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Real-Time IoT Monitoring for Coal Mine Hazard Prevention

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ABSTRACT: Heat waves, methane gas leaks, and rising water levels are some of the main dangers that might occur underground. This highlights the critical nature of safety measures taken in the mining industry. It is critical to establish reliable methods of communication and emergency protocols to guarantee the safety of staff. A excellent approach to accomplish this is to provide staff workers with a way to contact security in case of an emergency. Dependable means of communication between fixed ground devices and mine personnel are of the utmost importance. It would be imperative that any issues with the network be resolved promptly. To address the issue of mine safety, one potential solution is to implement an affordable wireless monitoring system that is compatible with Zigbee and the Internet of Things. Included in this one is an early warning system. Mining operations are now safer and wiser thanks to this system, which allows for continuous worker location tracking.

Keywords: *PIC Microcontroller ,wifi / GSM moule ,zigbee ,temperature sensor , gas sensor , water level sensor.*

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1. INTRODUCTION

Explosions in the mining industry are responsible for the deaths of approximately 12,000 people every year, according to estimates that were made very recently. As a result of this, many people consider it to be one of the most dangerous occupational fields in the world. Due to the fact that coal is a limited resource that carries a high monetary value, mining accidents are a cause for significant concern for the industry. Miners have been tragically losing their lives in hazardous environments as a result of electrical equipment that is both outdated and prone to malfunctioning. The careless disposal of hazardous materials and the lax enforcement of regulations have both contributed to the rise of concerns regarding the safety of miners. It is imperative that we put the well-being of mine workers first. The implementation of innovative solutions as soon as possible is absolutely necessary in order to lessen the likelihood of incidents and save lives. As a result of these issues, it became abundantly clear that a comprehensive plan was absolutely necessary in order to put an end to coal mining for good. The effectiveness of monitoring systems can be improved by utilizing sensors that are up to date. It is possible to conduct a more in-depth analysis of significant operational scenarios by applying the Thinger method

to the system's aggregated data. As a result of advancements in technology, individuals now have the ability to respond to threats in both automated and manual modes, which provides them with a great deal of freedom and flexibility. For the purpose of making mines safer all over the world, this tool has been an extremely important contributor. The management will be more effective, the operations will be safer, and the risks will have less of an impact. After we became aware of the problems, we made certain that additional precautions were taken to ensure the safety of the situation.

2. LITERATURE SURVEY

The concept of monitoring coal sites through the use of Bluetooth technology was proposed by Yongping Wu and Guo Feng. As part of the development of a short-range integrated wireless communication standard that is based on Bluetooth, an operating system and a standardized, low-power wireless interface are currently being developed. We are going to accomplish this objective by putting a plan into action. By reading this in-depth article, you will gain a comprehensive understanding of Bluetooth's history, development, and features. Through the utilization of wireless connection protocols that are founded on the Bluetooth Host Controller Interface (HCI), you can reduce the likelihood of encountering issues that are associated with Bluetooth updates.Sun, who is currently based in Zhenzhen, is of the opinion that a DCS system might be useful for monitoring coal mines. Because of the RS485 interface, it is possible to communicate in both directions with a large number of nodes connected to the network. Utilization of this monitoring device is possible for any microcontroller that is capable of managing the standard 8-bit architecture. Among the many useful characteristics that it possesses, its low cost and straightforward circuit design stand out as particularly noteworthy. It is possible that the master-slave architecture will cause the network's reliability to increase or decrease. Both the maximum data transmission distance and the real-time performance cap are capped at their respective maximums.

According to Jingjiang Song and Yingli Zhu, wireless networks have the potential to make coal mines safer places for workers to perform their jobs. The nRF241 and the MSP430F were utilized in the construction of the devices that are responsible for controlling the security of the coal mines in that region. The experts in system monitoring are tasked with the responsibility of performing routine checks on the levels of humidity and temperature that are found below the surface of the mine. After the data collection process has been completed, the microcontroller will send the data to a wireless communication module so that it can be transmitted. The task of data collection is carried out by a tracking facility that is situated away from the main location. The fact that the technology is used in coal bunkers demonstrates how susceptible it is to structural flaws and natural disasters. It is clear that the current communication system is dysfunctional and will soon be forgotten. Both the construction of the system and its maintenance are made more difficult by the harsh conditions that exist within the mine. Whatever the case may be, coal

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mines are notorious for their high levels of noise, and miners who work in isolated locations require a means of conveying vital information to one another.

