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IOT Based Coal Mine Safety Monitoring and Alerting System

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ABSTRACT

This project IoT based Coal mine safety monitoring and alerting system based on sensor network can timely and accurately reflect situation of environment and staff in the underground regions to computer system. The air pollution from coal mines is mainly due to emissions of hazardous gases include Sulphur dioxide (SO2), nitrogen dioxide (NO2), carbon monoxide (CO) etc. To monitor the concentration level of harmful gases, gas sensors are used. To check the temperature in the coal mine Temperature sensor is used. LDR sensor is used to detect the light intensity in mines. To check the pulse through Pulseoximeter ESP32-CAM is used to monitor the live streams inside the mine. This system also provides an early warning, which will be helpful to all miners present inside the mine to save their life before any accidents occurss

Keywords : Coal Mines, ESP 32 Camera, Coal Mines, Sensors

I. INTRODUCTION

The mines are the world's most dangerous mining operation, with thousands of workers dying each year as a result of massive explosions. According to a recent study, in such mining incidents, an estimated 12,000 people have died on average. Coal is a non-human resource that can be converted; there are a few problems in the mines; and workers risked their lives by working in coal mines; and, unfortunately, some miners end up losing their lives in coal mines. Often, such problems arise as a result of outdated technology and wireless devices, the final result being the mismanagement and spillage of toxic gases in coal mines poses a serious threat to archaeologists, underground operation. If farming is done by hand, more workers are needed, and the required quality work is not achieved. Seeds and fertilizers are also wasted due to inefficiency. The manual harvesting method is time consuming and expensive. The chemicals used in pesticides are toxic and dangerous to humans, and if you are not careful during spraying, they will develop respiratory infections. The eight deadliest mines in history have occurred in China.

Liaoning eruption kills 210 people, Guangdong floods kill 123 people, Xinjiang eruption kills 83 people, Shanxi eruption kills 72 people in 2015. A coal explosion at the Honkeiko Colliery in

China killed 1,549 miners, making it one of the most dangerous mining disasters in history. As a result, the importance of safety for mine workers in recent days, monitoring mine employees in underground mines has become extremely challenging. Internet of Things (IOT) is a set of gadgets(objects) connected to the net. IOT implementation varies substantially on a massive scale. Internet of Things Europe group has most essential IOT gadgets. Clever apps, clever power, enterprise, fitness, and clever cities as a whole encompass smart housing, smart transportation, and clever housing to call a few net of things(IOT) is a sport-changing invention in which all sensory records is stored within the cloud and accessed fast.

An accident that occurs while mining minerals or metals is known as a mining accident. Each year, tens of thousands of miners die in mining accidents, most of which occur in underground coal mining, while accidents also happen in mining [1]. Due to rock strata that are plain, typically incompetent rock, presence of CH4 gas, and coal powder, Coal mining is considered significantly more dangerous than hard rock mining. Most deaths nowadays occur in underdeveloped nations and rural areas of wealthy countries when safety precautions are not properly implemented [2]. As a result, it is critical to maintaining track of circumstances that might contribute to an accident to protect human safety. This project introduces a device used to keep track of the conditions within a coal mine, which might pose a threat to human life. The sensors andZigbee are employed for monitoring in this system. This system also incorporates a smart helmet with a panic button that each worker may activate individually. All sensors are linked to specific applications and send an alert signal when it exceeds a particular value. The alarm message is sent to the control room to take the necessary action quickly. If coal mine accidents are not adequately controlled, it may result in massive human fatalities.

A monitoring system has been built to record the readings ofdangerous gases and risky working conditions. The information gathered is subsequently forwarded to professionals for analysis and action. Over the years, it has been observed that coal mine contributes significantly to the country's rapid economic and social development. Scholars from around the world have undertaken substantial research to improve the degree of safety. Coal mines are an essential source of energy for human growth. Development. Mining failures may be exploited to increase security in the industry. Industrial series of failures or flaws are typically the cause of an accident. There are a number of practical measures available. Initiatives involving mines, such as the construction of safety lamps, can significantly impact. Law and creating a self-contained coal mine safety monitoring system are both in the works. The trajectory of China coal mine accidents over the last ten years were investigated, and the human elements involved in these accidents were investigated using multi-dimensional statistical analysis. The number of significant coal mine accidents and the number of people killed were constantly reducing, but occasional death accidents still accounted for most deaths. Human factors accounted for 94.09 percent of the causes of these incidents, with the willful violation, mismanagement, and flawed design accounting for 35.43 percent, 55.12 percent, and 3.54 percent, respectively.

