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Iot Based Online Weather Report Streaming With Graphs

Mr.MD Khaja Pasha [1], Sai Krishna [2], Suhas [3], Sravan Kumar [4], Vijaya Durga [5],
1 Assistant Professor,2,3,4,5 Students,
Department of Electronics and Communication Engineering , Lords Institute of Engineering and Technology, Hyderabad , Telangana

Abstract:
Accurate and timely weather reporting is essential for various applications, from agriculture to disaster management. This project proposes the development of an IoT-Based Online Weather Report Streaming System with Graphs using Arduino, LCD with I2C, DHT11 sensor, rain drop sensor, gas sensor, Node MCU module, and buzzer. The system monitors environmental conditions and transmits the data to an online platform for real-time streaming and graphical visualization. This project aims to provide continuous and accurate weather reports, enhancing decision-making processes and disaster preparedness.
Keywords: IoT, Online Weather Report, DHT11 Sensor, Rain Drop Sensor, Gas Sensor, Node MCU, Real-time Monitoring, Weather Data Visualization.

Introduction:

IoT is defined as the Internet of Things (IoT). It's entrenched with tool, electronics, and sensors to the web. It controls and exchanges information without interaction of people. Internet of things additionally defines the transfer of information, controlling and having permission to the accessories and intention with the aid of sensors by utilizing the web. The web of things, or IoT, is a network of interconnected computing devices, mechanical and digital machinery, items, animals, or individuals who can swap information across a network without needing human-to-human or human-to-computer interaction. Weather monitoring and reporting systems are essential tools for individuals and organizations to understand and respond to various weather conditions. These systems use sensors and other instruments to collect data on various weather parameters, such as temperature, humidity, air pressure, and precipitation. This data is then analysed and used to generate weather reports, which can be used for a wide range of purposes, such as agriculture, aviation, and disaster management.

Traditionally, weather monitoring and reporting systems have relied on stationary sensors and instruments, such as weather stations and meteorological balloons, to collect weather data. These systems have been effective in providing accurate and timely weather reports, but they have several limitations. For example, the coverage of these systems is often limited to specific geographic locations, and the data collected is often not available in real time. The recent developments in IoT technology have the potential to overcome these limitations and improve the accuracy and reliability of weather monitoring and reporting systems.

By using There are several examples of weather monitoring and reporting systems using IoT technology, including: The Smart Citizen Kit (SCK), developed by the Barcelona based company Open Dot, is a low-cost weather monitoring system that uses IoT technology to collect data on temperature, humidity, air pressure, and other weather parameters.
The system consists of a sensor module that can be mounted on a wall or other surface, and a mobile app that allows users to access the data collected by the sensor. The SCK has been used in various projects, including citizen science initiatives and environmental monitoring projects. The Netatmo Weather Station is a consumer-grade weather monitoring system that uses IoT technology to collect data on temperature, humidity, air pressure, and other weather parameters.

Literature Review:

The integration of the Internet of Things (IoT) in meteorological systems has significantly transformed how weather data is collected, analyzed, and disseminated. Numerous studies have explored IoT-based weather monitoring systems, which employ sensor networks to gather real-time data on parameters such as temperature, humidity, atmospheric pressure, wind speed, and rainfall. These systems are typically designed using low-cost, energy-efficient microcontrollers like Arduino or Raspberry Pi, which are connected to environmental sensors and equipped with Wi-Fi or cellular modules to transmit data to a central server or cloud platform. Literature consistently highlights the advantages of IoT in weather monitoring, such as real-time access to data, scalability, and minimal maintenance compared to traditional weather stations.
Recent advancements focus on enhancing data visualization and accessibility through web and mobile interfaces. Researchers have emphasized the importance of graphical representation of weather data, as graphs enable users to interpret trends, anomalies, and patterns more effectively than raw data tables. Technologies like Node.js, Firebase, Thing Speak, and MQTT protocols are commonly employed to facilitate real-time data streaming and dashboard updates. Studies also showcase the use of cloud platforms such as AWS, Azure, or Google Cloud for storing and processing large volumes of

weather data. These platforms support integration with charting libraries (e.g., Chart.js, D3.js) to create interactive, user-friendly interfaces that visualize temperature changes, humidity trends, and rainfall intensity over time.

