

ESP8266 DHT11/DHT22 Temperature and Humidity Web Server

Introduction

The project aims to build a simple yet effective IoT-based temperature and humidity monitoring system using an ESP8266 NodeMCU and a DHT11 or DHT22 sensor. The sensor collects real-time temperature and humidity data, and the ESP8266 hosts a web server that displays this information on a web page. The project demonstrates the power of embedded systems combined with web technology for remote environmental monitoring.

Objective

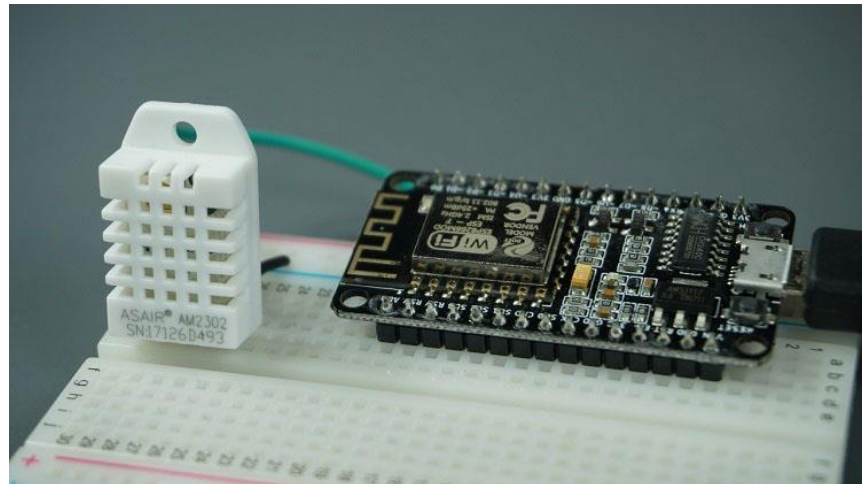
- To measure temperature and humidity using a DHT11/DHT22 sensor.
- To connect the ESP8266 NodeMCU to a Wi-Fi network.
- To display real-time sensor data on a web server interface hosted by the ESP8266.
- To understand how web technologies integrate with embedded systems.

Parts Required:

To build this project, you need the following parts:

Hardware Components

Component	Description
ESP8266 NodeMCU	Microcontroller with Wi-Fi
DHT11/DHT22	Temperature and humidity sensor
Breadboard	For easy circuit prototyping
Jumper Wires	To make electrical connections
Resistor (10kΩ)	Pull-up resistor for DHT signal
USB Cable	For programming and power

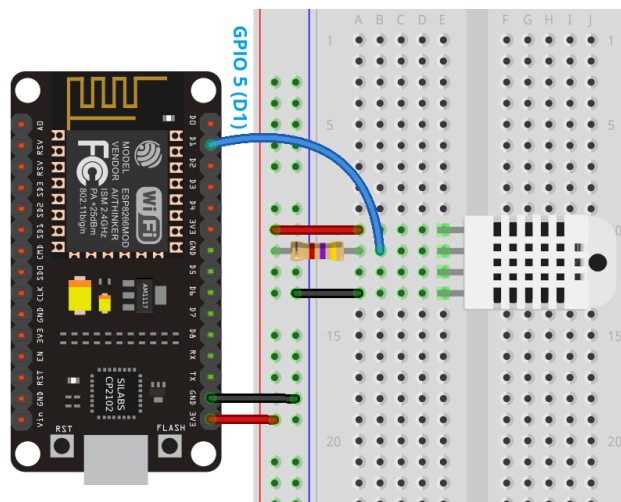


Software Requirements

- **Arduino IDE**
- **ESP8266 Board Package** (Installed via Board Manager)
- Libraries:
 - ESP8266WiFi.h
 - ESP8266WebServer.h
 - DHT.h

ESP8266 and DHT11/DHT22 Schematic Diagram

Before proceeding with the tutorial, wire the DHT11 or DHT22 temperature and humidity sensor to the ESP8266 as shown in the following schematic diagram.



Working Principle

1. **Sensor Readings:**
The DHT sensor reads the surrounding temperature and humidity data.
2. **Wi-Fi Connection:**
The ESP8266 connects to a predefined Wi-Fi network using provided SSID and password.
3. **Web Server:**
A web server runs on the ESP8266. When accessed through a browser, it serves a HTML page displaying sensor data.
4. **Auto-Refresh:**
The webpage auto-refreshes every few seconds to show the latest values, enabling real-time monitoring.

Code:

```
#include <ESP8266WiFi.h>

#include <ESP8266WebServer.h>

#include <DHT.h>

// Wi-Fi credentials

const char* ssid = "nodemcu";

const char* password = "12345678";

// DHT setup

#define DHTPIN 5          // D1 = GPIO5

#define DHTTYPE DHT22

DHT dht(DHTPIN, DHTTYPE);

// Web server

ESP8266WebServer server(80);

// Wi-Fi connection

void connectToWiFi() {

    WiFi.mode(WIFI_STA);

    WiFi.begin(ssid, password);
```

```

Serial.print("🌀 Connecting to Wi-Fi");

int tries = 0;

while (WiFi.status() != WL_CONNECTED && tries < 30) {

  Serial.print(".");

  delay(500);

  tries++;

}

Serial.println();

if (WiFi.status() == WL_CONNECTED) {

  Serial.println("✅ Wi-Fi Connected!");

  Serial.print("🌐 IP Address: ");

  Serial.println(WiFi.localIP());

} else {

  Serial.println("❌ Failed to connect to Wi-Fi. Check SSID/password.");

}

}

// HTML Web Interface

void handleRoot() {

  float temperature = dht.readTemperature();

  float humidity = dht.readHumidity();

  String html = "<!DOCTYPE html><html><head>"

    "<meta http-equiv='refresh' content='5'/>"

    "<meta name='viewport' content='width=device-width, initial-scale=1.0'/>"

    "<title>Temperature & Humidity Monitor</title>"

    "<style>"

