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Shri Bhagwan Mahaveer Jain Educational & Cultural Trust ®

JAIN COLLEGE OF ENGINEERING, BELAGAVI

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

FINAL YEAR

(2024 – 2025)

PROJECT REPORT

On

"Coal Mine Safety Monitoring and Alerting System with Smart Helmet"

PROJECT GUIDE

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CERTIFICATE

This is to certify that the **Project Work** entitled **"Coal Mine Safety Monitoring and Alerting System with Smart Helmet"** carried out by **Mr**. **Basavaraj B. Gudasalamani (2JI21EC030), Mr. Chetan A. Girigouda (2JI21EC038), Mr. Girish I. Nadakattin (2JI21EC051)**, **Mr**. **Vishal S. Tikoti (2JI21EC178)** are bonafide students of **Department of Electronics and Communication Engineering, Jain College of Engineering, Belagavi,** in partial fulfilment for the award of **Bachelor of Engineering** of the **Visvesvaraya Technological University, Belagavi** during the academic year **2024-2025**. It is certified that all corrections/suggestions indicated for project assessment have been incorporated in the report. The project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the Bachelor of Engineering degree.

______________________	____________________	_____________________
Prof. Shivanand Channi	**Prof. V R Bagali**	**Dr. J. Shivakumar**
Project Guide	HOD, Dept. of E&CE	Principal & Director
Dept. of E&CE, JCE Belagavi	JCE, Belagavi	JCE, Belagavi

Name of the examiners	Signature with date
1. ___________________________	____________________
2. ____________________________	____________________

DECLARATION

We **Mr. Basavaraj B. Gudasalamani (2JI21EC030), Mr. Chetan A. Girigouda (2JI21EC038), Mr. Girish I. Nadakattin (2JI21EC051)**, **Mr. Vishal S. Tikoti (2JI21EC178)** students of **8th semester B.E. Electronics & Communication Engineering, Jain College of Engineering, Belagavi** hereby declare that the dissertation entitled **"Coal Mine Safety Monitoring and Alerting System with Smart Helmet"** has been carried out in a batch and submitted in the partial fulfilment of the requirement for the award of Bachelor's Degree in Electronics & Communication Engineering under Visvesvaraya Technological University, Belagavi during the academic year **2024 – 25.**

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Date :

Vision of Institute

"To be a university as a resource of solution to diverse challenges of society by nurturing innovation, research & entrepreneurship through value based education."

Mission of Institute

- To provide work culture that facilitates effective teaching-learning process and lifelong learning skills.
- To promote innovation, collaboration and leadership through best practices.
- To foster industry-institute interaction resulting in entrepreneurship skills and employment opportunities.

Vision of Department

"To achieve excellence in education and research for developing globally competent, ethically sound Electronics & Communication Engineers".

Mission of Department

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2. To nurture needs of society by infusing scientific temper in students and to grow as a centre of excellence with efficient industry-institute interaction.
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1. Design, verify and develop analog and digital systems by using state of art technology to contribute to the societal needs..
2. Apply knowledge in various domain of IoT, real time systems, communication systems, VLSI and embedded systems, image and signal processing using hardware and software tools.

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5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modernengineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assesssocietal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability**: Understand the impact of the professional engineering solutionsin societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms ofthe engineering practice.

9. **Individual and team work**: Function effectively as an individual, and as a member or leader indiverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineeringcommunity and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the **engineering and management principles and apply these to one's own work, as a member and** leader in a team, to manage projects and in multidisciplinary environments.

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CO-PO/PSO Mapping:

L1: Remembering L2: Understanding L3: Applying L4: Analyzing L5: Evaluating L6: Creating

Course Outcomes	Description	Bloom's Cognitive level
21ECP76.01	**Understand the basic concepts and broad principles of industrial projects.**	**L3**
21ECP76.02	**Apply the theoretical concepts to solve industrial problems with team work and multidisciplinary approach.**	**L3**
21ECP76.03	**Get capable of self education and clearly understand the values of achieving perfection in project implementation and completion.**	**L3**
21ECP76.04	**Demonstrate professionalism with ethics; present effective communication skills relate engineering issues to broader societal context.**	**L3**
21ECP76.05	**Understand concepts of projects and production management.**	**L3**

Strength of CO Mapping to PO/PSOs with Justification:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	1		1	1							3
CO2	3	3	3	1					3				3	3
CO3	3	3	3	1	1			2	3	3	2	2	3	3
CO4								2		3				
CO5									3	3	2	2	3	
Avg	3	3	3	1	1	1	1	2	3	3	2	2	3	3

