IOT Based Coal Mine Safety Monitoring and Control Automation

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***Abstract*— Miners' safety is currently a big concern. Miners' health and lives are jeopardised by a number of serious difficulties, including not just the working environment, but also its consequences. Mining processes emit hazardous and toxic fumes, putting the lives of the people involved in the process in jeopardized. The mining industry is under a lot of strain as a result of this. An new method is necessary to boost mining output and lower costs while still taking worker safety into account. The health of miners is jeopardized by the hazardous gases that are frequently emitted in underground mines. Human senses are unable to detect these gases. The existence of poisonous gases in crucial places and their consequences on miners are investigated in this study. A real-time monitoring system is being created using a wireless sensor network with many sensors. This device keeps track of temperature, humidity, and a variety of harmful substances in the environment. This device also offers an early warning, which will aid the miners inside the mine in saving their lives before any fatalities occur. The system establishes a wireless sensor network using Things talk technology.**

Keywords—ThingSpeak, LDR, MQ series.

I INTRODUCTION

Now a days, safety of coal mine accidents has created serious issues and large economic losses. Henceforth, it is inevitable for worldwide industry of mining to enhance efficiency of operation and also to improvise global safety of mining. This project advises a concept in order to achieve monitoring remotely and automation over control of subversive physical sensor related devices utilized in mining. For implementation of this, an Open Service Gateway initiative (OSGi)-related uniform device shall be employed in WSN. For high efficiency of system proposed, a prototype is established and the outputs are analyzed. Underground mining of coal encompasses a larger risk than an open pit related mining is due to several complications of aeration as well as the latent for breakdown. The recent mines frequently contrivance many safety actions, edification and tutoring for workforces, well-being and protection excellence, which lead the way to notable fluctuations and progresses and extension of protection level twain in open and mining in subversive. In India a Coal is always been an important primary energy resource, which has been glaringly conferred to the nation's industrial progress. Approximately 75% of power production is influenced by it thus, Coal's importance in the energy sector is critical. Nonetheless the mass production escorts through the further bi-products, which evidences to remain a latent menace to the circumstances and the people accompanying by means of it. With respect to that the contemporary work is unfeigned venture in examining the severity and plotting a real-time monitoring of the system for the detection via the IOT based automation.

II LITERATURE SURVEY

Boddapati Venkata Sai Phani Gopal "Design of IOT Based Coal Mine Safety System using NodeMCU" In this article, a coal mining safety system is created using a Thinger Io platform as a data transmission channel [1]. D. Prabhu et al. "IOT Based Coal Mining Safety for Workers using Arduino", Proposed a system where Gas sensor modules are used in the coal mine safety system, fire sensor, humidity/temperature sensor, led and buzzer. Integration of all the sensor to Arduino Uno using IOT [2]. Shauohang Yu, Xiang Rong et al. "Review of fault diagnosis and early warning of coal mine ventilator", from this paper discussion and examining of the fault of various type of coal mine ventilator, analysation of the causes of failure from different angles and summarization of common consequences of the ventilator failure [3]. P. Koteshwara Rao et al. "Design and Implementation of Coal Mine Safety Using IOT", design of Wireless Sensor Network (WSN) with the aid of Raspberry pi controller, system controlling of ventilation demand depending upon the atmospheric condition to the mine workers within the mining area [4]. Keerthana E et al. "A Smart Security System with Monitoring in Mines" in this paper they proposed screening of security framework to the workers and offering security to the workers [5]. Bonala Ashwini et al. "IOT Based Coal Mine Safety Monitoring and Control Automation" The IoT security framework is proposed as a replacement for the current underground mining system in this study [6]. Joshi Gunjan Shailesh "Monitoring of Toxic gases and land slide prevention using IoT", The implementation of a mine monitoring system for the purpose of safety helped to overcome the urgent condition of providing enough oxygen through ventilation [7]. Borhade Ganesh Lahanu et al. "Mine safety system using wireless sensor network", On the basis of this study, design work was carried out [8]. S. R. Deokar et al. "Coal mine safety monitoring and alerting system", By constructing a real-time monitoring system, this article provides a clear and point-to-point perspective of the underground mine [9]. N. Balaji et al. "An Intelligence Device for Hazardous Event Detection for Mining Industry – smart helmet". The development of acute mining head protectors is derived from this work in order to recognise three types of hazardous situations, such as the maximum level

of hazardous gases, the removal of the excavator cap, and accidents [10]. Dr.Nagaraj Bhat et al. “An Internet of Things to Optimize Human Task Using Artificial Intelligence” from this paper the study of artificial intelligence and IOT technology is done [11].

