Smart Helmet Using IoT for Industrial Workers

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***Abstract*— The project aims to reduce the casualties that are caused by improper safety measures that are placed in industries that deal with toxic gases, chemicals, and harsh working conditions. This is achieved by the Internet of Things Technology. A Smart Helmet equipped with multiple sensors collects data on the personnel and the surroundings, and a microcontroller unit is connected to process the data collected by these sensors. The data collected would be sent to the ThingSpeak cloud platform, to be monitored.**

Keywords - Sensors, ESP32, Internet of things, ThingSpeak, Smart Helmet.

I. INTRODUCTION

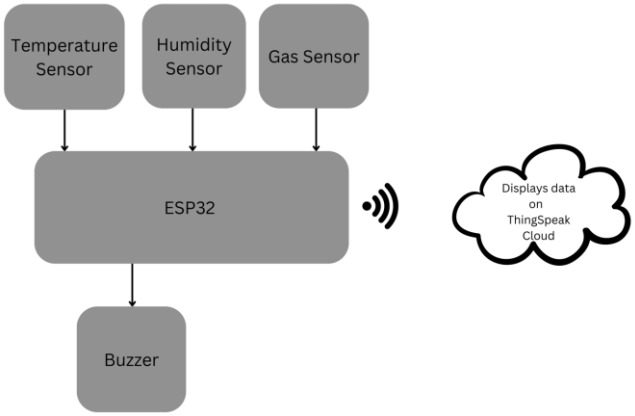
In India from May to December of 2020, around around 64 accidents were reported where 118 workers were killed, and several hundreds were injured. From January to June 2021, over 117 workers were killed, and about 142 workers were injured in about 52 industrial accidents in the mining and chemical sectors[1]. A major reason for these accidents is mediocre safety measures that are put in place in the industries.

Industrial safety is a major concern and one of the main aspects in various industries such as construction, mining, manufacturing, the oil and gas industry, shipbuilding, etc. Working hazards include but are not limited to suffocation due to extreme temperatures, chemical poisoning, and asphyxiation.

This project aims to reduce the casualties by introducing a safety helmet using IoT technology. The Internet of Things (IoT) refers to the network of physical objects, devices, vehicles, buildings, and other items embedded with sensors, software, and connectivity capabilities to collect, exchange, and act on data. The fundamental idea behind IoT is to enable everyday objects to communicate and interact with each other over the internet, creating a seamless and intelligent network of interconnected devices.

The purpose of this Smart Helmet is to monitor the status and the surrounding environment. The helmet is equipped with various sensors such as a temperature sensor, humidity sensor, and gas sensor. The data that is collected by the sensors is processed by a microcontroller unit. The controller unit then sends the data to the ThingSpeak cloud service where the sensor data can be monitored. When an abnormality is discovered in the sensor data an alert can be sent back to the microcontroller unit to alert the personnel wearing the helmet. A quick response formed by collecting data in real-time could reduce the safety hazards by a large factor.

II. BLOCK DIAGRAM



III. HARDWARE COMPONENTS

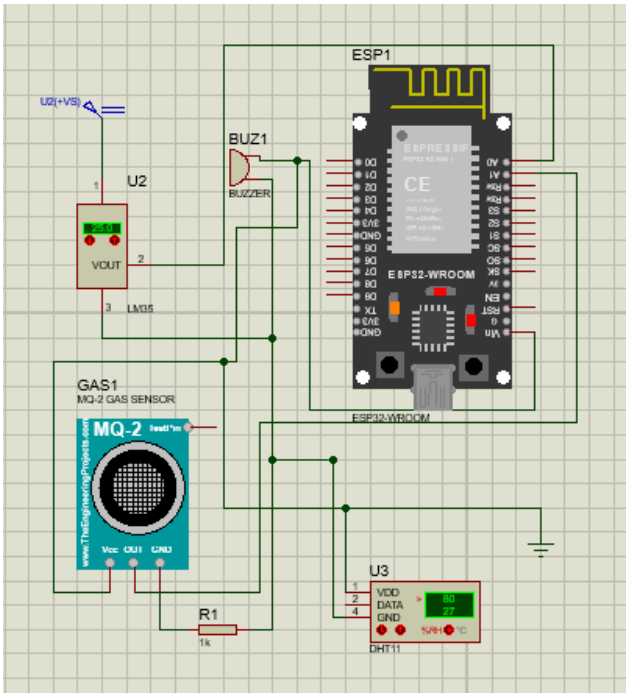
1) ESP32 Microcontroller
2) Buzzer
3) LM35 Temperature Sensor
4) Arduino MQ-2 Gas Sensor
5) DHT11 Humidity Sensor

