INTELLIGENT MINE SAFETY SYSTEM

by

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A project report submitted to

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SCHOOL OF ELECTRONICS ENGINEERING

in partial fulfilment of the requirements for the course of

CSE2010– COMMUNICATION FOR CPS

in

B. Tech. COMPUTER SCIENCE ENGINEERING

VIT®
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

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DECEMBER 2021

BONAFIDE CERTIFICATE

Certified that this project report entitled "**INTELLIGENT MINE SAFETY SYSTEM"** is a bonafide work of **Himanshu Barak (19BPS1074), Sahil Faizal (19BPS1083) , Shivam Batra (19BPS1131) ,Viresh Bhurke (19BPS1133), who** carried out the Project work under my supervision and guidance for **CSE2010-CPS COMMUNICATION**

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ABSTRACT

Due to many people dying in mine accidents, the mine safety plays a key role in the mine production process. By virtue of recent advancements in the Internet of Things, this paper proposes an intelligent monitoring system for coal mines, which aims at monitoring the coal mine production process. Nowadays due to global warming and climate changes there are challenging situations in the coal mine field. To lessen the cost and improve the profitability alongside item quality the automation in the field of coal mine-shaft is in reality vital, which will likewise decrease the diggers endeavors.

The project consists of two modules that are the Arduino UNO and the NODE Red dashboard. The Arduino UNO is equipped with various sensors such as Rain Sensor,Flame Sensor , Soil Moisture Sensor ,Gas Sensor ,DHT11 Sensor ,Air Pressure Sensor. The arduino is connected to a MQTT sensor which sends the sensor data to a NODE red dashboard for real time monitoring and analysis for raising alerts

ACKNOWLEDGEMENT

We wish to express our sincere thanks and deep sense of gratitude to our project guide, **Dr. Florence Gnana Poovathy J,** Associate Professor, School of Electronics Engineering, for her consistent encouragement and valuable guidance offered to us in a pleasant manner throughout the course of the project work.

We are extremely grateful to **Dr. Ganesan R,** Dean of School of Computer Science, VIT Chennai, for extending the facilities of the School towards our project and for his unstinting support.

We express our thanks to our Head of the Department **Dr. Neela Narayanan V** for his support throughout the course of this project.

We also take this opportunity to thank all the faculty of the School for their support and their wisdom imparted to us throughout the course.

We thank our parents, family, and friends for bearing with us throughout the course of our project and for the opportunity they provided us in undergoing this course in such a prestigious institution.

NAME WITH SIGNATURE **NAME WITH SIGNATURE**

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1. INTRODUCTION

1.1 OBJECTIVES AND GOALS

Coal is one of the most important commodities and raw materials for a number of industries. It is used for power generation as well as the extraction of many by-product chemicals and materials. The extraction of coal from the coal mine is, however, a complex and dangerous process. Many accidents take place in the coal mines world over which causes fatalities and economic losses. The dangers and hazards can be reduced significantly by making use of the latest smart technologies.

We aim to reduce these casualties by monitoring the conditions inside the mine and raising alert when the conditions become prone to accidents.

1.2 APPLICATIONS

Traditional coal mine monitoring systems tend to be wired network systems, which play an important role in coal mine safe production. With continuous enlargement of exploiting areas and extension of depth in coal mines, many laneways become blind areas, where there are lots of hidden dangers. Moreover, it is inconvenient to lay cables which are expensive and consume time.