CO-PO-PSO	Justification
CO1 → PO1 (3) CO1 → PO2 (3) CO1 → PO3 (3) CO1 → PO4 (1) CO1 →PO6(1) CO1 →PO7(1) CO1 → PSO2(3)	• Strongly mapped as students apply the electronics and communication engineering skills to understand the principles of industrial projects. • Strongly mapped as students identify, formulate, review research literature and analyse complex engineering problems. • Strongly mapped as students design solutions for complex engineering problems with appropriate consideration for the public health and safety. • Slightly mapped as students can use research-based knowledge and methods including design of experiments, analysis and interpretation to provide valid conclusions. • Slightly mapped as students can able to understand the impact of professional engineering project solutions in societal and environmental contexts. • Slightly mapped as students can be able to apply reasoning of contextual project knowledge to assess societal, health and safety issues. • Strongly mapped as apply knowledge in various domain of IoT, real time systems, communication systems, VLSI and embedded systems, image and signal processing using hardware and software tools.
CO2→ PO1 (3) CO2→ PO2 (3) CO2→ PO3 (3) CO2→ PO4 (1) CO2→ PO9 (3) CO2→ PSO1(3) CO2→ PSO2(3)	• Strongly mapped as students apply the electronics and communication engineering skills to understand the principles of industrial projects. • Strongly mapped as students identify, formulate, review research literature and analyse complex engineering problems. • Strongly mapped as students design solutions for complex engineering problems with appropriate consideration for the public health and safety. • Slightly mapped as students can use research-based knowledge and methods including design of experiments, analysis and interpretation to provide valid conclusions. • Strongly mapped as students can effectively act as an individual, and as a member or leader and work in a team. • Strongly mapped as students can design, verify and develop analog and digital systems by using state of art technology to contribute to the societal needs and solve industrial problem. • Strongly mapped as students apply knowledge in various domain of IoT, real time systems, communication systems, VLSI and embedded systems, image and signal processing using hardware and software tools and solve industrial problem.
CO3→ PO1 (3) CO3→ PO2 (3) CO3→ PO3 (3) CO3→ PO4 (1)	• Strongly mapped as students apply the electronics and communication engineering skills to understand the principles of industrial projects. • Strongly mapped as students identify, formulate, review research literature and analyse complex engineering problems.

CO3 → PO5(1) CO3 → PO8(2) CO3 → PO9 (3) CO3 → PO10 (3) CO3 → PO11 (2) CO3 → PO12 (2) CO3 → PSO1(3) CO3 → PSO2(3)	• Strongly mapped as students design solutions for complex engineering problems with appropriate consideration for the public health and safety. • Slightly mapped as students can use research-based knowledge and methods including design of experiments, analysis and interpretation to provide valid conclusions. • Slightly mapped asstudents can Create, select, and apply appropriate techniques, resources, and modernengineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations. • Moderately mapped as students can work ethically and professionally in the industry. • Strongly mapped as Students can effectively act as an individual, and as a member or leader and work in a team. • Strongly mapped as Students can comprehend and write effective reports and make documentation with effective presentation. • Moderately mapped as students can learn to management and financial skills required for the execution of project. • Moderately mapped as students can be engaged in life long learning in the broadest context of technological change through project implementation and completion. • Strongly mapped as students can design, verify and develop analog and digital systems by using state of art technology to contribute to the societal needs and solve industrial problem. • Strongly mapped as students apply knowledge in various domain of IoT, real time systems, communication systems, VLSI and embedded systems, image and signal processing using hardware and software tools and solve industrial problem.
CO4 → PO8 (3) CO4 → PO10 (3)	• Moderately mapped as students can work ethically and professionally in the industry. • Strongly mapped as Students can comprehend and write effective reports and make documentation with effective presentation.
CO5 → PO9 (3) CO5 → PO10 (3) CO5 → PO11 (2) CO5 → PO12 (2) CO5 → PSO1(3)	• Strongly mapped as Students can effectively act as an individual, and as a member or leader and work in a team. • Strongly mapped as Students can comprehend and write effective reports and make documentation with effective presentation. • Moderately mapped as students can learn to management and financial skills required for the execution of project. • Moderately mapped as students can be engaged in life long learning in the broadest context of technological change through project implementation and completion. • Strongly mapped as students can design, verify and develop analog and digital systems by using state of art technology to contribute to the societal needs and solve industrial problem.

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We extend our sense of gratitude to **Prof. V R Bagali, Assistant Professor &Head, Dept. of E&CE, JCE, Belagavi,** for extending support and cooperation which helped us in completion of the project work.