IV. SOFTWARE COMPONENTS

ESP32 is programmed using C programming language in Arduino Integrated Development Environment (IDE).

ESP32 microcontroller is connected to the cloud using its inbuilt WiFi module. It reads and sends sensor data to the Thingspeak server.

V. CIRCUIT DIAGRAM



VI. OPERATION

The circuit comprises sensors, communication modules, and a microcontroller. The sensors used are:

1. *DHT11 HUMIDITY SENSOR*

The DHT11 is a basic digital temperature and humidity sensor and has an operating range between 0 to 50 degrees Celsius and humidity between 20-80%. The sensor communicates over a single-wire digital interface. It sends a signal to the microcontroller in the form of a pulse whose duration represents the temperature and humidity values. It has a low power consumption and typically operates at 3.3V or 5V DC.

2. *LM35 TEMPERATURE SENSOR*

The LM35 is a popular analog temperature sensor that provides an analog voltage output proportional to the temperature in degrees Celsius. It typically operates in a temperature range from -55°C to 150°C. However, for many applications, the common operating range is 0°C to 100°C.

3. *ARDUINO MQ-2 GAS SENSOR*

The MQ-2 is a gas sensor module that is commonly used with microcontrollers for detecting various gases in the environment. It is sensitive to gases such as methane, propane, carbon monoxide, alcohol, and smoke. The sensor operates on the principle of resistance changes in response to the presence of different gases.

These sensors send analog data based on the way they are implemented. They sense the environment and each measured parameter is sent to the ESP32 microcontroller board in real time.

The ESP32 is a versatile and widely-used system-on-chip (SoC) microcontroller developed by Espressif Systems. It is known for its dual-core processor, integrated Wi-Fi and Bluetooth capabilities, extensive peripheral interfaces, and low power consumption. The ESP32 is popular in the field of IoT (Internet of Things) and embedded systems, offering a range of GPIO pins, memory options, and compatibility with various development environments such as the Arduino IDE. The ESP32 microcontroller pinout and specifications are as follows:

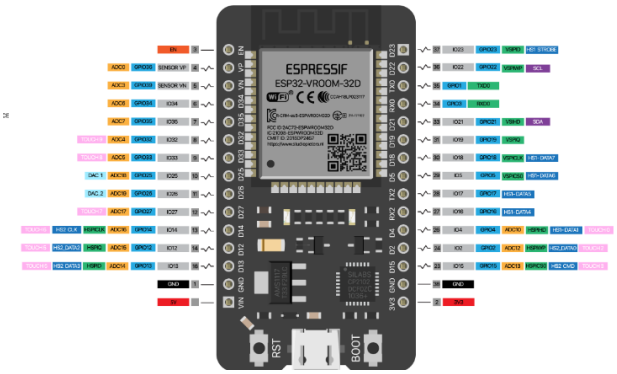


Fig.1(a) ESP32 Pinout

Specifications	
Operating Voltage	2.2V to 3.6V
GPIO	36 ports
ADC	14 ports
DAC	2 ports
Flash memory	16 Mbyte
SRAM	250 Kbyte
Clock Speed	Up to 240 MHZ
Wi-Fi	2.4 GHz
Sleep Current	2.5 µA

Fig.1(b) ESP32 Specifications

The data received by the ESP32 is processed and sent to the Thingspeak cloud server through the WiFi module. The obtained data can be viewed on the server where its accuracy can be tested and verified and conclusions can be drawn based on the observed data. Whenever any one of these sensors crosses a set threshold value, the buzzer will switch on, indicating a safety hazard. Further necessary safety measures, precautions, and improvements can be made in the working conditions for industrial workers based on the collected data.

