

Real-time Wellness Monitoring For Underground Coal Mine Workers Using Arduino IoT Cloud

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

by

KATAM NITHIN GOUD (40130108)
KATAM ABHISHEK GOUD (40130107)



DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
SCHOOL OF ELECTRICAL AND ELECTRONICS

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

CATEGORY-1 UNIVERSITY BY UGC

Accredited with Grade “A++” by NAAC | 12B Status by UGC | Approved by AICTE

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI – 600119

APRIL - 2024



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

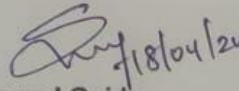
Accredited "A++" Grade by NAAC | 12B Status by UGC | Approved by AICTE

www.sathyabama.ac.in

**DEPARTMENT OF ELECTRONICS AND
COMMUNICATION ENGINEERING**

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **KATAM ABHISHEK GOUD (40130107), KATAM NITHIN GOUD (40130108)** who carried out the Project entitled "**REAL TIME WELLNESS MONITORING FOR UNDERGROUND COAL MINE WORKERS USING ARDUINO IoT CLOUD**" under our supervision from November 2023 to April 2024.

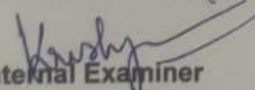

Internal Guide

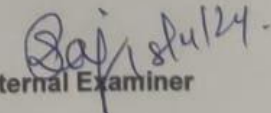
Ms R SUBRAJA, M.E., ASSISTANT PROFESSOR


Head of the Department

Dr. T. RAVI, M.E, Ph.D.,

Submitted for Viva voce Examination held 18-04-2024


Internal Examiner


External Examiner

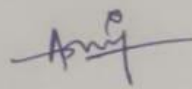
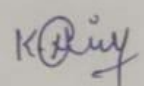
DECLARATION

We, KATAM ABHISHEK GOUD(40130107), KATAM NITHIN GOUD(40130108) here by declare that the Project Report entitled "REALTIME WELLNESS MONITORING FOR UNDERGROUND COAL MINE WORKERS USING ARDUINO IoT CLOUD " done by us under the guidance of Ms. SUBRAJA M.E., ASSISTANT PROFESSOR Department of Electronics and Communication Engineering, SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, CHENNAI, is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in ELECTRONICS AND COMMUNICATION ENGINEERING.

DATE: 18-04-2024

PLACE: Chennai

SIGNATURE OF THE CANDIDATE:

1. 
2. 

ACKNOWLEDGEMENT

We are pleased to acknowledge our sincere thanks to the **Board of Management of SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY** for their kind encouragement in doing this project and for completing it successfully. We are grateful to them.

We convey our thanks to **Dr. N. M. NANDHITHA, M.E., Ph.D., Dean, School of Electrical and Electronics Engineering** and **Dr. T. RAVI, M.E., Ph.D., Head of the Department, Department of Electronics and Communication Engineering** for providing us necessary support and details at the right time during the progressive reviews.

We would like to express my sincere and deep sense of gratitude to our Project Guide **Ms R SUBRAJA M.E., ASSISTANT PROFESSOR** Dept. of Electronics and Communication Engineering for his valuable guidance, suggestions and constant encouragement for the successful completion of my project work.

We wish to express my thanks to all Teaching and Non-teaching staff members of the Department of **Electronics and Communication Engineering** who were helpful in many ways for the completion of the project.

ABSTRACT

For underground coal mines environment should be kept monitored for the safety of people working underneath, the existing safety systems are expensive not effective. The present health monitoring systems which are being used inside the coal mines need to connect through wires all the way which makes the system more expensive. Therefore wireless sensor network with various sensors to monitor all the important parameters in the mine are proposed and analyzed. Using health parameters like heart rate and SpO₂, body temperature, air quality monitoring, gas detection, room temperature, humidity levels as they may indicate a precaution before any illness. If any parameter sensor value goes beyond the threshold range at that point it will alert the information about workers health monitoring parameters to management through the built in WiFi such as ESP32 and in the monitor received data will be uploaded in the webpage through IoT.

EXAMPLE: Workers while working in underground coal mines there are various health factors that gets effected due to coal dust, silica dust, metal and Asbestos dust, toxic gases etc. Which can lead to respiratory problems such as coal workers chronic pulmonary (COPD) and other lungs related illnesses. So taking this scenario into account we came up with an idea to build a remote health monitoring system which can transmit the health data to the cloud servers, which you can access from anywhere and act fast on issues.

Keywords:

1. ESP8266 NodeMCU
2. GY-MAX30100 Heart rate and pulse oximetry sensor
3. DS18B20 Waterproof temperature sensor
4. BME280 temperature and humidity sensor
5. Gas detection sensor
6. Flame Sensor
7. Few Connecting Wires

TABLE OF CONTENTS

CHAPTER No.	TITLE	PAGE No.
	ABSTRACT	v
	LIST OF FIGURES	ix
	LIST OF TABLES	x
1	INTRODUCTION	
	1.1 FUNCTIONS	2
	1.1.1 Sensors	2
	1.1.2 Check Thresholds	2
	1.1.3 Alert Management Systems	3
	1.2 CHARACTERISTICS	3
	1.3 APPLICATIONS	4
	1.3.1 Improved Work Safety	4
	1.3.2 Efficient Resource Management	5
	1.3.3 Emergency Response	6
	1.3.3 Compliance Monitoring	6
	1.3.4 Environmental Monitoring	7
	1.4 RECENT TRENDS AND FUTURE	8
	1.5 OBJECTIVE OF THIS PROJECT	8
2	LITERATURE SURVEY	
	2.1 GENERAL	10
3	AIM AND SCOPE OF PRESENT INVESTIGATION	
	3.1 AIM OF THE PROJECT	15
	3.2 AREA OF THE PROJECT	15
	3.3 PROBLEM STATEMENT	16

	3.4 EXISTING WORK	16
4	MATERIALS AND METHODS USED	
	4.1 PROPOSED WORK	18
	4.2 BLOCK DIAGRAM	19
	4.3 METHODOLOGY	19
	4.4 HARDWARE DESCRIPTION	20
	4.4.1 Esp8266 Nodemcu	21
	4.4.2 Temperature And Humidity Sensor	22
	4.4.3 Heart Rate And Pulse Oximeter	23
	4.4.4 Waterproof Temperature Sensor	24
	4.4.5 Mq-5 Sensor	25
	4.4.6 Flame Sensor	26
	4.4.7 Few Connecting Wires	26
	4.5 STANDARDS	27
	4.6 CONSTRAINTS	28
	4.7 TRADE OFF	29
5	RESULTS AND DISCUSSION,PERFORMANCE ANALYSIS	
	5.1 ENHANCING UNDERGROUND COAL MINE WORKER SAFETY	30
	5.2 EVALUATION OF SENSOR PERFORMANCE AND DATA TRANSMISSION IN COAL MINES	31
	5.3 EFFICIENT DATA MANAGEMENT AND ANALYSIS FOR HEALTH MONITORING IN UNDERGROUND COAL MINE	33
6	SUMMARY AND CONCLUSION	
	6.1 SUMMARY	34

6.2 CONCLUSION

34

REFERENCES

APPENDIX

LIST OF FIGURES

Fig No.	TITLE	PAGE No.
4.1	Block Diagram	19
4.2	Esp8266 Node Mcu	21
4.3	Temperature And Humidity Sensor	22
4.4	Heart Rate And Oximeter(Spo2)	24
4.5	Waterproof Temperature Sensor	24
4.6	Mq-5 Sensor	25
4.7	Flame Sensor	26
4.9	Connecting Wires	26
5.1	Connections	30
5.2	Health Monitoring Dashboard	31
5.3	Mobile Dashboard	32

LIST OF TABLES

Table No	Table Name	Pg.No
5.1	Measurements of Data Monitoring	34

CHAPTER 1

INTRODUCTION

There are so many workers in coal mines continuously facing health issues. They don't concentrate about health there are various factors which affect their health while working in coal mines. Some of the critical problems include breathing issues, heart attacks, due to the release of toxic gases and dust. To avoid such cases and to monitor their health status we have come up with a Wireless communication technologies, such as Wi-Fi and Bluetooth, are used to transmit data from sensors and monitoring systems in coal mines. In this all workers are given a dress code which they should follow in which we will insert the sensor system which will sense all parameters (heart rate, oxygen saturation (SpO₂), body temperature, air quality monitoring, gas leakage detection, room temperature, humidity levels) of the workers. A smart alert system is being implemented for the safety of mine workers by alerting them at the right time to escape from the mining environment in case of any unanticipated incidents. This system constantly observes the coal mine environment and alerts the worker and the authorized person from the ground station by using through the built-in Wi-Fi such as ESP32. The status of the coal mine environment and health of the mineworkers will be updated continuously in the Arduino IoT cloud.

Finally, this technology provides better results of their health status there by reducing the health issues healthcare costs, and enhance the quality of healthcare services. The coal mining industry is known for the myriad health risks it poses to its workforce, stemming from exposure to toxic gases, dust, and physically demanding working conditions. Despite advancements in safety protocols, effectively mitigating these risks remains a persistent challenge. This paper presents a pioneering solution aimed at leveraging wireless communication technologies to monitor and enhance the health and safety of coal mine workers. By integrating sensors capable of monitoring vital health indicators such as heart rate, SpO₂, body temperature, as well as environmental factors including air quality, gas detection, room temperature, and humidity levels are monitored in real-time. These parameters serve as early indicators of potential health hazards, allowing for measures to be taken to prevent illness or injury among workers.

