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SAFETY MONITORING ROBOT FOR COAL MINE

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Abstract— Coaling, the most important and abundant fossil fuel, has been used for centuries. Extracting coal from the coal mine is a complicated and risky process. Safely safeguarding a person's safety has been a primary concern in the underground coal mining industry. Ensuring the safety of miners has been a major challenge. Mining has posed a threat to miners' health and life due to its hazardous working environment and long-term effects. Due to the hazardous and damaging gases emitted by mining operations, the connected workers now face a survival threat. Placing significant pressure on the mining sector. To deal with these problems we have developed a safety monitoring robot for coal mine with wireless video streaming in the area which is hard to reach or hazardous areas.

Keywords — IoT, ESP32-CAM, NODEMCU ESP8266, MQ9 Gas sensor, dht11 sensor, Coal Mine.

I. INTRODUCTION

Coal is the most major and accessible fossil fuel in India, meeting 55% of the nation's energy demands and laying the groundwork for a long history of industrial development. Over the preceding 40 years, India's main energy consumption has climbed by over 700%. India now uses much less commercial primary energy per person annually than wealthy countries, at about 350 kgs. As a result of the nation's developing economy, expanding population, and desire for a higher quality of life, it is projected that India's energy consumption will increase. Due to the low reserve potential of petroleum and natural gas, environmental limits on hydroelectric projects, and the geopolitical context, coal will continue to play a significant part in India's energy picture.

For the upcoming century and beyond, Indian coal offers a distinctive environmentally favourable fuel source to the domestic energy sector. The majority of the country's hard coal deposits, which are dispersed throughout 27 major coalfields, are located in the east and south-central regions. (See Reserves of Coal.) The world's lignite deposits are estimated to be 36 billion tonnes, 90% of which are found in Tamil Nadu, a state in the south.

One of the most important factors in relation to industries, especially the mining industry, is safety. Human safety is the most crucial item to consider in underground coal mining. All mining industries adhere to a few fundamental precautions and guidelines in order to prevent any undesirable events. With several criteria being watched and required steps being made to avert hazards, communication is essential in every company nowadays. The primary goal of the project is to develop a wireless robotic system for industrial security applications that is both affordable and capable of wireless video streaming in dangerous or difficult-to-reach locations, thus replacing humans at these locations.

A robot is designed and constructed here to move into different locations and receive the details of that area with the help of inbuilt sensors on it. The sensors on it can detect gas like methane, smoke. The robot also detects the temperature and humidity. The robot operates in accordance with the program's instructions. It will be able to travel in all directions, including forward, backward, right, and left. The robot will transmit real-time streaming that can be viewed on a monitor or mobile device via a wireless Wi-Fi connection, meaning that one can control the robot using a mobile device or laptop via the Internet of Things (IoT), and all sensor data and alert notifications are always displayed on the Blynk app.

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II. LITERATURE SURVEY

Since George Devol developed the first robot in 1954, robotics has rapidly evolved in many fields. There are vast applications of robots in industrial and military work hence reducing manpower with the help of IOT and AI. In recent years robotics is also applied in security purpose or as surveillance robot in industries and military applications.

In paper [1] Proposed a study that uses sensors to measure gas concentrations, temperature and butane levels. The project's goal is to develop a Wi-Fi network between the Android phone and Raspberry Pi and a robot that can be controlled by an Android phone.

A wireless sensor network (WSN) based on ZigBee exploitation for mine environment observation system is proposed in this [2] paper. In this paper work, they demonstrate how to use humidity sensing equipment to measure the mine's humidity and carbon monoxide gas sensing equipment to measure the mine's temperature. Providing miners with an ID card for adequate mining security. To prompt the urgent emergency services to deliver the message to the fire and medical departments by connecting GSM to the server.

In paper [3] with the following sensors: tilt sensor ADXL335, gas sensor MQ2, temperature and humidity sensor DHT11. The receiver portion, located in the control room, will receive sensor data thanks to the presence of a zig bee module. The standalone wireless audio and video camera transmitter is placed on the robot. And keypad control for robots.

