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Design Of Unmanned Vehicle For Monitoring And Safety Control In Mines

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ABSTRACT— Miner's health is in peril mainly due to the toxic gases which are fairly often released in underground mines. These gases can't be detected easily by human senses. Miner's health and life is susceptible to several critical issues, which incorporates not only the working environment, but also the after effect of it. The accidents in coal mines are increased day by day. There are numerous life losses of the many skilled workers and laborers. There is no advent precaution measure to detect the alarming explanation for the coalpit accidents and supply an alert system. Occupational accidents and occupational diseases are common in the mining. The most common causes of accidents in coal mining are firedamp and mud explosions, landslips, mine fires, and technical failures associated with transport and mechanization. An analysis of occupational accidents within the consideration of social and economic factors reports that the important causes behind these accidents, which are said to happen inevitably thanks to technical deficiencies or failures.

I. INTRODUCTION

The accident is any uncertain activity thanks to unavoidable circumstances and carelessness of some people. This incident is occurring continuously all round the world. an outsized number of workers (approximately 2.3 million) die annually worldwide, 350,000 due to occupational accidents and approximately 2 million due to occupational diseases. Occupational health is defined as a neighborhood of application during which the consequences of labor life on health are investigated. A public health approach, using the notion of occupational health represents a partial understanding of health, results in defining workplace and work life as outside of public health. the explanations for that are that citizens are seen not as workers but as consumers which work life is removed of the healthcare field. This causes occupational health to detach from public health when organizing healthcare services . the essential area that problems arise in terms of worker's health and safety is that the production activities phase. Production activities contains main activities like excavation, ground support, and haulage also as activities like electricity maintenance, establishing and managing pressurized room networks, communication and signalization systems, and maintenance and repair of varied machines and equipment. especially , accidents in coal mining associated with collapses, pit fires, firedamp and coal dust explosions, haulage, and mechanization frequently occur in underground pits.

II. LITERATURE SURVEY

Topic : Wireless sensor network based on MSP430xx controller Mr. Kumarsagar et al. (2016)

It monitors the smoke, gas, temperature and humidity in an underground mine. this technique also controls

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the ventilation demand to miners depending using upon the monitoring data from the mine. this technique utilizes a wireless Zigbee transceiver for remote logging of knowledge at a central location to regulate the environmental state with the help of a motor and valve control circuitry.

Topic : Real-time monitoring system to provide prompt support for inspecting the health and safety management on construction sites. Berardo Naticchia et al. (2017)

They tested the precise applications of monitoring, interference between teams performing on large construction sites. The system is capable of alert within the occurrence of interference and to log any unexpected behavior.

Topic : Implementation of a platform to remotely monitor and control coal mine production processes over Industrial Ethernet based on the embedded engineering. Zhang Xiaodong et al. (2018)

The issues and faultiness of current coalpit monitoring system were taken into consideration. They examined the plan and. Integrated with each lower computer terminal are S3C2410 microprocessors which will be utilized for linking up to the monitoring network effectively.

III. PROPOSED WORK

The main objective of this proposed work is to monitor different type of flammable and toxic gases and also monitor the temperature and humidity of the surrounding the rover that is implemented in this work is used to help the workers in mine to determine whether the area ahead is safe or not.

A. Hardware Design

There are two units of the monitoring system: Rover and user interface. The rover unit includes Esp32 Microcontoller, Esp32 Camera, Sensors (Mq136, Mq2, Mq5, Dht22) as shown in the block diagram.

