IOT Based Coal Mine Safety Helmet

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***Abstract*— A smart helmet has been developed that is able to detect hazardous event in the mining industry. In the development of helmet, we have considered the three main types of hazardous such as air quality, helmet removal and the exhausting fan. The first is the concentration level of event CO, SO2, NO2 and some poisonous gas. The second hazardous was preferred when the miner removes the mining helmet from their head. As a result, the existing proposals very few have been implemented and tested in the real-world, identifying the existence of a gap between theory and real-world application at scientifically accepted level.**

***Index Terms: Smart Helmet*, Hazard Detection, Air Quality, Helmet Removal, ESP32 Microcontroller, IoT Communication.**

I. INTRODUCTION

Mining is the process of extracting valuable minerals from the earth. It plays an important role in today's world due to need for metals and other materials caused by rapid urbanization and industrialization. India is a land with many natural reserves of mineral and valuable rocks. Underground mining, surface mining, high wall mining, quarrying are some of the mining techniques used in the country. There are about 11 coal mines, 13 iron ore mines, 9 bauxite (aluminum ore) mines, 5 manganese mines, 5 copper mines, 3 diamond mines and 2 gold mines in India. The mining industry there is a high safety risk due to problems like mine ventilation, danger from hazardous gases, incidents like rock fall and head injuries.

II.WORKINGPRINCIPLE

The system is divided into two units. IR sensor is used to detect the miner is wearing the safety helmet or not, also.MQ-2 is nothing but a air quality sensor which is used to detect air pollution from coal mines. It is mainly used due to the emission of particulate matter and gas include Methane (CH4) & Carbon monoxide (CO). Data processing unit, the ESP32 micro controller which is used to get all the data from the above all sensors and concludes whether needs any intimation or alert unit from user wearing it. A ESP32 CAM for Live streaming. A bmp180 for temperature, pressure and altitude monitoring and a LDR for automatic light. A mems sensor is used for accident or fall detection. ESP32 Wifi unit is used to transfer the data from the processing unit and sends as a notification to the authority via blynk app. It is achieved through IOT.

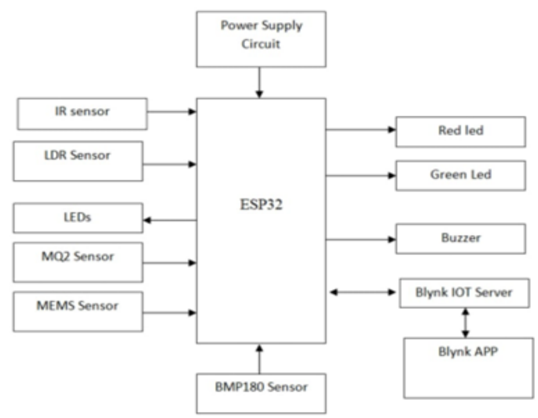


Fig: Block diagram

ESP32 Micro controller
ESP8266 took the embedded IoT world by storm. For less than $3, you could get a programmable, WiFi-enabled microcontroller being able to monitor and control things from anywhere in the world. Now Espressif (The semiconductor company behind the ESP8266) has released a perfect super-charged upgrade: the ESP32. Being successor to ESP8266; not only does it have a WiFi support, but it also features Bluetooth 4.0 (BLE/Bluetooth Smart) – perfect for just about any IoT project. Other features of the ESP32 include:

- Up to 18 12-bit Analog to Digital converters.
- Two 8-bit Digital to Analog converters.
- 10 capacitive touch switch sensors.
- Four SPI channels.

- Two I2C interfaces.
- Two I2S interfaces (for digital audio).
- Three UARTs for communications.
- Up to 8 channels of IR remote control.
- Up to 16 channels of LED PWM (pulse width modulation).
- An integrated Hall-effect sensor.
- An ultra-low-power analog preamp.
- An internal low-dropout regulator.

ESP32 Modules

There are many ESP32 modules available for experimenters. Just about any of them can be used for the experiments here.

Many of these boards have an integrated micro-USB connector that will simplify programming. Some boards don't have this feature and require an external FTDI adapter for programming.

Most of these boards are based upon the ESP32-WROOM chip.

The ESP32 DEV KIT and ESP32 NODEMCU boards are quite popular and available at Amazon and eBay. Adafruit makes the HUZZAH32 board. Spark fun has the ESP32-Thing board.

And the popular ESP32-Cam board integrates a small video camera and a microSD card socket along with an ESP32 (this board will require an FTDI adapter for programming).

Please note that these boards share many features but they don't have the same pinouts. In our experiments, I'll be referring to the pin function (i.e. GPIO 4) instead of an actual pin number. This will allow you to use a different board than the one I am using.

