iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** V **Month of publication:** May 2023

DOI: https://doi.org/10.22214/ijraset.2023.52596

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue V May 2023- Available at www.ijraset.com

Safe Mining System

Abhay Chopde[1], Om Tidke[2], Madhura Pande[3], Sahish Pandav[4]
Department of Electronics and Telecommunication, Vishwakarma Institute of Technology, Pune, 411037, Maharashtra, India

Abstract: ***Carbon monoxide (CO) is a highly toxic gas commonly found in mining environments, and its presence poses a significant risk to the health and safety of workers. This project presents a system designed to continuously monitor CO concentration levels and provide timely alerts when the gas reaches dangerous levels. The proposed system utilizes an MQ7 sensor and a 433MHz transistor, with multiple sensors strategically placed along the walls of the mining area. The system has been tested successfully above ground, demonstrating a peak CO concentration value of 78.0 parts per million (ppm). The sensors are recommended to be positioned at a distance of 1 meter from each other along the walls. Furthermore, the system has the potential for expansion to detect other hazardous gasses and detect fire incidents.***
Keywords: Smart Mining, Mining, Safety, Carbon monoxide sensor.

I. INTRODUCTION

The mining industry is widely recognized for its high-risk and hazardous working conditions. As extraction techniques advance to meet increasing production demands, ensuring the safety of mining sites becomes a paramount concern. Research has revealed that a significant number of incidents in the mining industry can be attributed to human error, underscoring the need for effective control measures to enhance safety levels.

India currently holds the position of the world's second-largest coal producer. In 2021, coal production in the country reached an impressive 715.95 million tons (MT) during the fiscal year, with 379.597 million tons (MT) produced between April and October. Coal plays a crucial role in India's energy sector, predominantly for power generation. The coal economy directly and indirectly supports the livelihoods of millions of Indians, including those employed in coal mining, transportation, power generation, sponge iron, steel, and brick sectors.

Mining workers face numerous hazards, such as inadequate ventilation, mine flooding, gas explosions, structural collapses, accidents during mine haulage, sudden material influxes, mine inundation, spontaneous combustion, and suboptimal evacuation routes. Despite concerted efforts, no comprehensive solution exists to accurately predict and prevent these risks before they manifest.

To address one of the most prevalent and dangerous hazards in mining incidents, this project proposes the development of a CO gas monitoring system. Carbon monoxide poses a significant threat to the health and safety of mining workers, necessitating the timely detection of hazardous CO concentrations. The system utilizes an MQ7 sensor and a 433MHz transistor, strategically placed along the walls of the mining site, to continuously monitor CO concentration levels. When gas levels reach dangerous thresholds, the system promptly alerts workers, enabling them to take necessary actions.

Moreover, the proposed system can be expanded to detect other hazardous gases and identify fire incidents. By offering real-time monitoring and alerts, the system aims to improve safety measures in mining environments, mitigating the risk of accidents and fatalities.

II. LITERATURE REVIEW

K.M Dange and R.T Patil proposed a system that can monitor temperature, humidity, gas and smoke in the mines with MSP430 microcontroller , LM34, SYHS220 and MQ 6 sensors. Here the various sensors would be at a slave node which will wirelessly communicate with a master node about their readings. J. H. Rowland & L. Yuan & R. A. Thomas used 8 sensors for fire detection and accordingly put forth that the minimum spacing between two sensors should be 1.43m.

III. METHODOLOGY

A. Components

1) Arduino UNO x 2

2) MQ - 7 Gas Sensor x 1 - Measures the air quality.(Carbon Monoxide Sensor).

