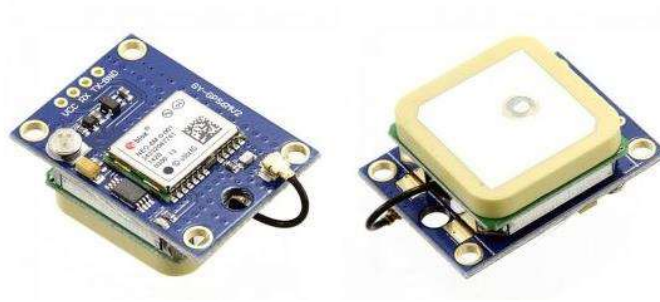


Figure 4.7 GPS Module

The u-blox NEO-6M GPS engine on these modules is quite a good one, and it also has high sensitivity for indoor applications. Furthermore, there's one MS621FE-compatible rechargeable battery for backup and EEPROM for storing configuration settings. The module works well with a DC input in the 3.3- to 5-V range (thanks to its built-in voltage regulator). The original circuit diagram of the module, borrowed from the web.

4.3.4 GAS SENSOR

They are commonly used to detect toxic or explosive gasses and measure gas concentration. Gas sensors are employed in factories and manufacturing facilities to identify gas leaks, and to detect smoke and carbon monoxide in homes. Gas sensors vary widely in size (portable and fixed), range, and sensing ability.



Figure 4.8 Gas sensor

FEATURES

High sensitivity to LPG, iso-butane, propane

Small sensitivity to alcohol, smoke.

Fast response.

Stable and long life

Simple drive circuit

APPLICATION

They are used in gas leakage detecting equipment's in family and industry, are suitable for detecting of LPG, iso-butane, propane, LNG, avoid the noise of alcohol and cooking fumes and cigarette smoke.

This is a simple-to-use liquefied petroleum gas (LPG) sensor, suitable for sensing LPG (composed of mostly propane and butane) concentrations in the air. The MQ-6 can detect gas concentrations anywhere from 200 to 10000ppm.

4.3.4 TEMPERATURE SENSOR

LM35 series temperature sensor is a precisely integrated circuit whose voltage output is linearly proportional to the centigrade temperature. These sensors have an added advantage over kelvin calibrated sensors and do not require the

subtracting of constant voltage from its output to obtain convenient centigrade scaling.

The Temperature can be detected with the help of a temperature sensor LM35.

The LM series are precision integrated circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature.

Station which when pressed immediately will alert Base station and thus will not wait for heart beats to go out of the normal range.

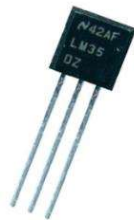


Figure 4.9 Temperature sensor

4.3.5 PULSE SENSOR

Pulse Sensor is a well-designed plug-and-play heart-rate sensor for Arduino. ... The sensor clips onto a fingertip or earlobe and plugs right into Arduino with some jumper cables. It also includes an open-source monitoring app that graphs your pulse in real time.

Heart rate data can be really useful whether you're designing an exercise routine, studying your activity or anxiety levels or just want your shirt to blink with your heart beat. The problem is that heart rate can be difficult to measure. Luckily, the Pulse Sensor Amped can solve that problem.

The Pulse Sensor Amped is a plug-and-play heart-rate sensor for Arduino. It can be used by students, artists, athletes, makers, and game & mobile developers who want to easily incorporate live heart-rate data into their projects. It essentially combines a simple optical heart rate sensor with amplification and noise cancellation circuitry making it fast and easy to get reliable pulse readings. Also, it sips power with just 4mA current draw at 5V so it's great for mobile applications.

Simply clip the Pulse Sensor to your earlobe or fingertip and plug it into your 3 *or *5 Volt Arduino and you're ready to read heart rate! The 24" cable on the Pulse Sensor is terminated with standard male headers so there's no soldering required. Of course Arduino example code is available as well as a Processing sketch for visualizing heart rate data.

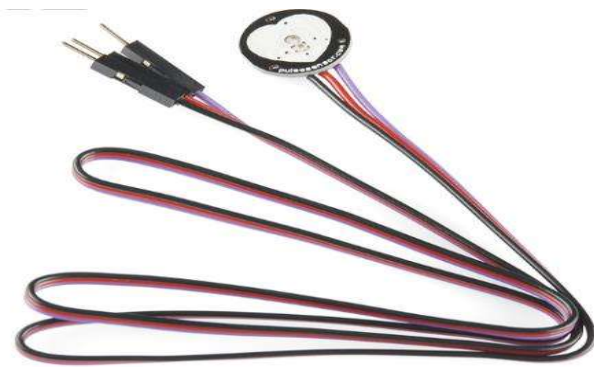


Figure 4.10 Pulse Sensor

4.4 PULSE WIDTH MODULATION

4.4.1 Introduction

PWM is an effective method for adjusting the amount of power delivered to the load. PWM technique allows a very smooth operation and reliable in nature. The