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ABSTRACT

The "Coal Mine safety monitoring and alerting system with smart helmet " project enhances worker safety in coal mines through a wearable helmet equipped with environmental sensors and real-time hazard detection. The system integrates methane (CH_4), carbon monoxide (CO), temperature, and humidity sensors to monitor air quality and atmospheric conditions. A microcontroller processes sensor data and activates an onboard buzzer alarm when hazardous thresholds (e.g., toxic gas leaks or extreme temperatures) are breached, providing immediate auditory alerts to the worker.

Focused on simplicity and reliability, the helmet operates as a standalone safety device, prioritizing direct hazard detection and localized warnings. By enabling miners to respond swiftly to dangerous conditions, the system aims to reduce accident risks and improve situational awareness in high-risk mining environments. The design emphasizes affordability, ease of use, and adaptability to rugged mining conditions, offering a practical solution to enhance occupational safety without reliance on complex infrastructure.

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CHAPTER 1

INTRODUCTION

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1.1 MOTIVATION

The Coal Mine Safety Monitoring and Alerting System, featuring a smart helmet, is designed to tackle the serious safety issues faced in coal mining. This initiative arises from the numerous risks miners encounter daily, which can result in tragic accidents if not effectively addressed. By incorporating cutting-edge sensors into a smart helmet, this system aims to enhance safety measures significantly. It offers real-time monitoring and immediate alerts, allowing for quick responses and proactive measures to prevent dangerous situations from escalating.

1.2 PROBLEM STATEMENT

The coal mining industry faces significant safety risks, leading to injuries and fatalities despite existing protocols. This project seeks to develop a smart helmet equipped with advanced sensors to monitor environmental conditions and miners' health in real time. The aim is to provide immediate alerts to prevent accidents and improve safety, ultimately creating a safer working environment for miners.

1.3 OBJECTIVES OF PROJECT :

- Implement a system that continuously monitors environmental conditions in the coal mine, including gas levels, temperature, humidity, and smoke, providing immediate alerts through a buzzer for hazardous changes.
- Develop a reliable alert mechanism that activates the buzzer to notify miners of dangerous conditions, ensuring prompt responses to prevent accidents.
- Provide training for miners on the proper use of the smart helmet and the significance of the alerts, fostering a culture of safety and awareness in the workplace.
- Design the system to complement and enhance existing safety measures, contributing to a comprehensive safety strategy for coal mining operations.

1.4 LITERATURE SURVEY

Coal mining is one of the most hazardous industries, exposing workers to risks such as gas explosions, cave-ins, and equipment failures. Ensuring miner safety is critical, and various technological advancements, including IoT-based smart helmets, have been explored to enhance real-time monitoring and alerting systems. These helmets incorporate sensors to detect environmental hazards, providing early warnings to miners and control stations, thereby reducing casualties and improving response times**.**

1. *Zhang, Y., et al. (2017) - Wireless Gas Monitoring System* Proposed a wireless system using MQ-series gas sensors to detect methane (CH4) and carbon monoxide (CO). The system transmits real-time data to a monitoring station, allowing early detection of hazardous gas leaks.
2. *Reddy, K., et al. (2018) - Zigbee-based Gas Leakage Detection* Designed a Zigbee-based gas detection system for underground mines. The system provides instant alerts to miners and the control room, improving safety and response time.
3. *Patil, A. & Deshpande, S. (2019) - Smart Helmet for Coal Mine Workers* Developed a smart helmet embedded with temperature, humidity, and gas sensors. The helmet includes a vibration motor that alerts miners in case of critical environmental changes.
4. *Wang, J., et al. (2020) - Bluetooth and GSM-based Coal Mine Safety Helmet* Introduced a helmet with Bluetooth and GSM communication modules for real-time miner tracking and two-way communication with surface control units, improving emergency response.
5. *Kumar, R. & Singh, V. (2021) - Accelerometer-based Fall Detection System* Implemented an accelerometer-based detection system that identifies sudden falls or impacts. The helmet automatically sends distress signals via GSM to rescue teams.
6. *Sharma, P., et al. (2022) - GPS-integrated Smart Helmet for Miners* Integrated GPS tracking with smart helmets to monitor miner locations in real time. This system enhances rescue operations by providing precise location data in emergencies.