Furthermore, literature reviews underline the role of machine learning and predictive analytics in enhancing the utility of IoT-based weather systems. While basic systems focus on live data streaming and display, more advanced implementations incorporate AI models to forecast weather conditions, detect outliers, and issue alerts. However, challenges such as sensor calibration, data accuracy, network reliability, and power consumption remain pertinent. Despite these challenges, the existing body of research confirms the efficacy of IoT-based weather monitoring systems with graphical outputs in providing accessible, real-time, and accurate environmental information to both experts and the general public.

IOT Based Online Weather Report Streaming With Graphs:

An IoT-based online weather reporting system with streaming graphs is an innovative application that integrates sensor technology with cloud computing and data visualization tools. It allows for real-time monitoring and reporting of environmental conditions such as temperature, humidity, atmospheric pressure, and rainfall. These systems are particularly useful for agriculture, smart cities, and disaster management where timely weather information is critical.

At the core of the system are IoT sensors like the DHT11 or DHT22 for temperature and humidity, BMP280 for pressure, and rain sensors. These devices collect live data from the surrounding environment and send it to a microcontroller or development board such as Arduino or Node MCU. The collected data is then transmitted via Wi-Fi or cellular networks to cloud platforms like Thing speak, Blynk, or Firebase.

Once the data reaches the cloud, it can be processed and displayed on a web or mobile dashboard. Streaming graphs update in real time to show changes in weather parameters. These graphs provide a visual and intuitive way to monitor trends, patterns, and anomalies. This system can also be programmed to send alerts during extreme weather conditions, making it highly functional and valuable for early warning and data logging.

Proposed System:

The proposed IoT-based system integrates various sensors to monitor temperature, humidity, rainfall, and gas levels. The Arduino processes the data from these sensors and displays it on an LCD with I2C. The Node MCU module transmits the data to an online platform for real-time streaming and graphical visualization. The buzzer provides immediate alerts for hazardous conditions. This system offers real-time, localized weather data, enhancing accuracy and timeliness in weather reporting

Block Diagram:

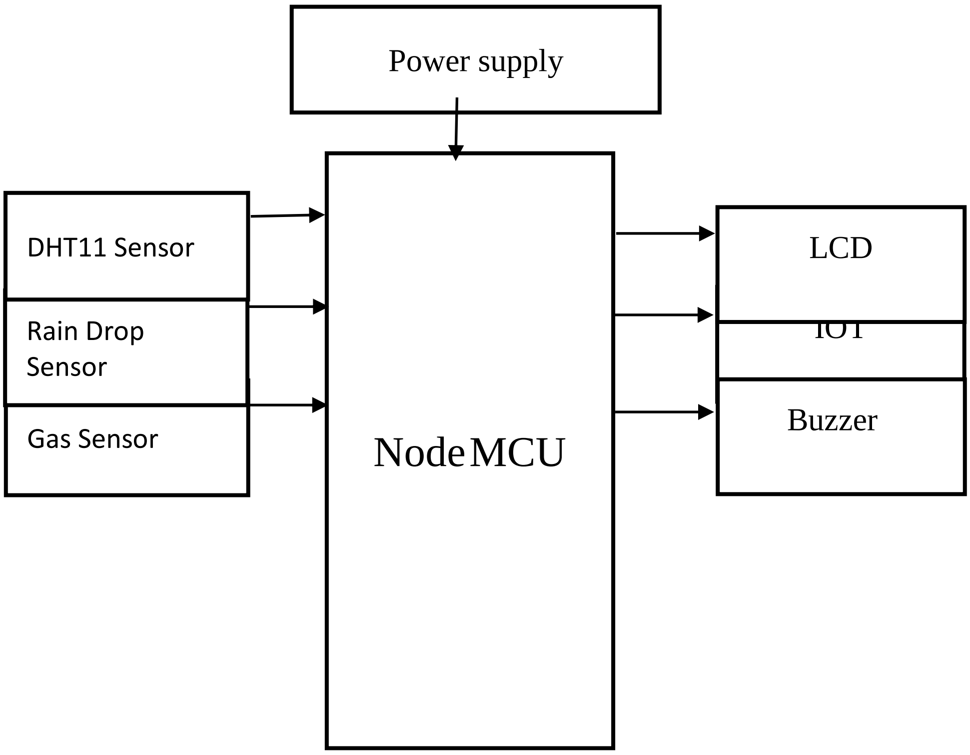

Fig.1: Block Diagram of Proposed System

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NODE MCU:

