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RF and IOT Based Coal Mine Safety Monitoring System Using AI and ML Algorithms

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Abstract—Coal mining is one of the most hazardous activities in the world. They frequently encountered unexpected emer-gencies. In general, there are two approaches to mining coal: surface mining and deep underground mining. There are more risks associated with underground coal mining because of various aeration-related issues and breakdown potential, surface mining poses fewer serious risks than underground mining. Millions of Indians are impacted by the coal industry, either directly or indirectly, according to the National Foundation of India. Many people lost their lives when mining was being done. In order to minimize these problems, we introduced a project by using Arduino Uno, ESP 01 and ML, we collected data by using variety of sensors. The DHT11 (digital temperature humidity sensor) measures both temperature; the MQ135 sensor detects gas concentrations with an accuracy of 85detects water. Using all of these sensors, we gather data from the environment and provide it to the server room by using RF module and it shows the output with help of display and AT89S52 controller. On the other hand, we used AIand ML algorithms to construct a dataset. We may quickly and readily discover the dangerous threats before the problem arises by using these predictive models.

Index Terms—Prediction model, Arduino UNO, ESP 01, RF Module, DHT 11 Sensor, MQ135 Sensor, Water Level Sensor, AT89S52 Controller, AI, CNN.

I. Introduction

Mining industry is one of the most prominent earning sources of many different countries, since the growth of the mining industries often regulate the resource acquisition potential and economic growth of the countries. Based on different characteristics of the mining industries, this industry might be categorized under geophysical industries or chemical industries. In India, we have 493 coalmines present. Coal is the most vital asset in the world. These petroleum products are natural assets of the earth which help create power and for some, purposes. Coal is a non-sustainable source which can't be supplanted commonly by humans, there are numerous coalmine mischance's happening in the mines, and the diggers are putting their lives in hazard by working in the coal mines. A Security is the standout amongst the most critical thing in safe production. This system controls the ventilation demand to mine workers depending upon present climate conditions within the mine field. If any kind of explosion occurs, the wired network will get damaged and it is very difficult to replace it. It will take high time consumption to repair those networks [1]. In order to overcome this, the coal mine safety measurement system using Internet of Things was designed and implemented. The device entails creating a Wireless Sensor Network (WSN) using an Arduino UNO controller to track the underground mine's condition. This improves production safety control and reduces coal mine accidents. IoT is a trend-setting innovation in which all the data from sensors is stored in the cloud where it can be easily accessed from the cloud. The coal mine safety which can monitor the various gas and temperature parameters and take action with the help of multimodal logistic regression algorithm applied on the real time collected data on cloud [2]. The machine learning model will take automatic action based on our dataset which will keep on growing as time passes and this model will keep on becoming more accurate.

today working conditions for the worker those who are working in mines. The mines were considered into two kinds where they are open ground mine and underground mine. Traditional coal mine monitoring systems tend to be wired network systems, which play an important role in coal mine

II. Literature Survey

The following research papers have been evaluated for finalizing the objectives of our project work. The research papers discussed in this collection are mostly relevant to our project COAL MINE SAFETY MONITORING SYSTEM USING IOT AND ML ALGORITHMS. Venkata Sai Phani Gopal Design of IOT Based Coal Mine Safety System using Node MCU ISSN in this paper The system is implemented to monitor and control various parameters in the coal mines such as light detection, leakage of gas, temperature and humidity conditions, Fire detection in the coal mine, The developed system is mainly implemented to improve the working condition inside the coal mines and also to ensure workers safety [3].

D. Prabhu, V. Naga Nikhil, J. Shiva Kumar IOT Based Coal Mining Safety for Workers using Arduino IJSEC in these paper the coal mine safety which can monitor the various gas and temperature parameters and take action with the help of multimodal logistic regression algorithm applied on the real time collected data on cloud The machine learning model will take automatic action based on our dataset which will