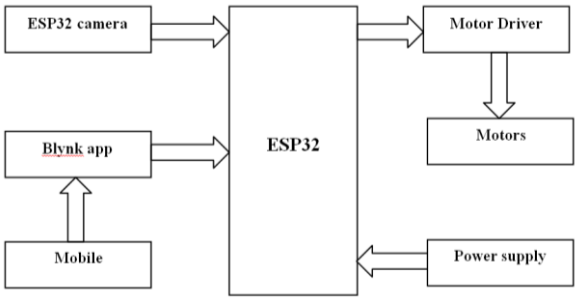

Fig. 1: Block Diagram

B. ESP32 Controller

This is ESP WROOM 32 MCU Module. ESP WROOM 32 may be a powerful, generic WiFi-BT-BLE MCU module that targets a good sort of applications, starting from low-power sensor networks to the foremost demanding tasks, like voice encoding, music streaming, and MP3 decoding.

At the core of this module is that the ESP32S chip, which is meant to be scalable and adaptive. There are 2 CPU cores which will be individually controlled or powered, and therefore the clock frequency is adjustable from 80 MHz to 240 MHz.

TABLE I. Specifications

Specification	
Processor	Two Low-Power Xtensa 32-bit LX6 Microprocessors
Operating voltage (v)	3.0V – 3.6V
Operating current (mA)	80
Clock Frequency (MHz)	80 ~ 240
Flash memory (MB)	4
Data Rate (Mbps)	150
SRAM Memory (KB)	520
Length (mm)	28
Width (mm)	50
Height (mm)	14
Weight (gm)	10
Shipment Weight	0.015 kg
Shipment Dimensions	6 × 8 × 2 cm

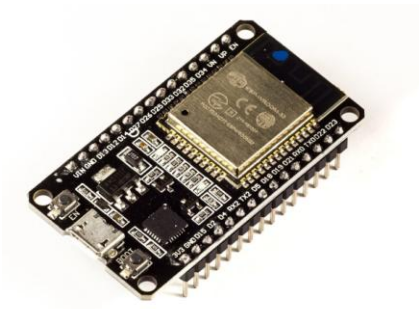

Fig. 2: ESP32 Microcontroller

ESP32 Camera

The ESP32-CAM is an Ai-Thinker's Original ESP32 CAM WiFi+Bluetooth with OV2640 Camera Module supported the ESP32 chip with the more facility of using a digital digicam. It is good for diverse IoT applications. The ESP32-CAM capabilities a completely aggressive small-sized

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digital digicam module as a way to perform independently at least gadget.
Ai-Thinker ESP32 CAM are frequently broadly applied in diverse IoT applications. It is appropriate for domestic clever devices, business wi-fi control, wi-fi monitoring, QR wi-fi identification, wi-fi positioning gadget alerts and different IoT applications. It is an ideal answer for IoT applications.

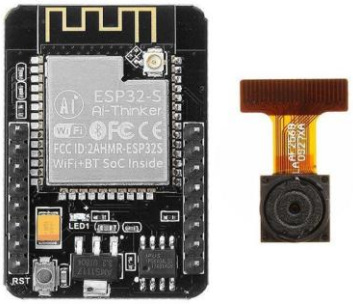

Fig 4: ESP32 Camera

C. Hydrogen sulphide sensor(MQ-136)

In MQ-136 gas sensor SnO2 is used as sensitive material with the lower conductivity in the clean air. When the target H2S gas exist, the sensor's conductivity increases along with the g as concentration increase.

Fig. 4: MQ-136 Sensor

MQ-136 sensor comprised of by micro AL2O3 as ceramic tube, Tin Dioxide (SnO2) as sensitive layer, heater and measuring electrode are fixed into the crust which is made by stainless steel net and plastic.

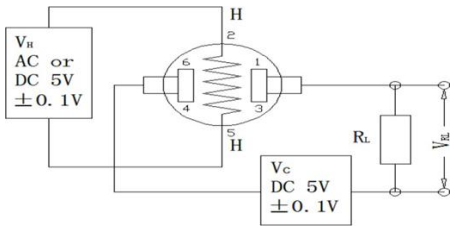

Fig 4: MQ-136 Test Circuit

D. Methane Sensor (MQ-2)

It is used for detecting methane.