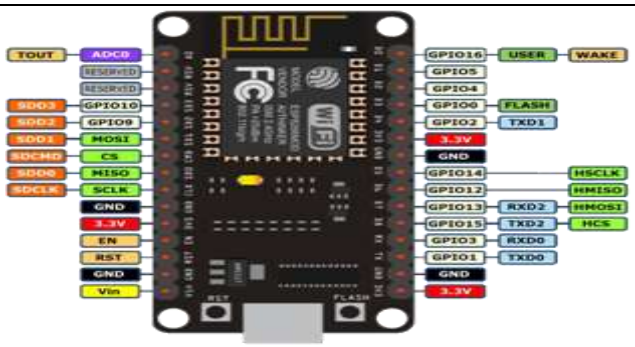
In paper [4] describes that it is dangerous for rescuers to enter mines without first familiarising themselves with the surroundings. Because an explosion might happen. Landslide, gas leak, high temperature, and other factors might all cause an explosion. A robot has been created to detect explosions caused by hazardous gas and high temperatures. The wireless camera on this robot is there for surveillance.

In paper [5] results obtained using a temperature sensor LM35 and the MQ 135 are presented. Wireless sensor network (WSN) based on Zig Bee. Robot enters coal mine, moves around, detects dangerous gas, offers protection from fire and explosion, warns underground dwellers of poisonous gases like CO, CO2, and CH4, and provides safety.

The paper evaluated the performance of wireless sensor network for underground mine's safety monitoring system based on Bluetooth technology. The system consists of MQ-4 is used for detecting hazardous gas and PIR is used for detecting obstacles. And wireless camera is used for live broadcasting [6].

III. NECESSARY REQUIREMENT OF THE PROPOSED SYSTEM

Table 1: Necessary Requirement of the Proposed System

Sr. No.	Components	Description	Structure
1	NODEMCU ESP8266	NodeMCU 8266 is a development board that supports various applications and is versatile enough to support programming languages. Hardware is based on the ESP-12 module with 128kb ram and 4Mb flash memory, and firmware is running on the ESP8266 Wi-Fi SoC from Espressif Systems.	 Fig.1: NODEMCU ESP8266

2	MQ9 Gas sensor	It is used to detect the presence of LPG, methane, Butane, Smoke, and flammable gases etc.	 Fig.2: MQ9 Gas sensor
3	Dht11 sensor	The Dht11 sensor is temperature and humidity sensor.	 Fig.3:Dht11 sensor
4	Esp32 CAM	ESP32 Cam can be used for surveillance as it supports OV2640 and OV7670 cameras with built-in flash. It also supports uploading over Wi-Fi.	 Fig.4: Esp32 CAM
5	L2982A motor driver	It serves as a motor driver module for DC and stepper motors. It can be used to speed- and direction-control 4 DC motors or 2 motors.	 Fig.5: L2982A motor driver
6	4X Gear motor	The motor has four gears. A gear motor is a part whose mechanism varies the motor's speed, causing it to run at a particular speed.	 Fig.6: 4X Gear motor