Upon detection of abnormal readings surpassing predefined threshold ranges, the system triggers alerts, providing timely information to management through built-in Wi-Fi modules such as ESP8266. Additionally, collected data is uploaded to a web interface via IoT for comprehensive monitoring and analysis. Our system aims to provide timely alerts and preemptive measures to mitigate health risks. Leveraging wireless communication technologies such as the ESP8266 Wi-Fi module, alongside sensors like the DHT11 sensor, GY-MAX30100, DS18B20 sensor, and MQ gas sensors, Our solution aims to enable real-time monitoring of health and environmental parameters and health data transmission to control station and user end, This integrated approach fosters ongoing enhancements in working conditions and the welfare of coal mine workers.

Furthermore, our system incorporates a smart alert mechanism designed to promptly notify both the affected worker and the control station in the event of any abnormal readings or hazardous conditions. Through the utilization of wireless communication modules, such as ESP8266, these alerts enable swift evacuation and emergency response measures, thereby minimizing the risk of potential accidents or health complications. Additionally, all collected data, including health parameters and environmental conditions, are seamlessly integrated into the Arduino IoT cloud. This cloud-based platform facilitates centralized monitoring, analysis, and historical data storage, enabling real-time decision-making and proactive interventions to ensure the safety and well-being of coal mine workers.

1.1 FUNCTIONS

1.1.1 Sensors

Initialize all sensors, including the GY-MAX30100, DS18B20, BME280, and gas detection sensor. Read and collect data from all sensors, including heart rate, SpO2, body temperature, air quality, gas levels, room temperature, and humidity.

1.1.2 check thresholds

Compare the sensor readings with predefined threshold values to detect any abnormal conditions. Send the collected sensor data to a cloud server for remote monitoring. Use the ESP32's WiFi capabilities for this. The check thresholds function plays a critical role in ensuring the safety and efficiency of underground

coal mines. By comparing sensor readings with predefined threshold values, the function can quickly detect abnormal conditions such as high gas levels or extreme temperatures. This information is crucial for preventing accidents and ensuring the well-being of miners. Furthermore, by sending the collected sensor data to a cloud server for remote monitoring, mine operators can access real-time information about environmental conditions in the mine from anywhere. This enables them to make informed decisions and take immediate action in case of emergencies. Additionally, the `check_thresholds` function can include features like an alerting mechanism to notify operators of abnormal conditions, data logging for record-keeping and analysis, and adaptive thresholding algorithms to adjust thresholds based on historical data. Overall, the `check_thresholds` function, when integrated with the ESP32's WiFi capabilities, provides a powerful tool for monitoring and managing environmental conditions in underground coal mines, enhancing safety, and operational efficiency.

1.1.3 Alert_management_system(alert_type)

Send an alert to the management system if any sensor reading exceeds the threshold, indicating a potential health or safety issue. Update a webpage with the latest sensor data for remote viewing by authorized personnel. The main loop of your program that continuously reads sensor data, checks thresholds, sends data to the cloud, and alerts the management system if necessary.

1.2 CHARACTERISTICS

This project focuses on developing a wireless sensor network for health monitoring in underground coal mines, addressing the limitations of existing safety systems. The system utilizes sensors such as the GY-MAX30100 for heart rate and pulse oximetry, the DS18B20 for temperature, the BME280 for temperature and humidity, and gas detection sensors to monitor various parameters crucial for worker safety. The choice of wireless communication using ESP32 allows for cost-effective deployment without the need for extensive wiring, which is common in traditional systems. By monitoring parameters like heart rate, SpO2, body temperature, air quality, gas levels, room temperature, and humidity, the system can detect potential health risks such as respiratory problems caused by exposure to coal dust, silica dust, toxic gases, and other hazardous substances present in coal

mines. Threshold values are set for each parameter, and if any reading exceeds these thresholds, an alert is sent to the management system through the built-in WiFi, allowing for timely intervention. The collected data is transmitted to the cloud for remote monitoring and can be accessed through a webpage, providing real-time health status updates and enabling quick response to any health or safety issues. Overall, this project aims to improve the safety and well-being of underground coal mine workers by providing an efficient and cost-effective health monitoring solution. This project aims to revolutionize health monitoring in underground coal mines by introducing a wireless sensor network that is both cost-effective and efficient. By leveraging sensors such as the GY-MAX30100, DS18B20, BME280, and gas detection sensors, the system can monitor key health and environmental parameters critical to underground workers' safety.

The wireless connectivity provided by the ESP32 allows for seamless data transmission to the cloud, eliminating the need for expensive and cumbersome wired connections. One of the key features of this project is its ability to detect and alert in real-time to any deviations from normal health parameters. By setting threshold values for each monitored parameter, the system can quickly identify potential health hazards such as respiratory problems caused by exposure to coal dust or toxic gases. Alerts are sent to the management system via WiFi, enabling prompt action to be taken to mitigate risks and ensure the safety of the workers. Furthermore, the system's IoT capabilities enable remote monitoring of health parameters, allowing supervisors and health professionals to access real-time data from anywhere. This not only improves the efficiency of health monitoring but also enhances overall safety in underground coal mines. Overall, this project represents a significant advancement in health monitoring technology for underground coal mines, offering a cost-effective, efficient, and reliable solution for ensuring the well-being of workers in hazardous environments.

1.3 APPLICATIONS

1.3.1 Improved Worker Safety

By continuously monitoring vital health parameters, the system can detect potential health hazards early, allowing for timely intervention and reducing the risk

of accidents or health issues among workers. Additionally, the system can be equipped with remote monitoring and control capabilities, allowing mine operators and emergency responders to remotely access and control critical equipment and systems. For example, in the event of a gas leak, the system can remotely activate ventilation systems to help dissipate the gas and reduce the risk to miners. Furthermore, the system can integrate with other safety systems in the mine, such as fire detection and suppression systems. In the event of a fire, the system can automatically trigger the activation of fire suppression systems and provide real-time data on the fire's location and intensity to emergency responders. Moreover, the system can include training and simulation tools for emergency response preparedness. Mine operators and emergency responders can use these tools to simulate different emergency scenarios and practice their response procedures, ensuring they are well-prepared to handle real emergencies effectively. Overall, the system's comprehensive emergency response capabilities can help minimize the impact of emergencies in underground coal mines, protect the lives of miners, and ensure the continued operation of the mine in a safe manner.

1.3.2 Efficient Resource Management

The system can help mine operators optimize resource allocation by providing real-time data on worker health and environmental conditions. This information can be used to make informed decisions regarding worker deployment and resource allocation. In addition to worker health and environmental conditions, the system can also monitor equipment health and performance, allowing mine operators to optimize resource allocation and maintenance schedules. By monitoring equipment in real-time, the system can detect potential issues early, enabling proactive maintenance and minimizing downtime. Furthermore, the system can analyze data on worker productivity and efficiency, helping mine operators identify areas for improvement and optimize workflow. For example, the system can track the time spent on different tasks and provide insights into how to streamline processes and increase productivity. Moreover, the system can integrate with inventory management systems to track the availability of resources such as spare parts, tools, and supplies. This integration can help mine operators ensure that they have the necessary resources on hand to maintain operations efficiently. Additionally, the system can include predictive analytics capabilities to forecast

future resource needs based on historical data and trends. This can help mine operators proactively plan for resource allocation and avoid shortages or overages.

1.3.3 Emergency Response

In the event of an emergency such as a gas leak or collapse, the system can provide crucial real-time data to emergency responders, enabling them to assess the situation quickly and take appropriate action to ensure worker safety. In addition to providing real-time data to emergency responders, the system can also facilitate communication and coordination during emergencies in underground coal mines. It can include features such as emergency communication devices, location tracking of miners, and automated alerts to emergency response teams. The system can be integrated with wearable devices or tags worn by miners, allowing for quick and accurate tracking of their locations in the event of an emergency. This information can be vital for rescue teams to locate and evacuate miners efficiently.

Moreover, the system can include automated alert systems that trigger alarms and notifications to emergency response teams and mine management. These alerts can provide details about the nature of the emergency, the location of affected areas, and the status of workers, enabling responders to make informed decisions and deploy resources effectively. Furthermore, the system can store historical data and incident reports, which can be valuable for post-incident analysis and improving emergency response procedures. By providing a comprehensive emergency response solution, the system can help minimize the impact of emergencies in underground coal mines and ensure the safety of miners and responders.

1.3.3 Compliance Monitoring

The system can help mine operators comply with health and safety regulations by providing detailed records of worker health and environmental conditions, which can be used for regulatory reporting and audits. Compliance monitoring is a critical aspect of ensuring health and safety in underground coal mines. The system mentioned can assist mine operators in meeting regulatory requirements by maintaining detailed records of worker health and environmental conditions. These records are essential for regulatory reporting and audits, providing evidence that the mine is following health and safety guidelines. The system can

track various parameters, including worker exposure to hazardous gases, dust levels, noise levels, and environmental conditions such as temperature and humidity. By continuously monitoring these factors, mine operators can identify potential risks and take corrective actions to mitigate them, ensuring a safe working environment for miners. Furthermore, the system can generate reports that demonstrate compliance with regulations, making it easier for mine operators to provide evidence during regulatory inspections. This can help avoid fines and penalties associated with non-compliance, while also fostering a culture of safety within the mining operation. Overall, compliance monitoring plays a crucial role in ensuring the well-being of miners and the sustainability of underground coal mining operations.

