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Coal Mine Helmet

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Abstract: *The Coal Mining Helmet designed in this paper aims to provide safety to miners by alerting them. All the factors can be noted only if the person is wearing the helmet. The output from the helmet module keeps updating every second i.e., real time data is been updated to the cloud. These wearable devices get to share their data or retrieve the data through other source by making use of internet of things. Alerts are sent to the miner and the supervisor if any threat is detected. Ubiquitous computing and wearable computers have contributed hugely to the evolution of wearable devices. Thus, this wearable device incorporates the various sensors, alerting mechanism and communication system to develop and enhance safety of the miner. The hardware comprises of data collection, data processing and data communication sections. Sensors employed a) Temperature and humidity sensor (DHT11): In mines, the level of temperature and humidity becomes high at times and prove to be fatal to the miner. The liberation of these gases could lead to breathing problem to the person inside the mines and could lead to choking. If one or more of these quantities exceed the threshold limit, an alert is sent to the miner as well as the base Authorizer. The data collection or measuring of the parameters is done using WSN technology. WSN technology is a network of sensors, where each of the sensors has different parameters to sense yet perform together as a part of the system. The level of temperature and humidity is known to the miner by displaying it on an OLED (Organic LED) and for the gas a threshold is set and a buzzer alert is given if it is beyond the threshold.*

Keywords: OLED (organic LED), Humidity sensor (DH11), MQ2, Arduino

I. INTRODUCTION

The world is having extensive and diverse mineral resources and large mining industry. Proper supervision and proper communication is very important requirement of the mining industry. Supervisors are held responsible for all injuries sustained under their supervision, and should therefore be aware of potentially risky situations. The issue being addressed is the enhancement of a mining helmet in order to increase miner safety awareness.. When working with noisy equipment, being aware of one's surroundings can sometimes be challenging. Miners in the mining business frequently remove some of their safety equipment because it is too heavy, heated, or uncomfortable to wear Miners, on the other hand, rarely remove their helmets. Presently mining safety helmets only have the purpose of protecting the miner's head against potential hazardous bumps No technology has been put to the safety helmets to alert miners when a fellow miner has encountered a hazardous incident.

As a result, the project's goal is to add a wireless sensor node network to an existing mining safety helmet in order to make it even safer. The goal was expanded to include designing a system that could fit inside a safety helmet and last long enough on battery power.

Another issue was modifying the helmet's physical design without compromising its function. The additional weight had to be kept as light as possible. A mining helmet must be changed to improve miner safety by incorporating intelligence When a miner removes his helmet, A miner must be told before removing his helmet.

If an object falls on a miner even when wearing his helmet, he can become unconscious or immobile. The system must decide whether a miner has suffered a potentially fatal injury. These two events are defined as hazardous events. Thirdly ,dangerous gases need to be detected and announced.

1.1 Architecture

The system architecture is divided into two parts transmitter part and receiver part transmitter part consists - Gas sensor, Temperature and Humidity sensor, LDR, and Power supply. Then there is Arduino Uno and in the receiver section there is

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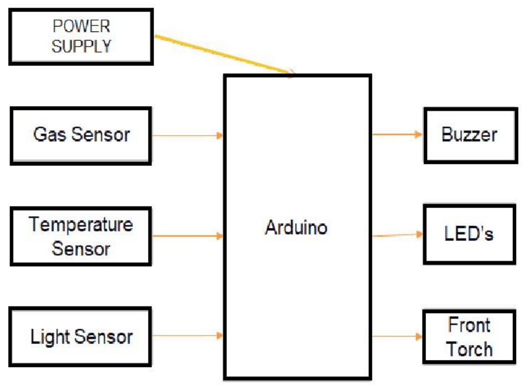
a buzzer and LED. When the miner enters, he activates the helmet circuitry. The temperature and humidity sensor DHT11 observes the surrounding temperature and humidity continuously and checks if the worker is safe or not and saves the data. Hence when temperature or humidity any one of the conditions becomes unfavorable for the workers, safety measures could be taken means the LED will blink and indicate that it is not safe for the worker. The gas sensor i.e., MQ2 sensor detects poisonous gases like ethane, methane, butane, etc., and if such gas is detected then the buzzer will be turned ON and it will start beeping and The system must decide whether a miner has suffered a potentially fatal injury. This helps n avoiding the exposure of workers to the harmful toxic gases.

