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IOT-ENHANCED COAL MINE SAFETY MONITORING AND ALERTING SYSTEM: ENSURING WORKER SAFETY IN HAZARDOUS ENVIRONMENTS

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ABSTRACT - Coal plays a critical role in certain initiatives and serves as a significant power source. The energy source in closest proximity to the coal mine holds the utmost significance and value. Due to climate-related variables such as moisture, humidity, and the emission of toxic gases, tunneling in coal mines is hazardous and potentially fatal. When these elements converge, they produce a perilous milieu for authorities, thereby endangering their lives. In order to address the current issue, a model has been developed capable of detecting unanticipated natural boundaries within mines. It then transmits alerts to the mine control center in order to expedite the dispatch of assistance in the event that something becomes hazardous. The Internet of Things will ensure that the website's numbers are always current. The LoRaWAN system is a multi-point standard and media access control (MAC) system designed for large organizations. It facilitates communication between low-power devices and semi-permanent remote connections via Internet of Things (IoT) applications. The LoRaWAN convention pertains to a LoRa-compatible low-power wide-area networking (LPWAN) system. One notable advantage of LoRaWAN over LPWAN is its enhancement of the latter with regard to battery life, adaptability, security, and utility. A high probability exists that personnel working underground will experience visual impairment and subsequently pass out. This issue was resolved by constructing an accelerometer using MEMS technology.

KEYWORDS:- Coal Mining, Safety Engineering, Internetof Things(IoT),Sensor, LoRaWAN, LPWAN.

1.INTRODUCTION

Exploring caverns can be extremely hazardous for those who perform cave operations, and the dangers increase as the cave's depth increases. The gravity of the situation intensifies in proportion to the mine's expansion. Particularly detrimental is the misuse of security estimates in the mining industry. Coal, owing to its multifaceted utility, is an indispensable resource for every nation. The production of concrete, the advancement of nuclear energy, and the lignite fuel industry are the three most significant sectors. Operating coal mineshafts presents a number of hazards, such as extreme temperatures, sticky conditions, and the possibility of hazardous chemical discharges that may imperil personnel. A negligible proportion of laborers had no intention of pursuing mining as a profession or had started their working days in coal mine shafts. As a consequence, the coal mining exchange is experiencing difficulty filling positions. Constant technological advancements contribute to the daily improvement in the safety of miners. Incidents involving underground mining persist notwithstanding the adoption of improved mine awareness systems made possible by a particular innovation. The majority of accidents and fatalities occur during coal mine excavation due to the perilous and severe working conditions. Consequently, there is a substantial demand for shaft inspection systems in coal mines.

Conducting a comprehensive physical assessment of all environmental issues that emerge within a mine could prove to be a formidable undertaking. When used appropriately in coal mine chambers, inexpensive, remotely controlled specialized tools can significantly facilitate this task. Water level, temperature, and humidity sensors that are energy-efficient and affordably priced are incorporated into the proposed device. Adhesion, temperature,

humidity, and gas concentration are all hazardous elements that necessitate continuous decomposition to ensure that individuals are promptly informed in order to safeguard mine workers and themselves. The primary objective of the proposed framework is to enhance public consciousness regarding the perilous gases present in coal mines and the safety restrictions imposed on excavators. Utilizing LoRaWAN technology, data from the miner portion is transmitted to the page via the Internet of Things. This feature enables individuals situated in different geographical areas to engage in communication. Additionally, in the event of an injury occurring within the coal mine shaft, the administrator will be expeditiously notified.

