SASTRA
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Smart Helmet with Landslide and Toxic gas alert for Workers in Mines

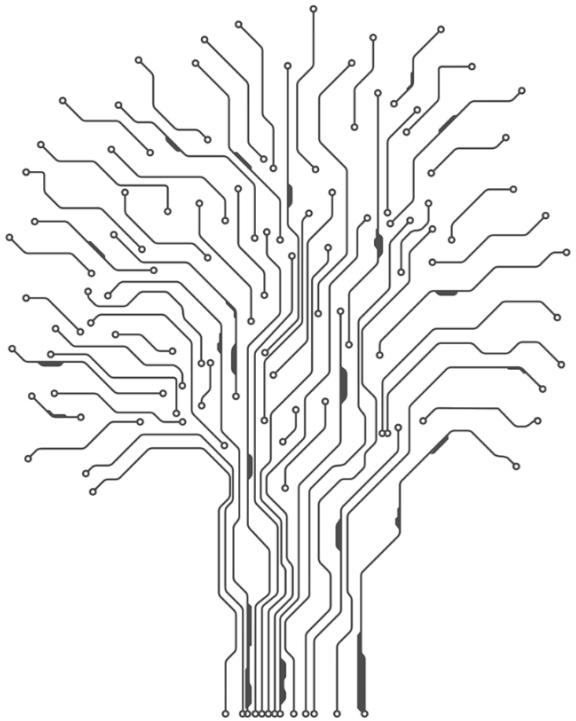
Guide:

Dr. SIVA J
(Senior Assistant Professor)
Department of ECE

Team Members:

Dharanish P T - 124005145
Arockiya Lipson A R - 124159078
Nithiya S - 124005071

Literature Survey:



Mining presents various dangers:

- Cave-ins, explosions, and equipment accidents.
- Respiratory diseases due to CO,CH4, and H2S.

"Sneha K, Reddy J, Ganesh P. **IoT Based Smart Helmet for Workers in Mines Using LoraWAN**. In2023 2nd International Conference on Vision Towards Emerging Trends in Communication and Networking Technologies (ViTECoN) 2023 May 5 (pp. 1-6). IEEE"

This article provides solution to:

- Hazardous gases.
- High temperature.

PROBLEM STATEMENT AND SOLUTION:

- Additional accidents are caused by **landslide while mining.**

- **Seismograph** based on **accelerometer and gyroscope** sensor are introduced.

- Thus this project **"Smart Helmet with Landslide and Toxic gas alert for Workers in Mines"** is being developed.

SMART HELMET

MQ 9

MQ 135

DHT 11

RGY light

ESP 32

Data received from landslide device using ESP-now

LoRa WAN

Data sent to receiver using LoRa WAN

NEO-6M

Panic switch

Buzzer

SMART HELMET

The smart helmet comes with **sensors** that **collect environmental data** from the mining site. This **data** is then **shown on the serial monitor.** Moreover, there is a **panic switch** provided **for emergency situations.** When pressed, it **sends an alert to both the control center and the nearby workers.** The data from the Landslide device **is processed and transmitted to the receiver through LoRaWAN.**

```
temperature:29.30
Humidity:94.00
latitude
10.78
longitude
78.68
{"Temperature" : "29.30","Humidity" : "94.00","MQ-9" : "304" , "MQ-135" : "540" ,"Packet_id" : "288","earth" : "0","emergency" : "0","longitude" : "78.68",'
temperature:29.30
Humidity:94.00
latitude
10.78
longitude
78.68
{"Temperature" : "29.30","Humidity" : "94.00","MQ-9" : "302" , "MQ-135" : "531" ,"Packet_id" : "289","earth" : "0","emergency" : "0","longitude" : "78.68",'
```

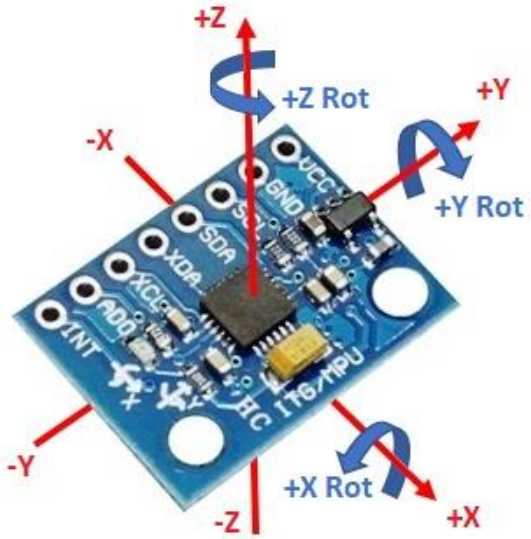
This figure indicates the **data read from sensors** and they are **sent to receiver using LoRaWAN**

