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IOT AND LORA BASED MINING WORKER SAFETY SECURITY SYSTEM

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Abstract

Coal is one of the most significant fuel sources overall and is essential to several projects. Within the coal mine, it is the most significant and indispensable local energy resource. Because of climate-related issues such heat, wetness, and the introduction of toxic gases, excavators work in coal mineshafts where conditions are unsafe and potentially fatal. Representatives are placed in a risky environment that poses a serious risk to their life due to the combination of these circumstances. A model that detects ecological boundaries from unexpected places inside the mines has been developed in an attempt to mitigate the impact of the problem. The mine control room may then take the necessary action anytime a seemingly unsafe scenario occurs because it provides alerts to them.

Key words - Coal Mine, Indispensable, Fatal, Mitigate

1.INTRODUCTION

During an underground mining operation, human workers could find themselves in a particularly perilous scenario, where risks rise as one ascends towards the surface. The longer the mine, the greater the perceived risk. The execution of the security estimates is really poor, especially in the mining enterprises. Coal is a useful resource that may be applied to many different areas for any country. The three most important uses of coal are in the development of nuclear energy, the production of concrete, and the fuel's versatility as a fuel. For the experts that labour there, the coal mineshafts offer a range of dangerous circumstances, including high humidity and temperature along with the emission of toxic gases. The level of worker security in the mining operations is steadily rising thanks to advances. Subterranean mine explosions still occur despite a moderate level of technology that has made mine perception processes extremely sophisticated. The primary reasons for mishaps and tragedies in coal mineshafts are

the severe weather and hazardous working conditions. This significantly raises the need for mine inspection frameworks for coal mineshafts.

It is exceedingly exhausting to physically investigate every ecological scenario that occurs during a mine. This task might be easily finished with the help of inexpensive remote, specialised gadgets that are used in coal mineshafts at the right angle. The suggested approach uses less power and more affordable sensors to monitor the temperature, moisture content, and water level in the work area. For the safety of my labour, the ongoing disintegration of the water level, temperature, stickiness, and bold gas level provides a perilous circumstance at the right moment. The proposed framework's major goal is to raise awareness of the dangerous gas present in coal mining environments and the safety limitations placed on excavators. The data from the digger part is relayed via LoRaWAN technology.

2. LITERATURE SURVEY

Utilising LoRa, the designed system enables communication up to a predetermined distance between a remote organisation. In order to increase the communication range, it also takes use of another LoRa that receives and repeatedly retransmits similar data. By adding Lora repeaters, the correspondence's range is increased.[1] Directing sensor data in this manner up until a point where GPRS packets are accessible, after which the data is sent to the cloud.[2] The proposed framework employs multiple sensors to detect the different safety boundaries for coal excavators. These sensors measure the depth, tension, temperature, moisture content, danger gas level, fire inside the mine, and geophysical area of the diggers within the mines of the minor. In order to create a compact device, this article investigates the best way to use the Internet of Things (IoT) protocol in combination with a number of other cutting-edge methods and services, including distributed capacity, edge warning services, and deployed data mining. The created model consists of two sections: an excavator state screen and an all-out inspection segment.[3] Lower radio frequencies with a longer range are employed for Lora WAN applications. The Lora WAN is a low-power, wide region organising (LPWAN)convention in the context of LoRa technology. Lora WAN is extremely popular due to its superiority over LPWAN in terms of cost-effectiveness, stability, reach, and battery life. The suggested system makes use of sensors that identify groups of gases in the atmosphere (methane and carbon monoxide), measure the temperature and moisture of the mine, and monitor the excavator's heart rate. Consequently, it sets off the alarms and delineates the excavator area.[4] The developed model makes use of a number of sensors to identify natural limits from different mine locations and alert the mine control room, allowing appropriate action to be done whenever, by all accounts, something is happening. In this case, the Node MCU is used as a MQTT distributor for these limits that the different sensors have identified. This also generates a warning for the experts to vacate the area.[5] In order to develop more efficient frameworks to increase production and decrease the risk of workers potentially losing their life, this dispersed information can also be stored in papers for information gathering and massive information analysis.[6]Using the Internet of Things (IoT) protocol in conjunction with a number of other cutting-edge methods and services, including distributed capacity, edge warning services, and deployed data mining, this article investigates the best way to build a small device. An all-out inspection section and a screen for the excavator's condition comprise

the two components of the produced model.[7] Lower, longer-range radio frequencies are employed for Lora WAN applications. Considering LoRa technology, the Lora WAN convention is a low-power, wide area organising convention (LPWAN). Lora WAN is quite popular because it is more reliable, stable, cost-effective, and has a longer battery life than LPWAN