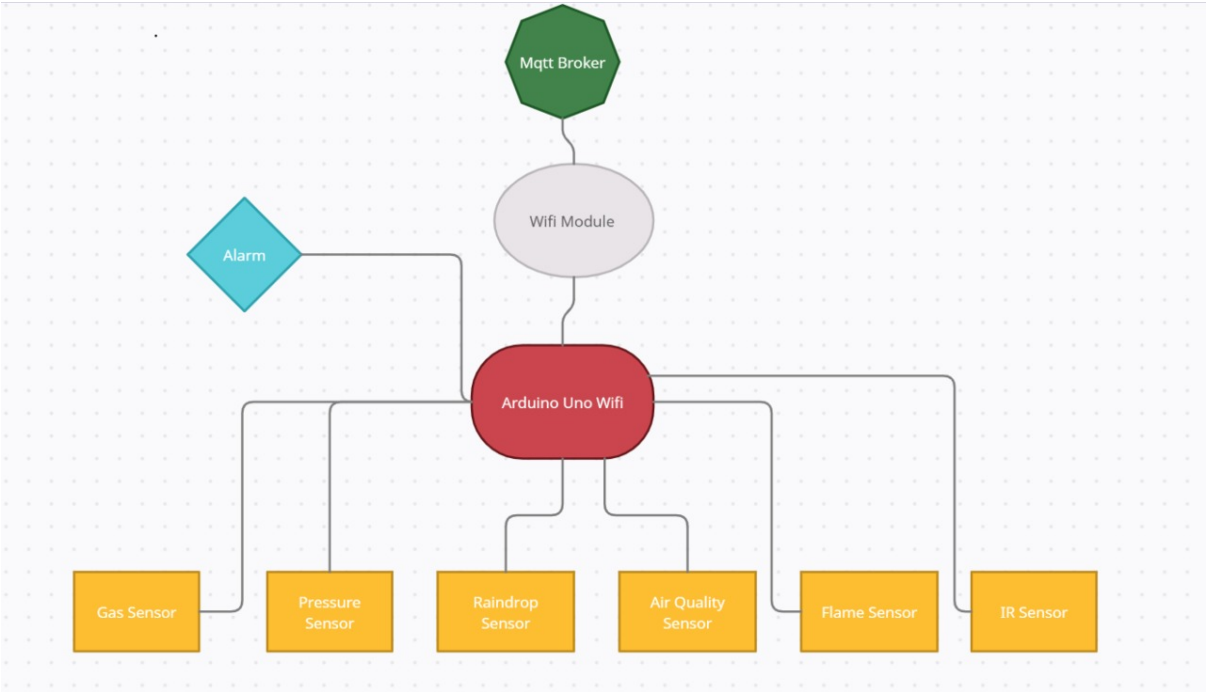
In order to solve these problems, we will design a coal mine safety monitoring system based on IoT, which can improve the level of monitoring production safety and reduce accidents in the coal mines. Also with the help of MQTT protocol we are able to get those parameter values quickly without any loss of data over an increased range and can even access areas where laying cables is difficult.