LANDSLIDE ALERT

The ESP32 in the landslide alert device is connected to the MPU6050, which reads the 3-axis readings of the accelerometer and gyroscope. The gyroscope is recalibrated and reset to zero at the start, and any deviation in its value triggers a warning for potential landslides. The data is transmitted to the smart helmet via ESP-NOW Protocol.

```
Accelerometer X: 6.3 m/s^2, Y: 0.4 m/s^2, Z: 9.0 m/s^2
Gyroscope X: 0.7 rps, Y: -0.8 rps, Z: -0.2 rps
Earthquake Detected x
Temperature: 29.22 degC
1.61
Sent with success
```

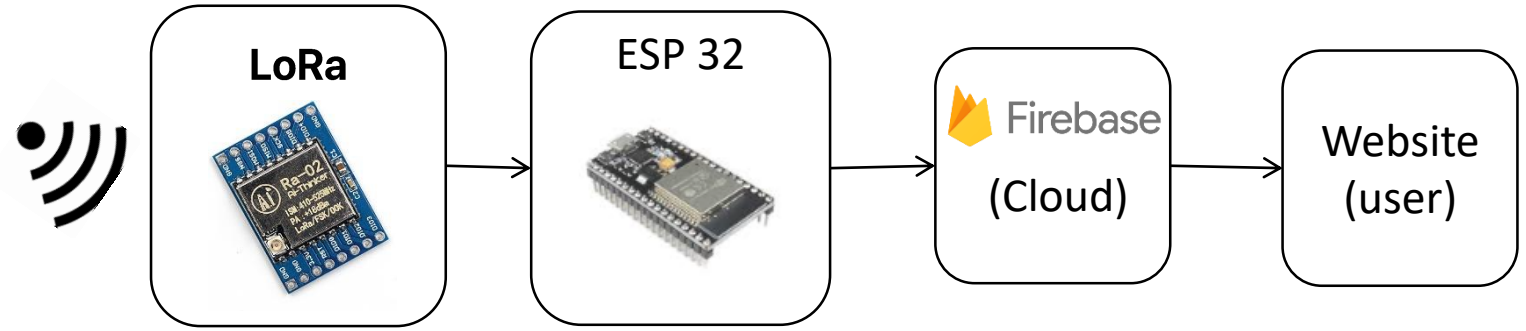
How MPU6050 Gyroscope act as a landslide detector?



1) Gyroscope measures the angular movement of the plane in 6 planes (X,Y,Z or -X,-Y,-Z).
2) We have took modulus for the inverse axis so even if it moves in negative axis the sum will be positive(-X=X,-Y=Y,-Z=Z)
3) Gyroscope resets itself after every move it does (i.e. IT IS INITIALLY "0" EVERYTIME).
4) Here we have added the movement in all planes (|X|+|Y|+|Z| = "A")
5) So if the gyroscope moves in any plane then [Value of A > "0"]
6) We have set calibration value as "0.6"
7) If A > 0.6 Then the device gives LANDSLIDE ALERT!

RECEIVER MODULE

Data received using LoRa WAN

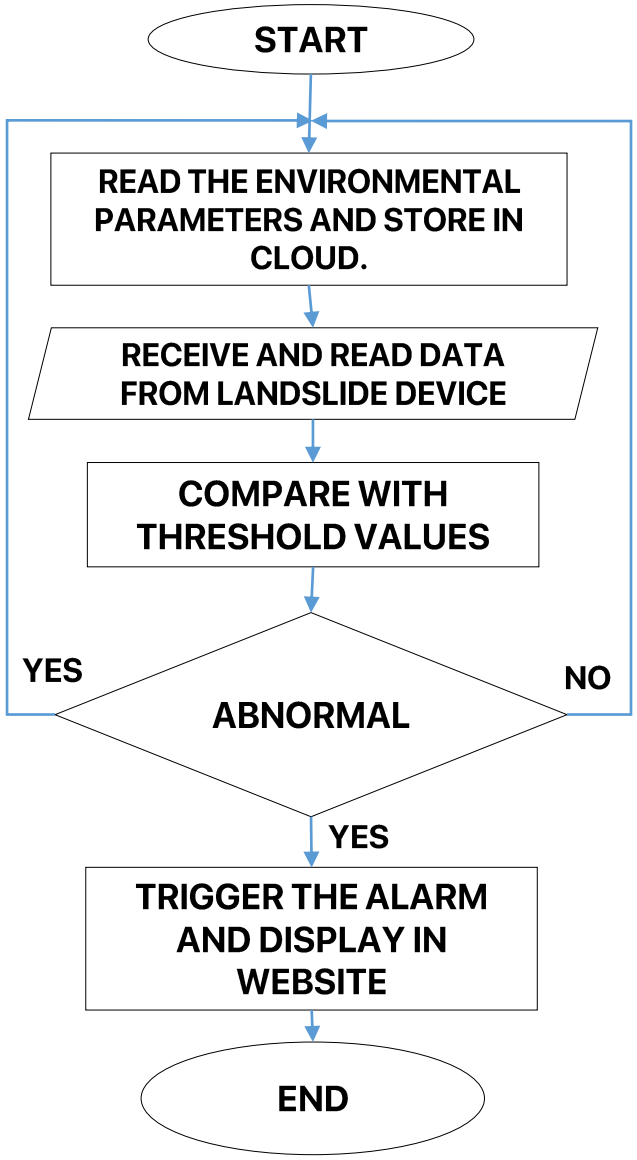



```
LoRa initialization ok !!
connecting to wifi ..
.IP address:192.168.163.21
signup complete!!
{"Temperature" : "29.10","Humidity" : "90.00","MQ-9" : "495" , "MQ-135" : "418" ,"Packet_id" : "123","earth" : "1","emergency" : "0"}
1
0
Received packet

 packet_ID :123
```

