COAL MINE MONITORING AND ALERTING SYSTEM

A THESIS

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THESIS CERTIFICATE

This is to certify that the thesis entitled "**COAL MINE MONITORING AND ALERTING SYSTEM**" submitted By A.M.N.Sri Harsha (N200484), M.Jayanthi (N200380), S.Lakshmi Devi (N200172),L.Spandana(N200044) to the Department of Electronics and Communication Engineering, Rajiv Gandhi University of Knowledge Technologies - Nuzvid campus, AP for the award of the degree of B.Tech in ECE is a bonafide record of work carried out by him under my supervision. The contents of this thesis, in full or in parts, have not been submitted to any other Institute or University for the award of any degree or diploma.

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ABSTRACT

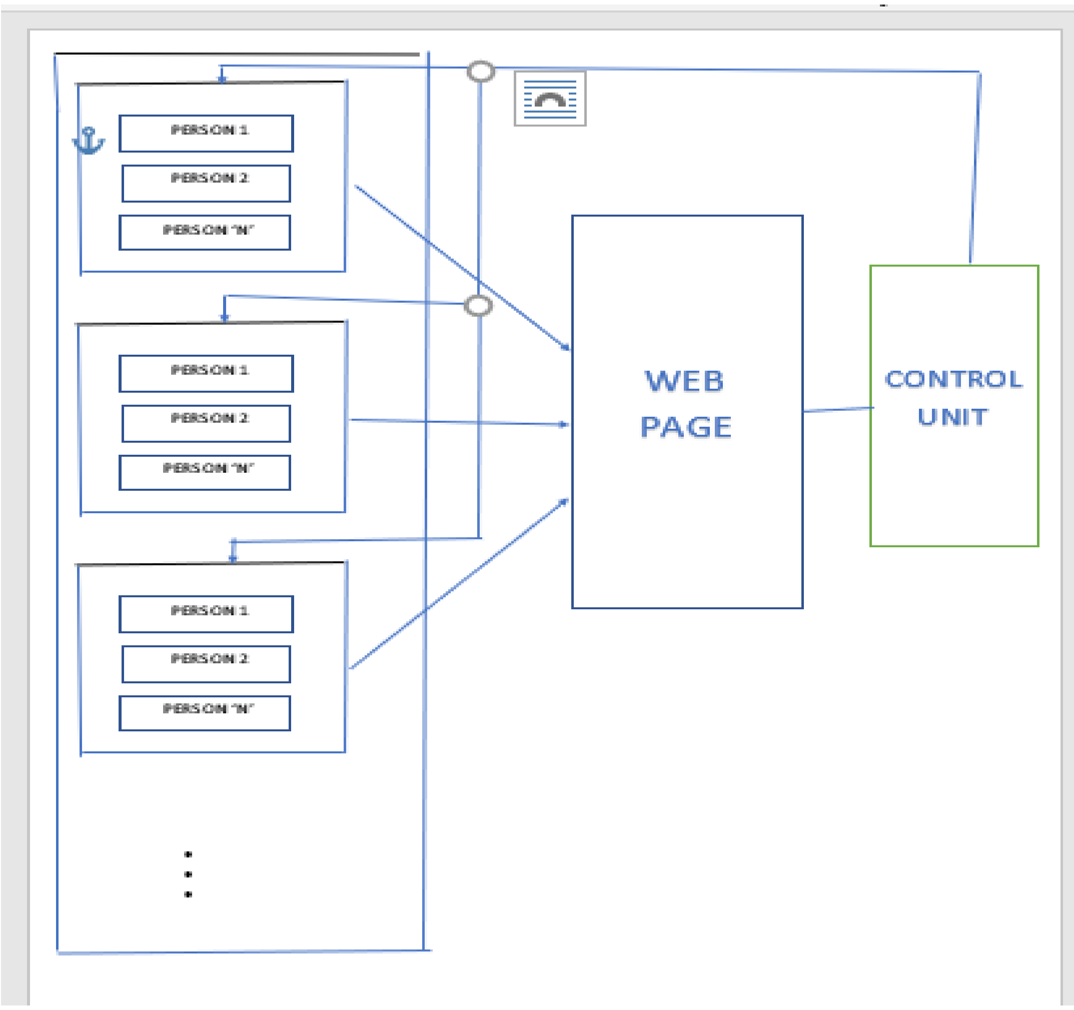
The Coal Mine Monitoring and Alerting System (CMMAS) plays a critical role in ensuring the safety of workers and the environment in coal mining operations by detecting hazardous conditions in real-time. This paper presents a cost-effective and efficient system utilizing NodeMCU (a low-cost microcontroller with Wi-Fi capabilities) to monitor essential parameters such as gas levels (methane, carbon monoxide), temperature, humidity, and environmental conditions within the mine. The system employs various sensors connected to the NodeMCU, which processes and transmits the data to a cloud-based platform using Firebase, a real-time database service. The collected data is continuously updated on a website, allowing operators and stakeholders to monitor mine conditions remotely and receive instant alerts on any detected anomalies or dangerous situations, such as gas leaks, temperature spikes, or excessive dust. This system provides real-time alerts through notifications, enabling prompt responses to mitigate risks and prevent accidents. Additionally, historical data stored on Firebase can be analyzed for trend monitoring, predictive maintenance, and safety audits. The integration of NodeMCU and Firebase offers a scalable, reliable, and accessible solution for improving coal mine safety, operational efficiency, and emergency response times.