The organization of this document is as follows. In Section 2 (**Literature survey**), shown, In Section 3 (**Proposed method**), presented. In Section 4 discussed Experimental Results and Discussed in Section 5(**Conclusion**).

II. LITERATURE SURVEY

Ultra-modern mining workers have a big issue in phrases of safety. The mining protection machine ensures that the running environment is free of hazards. The undertaking's number one purpose is to save you mining injuries and decorate operating conditions. The Arduino Uno is employed for

extended reliability in the IOT-primarily based mine protection gadget, which has multiple sensors for numerous functions. This machine is used inside the mining enterprise, and all sensors are considered as one unit sensors screen an expansion of characteristics from the operating area along with temperature and humidity, light intensity, hazardous gasoline levels inside the air, and flame hint.[1]

Safety is the most important aspect of any industry. Safety and security are extremely important in the mining business. To avoid mishaps, the mining sector takes several fundamental safeguards. Temperature rises, water levels rise, and methane gas leaks continue to cause accidents in underground mines. It ensure worker safety here. When a worker is in danger, it can use the panic button to alert security. To improve underground mine safety, a reliable communication system between subterranean mine workers and the fixed ground mining system must be built. The verbal exchange community cannot be disrupted at any time or under any occasions. This suggestion proposes a low-free Zigbee-based totally wireless mine surveillance device with early-caution intelligence. The reputation of employees may be tracked via IOT. [2]

Many coal miners are involved approximately their occupational protection bad ventilation in subterranean mines exposes people to toxics gases, heat, and dirt, which could reason illness, damage, and dying. This paper affords a concept for a web of things wireless sensor community that could detect temperature, humidity, and gasoline in an underground mine the usage of an ARM controller. The Arduino UNO, Node MCU, DHT11 sensor, gas sensor, hearth sensor to hit upon hearth and send an alarm, and LDR to detect mild depending on light levels are all used in this gadget. Traditional coal mineshaft monitoring systems are frequently wired organisation systems that play an important role in ensuring coal mineshaft security.[3]

It implement a safety system for coal mines and their workers in this study. Because of the dangers associated with coal mining, this method is required. For example, there is a risk of highly toxic gases being present in coal mines, and an increase in temperature inside the mine could be a serious concern, necessitating the implementation of a safety system for coal mine workers as well as to safeguard the mine's resources. It use a platform called Thing-Speak to develop such a system. Thing-Speak is a platform that displays data gathered from many sources. The source in this case is a Node-MCU, which provides inputs for connecting various sensors and will perform according to the specified code. The code was written in the Arduino IDE using the Embedded C programming language. Gas, humidity, temperature, fire, and light are all monitored by this system. This system uses Thing-Speak, MQTT, and Buzzers to warn the user in the event of any anomalies to the admin and workers.[4]

Miners' safety is currently a big concern. Miners' health and lives are jeopardised by a number of serious challenges, including not just the working environment but also its consequences. The wireless sensor network totally coal mine protection tracking machine can exactly and immediately replicate the dynamic state of affairs of underground employees to the ground computer machine and mobile unit. Particulate count and gases which includes sulphur dioxide(SO2), nitrogen dioxide(NO2), and carbon monoxide(CO) are many of the pollutants launched with the aid of coal mines. Semiconductor gas sensors are used to monitor the concentration levels of hazardous gases.[5].