3. PROPOSED SYSTEM

A few parts make up this testing framework: LCD (liquid crystal display), various sensors, PIC boards, LORA modules, and USB interfacing boards; other minor electronic components. This section provides a comprehensive overview of each component as well as its operational guidelines .Four sensors have been used to identify the different limits on the transmitting side of the observation region. The scenario is screened using the real boundaries by sensors. The LCD and LORA transmitter are used by the sensors to communicate with the Micro-regulator. POT is used to adjust the LCD's brightness. The administrator of the control room and the excavator communicate remotely via LORA transmitter and LORA recipient. This has a potential 8-kilometer range.

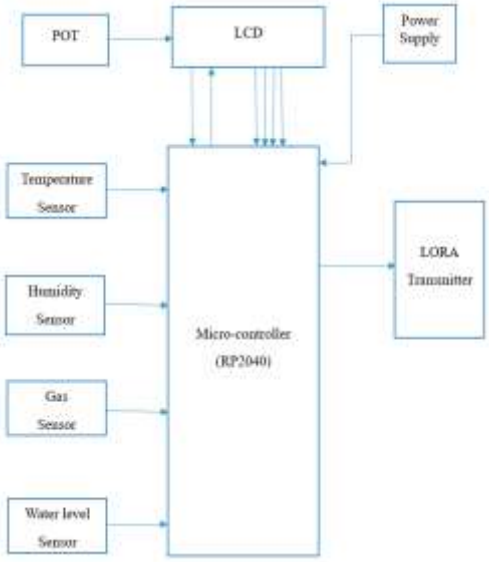

Fig 1: Monitoring section - Transmitter part

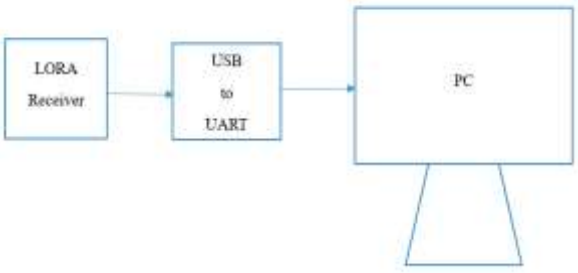

Fig 2: Monitoring section - Receiving part

Every sensor's upsides are identified in this observation section and sent to the microcontroller. The LORA transmitter and the LCD, which displays the qualities that have been identified, get

these qualities from the micro-controller. These attributes are sent to the LORA receiver by the LORA transmitter. The receiver of LORA sends attributes to the PC via the USB/UART connector. Through IOT, the received data will be reliably sent to the page. Across the continuous organisational framework, the Internet of Things maintains remote detection and control. The framework for displaying the data on the web makes use of an IoT board that has been identified with GPRS. The information can also be viewed using the IP address of the authorised person's mobile device.

3.1. Microcontroller

The micro-controller in the suggested system is an RP2040. All of the sensors are interfaced with the module using a micro-controller.

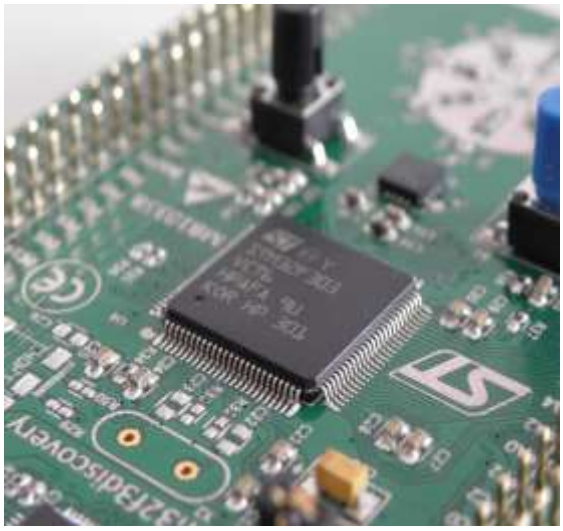

Fig 3: Micro-controller RP2040

3.2. LCD

The sensed values are displayed using an LCD.