Technically speaking Node MCU is a firmware for ESP8266 developed using C Programming Language, Express if NON-OS SDK and Lua scripting language. Traditionally, we write code for our Microcontrollers like Arduino, STM32, 8051 etc., either in C or C++ and compile it with a set of tools and generate a binary file. This binary file is then uploaded into the flash memory of the microcontroller and it gets executed. Things are quite different with Node MCU. You can consider the Node MCU firmware as an interpreter for Lua Scripts. So, if your ESP8266 is loaded with Node MCU Firmware, you can simply write your application in Lua and send it to the ESP8266.Node MCU Firmware will interpret the byte code and executes the commands. There is no compilation, no binary file etc. Just write a script and run it the team which developed Node MCU Firmware also developed a breakout board for ESP-12E module called the Node MCU Devkit. So, many of us are actually using the board called Node MCU and programming it with Arduino IDE and not the Lua Scripts.

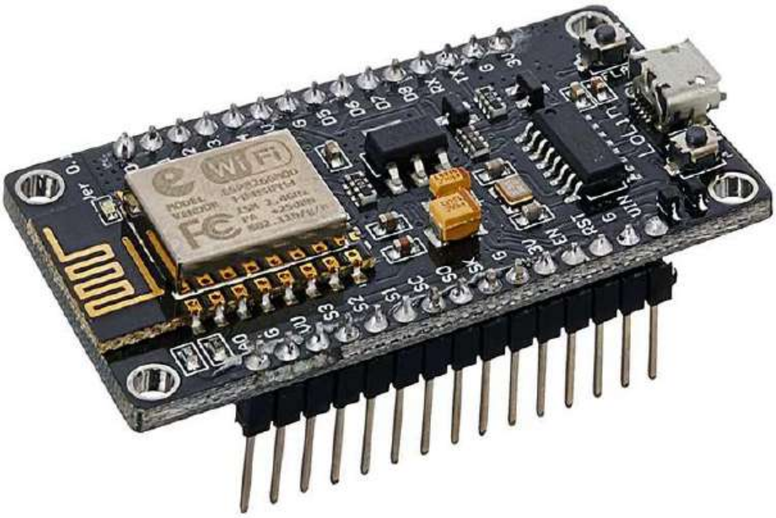

Fig.2: Node MCU ESP8266 development board

IMPORTANT NOTE: Only one firmware can exist on the ESP8266. It can be either AT Commands Firmware, Node MCU Firmware or Arduino based code. Once you upload an Arduino sketch, the Node MCU firmware gets erased. If you want to work with Lua Scripts and Node MCU, then you have to flash the Node MCU Firmware.

ESP-01 vs. Node MCU (ESP-12E):

As mentioned earlier, the Node MCU Devkit is actually a Breakout Board for the ESP-12E Module. The ESP-01 is the vanilla version of the ESP8266 Wi-Fi SoC made by Ai–Thinker, a third part module manufacturer for ESP8266.

Brief about Node MCU ESP8266:

The **Node MCU ESP8266 development board** comes with the ESP-12E module containing the ESP8266 chip having Tensilica Xtensa 32-bit LX106 RISC microprocessor. This microprocessor supports RTOS and operates at 80MHz to 160 MHz adjustable clock frequency. Node MCU has 128 KB RAM and 4MB of Flash memory to store data and programs. Its high processing power with in-built Wi-Fi / Bluetooth and Deep Sleep Operating features make it ideal for IoT projects.

Node MCU can be powered using a Micro USB jack and VIN pin (External Supply Pin). It supports UART, SPI, and I2C interface.

- **ESP8266 Chip**: The core of the Node MCU module is the ESP8266 chip, which provides Wi-Fi connectivity and microcontroller functionality.

- **GPIO Pins**: The Node MCU board includes multiple digital and analog pins that can be used to connect various peripherals such as sensors, LEDs, and motors.

- **Serial Communication Protocols**: It supports UART, SPI, and I2C protocols, enabling communication with other devices and modules.