2.LITERATURE SURVEY

The developed framework employs LoRa technology, which facilitates communication among geographically separated entities within a designated frequency range. Furthermore, it expands the range of the connection by employing an additional LoRa device to transmit and receive identical data in duplicate. With Lora repeaters, the correspondence length increases. Ultimately, sensing data is conveyed to a designated area through GPRS packets, which subsequently traverse towards the cloud. Multiple monitors within the system under investigation are capable of identifying and establishing explicit safety limits for coal excavators. Within the mines, the sensors are tasked with monitoring a variety of factors, including the temperature, humidity, fire situation, depth of the minor, stress applied to the minor, quantity of hazardous gases present, and geophysical area surrounding the diggers. In addition, a crisis switch is strategically placed to activate an alarm in the exceedingly remote possibility that an anomalous event transpires within the caverns. By employing cutting-edge correspondence techniques, the proposed observation device model constructs an intelligent, cost-effective, and reliable electronic estimation system. This eliminates issues with adhesion and heating. Combining the Internet of Things (IoT) protocol with a number of other cutting-edge methods and services, such as deployable data mining, distributed capacity, and periphery warning services, is the optimal strategy for developing a compact device, according to the study's findings. Two portions comprise the developed model: one is designated for conducting a thorough inspection, while the other is utilized to track the condition of the excavator. Lora WAN applications utilize lower radio frequencies in order to establish connections with a greater number of devices across greater distances. The Lora WAN provides low-power, wide-area networking (LPWAN) by utilizing LoRa technology, which is advantageous to LPWAN. Lora WAN is distinguished by its robustness, affordability, extended range, and durability. Underground mining excavators are susceptible to malfunction for a variety of reasons. To address this apprehension, we wish to provide further clarification that should a fall occur, the system will expeditiously alert the supervisor through the LoRaWAN module. Sensors are utilized by the proposed architecture to detect chemical species such as carbon monoxide and methane in the atmosphere. Furthermore, the excavator pulse, temperature, and moisture content are all detected by the sensors. It delineates the excavation area and generates alarms in response. The proposed system comprises an assortment of monitors capable of detecting natural boundaries at different mine sites and promptly notifying the mine control room in the event of an incident in order to facilitate the implementation of the necessary measures. This Several sensors detect these lines, and the Model MCU relays this information via MQTT. Additionally, this notifies the specialists of the urgent need to vacate the vicinity. Additionally, this data may be captured and retained with the purpose of collecting and analyzing vast quantities of information to develop more effective systems that enhance efficiency and minimize workplace fatalities. Numerous sensors are utilized by the proposed method to determine a variety of health-related variables, including the pace of an excavator, the temperature and humidity levels being monitored, the exact depth area, and the global location of the digger. By the Wi-Fi security function, each of these border points will

subsequently be linked to a robust web standard. Consequently, it becomes practicable to promptly identify any diggers and conduct a thorough background investigation on all mine personnel in the event of an emergency.The novel concept proposes an Internet of Things (IoT) implementation tailored specifically for coal mine entrances. It utilizes specialized sensors and remote networks, including but not limited to 3G/WIFI, Industrial Ethernet, and remote sensor networks, in order to generate novel indicators.

3.PROPOSED SYSTEM

This testing framework comprises an LCD (liquid crystal display), numerous sensors, PIC boards, LORA modules, and USB interface boards, among a few other minuscule electronic components. This section provides a comprehensive overview of each segment, accompanied by beneficial recommendations for each.

The method comprises two distinct components, namely alerting and monitoring. The verifying section is comprised of two partitions: the receiving portion and the transmitting portion.

Four sensors were utilized on the signal-sending end to denote the distinct boundaries of the viewing area. Actual limits are used by sensors to determine what is occurring. The micro-regulator is linked to the LCD and LORA transmitters via the sensors. POT is utilized to adjust the luminance of the LCD. By utilizing a LORA radio and receiver, the operator of the excavator and the operator of the control center are able to remotely communicate. Theoretical range of two kilometers is possessed by this.