keep on growing astime passes and this model will keep on becoming more accurate. A cost effective NRF based wireless mine supervising system with early-warning intelligence is proposed in this paper [4]. Shauohang Yu, Xiang Rong, X. Shi Review of fault diagnosis and early warning of coal mine ventilator Chinese Automation Congress, This study aims to present the preliminary results of diagnostic tests for pumps performing operational tasks in a mine shaft dewa-tering system. The tests used three basic diagnostic methods: vibration analysis, thermal imaging and acoustic testing [5]. P. Koteshwara Rao, A. Hareesh, B. Vineendra Kumar , CH. Ravi Kiran DESIGN AND IMPLEMENTATION OF COAL MINE SAFETY USING IOT IJETTCS The transmitter module also has an LCD, all the sensor data is displayed on the LCD screen by the Raspberry Pi controller. The RF transmitter present on the transmitter module sendsthe sensor data to the receiver module. The receiver module also has an Node MCU controller, LCD display, and an RF receiver. The RF receiver receives the sensor values from the RF transmitter on the transmitter module. The received sensor values are displayed on the LCD screen. The Node MCU also sends the sensor data to the remote IoT server using the Wi-Fi module every two minutes [6]. Keerthana E, Kruthika M, Kalyani Suruthi SA Smart Security System with Monitoring in Mines ISSN, This paper is about security framework to screen the workers and offer security to them. At the entryway there is no security on permitting all specialists inside without checking whether the workers wearing a wellbeing helmet, overcoat and shoes. In proposed framework the smart helmet contains gas sensor, temperature sensor, heart rate sensor with Audio play back recorder (APR module). At entrance of the mines, the representatives can be observed by raspberry pi, CSI (camera opening interface) with the assistance of a camera. The picture of a worker can be caught and checked whether the worker wearing a protective cap or not. The reference database was at that point put away in raspberry pi [7]. Y.F. Shan, Z.B. Gao Study on Double Adaptive AIS-PSO Based Model for Gas Concentration Soft-Sensing This paper analyses the basic principle of multi-source data fusion, constructs the prediction model of coal mine gas OL with this technology, takes the optimal value of weighting factor as the input value of the model, and completes the design of coal mine gas OL prediction method based on multi-source data fusion. The experimental results show that the accuracy of this method can reach 98Joshi Gunjan Shailesh proposed 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 [9]. Lahanu, Borhade Ganesh proposed, the subsystems of the prototype system are then simulated. The hardware consisted of electronic circuitry where a microcontroller is the principal processing unit. Agraphical user interface is also implemented. Anumber of qualification tests are carried out. The tempera-ture, humidity, airflow, and noise sensor measurements have an accuracy of 89.01Sathishkumar proposed a system, it is particularly risky for rescuers to enter a coal mineshaft burrow in a debacle without earlier attention to the climate on the grounds that ensuing blasts are probably going to happen at any second. It is along these lines basic to recognize unstable climate data like toxic gases and high temperatures, just as to direct a visual review of excavators caught in a fell passage through the imploded burrow. This information would aid rescuers in devising a strategy and equipping themselves to carry out the rescue operation defensively. This paper proposes a design for coal mines that will reduce the damage caused by a coal mine accident and allow for a more effective rescue operation [11]. Gong, Xue, Haitao Wang, and Wenhao Liang proposed n this paper, the LSTM neural network model is built and the time step length and depth of the model are analyzed. The super parameters of the model are optimized, and the accuracy and reliability of coal mine fire prediction and early warning are improved [12].

III. Methodology

Human safety is very important these days. In the past, coal miners used helmets, which helped save fewer lives during rescue operations. Because so many people perish before being saved, these projects are designed to address this issue. This project provides information before a problem arises. We are utilising many kinds of sensors. Initially, a digital temperature sensor (DHT11) gathers data from its surroundings to measure the temperature. A gas sensor (MQ135) identifies potentially toxic gases, and a water level sensor finds leaks in the water supply. In the event that more processing power is required, we use 230 volts of AC, which is converted to 12 volts of AC via a step-down converter. For this project, we only needed DC, so we used a bridge rectifier to convert AC to DC. All of the sensed data is then sent to the Arduino UNO Microcontroller ATmega 328P, which is equipped with digital I/O pins 14 through 16, a power jack, analogue I/Ps 6 through 14, a ceramic resonator at A16 MHz, a USB port, an RST button, and an ICSP header. By connecting this board to the computer, all of these can assist the microcontroller in doing further operations. Information is sent to the RF Module and IOT technologies by the Arduino. A device that transmits and receives radio frequency (RF) signals is called an RF module. Usually, an RF module consists of two primary parts: a transmitter and a receiver. The range of the RF module is intended to be over 100 metres. With the aid of a WiFi module called ESP-01, the sensors will continuously sense the data, and if anything changesin that area, it willinstantlyprovide information to the control module. Any microcontroller may gain access to your WiFi network with the ESP-01 ESP8266 Serial WIFI Wireless Transceiver Module, a self-contained SOC with an integrated TCP/IP protocol stack. Either an application can be hosted on the ESP8266, or it can delegate all Wi-Fi networking tasks to another application processor. Using this ESP-01, we were able to gather data, store it in the cloud, andthen use AI and MLalgorithmsto construct a dataset. Here, CNN is being used. An artificial neural network type called a convolutional neural network (CNN) is mostly