1.5 DESIGN APPROACH

Hardware Design & Development

- Requirement Gathering
- hardware Design Document
- Design and Development
- Coding

Testing

- Module Testing (Hardware modules)
- Unit & Integration testing of the sensor
- System Testing

CHAPTER 2

HARDWARE DESIGN

2.1 BLOCK DIAGRAM

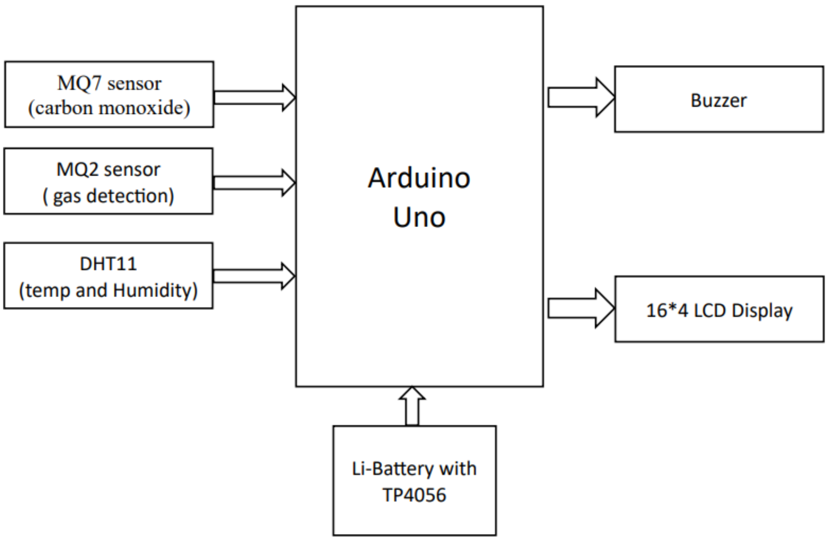


Figure 1: Block Diagram

The above figure shows the detail block diagram of **Coal mine safety monitoring and alerting system** project. It consists of Arduino Uno i.e. ATMEGA328P microcontroller which is a heart of our project. The system consists of a Li-Battery with TP4056 for power, an MQ7 sensor for detecting carbon monoxide, an MQ2 sensor for gas detection, a DHT11 sensor for temperature and humidity, a 16*2 LCD display for showing information, and a buzzer for alarm. This system could be used for a variety of purposes, such as monitoring air quality in a constructive building, or providing early warning of gas leaks.

2.2 ARDUINO UNO

The “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.

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 crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter. "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. 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 crystal oscillator, 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.

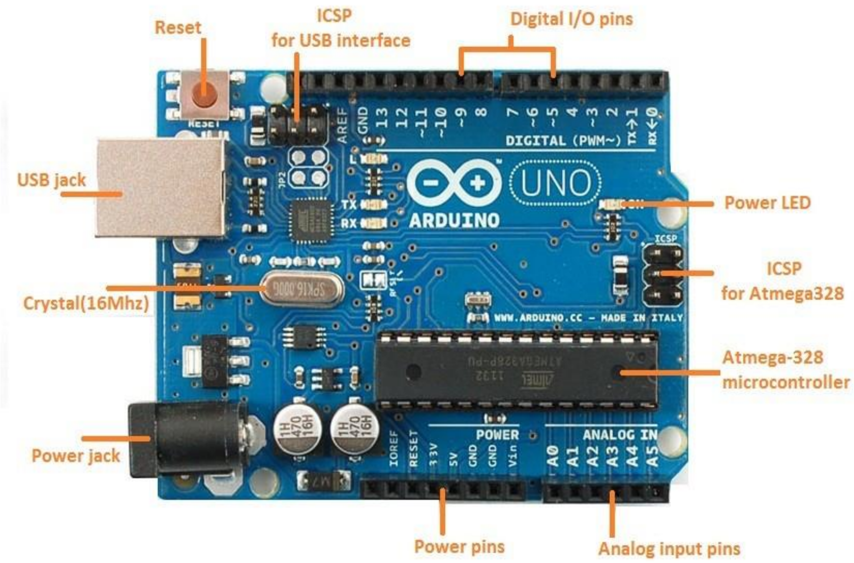


Figure 2: Arduino Uno

ATMEGA328P MICROCONTROLLER

The Atmel Pico Power ATmega328/P is a low-power CMOS 8-bitmicrocontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega328/P achieves throughputs close to 1MIPS per MHz. This empowers system designed to optimize the device for power consumption versus processing speed.