III. PROPOSED METHOD

The "IoT Based Coal Mine Safety Monitoring and Alerting System" is a project designed to improve the safety of coal miners by monitoring and alerting of hazardous conditions in the mines. The system is composed of various components, including Arduino, gas sensor, LDR sensor, temperature sensor, ESP32 camera, LCD, buzzer, ESP8266 (Wi-Fi), and Ubidots

(IoT). The gas sensor is used to detect harmful gases such as carbon monoxide and methane, while the LDR sensor is used to detect abnormal light patterns or fluctuations. The temperature sensor monitors the temperature of the mines to detect any abnormal temperature changes. The ESP32 camera captures images and video footage of the mines, and the LCD displays the data collected from the sensors and cameras in real-time. The buzzer alerts the miners and authorities in case of any hazardous conditions. The ESP8266 (Wi-Fi) is used to connect the system to the internet, enabling remote monitoring and control. Ubidots (IoT) is used to store and analyze the data collected from the sensors and cameras. Overall, the project aims to provide a comprehensive solution for monitoring the safety of coal mines using advanced technologies such as IoT and machine learning. By implementing this system, the safety of miners can be significantly improved, and the risk of accidents can be minimized.

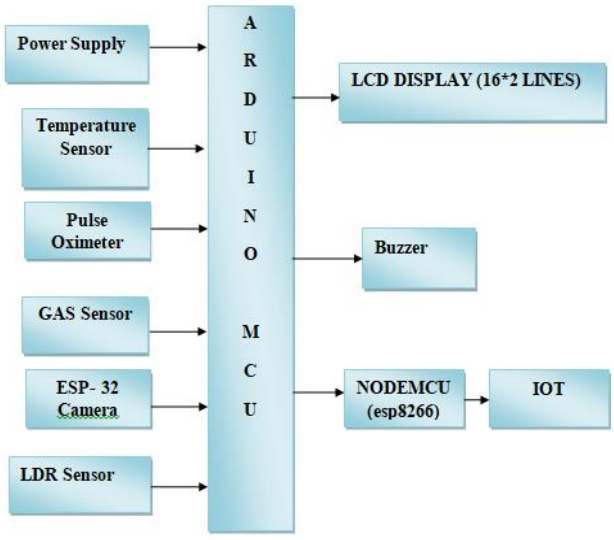

Figure 1: Proposed block diagram

Operation

The mining industry is considered to be one of the most hazardous industries in the world. With the increasing demand for coal, ensuring the safety of miners has become a major concern for mining companies. In order to address this concern, an IoT-based coal mine safety monitoring and alerting system has been developed using Arduino, gas sensor, temperature sensor, LDR sensor, ESP32 CAM, buzzer, LCD, relay module, load, and IoT(Ubidots). The system continuously monitors the gas concentration levels, temperature, and light levels inside the mine. If the gas concentration level exceeds the set threshold value, an alert is sent to the miners via a buzzer and LCD display, and the load is switched off to prevent any further danger. The system also uses an ESP32 CAM to send real-time images of the mine to the control room for remote monitoring.

The data collected by the system is sent to the IoT platform Ubidots, where it can be monitored and analyzed in real-time. This allows for quick decision-making in case of any emergency situations. The system provides an efficient and reliable solution for ensuring the safety of miners in coal mines

A. Hardware Description

1) Arduino : It is a microcontroller board shown in fig.3 based on the Atmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller. Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases.

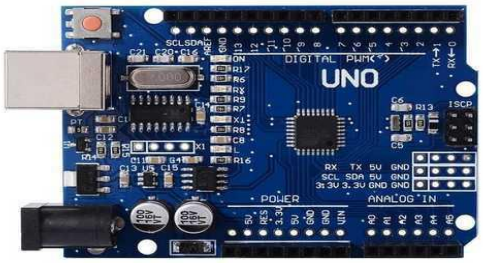

Figure 2: Arduino Microcontroller

2) Temperature Sensor:

The temperature sensor measures the ambient temperature of the user's surroundings. This data is crucial for monitoring environmental conditions that

may affect the user's health, such as fever or extreme temperatures.