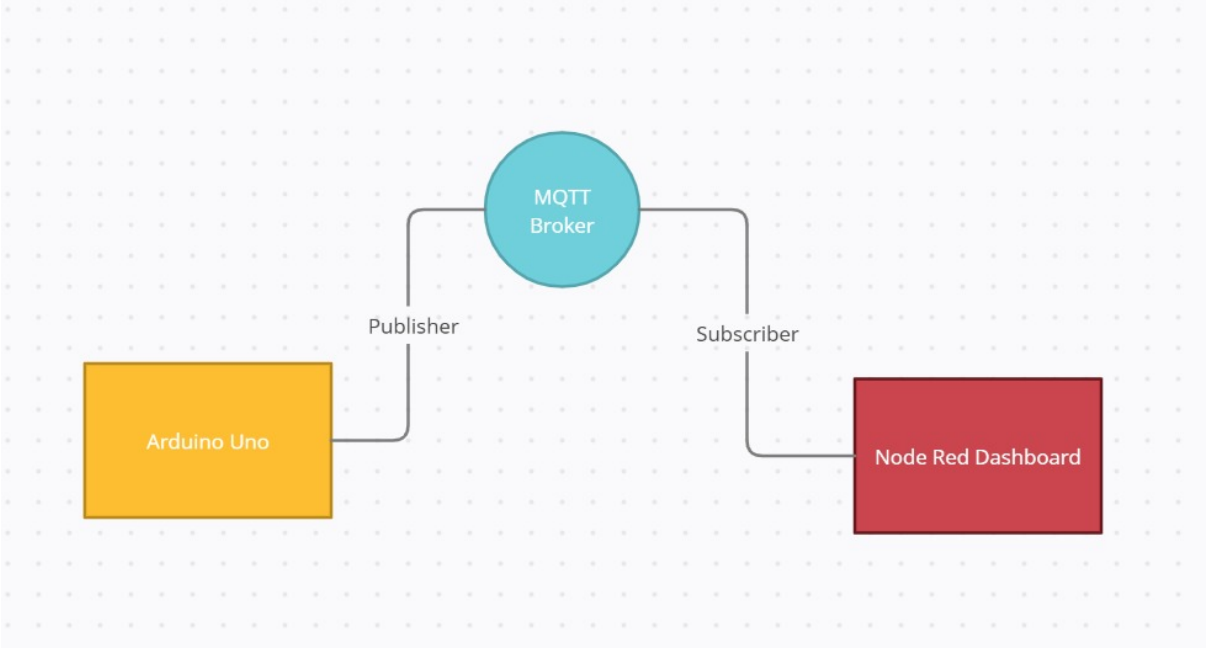
1.3 FEATURES

The system takes into account the major causes leading to disasters in the mining industry like increase in temperature, air pressure, humidity, soil moisture, presence of toxic gases, rainfall etc. which leads to loss of invaluable lives and resources. The Intelligent Alerting System and Informative Dashboard helps the respective authorities to monitor the conditions in Real Time and send assistance in times of need. The system gathers data from an array of embedded wireless sensor networks and decides accordingly. The proposed system is designed to be both functionally and economically effective. Alarm System triggers when the sensor values cross a specific threshold.

2. DESIGN

2.1 BLOCK DIAGRAM





2.2 HARDWARE ANALYSIS

Use case of each component used:

- **DHT11 Sensor** - to record the temperature and humidity
- **Soil Moisture Sensor** - to capture the moisture present in the soil
- **Gas Sensor(MQ-135)** - for detecting ammonia(NH3), sulphur(S), benzene(C6H6), carbon dioxide(CO2) and other gases
- **Light Intensity Sensor -** to monitor the intensity of light
- **Flame Sensor -** to detect the presence of flame(or fire)
- **Rain Detection Sensor -** to detect the occurrence of rain
- **Air Pressure Sensor** - to detect air pressure in the region
- **Resistors, Bread Board, Jumper Cables -** for connection purposes