2.3 MQ7 SENSOR

2.3.1 MQ7 Sensor Details

Figure 3: MQ7 Sensor

FEATURES

- Supply Voltage: 5v
- Output: Analog output given to Arduino UNO's A2 pin
- The sensor's response time is rapid, and it can measure concentrations of CO in the air from 10 to 1000 ppm

Table 1 : MQ7 Sensor Pin Description

SL NO	PINS	PIN DESCRIPTION
1	VCC	Power supply(5V)
2	GND	Ground
3	OUT	Analog output (A1)

The MQ7 Carbon Monoxide (CO) sensor detects CO based on changes in resistance of its tin dioxide (SnO_2) layer. It requires a heating cycle, alternating between 1.5V (90s) for stabilization and 5V (60s) for CO detection. When CO is present, it reduces oxygen on the sensor's surface, lowering resistance and increasing output voltage. The sensor provides analog (A0) output for continuous monitoring and digital (D0) output when CO exceeds a set threshold. A 60-second preheat time is required for stable readings, making it suitable for Arduino-based air quality monitoring systems.

2.4 MQ2 SENSOR

2.4.1 MQ2 Sensor Details

The MQ2 Gas Sensor detects gases like LPG, propane, methane, hydrogen, alcohol,and smoke based on changes in resistance of its tin dioxide (SnO_2) layer.

Figure 4: MQ2 Sensor

It operates at 5V and provides both analog (A0) and digital (D0) outputs. When target gases are present, they reduce the oxygen on the sensor's surface, decreasing resistance and increasing output voltage. The analog output (A0) gives a continuous gas concentration reading, while the digital output (D0) triggers HIGH when gas levels exceed a set threshold (adjustable via a potentiometer). The sensor requires a preheat time of 20 seconds for accurate readings and is widely used in gas leakage detection systems with Arduino.

Table 2 : MQ2 Pin Description

SL NO	PINS	PIN DESCRIPTION
1	VCC	Power supply(5V)
2	OUT	Analog output (A0)
3	GND	Ground

2.5 DHT11 SENSOR

2.5.1 DHT11 Sensor Details

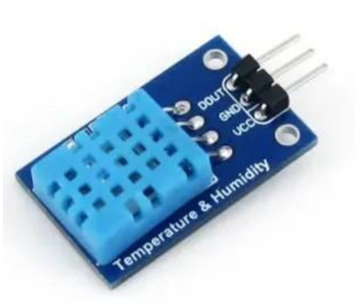


Figure 5: DHT 11 SENSOR

The DHT11 Temperature and Humidity Sensor measures temperature (0°C to 50°C, ±2°C accuracy) and humidity (20% to 90% RH, ±5% accuracy) using a capacitive humidity sensor and a thermistor. It operates at 3.3V to 5V and communicates with an Arduino via a single-wire digital output. The sensor requires a preheat time of 1-2 seconds and provides new readings every 1 second. A 10kΩ pull-up resistor is needed on the data pin for stable communication. It is widely used in weather monitoring, HVAC systems, and indoor climate control applications.

Table 3 : DHT 11 Pin Description

SL NO	PINS	PIN DESCRIPTION
1	VCC	Power supply(3.3V-5V)
2	OUT	Digital out
3	GND	Ground

2.6 BUZZER.

2.6.1 Buzzer Details

Figure 6: Buzzer

A buzzer is an audio signaling device that produces sound when powered. It operates at 3.3V to 5V and comes in two types: active and passive. An active buzzer generates a fixed sound when powered, while a passive buzzer requires a PWM signal to produce different tones. The buzzer has three pins: VCC (power), GND (ground), and Signal (control pin), which connects to an Arduino digital pin (e.g., D9). It is commonly used for alarms, notifications, and sound effects in electronic projects.

Table 4 : Buzzer Sensor Pin Description

SL NO	PINS	PIN DESCRIPTION
1	Positive	Digital output
2	Negative	Ground

2.7 16*2 LCD DISPLAY

2.7.1 : 16*2 LCD Display details

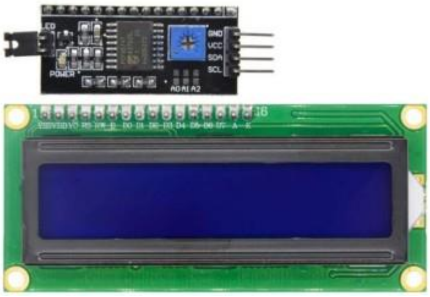


Figure7 : I2C and 16*2 LCD display

The 16×2 LCD Display with I2C module is a widely used screen in embedded systems for displaying text and numerical data. Unlike a standard 16×2 LCD, which requires multiple GPIO pins, the I2C version simplifies connections using only two communication lines (SDA and SCL), making it ideal for microcontrollers like Arduino. The display can show two lines of 16 characters each, supports custom characters, and has an adjustable backlight. The I2C adapter is based on the PCF8574 chip, which converts I2C signals into parallel commands for the LCD. This display is commonly used in DIY electronics, sensor monitoring, and IoT applications due to its low power consumption and ease of integration.