3.PROPOSED SYSTEM

Block Diagram Description:

The monitoring system is made up of a multitude of relatively small electronic components. This category includes a wide variety of components, including Xbee and Zigbee USB interface modules, PIC boards, sensors, LCDs, and further components. There is a significant amount of space in the document that is dedicated to describing the capabilities of each component.

In the absence of temperature sensors, gas sensor modules, water level monitors, and valves, the safety systems associated with coal mines would be severely compromised. Because the controller is responsible for ensuring that everything is in proper alignment, the system is able to perform its functions. The first step is to sign up for an account on the platform known as ThingSpeak. For the system to be able to function properly, the control and monitoring components are absolutely necessary. The monitoring system is constantly connected to the sensors and receives data from them. To determine the quality of the air in coal mines, gas monitors are utilized. In the event that the gas level gets higher than a predetermined threshold, a siren will sound to alert the workers. In situations where there are no issues with the transfer of data to the cloud, the process of analyzing sensor readings becomes significantly simpler. The data control devices used in coal mines are able to obtain readings of the water level and temperature through the use of Zigbee connections. From the right, you can see the block diagram of the system that you have selected.

Control Unit:

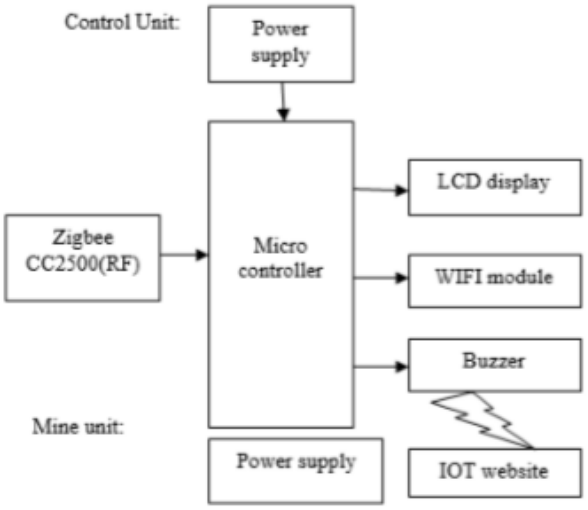

Fig.1.BlockDiagram of the System

This tracking system is made up of Xbee modules, Zigbee USB interface boards, liquid crystal displays (LCDs), sensors, PIC boards, and other very small electrical parts.

1-PIC 18F4520

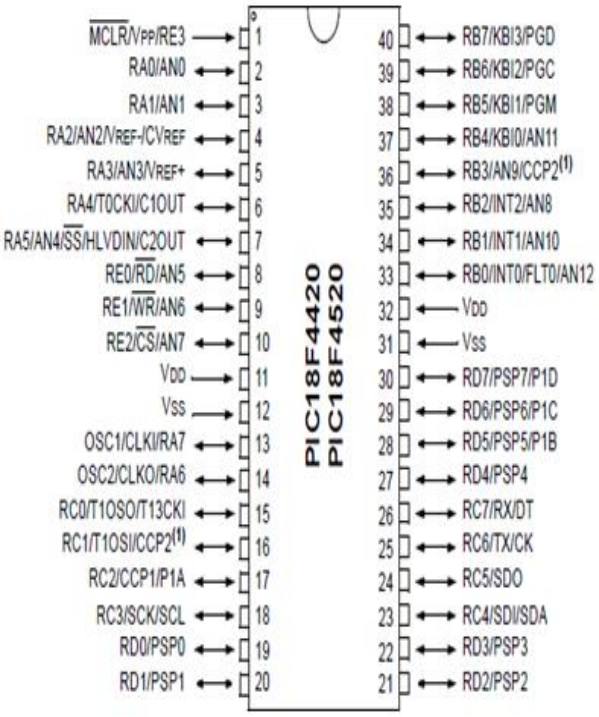

Fig.2.Pin Diagram of PIC18F4520

Operating frequency 20 MHz 40 pins

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2-ZIGBEE

There are a number of low-power wireless transceivers that operate on the 2.4 GHz band, and the CC2500 is one of them. This particular circuit is suitable for use with both ISM and SRD operations within the frequency range of 2400–2483.5 MHz. The radio frequency (RF) transceiver incorporates a baseband modem that can be adjusted. It is possible to configure the modem to operate at a data rate of 500 k Baud, which is just one of its many functions.