IV. STRUCTURE OF THE PROPOSED SYSTEM

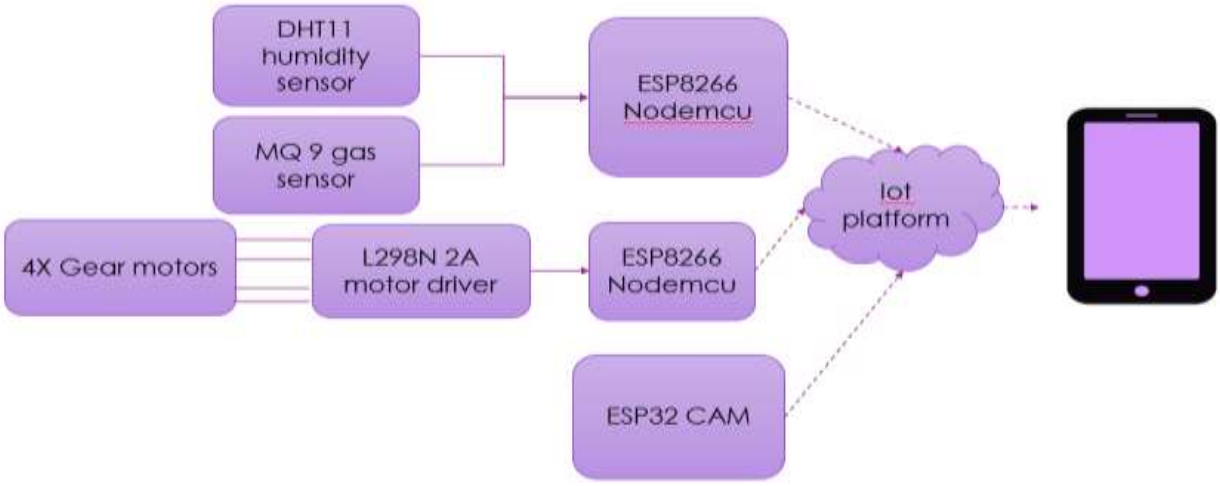


Fig 8. Block Diagram

Fig.8 represents the block diagram of the proposed system. In these system, each sensor will perform their respective working at a time. We use MQ9 gas sensor to measure flammable gases. The Dht11 sensor is temperature and humidity sensor. When system is start first it is connected with wifi if it is not connected with wifi it is not start after wifi connection sensor start their working and all these sensor data goes to the

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Nodemcu ESP8266. Nodemcu ESP8266 module process the code. We write blynk app auth token in code. Using blynk app auth token it connect to blynk server And display on android using blynk app. Blynk is an IoT platform for iOS or Android phones that allows users to remotely control devices like Arduino, Raspberry Pi, and NodeMCU. And we also add one feature is alert Notification. In this feature if dht11 sensor temperature is high and humility is low then alert message is send. That means if temperature is above 37°C and humidity is below 50% then alert Notification send on blynk app. Same as mq9 sensor if detecting range is above 400ppm then flammable gas is there and alert Notification send on blynk.

We have used 4 gear motor and it is been controlled by the L296N 2A motor driver which takes input from the esp8266 node mcu module. The node mcu is connected to the mobile via wifi and the commands to run the robotic car is given by a mobile application.

We have also used an Esp32 CAM module, so that the operator can detect the obstacles by seeing the live broadcasting on the mobile screen, while the robotic car is in the coal mine.

For programming us use Arduino Ide is a cross-platform programme that uses C and C++ functions. With the aid of third-party cores, it may also be used to create and upload applications to other vendor development boards that are compatible with Arduino.