microcontroller can have generated PWM signal to adjusting the duty cycle of pulse simultaneously the motor terminal voltage can vary with duty cycle and also speed will be a vary. The ratio of on time to off time is called as duty cycle. The desired speed can be obtained by changing the duty cycle. The Pulse-Width-Modulation (PWM) in microcontroller is used to control duty cycle of DC motor drive. PWM is an entirely different approach to controlling the speed of a DC motor. Power is supplied to the motor in square wave of constant voltage but varying pulse-width or duty cycle. Duty cycle refers to the percentage of one cycle during which duty cycle of a continuous train of pulses. Since the frequency is held constant while the on-off time is varied, the duty cycle of PWM is determined by the pulse width. The figure shown below the change of duty cycle of the PWM microcontroller. The microcontroller having a 25% duty cycle then it provides a $\frac{1}{4}$ of power to the motor, when microcontroller having a 50% duty cycle then microcontroller provide a $\frac{1}{2}$ of power to the motor, when microcontroller having a 75% duty cycle then microcontroller provide a $\frac{3}{4}$ of power to the motor and finally the microcontroller provide a 100% duty cycle then microcontroller provide a full power to the motor.

4.4.2Types of Pulse Width Modulation

There are three conventional types of pulse width modulation technique and they are named as follows:

Trail Edge Modulation

In this technique, the signal's lead edge is modulated, and the trailing edge is kept fixed.

Lead Edge Modulation

In this technique, the signal's lead edge is fixed, and the trailing edge is modulated.

Pulse Center Two Edge Modulation

In this technique, the pulse centre is fixed and both edges of the pulse are modulated.

4.4.3 Generation of Pulse Width Modulation Signal

A pulse width modulating signal is generated using a comparator. The modulating signal forms one part of the input to the comparator, while the non-sinusoidal wave or saw tooth wave forms the other part of the input.

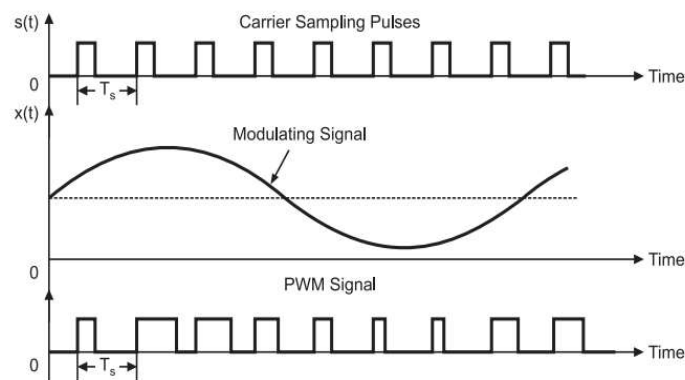


Figure 4.11 Generation of PWM signal

The comparator compares two signals and generates a PWM signal as its output waveform. If the saw tooth signal is more than the modulating signal, then the output signal is in a “High” state. The value of the magnitude determines the comparator output which defines the width of the pulse generated at the output.

4.4.4 Parameters associated with PWM signal

Duty Cycle of PWM

As we know, a PWM signal stays “ON” for a given time and stays “OFF” for a certain time. The percentage of time for which the signal remains “ON” is known as the duty cycle. If the signal is always “ON,” then the signal must have a 100 % duty cycle. The formula to calculate the duty cycle is given as follows:

The average value of the voltage depends on the duty cycle. As a result, the average value can be varied by controlling the width of the “ON” of a pulse.

Frequency of PWM

The frequency of PWM determines how fast a PWM completes a period. The frequency of a pulse is shown in the figure below.

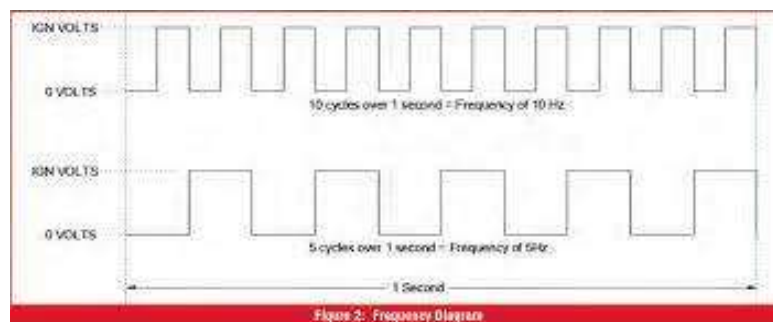


Figure 4.12 Frequency of PWM

The frequency of PWM can be calculated as follows:

Frequency = $1/\text{Time Period}$

Time Period = On Time + OFF time

Output Voltage of PWM signal

The output voltage of the PWM signal will be the percentage of the duty cycle. For example, for a 100% duty cycle, if the operating voltage is 5 V then the output voltage will also be 5 V. If the duty cycle is 50%, then the output voltage will be 2.5V.