used for data processing and image identification; it stores the information found on a web page. Additionally, we will use the display to communicate with the outside server room at the same time. If an emergency arises, these prediction models will be used to send out an alert.

As shown in the fig.1 The DHT11 is a commonly used Temperature and humidity sensor that comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. The DHT11 is a commonlyused Temperature and humidity-sensor. The sensor comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. The sensor is also factory calibrated and hence easy to interface with other microcontrollers. The sensor can measure temperature from 0°C to 50°C and humidity to 90

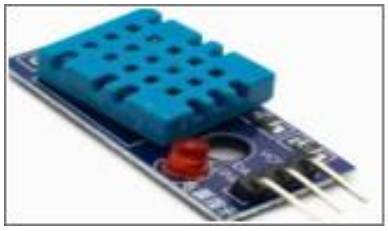

Fig. 1. DHT 11 Sensor

As shown in the fig.2 MQ-135 Gas sensor can detect gases like Ammonia (NH3), sulfur (S), Benzene (C6H6), CO2, and other harmful gases and smoke. Similar to other MQ series gas sensor, this sensor also has a digital and analog output pin. When the level of these gases goes beyond a threshold limit in the air the digital pin goes high. This threshold value can be set by using the on-board potentiometer. The analog output pin, outputs an analog voltage which can be used to approximate the level of these gases in the atmosphere. AS

Fig. 2. MQ135 Sensor

shown in fig.3 The ESP8266 WiFi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all WiFi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your microcontroller device and get about as much WiFi-ability as a WiFi Shield offers (and that's just out of the box)!

The ESP8266 module is an extremely cost-effective board with a huge, and ever growing, community

Fig. 3. ESP8266 WiFi Module

As shown in fig.4 The Arduino Uno is one kind of micro-controller board based on ATmega328, and Uno is an Italian term which means one. Arduino Uno is named for marking the upcoming release of microcontroller board namely Arduino Uno Board 1.0 This board includes digital I/O pins-14, a power jack, analog i/ps-6, ceramic resonator-A16 MHz, a USB connection, an RST button, and an ICSP header. All these can support the microcontroller for further operation by connecting this board to the computer. The power supply of this board can be done with the help of an AC to DC adapter, a USB cable, otherwise a battery. This article discusses what is an Arduino Uno microcontroller, pin configuration, Arduino Uno specifications or features, and applications

Fig. 4. Arduino

As shown in the fig.5 this block diagram we collected the data by using different sensors like DTH 11 sensor , MQ135 Sensor , Water level sensor, power supply will connected to the Arduino UNO controller , then it will perform internal operation and give output to the LCD display , RF module and IOT module .IOT module that will connected to the web page by using ML algorithm. RF module output will given to the another RF module present in the outside the coal mine then the RF module will directly connected to the AT89S52 controller it will give direct connection to the Display it will display the outputs in the display