Fig-3 Zigbee

3-LM35TEMPERATURESENSOR

Creating a connection between it and a microprocessor is one potential solution. There is a requirement for the utilization of a multimeter in order to take measurements at a rate of 10 millivolts per hundred degrees. At a temperature of thirty degrees Celsius, the linear scale displays a reading of three hundred millivolts. The LM35 series of integrated circuit temperature sensors are capable of providing accurate measurements of the voltage output, which is directly proportional to temperature readings in Celsius. In comparison to linear temperature sensors that are based on Kelvin, the LM35 is a significant advancement because of its low power consumption and its capacity to calibrate to 25 degrees Celsius without any adjustments. There is a significant advantage to this.

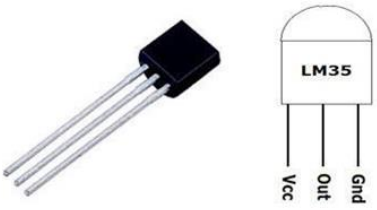

Fig.4-.LM35TemperatureSensor 4 -16*2 LCD DISPLAY

Electronic visual components can be found in a wide variety of applications, including screens made of liquid crystal display technology. It is essential to have a 16x2 pixel LCD screen because there are a great number of additional circuits and devices. It is impossible to compare either of these lights to other multi-segment LEDs, particularly those with seven segments. An in-depth description of the events that took place is presented down below. Using liquid crystal displays (LCDs) rather than the seven components has a number of advantages that should not be overlooked. Some of these benefits include a decrease in price, an easier installation process, and an increase in the capacity to display a greater number of data, animations, and characters. Sixteen characters can be displayed across the two rows of a 16x2 liquid crystal display (LCD). It is possible to accomplish this due to the fact that the LCD has an aspect ratio of 16:2. As a consequence of this restriction, the maximum number of characters that could be displayed was sixteen. The characters are displayed on a liquid crystal display (LCD) that has a pixel matrix that is 5 by 7. The orders are displayed on the other side of the LCD, while the data is displayed on the other side.

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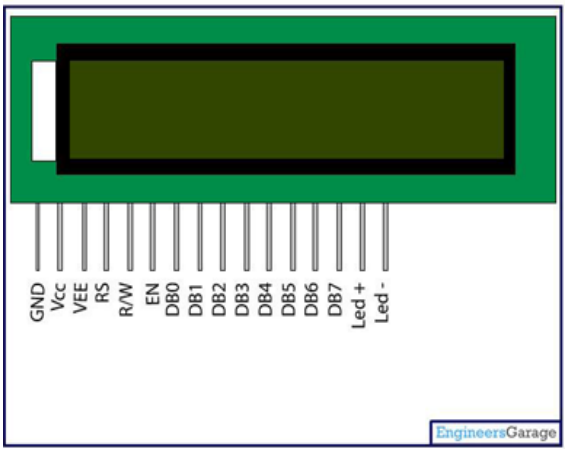

Fig.5-16*2LcdDisplay 5 -GSM MODULE

A microcontroller, desktop computer, or laptop unit can be connected to a GSM receiver through the use of an RS232 cable, a USB to Serial adapter, or an RS232 to TTL converter. You might find that one of these options is more suitable for you. In order for the SIM800 28 modem to be connected, it is necessary to have an adapter that uses the RS232 protocol rather than the USB protocol. Launching Device Manager and locating the COMinterface of the USB to Serial Adapter is the second step in the process. When connecting to the modem's COM port with Putty or any other terminal program, you should always use a baud rate of 9600. A serial connection makes it easier for microcontrollers and personal computers to communicate with one another, which in turn makes it simpler for AT commands to be sent and received. Through this connection, you are also able to send and receive automated telephone commands. Following the receipt of AT commands, the SIM800 modem is able to make a response that is either "OK" or a code such as "AT^r."