III SYSTEM REQUIREMENT SPECIFICATION

A. RASPBERRY PI

The third cohort model is the Raspberry Pi-3 Model B+. This influential credit-card sized single board processer outperforms the original Raspberry-Pi Model B+ and Raspberry Pi-2 Model B in several bids. The Raspberry Pi-3 Model B, while preserving the standard board setup, provides you with a more powerful computer that is 10 times quicker than the previous iteration. Raspberry Pi also includes wireless Bluetooth and LAN connectivity, giving it the ideal platform for creating powerful connected designs.

B. LDR SENSOR

Light Dependent Resistors are created from an unprotected semiconductor material such as cadmium sulphide that alters its electrical resistance from thousands of Ohms in the dark to only a few hundred Ohms when light cascades on it, forming quantifiable hole- electron pairs. This obvious impact is an increase in conductivity with a decrease in resistance for an increase in brightness. The photo-resistive cells have a long retort time, which necessitates a response time of several seconds and a change in light intensity.

C. TEMPERATURE AND HUMIDITY SENSOR(DHT11)

It is one among DHTXX series of Humidity sensors. The other sensors in this series would be DHT22. Both these sensors are considered as Relative Humidity Sensor. Because, they will check humidity and temperature. These sensors are cheap, small and slow yet they are very common amongst hobbyists.

D. MQ2 GAS SENSOR

This sensor is an electronic sensor and it is used to sense the multiple gas concentration in the air such as’LPG, propane, methane, hydrogen, alcohol, smoke and carbon monoxide.’ This sensor is also called chemiresistor. When it comes in contact with the gases the detection of gases is done by the change in the value of resistance and also it is a metal oxide semiconductor type gas sensor. A voltage divider network present in the sensor measures the concentrations of gases in the gas. It works on 5V DC Voltage and it is able to detect gases in the concentration of range 200 to 10000ppm.

E. LED (LIGHT EMITTING DIODE)

They are like tiny light-bulbs with low energy consumption, small in size, rapid switching capability and their long lifespan makes them ideal for mobile devices and other low-power applications.

F. BUZZER

It's a system that combines a DC power source with electronic transducers. They're typically found in timers, alarm clocks, electronic toys, and a variety of other goods that generate sound. Buzzers are of two types which are active buzzer and passive buzzer. Sound is generated only when the buzzer is electrified. It spawns sound at a single frequency. It operates at a noticeable frequency of 2 KHz.

G. PYTHON

Python is a high-level, general-purpose programming language with a transcriber. Python's design philosophy, founded by Guido von Rossum and originally released in 1991, emphasises code readability through the use of notable whitespace. This language takes an object-oriented approach to programming, making it easier for programmers to produce understandable code.

H. IOT

The Internet of Things (IoT) is a type of network in which goods are connected to the Internet using radio frequency identification (RFID), infrared sensors, global positioning systems (GPS), laser scanners, and other information sensing devices in accordance with agreed-upon protocols for information exchange and communication, resulting in intelligent identification, location, tracking, supervising, and management.

IV SYSTEM DESIGN

The block consists of sensors, camera module and power supply connected to raspberry pi 3 b+ model which has in-built Wi-Fi module in it. The sensors such as DHT11, MQ2, LDR and Ultrasonic are used here. Ultrasonic is used to recognize the obstacle which are present in mining area to help the miners to move safely. The parameters like toxic gases, hazardous gases example methane, propane, carbon dioxide are sensed by the MQ2 sensor and DHT11 sensor gives the data of temperature and humidity to withstand or bear the atmosphere by the miners in the mining area. LDR sensor gives the data about the light present in the mining area, the records will be continuously updated to the cloud and also sent to the authority if the sensors cross its threshold value the buzzer will be on and also a short video is sent to the authority mail box by using camera module for recording. The motor driver is used for the vehicle movement front, back, right and left using the Bluetooth protocol, for higher range or distance we can use ZigBee or LoRa protocols for wireless communication the speed of the vehicle will be constant, the motor driver needs continuous power supply for the movement of the vehicle.