Table 5 : I2C AND 16*2 LCD Display pin configuration

SL NO	PINS	PIN DESCRIPTION
1	SDA	Analog pin A4
2	SCL	Analog pin A5
3	VCC	Power supply (5V)
4	GND	Ground

2.8 POWER SUPPLY REQUIREMENTS

2.8.1 : 3.7V Rechargeable Lithium ion battery

Figure 8 : 3.7V Rechargeable Lithium ion battery

Specifications:

- Input Voltage : 4.2 V
- Output Power : 7.4 W
- Output Voltage : DC 3.7 V
- Output Current : DC 1.8A - 2A

2.8.2: TP4056 module

Figure 9 : TP4056 Module

The TP4056 module is a lithium-ion battery charger for 3.7V single-cell batteries, using a constant current/constant voltage (CC/CV) charging method. It operates at 4.5V–5.5V input (via micro USB or Type-C) and provides a 4.2V, 1A charge. Equipped with overcharge, over-discharge, and short-circuit protection (if using DW01+ and 8205A MOSFETs), it ensures safe charging. LED indicators show charging status (red: charging, blue/green: fully charged). Commonly used in power banks, IoT devices, and battery-powered projects.

2.9 HARDWARE RESOURCE ALLOCATION

Table 3 : Hardware Resource Allocation

ATMEGA328 Pin Number	Description
A0	MQ2 Sensor
A1	MQ7 Sensor
A4	SDA of I2C
A5	SCL of I2C
D2	DHT 11
D8	Positive buzzer pin

2.10 PROGRAMMING LANGUAGE

- C

2.11 DEVELOPMENT TOOLS

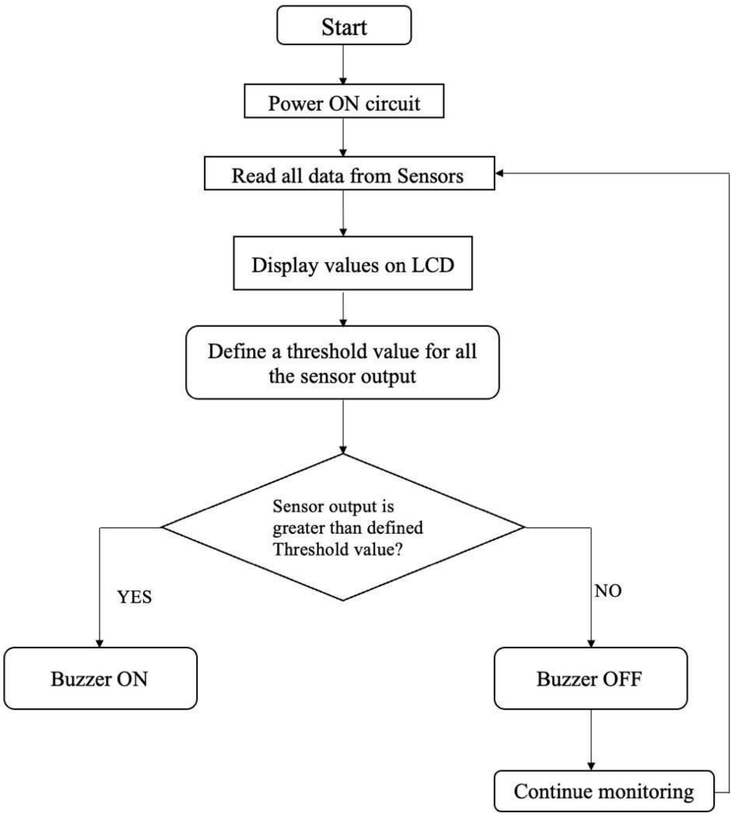
- Arduino SDK 1.6.9

2.12 ARDUINO IDE

Arduino software is needed to program Arduino boards and must be downloaded from the Arduino website and installed on a computer. This software is known as the Arduino IDE (Integrated Development Environment). Drivers must be installed in order to be able to program an Arduino from the Arduino IDE.