4.4.5 Applications of Pulse Width Modulation

Due to the high efficiency, low power loss, and the PWM technique's ability to precisely control the power, the technique is used in a variety of power applications. Some of the applications of PWM are as follows

The pulse width modulation technique is used in telecommunication for encoding purposes.

The PWM helps in voltage regulation and therefore is used to control the speed of motors.

The PWM technique controls the fan inside a CPU of the computer, thereby successfully dissipating the heat.

PWM is used in Audio/Video Amplifiers.

4.4.6 Advantages and Disadvantages of Pulse Width Modulation

First, let us talk about the advantages of the pulse width modulation technique before discussing its disadvantages.

PWM technique prevents overheating of LED while maintaining its brightness.

PWM technique is accurate and has a fast response time.

PWM technique provides a high input power factor.

PWM technique helps motors generate maximum torque even when they run at lower speeds.

The above were some of the advantages of the Pulse width modulation technique, now let us look at some of the disadvantages

As the PWM frequency is high, switching losses are considerably high.

It induces Radio Frequency Interference (RFI).

They are used in telecommunication for encoding purposes.

They are used in Audio/Video amplifiers

4.5 Summary

In this chapter we discussed about Proteus software and its simulation diagram and also gives the information about the working of the Proteus software. Apart from these it also contains the information regarding its advantages and disadvantages. We also discussed about the components Arduino, GSM Module, GPS Module, Gas Sensor, Pulse Sensor, and Temperature Sensor. We have discussed about the generation and types of pulse with modulation apart from this we discussed about the applications.

CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 Results and Discussions

The suggested system has two portions, one to track the state of the mineworkers, and the other is the overall monitoring section, as we have already described. The outflows are the main cause of air pollution in the mine worker region. Additionally, it warns the miner when dangerous gases, including CO, LPG, and CH₄, exceed their safety limits, personal fall detection, and removes helmets. All of the miners within the mine will benefit from this before anybody gets injured.

We will be monitoring the Heartbeat of the worker by using a Heartbeat Sensor about the condition of the Heart. We will be measuring the temperature of the surrounding atmosphere by using a Temperature sensor. So that we can be able to know the working in which condition. We can also be able to measure the toxic gases and their percentage of presence in the atmosphere using the gas and smoke sensor. Panic switch will be able to help the worker when he is in an Emergency. We are having GSM Module for the communication which will be happening with mine workers. GPS Module helps in getting the location coordinates of the person at what location is he working. All the sensors will be equipped so that we can be able to monitor the worker's health status and health condition from time to time, which helps in decreasing the death rate and helping the workers in a much more useful way.

CHAPTER 6

CONCLUSIONS AND FUTURE SCOPE

6.1 Conclusions

For the purpose of offering an exact and detailed vision of the underground mine, a real-time monitoring system is formed. This system informs the miner when dangerous gases, including CH₄, LPG, and CO, surpass their limit, a person falls, or the helmet is removed. It also displays the information on the base station PC. To save their lives before there are any casualties would be beneficial to all miners present within the mining area. All potential safety hazards, like water leakage, vibration, dust, etc., might be tracked in the future utilizing more sensors. Additionally, we may increase the data transmission distance by using the number of salves.

The proposed concept of a Smart Sensor Suite for Coal Mine Safety Workers has-been successfully implemented and tested using the Arduino Uno microcontroller. The system adopted a ZigBee wireless technology to build wireless sensor networks and realized real-time surveillance with early-warning intelligence on methane, temperature, and humidity in the mining area to reduce potential safety problems in coal production. This system will greatly help in reducing future dangers caused in the coal mines, which will give proper rescue and avoid many human deaths. Here, we will be using GPS and GSM Module which help our communication with the workers in coal mines about the necessary information which should be communicated with the persons who were outside of the mines. With the help of the GPS Module, we will be receiving the exact location of the worker at a particular place. And the panics which are used in emergencies for the workers at uncomfortable times. With the help of this proposed suite system, we can greatly help the workers to know about their health status and their mental condition which is very helpful for the workers. The compact and efficient design ensures the practical implementation of the system. The system can be changed as per the conditions of the coal mines by simply

editing the software which makes it more flexible for various coal mine environments.

6.2 Future Scope

This project can be enhanced in the future in such a way that, it will be more effective and accurate by using of wireless network where we will have a strong signal in the area for effective communication. We can also update, in such a way that, we can be able to monitor the data for each and every minute, so that, the health status of the workers will be improved and the damage of the death rate decrease.

In future using additional sensors all possible safety issues could be monitored such as dust, vibration, water leakage etc. Also we can use number of salve and improve the data transmission distance. And usage of real time Gps gives the information about the location coordinates in day to day life which helps in knowing the location of the worker during each interval of time.

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