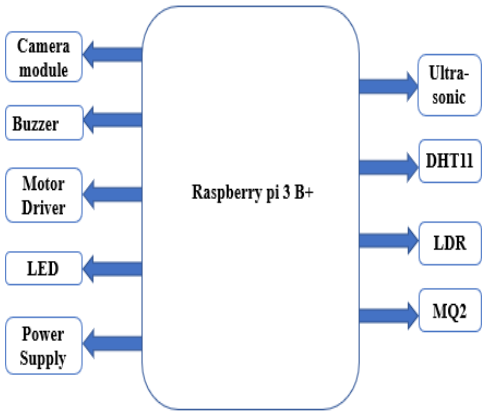

Figure 1: Block Diagram of IOT Based Coal Mine Safety and Control Automation

V METHODOLOGY

It is used as the major controller unit in the system to control all the hardware components system is interface with the software using python coding language. The MQ2 gas sensor, DHT11 sensor, LDR sensor, Ultrasonic sensor, camera module and motor driver unit all are connected to the raspberry pi unit. Initially when the system is turned 'ON' raspberry pi starts running the code and check for the hardware components connected to the system and all components starts their respective functions.

The automated vehicle starts moving in the mining area at the same time the gas sensor detects the dangerous gas content in the mining atmosphere. LDR detects the darkness in the mining area, camera is turned on and every time the ultrasonic sensor detects any obstacles the camera takes a video of that area and sends to main unit

All the data that are sensed are send to the main unit are directly uploaded to the cloud using IOT platform for every 10 seconds interval. The vehicle will be continuously roaming around the mining area sensing the surrounding atmosphere with the help of the sensors mounted on the vehicle and process of uploading the collected data to the cloud continues.

There are some threshold values set in the code, every time the data is received from the sensors the main unit will compare the data with threshold values if the received value is exceeds the threshold value then an emergency message is sent using Wi-Fi module to the main authority with the exceeded values, at the same time to alert the mining workers to move for a safe zone. Alarm buzzer will starts ringing to alert the workers that the mining area is in danger, by this we can prevent the worker involving in any of the dangerous accidents.

Since every data has been uploaded to the cloud using IOT platform whenever any accident occurs the main authority can analyze the cause for the accident by checking the variations in the data and the reason for the accident. So, then they can take precautionary measures to avoid the same type of accident to reduce the losses caused by the accident.

VI IMPLEMENTATION

Initially, Raspberry pi model needs an OS to be installed this can be achieved by downloading the OS file from the Raspberry pi website the OS we are using here is Raspbian stack it can be installed using the SD card.

Here we can see the sensors like DHT11, MQ2, Ultrasonic and LDR sensors are internally connected to the Raspberry Pi 3 B+ model to sense the data like temperature, Humidity, Gas, Light and Obstacle which is continuously sent to the cloud using Wi-fi model, we are using Thingspeak platform to observe the output from the sensors, Camera module gives the short video of mining area if any obstacle or accident occurs the video is converted from H264 to MP4 and sent to the authority mail.

We are using motor driver for the movement of the vehicle using the Bluetooth protocol APK, For the forward movement of the vehicle we are assigning the key (F), similarly for the backward movement of the vehicle we are assigning the key (B), For the right and left movement the keys are (R) and (L), to stop the vehicle we are assigning the key (S).

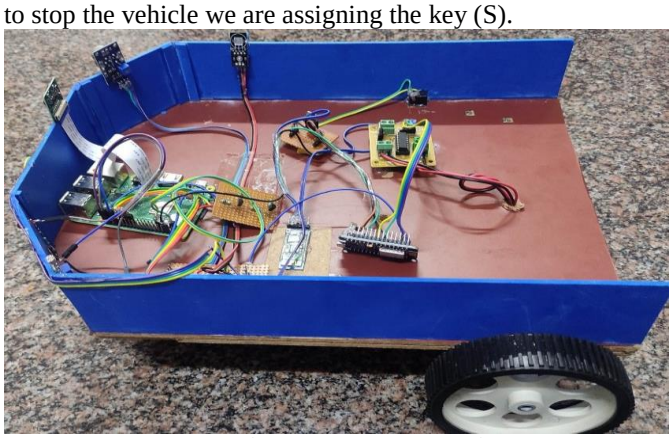

Figure 2: Implementation of IOT Based Coal Mine Safety and Control Automation model