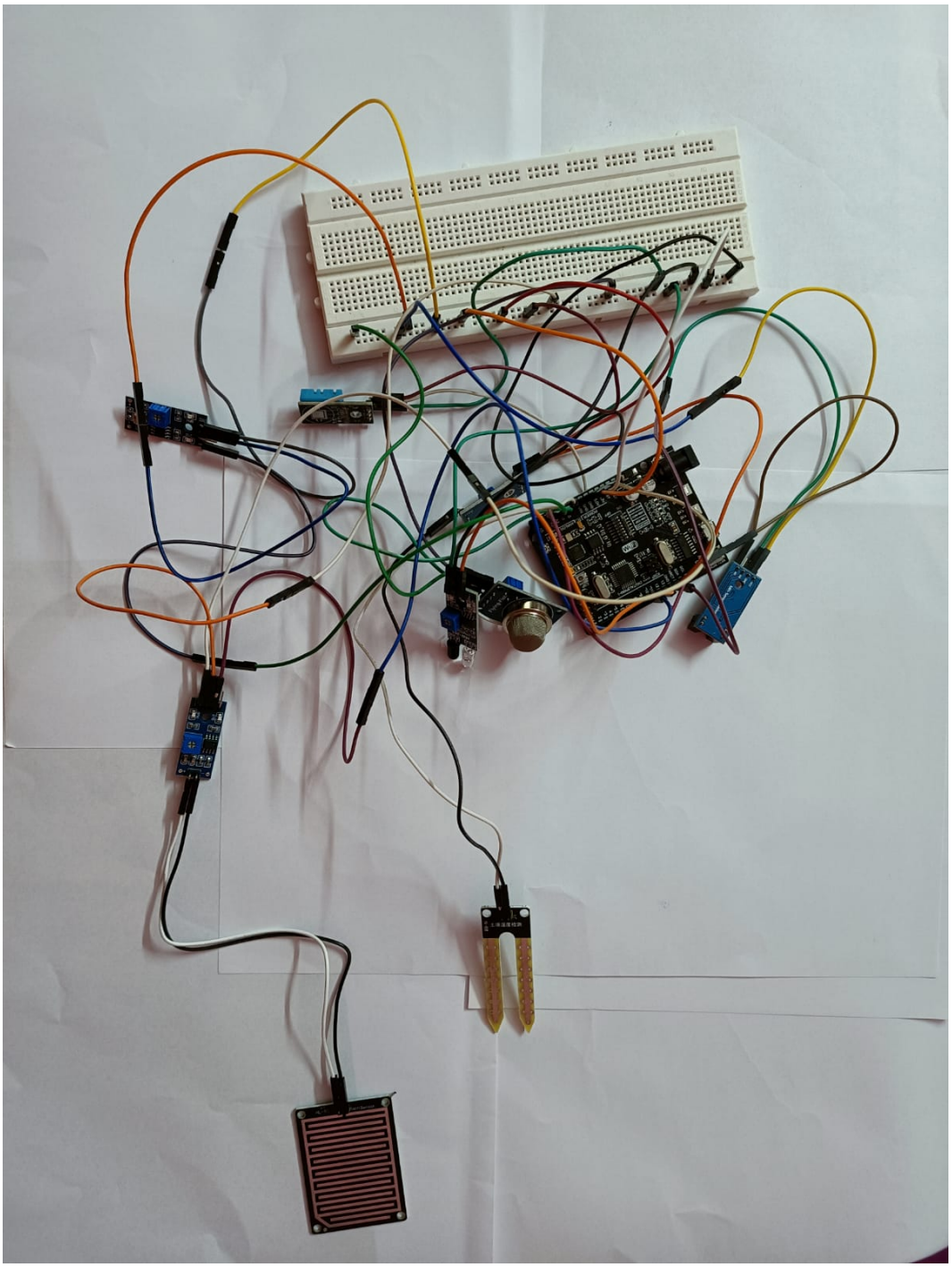
Working

The sensors are connected to the respective digital and analogue ports of an ARDUINO WiFi module. The data received from the sensors are processed within the microcontroller. Then if any discrepancies are found notifications and warnings are sent to the ADMIN Panel using the MQTT protocol. Wherein the ARDUINO unit acts as Publisher and the ADMIN panel as Subscriber. The broker used here is an open-source one offered by Eclipse Mosquitto.The data collected over time is sent to the Node-RED dashboard also for visualization to understand the variance of the environmental parameters over time. The sensor integration with the microcontroller was done using embedded C through Arduino IDE while Python was used for the subscriber part with PyCharm IDE.

Only important parameters adversely affecting the mining industry have been considered like harmful gases emitted, temperature and humidity inside, light intensity as to see if it is getting dark or not, if the fire is seen or not, rainfall has started or not. MQTT has been used because of its ease of implementation, efficient transmission of data, low power and fast transfer with minimal bandwidth.

For flame and soil moisture sensor, digital connection and returns 0 and 1 if detected or not. While for DHT11 sensor and Light Intensity sensor analogue connection is used and a threshold is set for issuing notification and warning.
These threshold values are considered based on the project environment and the parameter for the same can be changed in the future to suit the mine conditions.
Air Pressure sensor has also been incorporated to keep track of the air pressure conditions of the mine.