INTRODUCTION:

Coal mining is an essential industry that provides a significant portion of the world's energy, but it also poses numerous risks to workers and the environment. Hazardous conditions such as gas leaks (methane, carbon monoxide), equipment malfunctions, dust accumulation, and sudden changes in temperature or humidity are frequent concerns in mining operations. These dangers not only threaten worker safety but also can lead to costly operational disruptions. To address these challenges, there is a growing need for an advanced monitoring and alerting system that provides real-time insights into the mine's environmental conditions and ensures prompt responses to potential risks.

This paper proposes a Coal Mine Monitoring and Alerting System (CMMAS) based on NodeMCU, a compact and affordable microcontroller with Wi-Fi capabilities, for effective monitoring of critical parameters within the coal mine. NodeMCU interacts with a variety of sensors to measure factors like temperature, humidity, and gas concentrations, which are key indicators of safety risks. The data collected from these sensors is transmitted wirelessly to Firebase, a cloud-based real-time database, which ensures seamless storage and access to data for remote monitoring.

By sending this information to a website through Firebase, the system allows operators and safety personnel to continuously monitor mine conditions from any location, improving operational oversight and safety measures. Additionally, the real-time alerting feature provides immediate notifications in case of detected anomalies, such as high gas levels or unsafe temperature fluctuations, enabling swift action to prevent potential disasters. This integration of NodeMCU and Firebase into a unified system not only enhances safety and risk management but also offers a cost-effective, scalable solution for coal mines of varying sizes and complexities.



PERSON 1
PERSON 2
PERSON "N"
PERSON 1
PERSON 2
PERSON "N"
PERSON 1
PERSON 2
PERSON "N"
WEB PAGE
CONTROL UNIT

COMPONENTS USED:

DHT 11:

The DHT11 sensor is used in a Coal Mine Monitoring and Alerting System (CMMAS) to measure temperature and humidity within the mine. Integrated with the NodeMCU microcontroller, the sensor collects environmental data and sends it to Firebase, a cloud-based platform. Firebase stores the data, making it accessible on a website interface for real-time monitoring. If temperature or humidity levels exceed predefined safe thresholds, alerts are triggered to notify operators of potential hazards. This system ensures continuous, remote monitoring, providing early warnings for unsafe conditions, enhancing safety, and improving operational efficiency in coal mining environments.

MQ2 GAS SENSOR:

The MQ2 gas sensor is used in a Coal Mine Monitoring and Alerting System (CMMAS) to detect harmful gases such as methane and carbon monoxide, which pose significant safety risks in coal mines. Integrated with the NodeMCU microcontroller, the MQ2 sensor measures gas concentration levels and sends the data to Firebase, a cloud-based platform. The data is displayed on a website for real-time monitoring, enabling mine operators to remotely track gas levels. If the gas concentration exceeds safe thresholds, the system triggers alerts to notify operators, ensuring quick responses to potential hazards and improving overall mine safety.

NODEMCU :

The NodeMCU microcontroller is central to the Coal Mine Monitoring and Alerting System (CMMAS), acting as the interface between sensors and the cloud. It collects data from various sensors, such as the DHT11 for temperature and humidity or the MQ2 for gas detection, and processes this information. Using its built-in Wi-Fi capabilities, NodeMCU sends the data to Firebase, a cloud-based platform. Firebase stores and displays the data on a website for real-time monitoring. The system can trigger alerts if unsafe conditions are detected, allowing operators to monitor the mine remotely and respond quickly to potential hazards.