Features

- Good sensitivity for Combustible gas
- High sensitivity to Methane
- Long life and low cost
- Simple drive circuit

Fig 4: MQ-2 Sensor

In the wiring of the sensor is both 'A' pins and both 'B' pins are connected together. It is a safer phenomenon and it is having more reliable output results.

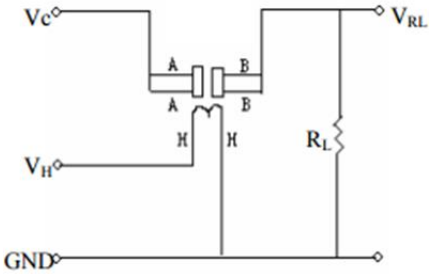

Fig 4: MQ-2 Sensor Wiring Circuit

E. Natural Gas Sensor (MQ-5)

The MQ-5 gas sensor uses a small heater inside it with an electro-chemical sensor. According to need it can be calibrated but for this a known concentration of the measured gas or a group of gasses is needed. Analog output is given by this and can be read by anlog input of the Arduino.

The sensor is comprising Tin Dioxide (SnO2) sensitive layer, micro AL2O3 ceramic tube and heater and measuring electrode are fixed within a crust which is made by plastic and stainless steel net.in MQ-5 6 pins are there out of which 4 are used to give signals and remaining 2 are current-availiation. for the heater some sensors use 5V, others need 2V. the heater should be on for about 3 minutes After the "burn-in time".

Fig 4: MQ-5 Sensor

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Features

- High sensitivity to natural gas, LPG, town gas.
- Small sensitivity to smoke, alcohol.
- Fast response.
- Stable and long life.
- Simple drive circuit
- Wide detection range
-

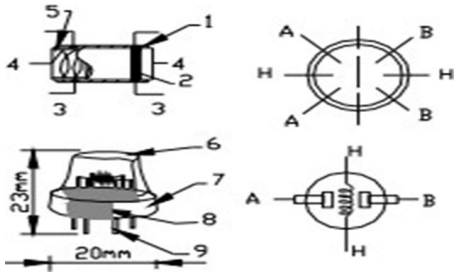

Fig 4: Structure of MQ-5 sensor

F. H-Bridge

L298N 2A DC Motor Driver Module is a excessive energy motor driving force best for using DC Motors and Stepper Motors. It makes use of the famous L298N motor driving force IC and has on board 5V regulator which it could deliver to an outside circuit. It can manage up-to four DC cars, or 2 DC cars with directional and pace manage.

This motor driving force is best for robotics and mechatronics tasks and best for controlling cars from microcontrollers, switches, relays, etc... Perfect for using DC and Stepper cars for micro mouse, line following robots.

Fig 4: DC Motor Drive

TABLE II. Specification

Specification	
Driver Model	L298N 2A
Driver Chip	Double H Bridge L298N
Motor Supply Voltage(Maximum)	46V
Motor Supply	
Current(Maximum)	2A

TABLE II. Specification

Specification	
Logical Voltage	5V
Driver Voltage	5-35V
Driver Current	2A
Logical Current	0-36mA
Maximum Power (W)	25W
Length (mm)	44 mm
Width (mm)	44 mm
Height (mm)	28 mm

G. DC Motor

30 RPM Centre Shaft DC Motor is excessive best low fee DC geared motor. The entire meeting is included with a plastic ring. DC Motor – 30RPM – 12Volts geared vehicles are typically a easy DC motor with a gearbox connected to it. This may be utilized in all-terrain robots and sort of robot applications. These vehicles have a three mm threaded drill hollow withinside the center of the shaft accordingly making it easy to attach it to the wheels or another mechanical meeting.