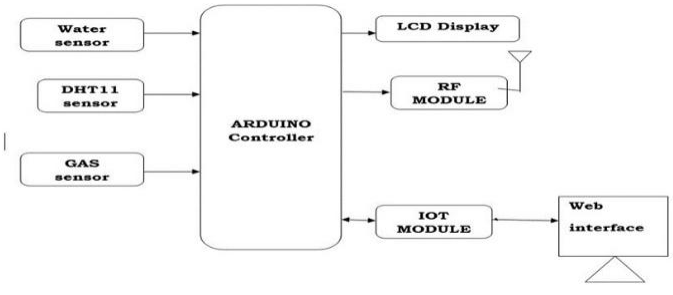

Fig. 5. Transmitter Block Diagram

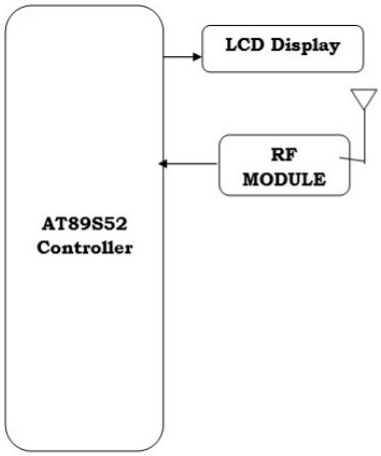

Fig. 6. Receiver Block Diagram

IV. Results and Discussions

In this section the implementation of an Internet of Things and radio frequency (RF)-based safety monitoring system for coal mines would entail the placement of sensors all over the mine to keep an eye on things like temperature, humidity, and possibly even worker vital signs. These sensors would use radio frequency (RF) technology to wirelessly interact with a central hub inside the mine, it might aid in opti-mizing operations.. By leveraging RF technology, the system enables seamless communication between devices deployed throughout the mine, facilitating instant data transmission and feedback. IoT devices play a crucial role in collecting comprehensive data

In fig.7 Understanding temperature variations in coal mines is important for ensuring the safety and well-being of miners, as excessively high temperatures can lead to heat stress, reduced productivity, and other health hazards. Proper ventilation, monitoring systems, and engineering controls are essential for managing temperature levels effectively.

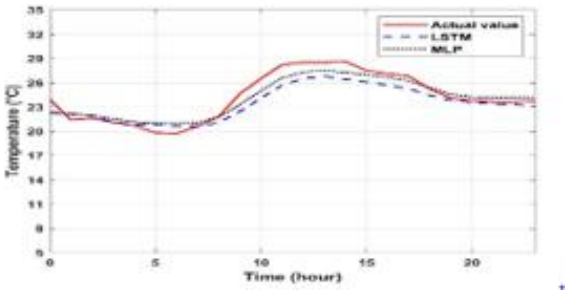

Fig. 7. Representation of Temperature Variation

In fig.8 Understanding and managing gas variations in coal mines are essential for ensuring the safety of miners and preventing gas-related accidents. Strict adherence to safety protocols, regular gas monitoring, effective ventilation systems, and comprehensive training for miners are critical components of gas management in coal mining operations.

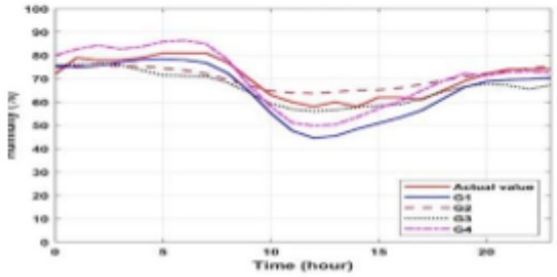

Fig. 8. Representation of Gas Variation

In fig.9 Humidity variation in coal mines is influenced by factors such as groundwater seepage, ventilation effectiveness, temperature changes, and seasonal variations. Proper management of humidity levels is essential for maintaining safe and comfortable working conditions for miners, prevent-ing equipment corrosion, and minimizing the risk of health hazards. Effective ventilation systems, drainage mechanisms, and monitoring of environmental conditions are critical for controlling humidity levels within coal mines and ensuring the well-being of workers.

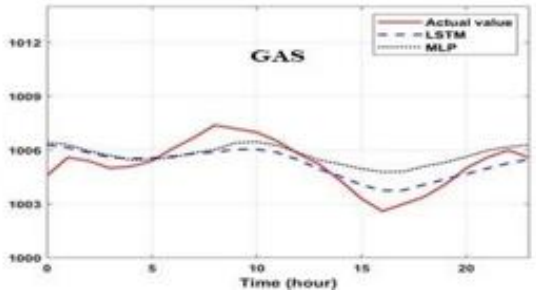

Fig. 9. Representation of Humidity

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