6-PIEZOELECTRICBUZZER

Features

0 sealed: yes

0operatingpower:3-6VDC/ 25mA

0 extremely compact, ultrathin construction

0 no electrical noise

0low current consumption yet high sound pressure level

Fig.6 Piezoelectric Buzzer

7 -MQ- GAS SENSOR

It is now possible to acquire a gas detector that makes use of a MQ sensor. It is possible to achieve this capability through the combination of digital and analog interfaces. In the event that the module is supplied with 5V, the power LED will illuminate and become active. In the event that gas detection is not present, the output LED will remain off, and the digital output input will return to its default state. It is absolutely necessary to have all of these appliances preheated before using them. It is necessary to make adjustments to the variable in order to ensure that the output is in accordance with the changes that were seen in the digital pin after the gas sensor was submerged in the substance that was being investigated. In the event that the gas concentration threshold is not met, the digital pin will display a high voltage of 5V. However, what happens when the threshold is not met? Through the use of this symbol, one hundredth of a volt is represented. There won't be any

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differences in the output of the analog interface. For optimal performance, it is necessary to connect the gas concentration sensor to a central processing unit (CPU) that is capable of handling analog inputs ranging from 0 V to 5 V. The sensitivity of the sensor to different gas concentrations can be determined by making adjustments to these settings.

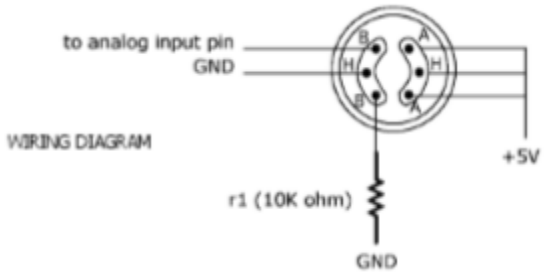

Fig.7 DiagramOfGasSensor 8 - WATER LEVEL SENSOR

Fig.8 -WaterLevel Sensor

By using the float switch, you will be able to determine the depth of something that is submerged in the water. This device has the capability to activate a variety of features, including pumps, warning lights, and indicators, among others. Using a float valve, you are able to determine the amount of liquid that is contained within a container. You won't believe how impressive it is that the switch can simultaneously activate a pump, an alarm, and a light all at the same time. Gardening, evaporator coils, condensation lines, evaporator tanks, pumps, ponds, basement alarms, boats, pressure washers, carpet cleaners, fluid control, ice makers, coffee makers, and countless other uses are just a few examples of the diverse array of possible applications. There are countless other uses as well. It is possible to use it in a variety of ways both in the automobile and at home. It is possible that the float could cycle between open and closed states as an alternative to remaining in a single state.

ADVANTAGES:

- Cost is less
- Provide wireless connection security
- Improved services in coal mine.