The **receiver receives the data** from the Smart Helmet **via LoRaWAN** and **push it into the firebase** cloud via NODEMCU ESP32.

Flowchart:


START
READ THE ENVIRONMENTAL PARAMETERS AND STORE IN CLOUD.
RECEIVE AND READ DATA FROM LANDSLIDE DEVICE
COMPARE WITH THRESHOLD VALUES
YES
ABNORMAL
NO
YES
TRIGGER THE ALARM AND DISPLAY IN WEBSITE
END

Lora Module Connection with ESP32 NodeMCU.

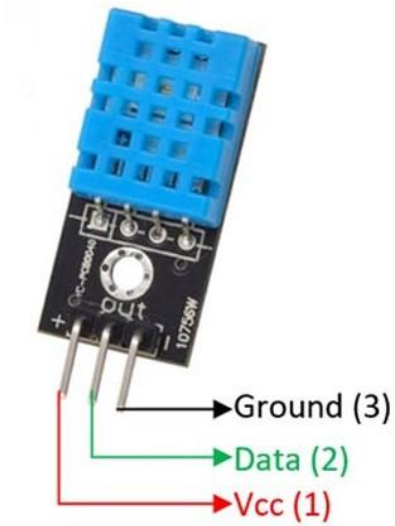
SENSOR	SENSOR PIN	ESP32 NodeMCU Pin
DHT 11	Vcc	Vin
	GND	GND
	DATA	D4
MQ 7	Vcc	Vin
	GND	GND
	A0(Analog)	D34
MQ 135	Vcc	Vin
	GND	GND
	A0(Analog)	D35
NEO 6M	Vcc	3.3 V
	GND	GND
	TX	RX2
	RX	TX2
Buzzer	5V	D13
	GND	GND

MQ 7, MQ 135, DHT 11 Connection With ESP32 NodeMCU.

SENSOR	SENSOR PIN	ESP32 NodeMCU
LORA (SX1276)	3.3V	3.3 V
	GND	GND
	MISO	D19
	MOSI	D23
	NSS	D5
	SCK	D18
	RST	D14
	DIO0	D2
	ANA	Antenna
RYG Light	GND	GND
	R(Red)	D13
	Y(Yellow)	D33
	G(Green)	D26

DHT11

DHT11 Pinout

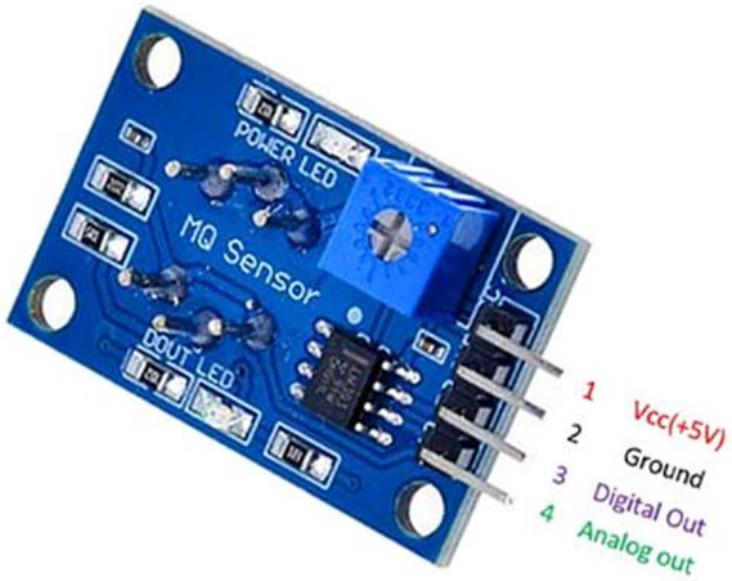


- Low power, low cost.
- Used to measure Temperature and humidity.
- Has dedicated NTC to measure temperature.
- Uses digital-signal-acquisition technique.
- High reliability and excellent long-term stability.