- **Open-Source Firmware**: The Node MCU firmware is open-source and based on the Lua scripting language, making it easy to program and customize.

- **Compact Design**: The Node MCU module is small and lightweight, making it suitable for various applications, from hobby projects to professional IoT solutions

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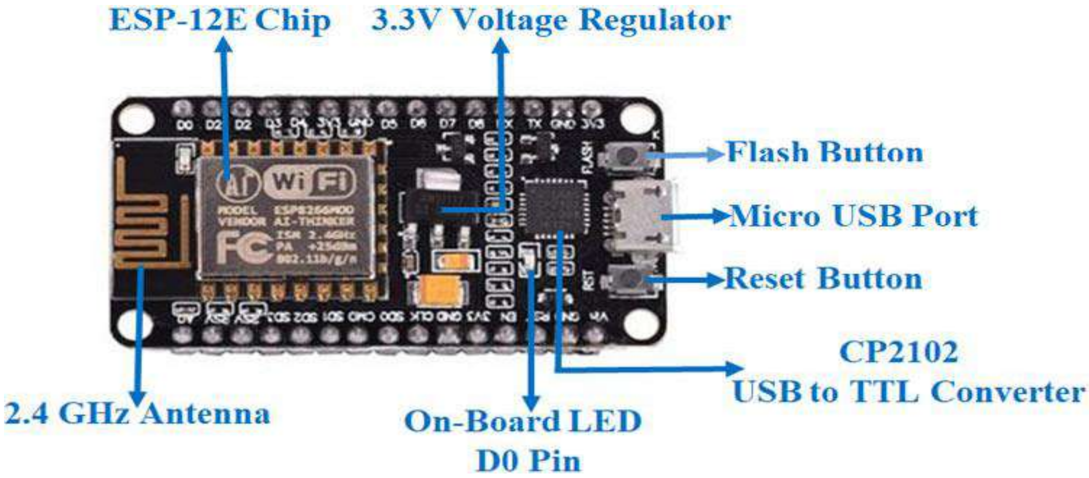

Fig.3: ESP8266 Wi-Fi Development Board

DHT11-Temperature and Humidity Sensor:

The DHT11 sensor is a digital device commonly used in IoT-based weather monitoring systems to measure temperature and humidity. It is compact, low-cost, and easy to interface with microcontrollers such as Arduino and NodeMCU. The sensor contains a capacitive humidity sensor and a thermistor, both managed by an internal microcontroller that processes the readings and sends them in digital format.

For measuring humidity, the DHT11 uses a capacitive sensing method. It consists of two electrodes with a moisture-absorbing dielectric material between them. As the humidity level in the environment changes, the dielectric constant of the material changes, altering the capacitance. This change is detected by the internal microcontroller and converted into a digital humidity value. For temperature measurement, the DHT11 uses a thermistor, a type of resistor whose resistance changes with temperature. The sensor calculates the temperature based on the resistance variation.

The DHT11 communicates with the microcontroller using a single digital data pin. It sends a 40-bit signal consisting of temperature and humidity values along with a checksum for error checking. Although it has a relatively slow sampling rate (1 reading per second), the DHT11 is suitable for basic applications that do not require highly precise or frequent readings. Its ease of use and digital output make it an ideal component for simple and affordable weather monitoring systems.

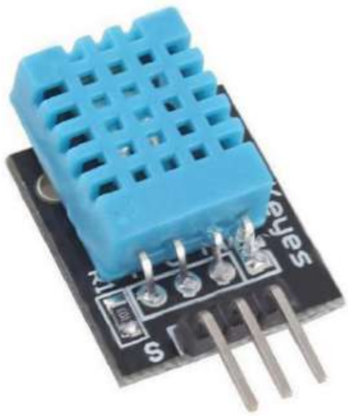

Fig.4: DHT11–Temperature and Humidity Sensor

Gas Sensor:

A gas sensor is an electronic device used to detect the presence and concentration of gases in the air. These sensors are widely used in industrial safety systems, environmental monitoring, and IoT-based applications. The most commonly used gas sensors, such as the MQ series (e.g., MQ-2, MQ-5), are designed to detect specific gases like methane, carbon monoxide, LPG, alcohol, and smoke. They typically consist of a sensing element, a heater coil, and electrodes to convert chemical reactions into electrical signals.