Programming the ESP32
The ESP32 can be programmed using many different development environments. Code can be written in C++ (like the Arduino) or in MicroPython.
To make use of all of the ESP32 features Espressif provided the Espressif IoT Development Framework, or ESP-IDF. Types of Infra-Red Sensors, Infra-red sensors are broadly classified into two types:

Thermal infrared sensors – These use infrared energy as heat. Their photo sensitivity is independent of wavelength. Thermal detectors do not require cooling; however, they have slow response times and low detection capability.

Quantum infrared sensors – These provide higher detection performance and faster response speed. Their photo sensitivity is dependent on wavelength. Quantum detectors have to be cooled so as to obtain accurate measurements. The only exception is for detectors that are used in the near infrared region.

Working Principle

A typical system for detecting infrared radiation using infrared sensors includes the infrared source such as blackbody radiators, tungsten lamps, and silicon carbide. In case of active IR sensors, the sources are infrared lasers and LEDs of specific IR wavelengths. Next is the transmission medium used for infrared transmission, which includes vacuum, the atmosphere, and optical fibers.

Applications

• Tracking and art history

• Climatology, meteorology, and astronomy

• Thermography, communications, and alcohol testing

• Heating, hyper spectral imaging, and night vision\

• Biological systems, photo biomodulation, and plant health

• Gas detectors/gas leak detection

• Water and steel analysis, flame detection

LIGHT EMITTING DIODE(LED)

A light-emitting diode (LED) is a two-lead semiconductor light source. It is a p–n junction diode that emits light when activated.[5] When a suitable current is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor. LEDs are typically small (less than 1 mm^2) and integrated optical components may be used to shape the radiation pattern.

Appearing as practical electronic components in 1962, the earliest LEDs emitted low-intensity infrared light. Infrared LEDs are still frequently used as transmitting elements in remote-control circuits, such as those in remote controls for a wide variety of consumer electronics. The first visible-light LEDs were of low intensity and limited to red. Modern LEDs are available across the visible, ultraviolet, and infrared wavelengths, with very high brightness.

III. USING A LDR WITH ARDUINO

The easiest way to measure a resistive sensor is to connect one end to Power and the other to a **pull-down** resistor to ground. Then the point between the fixed pull down resistor and the variable photocell

Resistor is connected to the analog input of a microcontroller such as an Arduino, For this example I'm showing it with a 5V supply but note that you can use this with a 3.3v supply just as easily. In this configuration the analog voltage reading ranges from 0V (ground) to about 5V (or about the same as the power supply voltage).

The way this works is that as the resistance of the photocell decreases, the total resistance of the photocell and the pull down resistor decreases from over 600KΩ to 10KΩ. That means that the current flowing through both resistors *increases* which in turn causes the voltage across the fixed 10KΩ resistor to increase.

BMP180 SENSOR

This precision sensor from Bosch is the best low-value sensing answer for measuring barometric pressure and temperature. because pressure adjustments with altitude you can additionally use it as an altimeter! The sensor is soldered onto a PCB with a 3.3V regulator, I2C degree shifter and pull up resistors on the I2C pains.The BMP180 is the following-generation of sensors from Bosch, and replaces the BMP085. the coolest information is that it is completely same to the BMP085 in phrases of firmware/software program - you could use our BMP085 tutorial and any example code/libraries as a drop-in alternative. The XCLR pin isn't physically present on the BMP180 so if you need to recognize that statistics is ready you may need to query I2C bus.

This board is 5V compliant - a three.3V regulator and a i2c level shifter circuit is blanketed so that you can use this sensor competently with 5V good judgment and power. using the sensor is easy. for example, if you're the use of an Arduino, certainly connect the VIN pin to the 5V voltage pin, GND to ground, SCL to I2C Clock (Analog five) and SDA to I2C facts (Analog four).

MEMS

MEMS (micro electro-mechanical systems) technology has gone from an interesting academic exercise to an integral part of many common products. But as with most new technologies, the practical implementation of MEMS technology has taken a while to happen. The design challenges involved in designing a successful MEMS product (the ADXL2O2E) are described in this article by Harvey Weinberg from Analog Devices.

In early MEMS systems a multi-chip approach with the sensing element (MEMS structure) on one chip, and the signal conditioning electronics on another chip was used. While this approach is simpler from a process standpoint, it has many disadvantages.

* The overall silicon area is generally larger.

* Multi chip modules require additional assembly steps.

* Yield is generally lower for multi-chip modules.

* Larger signals from the sensor are required to overcome the stray capacitance of the chip-to-chip interconnections, and stray fields necessitating a larger sensor structure.

* Larger packages are generally required to house the two-chip structure.

Of course, history teaches us that integration is the most cost effective and high-performance solution. So Analog Devices pursued an integrated approach to MEMS where the sensor and signal conditioning electronics are on one chip.

IV. ARDUINO UNO INSTALLATION

Step 1

First, we must have our Arduino board (we can choose our favorite board) and a USB cable. In case we use Adriana UNO, Arduino Duemilanove, Nano, Arduino Mega 2560, or Diecimila, we will need a standard USB cable (A plug to B plug), t In case we use Arduino Nano, we will need an A to Mini-B cable.