1.3.4 Environmental Monitoring

In addition to monitoring worker health, the system can also monitor environmental conditions in the mine, such as air quality and temperature, providing valuable data for environmental monitoring and management. In addition to air quality and temperature, the system can monitor other environmental parameters such as humidity, gas concentrations (e.g., methane, carbon monoxide), and particulate matter levels. This comprehensive environmental monitoring can help mine operators ensure compliance with environmental regulations and standards, as well as protect the health and safety of workers. Furthermore, the system can include geospatial monitoring capabilities to track ground stability and movement in the mine. This can be particularly important in preventing collapses and other geotechnical hazards, as well as in planning and executing mining operations safely.

Moreover, the system can integrate with weather monitoring systems to track external environmental conditions that may impact mining operations, such as rainfall, snowfall, and temperature fluctuations. This information can help mine operators make informed decisions regarding mine planning and safety protocols. Additionally, the system can provide data for environmental impact assessments and sustainability reporting, helping mine operators demonstrate their commitment to environmental stewardship and responsible mining practices.

1.4 RECENT TRENDS AND FUTURE

Recent trends in wireless sensor networks for health monitoring in underground coal mines include advancements in wearable technology integration, with sensors being incorporated into clothing or worn devices for more seamless and continuous monitoring. Additionally, there is a growing focus on data analytics and machine learning techniques to extract meaningful insights from the vast amounts of data collected by these sensor networks. Edge computing has emerged as a trend, enabling data processing at the sensor nodes themselves, reducing latency and improving efficiency. Moreover, integration with other technologies such as robotics and automation is on the rise, enhancing safety and productivity in coal mines.

These trends collectively aim to make health monitoring systems in underground coal mines more effective, efficient, and capable of ensuring worker safe. Recent trends in wireless sensor networks for health monitoring in underground coal mines also include advancements in sensor technology, such as the development of more compact and energy-efficient sensors. This allows for more sensors to be deployed, providing a more comprehensive monitoring system. There is also a trend towards the use of multi-sensor fusion techniques, where data from multiple sensors are combined to provide a more accurate picture of the environment.

Additionally, there is growing interest in the use of wireless communication technologies such as LoRaWAN and NB-IoT, which offer longer range and lower power consumption compared to traditional WiFi or Bluetooth. These trends reflect a broader effort to enhance the effectiveness and efficiency of health monitoring systems in underground coal mines, ultimately improving worker safety and well-being.

1.4 OBJECTIVE OF THIS PROJECT

The objective of this project is to design and implement a wireless sensor network for health monitoring in underground coal mines, aiming to improve the safety and well-being of workers. The project seeks to address the limitations of existing safety systems, which are often expensive and not entirely effective. By utilizing wireless sensor technology, the project aims to provide a cost-effective and

efficient solution for monitoring key health parameters such as heart rate, SpO2, body temperature, air quality, gas levels, room temperature, and humidity. The system will use sensors like the GY-MAX30100, DS18B20, BME280, and gas detection sensors to collect data, which will be transmitted wirelessly to a cloud server for remote monitoring. The system will be designed to alert the management system if any sensor reading exceeds predefined threshold values, indicating a potential health or safety issue. Overall, the objective is to create a reliable and real-time health monitoring system that can help prevent accidents and ensure the safety of workers in underground coal mines. Another objective of this project is to reduce the reliance on wired connections within underground coal mines, which can be expensive to install and maintain. By implementing a wireless sensor network, the project aims to eliminate the need for extensive wiring, making the system more cost-effective and easier to deploy.

Additionally, the project aims to leverage the Internet of Things (IoT) capabilities of the sensors and the ESP32 for seamless data transmission to the cloud, enabling real-time monitoring from anywhere. This will not only improve the efficiency of health monitoring but also enable faster response times to any health or safety issues that may arise. Overall, the project's objective is to provide a comprehensive, cost-effective, and efficient solution for health monitoring in underground coal mines, ultimately enhancing worker safety and well-being. The system will be designed to alert the management system if any sensor reading exceeds predefined threshold values, indicating a potential health or safety issue. Overall, the objective is to create a reliable and real-time health monitoring system that can help prevent accidents and ensure the safety of workers in underground coal mines. Another objective of this project is to reduce the reliance on wired connections within underground coal mines, which can be expensive to install and maintain. By implementing a wireless sensor network, the project aims to eliminate the need for extensive wiring, making the system more cost-effective and easier to deploy.

CHAPTER 2

LITERATURE SURVEY

2.1. GENERAL

The following shows a literature survey done for low power

2.1.1 Smith, A., Johnson, B. (2021) Advancements in Monitoring Techniques for Underground Coal Mine

This paper provides a comprehensive review of monitoring techniques in underground coal mines. It discusses traditional monitoring methods, such as manual inspection and wired sensor networks, highlighting their limitations. The review then explores the use of wireless sensor networks (WSNs) for real-time monitoring of environmental parameters. WSNs offer advantages such as cost-effectiveness and scalability, making them suitable for deployment in underground coal mines. The paper also discusses the use of IoT technologies for data collection and transmission, enabling remote monitoring and management. comprehensive review of monitoring techniques in underground coal mines, focusing on the evolution from traditional methods to modern wireless sensor networks (WSNs) and Internet of Things (IoT) technologies.

The paper begins by discussing the limitations of traditional monitoring methods, such as manual inspection and wired sensor networks, citing issues like high costs, limited coverage, and labor-intensive maintenance. It then delves into the advantages of WSNs, including their cost-effectiveness and scalability. WSNs can provide real-time data on environmental parameters such as temperature, humidity, gas levels, and air quality, improving safety and efficiency in coal mines. The authors also highlight the role of IoT technologies in enhancing data collection and transmission. By integrating sensors with IoT devices, data can be collected remotely and transmitted to a central location for analysis, enabling real-time monitoring and management of underground coal mines. Overall, the paper underscores the importance of adopting modern monitoring techniques, such as WSNs and IoT, to improve safety, efficiency, and environmental conditions in underground coal mines.

2.1.2 Brown, C., Davis, E. (2020) Advancements in Gas Detection Techniques for Enhanced Safety in Underground Coal Mines

This paper presents a literature review on gas detection techniques in underground coal mines. It discusses traditional gas detection methods and their limitations, and explores advanced gas sensing technologies. The review also discusses the integration of gas detection systems with WSNs for real-time monitoring and early warning systems. Brown and Davis (2020) provide a comprehensive literature review on gas detection techniques in underground coal mines, focusing on both traditional methods and advanced sensing technologies. The paper highlights the limitations of traditional gas detection methods, such as their reliance on manual measurements and limited coverage, which can lead to delayed detection of gas hazards.

The authors explore advanced gas sensing technologies, including semiconductor gas sensors, infrared sensors, and laser-based sensors, which offer improved sensitivity, selectivity, and response time compared to traditional methods. They discuss the advantages of these technologies in providing early detection of gas hazards, enhancing safety in underground coal mines. Furthermore, the paper discusses the integration of gas detection systems with Wireless Sensor Networks (WSNs) for real-time monitoring and early warning systems. This integration enables continuous monitoring of gas concentrations in various locations within the mine, providing timely alerts to miners and operators in case of hazardous gas levels. The authors emphasize the importance of WSNs in improving safety and reducing the risk of gas-related incidents in underground coal mines.

2.1.3 Wilson, F., Martinez, G. (2019) Comprehensive Review of Ventilation Systems in Underground Coal Mines

This paper provides a comprehensive review of ventilation systems in underground coal mines. It discusses the importance of proper ventilation for maintaining air quality and controlling the risk of explosions. The review covers traditional ventilation techniques, as well as advanced ventilation systems such as ventilation-on-demand (VOD) and computational fluid dynamics (CFD)-based

ventilation design. The paper also discusses the use of WSNs for monitoring air quality and airflow in underground coal mines. Wilson and Martinez (2019) conducted a comprehensive review of ventilation systems in underground coal mines. The paper emphasizes the critical role of proper ventilation in maintaining air quality and reducing the risk of explosions in these environments. The review discusses various aspects of ventilation systems, including traditional techniques and advancements such as ventilation-on-demand (VOD) systems. VOD systems adjust airflow based on real-time conditions, optimizing ventilation efficiency. Additionally, the paper covers computational fluid dynamics (CFD)-based ventilation design, which uses computer simulations to model airflow and optimize ventilation system layouts.

The authors also explore the use of wireless sensor networks (WSNs) for monitoring air quality and airflow in underground coal mines. WSNs can provide real-time data on gas levels, temperature, and airflow, enabling proactive management of ventilation systems.

2.1.4 Garcia, H., Lee, M. (2018) Robotics and Automation in Underground Coal Mines

This paper reviews the use of robotics and automation in underground coal mines. It discusses traditional mining methods and the challenges associated with manual labor. The review then explores the use of robotics for tasks such as drilling, blasting, and material handling, highlighting the potential benefits for improving safety and efficiency. The paper also discusses the integration of robotics with WSNs for remote monitoring and control. Garcia and Lee (2018) provide a comprehensive review of the use of robotics and automation in underground coal mines, with a focus on improving safety, efficiency, and productivity. The paper begins by discussing the challenges associated with traditional mining methods, such as manual labor-intensive tasks and the risks involved in underground mining operations. The authors then explore the use of robotics for various tasks in underground coal mines, including drilling, blasting, and material handling. They discuss the potential benefits of robotics, such as increased precision, reduced risk to human operators, and improved efficiency in completing tasks.