The working principle of a gas sensor is based on chemiresistance. Inside the sensor, the sensitive material (usually tin dioxide, SnO_2) reacts with the target gas molecules when they come into contact. In clean air, the resistance of the sensor is stable. However, when a specific gas is present, it reacts with the sensor surface, causing a change in electrical resistance. This change is detected and measured by a microcontroller, which calculates the concentration of the gas based on the variation in resistance.

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Fig.5: Gas Sensor

The sensor requires some preheating time to stabilize before it starts giving accurate readings. It operates using both analog and digital outputs. The analog output provides a varying voltage signal proportional to the gas concentration, while the digital output is triggered when the gas level exceeds a predefined threshold. Gas sensors are highly useful in IoT-based systems for real-time air quality monitoring and triggering alarms in case of hazardous gas leaks.

Rain Drop Sensor Module:

The rain drop sensor module is a smart and low-cost rain sensing device. It has two parts i.e. a rain sensing pad and a control board. The sensitive sensing pad detects any water present on it while the control board reads these signals and can also binarize them. The rain drop module has a major application in the automobile industry. It can be used to monitor the rain and send closure requests to shutters or windows whenever the rain is detected. The post is a guide to help make your own smart project.

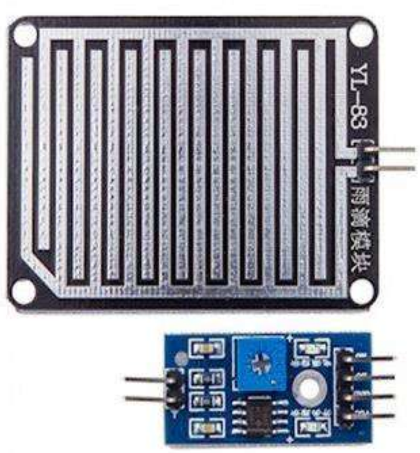

Fig.6: Rain Drop Detection Sensor

Rain Drop Pin out

The rain drop control sensor is embedded with LM393 voltage comparator, current limiting resistors to adjust signal states and divide the voltage and capacitors as biasing elements. The pin out of the Rain Drop Sensor module is as shown:

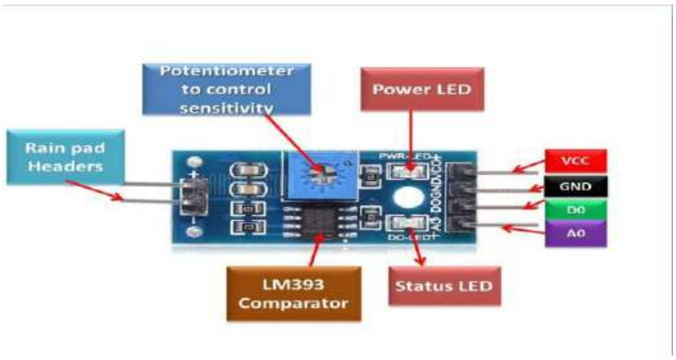

Fig.7: Rain Sensor Module

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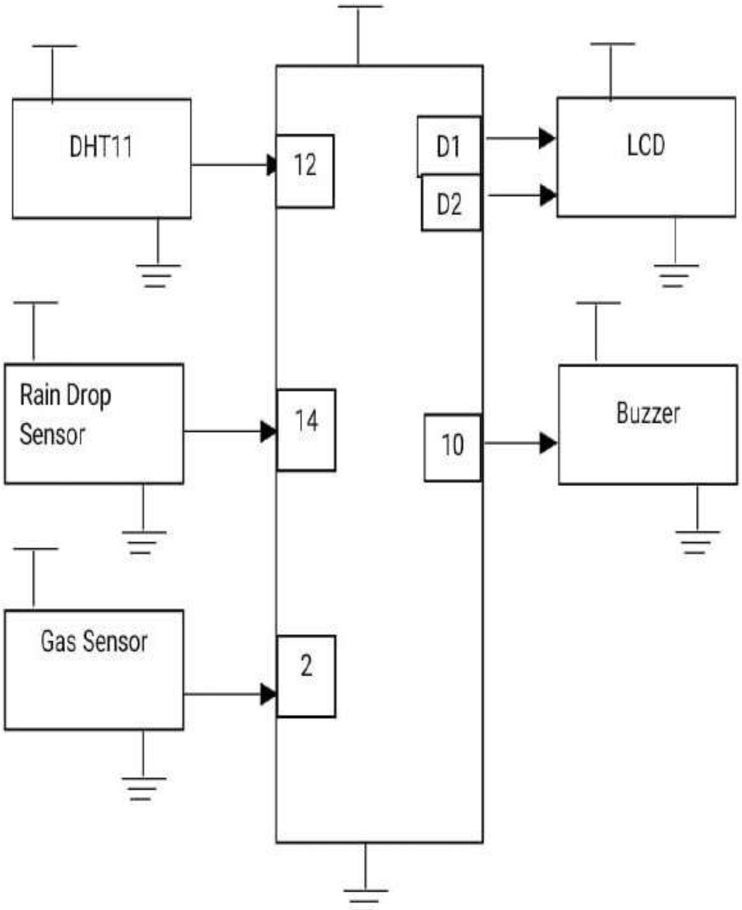
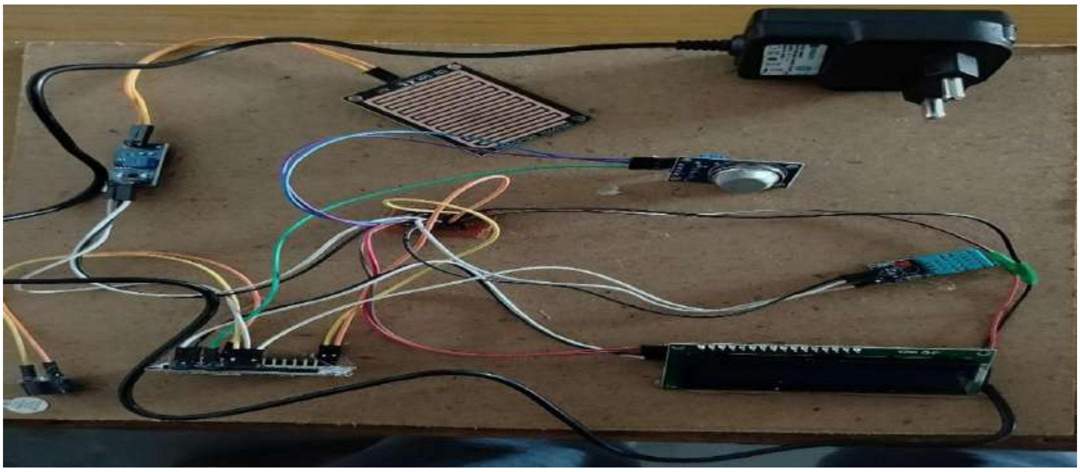
Schematic Diagram :



Result:

The IoT-based online weather report streaming system successfully collects real-time environmental data such as temperature, humidity, and gas levels using sensors like DHT11 and gas sensors. The data is transmitted via a microcontroller (e.g., NodeMCU) to an online platform where it is visualized through live graphs. This enables continuous monitoring and analysis of weather conditions from remote locations, enhancing accuracy and accessibility of weather forecastin