1.2 Block Diagram



1.3 Working of Sensors

A. MQ2

MQ2 is a metal oxide semiconductor-type gas sensor. A voltage divider network in the sensor is used to monitor gas concentrations in the gas. A sensing element, mostly aluminum-oxide-based ceramic covered with Tin dioxide, is contained in a stainless-steel mesh in this sensor. Six connecting legs are linked to the sensor element. The heating of the sensing element is handled by two leads, while the output signals are handled by the remaining four. When a sensor material is heated to a high temperature in air, oxygen is adsorbed on the surface. The donor electrons in tin oxide are then drawn to this oxygen, blocking the current from flowing. When reducing gases are present, these oxygen atoms react with the reducing gases, lowering the adsorbed oxygen's surface density.

Now that current can flow through the sensor, analogue voltage values can be created. These voltage values are used to determine the gas concentration. When the gas concentration is high, the voltage values are higher.

B. DHT11

DHT11 is a low-cost digital sensor for sensing temperature and humidity Any microcontroller, such as Arduino or Raspberry Pi, may readily communicate with this sensor to measure humidity and temperature instantaneously.

A capacitive humidity detecting element and a thermistor for temperature detection make up the DHT11 sensor. A moisture-holding substrate acts as a dielectric between the humidity sensor capacitor's two electrodes. With changes in humidity levels, the capacitance value changes.

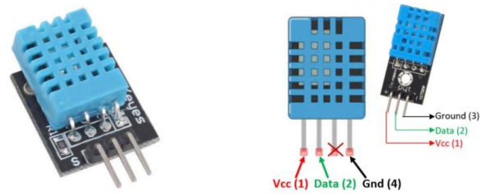


Figure 3: DHT11 Sensor

The IC measure, process these changed resistance values and changes them into digital form. This sensor measures temperature with a Negative Temperature Coefficient Thermistor, which decreases resistance as temperature rises. To get a larger resistance value even for the smallest change in temperature, this sensor is usually made up of semiconductor ceramics or polymers. DHT11 has a temperature range of 0 to 50 degrees Celsius with a 2-degree accuracy. The humidity range of this sensor is from 20 to 80% with 5% accuracy.

This sensor's sampling rate is 1Hz, i.e. it gives one reading for every second DHT11 is a tiny transistor with a 3 to 5 volt working voltage. During measurement, During measurement, the maximum current used is 2.5mA..

VCC, GND, Data Pin, and a not connected pin are the four pins on the DHT11 sensor For communication between the sensor and the microcontroller, a pull-up resistor of 5k to 10k ohms is provided.

C. LDR

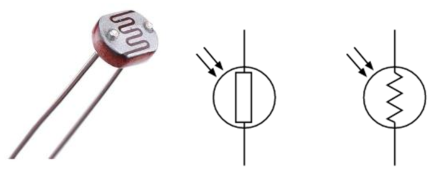


Figure 4: LDR

An electronic component like LDR or a light-dependent resistor is responsive to light. Once light rays drop on it, then immediately the resistance will be changed. The working principle of an LDR is photoconductivity, which is nothing but an optical phenomenon. The materials conductivity improves when light is absorbed by the substance. When light shines on the LDR, the electrons in the material's valence band rush to the conduction band. However, the photons in the incident light must have an energy greater than the band gap of the incident light As a result, when light has a lot of energy, more electrons are stimulated to the conduction band, resulting in a lot of charge carriers. When the effect of this process and the flow of the current starts flowing more, the resistance of the device decreases.