Furthermore, the paper examines the integration of robotics with Wireless Sensor Networks (WSNs) for remote monitoring and control. This integration allows for real-time monitoring of mining operations and the environment, as well as the ability to remotely control robotic equipment. The authors highlight the importance of WSNs in enabling safer and more efficient mining practices through automation and remote operation.

2.1.5 Nguyen, L., Patel, R. (2017) Advancements in Ground Control Techniques for Enhanced Safety in Underground Coal Mines

This paper presents a literature review on ground control techniques in underground coal mines. It discusses the importance of ground control for preventing roof collapses and ensuring the safety of miners. The review covers traditional ground control methods, as well as advanced ground control techniques such as rock reinforcement and numerical modeling. The paper also discusses the use of WSNs for monitoring ground stability in underground coal mines. Nguyen and Patel (2017) offer a thorough literature review on ground control techniques in underground coal mines, emphasizing their crucial role in preventing roof collapses and ensuring miner safety. The paper starts by highlighting the significance of ground control in maintaining stable mine openings and reducing the risk of rockfalls and collapses.

The authors delve into traditional ground control methods, such as timbering and bolting, discussing their effectiveness and limitations. They then explore advanced ground control techniques, including rock reinforcement with materials like resin and mesh, as well as numerical modeling to predict and manage ground stability. Additionally, the paper discusses the integration of Wireless Sensor Networks (WSNs) for monitoring ground stability in underground coal mines. WSNs enable real-time monitoring of ground conditions, allowing miners and operators to detect potential hazards early and take preventive measures. The authors emphasize the importance of integrating WSNs with ground control techniques to enhance safety and efficiency in underground coal mining operations.

2.1.6 Kumar E (2018) MSP430-Based Design for Coal Mine Monitoring and Climate Control System Using Zigbee Technology

Kumar et al. [1] proposed a design for coal mine monitoring based on the MSP430 microcontroller. The system integrates sensors for temperature, humidity, gas, and smoke detection to ensure the safety of workers in underground coal mines. A Zigbee transceiver is used at a central location to communicate with the sensors and control the climatic conditions using motor control. The system aims to provide real-time monitoring and control of environmental parameters in coal mines, enhancing safety and efficiency. The literature survey in the IEEE paper by Kumar et al. likely discusses the challenges and existing solutions in coal mine monitoring. It might highlight the importance of monitoring environmental parameters such as temperature, humidity, gas levels, and smoke in underground coal mines to ensure the safety and well-being of workers. The survey may also discuss the limitations of traditional monitoring systems and the need for more advanced, automated systems that can provide real-time data and control capabilities. It might mention previous research or projects that have attempted to address similar challenges, noting their approaches and findings.

Additionally, the survey could touch upon the significance of using wireless communication technologies like Zigbee for transmitting data from sensors to a central monitoring station. It might discuss the advantages of Zigbee, such as low power consumption and the ability to create mesh networks, which are particularly suitable for underground environments. The literature survey in the IEEE paper by Kumar et al. likely discusses the challenges and existing solutions in coal mine monitoring. It might highlight the importance of monitoring environmental parameters such as temperature, humidity, gas levels, and smoke in underground coal mines to ensure the safety and well-being of workers. Overall, the literature survey likely provides a comprehensive overview of the current state of coal mine monitoring technology and sets the stage for the proposed MSP430-based design by Kumar et al.

CHAPTER 3

AIM AND SCOPE OF PRESENT INVESTIGATION

3.1 AIM OF THE PROJECT

The aim of this project is to design and implement a wireless sensor network for health monitoring in underground coal mines. The project aims to improve the safety and well-being of workers by monitoring key health parameters such as heart rate, SpO₂, body temperature, air quality, gas levels, room temperature, and humidity. The project seeks to address the limitations of existing safety systems, which are often expensive and not entirely effective. By utilizing wireless sensor technology, the project aims to provide a cost-effective and efficient solution for health monitoring in underground coal mines. The system will use sensors like the GY-MAX30100, DS18B20, BME280, and gas detection sensors to collect data, which will be transmitted wirelessly to a cloud server for remote monitoring. The system will be designed to alert the management system if any sensor reading exceeds predefined threshold values, indicating a potential health or safety issue. Overall, the aim is to create a reliable and real-time health monitoring system that can help prevent accidents and ensure the safety of workers in underground coal mines.

3.2 AREA OF THE PROJECT

The project falls within the domain of Internet of Things (IoT) and sensor networks, with a specific focus on health monitoring in industrial environments, particularly underground coal mines. It encompasses aspects of sensor technology, wireless communication, data analytics, and cloud computing. The project area also includes the application of advanced algorithms for real-time data processing and analysis, as well as the development of user interfaces for data visualization and management. Additionally, the project involves considerations for system integration, scalability, and reliability to ensure effective deployment in the challenging conditions of underground coal mines. Overall, the project area encompasses a multidisciplinary approach, combining elements of engineering, computer science, and industrial safety.

3.3 PROBLEM STATEMENT

The problem that Real-Time Wellness Monitoring For Underground Coal Mine Workers Using Arduino IoT Cloud aim to address is the challenge of effectively managing and monitoring the health of individuals, particularly those with chronic illnesses or mobility issues. Traditional healthcare models often rely on in-person visits to hospitals or clinics, which can be time consuming and expensive for both patients and healthcare providers. Furthermore, many individuals with chronic illnesses require ongoing monitoring of their health status, which can be difficult to achieve through traditional healthcare models. This can lead to delays in treatment or missed opportunities for early intervention, potentially leading to more serious health issues. However, there are several challenges associated with implementing IoT-based remote health monitoring systems. One of the main challenges is ensuring the security and privacy of the data being collected and transmitted by these devices. There are also concerns around the accuracy and reliability of the data collected by these devices, as well as the potential for technical issues to arise. Addressing these challenges will be critical in ensuring the successful implementation and adoption of IoT-based remote health monitoring systems. However, if these challenges can be overcome, there is enormous potential for these systems to improve patient outcomes and reduce healthcare costs.

3.4 EXISTING WORK

Existing work in health monitoring for underground coal mines has focused on several key areas. Firstly, gas detection systems have been a major focus, with research aiming to improve the accuracy and efficiency of detecting gases such as methane and carbon monoxide. This work has involved the development of advanced sensors and the integration of these systems with wireless sensor networks for real-time monitoring. Secondly, ventilation systems have been studied extensively to ensure proper airflow and air quality in underground mines. Computational fluid dynamics (CFD) simulations and ventilation-on-demand (VOD) systems have been explored to optimize ventilation and reduce the risk of gas build-up. Ground control techniques have also been a significant area of research, with studies looking at methods to prevent roof collapses and ensure the stability of underground structures. This includes the use

of advanced monitoring systems to detect changes in ground stability and identify potential hazards. Automation has emerged as a promising area for improving safety and efficiency in underground coal mines. Research in this area has focused on the development of robotic and autonomous systems for tasks such as drilling, blasting, and material handling, reducing the need for human workers in hazardous environments. Lastly, health monitoring of miners has been a key area of interest, with studies looking at the use of wearable devices and sensors to monitor vital signs and detect early signs of health issues.

Overall, existing work in health monitoring for underground coal mines has contributed to improving safety, efficiency, and overall working conditions in these challenging environments. The project aims to improve the safety and well-being of workers by monitoring key health parameters such as heart rate, SpO₂, body temperature, air quality, gas levels, room temperature, and humidity. The project seeks to address the limitations of existing safety systems, which are often expensive and not entirely effective. By utilizing wireless sensor technology, the project aims to provide a cost-effective and efficient solution for health monitoring in underground coal mines. The system will use sensors like the GY-MAX30100, DS18B20, BME280, and gas detection sensors to collect data, which will be transmitted wirelessly to a cloud server for remote monitoring. The system will be designed to alert the management system if any sensor reading exceeds predefined threshold values, indicating a potential health or safety issue. Overall, the aim is to create a reliable and real-time health monitoring system that can help prevent accidents and ensure the safety of workers in underground coal mines

CHAPTER 4

MATERIALS AND METHODS USED

4.1 PROPOSED WORK

The proposed system aims to revolutionize health monitoring in underground coal mines by implementing a wireless sensor network (WSN) for real-time data collection and transmission. The system will utilize a variety of sensors, including the GY-MAX30100 for heart rate and pulse oximetry, the DS18B20 for temperature, the BME280 for temperature and humidity, and gas detection sensors for monitoring air quality. These sensors will be integrated into wearable devices or placed in strategic locations throughout the mine to continuously monitor key health parameters of the workers. The data collected by these sensors will be transmitted wirelessly to a central server using the ESP32 module, which will then be processed and analyzed in real-time. One of the key features of the proposed system is its ability to detect and alert in real-time to any deviations from normal health parameters. Threshold values will be set for each monitored parameter, and if any reading exceeds these thresholds, an alert will be sent to the management system. This will enable prompt action to be taken to mitigate risks and ensure the safety of the workers.

Additionally, the system will leverage the Internet of Things (IoT) to enable remote monitoring and management of the health parameters. Supervisors and health professionals will be able to access real-time data from anywhere, allowing for quick response to any health or safety issues that may arise. Overall, the proposed system aims to provide a comprehensive, cost-effective, and efficient solution for health monitoring in underground coal mines, ultimately improving the safety and well-being of the workers.