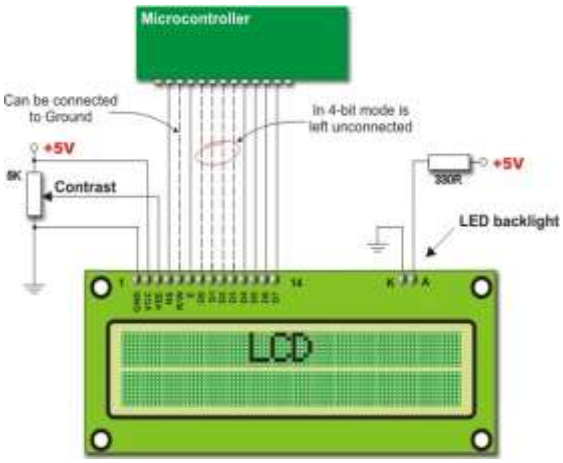

Fig 4: LCD display

3.3. Temperature and Humidity Sensor

LM35, is used to measure the temperature inside coal mines.The suggested framework uses this moisture sensor to identify stickiness inside the coal mineshaft. Electronic devices called temperature and humidity sensors are used to gauge the outside air temperature and moisture content. They are frequently used in many different applications, including HVAC systems, interior environmental monitoring, and weather monitoring. Typically, these sensors use capacitive or resistive elements to sense humidity and thermistors or resistance temperature detectors (RTDs) to measure temperature.

Fig 5: Temperature and Humidity Sensor

3.4. *WATER LEVEL SENSOR*

In the suggested system, magnetic reed is used. The water level inside the mine is high if the reed is in its highest position. The water level is low if the reed is in its bottom position.

Fig 6: Water Level Sensor

3.5. GAS SENSOR MQ4

To identify variations in the concentration of hazardous gases.

Fig 7: MQ4 GAS SENSOR

3.6. LoRaWAN

The organization's correspondence convention and framework architecture are characterised by LoRaWAN. The long-range correspondence link is maintained by the LoRa actual layer. A LORA transmitter inside the mine and a LORA receiver in the mine control room have been used for the correspondence purpose.

Fig 8: LoRa

3.7. Raspberry pi Pico

Fig 9: Raspberry pi Pico

There are 20 pins on each side of the Raspberry Pi Pico and Raspberry Pi Pico W, for a total of 40 pins. Out of the 40 pins, 26 of them are programmable general-purpose input/output (GPIO) pins that you can use to connect peripherals like as motors, sensors, and LEDs, or even to communicate with other microcontroller boards. The Raspberry Pi Pico has a 12-bit ADC with four channels on a fixed set of pins (plus an extra internal temperature sensor). This means it can transform an analog signal into a digital signal as a number ranging from 0 to 4095.A low-cost, high-performing microcontroller board with customisable digital interfaces is the Raspberry Pi Pico. Important characteristics consist of:

- Designed in the United Kingdom by Raspberry Pi, the RP2040 microcontroller chip.
- Arm Cortex M0+ dual-core CPU with a programmable clock that can reach 133 MHz

- 2MB of on-board flash memory and 264kB of SRAM
- USB 1.1 supporting both hosts and devices
- Dormant and low-power sleep modes
- Programming with drag and drop over USB mass storage
- GPIO pins with 26 × multi-function
- On-chip precise timer and clock
- On-chip accelerated floating-point libraries
- Eight-inch Programmable I/O (PIO) state machines to accommodate customised peripheral

3.8. NodeMCU(ESP8266)

Fig 10: NodeMCU(ESP8266)

The open-source NodeMCU development board and firmware are based on Lua and are specifically designed for Internet of Things applications. Figure 10 depicts the Nodemcu's hardware. It contains firmware for the ESP8266 Wi-Fi SoC manufactured by Hardware and systems built on the ESP-12 module are called Espressif Systems.

4. Software Implementation of project

4.1.Thonny IDE

Thonny is a Python programming language Integrated Development Environment (IDE). It has features that are helpful for more experienced developers, but it is also made to be user-friendly for beginners. The following are some salient features of Thonny Python software: Thonny is a good option for novices learning Python programming because of its simple and easy-to-use interface. To make writing Python code simpler and more effective, Thonny comes with an integrated code editor that includes features like syntax highlighting, code completion, and code indentation. When running a programme, you can inspect and work with variables and their values using Thonny's variable explorer. This might be useful for tracking the status of your programme and debugging it. Thonny includes an interactive Python shell that allows you to run code in Python. This lets you execute commands or test brief segments of code without needing to write a separate script. Thonny assists with the setup and upkeep of virtual

environments, which are segregated settings for Python applications. This facilitates the organisation and separation of system-wide Python installations from project dependencies.
Thonny comes with code analysis tools that can be used to find common style problems and coding faults. Additionally, it promotes adherence to PEP 8, the standard style guide for Python programming. Through its plugin architecture, Thonny's capability can be expanded with the addition of new tools and features. It can therefore be tailored and adjusted to meet various development requirements.