AP PLICATIONS

- For Underground Mine System

4. RESULT:

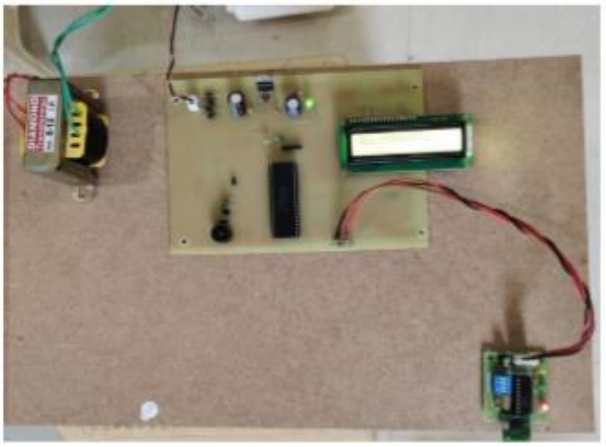

Fig.9 Controlunit

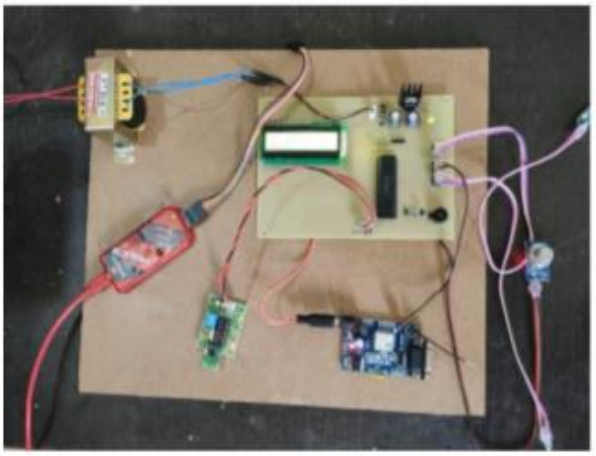

Fig.10 Mineunit

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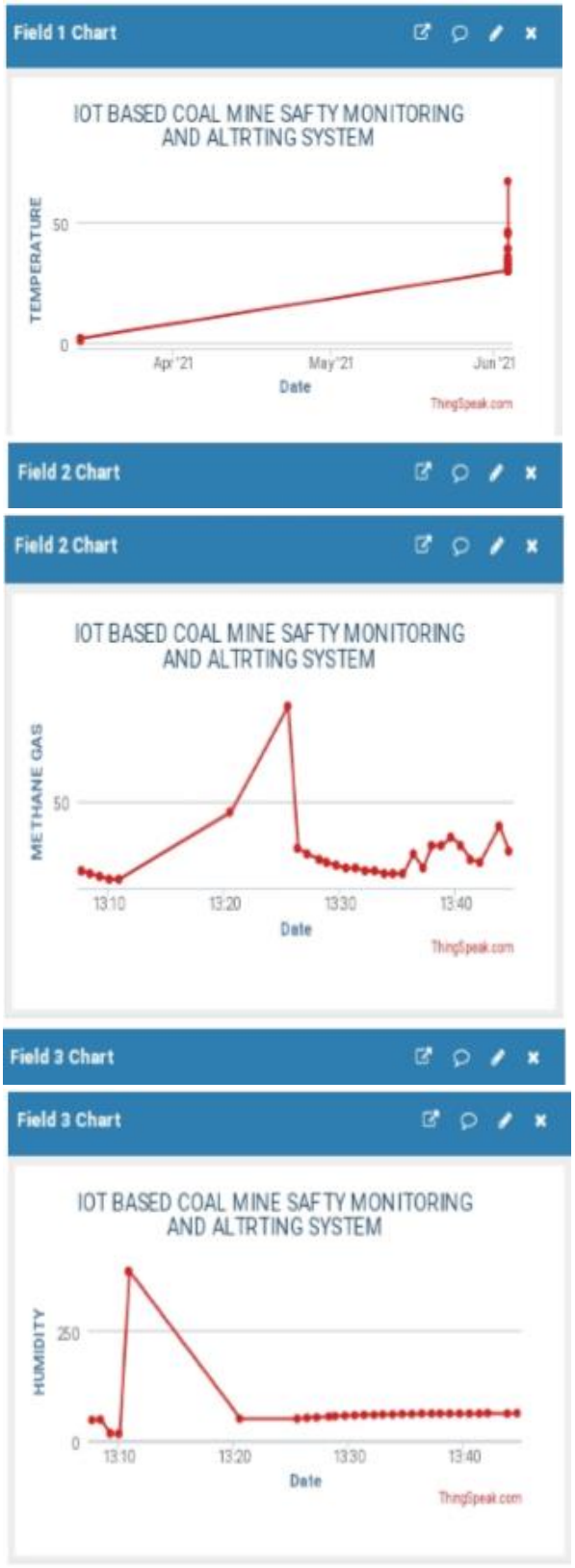

Fig.11 Output on IOT website

The sensitivity of the proposed system to values that are higher than the threshold is depicted in the graph that can be found below. This graph serves to illustrate this point. An alert will be displayed on the LCD panel in the event that the humidity level exceeds 500 parts per million, the gas concentration exceeds 250 parts per million, or the temperature exceeds 50 parts per million. It is only going to be one person who is informed. Because of the Internet of Things (IoT), it is possible to find solutions to these issues by connecting to remote locations.

5. CONCLUSION

The installation of an IoT-based alarm and monitoring system can ensure the safety of modern coal miners. In the event that you come across any structural problems, potential fire hazards, or gas leaks, it is your immediate responsibility to report them to the appropriate authorities. Enhanced worker safety can be achieved through the utilization of automated alerts and networked sensors in a number of ways. Two of these ways include the elimination of human inspectors and the reduction of response times in emergency situations. Keeping a close eye on its surroundings is accomplished through the utilization of sophisticated data analysis. By doing so, you will be able to anticipate problems and make preparations for them in advance by gaining a better understanding of the potential issues that may arise. This technology improves the efficiency of operations, the intelligence of mining, and the safety of the mining process. Because of this, it is both contemporary and affordable at the same time.

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