4.2 BLOCK DIAGRAM

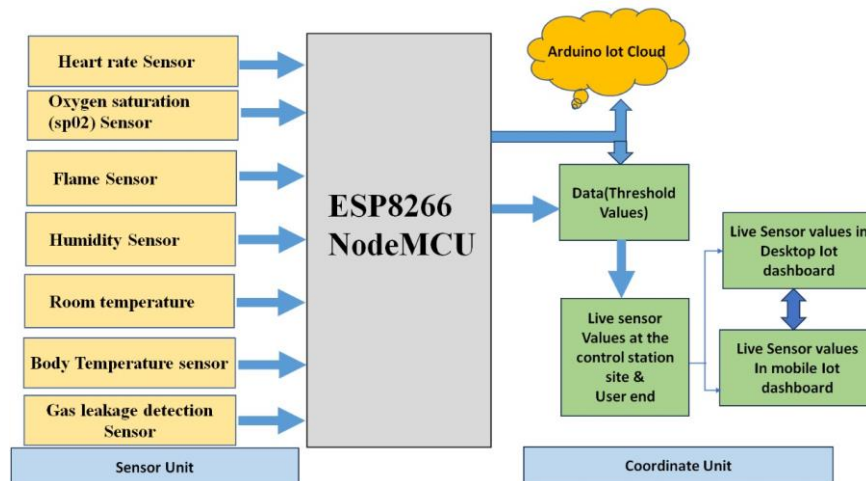


Fig: 4.1 : Block Diagram

4. 3 Methodology:

The methodology for an Real-Time Wellness Monitoring For Underground Coal Mine Workers Using Arduino IoT Cloud typically involves the following steps

- **Data Collection:** IoT devices are used to collect health data from individuals at home. This data may include vital signs, medication adherence, and other relevant health parameters.
- **Data Analysis:** The healthcare provider analyzes the collected health data using algorithms and machine learning techniques to identify any anomalies or trends that require intervention.
- **System Maintenance:** Regular maintenance is required to ensure the smooth operation of the IoT-based remote health monitoring system. This may involve updating software, replacing faulty devices, and ensuring the security of the system.

Overall, the methodology for an Real-Time Wellness Monitoring For Underground Coal Mine Workers Using Arduino IoT Cloud involves designing a system architecture that collects and transmits health data securely, analyzing this data to identify trends or anomalies, and intervening if necessary to provide remote care or request in-person evaluation. Regular maintenance is also required to ensure the smooth operation of the system.

4.4 HARDWARE DESCRIPTION

Real-Time Wellness Monitoring For Underground Coal Mine Workers Using Arduino IoT Cloud is a solution that uses Internet of Things (IoT) devices to collect real-time health data from individuals at home and transmit it securely to healthcare providers for monitoring and intervention. This approach enables healthcare providers to access real-time data on a patient's health status, enabling them to intervene early if necessary and provide more personalized and effective care. The system involves various IoT sensors, such as wearable devices, smartwatches, and mobile apps, that collect data on vital signs, such as blood pressure, heart rate, respiratory rate, and temperature, gas detection and transmit it to a cloud-based platform for analysis. The healthcare providers can access this data and monitor the patient's health remotely. They can also set up alerts to notify them of any changes in the worker's health status, allowing them to intervene early if necessary. Real-Time Wellness Monitoring For Underground Coal Mine Workers Using Arduino IoT Cloud offer a range of solutions to address the challenges associated with traditional healthcare models, including improved access to healthcare, real-time monitoring and early intervention, personalized and effective care, and reduced healthcare costs. However, to ensure the successful implementation of these systems, it is essential to address the challenges associated with data security and privacy, data accuracy and reliability, and technical support.

Components Required

The Components required to Construct the proposed system is Hardware Components.

1. ESP8266 Node MCU
2. GY-MAX30100 Heart rate and pulse oximetry sensor
3. DS18B20 Waterproof temperature sensor
4. BME280 temperature and humidity sensor
5. Gas detection sensor
6. Flame Sensor
7. Few Connecting Wires

4.4.2 Temperature and humidity sensor

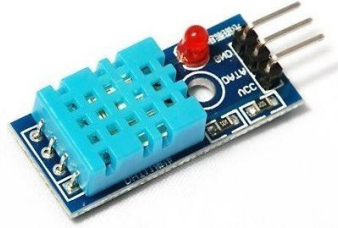


Fig: 4.3 : Temperature and Humidity Sensor

The BME280 sensor is a versatile device capable of measuring temperature, humidity, and barometric pressure with high accuracy and reliability. With a temperature measurement range of -40°C to $+85^{\circ}\text{C}$ and an accuracy of $\pm 1^{\circ}\text{C}$, it is suitable for a wide range of environmental monitoring applications. The humidity measurement range of 0% to 100% with an accuracy of $\pm 3\%$ enables precise monitoring of humidity levels in various environments. Additionally, the sensor can measure barometric pressure with an accuracy of ± 1 hPa, making it useful for weather forecasting and altitude measurements. The BME280 communicates over I2C or SPI interfaces, allowing easy integration with popular microcontrollers like Arduino and Raspberry Pi. Its low power consumption makes it suitable for battery-powered applications. Overall, the BME280 is a reliable sensor choice for projects requiring accurate environmental monitoring capabilities. The BME280 sensor is a versatile environmental sensor capable of measuring temperature, humidity, and barometric pressure with high accuracy and reliability. It offers a temperature measurement accuracy of $\pm 1^{\circ}\text{C}$ within the range of -40°C to $+85^{\circ}\text{C}$, ensuring precise temperature monitoring in various conditions. For humidity measurement, the sensor provides a typical accuracy of $\pm 3\%$ over the range of 0% to 100%, enabling accurate humidity sensing for environmental monitoring applications. Additionally, the BME280 can measure barometric pressure with an accuracy of ± 1 hPa, making it suitable for weather forecasting and altitude sensing applications.

4.4.3 Pulse Oximeter and Heart rate sensor

MAX30100 operates between 3.3v to 5v DC voltage. This sensor has IR and Red LEDs which emits on the finger and measures the SpO2 and Heart rate. We are using the latest GY-MAX30100 Heart rate and Pulse Oximetry sensor instead of old MAX30100 as it has design issues. This sensor is compact and measures Blood oxygen percentage along with the heart rate which is number of times the heart beats in one minute. The GY-MAX30100 is a sensor module that integrates a pulse oximeter and a heart rate sensor in a single package, making it ideal for applications requiring monitoring of blood oxygen saturation and heart rate. The sensor uses infrared light to measure the oxygen saturation level in the blood by detecting the absorbance of light at different wavelengths. It also measures the heart rate by detecting the pulsatile component of the blood flow. The GY-MAX30100 offers high accuracy and sensitivity, making it suitable for medical devices, fitness trackers, and other wearable devices. It communicates with microcontrollers via I2C interface, enabling easy integration into various projects. Overall, the GY-MAX30100 is a reliable sensor for non-invasive monitoring of blood oxygen saturation and heart rate in real-time. The GY-MAX30100 is a popular sensor module that integrates a pulse oximeter and heart rate sensor.

The MAX30100 sensor is a versatile device used for pulse oximetry and heart rate monitoring applications. Using red and infrared light, it measures the absorption of hemoglobin in the blood to calculate the oxygen saturation level (SpO2). Additionally, it can monitor heart rate based on the pulse waveform, providing valuable health data for medical and fitness applications. The sensor offers high accuracy in both SpO2 and heart rate measurements, ensuring reliable performance. It also measures the heart rate by detecting the pulsatile component of the blood flow. The GY-MAX30100 offers high accuracy and sensitivity, making it suitable for medical devices, fitness trackers, and other wearable devices. It communicates with microcontrollers via I2C interface, enabling easy integration into various projects. Overall, the GY-MAX30100 is a reliable sensor for non-invasive monitoring of blood oxygen saturation and heart rate in real-time.

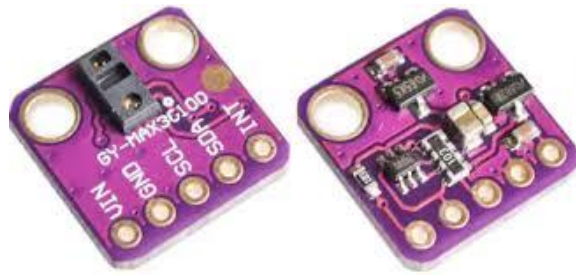


Fig: 4.4 : Heart Rate and Oximeter

Integrated within the sensor module are an LED light source and a photodetector, essential components for measuring light absorption in the blood. Despite its powerful capabilities, the MAX30100 sensor has low power consumption, making it suitable for use in battery-powered devices. Communication with microcontrollers is achieved through the I2C interface, allowing for easy integration with a variety of microcontroller platforms. Its small form factor further enhances its versatility, enabling integration into wearable devices and other compact applications for continuous health monitoring.