4.2. ThingView Free

Fig 11:ThingView Free

A free and open-source 3D model viewer called ThingView is made for viewing STL and G-code files, which are frequently used in 3D printing. It offers a straightforward and user-friendly interface for previewing and examining 3D models prior to printing. ThingView has the following important features:

- File Formats Supported: ThingView is compatible with STL files, which are commonly used for 3D modelling and printing. G-code files, which include instructions for 3D printers, are also supported by it.
- Realistic 3D model viewing is made possible by the programme, which also lets you pan, zoom, and rotate the model to examine it from various perspectives.
- Measurement Tools: You may measure dimensions, angles, and distances inside the 3D model with ThingView's measurement tools. This aids in guaranteeing the model's correctness for printing.
- Cross-Platform Compatibility: ThingView may be used on a variety of operating systems and is compatible with Windows, macOS, and Linux, among other platforms.
- Customisable choices: To fit your tastes and workflow, you can adjust the software's rendering quality, backdrop colour, and display choices, among other things.
- Free & Open-Source: The GNU General Public Licence (GPL) governs the distribution of ThingView, an open-source programme. This makes it an affordable option for both professionals and fans interested in 3D printing because it is free to download, use, and alter.
- All things considered, ThingView is an invaluable tool for anyone working on 3D printing projects since it offers an intuitive interface along with all the necessary capabilities for viewing and examining 3D models.

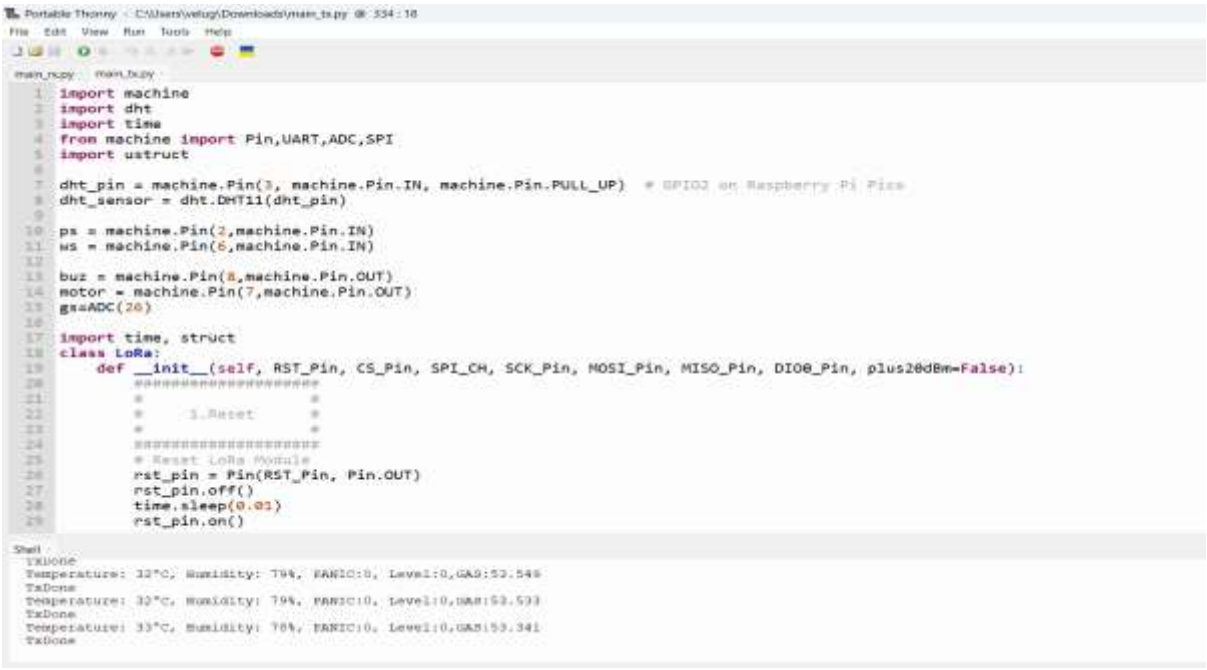

Fig 12 : Done Compiling and Uploading code

5.WORKING

An efficient system for the safety and security of mine workers can be built by combining LoRa (long range) and IoT (Internet of Things) technologies. This is how it typically operates:

- Sensor Deployment: A range of sensors are placed throughout the mine to keep an eye on a number of variables, including location, motion, temperature, humidity, and gas levels.
- Data Collection: The sensors wirelessly send the real-time data they gather to a gateway or central IoT platform.
- Data processing: The Internet of Things platform collects, analyses, and produces insights that can be put to use. For instance, it is capable of identifying anomalous circumstances like elevated gas concentrations or unapproved access to restricted regions.
- Alert Generation: The system instantly creates notifications in the event that it detects a potentially dangerous situation or security breach. By using their wearable technology or smartphones, these signals can be communicated immediately to the workers as well as to safety personnel and mine supervisors.
- Communication with Workers: The workers are communicated with via LoRa technology, which is renowned for its long-range and low-power characteristics. Every employee has a wearable gadget or tag that connects to LoRa gateways positioned all over the mine. This makes it possible to continuously track the location and vital signs of the employees.
- Emergency Response: The system has the ability to initiate automated emergency response processes in the event of an emergency, such as a gas leak, cave-in, or injury.

This could entail setting off sirens, directing evacuation routes, and providing accurate position data to rescue services.

- Data Analytics and Reporting: In addition, the system keeps track of data for reporting on regulatory compliance and historical analysis. It facilitates pattern recognition, safety process optimisation, and general mine operations improvement.

Mine worker safety and security systems may greatly improve safety protocols, speed up emergency reaction times, and guarantee a safer working environment for miners by utilising IoT and LoRa technology

6.EXPECTED RESULTS

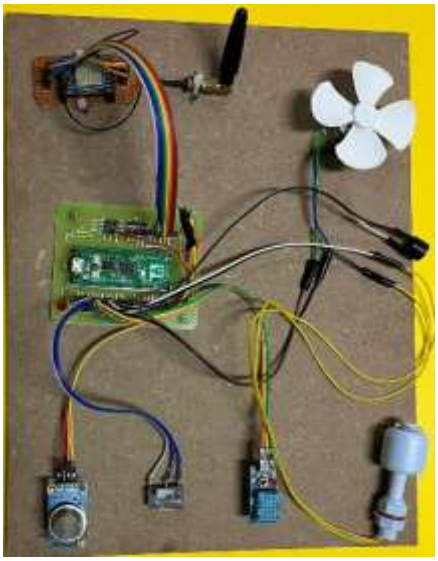

Fig 13: Transmitting part - Sensors and LORA transmitted interfaced with the micrcontroller

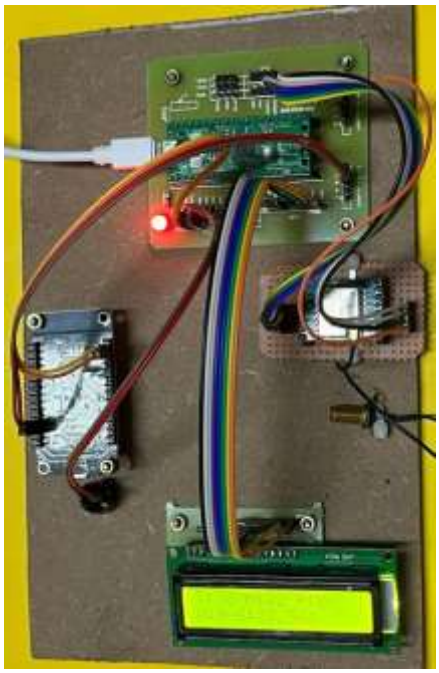

Fig 14: Receiving part -Lora receiver

```
InDone
Temperature: 34°C, Humidity: 70%, PANIC:0, Level:0,GAS:52.94
InDone
Temperature: 34°C, Humidity: 70%, PANIC:0, Level:0,GAS:52.828
InDone
```