30 RPM 12V DC geared vehicles extensively use for robotics applications. Very clean to apply and to be had in preferred size. Also, you don't should spend plenty of cash to manipulate vehicles with a Raspberry pi or well matched board. The maximum famous L298N H-bridge module with onboard voltage regulator motor driving force may be used with this motor that has a voltage of among five and 35V DC or you could pick out the maximum specific motor diver module from the huge variety to be had in our Motor diver's class as in keeping with your precise requirements.

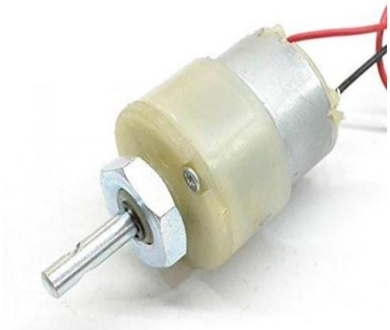

Fig. 4: DC Motor

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TABLE III. Specifications

Specification	
Gear Material	Metal
Rated RPM	30
Operating Voltage(VDC)	12
Rated Torque(kg-cm)	4.5
Stall Torque(Kg-Cm)	18
Load Current(A)	0.42
No-Load Current	60mA
Gearbox Diameter (mm)	36
Motor Diameter(mm)	32
Motor Length(mm)	75
Shaft Diameter (mm)	6
Shaft Length (mm)	22
Weight (gm)	90

H. Software Design

The whole design is designed in the arduino platform. The rover is then controlled using Blynk application on the mobile. The whole module is connected with a particular wifi which is encoded in the esp32 microcontroller. The mobile is also connected with the same wifi as the rover. The movement key is provided in the blynk app as the rolling switch. The esp32 camera is connected through the wifi and displays the contents to a specific ip address.

I. Arduino IDE

The Arduino incorporated improvement environment (IDE) is a crossplatform application (for Windows, macOS, Linux) this is written withinside the programming language Java. It is used to put in writing and add applications to Arduino well suited boards, however also, with the assist of third birthday birthday celebration cores, different dealer improvement boards.

The supply code for the IDE is launched below the GNU General Public License, model 2. The Arduino IDE helps the languages C and C++ the usage of unique regulations of code structuring. The Arduino IDE elements a software program library from the Wiring project, which affords many not unusualplace enter and output procedures.

Fig. 4: Arduino IDE

J. Blynk Application

Configure the Blynk App:

- Download the Blynk App from Google play store or Apple store.
- Create a new project in the Blynk app. Enter the project name and choose the device. In this IoT project, I have used NodeMCU, so I have selected NodeMCU.
- After that Blynk will send an Auth Token to the registered email id. The Auth Token will be required while programming the ESP8266.

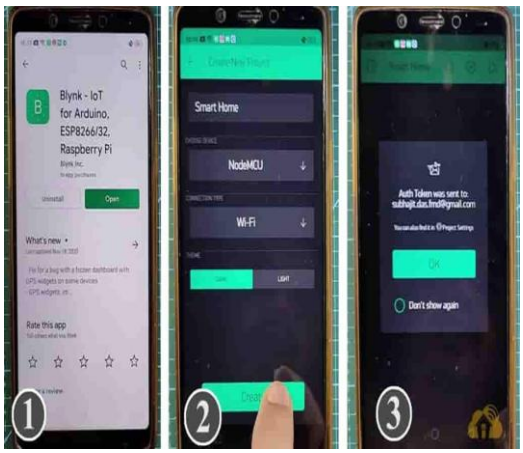

Fig. 4: configure Blynk app

IV. IMPLEMENTATION

The sensor unit is placed on top of the rover model and attached firmly. The esp32 microcontroller is connected to the same wifi as that of the mobile and after the connection is established the rover is tested for the movement and the gas sensors are tested with the help of different gases. As the gas level gets higher than the pre defined value that is coded in the microcontroller it gives an alert signal in blynk app bby signalling the user by a on button and by using the specified ip address we can monitor the details through the camera.