4.4.4. waterproof temperature sensor



Fig: 4.5 : Waterproof Temperature Sensor

DS18B20 temperature sensor is a 1-Wire sensor which means it can send the data only through single data wire (and GND) to microcontrollers. DS18B20 temperature operates between 3V-5.5V. It consumes very low power nearly 1mA. The DS18B20 is a digital temperature sensor that is popular for its high accuracy and ease of use. One of its key features is its waterproof casing, which allows it to be used in a variety of environments, including those with moisture or immersion in water. The sensor communicates over a 1-Wire interface, which means that multiple sensors can be connected to the same data line, simplifying wiring in multi-sensor

setups. The DS18B20 has a temperature measurement range of -55°C to $+125^{\circ}\text{C}$ with an accuracy of $\pm 0.5^{\circ}\text{C}$ in the range of -10°C to $+85^{\circ}\text{C}$. This makes it suitable for a wide range of temperature sensing applications, such as environmental monitoring, industrial control, and home automation. The DS18B20 is compatible with a variety of microcontrollers and development platforms, including Arduino, Raspberry Pi, and NodeMCU, making it easy to integrate into projects. The DS18B20 is a digital temperature sensor that comes in a waterproof package, making it suitable for use in harsh environments.

4.4.5. MQ-5 Sensor



Fig: 4.6 : MQ-5 sensor

The MQ-5 gas sensor is a commonly used gas sensor for detecting a variety of gases in the environment. It is particularly popular for detecting flammable gases, such as natural gas (methane) and liquefied petroleum gas (LPG), as well as other gases like carbon monoxide (CO) and hydrogen (H₂). In industrial environments, the MQ-5 sensor can be used for monitoring gas leaks and ensuring the safety of workers in areas where flammable gases may be present. The MQ-5 is a gas sensor that is sensitive to LPG, natural gas, and coal gas. The MQ-5 sensor is commonly used for detecting gases such as LPG, natural gas, and methane. It operates by providing an analog output voltage that is proportional to the concentration of the gas in the air, allowing for easy interfacing with microcontrollers and other devices. One of its key features is its high sensitivity to the target gases, enabling the detection of even small concentrations.

4.4.6 Flame Sensor

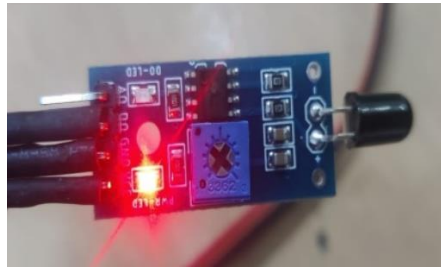


Fig: 4.7 :Flame sensor

The flame sensor is a specialized device designed to detect the presence of fire or flames by sensing infrared (IR) radiation emitted by flames. It operates on the principle that flames emit IR radiation at specific wavelengths, allowing the sensor to distinguish between flames and other sources of IR radiation. Flame sensors are used in a variety of applications, including fire detection systems, gas stoves, and industrial furnaces, where the early detection of flames is critical for safety. These sensors are highly sensitive and have fast response times, enabling them to detect flames quickly and accurately. To prevent false alarms, flame sensors are often equipped with filters and algorithms that help differentiate between flames and other sources of IR radiation. Overall, flame sensors play a crucial role in fire safety by providing reliable detection of flames, helping to prevent accidents and protect lives and property

4.4.8 Few Connecting Wires



Fig: 4.7 : Connecting Wires

A jump cable is used to connect the test plate, the prototype or the internal circuit with other non-joined instruments. Jumper cables, also known as booster cables or jump leads, are a pair of insulated wires of sufficient capacity with alligator clips at each end to interconnect the disabled equipment/vehicle with an auxiliary source, such as another equipment with the same system voltage or to another battery. body temperature of workers, ensuring their safety and well-being. The presence of hazardous gases, such as methane, is detected using MQ gas sensors, enabling early identification of potential risks and allowing for timely interventions to prevent accidents.

Additionally, the The GY-MAX30100 sensor, monitors the vital signs of workers, providing valuable health insights and enabling prompt medical assistance if needed. The data is then transmitted via the ESP8266 Wi-Fi module to a control station, where it is analyzed in real-time. If any parameter exceeds its designated threshold range, an alert is generated to notify mining staff and user promptly. Connecting wires, also known as jumper wires, are essential components for connecting various electronic components in circuits. They come in different lengths, colors, and types, such as male-to-male, male-to-female, and female-to-female, to suit different connection needs.

4.5 STANDARDS

IEEE 802.15.4: This standard defines the physical and MAC layers for low-rate wireless personal area networks (LR-WPANs), which can be used for communication in WSNs.

IEEE 15001: This standard specifies requirements for an energy management system, which can be relevant for ensuring the efficiency of the monitoring system's energy usage, especially in the context of battery-powered sensors.

IEEE 27001: This standard provides requirements for information security management systems, which are crucial for ensuring the security and confidentiality of the health data collected and transmitted by the system.

IEEE 13485: This standard specifies requirements for a quality management system for medical devices, which can be applicable if the monitoring system includes medical devices or components.

IEEE 11073: This standard defines communication protocols for interoperability between medical devices and health information systems, which can be relevant for ensuring compatibility with existing healthcare infrastructure.

VALIDATION: This standard provides guidelines for emergency medical services (EMS) communications, which can be relevant for ensuring that the monitoring system complies with requirements for emergency response in underground coal mines.

4.7 CONSTRAINTS

There are several constraints that need to be considered in a project involving remote health monitoring in underground coal mines using wireless sensor networks (WSNs):

- **Power Supply:** Underground environments may not have readily available power sources, so the system needs to be designed to operate efficiently on limited power, potentially using batteries or energy harvesting techniques
- **Communication Range:** The WSNs must have sufficient communication range to transmit data reliably from sensors located deep within the mine to a central monitoring station.
- **Environmental Conditions:** The sensors and WSN components must be able to withstand the harsh environmental conditions in underground mines, including high humidity, dust, and potential exposure to gases.
- **Data Security:** Measures must be implemented to ensure the security and privacy of health data collected and transmitted by the system, in compliance with relevant data protection regulations.
- **Interference:** The monitoring system must be designed to minimize interference from other electronic equipment and communication systems used in the mine to ensure reliable data transmission. Minimizing interference from other electronic equipment and communication systems is crucial for ensuring the reliable operation of a monitoring system in underground coal mines.
- **Cost:** The system needs to be cost-effective to be viable for implementation in underground coal mines, where budget constraints are often tight.

- **Reliability:** The system must be reliable and able to withstand the harsh and unpredictable conditions of underground coal mines, including dust, humidity, and temperature variations.
- **Data Transmission:** Reliable and high-speed data transmission is crucial for real-time monitoring. The system should be able to transmit data wirelessly over long distances in the underground environment.
- **Scalability:** The system should be scalable to accommodate a large number of sensors and workers, as well as potential future expansions or upgrades.

4.6 TRADE OFF

- **Cost vs. Performance:** Higher-performance sensors and communication modules may offer better accuracy and reliability but can also be more expensive. Balancing cost constraints with the need for reliable performance is essential.
- **Power Consumption vs. Battery Life:** Sensors and communication modules that consume less power can prolong the battery life of the monitoring system. However, this may come at the expense of performance or data transmission range.
- **Data Rate vs. Transmission Range:** Higher data rates may allow for more frequent data transmission and real-time monitoring but can reduce the transmission range. It's important to find a balance that meets the monitoring requirements while ensuring reliable communication.
- **Sensor Accuracy vs. Sensor Cost:** More accurate sensors typically come at a higher cost. Depending on the application requirements, it may be necessary to prioritize accuracy or cost-effectiveness.
- **Data Security vs. Accessibility:** Ensuring data security is crucial, especially when transmitting health data. However, stringent security measures can sometimes hinder accessibility and usability of the system.
- **Scalability vs. Complexity:** Designing a system that is easily scalable to accommodate a growing number of sensors and monitoring points can increase system complexity. Balancing scalability with system complexity is important to ensure ease of maintenance and operation.

CHAPTER 5

RESULTS AND DISCUSSION, PERFORMANCE ANALYSIS

5.1 Enhancing Underground Coal Mine Worker Safety

Improving the safety and health of underground coal mine workers is a critical concern due to the hazardous nature of the environment. Remote monitoring systems using wireless sensor networks (WSNs) offer a promising solution to enhance safety and health outcomes. By deploying WSNs with various sensors to monitor key parameters such as temperature, humidity, gas levels, and worker vital signs, including heart rate and SpO₂, mine operators can gain real-time insights into the working conditions and the health status of workers. These systems provide early detection of potential hazards, such as gas leaks or unsafe environmental conditions, enabling prompt intervention to mitigate risks.

Additionally, remote monitoring allows for continuous health surveillance, which can lead to the early detection of health issues and timely medical intervention. The use of IoT technologies enables data transmission to cloud servers for centralized monitoring and analysis. This data can be accessed by mine operators and health professionals, allowing for informed decision-making and proactive management of safety and health risks. Overall, remote monitoring systems using WSNs offer a cost-effective and efficient means to improve the safety and health of underground coal mine workers by providing real-time monitoring, early hazard detection, and continuous health surveillance.

