Smart Safety Device for Coalmine Workers

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Abstract: **The lack of efficient prevention of hazardous accidents that miners face in the coal mine can be addressed by designing an automated sensor detection. It is embedded with different sensors so that it can detect the surrounding atmospheric conditions that change during any accident thereby alerting workers and send rescue signals to the control cabin.**

Keywords: **Coalmines, Accidents, NodeMCU, DHT11, MQ2, WiFi transfer, IoT.**

1. Introduction

The accidents occurring in the mines can be predicted by sensing the surrounding atmospheric conditions continuously and detecting abnormal conditions that change during or before an accident. The major parameters include temperature, humidity and smoke concentrations. We also need to detect concentrations of any poisonous gases. We detect temperature and pressure using DHT11 sensor. Smoke levels and concentrations of some common toxic gases can be detected using MQ2 sensor. NodeMCU microprocessor can be used since it has a built in WiFi module through which data and alert signals can be sent to control cabin.

2. Components

A. Hardware Components

1) NodeMCU

Node Microcontroller Unit is named as NodeMCU which is open-source software and firmware that is built around System-on-Chip (SoC) called the ESP8266. The ESP8266 is designed and manufactured by Express. It contains the crucial elements like CPU, RAM, networking (Wi-Fi), modern operating system and SDK. The NodeMCU aims to simplify ESP8266 development. It has an operating voltage of 3.3v. It has an operating temperature range of 40˚c ~ 125˚c. ESP8266 Wi-Fi SoC is embedded with the memory controller, including SRAM and ROM. Micro Controller Unit can enter the memory units through IBus, dBus, and AHB interfaces.

2) DHT11

The DHT11 is 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.

3) MQ2

MQ2 is one of the commonly used gas sensors in MQ sensor series. It is a metal oxide semiconductor (MOS) type gas sensor also known as Chemiresistors as the detection is based upon change of resistance of the sensing material when the gas comes in contact with the material. It works on 5v DC and draws around 800mW. It can detect LPG, smoke, alcohol, propane, hydrogen, methane and carbon monoxide concentrations anywhere from 200 to 10000ppm.

4) Buzzer

A buzzer or beeper is an audio signaling devices, which may be mechanical, electrotechnical, or piezoelectric (piezo for short).

B. Software Components

1) Arduino IDE

The Arduino Integrated Development Environment (IDE) contain a text editor for written code, a message area, a text console, a tool bar with button for common functions and a series of menus. It connects the Arduino hardware to upload program and communicate with them.

2) ThingsBoard

It is an open source IoT platform for data collection, processing, visualization, and device management. It enables device connectivity via industry standard IoT protocols – MQTT, CoAP and HTTP and supports both cloud and on-premises deployments.
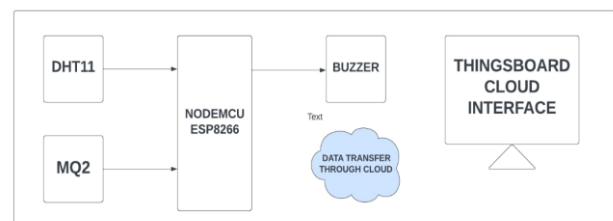
3. Working Operation

Fig. 1. Block diagram

- Power supply is given to NodeMCU microcontroller. The digital outputs from DHT11 and MQ2 sensors is given to the microcontroller.
- The values of temperature, humidity, concentrations of

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smoke and toxic gases are continuously monitored on the thingsboard interface that are transferred through WiFi.
- If any values exceed the normal range, the buzzer rings as an indication of possible danger. The signal is also displayed on IoT interface.

4. Real Time Statistics

1) Temperature

The average geothermal gradient of the coal bearing strata is 2.88ºC/100m. The average surface temperature gradient of the coal strata is 3.23ºC/100m and the average floor temperature of coal seam is 41.38ºc. The body core temperature does not reach dangerous levels event at apparent temperature of 54ºC.

Therefore, any temperature that is exceedingly higher than this value might indicate possibility of an accident.
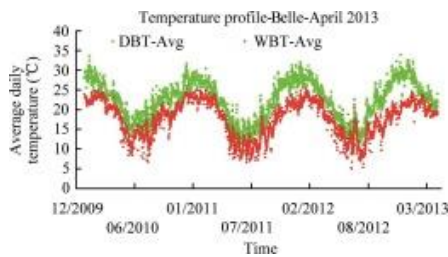

Fig. 2. Temperature statistics

2) Humidity

From various studies, the relative humidity of a mine must be around 80% for a thermally comfortable, safe, and healthy working environment for the miners.
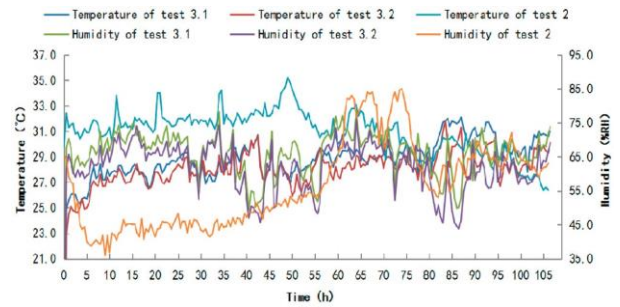

Fig. 3. Humidity statistics

3) Air Quality Standards

The standard air quality conditions are mentioned below.

Table - I

Category	Pollutant	Time weighted average	Concentration in Ambient Air	Method of Measurement
1	2	3	4	5
I	Suspended Particulate Matter (SPM)	Annual Average *	360 μg/m³	– High Volume Sampling (Average flow rate not less than 1.1 m³/min)
		24 hours **	500 μg/m³	
New Coal Mines (Coal Mines commenced operation after the date of publication of this notification)	Respirable Particulate Matter (size less than 10 μm) (RPM)	Annual Average *	180 μg/m³	– Respirable Particulate Matter sampling and analysis
		24 hours **	250 μg/m³	
	Sulphur Dioxide (SO₂)	Annual Average *	80 μg/m³	– Improved West and Gaeke method
		24 hours **	120 μg/m³	– Ultraviolet fluorescene
	Oxide of Nitrogen as NO₂	Annual Average *	80 μg/m³	– Jacob & Hochheiser Modified (Na-Arsenic) Method
		24 hours **	120 μg/m³	– Gas phase Chemiluminescence

5. Conclusion

This paper presented the implementation of smart safety device for coalmine workers.

References

[1] "Standards For Coal Mines," Notification No. GSR 742(E), Dt: 25th September 2000 (Stipulated by Ministry of Environment and Forests (MoEF), New Delhi.
[2] B. Belle and M. Biffi, "Cooling pathways for deep Australian longwall coal mines of the future," in *International Journal of Mining Science and Technology*, vol. 28, no. 6, pp. 865-875, 2018.
[3] Li J, Yang L, Song T, Qi R. Research on the Effects of the High Temperature and Humidity Environment on Human Comfort in Coal Mine Emergency Refuge System. Safety. 2019; 5(2):28.