A. Work Flow

The work flow of the model is given in the form of steps below:

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Step 1: Take input through gas, humidity and temperature sensor.
Step 2: Input data is compared with their threshold value.
Step 3: If data is above the threshold value, it is notified to the user through phone/laptop.
Step 4: Data is transmitted to the user interface unit through wireless sensors.
Step 5: Data is displayed on user interface.

B. Hardware Setup

The fig below shows the complete rover model with the sensing unit attached to the top. The complete model is made with the help of pvc pipe as they are hollow and therefore contributes less weight. We have incorporated 6 off-road purpose tires due to which it will be easier to converse a rough terrain.

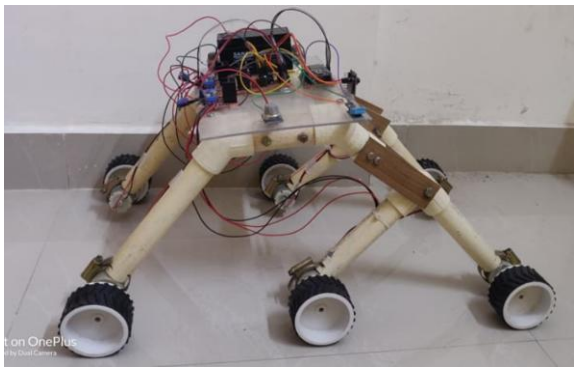

Fig. 4(a): Hardware setup of the proposed model

These motor drivers are connected in parallel to ensure equal voltage drop across them. All the dc motors will be powered by the 12v dc supply from the battery which is attached with the sensing unit on the top. As the other units require 5v of supply the dc motors are directly connected to the supply as they require 12v of supply while the others are provided through a voltage regulator to grasp on the 5v through the battery.

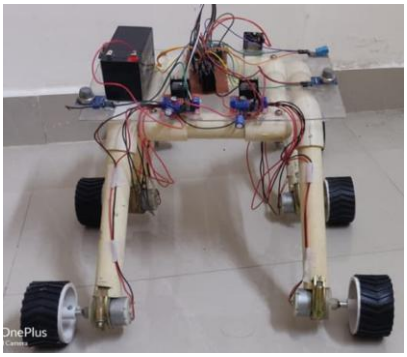

Fig. 4(b): Hardware setup of the proposed model

C. Software Setup

The sensing unit of the system is attached to the top part of the rover model. This model is then powered by a 12v battery supply which is also attached to the top part along with the sensing unit. All the sensors which includes MQ2, MQ5, MQ136 and Humidity and Temperature sensors are attached to the top part with the help of a glue gun which is then connected to the pin board through which it is connected to the esp32 microcontroller. There are 2 motor drive controllers which are also connected to the esp32 microcontroller through the pin board. All of these sensors as well as the motor drive controller and the esp32 microcontroller are being supplied with the help of the battery.

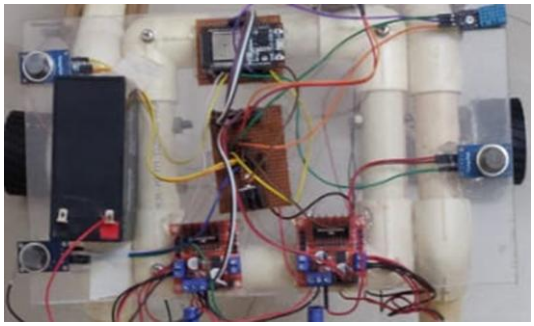

Fig. 4: Sensing unit of the proposed model

V. RESULTS AND DISCUSSIONS

The utilization of any module designed can only be verified after it is used and desired results are achieved. After the design of circuit, it is required to verify the working of the module and also it should be verified for desired results. For this purpose, the module should be tested for different gasses, temperature and humidity accompanied by a regular monitoring of desired output.

a) TESTING OF THE MODULE

The module was tested in the laboratory for natural gasses, CH4 and H2S individually. The values of each gas were obtained at an interval of 0.5 sec and the obtained value was compared with the atmospheric value of the gas.

b) TESTING OF H2S GAS

The module was tested for H2S gas. The MQ136 sensor detects the concentration of H2S gas in the atmosphere and it is displayed in the ARDUINO IDE window as shown in the figure and graph is illustrated in the figure.