WORKING:

i)Data Transfer between sensors and NodeMCU :

In the Coal Mine Monitoring and Alerting System, data transfer between sensors and NodeMCU is achieved through digital and analog communication. The sensors, such as the **DHT11** for temperature and humidity and the **MQ2** for gas detection, are connected directly to the NodeMCU microcontroller.

- **DHT11 Sensor**: The DHT11 sensor outputs digital signals for temperature and humidity. NodeMCU reads these values via its GPIO pins, using appropriate libraries (e.g., DHT sensor library) in the Arduino IDE to process the data.
- **MQ2 Sensor**: The MQ2 gas sensor generates an analog output corresponding to the gas concentration levels (e.g., methane, carbon monoxide). NodeMCU reads the analog data through its ADC (Analog-to-Digital Converter) pins, converting the analog signal into a readable value.

Once the data is collected, NodeMCU processes and transmits it to **Firebase** via Wi-Fi, where it is stored and displayed on a website. The data can be accessed remotely for continuous monitoring and alerting.

ii) Data Transfer between NodeMCU and Firebase Console:

In the Coal Mine Monitoring and Alerting System, data transfer between NodeMCU and Firebase is crucial for real-time monitoring. The NodeMCU, a Wi-Fi-enabled microcontroller, collects data from sensors such as the DHT11 (for temperature and humidity) and MQ2 (for gas detection). This data is processed by NodeMCU and sent to Firebase using the HTTP or Firebase Realtime Database protocol.

To establish the connection, the NodeMCU is programmed with an Arduino IDE that includes Firebase libraries, enabling it to authenticate and connect to the Firebase database via Wi-Fi. Once connected, the sensor readings are pushed to Firebase, where they are stored in real-time.

Firebase serves as a cloud-based platform, allowing the data to be displayed on a website for remote monitoring. When unsafe conditions are detected (e.g., high gas levels or temperature), alerts are triggered and can be accessed through the Firebase console, notifying operators of potential hazards. This seamless data transfer ensures constant monitoring and quick responses in coal mines.

iii)Data Transfer between Firebase Console and Web Page:

In the Coal Mine Monitoring and Alerting System, data transfer between Firebase and the webpage is facilitated using Firebase Realtime Database and its integration with a website. Once the NodeMCU collects sensor data (from devices like the DHT11 and MQ2) and uploads it to Firebase, the data is stored in the Firebase Realtime Database.

To display this data on a webpage, Firebase's JavaScript SDK is used. The website, which is built using HTML, CSS, and JavaScript, establishes a connection to Firebase using the SDK. It listens for updates in the Firebase database, automatically retrieving and displaying the most recent sensor data (temperature, humidity, and gas levels) in real-time.

Whenever NodeMCU uploads new data, Firebase triggers updates on the webpage, ensuring that mine operators can view live sensor readings. Additionally, Firebase's event-based triggers allow for alerts to be displayed on the website if unsafe conditions (like high gas levels) are detected, enabling immediate action.

CODE:

Arduino code:

```
#include <ESP8266WiFi.h>
#include <FirebaseESP8266.h>
#include <DHT.h>

// Firebase config
#define FIREBASE_HOST "coal-project-5e6db-default-rtdb.asia-
southeast1.firebasedatabase.app"
#define FIREBASE_AUTH "nDwKqzGeQJjcLP98Kq3xt8Ib4ascTwQ4mXusBqi"

// Wi-Fi credentials
#define WIFI_SSID "harsha"
#define WIFI_PASSWORD "9394499669"

// DHT Sensor setup
#define DHTPIN D2
#define DHTTYPE DHT11

DHT dht(DHTPIN, DHTTYPE);

FirebaseData firebaseData;
FirebaseConfig firebaseConfig;
FirebaseAuth firebaseAuth;

// Buzzer setup
#define BUZZER_PIN D4

void setup() {
```

```
  Serial.begin(115200);
  dht.begin();

  // Setup buzzer pin
  pinMode(BUZZER_PIN, OUTPUT);
  digitalWrite(BUZZER_PIN, LOW);

  // Connect to Wi-Fi
  WiFi.begin(WIFI_SSID, WIFI_PASSWORD);
  Serial.print("Connecting to Wi-Fi");
  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }
  Serial.println();
  Serial.println("Connected to Wi-Fi");

  // Configure Firebase
  firebaseConfig.host = FIREBASE_HOST;
  firebaseConfig.signer.tokens.legacy_token = FIREBASE_AUTH;

  Firebase.begin(&firebaseConfig, &firebaseAuth);
  Firebase.reconnectWiFi(true);

  Serial.println("Connected to Firebase");
}

void loop() {
  float h = dht.readHumidity();
  float t = dht.readTemperature();
```

```
// Example threshold values, adjust as necessary
int gasValue = analogRead(A0);
bool buzzerState = (t > 38 || h > 90 || gasValue > 900);

// Control the buzzer
if (buzzerState) {
  digitalWrite(BUZZER_PIN, HIGH); // Turn buzzer ON
} else {
  digitalWrite(BUZZER_PIN, LOW);  // Turn buzzer OFF
}

// Print sensor values to Serial Monitor
Serial.print("Temperature: ");
Serial.print(t);
Serial.print(" °C, Humidity: ");
Serial.print(h);
Serial.print(" %, Gas: ");
Serial.print(gasValue);
Serial.print(", Buzzer: ");
Serial.println(buzzerState ? "ON" : "OFF");

// Send data to Firebase with retry logic
bool success = false;
int retryCount = 3;
String path = "/blocks/block1/node1";

for (int i = 0; i < retryCount; i++) {
  if (Firebase.setFloat(firebaseData, path + "/temp", t) &&
      Firebase.setFloat(firebaseData, path + "/humi", h) &&
      Firebase.setInt(firebaseData, path + "/gas", gasValue) &&
      Firebase.setBool(firebaseData, path + "/buzzer", buzzerState)) {
```

```
      success = true;
      break;
    } else {
      Serial.println("Failed to send data, retrying...");
      Serial.println("Error: " + firebaseData.errorReason());
      delay(2000); // Wait 2 seconds before retrying
    }
  }

  if (success) {
    Serial.println("Data sent successfully");
  } else {
    Serial.println("Failed to send data after retries");
  }

  delay(5000); // 5 seconds delay between requests
}
```

WEB PAGE:

Index.html

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>Coal Project Monitoring</title>
    <link rel="stylesheet" href="styles.css">
</head>
<body>
    <div class="container">
```

```
    <h1>Coal Project Monitoring</h1>

    <div class="block" id="block1">
        <div class="indicator" id="block1-indicator"></div>
        <h2>Block 1</h2>
        <div class="nodes" id="nodes-block1"></div>
    </div>

    <div class="block" id="block2">
        <div class="indicator" id="block2-indicator"></div>
        <h2>Block 2</h2>
        <div class="nodes" id="nodes-block2"></div>
    </div>

    <div class="block" id="block3">
        <div class="indicator" id="block3-indicator"></div>
        <h2>Block 3</h2>
        <div class="nodes" id="nodes-block3"></div>
    </div>

    <div class="block" id="block4">
        <div class="indicator" id="block4-indicator"></div>
        <h2>Block 4</h2>
        <div class="nodes" id="nodes-block4"></div>
    </div>
</div>

<!-- Firebase App (the core Firebase SDK) -->
<script src="https://www.gstatic.com/firebasejs/8.10.0/firebase-app.js"></script>

<!-- Firebase Database SDK -->
```

```html
    <script src="https://www.gstatic.com/firebasejs/8.10.0/firebase-database.js"></script>

    <!-- Your custom JavaScript -->
    <script src="script.js"></script>
</body>
</html>
```

Style.css

```css
body {
    font-family: Arial, sans-serif;
    background-color: #f4f4f4;
    margin: 0;
    padding: 20px;
}

.container {
    max-width: 800px;
    margin: auto;
    background: #fff;
    padding: 20px;
    box-shadow: 0 0 10px rgba(0, 0, 0, 0.1);
}

h1 {
    text-align: center;
    margin-bottom: 20px;
}

.block {
    border: 1px solid #ddd;
```

```css
  margin-bottom: 20px;
  padding: 10px;
  position: relative;
}

.indicator {
  width: 20px;
  height: 20px;
  border-radius: 50%;
  background-color: green;
  position: absolute;
  top: 10px;
  right: 10px;
}

.nodes {
  display: none;
  margin-top: 10px;
}

.node {
  background: #f9f9f9;
  padding: 10px;
  border: 1px solid #ddd;
  margin-bottom: 10px;
}
```

Script.js :