Step 2

Download Arduino IDE Software. We can get different versions of Arduino IDE from the Download page on the Arduino Official website. We must select wer software, which is compatible with wer operating system (Windows, IOS, or Linux). After wear file download is complete, unzip the file.

Step 3 − Power up our board.

The Arduino Uno, Mega, Duemilanove and Arduino Nano automatically draw power from either, the USB connection to the computer or an external power supply. If we are using an Arduino Diecimila, we have to make sure that the board is configured to draw power from the USB connection. The power source is selected with a jumper, a small piece of plastic that fits onto two of the three pins between the USB and power jacks.

Step 4 − Launch Arduino IDE.

After our Arduino IDE software is downloaded, we need to unzip the folder. Inside the folder, we can find the application icon with an infinity label (application.exe). Double click the icon to start the IDE.

Step 5 − Open our first project.

Once the software starts, we have two options

* Create a new project

Step 6 − Select our Arduino board.

To avoid any error while uploading wear program to the board, we must select the correct Arduino board name, which matches with the board connected to wer computer.

Go to Tools → Board and select wear board.

Here, we have selected Arduino Uno board according to our tutorial, but we must select

the name matching the board that we are using.

Step 7 − Select wer serial port.

Step 8 − Upload the program to wer board.

Before explaining how we can upload our program to the board, we must demonstrate the function of each symbol appearing in the Arduino IDE toolbar.

BLYNK APP

Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, vizualize it and do many other cool things.There are three major components in the platform:

• Blynk App - allows to you create amazing interfaces for your projects using various widgets we provide.

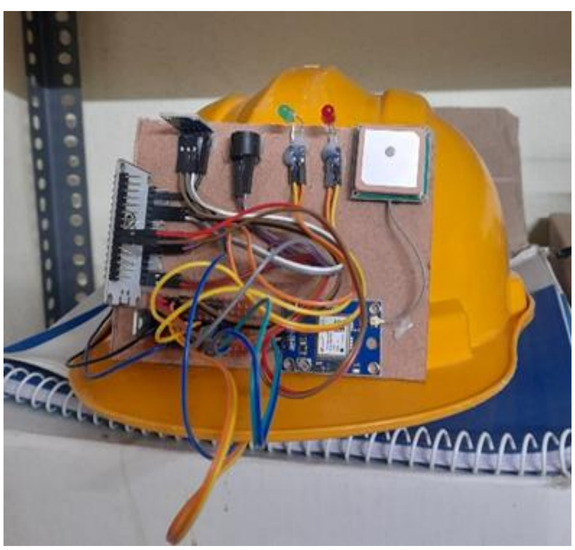
• Blynk Server - responsible for all the communications between the smartphone and hardware. You can use our Blynk Cloud or run your private Blynk server locally. It's open-source, could easily handle thousands of devices and can even be launched on a Raspberry Pi.

• Blynk Libraries - for all the popular hardware platforms - enable communication with the server and process all the incoming and outcoming commands.

- Similar API & UI for all supported hardware & devices
- Connection to the cloud using:
    - WiFi
    - Bluetooth and BLE
    - Ethernet
    - USB (Serial)
    - GSM
- Set of easy-to-use Widgets
- Direct pin manipulation with no code writing
- Easy to integrate and add new functionality using virtual pins
- History data monitoring via Super Chart widget
- Device-to-Device communication using Bridge Widget
- Sending emails, tweets, push notifications, etc.
- New features are constantly added!

V. RESULTS AND DISCUSSION

This project is well prepared and acting accordingly (including all the hardware and software) as per the initial specifications and requirements of our project. Because of the creative nature and design the idea of applying this project is very new, the opportunities for this project are immense.



VI. CONCLUSION

IR sensor is used to detect the miner is wearing the safety helmet or not, also.MQ-135 is nothing but a air quality sensor which is used to detect air pollution from coal mines. It is mainly used due to the emission of particulate matter and gas include Methane (CH4) & Carbon monoxide (CO). Data processing unit, the NodeMCU ESP8266 micro controller which is used to get all the data from the above all sensors and concludes whether needs any intimation or alert unit from user wearing it. Wifi unit is used to transfer the data from the processing unit and sends as a notification to the authority via blynk app.

VII. APPLICATIONS

• It can be used in real time safety system.

• We can implement the whole circuit into small module later.

• Less power consuming safety system.

• This safety system technology can further be enhanced into four wheeler also by replacing the helmet with seat belt.

VIII. FUTURE SCOPE

• Especially the smart helmet is designed to provide security, safety and comfort journey to the coal miner.

• In future the helmet can be enhanced by adding some other features like, alcohol detection and coal miner fatigue detection system to provide a better safety and security to the miner.

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