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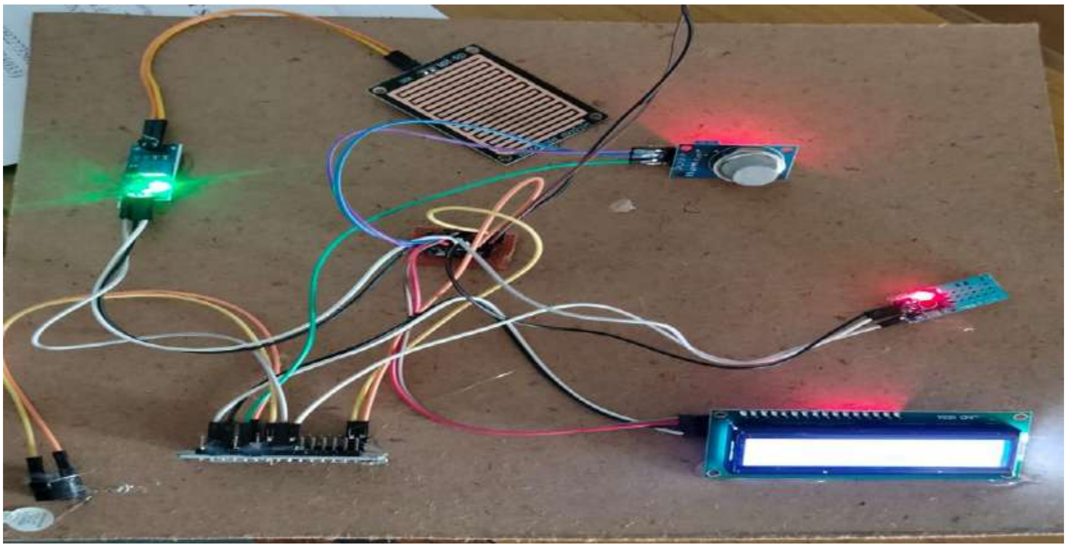
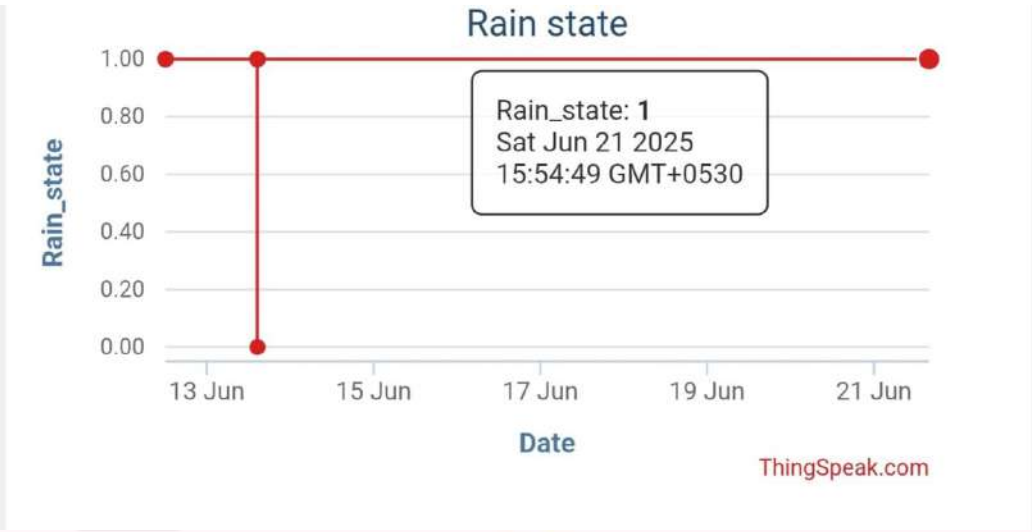
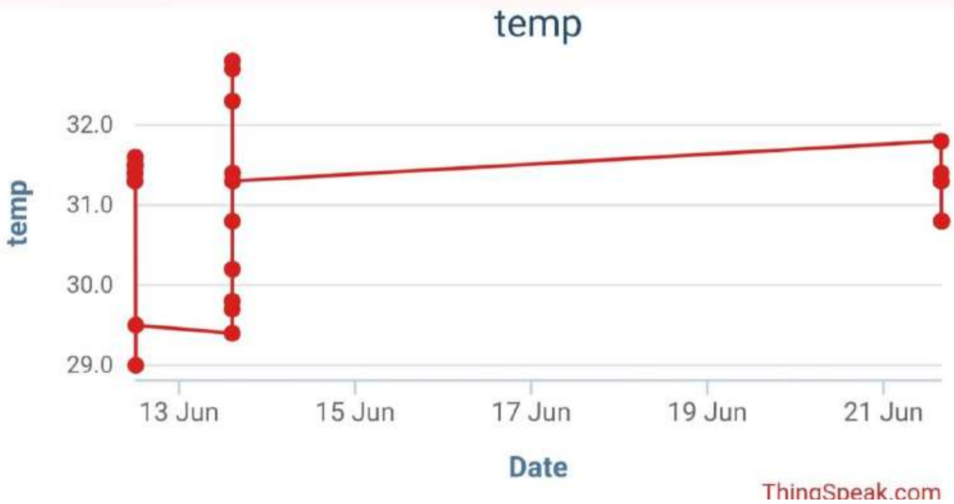
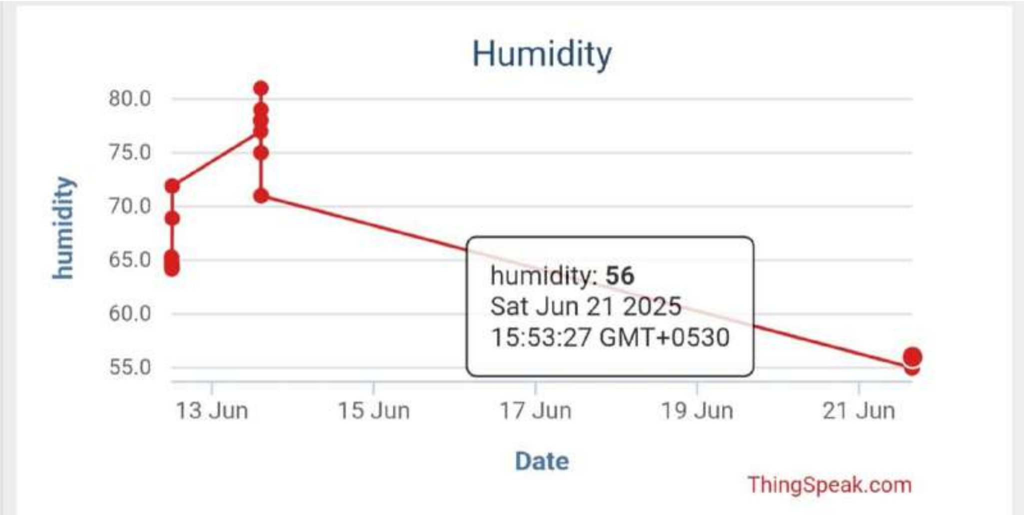
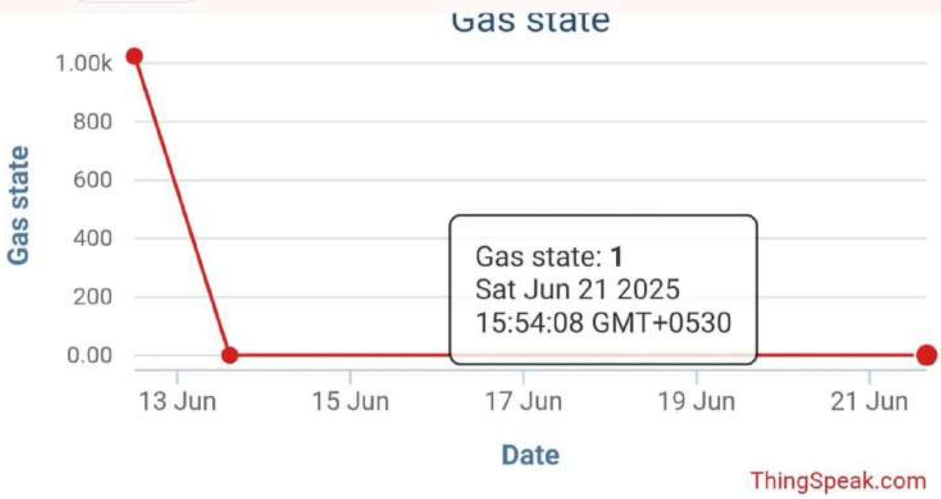


Graphs:









Future Scope:

1. Advanced Sensors Integration – Add sensors for rainfall, wind speed, air pressure, and UV index for more detailed data.
2. AI & Machine Learning – Use AI for predictive analytics and early warning systems.
3. Cloud Storage & Big Data – Store large datasets for long-term climate analysis and trend prediction.
4. Mobile App Support – Develop mobile apps for instant weather alerts and live monitoring.
5. Smart Agriculture – Help farmers monitor climate conditions and optimize crop management.
6. Disaster Management – Provide real-time alerts during floods, storms, or extreme weather.
7. Smart City Integration – Integrate witl infrastructure for traffic, pollution, and energy management.
8. Scalability – Deploy in multiple locations to create a wide weather-monitoring network.
9. Solar-powered Nodes – Use solar energy to power sensors in remote or rural areas.
10. Environmental Research – Aid researchers in studying climate change and environmental patterns.

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