D. Algorithm

1. Start
2. Import DHT11 libraries and define the pins of DHTPIN as 2 and DHTTYPE as DHT11.
3. Set the smokeA0 variable to A0, the buzzer to 11, and the light and gled to 10.
4. In the Setup, the function defines the input and output pins using pinMode and usingserial begin to start the Arduino. The input pins are SmokeA0 and DHTPIN and the output pins are green led and buzzer.
5. In Loop function read the sensor value of MQ2 using analog read and if the sensor value is greater than 300 then print that smoke is detected and also keep a delay of 2 sec between two values.
6. Read the LDR as analog read and store it in a light variable if the value of light if there are fewer than 500, print Keep the light intensity low if the light value is greater than the print value, keep the light intensity low and turn it on; if the value of light is greater than print, keep the light intensity high and turn it off.
7. In DHT11 use the inbuilt function such as readHumidityto get humidity and readTemperature to get the temperature and store them in humi and tempc variable respectively, if the value of humi is greater than 22 or tempc is greater than 33 then turn the gled on.
8. stop

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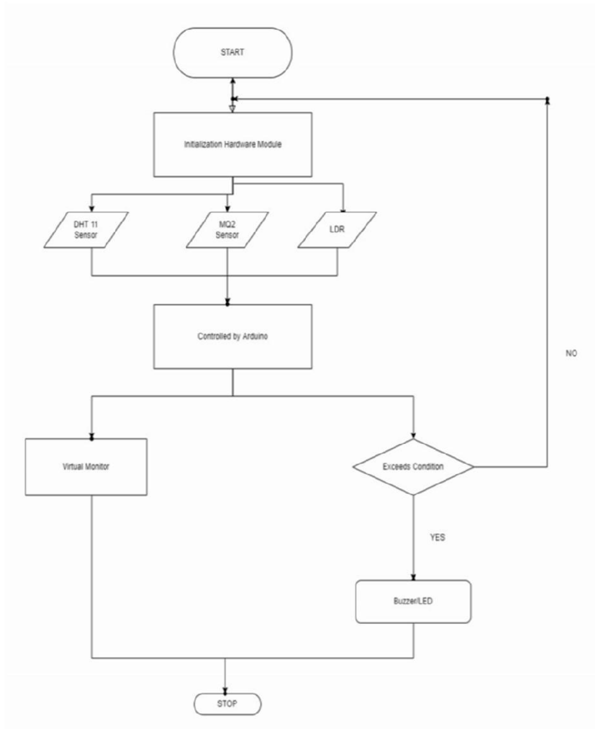
D. Flowchart

Figure 5 shows the flowchart of the coal mining helmet. The system will start up initially. The Arduino will receive the data from the DHT 11, MQ 2, and LDR register and sensors.

The Arduino will compare the predefined conditions with the existing ones to find the difference. If the real-time readings cross the predefined values, then the output will be given through a buzzer and LEDs.



E. Formulae

MQ2

- Sensor Voltage = AnalogReading * 3.3V / 4095
- LPG sensor: PPM = 26.572*e^(1.2894*V_RL)
- Methane sensor: PPM = 10.938*e(1.7742*V_RL)
- CO sensor: PPM = 3.027*e^(1.0698*V_RL)
- V_RL = Sensor Voltage

DHT11

- Relative Humidity = (density of water vapor / density of water vapor at saturation) x 100%
- Absolute=Mass(vapor) / volume. Unit-grams/m3
- Specific: Mass(vapor) / total mass.
- Dew Point: Temperature (above 0°C) at which the water vapor in a gas condenses to liquid water)
- Frost POINT: Temperature (below 0°C) at which the water vapor in a gas condenses to ice

LDR

The resistance of the Light Dependent Resistor (LDR) varies according to the amount of light that falls on it. The relationship between the resistance RL and light intensity Lux for a typical LDR is

$$RL = 500/Lux \quad (1)$$

If the LDR is connected to 5V through a 3.3K resistor, using the voltage divider rule, the output voltage of the LDR is

$$Vo = 5(RL/(RL + 3.3)) \quad (2)$$

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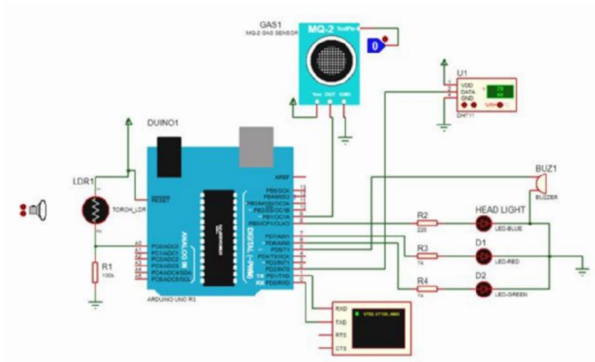
Substituting RL from equation (1)into equation (2), we obtain the light intensity Lux = ((2500/Vo)-500)/3.