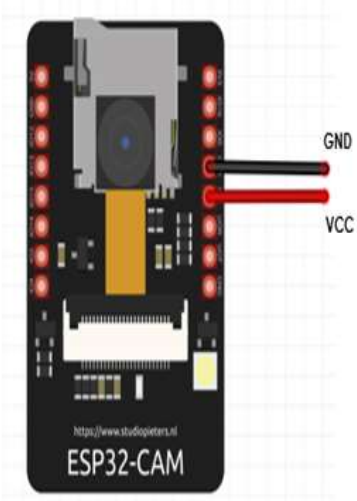

Fig 9. ESP CAM circuit diagram

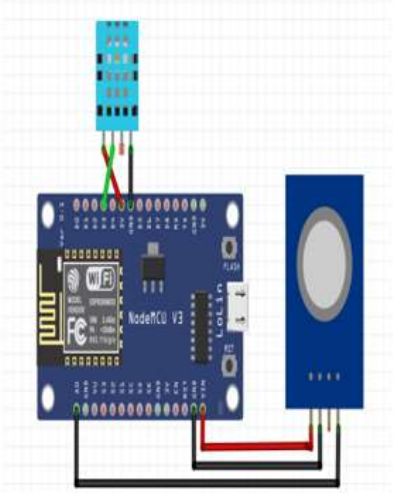

Fig 10. Circuit Diagram of sensor part

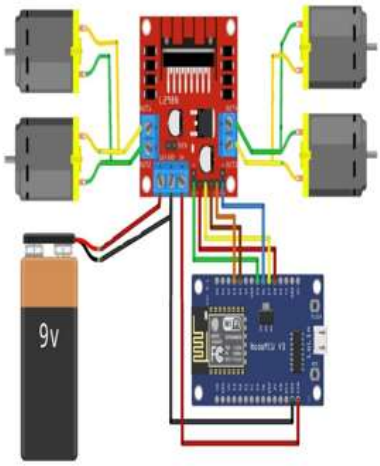

Fig 11. Circuit Diagram of Remote control car

Fig. 9 represent the ESP CAM circuit diagram after upload program. ESP CAM VCC pin is connected to 5volt battery and gnd pin is connected to ground of battery. For program uploading on esp cam we need to connect FTDI cable to TTL and using Arduino ide we upload the code.

Fig. 10 represent the circuit diagram of sensor part. To sensor are connected. First is dht11 sensor. It is operate on 3.3 volt dc. Dht11 sensor data pin is connected to D3 pin of esp8266. And second is mq9 gas sensor. It is operates on 5 volt dc. Gas sensor analog pin is connected to A0 pin of esp8266.

Fig. 11 represent the circuit diagram of remote control car. 4x gear motor is connected to L2982A motor driver. L2982A Motor Driver input and Enable pins is connected to digital pins of esp8266.

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V. RESULT.

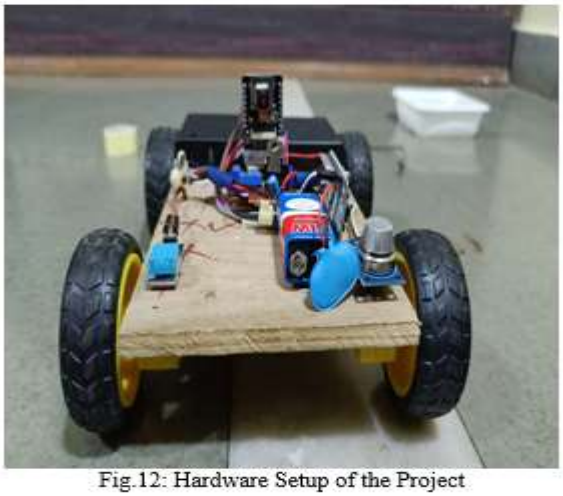

Fig.12: Hardware Setup of the Project

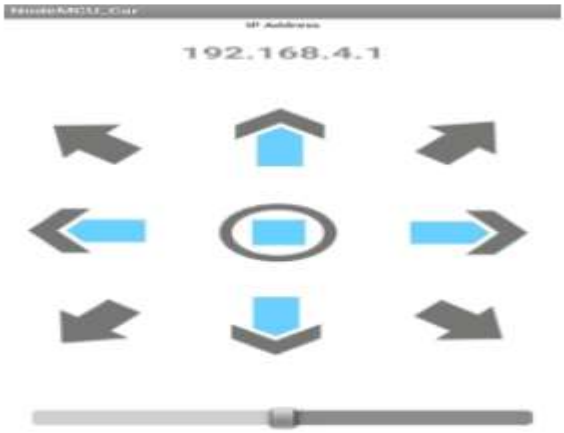

Fig.13: Motor Control Web App

Fig.12 represent the he hardware setup of the project and Fig. 13 is the motor control web app. This app is designed to make it simple for you to construct a straightforward Wifi robot automobile. In addition to allowing you to transfer Arduino sketch/code straight from your Android phone to ESP8266 through USB OTG or Wifi OTA, the software also allows you to drive an ESP8266-based robot vehicle over WiFi. Using this app car move right, left ad other direction as per the instructions.