VII. RESULTS

A ThingSpeak channel by the name “Smart Helmet for Industrial Workers” is made which records the real-time values obtained from the sensors mentioned previously. Each sensor data is displayed on a different chart to draw observations.

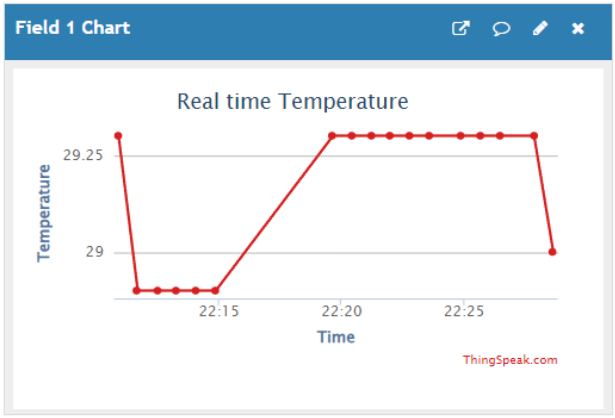


Fig.2 Temperature values

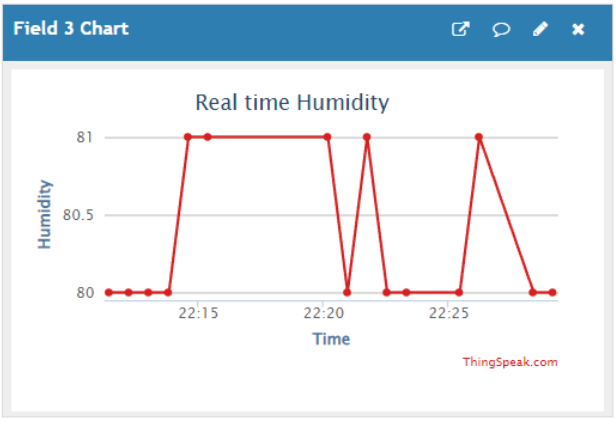


Fig.4 Humidity values

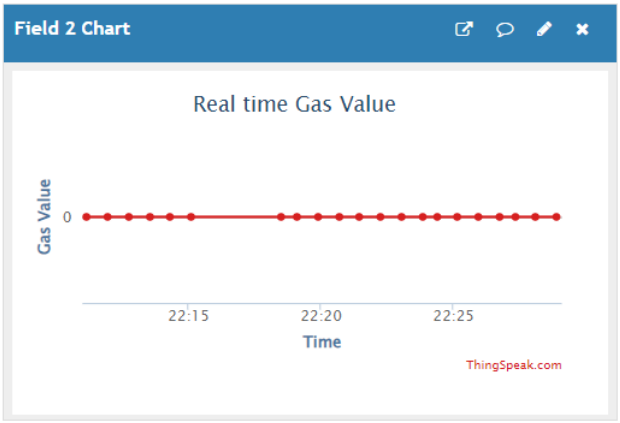


Fig.3 Gas values

VIII. CONCLUSION

A smart helmet is proposed that ideally detects different types of hazardous events such as humidity, temperature, gas, or concentration of combustible gases and other parameters depending on the industry it is used. The helmet sends the readings of the parameters to the server through the Thingspeak cloud which is being inspected continuously in real-time as and when the data is read. If any reading exceeds its limit or a set threshold, the helmet sends information through IoT and alerts others through the buzzer. The system requirements and the required components are low-cost and easily available making this a viable implementation. It ensures the safety of the workers and allows for better working conditions as well as observing changes in each industry. It can prove to be a reliable system with quick response and easy installation. The helmet also has a flexible design where different sensors can be added or removed according to various applications in a number of industries.

IX. REFERENCES

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[2] Lakshmi, S. S., Dagar, A., Gupta, N., Kaur, M., & Gupta, R. (2021, July). A TECHNICAL REVIEW ON IOT-BASED MINING TRACKING AND SAFETY HELMET. *International Journal of Innovative Research in Computer Science & Technology*