VII RESULTS

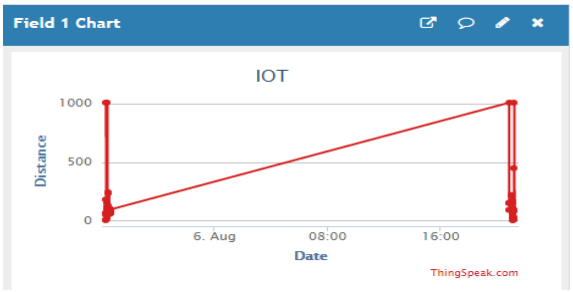

Figure 3: Output of Distance of the obstacle

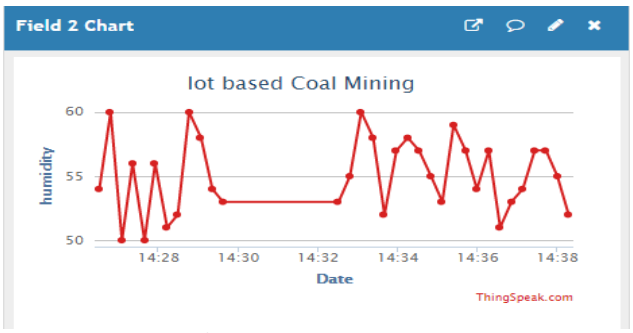

Figure 4: Output of Humidity sensed by the DHT11 sensor

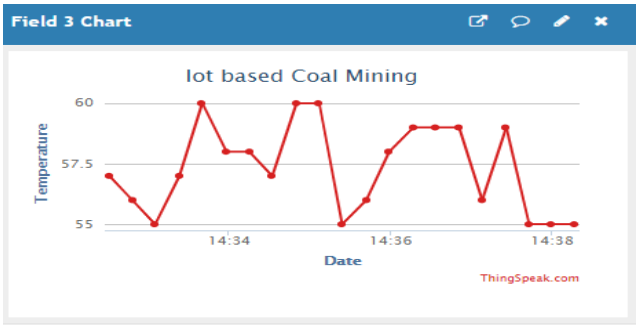

Figure 5: Output of Temperature sensed by the DHT11 sensor

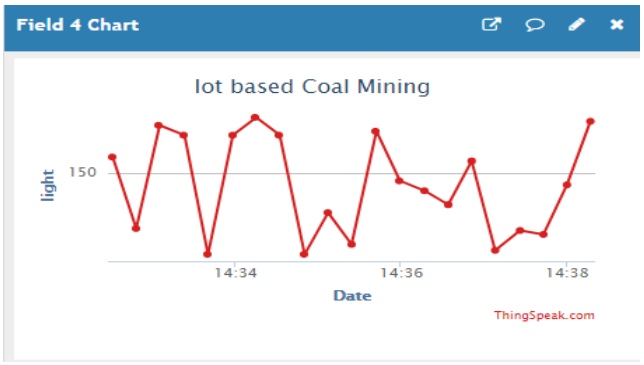

Figure 6: Output of Light from the LDR sensor

Figure 3, 4, 5 and 6 depicts the outputs of all actuators connected to our system in order to learn the on time, supervise of hazardous smokes and further constraints contemporary in the mining area have been scrutinized using WSN.

VIII CONCLUSION

Te proposed system gives indistinct and more point-to-point awareness of the subversive mine a real time monitoring system is developed when a sensor value crosses the threshold level alarm triggers and alerts the miners present in the mining area. It will be helpful to all miners to save their lives present inside the mining area before any accident occurs.

IX FUTURE SCOPE

Coal mining safety monitoring and control using IoT Additional safety hazards, including as dust, landslides, fire, and vibration, can be addressed with automation. Additional sensors can be used to address these safety concerns. Water leaks, subsidence, and other mining operations can all be monitored. By making the system functional, all critical data may be delivered to the authorities, whereas cable connection may become an impediment. Because the method allows for easy access, the administrated can be controlled from the outside. When other mechanized vehicles are utilized for the other topographic zones, this framework can be applied at a high level.

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