2.3 SNAPSHOTS



3. SOFTWARE ANALYSIS

3.1 SOFTWARE Coding

Arduino Coding

```
#include <ESP8266WiFi.h>
#include <PubSubClient.h>
#include "DHT.h"
#define DHTTYPE DHT11
#define dht_dpin A0
#include <Adafruit_BMP085.h>
#define seaLevelPressure_hPa 1013.25
#define light_sensor A2
Adafruit_BMP085 bmp;
#define rainSensor 10
#define gasSensor A1
const char* ssid = "SF";
const char* password =  "59001230";
const char* mqtt_server = "mqtt.eclipseprojects.io";
const int mqtt_port = 1883;
DHT dht(dht_dpin, DHTTYPE);
const int soilSensor = 13;
int flameSensor = 12;
float h;
float t;
int val = 0;
int rain;
int pressure;
```

```
int light;
int g;
int sensorState = 0;
WiFiClient espClient;
PubSubClient client(espClient);
void setup()
{
  Serial.begin(115200);
   if (!bmp.begin()) {
  Serial.println("Could not find a valid BMP085 sensor, check wiring!");
  while (1) {}
  }
  pinMode(soilSensor, INPUT);// Sensor 1
  pinMode(gasSensor,INPUT); // Sensor 2
  pinMode(flameSensor,INPUT); // Sensor 3
  pinMode(light_sensor,INPUT); // Sensor 5
  pinMode(pressure_sensor,INPUT); // Sensor 6
  pinMode(rainSensor,INPUT); // Sensor 7
  dht.begin(); // Sensor 4
  // WiFi and MQTT Connection
  WiFi.begin(ssid, password);
```

```
  while (WiFi.status() != WL_CONNECTED)
  {
    delay(500);
    Serial.println("Connecting to WiFi..");
  }
  Serial.print("Connected to WiFi :");
  Serial.println(WiFi.SSID());
  client.setServer(mqtt_server, mqtt_port);
  while (!client.connected())
  {
    Serial.println("Connecting to MQTT...");
    if (client.connect("mqtt.eclipseprojects.io"))
    {
      Serial.println("connected");
    }
    else
    {
      Serial.print("failed with state ");
      Serial.println(client.state());
      delay(2000);
    }
  }
  delay(700);
```

```
}

void loop(){
 sensorState = digitalRead(soilSensor);
 g = analogRead(gasSensor);
 val = digitalRead(flameSensor);
 h = dht.readHumidity();
 t = dht.readTemperature();
 light = analogRead(light_sensor);
 rain = digitalRead(rainSensor);
 pressure = bmp.readPressure();
 //Rain Detection Sensor
 if(rain){
  // Status: Clear
  client.publish("rain","C");
 }else{
  // Status: It is raining
  client.publish("rain","R");
 }
 if(light<=400){
  // Dark
```

```
  // Dark
  client.publish("light","D");
  }
  else{
    // Normal
    client.publish("light","NL");
  }
 if(g>200){
  // Gas Detected
    client.publish("gas","Sf");
  }
  // Soil Moisture Sensor
  if(sensorState==0){
    // No Moisture
    client.publish("soil-moisture","f");
  }else{
    // Moisture Found
    client.publish("soil-moisture","Mf");
  }
  // Flame Sensor
   if (val == HIGH) // No Flame
   {
      client.publish("flame","NF");
```

```
    }
    else // Flame Detected
    {
       client.publish("flame","F");
    }
    // DHT11 Sensor
     if(h>90){ // > 90%
       client.publish("DHT","h");
     }
     if(t>20){
        client.publish("DHT","t");
      }
      // Air Pressure Sensor
      if(pressure <= 1000){
       client.publish("pressure","N");
      }else{
       client.publish("pressure","H");
      }
 delay(3000);
}
```