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Sensitivity characteristics(MQ - 7):

symbol	Parameters	Technical parameters	Remark
Rs	Surface resistance Of sensitive body	2-20k	In 100ppm Carbon Monoxide
a (300/100ppm)	Concentration slope rate	Less than 0.5	Rs (300ppm)/Rs(100ppm)
Standard working condition	Temperature -20℃±2℃ relative humidity 65%±5% RL:10KΩ±5%		
	Vc:5V±0.1V VH:5V±0.1V VH:1.4V±0.1V		
ıt time	No less than 48 hours	Detecting range: 20ppm-2000ppm carbon monoxide	

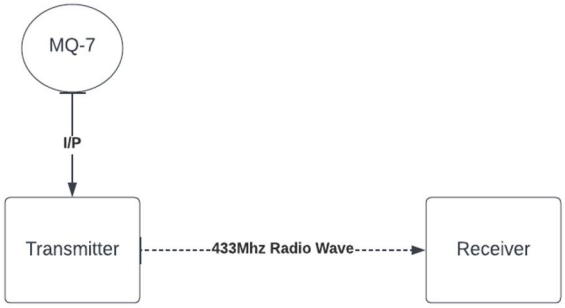
Fig (1). Sensitivity Characteristics

433Mhz Radio Frequency Transceiver(For communication).

Item	Typical	Unit
Working Voltage	5	VDC
Quiescent Current	5	mA
Receiver Sensitivity	-105	dBm
Operating frequency	433.92	MHz

Fig (2). 433MHz Characteristics

This project consists of 2 major components, Transmitter and receiver. Input sensor is connected to the transmitter part.



Fig(3.)

Arduino is used to ensure the integrity of the circuit. Transmission is done over 433Mhz Radio Tx module.
Second most important part is the receiver (433Mhz Radio Rx). It is connected with a PC interfacing with an arduino.
Data transmitted by Sensor is Received and processed by the arduino. We can fetch real time sensor readings on a laptop screen.
Each sensor should be placed minimum 1 meter away from each other. A sensor should also be present on the miner for a fail-safe measure. This sensor would instantaneously alert the miner if the CO concentration has reached a dangerous level.

IV. RESULTS AND DISCUSSION

We have tested the sensor for CO detection by just burning a matchstick and extinguishing at the same time producing Carbon Dioxide and Carbon Monoxide due to Incomplete combustion. The sensor worked well showing the peak value of 78.0 ppm. It is not possible to recreate the underground mining environment.
The research says that the average CO levels in Coal Mines 30-35 ppm. And can go beyond 200 ppm spontaneously due to extensive mining activities. OSHA standards prohibit worker exposure to more than 50 parts of CO gas per million parts of air averaged during an 8-hour time period. The excursion (or short-term limit) for CO in coal mines is 75 ppm for 15 minutes without proper approved respiratory protection.

CO levels(in ppm)	Risk
0 - 9	Recommended Levels
10-30	Low
30 - 70	Physical symptoms after 6-8hr
71 - 150	Physical symptoms after 2-3 hr
150 - 400	Physical symptoms after 1-2 hr, Life threatening 3hr.
400 +	Physical symptoms in 45 minutes. Unconscious in 2 hours. Fatal in 2-3 hours.

V. FUTURE SCOPE

A sensor with better sensitivity can be used for better results and can cover up a larger area. The mesh around the sensor gets covered by dirt if not being in maintenance. The mesh must be clean to ensure accurate sensing. Automatic mesh cleaning system can be used.

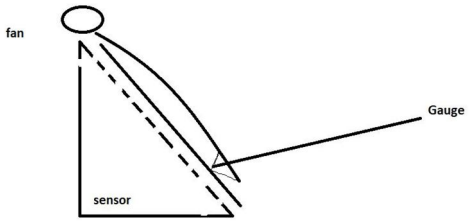


Fig (4.)