Item	Measurement Range	Humidity Accuracy	Temperature Accuracy	Resolution	Package
DHT11	20-90%RH 0-50 ℃	±5%RH	±2℃	1	4 Pin Single Row

MQ9

MQ9 Pinout



- Metal Oxide Semiconductor(MOS) type Gas Sensor.
- Used to detect Carbon Monoxide(CO), Carbon Dioxide(CO2), and Methane(CH4).
- Aluminum-oxide based ceramic sensing element,
- Coated withTin dioxide (SnO_2).
-Enclosed in stainless-steel mesh.

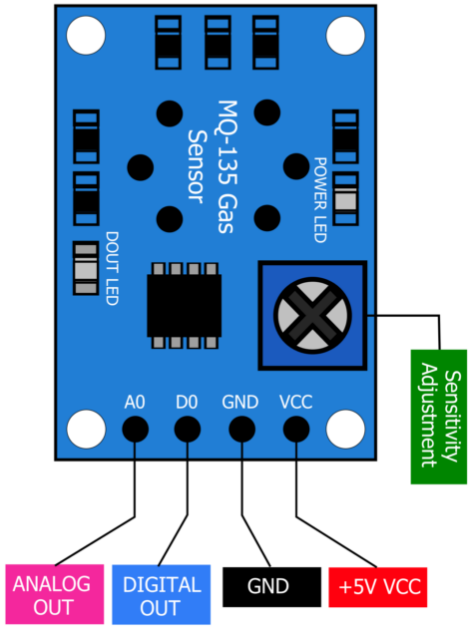
CO detection Range: 20ppm to 2000ppm.
Operating Voltage: 5V.
Operating Temp: 20 to 50 degree Celsius.

MQ135

Front View

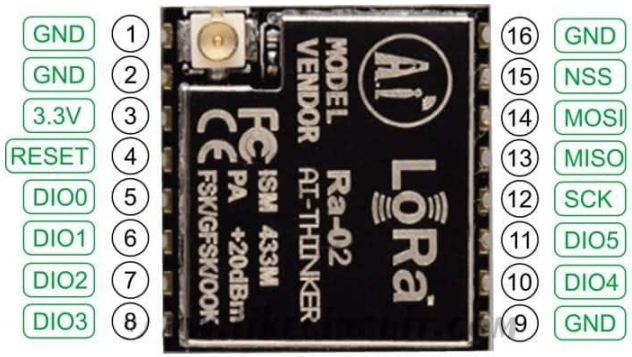
- Used for detecting air pollutants
- Ex: Ammonia and benzene.
- Operates on the principle of difference in resistance
- Used for air quality monitoring.

Back View



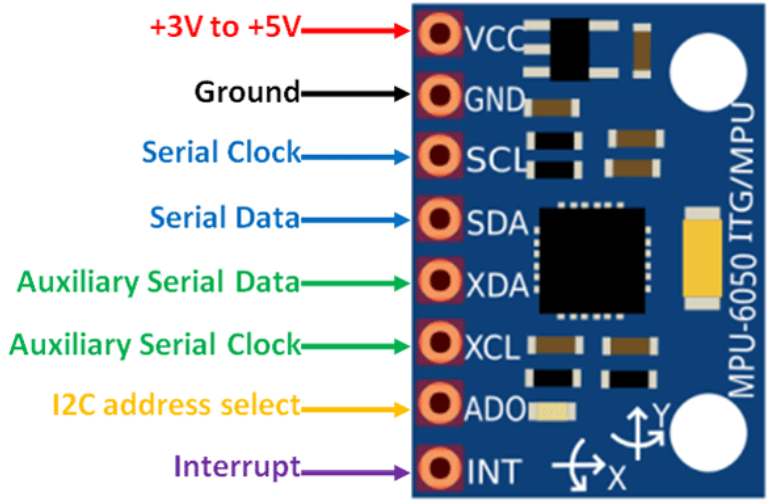
Detection Range: 10ppm-300ppm-NH3, 10ppm-1000ppm-Benzene, 10ppm-300ppm-Alcohol.
Operating Voltage: 5V.
Operating Temp: -10 to 50 degree Celsius.