Python MQTT

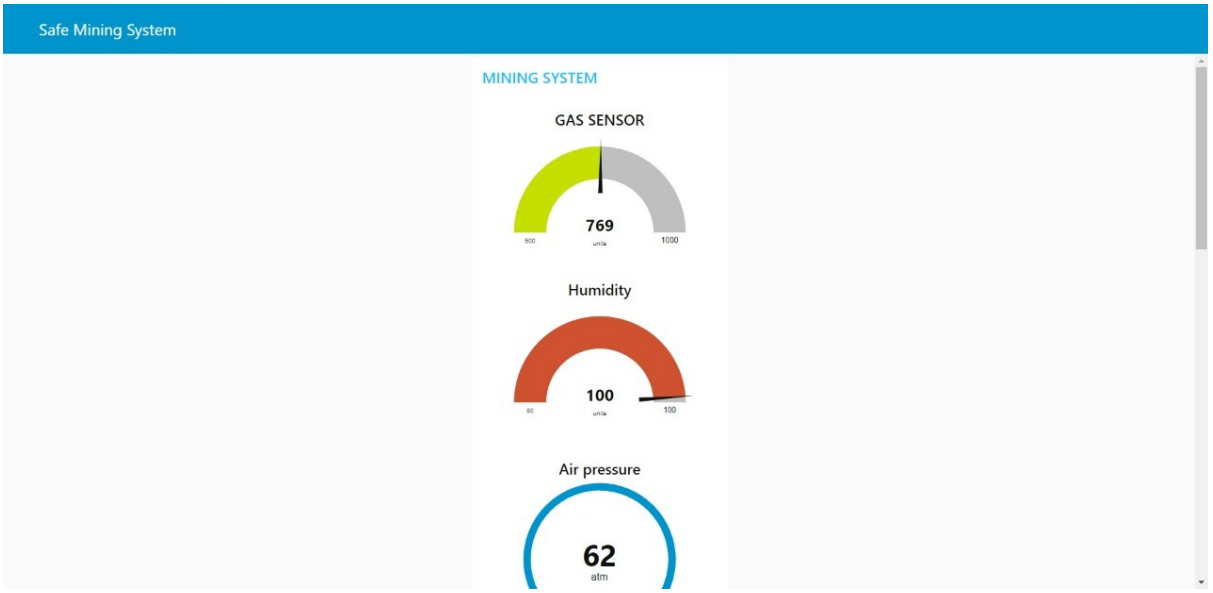
mqtt.py

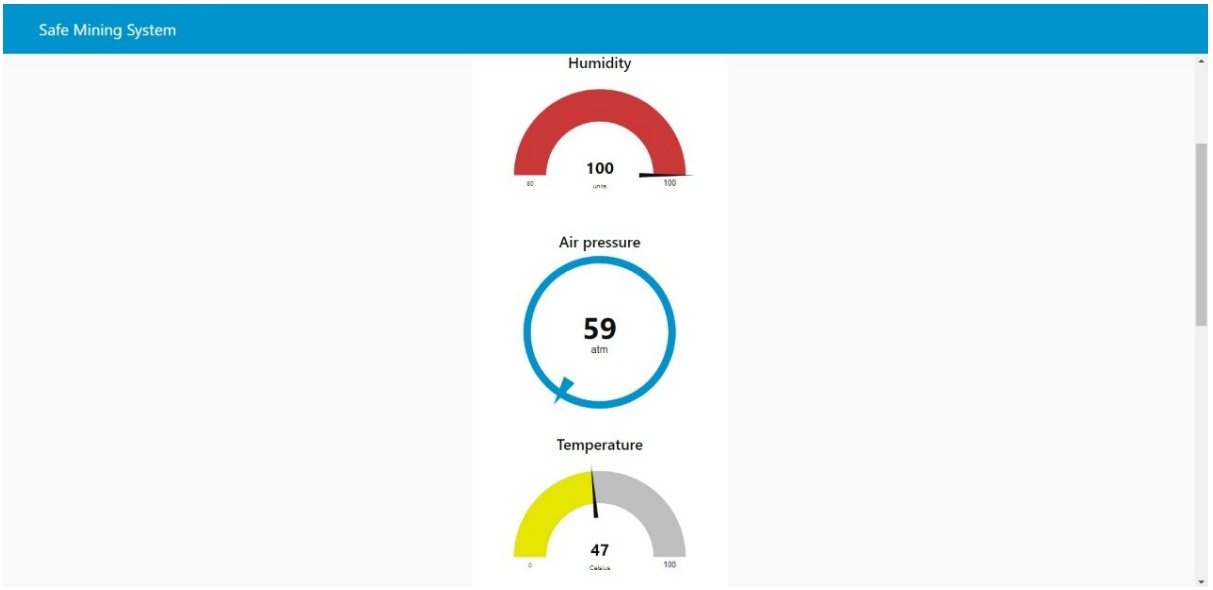
```python
import paho.mqtt.client as mqtt
import time
import folium
import os

flg = True
flm = True
fls = True
fp = True
fr = True
fl = True
fld1 = True
fld2 = True

def on_message(client, userdata, message):
    global flg,flm,fls,fld1,fld2,fp,fr,fl
    msg = str(message.payload.decode("utf-8"))
    if message.topic == "gas":
        if flg:
            print("Harmful Gases Detected...")
            flg = False
    if message.topic == "flame":
        if flm:
            print("Flame Detected....")
            flm = False
    if message.topic == "soil-moisture":
        if fls and msg=='Mf':
            print("Soil Moisture High....")
            fls = False
        elif fls and msg=='f':
            print("Moisture NOT found..")
            fls = False
    if message.topic == "DHT":
```