Fig 15: Observed values in PC

Fig 16: Displayed values on LCD

7.GRAPHS

Fig 17: Temperature vs Time

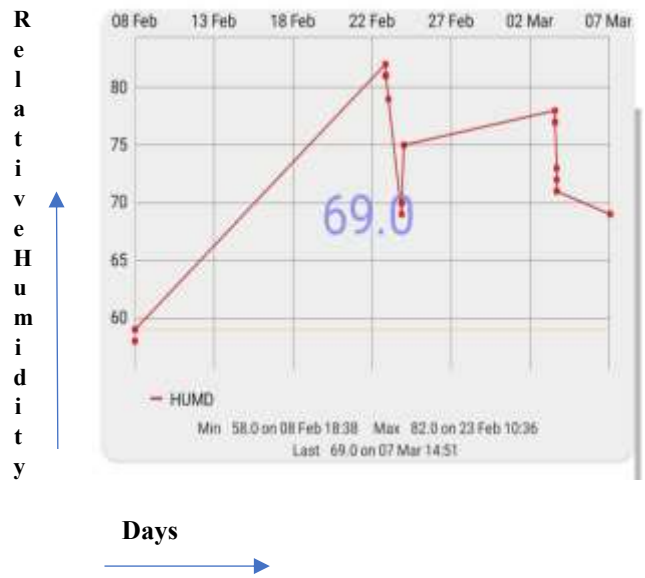

Fig 18: Humidity v/s Time

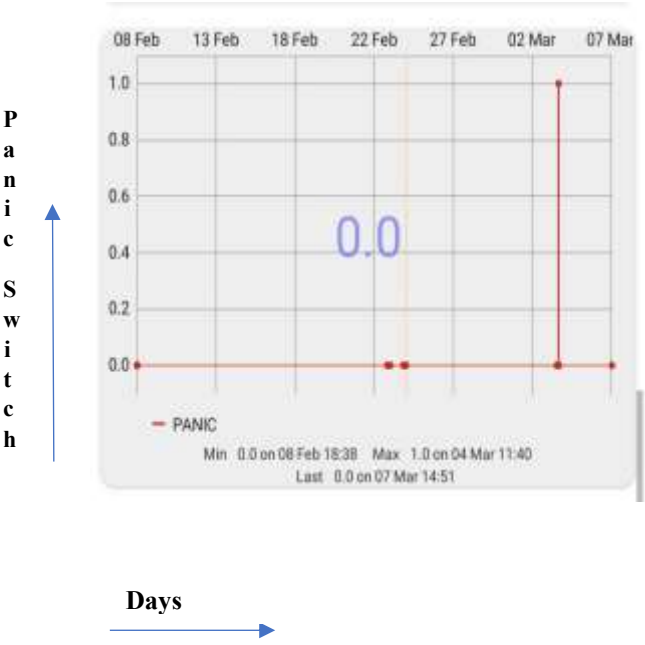

Fig 19: Panic switch v/s Time

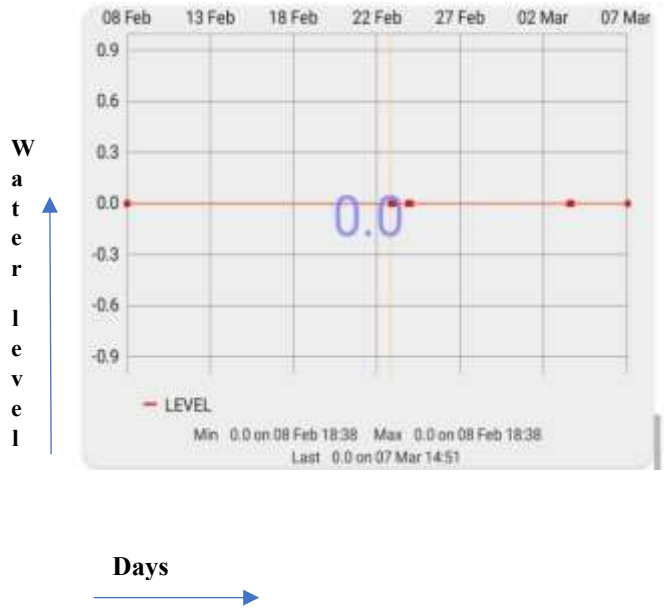

Fig 20: Water level v/s Time

Fig 21: Gas level v/s Time

8.CONCLUSION

The main strategy for the life-saving measures for the elaborate specialists and diggers is presented in this study. General purpose sensors are used for the presentation of build. The system will function with continual extra accuracy thanks to the use of modest sensors. The detecting component networks continuously acquire the natural remnants of underground mines, transmit information, and send it off PC. This will ensure the safety of the underground diggers during their whole shift. If an annoying condition is discovered, it alerts the administrator inside the room. It displays the important time values in a clear and effective

manner. The Internet of Things concepts aided in the development of efficient and low-power systems. This study declares that Internet of Things applications will spread widely over the entire world.

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