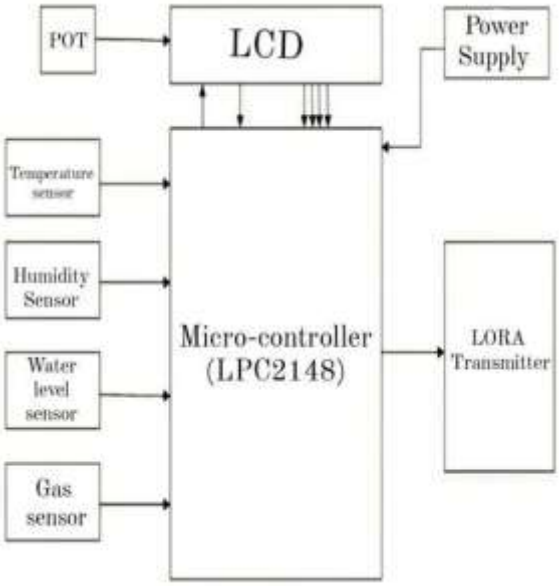


Fig 1: Monitoring section - Transmitter part

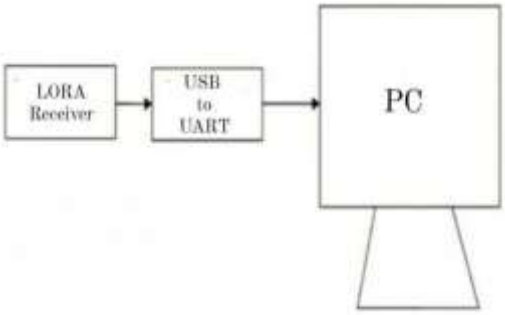


Fig 2: Monitoring section - Receiving part

During this step, the computer is told how strong each sensor is. After getting these values from the CPU, the LORA transmitter and LCD show the right features. This information is sent to the LORA receiver from the LORA emitter. To send this info, the LORA receiver talks to the computer through USB/UART. The Internet of Things makes sure that data sent to the website is sent reliably. The ongoing design of the Internet of Things makes it possible to watch and control physical objects from afar. To show data online, the framework uses an internet of things (IoT) module that works with GPRS. Another way to get the info is to look at the IP address of the authorized user's phone.

Fig 3: Alerting section

The warning feature will work if an Arduino Uno, a GSM module, and a MEMS gyroscope sensor

are built into the band of the digger. There will be a warning sent by the excavator if any of the following things happen.

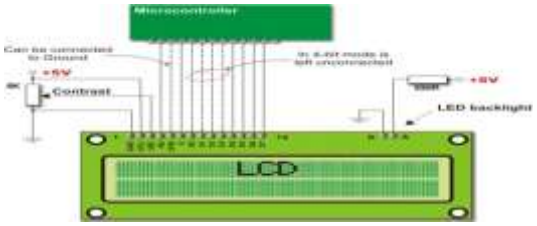
- But what happens if an accelerometer picks up a fall?
- If the temperature inside the digger goes above a certain level.
- The manager in the control room will use the GSM module to send the alarm.

MICROCONTROLLER

An LPC2148 microprocessor is part of the suggested design. Each sensor is linked to the module by a computer.

LCD

The numbers that were found are shown on an LCD.



TEMPRATURE SENSOR

The LM35 temperature sensors are used in the suggested device to find out how hot it is inside coal mines.

HUMIDITY SENSOR

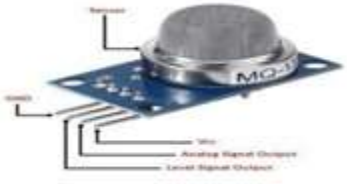
The HSM-20G moisture sensor is used by the suggested system to measure how much sticking matter there is in the coal mineshaft.

WATER LEVEL SENSOR

Magnetic reeds are used in the suggested setup. The water level in the mine is pretty high at the top of the reed. At a depth of one meter, the water level is too low.

GAS SENSOR

When the amounts of dangerous gases change, MQ4 can pick it up.



LORAWAN

A business can learn how to connect its gadgets and set up its network with LoRaWAN. The LoRa physical layer keeps a link for long-distance transmission open. The mine control center and an internal LORA generator could talk to each other through a LORA receiver.

BODY TEMPERATURE SENSOR

It checks the core temperature of a miner like any other digital temperature sensor.

GSM MODULE

The mine boss and the digger can talk to each other because of a GSM module, which is a chip or circuit.

MEMS ACCELEROMETER

Microelectromechanical system (MEMS) accelerometers are sensitive, short-range tools that engineers use to find structures and miner falls.

ARDUINO NANO

The open-source microcontroller board called Arduino Nano can be designed to do a lot of different electronic tasks. Its main features are that it is simple, flexible, and cheap. It acts as a link between all the programs in the warning part.

4.EXPECTED RESULTS

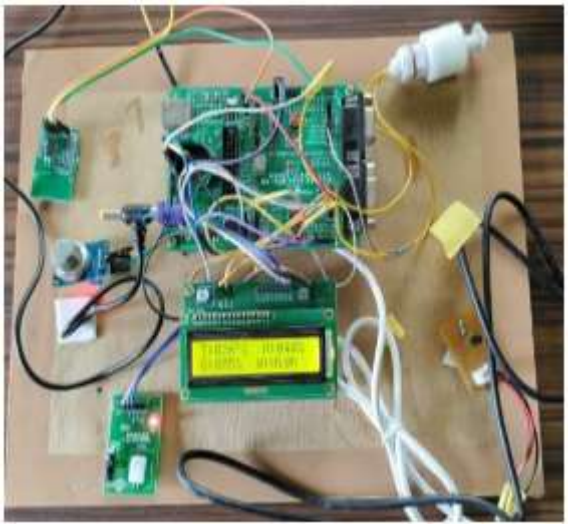


Fig 4.1: Transmitting part - Sensors and LORA transmitted interfaced with the micro-controller