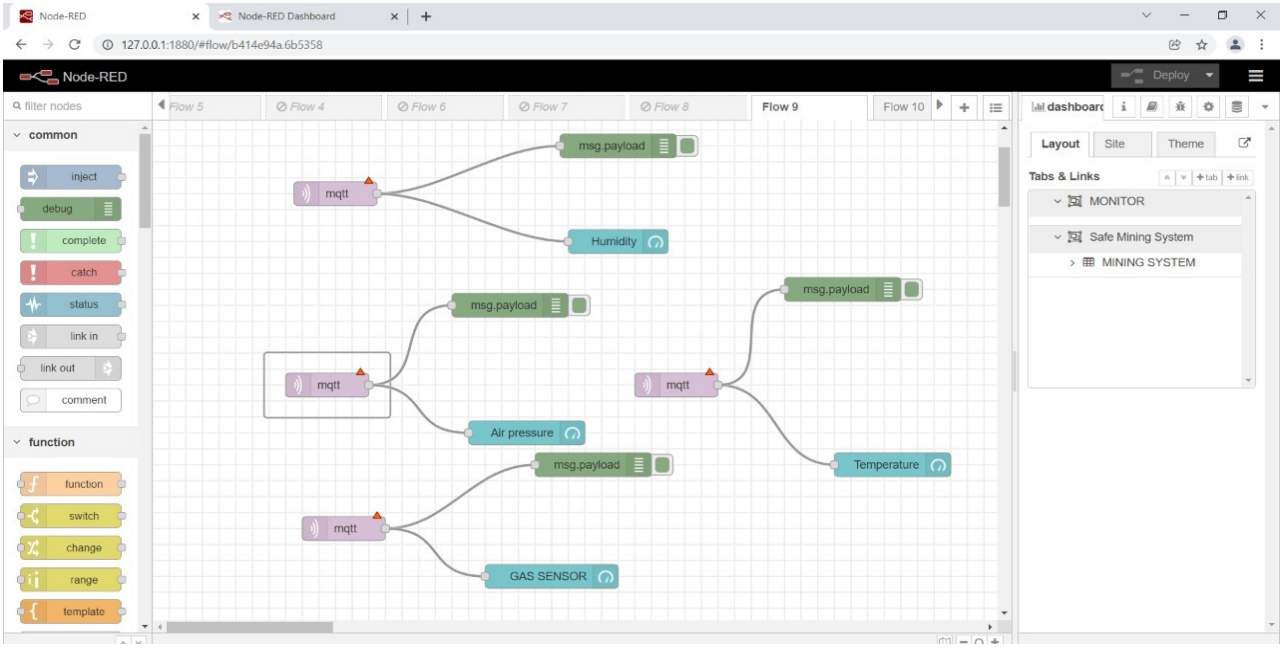
```
6
7       client.loop_start()
8       client.subscribe("gas")
9       client.subscribe("flame")
0       client.subscribe("soil-moisture")
1       client.subscribe("DHT")
2       client.subscribe("light")
3       client.subscribe("rain")
4       client.subscribe("pressure")
5       client.on_message = on_message
6       time.sleep(30)
7
8
```

```
33      if message.topic == "DHT":
34          if fld1 and msg=='t':
35              print("Temperature High...")
36              fld1 = False
37          elif fld2 and msg=='h':
38              print("Humidity High...")
39              fld2 = False
40      if message.topic == "light":
41          if fl and msg == 'D':
42              print("Getting Dark")
43              fl = False
44          elif fl and msg == 'NL':
45              print("Normal LIGHTING")
46              fl = False
47      if message.topic == "pressure":
48          if fp and msg == 'N':
49              print("Normal Air Pressure")
50              fp = False
51          elif fp and msg == 'H':
52              print("HIGH Air Pressure")
53              fp = False
54      if message.topic == "rain":
55          if fr and msg == 'C':
56              print("NO Rain")
57              fr = False
58          elif fr and msg == 'R':
59              print("It's Raining")
60              fr = False
61
62
63      mqttBroker = "mqtt.eclipseprojects.io"
64      client = mqtt.Client("admin")
65      client.connect(mqttBroker)
```

RESULTS


Safe Mining System
MINING SYSTEM
GAS SENSOR
769
Humidity
100
Air pressure
62
atm


Safe Mining System
Humidity
100
Air pressure
59
atm
Temperature
47


Node-RED
Node-RED Dashboard
127.0.0.1:1880/#flow/b414e94a.6b5358
Deploy
filter nodes