Lora SX1276:



Parameters	Specification
Operating voltage	DC voltage 1.8 V – 3.7 V
Frequency Range	137 - 525 MHz
Radio Frequency Input Level	+10 dBm
Modulation	FSK/OOK/LoRa™/ GMSK/MSK
Bandwidth	7.8 – 500 kHz
Effective bit rate	0.018 - 31.5 kbps
Receiver sensitivity	-111 dBm to -148 dBm
Operating temperature	-40 °C to +85 °C
Radio Frequency Output Power	+20 dBm
Range distance	3 – 5 Km
Dimension	20.5 x 15.5 x 2.0 mm

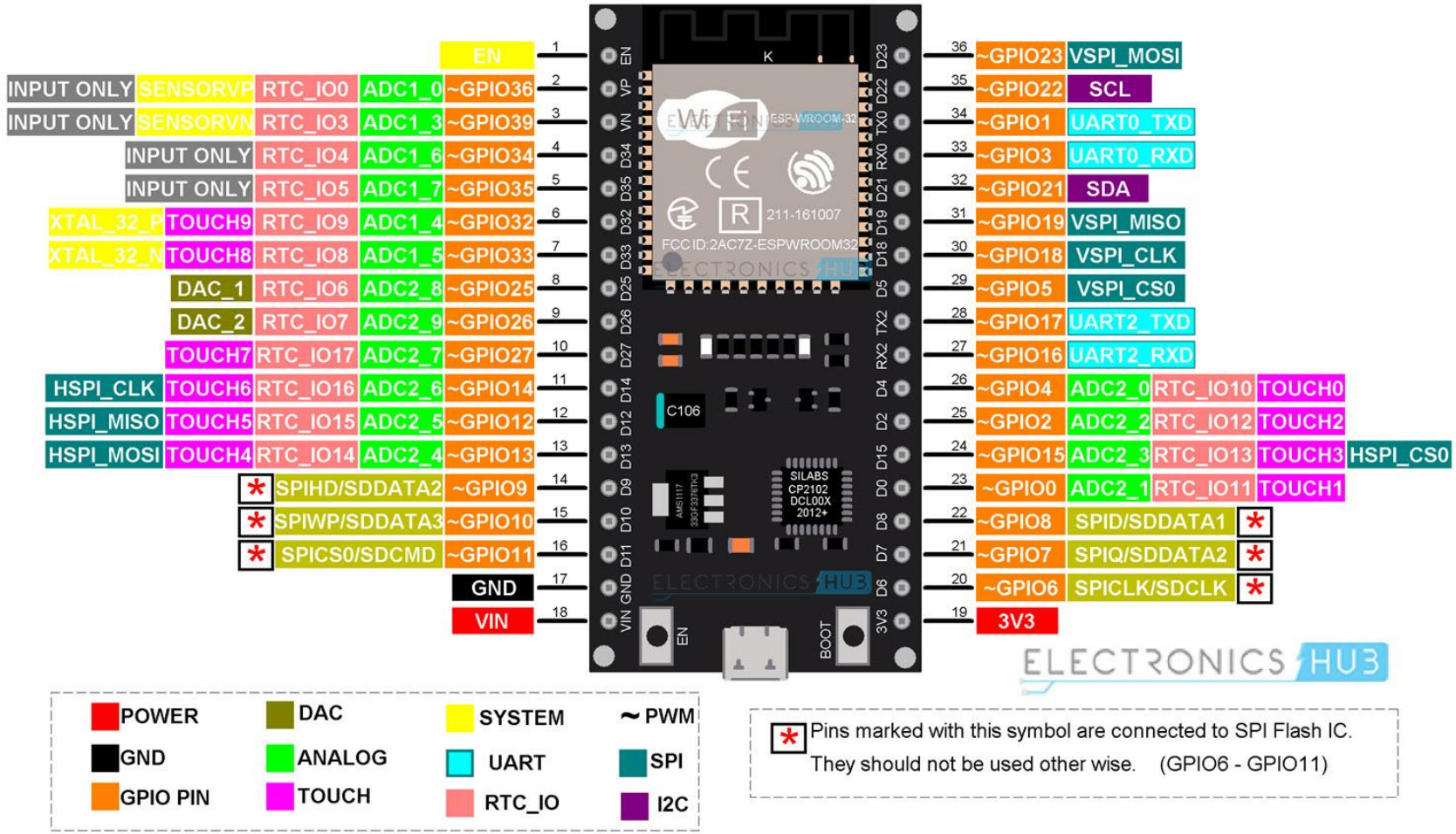
MPU6050 Pinout:



MPU6050 Connection with ESP32 NodeMCU.