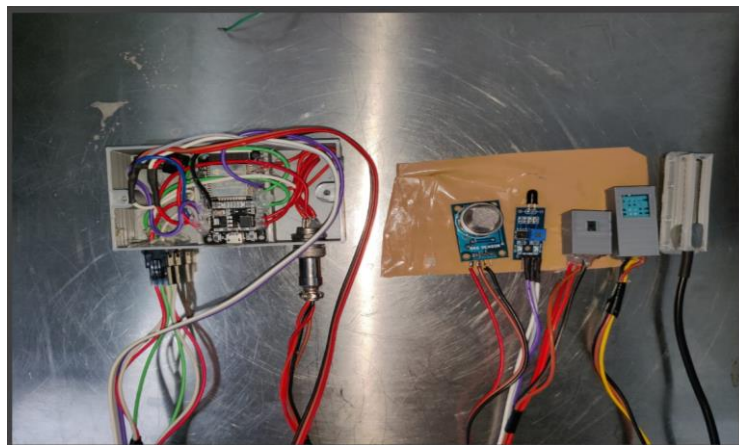


Fig:5.3 : Connections

5.2 Evaluation of Sensor Performance and Data Transmission in Coal Mines

Similarly, the reliability of data transmission is paramount. The system should ensure minimal data loss or corruption, especially in critical situations where timely information is essential for worker safety. Evaluating the transmission range of sensors is crucial to ensure that data can be transmitted effectively from various locations within the mine. Additionally, the system should be designed to minimize interference from other electronic equipment present in the mine, which could affect the reliability of data transmission. Overall, a thorough evaluation of sensor performance and data transmission in the underground coal mine environment is essential to ensure that remote monitoring systems can effectively monitor and safeguard the health and safety of mine workers.



Fig No: 5.1: Health Monitoring Dashboard

Fig 5.1 Integration of sensors into coal miners' clothing enhances workplace safety by monitoring vital signs and environmental factors. Real-time data analysis enables early detection of health risks and improves resource management for a safer work environment. These systems demonstrate a commitment to worker welfare in hazardous industries like coal mining.

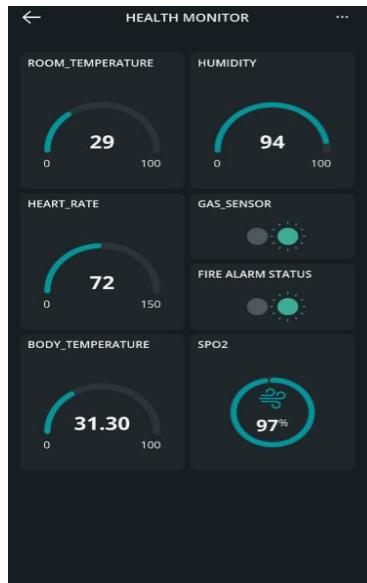


Fig No: 5.2 : Mobile Dashboard

Fig 5.2 Shows the remote accessibility enables prompt decision-making, intervention, and support in case of any emergencies or concerning trends detected in the data. Additionally, it facilitates long-term analysis and tracking of miners' health over time, aiding in the development of proactive measures to improve occupational health and safety standards in the mining industry worldwide.

Table No 5.1 : Measurements for Data Monitoring

Sl. No	PARAMETERS	SENSOR MEASUREMENTS		
		DATA 1	DATA 2	DATA 3
1	Heart rate	72	66	69
2	Pulse oximetry	97	93	88
3	Flame Sensor	0	1	0
4	Gas detection sensor	1	0	1
5	Temperature sensor	29	32	35
6	Humidity sensor	94	84	77
7	Body Temperature	31.30	28.813	15.71

5.3 Efficient Data Management and Analysis for Health Monitoring in Underground Coal Mines

Efficient data management and analysis play a crucial role in health monitoring systems for underground coal mines. With sensors continuously collecting data on environmental parameters and workers' health indicators, the volume of data generated can be significant. Efficient data collection mechanisms, such as wireless sensor networks (WSNs), ensure that data is captured reliably and transmitted to a central location for analysis. The use of WSNs also allows for real-time monitoring, enabling prompt intervention in case of emergencies. Data storage is another critical aspect, with cloud-based storage solutions offering scalability and accessibility. Storing data in the cloud also facilitates remote access, allowing mine operators and health professionals to monitor the health status of workers from anywhere. Data analysis techniques, such as statistical analysis and machine learning, can provide valuable insights from the collected data. These techniques can help identify patterns, trends, and anomalies, enabling proactive measures to be taken to prevent health issues and improve safety in underground coal mines.

Utilizing wireless sensor networks and IoT technology, our proposed system revolutionizes health monitoring in underground coal mines. Real-time tracking of vital health parameters and environmental conditions ensures timely detection of potential hazards, enhancing worker safety. With seamless integration of ESP8266 Wi-Fi module and advanced sensors, our solution facilitates efficient data transmission and monitoring. By providing instant alerts to control stations and workers, we empower proactive interventions to mitigate risks and prevent health complications. The implementation of smart alert mechanisms enables swift evacuation and emergency response, minimizing the risk of incidents. Through centralized monitoring on the Arduino IoT cloud, our system enables data-driven decision-making for improved safety standards in coal mining operations.

Overall, efficient data management and analysis are essential for ensuring the effectiveness of health monitoring systems in underground coal mines, enabling timely interventions and improving the overall safety and health of mine workers.

CHAPTER 6

SUMMARY AND CONCLUSION:

6.1 SUMMARY

The project aims to develop a remote health monitoring system for workers in underground coal mines using wireless sensor networks (WSNs). The system will utilize various sensors to monitor health parameters such as heart rate, SpO2, body temperature, air quality, gas detection, room temperature, and humidity levels. These parameters are crucial for detecting potential health issues early, especially in environments where workers are exposed to coal dust, silica dust, toxic gases, and other hazards. The system will use the BME280 sensor for temperature, humidity, and barometric pressure measurements, the GY-MAX30100 sensor for pulse oximetry and heart rate monitoring, the DS18B20 waterproof temperature sensor, and the MQ-5 sensor for gas detection. These sensors will be integrated into the WSN, which will transmit data to cloud servers for remote access and management.

6.2 CONCLUSION

Real-Time Wellness Monitoring For Underground Coal Mine Workers Using Arduino IoT Cloud have great potential to revolutionize healthcare by enabling real-time monitoring of worker's health remotely, reducing the need for in-person visits, and providing timely interventions in case of emergencies. These systems can help improve the quality of care, reduce healthcare costs, and increase worker's satisfaction. The use of IoT devices, such as wearables and sensors, can collect and transmit vital signs, activity levels, and other health-related data to healthcare providers in real-time, enabling them to detect and respond to changes in a patient's health status promptly. This can help prevent complications, reduce hospital readmissions, and improve outcomes for patients with chronic diseases. IoT-based remote health monitoring systems have the potential to transform healthcare and improve patient outcomes.

REFERENCES

- [1] Fahad, L. G., Azziz, M. S., & Rahaman, M. S. (2019). IoT based health monitoring system for underground coal mines. In 2019 IEEE International Conference on Engineering, Technology and Innovation (ICE/ITMC) (pp. 1-6). IEEE.
- [2] Gaur, A., Bhalla, K., & Sanghvi, S. (2019). IoT-based Real-time Health Monitoring System for Underground Coal Mines. *International Journal of Computer Applications*, 182(12), 10-14.
- [3] Gupta, R., Yadav, P., & Sharma, R. (2019). Wireless Sensor Network-based Health Monitoring System for Coal Mines: A Review. *International Journal of Science, Engineering and Technology Research (IJSETR)*, 8(10), 3210-3216.
- [4] Han, G., Jia, C., Liu, X., & He, J. (2014). The research of ZigBee-based mine safety monitoring system. In 2014 IEEE Workshop on Advanced Research and Technology in Industry Applications (WARTIA) (pp. 102-105). IEEE.
- [5] Kumar, A., Rani, P., & Singh, V. (2020). Wireless Sensor Network for Health and Environmental Monitoring in Underground Coal Mines: A Review. *International Journal of Wireless & Mobile Networks (IJWMN)*, 12(3), 45-57.
- [6] Kumar, S., Jha, M., & Singh, A. (2020). Health Monitoring and Safety Management in Underground Coal Mines using IoT. *International Journal of Electrical and Computer Engineering (IJECE)*, 10(6), 4456-4463.
- [7] Mishra, S., & Mishra, P. (2019). Wireless Sensor Network-based Health Monitoring System for Underground Coal Mines. *International Journal of Electronics and Communication Engineering & Technology (IJECET)*, 10(2), 110-118.
- [8] Raza, M., Wallgren, L., & Voigt, T. (2013). S-MAC WSNs for monitoring of underground mine environment. In 2013 IEEE 14th International Symposium on "A World of Wireless, Mobile and Multimedia Networks" (WoWMoM) (pp. 1-6). IEEE.

- [9] Reddy, P., Kumar, M., & Prasad, K. (2018). A Review on Wireless Sensor Network-based Health Monitoring Systems for Coal Mines. *International Journal of Computer Science and Mobile Computing*, 7(12), 85-91.
- [10] Roy, S., Banerjee, S., & Das, P. (2018). A Wireless Sensor Network-based Health Monitoring System for Underground Coal Mines. *International Journal of Mining Science and Technology*, 28(3), 451-458.
- [11] Sahoo, S. K., & Jena, D. (2016). Remote health monitoring of underground coal mines based on wireless sensor network. In *2016 2nd International Conference on Contemporary Computing and Informatics (IC3I)* (pp. 723-727). IEEE.
- [12] Sharma, N., & Saxena, V. (2019). Health and Safety Monitoring in Underground Coal Mines using Wireless Sensor Networks. *International Journal of Advanced Research in Computer Science*, 10(3), 20-25.
- [13] Singh, A., Singh, R., & Singh, B. (2021). IoT-based Health Monitoring System for Underground Coal Mines. *International Journal of Engineering and Advanced Technology (IJEAT)*, 10(6), 287-294.
- [14] Strollo A.G.M , E. Napoli, D. De Caro, N. Petra, G. Saggese, and G. Di Meo, "Approximate multipliers using static segmentation: Error analysis and improvements," *IEEE Trans. Circuits Syst. I, Reg. Papers*, vol. 69, no. 6, pp. 2449–2462, Jun. 2022.
- [15] Zhao, Y., Xia, F., & Wang, Z. (2012). Design of mine safety monitoring and control system based on ZigBee wireless sensor network. In *2012 IEEE International Conference on Automation and Logistics (ICAL)* (pp. 952-956). IEEE.