Fig.14: Sensor Data Displayed

Fig.15: If Flammable Gas is there the Notification Send

Fig.14 represent the sensor data displayed such as temperature is 28.20°C, humidity is 61.0% and flammable gas value is 253ppm. Using the value we know which gas is there like if detecting value range is between 20ppm-2000 then carbon monoxide is there and range vale 500ppm-10000ppm then CH4, LPG gas is there. Fig. 15 represent the alert Notification of flammable gas. In this figure flammable gas is detecting using mq 9 gas detector. This sensor value is goes to above 400pp. That's why alert Notification pop up screen is displayed.

Fig.16: Live Broadcasting

Fig.15 represent the live broadcasting. We have used a web server to display the camera live footage. A particular ip address is assigned by the stm32 cam module which is pasted in the google chrome/browser and we get to the live footage from the camera via the wifi connection.

VI. FUTURESCOPE

- The current project can be further modified by installing fire extinguisher.
- In this project in future we can further implement a system using GPS model to know about location of coal miners.
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VII. CONCLUSION

The main objective of this Safety Monitoring Robot for Coal Mine is to make it more innovative, user friendly, time saving and more efficient. Measuring three parameters such as gas, temperature, humidity and the system also notify flammable gas, high temperature. It can successfully replace the wired communication between the control room and the mine area by connecting both the mediums wirelessly. It can be assembled within a few minutes and can be brought under application very quickly.

VIII.REFERENCES

[1] Jayant Nivritti Patil, "Advanced Rescue And Monitoring Robot For Coal Mine" presented at International Research Journal of Engineering and Technology (IRJET). Volume: 04 Issue: 07 July 2017.

[2] Madhu Nakirekanti, Dr.Raja Murali Prasad, Eliyaz Mahammad, K.Narsimha Reddy, "Coal Mining Safety Monitoring System" presented at IInternational Journal of Mechanical Engineering and Technology (IJMET) Volume 8, Issue 12, December 2017.

[3] Sachin M. Ledange , S. S. Mathurkar, "Robot based Wireless Monitoring and Safety System for Underground Coal Mines using ZigBee" presented at SSRG International Journal of Electronics and Communication Engineering (SSRG – IJECE) – Volume 3 Issue 10 – October 2016.

[4] T.S. Kumar Reddy; G. Balasiva Krishna; "Hazardous gas detecting rescue robot in coal mines", International Journal of Mechanical and Production Engineering, ISSN:2320-2092, volume2, Issue-5, May-2014.

[5] S. D. Mitragotri , Dr.A. R. Karwankar; "Coal Mine Robot for Detection of Hazardous Gas", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, ISSN : 2278 – 8875, Vol. 5, Issue 4, April 2016.

[6] Deepan A, Jayakrishna S V, Nagha abirami S S , Vanmathi M E , Andril Alagusabai; "Detection of Hazardous gas using Land Rover Robot in Mines First", International Research Journal of Engineering and Technology (IRJET), ISSN: 2395-0072, Volume: 05, Issue: 04, Apr-2018

[7] P. Mansi and L. P. Pratap, "Advancement of a wall climbing robot for various applications," International Journal of Engineering & Technology, vol. 5, pp. 9–11, 2016.

[8] Pritesh Chaudhari, Manas A Dani, Mansi Mhalsakant Gajare, Payal D Deshmukh, "Mine Safety Robot" presented at Conference December 2019.

[9] Marco Schwartz, Discover the aREST Framework: Easily control your Arduino, Raspberry Pi & ESP8266 Projects, 2016

[10] W. Qiao, "Analysis and measurement of multifactor risk in underground coal mine accidents based on coupling theory," Reliability Engineering and System Safety, vol. 208, 2012.