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Fig. 4: Output in Blynk app

c) TESTING FOR CH4 GAS

The module was tested for CH4 gas. The MQ2 sensor detects the concentration of CH4 gas in the atmosphere and it is displayed in the ARDUINO IDE window as shown in the figure and graph is illustrated in the figure.

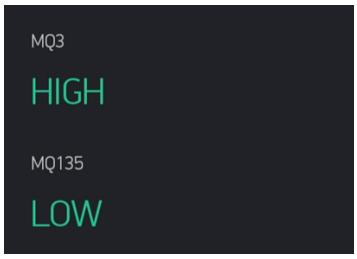

Fig. 4: Output of Blynk app

d) TESTING FOR NATURAL GASSES

The module was tested for CO gas. The MQ-5 sensor detects the concentration of CO gas in the atmosphere and it is displayed in the ARDUINO IDE window as shown in the figure and graph is illustrated in the figure.

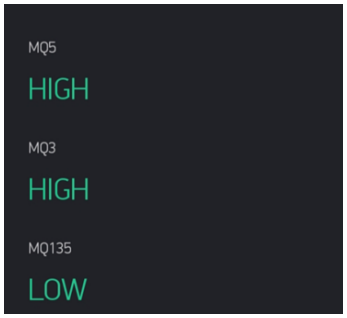

Fig. 4: Output in Blynk app

e) TESTING FOR HUMIDITY AND TEMPERATURE

The module was tested for different temperature and humidity by placing it at different places at different time of the day to check whether the temperature and humidity are updating regularly and sending the updated value to the blynk app.

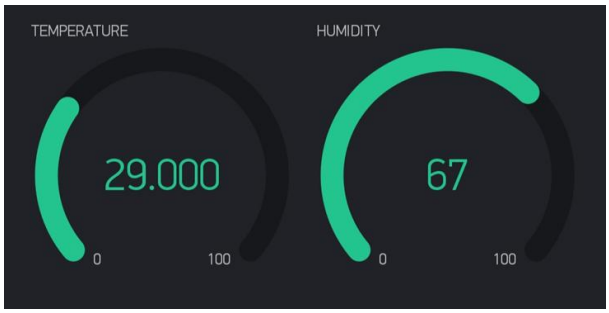

Fig. 4: Temperature and Humidity readings

f) TESTING FOR ROVER MOVEMENTS

The module was tested for the movement of the rover in rough terrain. The movement of the rover is mainly controlled by the mobile application using the blynk software. A movement roller is installed in the blynk app through which all the movements are controlled.

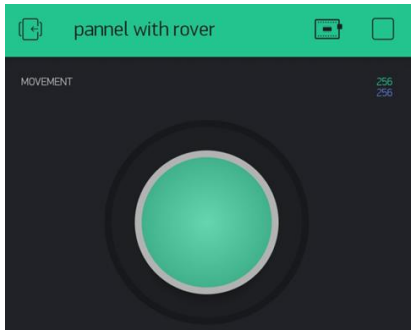

Fig. 4: Rover Movement controller

VI. CONCLUSION

The designed actual time fueloline tracking gadget is applied on order to discover the fueloline awareness and the subsequent conclusions have been obtained:

- The designed module offers the right price of fueloline awareness.
- Each node in a selected framework capabilities because the pioneer robotic while all its parameters are configured properly.
- Sensor nodes can reconfigure remotely over a wi-fi community and maximum of the processing accomplished in software program on laptop side.
- The calibration equations of fueloline sensors may also have affected the accuracy of the ppm results..

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