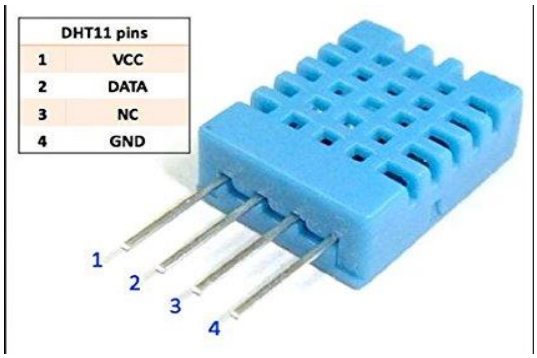

Figure 3:Temperature sensor

3) Pulse Oximeter:

The pulse oximeter measures the user's heart rate and blood oxygen saturation levels. This vital information helps assess cardiovascular health and respiratory function, allowing for early detection of potential health issues.

Figure 4: Pulse oximeter

4) ESP32 CAM

The ESP32-CAM is a small size, low power consumption camera module based on ESP32. It comes with an OV2640 camera and provides onboard TF card slot. The ESP32-CAM can be widely used in intelligent IoT applications.

Figure 5: Pulse oximeter

5) Buzzer

Buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, train and confirmation of user input such as a mouse click or keystroke. Buzzer will ring at proper time.

Figure 6: Pulse oximeter

6) *Wi-Fi:* The ESP8266 Wi-Fi Module shown in fig.7 is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware. The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community

Figure 7: Node MCU

7) MQ 135 SENSOR (Gas Sensor)

The MQ-135 shown in fig.8 is used to measure air quality. The MQ series of gas sensors use a small heater inside with an electrochemical sensor. They are sensitive to a range of gasses and are used indoors at room temperature. The output is an analog signal and can be read with an analog input of the Arduino. Also, the sensitivity can be adjusted by the potentiometer. The MQ-135 alcohol sensor consists of a tin dioxide (SnO2), a perspective layer inside aluminium oxide micro tubes and a heating element inside a tubular casing.

Figure 8: Gas sensor

8) LCD: It stands for liquid crystal display, which is used to show the status of an application, displaying values, debugging a program, etc. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. The 16 x 2 intelligent alphanumeric dot matrix display is capable of displaying 224 different characters and symbols. This LCD has two registers, namely, Command and Data. shown in fig.9.

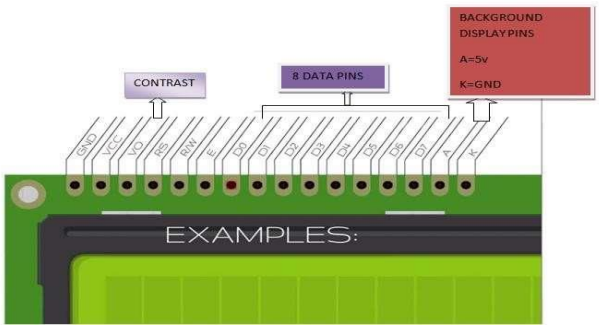

Figure 9: LCD Module

9) Power Supply: The power supply will supply the regulated power supply to the unit which is first converted into 12V AC. 12V AC is converted into DC using rectifier circuit. Finally the 7805 voltage regulator provides constant 5V DC supply which will be given to circuit shown in fig.10.

Figure 10: Power Supply

C. Software Description

10) Arduino IDE: To Program the Atmega328 Microcontroller we used this IDE. Arduino microcontrollers are pre-programmed with a boot loader that simplifies uploading of programs to the on-chip flash memory. .

11) UBIDOTS: Ubidots is an over the Internet or via a Local Area Network. Ubidots enables the creation of sensor logging applications, location tracking

applications, and a social network of things with status updates. Template is shown in fig.11.