APPENDIX

A.PLAGARISM REPORT OF PAPER

ORIGINALITY REPORT			
8%	8%	5%	0%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS
PRIMARY SOURCES			
1	www.ijeat.org Internet Source	3%	
2	www.circuitschools.com Internet Source	3%	
3	www.researchgate.net Internet Source	1%	
4	"Emerging Trends in Computing and Expert Technology", Springer Science and Business Media LLC, 2020 Publication	1%	
5	C Karthick, T Vino, K Surendra, L R Rewanth kumar Reddy. "Sign Sequence based Gesture Recognatiton Using MEMS Accelerometer for Augumentad Reality Applications", IOP Conference Series: Materials Science and Engineering, 2019 Publication	1%	
6	www.smores.com Internet Source	<1%	

B.PAPER SUBMISSION TO THE CONFERENCE

6 of 1,205

2024 IEEE World Conference on Applied Intelligence and Computing : Submission (731) has been created.

Inbox x

Microsoft CMT <email@msr-cmt.org>

to me

Sun, 14 Apr, 00:42 (1 day ago)

Hello,

The following submission has been created.

Track Name: AICconf2024

Paper ID: 731

Paper Title: Real-Time Wellness Monitoring For Underground Coal Mine Workers Using Arduino Iot Cloud

Abstract:
For underground coal mines environment should be kept monitored for the safety of people working underneath, the existing safety systems are expensive not effective. The present health monitoring systems which are being used inside the coal mines need to connect through wires all the way which makes the system more expensive. Therefore wireless sensor network with various sensors to monitor all the important parameters in the mine are proposed and analyzed. Using health parameters like heart rate and SpO2, body temperature, air quality monitoring, gas detection, room temperature, humidity levels as they may indicate a precaution before any illness. If any parameter sensor value goes beyond the threshold range at that point it will alert the information about workers health monitoring parameters to management through the built in WiFi such as ESP32 and in the monitor received data will be uploaded in the webpage through IoT.
EXAMPLE: Workers while working in underground coal mines there are various health factors that gets effected due to coal dust, silica dust, metal and Asbestos dust, toxic gases etc. Which can lead to respiratory problems such as coal wokers chronic pulmonary(cwcp) and other lungs related illness. So taking this scenario into account we came up with an idea to build a remote health monitoring system which can transmit the health data to the cloud servers, which you can access from anywhere and act fast on issues.
Keywords:
1. ESP8266 NodeMCU
2. GY-HAX30100 Heart rate and pulse oximetry sensor
3. DS18B20 Waterproof temperature sensor
4. BME280 temperature and humidity sensor
5. Gas detection sensor
6. Few Connecting Wires

Created on: Sat, 13 Apr 2024 19:12:11 GMT

Last Modified: Sat, 13 Apr 2024 19:12:11 GMT

Submissions

Search help articles

Help Center

Select Your Role : Author

AICconf2024

KATAM ABHISHEK GOUD

Author Console

+ Create new submission

1 - 1 of 1

Show: 25 50 100 All

Clear All Filters

731

Real-Time Wellness Monitoring For Underground Coal Mine Workers Using Arduino Iot Cloud

Hide abstract

For underground coal mines environment should be kept monitored for the safety of people working underneath, the existing safety systems are expensive not effective.
The present health monitoring systems which are being used inside the coal mines need to connect through wires all the way which makes the system more expensive. Therefore wireless sensor network with various sensors to monitor all the important parameters in the mine are proposed and analyzed. Using health parameters like heart rate and SpO2, body temperature, air quality monitoring, gas detection, room temperature, humidity levels as they may indicate a precaution before any illness. If any parameter sensor value goes beyond the threshold range at that point it will alert the information about workers health monitoring parameters to management through the built in WiFi such as ESP32 and in the monitor received data will be uploaded in the webpage through IoT.
EXAMPLE: Workers while working in underground coal mines there are various health factors that gets effected due to coal dust, silica dust, metal and Asbestos dust, toxic gases etc. Which can lead to respiratory problems such as coal wokers chronic pulmonary(cwcp) and other lungs related illness. So taking this scenario into account we came up with an idea to build a remote health monitoring system which can transmit the health data to the cloud servers, which you can access from anywhere and act fast on issues.

Submission files:

Conference paper-1.pdf

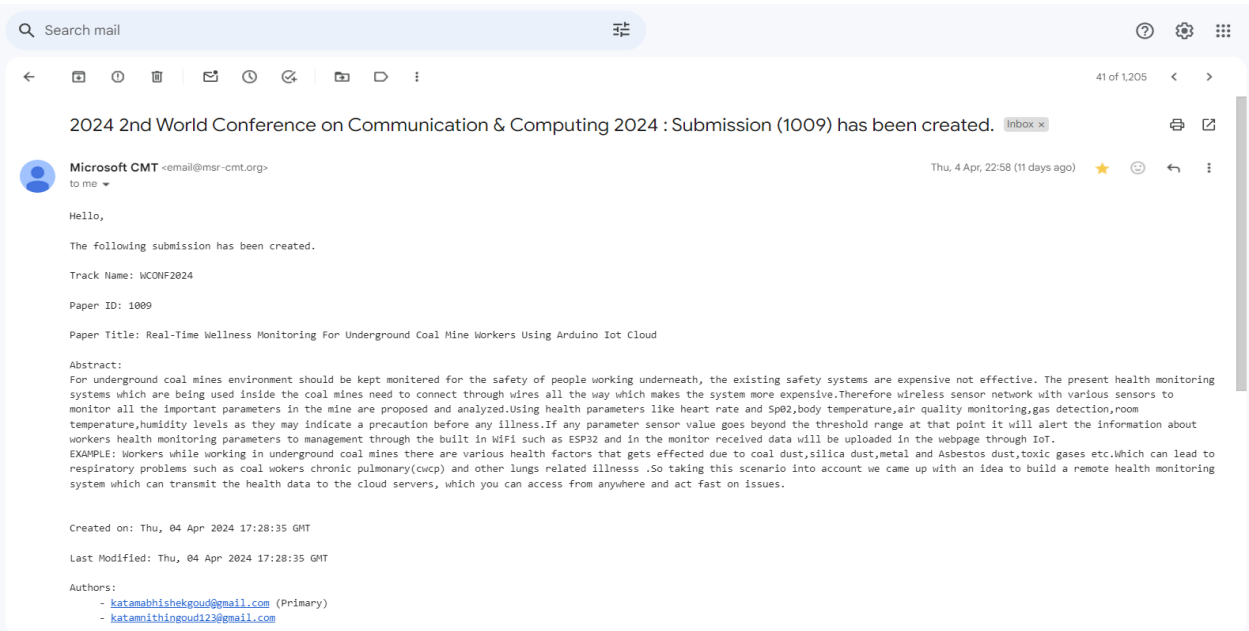
Submission:

Edit Submission

Edit Conflicts

Delete Submission

© 2024 Microsoft Corporation [About CMT](#) | [Docs](#) | [Terms of Use](#) | [Privacy & Cookies](#) | [Request Free Site](#)



Submissions

Search help articles

Help Center

Select Your Role : Author

WCONF2024

KATAM ABHISHEK GOUD

Author Console

+ Create new submission

1 - 1 of 1

Show: 25 50 100 All

Clear All Filters

Paper ID	Title	Files	Actions
Clear	Clear		
1009	Real-Time Wellness Monitoring For Underground Coal Mine Workers Using Arduino Iot Cloud Hide abstract For underground coal mines environment should be kept monitored for the safety of people working underneath, the existing safety systems are expensive not effective. The present health monitoring systems which are being used inside the coal mines need to connect through wires all the way which makes the system more expensive. Therefore wireless sensor network with various sensors to monitor all the important parameters in the mine are proposed and analyzed. Using health parameters like heart rate and SpO2, body temperature, air quality monitoring, gas detection, room temperature, humidity levels as they may indicate a precaution before any illness. If any parameter sensor value goes beyond the threshold range at that point it will alert the information about workers health monitoring parameters to management through the built in WiFi such as ESP32 and in the monitor received data will be uploaded in the webpage through IoT. EXAMPLE: Workers while working in underground coal mines there are various health factors that gets effected due to coal dust, silica dust, metal and Asbestos dust, toxic gases etc. Which can lead to respiratory problems such as coal workers chronic pulmonary (CWP) and other lungs related illnesses. So taking this scenario into account we came up with an idea to build a remote health monitoring system which can transmit the health data to the cloud servers, which you can access from anywhere and act fast on issues.	Submission files: Conference paper-1.pdf	Submission: Edit Submission Edit Conflicts Delete Submission

© 2024 Microsoft Corporation

[About CMT](#) | [Docs](#) | [Terms of Use](#) | [Privacy & Cookies](#) | [Request Free Site](#)