II. CIRCUIT DIAGRAM AND WORKING

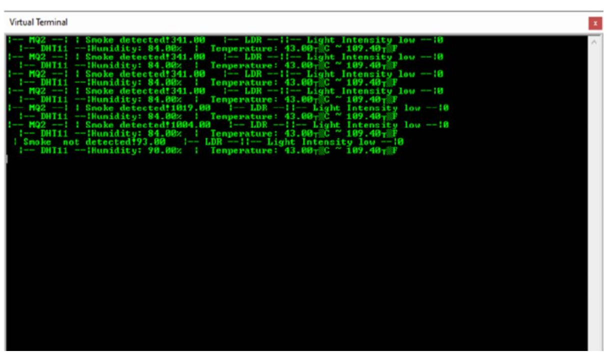


The above circuit diagram consists of components such as Arduino UNO, MQ2 sensor, Dht11 sensor, Ldr resistor, and three led. we have a common VCC for most devices and is connected with pin reset to the left we have LDR the negative pin of LDR is connected to the ground and the Positive end is connected with a resistor of 100K ohm at A0 pin the output of Ldr is given with blue LED which is connected to the output pin 8.

MQ2 sensor consists of three pins the VCC, Ground, and output the output pin is connected to pin 9, and output is given with Red LED and buzzer. DHT11 sensor consists of 3 pins VCC, Ground, and Data the data pin is connected to the output pin 2 and the output is given with green led

III. TESTING/ OUTPUT

The output of MQ2, LDR, DHT11 are shown respectively on the virtual terminal. Apart from this the real time notification or alert for MQ2 will be given by the buzzer, for DHT11 output can be seen in green LED and for LDR output can be seen in red LED.



IV. COMPARISON

4.1 MQ2, MQ3, MQ5

Symbol	MQ-2	MQ-3	MQ-5
Gas Detection	Combustible Gas, Smoke	Alcohol Vapour	LPG, Natural Gas
Detect Concentration	300 – 10000 ppm	0.04 – 4mg/L alcohol	300 – 10000 ppm

A. DHT11 and DHT22

Parameter	DHT11	DHT22
Temp. Measurement Range	0 to 50 Deg. C	-40 to 80 Deg. C
Temp. Accuracy	+- 1 to 2 Deg. C	+- 0.5 Deg. C

Relative Humidity Range	30% to 90%	0% to 100 %
Relative Humidity Accuracy	+- 4% to 5%	+-2% to 5%
Operating Voltage	3.3 V to 5V	3.3 V to 5 V
Resolution	8 bits	16 bits
Sampling period	>=1 sec	>=2 sec

V. FUTURE SCOPE

The plan is to include a wi-fi module that can collect all the necessary info and update it in the database. The data will be sent continuously, therefore the database will contain the real-time on-site environment details. The database will then be made available remotely so that the supervisors and higher authorities can take care of in case of any hazardous condition and the medical help can be made available sooner. The GPS module will help the emergency department to locate the miners in case of dangerous situations and to send help sooner.

VI. CONCLUSION

We have successfully made a smart helmet for miners that can detect gases, humidity, temperature, and light. The threshold values have been manually set but can be updated as per the normal scenario of the mining sites. In case of any unpredictable scenarios the changes will be detected by the sensors and if hazardous the notification can be received in the form of change in LED color and alarm from buzzer so that the miner can act accordingly. We have also integrated a GPS module which can give real time position of miners in case they are unreachable.

1. This system has built a monitoring system for underground environmental of coal mine based on wireless sensor network, which can monitor data in real time.
2. It can realize information interaction between mine terminal and mine and alarm abnormal environmental parameters.
3. This system has the advantages of convenient networking, good flexibility and expansibility, low installation and maintenance cost.

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