MPU6050	ESP32
Vcc	3.3 V
GND	GND
SCL	D22
SDA	D21

Esp32 in NodeMCU Development Board

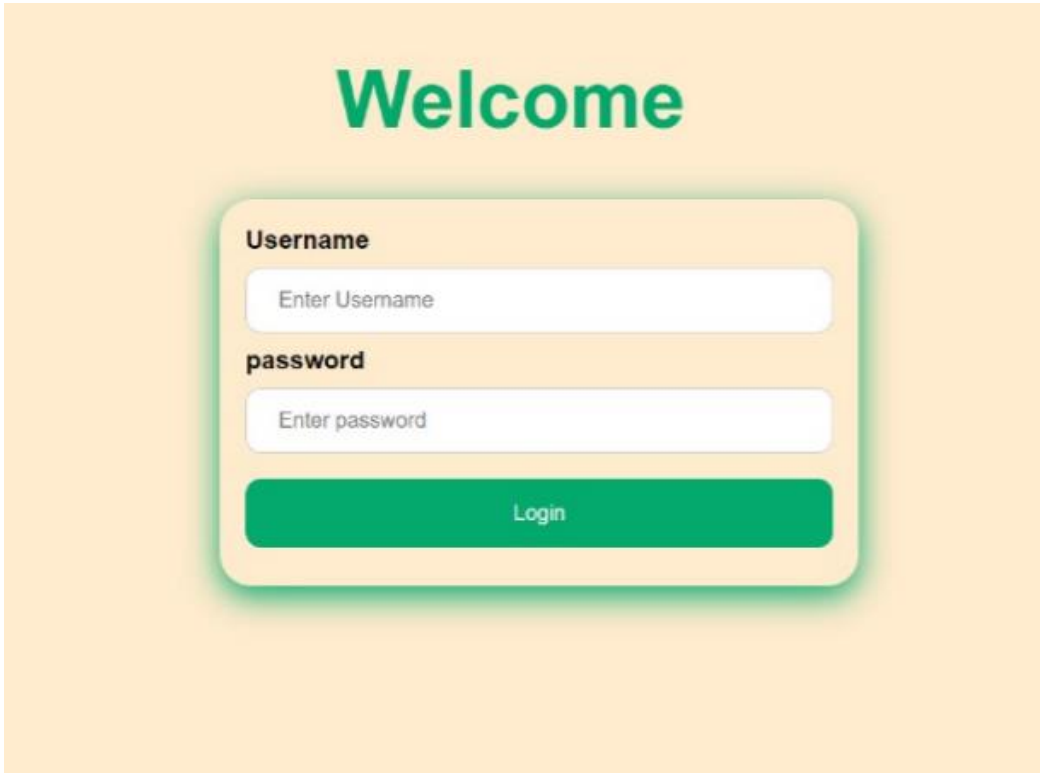


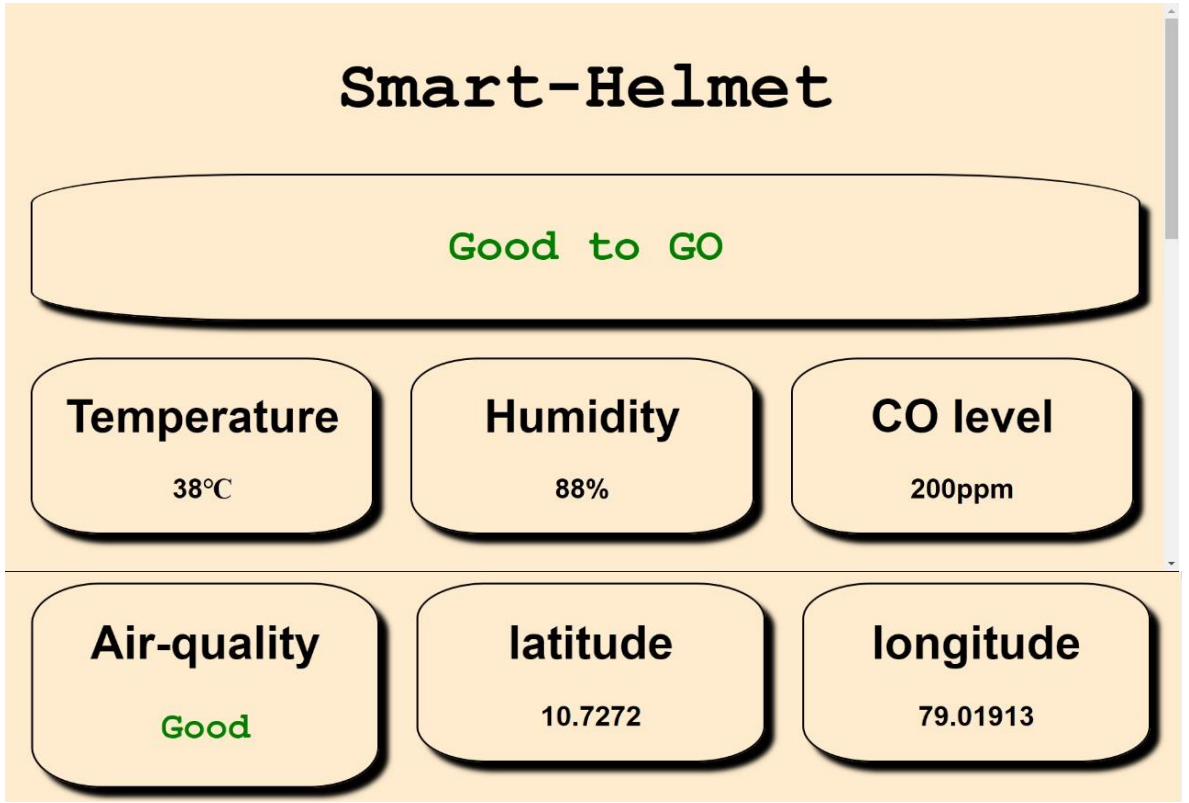
MAIN FEATURES	
Model	NodeMCU ESP32
Special features	Wifi and BT
Processor	Tensilica LX6 Dual-Core
Clock frequency	240 MHz
SRAM	512 kB
Memory	4 MB
Wifi standard	802.11 b/g/n - 2.4 GHz
Operating voltage	3.3 V; 5 V via micro-USB
Logic level	3.3 V
Max. current draw per GPIO	40 mA
Interfaces	I2C, SPI, UART, DAC, ADC

- **Has 2.4 GHz dual-mode Wifi and BT wireless connection.**
- **512 KB SRAM and a 4MB flash memory in development board**
- **The board has 21 pins including I2C, SPI, UART, DAC, and ADC.**

Website:

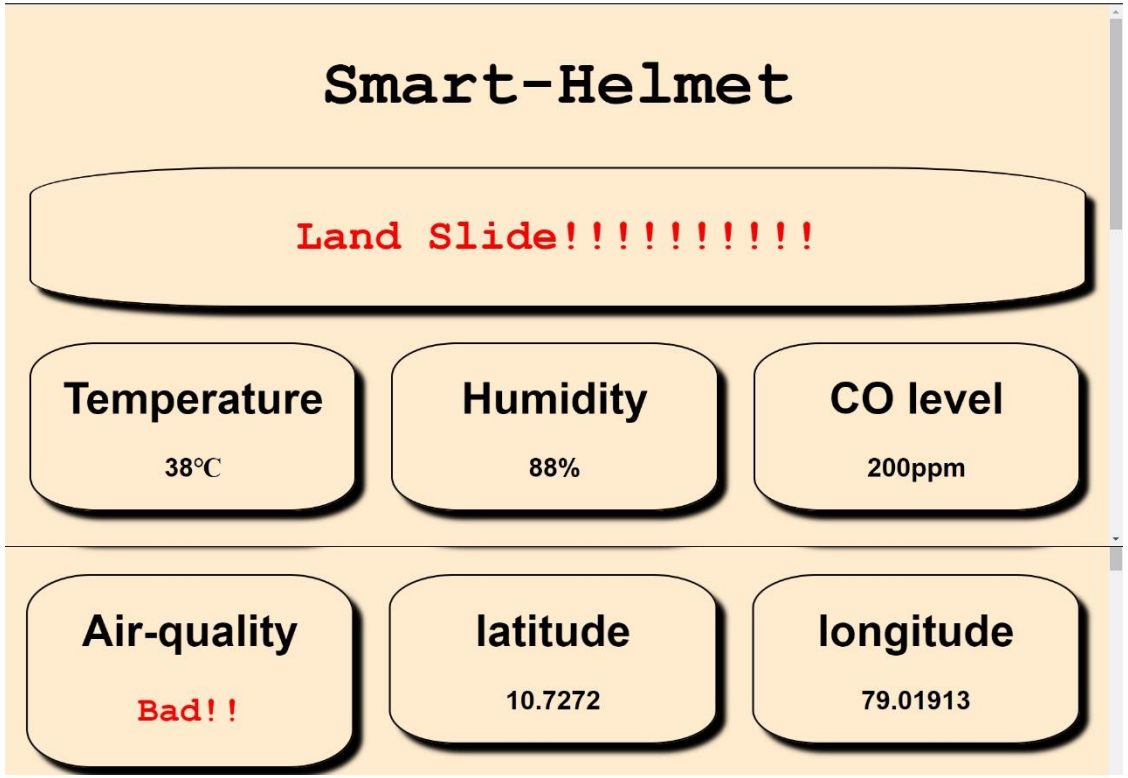
- Authentication
- Location Tracking

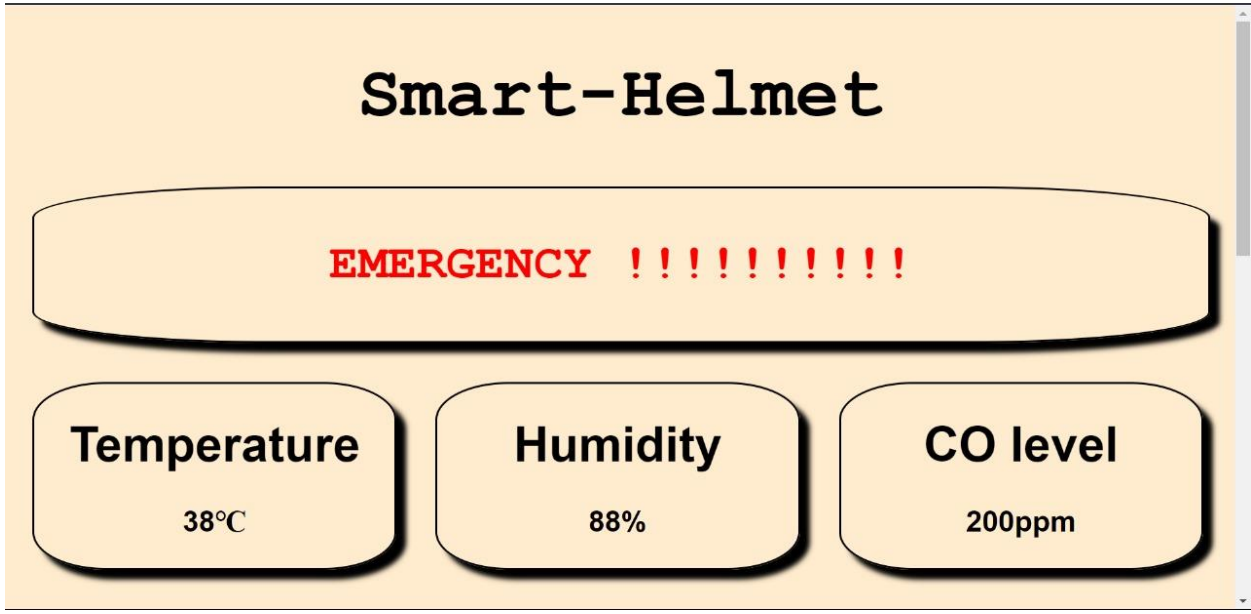




Authentication and Website indication in normal conditions

Indication in website incase of alert





Firebase

- Backend-as-a-Service
- Performance Monitoring
- Firebase Analytics

References:

[1] Y. I. Khamis et al., Mahmoud Alawi, Ramadhani, A., Waheed, M (2022). "**An IoT Based Worker Safety Helmet Using Cloud Computing Technology**", Tanzania Journal of Engineering and Technology (Tanz. J. Engrg. Technol.), Vol. 41 (No. 1), May 2022.

[2] Tarek Eldemerdash, Raed Abdulla, Vikneswary Jayapal, Chandrasekharan Nataraj, Maythem K. Abbas, **"Iot Based Smart Helmet for Mining Industry Application"**, International Journal of Advanced Science and Technology Vol. 29, No. 1, (2020), pp. 373 - 387.

[3] Kumaravel A, Ajith K, Sravani K, Lakshmi Sreenivasa Reddy L, "**IOT Mining Tracking and Worker Safety Helmet**", International Journal of Advanced Research in Computer and Communication Engineering, Vol. 10, Issue 5, May 2021, DOI 10.17148/IJARCCE.2021.10579.

[4] Rahabul Islam, Md. Wahidur Rahman, Rahmina Rubaiat, Md. Mahmodul Hasan, Md. Mahfuz Reza, Mohammad Motiur Rahman, **"LoRa and server-based home automation using the internet of things (IoT)"**, Journal of King Saud University – Computer and Information Sciences 34 (2022) 3703–3712.

Thank You!