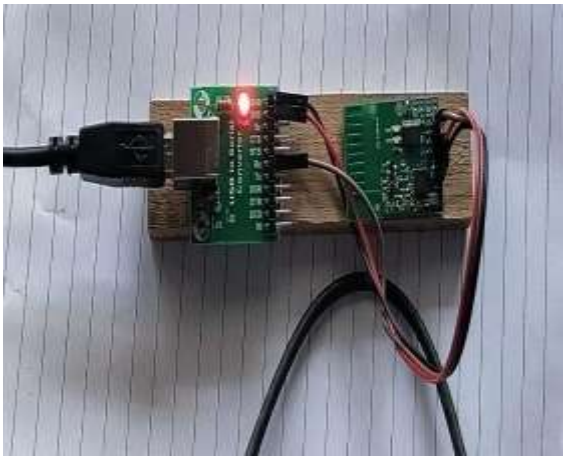


Fig 4.2: Receiving part : Lora receiver

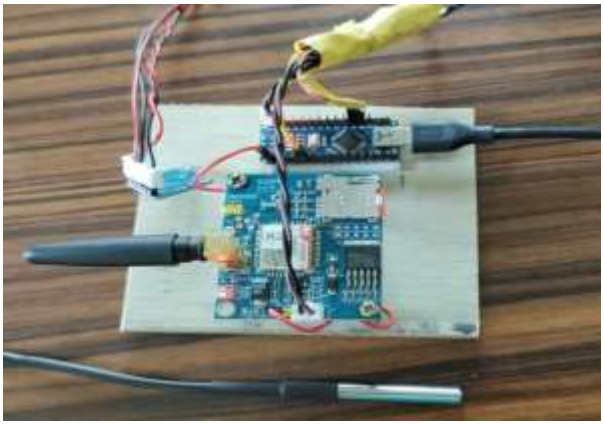
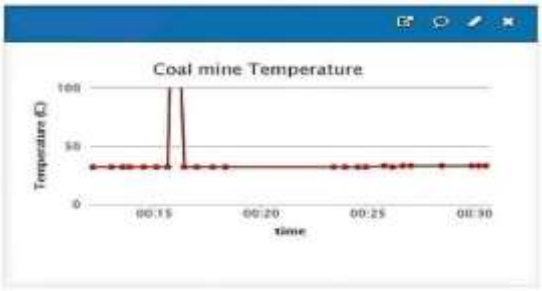


Fig 4.3: Alerting section

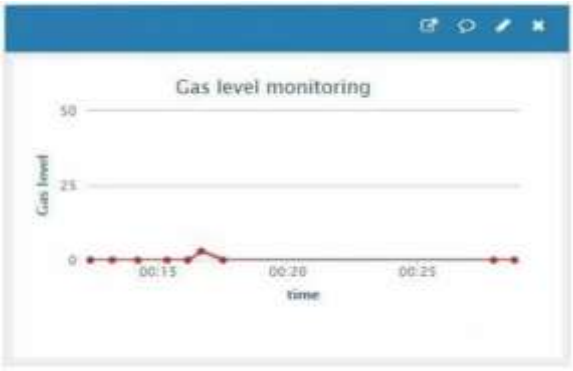
Fig 4.4: Values as recorded in PC

5.GRAPHS



Graph 1: Temperature v/s Time

Graph 2: Humidity v/s Time



Graph 3: Gas level v/s Time

6.CONCLUSION

This study shows the best way for complicated experts and diggers to carry out life-saving treatments. The general-purpose sensors that are attached to the structure make it stand out. It is always possible for the system to work better by adding small parts. By sharing data and sending it from the computer, networks of detectors are always getting artifacts out of underground mines. The safety of the underground diggers is very important, so this is a good idea. Someone in the room needs to let the boss know about any problems that happen. The important time values are shown in a way that is clear and effective. The ideas behind the Internet of Things made it easier to make tools that use less energy. After reading this study, more people will be able to use apps for the Internet of Things.

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