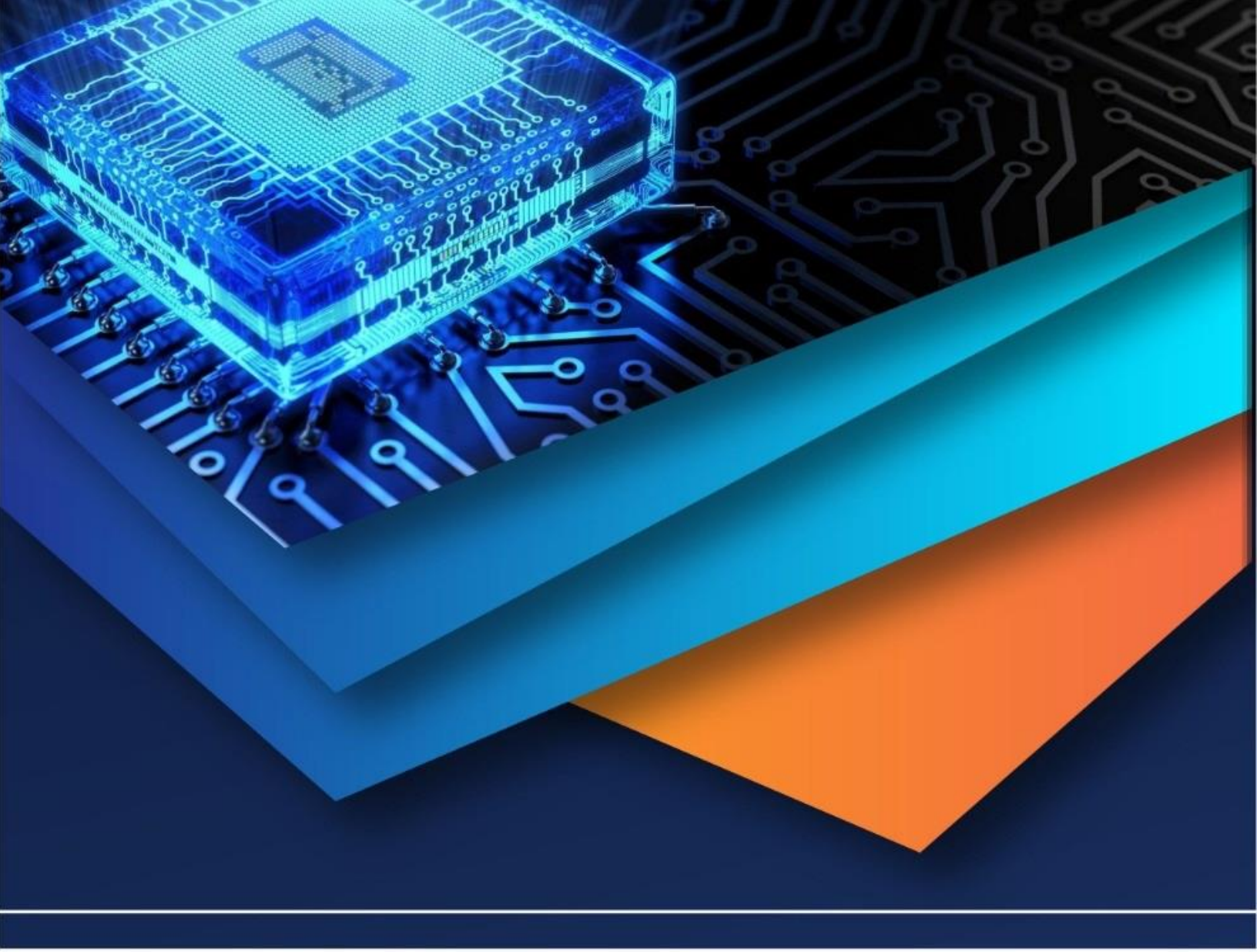
The fan will blow high pressure air into a mesh at a certain angle to avoid dust accumulation on the sensor mesh. Hence, increasing its maintenance cycle.

VI. CONCLUSION

The project is able to detect CO till 2000.00 pm. The MQ7 sensor is programmed to only monitor CO. These sensors are proposed to be placed at most 1 meter apart and also on the miner so as to monitor the gas and continuously communicate with a central node.

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