2.13 DESIGN

2.13.1 MAIN FLOW DIAGRAM



Flowchart 1: Main Module

The flowchart illustrates a real-time sensor-based monitoring system designed to detect critical conditions and trigger an alarm using a buzzer. The process begins with powering on the circuit, after which the system reads data from connected sensors, such as gas sensors (MQ2, MQ7), temperature and humidity sensors (DHT11), or other environmental sensors. The collected data is then displayed on an LCD screen, allowing users to monitor the readings in real time.Next, a threshold value is defined for each sensor based on safe operating limits. The system continuously compares the sensor readings against these thresholds. If any sensor output exceeds the predefined threshold, the buzzer is activated, providing an alert to indicate a hazardous condition, such as a gas leak, high temperature, or poor air quality. If the sensor readings remain below the threshold, the buzzer stays OFF, and the system continues monitoring without any alarm.

This process repeats in a loop, ensuring constant surveillance and immediate response to potential dangers. The system is highly useful in applications such as industrial safety, home automation, fire detection, gas leakage prevention, and environmental monitoring. By integrating sensors with an LCD display and a buzzer, this setup provides a simple yet effective real-time alert mechanism, making it ideal for various safety and automation projects.

CHAPTER 3

RESULT

The Coal Mine Safety Monitoring and Alerting System successfully detects hazardous conditions in underground mining environments and provides real-time alerts. By integrating MQ7 (Carbon Monoxide Sensor), MQ2 (Gas/Smoke Sensor), DHT11 (Temperature and Humidity Sensor), a Buzzer, a 16×2 LCD Display with I2C Module, and a TP4056-powered dual 3.7V battery system, the system ensures continuous environmental monitoring for improved miner safety.

Key Outcomes:

1. **Gas and Smoke Detection:**
   The MQ7 sensor accurately detects carbon monoxide (CO) levels, which is crucial for detecting toxic gas leaks in mines. The MQ2 sensor detects LPG, methane, smoke, and other flammable gases, helping prevent fire hazards and explosions. If the gas concentration exceeds the defined threshold, an alert is triggered via the buzzer.

2. **Temperature and Humidity Monitoring:**
   The DHT11 sensor continuously monitors temperature and humidity levels in the mine.If the temperature rises above safe working conditions, an alert is activated.High humidity detection ensures that mine ventilation systems can be adjusted to prevent suffocation or heat-related issues.

3. **Real-time Data Display and Alerts:**
   The 16×2 LCD with I2C module displays real-time values of CO concentration, gas levels, temperature, and humidity, allowing miners to stay informed. The buzzer provides an immediate audio warning when dangerous conditions are detected, helping miners take precautionary actions quickly.

4. **Power Management and Portability:**
   The system is powered by two 3.7V lithium-ion batteries connected to a TP4056 charging module, ensuring a stable power supply for continuous operation .The TP4056 module manages safe charging, overcharge protection, and efficient battery usage, making the system reliable in underground conditions.

Figure 10 : System start

Figure 11 : Sensor reading showing in LCD display

Figure 12 : sensor reading showing in both LCD and terminal when connected to laptop

CHAPTER 4

APPLICATIONS, ADVANTAGES AND DISADVANTAGES

4.1 APPLICATIONS

- **Real-Time Miner Safety Monitoring** – Continuously tracks environmental conditions like toxic gases, temperature, and humidity, ensuring a safer working environment for miners.
- **Gas and Fire Hazard Detection** – Detects the presence of harmful gases such as methane and carbon monoxide, preventing explosions and respiratory hazards.
- **Accident and Fall Detection** – Identifies sudden falls or impacts, triggering immediate alerts to the control room for quick rescue operations.
- **Health Monitoring of Miners** – Tracks miners' vital signs (heart rate, body temperature, oxygen levels) to detect early signs of fatigue, heatstroke, or other health risks.
- **Wireless Communication and Alerting** – Enables real-time communication between miners and control stations, even in deep underground areas where traditional communication is unreliable.
- **Emergency Rescue Assistance** – Helps locate trapped or injured miners using GPS and wireless tracking, improving response time during disasters.

4.2 ADVANTAGES

- **Real-Time Monitoring** – Continuously tracks environmental hazards and miners' health conditions, ensuring early detection of risks.
- **Accident Prevention** – Detects toxic gases, excessive heat, and fire hazards, preventing life-threatening incidents.
- **Immediate Alerts & Communication** – Sends instant notifications to miners and control rooms, allowing quick emergency response.
- **Health Protection** – Monitors vital signs like heart rate and oxygen levels, reducing risks of fatigue and heatstroke.
- **Improved Rescue Operations** – GPS and wireless tracking help locate miners quickly in case of accidents or cave-ins.
- **Automation & IoT Integration** – Reduces human intervention in high-risk areas by integrating with smart mining systems.
- **Enhanced Work Efficiency** – Ensures a safer environment, allowing miners to work with confidence, leading to increased productivity.
- **Regulatory Compliance** – Helps mining companies meet safety regulations by maintaining records of hazardous conditions.
- • **Data Logging and Analysis** – The system can store historical safety data, helping mining companies analyze trends, predict hazards, and improve future safety .