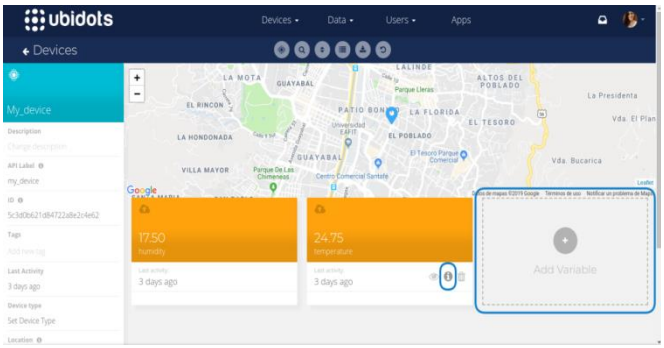

Figure 11: UBIDOTS Web page

D. Implementation

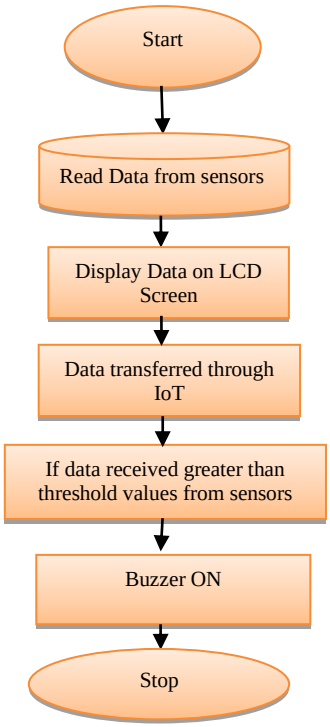

Figure 12: Flow Diagram

IV. EXPERIMENNTAL RESULTS

This figure 13 likely depicts the physical setup of the IoT-based coal mines safety monitoring system. It may include sensors, IoT devices, and other hardware components arranged in a specific configuration to facilitate the detection and monitoring process

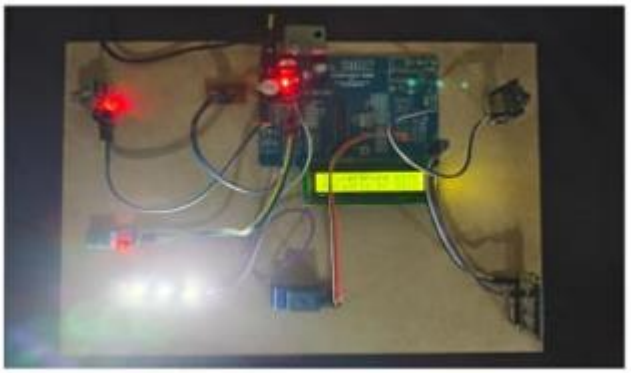

Figure 13: Hardware setup

In this figure 14, displayed the data in LCD, which is received from sensors.

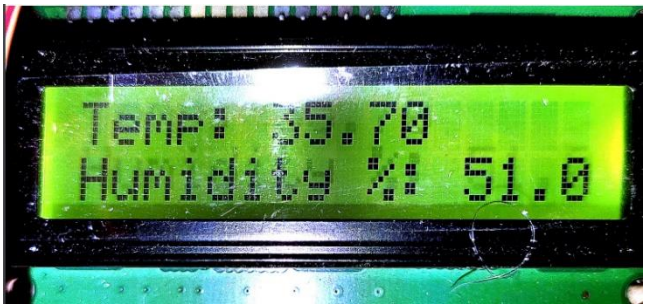

Figure 14: Showing the LCD that temperature and humidity sensor

V. CONCLUSION

This an IoT based coal mine safety monitoring and alerting system using Arduino, gas sensor, temperature sensor, LDR Sensor, ESP32 CAM, buzzer, LCD, relay module, load, and IoT platform (Ubidots) can be an effective solution for improving safety in coal mines. By continuously monitoring the mine environment for hazardous conditions, the system can provide real-time alerts and notifications to miners and supervisors, helping to prevent accidents and improve overall safety. The system is also cost-effective, easy to maintain, and can increase productivity by allowing miners to focus on their work without worrying about hazardous conditions. Overall, an IoT based coal mine safety monitoring and alerting system can be a valuable investment for any

coal mining operation looking to improve safety and efficiency.

VI. FUTURE SCOPE

The system can be integrated with advanced AI technologies like machine learning, computer vision, and natural language processing to enhance its capabilities. For example, machine learning algorithms can be used to predict hazardous conditions in the mine based on historical data, and computer vision can be used to detect the presence of miners in the mine and identify their location.

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