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# Versatile Monitoring and Display System Based on Hardware: Implementation and Results

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***Abstract***

***This paper presents the development and implementation of a Versatile Monitoring and Display System (VMDS) that utilizes MQ-135 and DHT22 sensors for real-time monitoring of air quality, temperature, and humidity. The system is built around a microcontroller unit (MCU) and a display module to visualize the collected data. The hardware components, circuit connections, and real-time output results are discussed in detail. The results demonstrate the system's capability to provide accurate environmental monitoring, making it suitable for smart homes, industrial safety, and environmental applications.***

## Keywords

Monitoring system, hardware interface, real-time display, sensors, microcontroller, IoT integration

## 1. Introduction

Monitoring environmental parameters is crucial in various fields, including industrial automation, environmental monitoring, and smart home systems. The **Versatile Monitoring and Display System (VMDS)** is designed to measure and display **temperature, humidity, and air quality** using hardware components. This system helps in analyzing real-time

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environmental conditions and provides data visualization on a display module. The implementation of **MQ-135 and DHT22 sensors** with an **MCU (such as Arduino or ESP8266)** ensures efficient processing and accurate data representation.

## 2. Hardware Components

The system is implemented using the following components:

2.1. Sensors

- MQ-135 Gas Sensor – Measures air quality (CO2, NH3, benzene, smoke).
- DHT22 Temperature and Humidity Sensor – Provides accurate readings of ambient temperature and humidity.

2.2. Processing Unit

- Microcontroller (ESP8266) – Collects and processes sensor data, sending it to the display unit.

2.3. Display Unit

- TM1637 4 Bit digital tube LED Display – Shows real-time sensor data.

2.4. Power Supply

- **5V DC Adapter** – Powers the system components.

## 3. Circuit Design and Implementation

3.1. Circuit Connections

- The DHT22 sensor is connected to the MCU's digital pin for temperature and humidity readings.
- The MQ-135 sensor is connected to an analog pin of the MCU for air quality measurement.
- The LCD display is interfaced using I2C (TM1637) – Uses only 2 pins (CLK, DIO), making it the most efficient choice. communication for efficient data transfer.
- The system is powered through a 5V DC supply or USB connection.

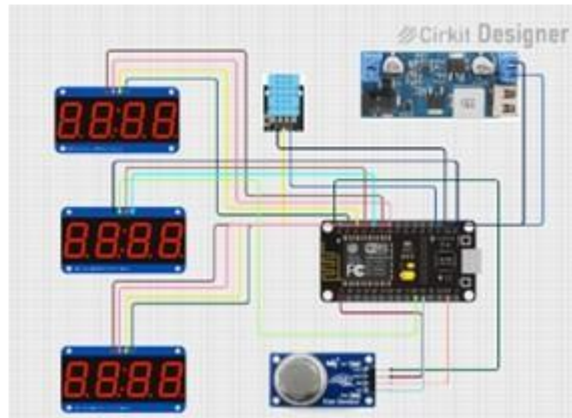
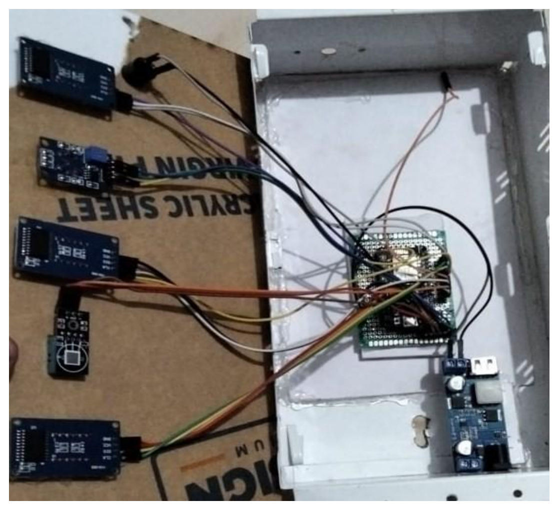


Fig 1.circuit diagram

3.2. Working Principle



1. Sensors collect environmental data in real time.
2. The MCU processes the collected data and converts it into readable values.
3. The display module updates with the latest temperature, humidity, and air quality values.
4. If integrated with IoT, the data can be sent to a cloud server for remote monitoring.

## 4. Results and Observations

The system was tested in different environmental conditions, and the real-time readings were recorded.

4.1. Experimental Setup

- The system was placed in three different locations:
    - Indoor Room (Controlled Environment)
    - Outdoor Area (Open Space)
    - Industrial Zone (High Pollution Level)

4.2. Recorded Data

| Location | Temperature (°C) | Humidity (%) | Air Quality (PPM) |
|---|---|---|---|
| Indoor Room | 24.5 | 32 | 151 |
| Outdoor Area | 30.2 | 41 | 254 |
| Industrial Zone | 25 | 35 | 400+ |

- Observation: The air quality in the industrial zone was significantly higher, indicating higher pollutant levels.
- The temperature and humidity values varied based on location conditions.
- The system provided real-time updates on the display, ensuring immediate monitoring.

## 5. Applications

- Environmental Monitoring – Tracks air quality and climate conditions.
- Smart Homes & Offices – Ensures a healthy indoor environment.
- Industrial Safety – Detects harmful gas levels in factories.
- Agriculture & Greenhouses – Maintains optimal climatic conditions for crops.

## 6. Conclusion

This research demonstrates a hardware-based monitoring system capable of measuring temperature, humidity, and air quality in real time. The MQ-135 and DHT22 sensors provided reliable data, while the display unit ensured easy visualization of environmental parameters. Future improvements can include AI-based data analysis and IoT connectivity for cloud-based monitoring and predictive analytics.

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