4.3 DISADVANTAGES

- **High Initial Cost** – Implementation requires advanced sensors, communication modules, and IoT infrastructure, making it expensive.
- **Battery Limitations** – Continuous monitoring and wireless communication may drain battery life quickly, requiring frequent recharging or replacement.
- **Connectivity Issues** – Underground mines often have weak network signals, which can affect real-time data transmission.
- **Maintenance and Durability** – Sensors and electronic components may require regular maintenance and may not withstand extreme mining conditions.
- **Potential Sensor Malfunctions** – Dust, humidity, and rough environments may cause sensor inaccuracies, leading to false alerts.
- **Training Requirements** – Workers may need training to properly use the system and interpret alerts effectively.
- **Limited Adoption in Small Mines** – Smaller mining operations may find it difficult to invest in and implement such advanced systems.

CHAPTER 5

CONCLUSION AND FUTURE SCOPE

5.1 CONCLUSION

The Coal Mine Safety Monitoring and Alerting System with Smart Helmet significantly enhances the safety of miners by integrating real-time environmental and health monitoring within a wearable device. The system's ability to detect hazardous conditions, such as toxic gas leaks and miners' vital sign abnormalities, ensures proactive intervention and reduces the likelihood of accidents and fatalities. The smart helmet offers continuous safety oversight, enabling immediate alerts to both miners and control rooms, even in remote underground areas where traditional communication methods often fail.

By incorporating wireless communication, accident detection, and real-time alerts, the system improves overall mine safety and emergency response efficiency. It represents a major advancement in using technology to mitigate risks in coal mining operations, shifting from reactive to proactive safety measures. The system's integration of **IoT** and **sensor technology** ensures a more robust and data-driven approach to coal mine safety, enhancing protection for workers while minimizing the environmental and health risks inherent to mining operations.

5.2 FUTURE SCOPE

The Coal Mine Safety Monitoring and Alerting System with Smart Helmet holds significant potential for further advancements. Future developments could integrate Artificial Intelligence (AI) and Machine Learning (ML) algorithms to predict hazardous conditions and monitor the health of miners more accurately. This could allow for real-time hazard prediction, improving safety measures before dangerous situations arise. Additionally, the system could incorporate Augmented Reality (AR**)**, offering miners a heads-up display with vital information like gas levels, escape routes, and structural integrity, enhancing situational awareness.

Future improvements could also focus on extending the system's capabilities with longer-lasting batteries**,** advanced sensor**s** for more precise environmental and biometric monitoring, and better connectivity solutions for seamless communication in remote mining areas. The system could eventually be adapted for autonomous mining operations, integrating with unmanned vehicles and equipment to enhance both safety and operational efficiency.

CHAPTER 6

REFERENCES

1. *Zhang, Y., et al. (2017) - Wireless Gas Monitoring System* Proposed a wireless system using MQ-series gas sensors to detect methane (CH4) and carbon monoxide (CO). The system transmits real-time data to a monitoring station, allowing early detection of hazardous gas leaks.
2. *Reddy, K., et al. (2018) - Zigbee-based Gas Leakage Detection* Designed a Zigbee-based gas detection system for underground mines. The system provides instant alerts to miners and the control room, improving safety and response time.
3. *Patil, A. & Deshpande, S. (2019) - Smart Helmet for Coal Mine Workers* Developed a smart helmet embedded with temperature, humidity, and gas sensors. The helmet includes a vibration motor that alerts miners in case of critical environmental changes.
4. *Wang, J., et al. (2020) - Bluetooth and GSM-based Coal Mine Safety Helmet* Introduced a helmet with Bluetooth and GSM communication modules for real-time miner tracking and two-way communication with surface control units, improving emergency response.
5. *Kumar, R. & Singh, V. (2021) - Accelerometer-based Fall Detection System* Implemented an accelerometer-based detection system that identifies sudden falls or impacts. The helmet automatically sends distress signals via GSM to rescue teams.
6. *Sharma, P., et al. (2022) - GPS-integrated Smart Helmet for Miners* Integrated GPS tracking with smart helmets to monitor miner locations in real time. This system enhances rescue operations by providing precise location data in emergencies.