Flow 5
Flow 4
Flow 6
Flow 7
Flow 8
Flow 9
Flow 10
common
inject
debug
complete
catch
status
link in
link out
comment
function
function
switch
change
range
template
mqtt
msg.payload
Humidity
mqtt
msg.payload
Air pressure
mqtt
msg.payload
GAS SENSOR
mqtt
msg.payload
Temperature
dashboard
Layout
Site
Theme
Tabs & Links
MONITOR
Safe Mining System
MINING SYSTEM

Conclusion:

The IIoT is a source of industrial automation and opens possibilities for important insights applicable in several business areas. We use the guidelines given by global IIoT standards and related initiatives to produce the final project. The produced IIoT application can act as a bridge between technical gaps of interoperability and exchange of data that exist in the mining environment. The implementation of such high-level architecture can be made possible by considering various technologies such as OT/IT applications, IoT devices.

Future Work:

The article makes open research issues and future works for researchers. We have demonstrated how sensors and different communication protocols can be used for making the mining industry safer. Later researchers can focus on use of cloud and fog computing for making the project more advanced. The above-mentioned challenges for the edge can be addressed with the advancements in the virtualization techniques for edge computing.Not only the mining industry but almost all the industries are quite complex at the edge with the advancement of IoT based microservices, and systems. There are a great number of solutions available for cloud computing services, but a standard or concrete solution targeting the same problem for the edge/fog does not exist.

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