```
// Firebase configuration
var firebaseConfig = {
  apiKey: "AIzaSyDrg4FCw5K-4Dn40HG9kVHbmm90giZsmVU",
  authDomain: "coal-project-5e6db.firebaseapp.com",
  databaseURL: "https://coal-project-5e6db-default-rtdb.asia-
southeast1.firebasedatabase.app",
  projectId: "coal-project-5e6db",
  storageBucket: "coal-project-5e6db.appspot.com",
  messagingSenderId: "726696828468",
  appId: "1:726696828468:web:3eaf4d8b3c123456789abc"
};

// Initialize Firebase
firebase.initializeApp(firebaseConfig);
var database = firebase.database();

// Fetch data from Firebase
function fetchData() {
  var blocksRef = database.ref('/blocks');
  blocksRef.on('value', (snapshot) => {
      var data = snapshot.val();
      updateBlock('block1', data.block1);
      updateBlock('block2', data.block2);
      updateBlock('block3', data.block3);
      updateBlock('block4', data.block4);
  });
}

// Update block data
function updateBlock(blockId, blockData) {
  var blockIndicator = document.getElementById(${blockId}-indicator);
```

```
  var nodesContainer = document.getElementById(nodes-${blockId});
  nodesContainer.innerHTML = '';

  var blockHasAlarm = false;

  for (var nodeId in blockData) {
    var nodeData = blockData[nodeId];
    var nodeDiv = document.createElement('div');
    nodeDiv.classList.add('node');

    var buzzerState = nodeData.buzzer ? 'ON' : 'OFF';
    nodeDiv.innerHTML = `
      <h3>${nodeId}</h3>
      <p>Temperature: ${nodeData.temp} °C</p>
      <p>Humidity: ${nodeData.humi} %</p>
      <p>Gas: ${nodeData.gas}</p>
      <p>Buzzer: ${buzzerState}</p>
    `;

    if (nodeData.buzzer) {
      blockHasAlarm = true;
    }

    nodesContainer.appendChild(nodeDiv);
  }

  blockIndicator.style.backgroundColor = blockHasAlarm ? 'red' : 'green';
}

// Toggle nodes display when a block is clicked
function toggleNodeVisibility(blockId) {
```

```
  var nodes = document.getElementById(nodes-${blockId});
  nodes.style.display = nodes.style.display === 'none' ? 'block' : 'none';
}

// Add event listeners for each block
document.getElementById('block1').addEventListener('click', function() {
  toggleNodeVisibility('block1');
});

document.getElementById('block2').addEventListener('click', function() {
  toggleNodeVisibility('block2');
});

document.getElementById('block3').addEventListener('click', function() {
  toggleNodeVisibility('block3');
});

document.getElementById('block4').addEventListener('click', function() {
  toggleNodeVisibility('block4');
});

// Initialize
fetchData();
```

SCOPE OF THE PROJECT:

The scope of the Coal Mine Monitoring and Alerting System (CMMAS) using NodeMCU and Firebase is to improve safety, efficiency, and risk management in coal mines by providing real-time environmental monitoring. The system monitors key parameters such as temperature, humidity, and hazardous gases (e.g., methane and carbon monoxide) using sensors like DHT11 and MQ2, which are connected to the NodeMCU microcontroller. NodeMCU processes the sensor data and sends it wirelessly to Firebase, a cloud-based platform that stores and displays the data on a website. This enables mine operators to remotely monitor mine conditions in real-time, enhancing decision-making and emergency response capabilities.

The system's scope includes triggering immediate alerts if unsafe conditions arise, such as high gas concentrations or dangerous temperature fluctuations. Additionally, the system allows for trend analysis and predictive maintenance based on historical data. It is scalable, cost-effective, and can be customized for mines of various sizes, ensuring enhanced worker safety and operational efficiency.

CONCLUSION:

Coal Mine Monitoring and Alerting System (CMMAS) utilizing NodeMCU and Firebase offers a robust and efficient solution to enhance the safety and operational efficiency of coal mining operations. By continuously monitoring critical parameters such as temperature, humidity, and hazardous gas levels, the system provides real-time data that is transmitted to Firebase for storage and easy access via a website. This remote monitoring capability enables mine operators to detect potential hazards early, ensuring rapid response to unsafe conditions, such as gas leaks or temperature spikes. The system's alert mechanism notifies operators immediately, helping to prevent accidents and protect workers. Additionally, the cloud-based infrastructure allows for historical data analysis, which can aid in predictive maintenance and long-term safety planning. Overall, the integration of affordable, scalable components like NodeMCU, along with real-time data transmission, provides an effective and cost-efficient tool for improving safety and operational management in coal mines.