```

```

"body { margin: 0; font-family: 'Segoe UI', sans-serif; background: linear-gradient(to
right, #e0f7fa, #fce4ec); display: flex; flex-direction: column; align-items: center; justify-
content: flex-start; min-height: 100vh; padding: 20px; }"

".container { max-width: 600px; width: 100%; }"

".card { background-color: #fff; border-radius: 15px; box-shadow: 0 6px 20px
rgba(0,0,0,0.1); padding: 20px; margin: 15px 0; text-align: center; }"

".card h2 { color: #333; margin-bottom: 10px; }"

".value { font-size: 2.2em; font-weight: bold; margin-top: 10px; }"

".temp { background: linear-gradient(135deg, #ffebee, #ffcdd2); }"

".humid { background: linear-gradient(135deg, #e1f5fe, #b3e5fc); }"

".college { background: linear-gradient(135deg, #ede7f6, #d1c4e9); }"

".students { font-size: 1em; margin-top: 10px; width: 100%; border-collapse: collapse;
}"

".students th, .students td { border: 1px solid #ccc; padding: 10px; }"

".students th { background-color: #f3e5f5; }"

".students td { background-color: #fafafa; }"

"@media (max-width: 600px) { .value { font-size: 1.8em; } }"

"</style></head><body>";

html += "<div class='container'>";

html += "<div class='card college'>";

html += "<h2>Priyadarshini J. L. College of Engineering</h2>";

html += "<h3>Dept. of Electronics & Telecommunication</h3>";

html += "<h3>Temperature & Humidity Sensor</h3>";

html += "</div>";

if (isnan(temperature) || isnan(humidity)) {

    html += "<div class='card'><p><strong> ⚠ Error reading from DHT
sensor.</strong></p></div>";

} else {

    html += "<div class='card temp'>";

```

```

    html += "<h2> Temperature</h2>";
    html += "<div class='value'>" + String(temperature, 1) + " °C</div>";
    html += "</div>";
    html += "<div class='card humid'>";
    html += "<h2>Humidity</h2>";
    html += "<div class='value'>" + String(humidity, 1) + " %</div>";
    html += "</div>";
}

html += "<div class='card'>";
html += "<h2> Student Details</h2>";
html += "<table class='students'>";
html += "<tr><th>Name</th><th>Roll No.</th></tr>";
html += "<tr><td>Reshma Satpute</td><td>06</td></tr>";
html += "<tr><td>Vedant Pathrabe</td><td>28</td></tr>";
html += "<tr><td>Lavanya Gabhane</td><td>40</td></tr>";
html += "</table>";
html += "</div>";
html += "</div></body></html>";
server.send(200, "text/html", html);
}

// Setup
void setup() {
    Serial.begin(115200);
    delay(1000);
    Serial.println("🚀 Booting...");
    dht.begin();
    delay(2000);
}

```

```
connectToWiFi();  
server.on("/", handleRoot);  
server.begin();  
Serial.println("🌐 Web server started.");  
}  
// Main loop  
void loop() {  
  if (WiFi.status() != WL_CONNECTED) {  
    connectToWiFi();  
  }  
  server.handleClient();  
}
```

Advantages

- Real-time environmental monitoring.
- Simple and cost-effective design.
- No need for additional cloud service – works locally.
- Responsive and user-friendly interface.

Limitations

- Web interface is only accessible within the local network unless port forwarding or cloud integration is done.
- DHT11 has limited accuracy and range; DHT22 is recommended for better performance.
- Sensor data may be delayed by 1-2 seconds due to refresh rate.

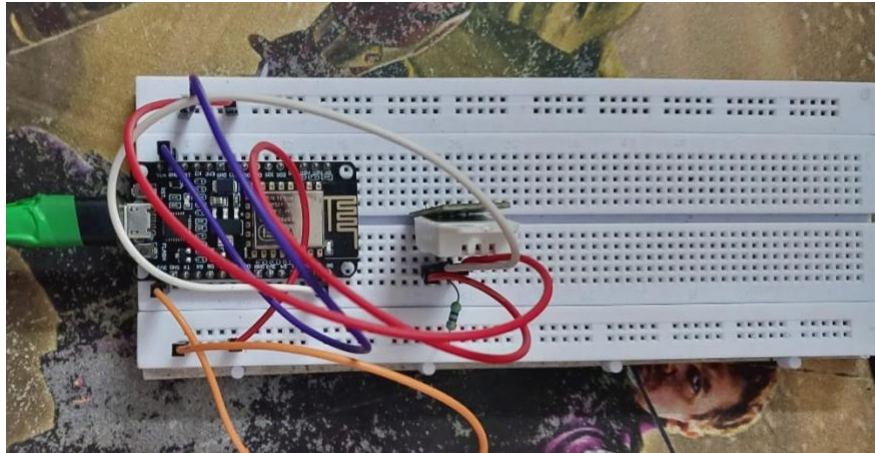
Future Scope

The integration of ESP8266 with DHT11/DHT22 sensors to create a web-based temperature and humidity monitoring system holds significant potential for future advancements. As the demand for smart environmental monitoring grows, this project can be extended and scaled in various ways:

- 1. Cloud Integration:**
By connecting the ESP8266 to cloud platforms like ThingSpeak, Firebase, or Blynk, data can be stored, analyzed, and visualized in real-time from anywhere in the world. This allows long-term data logging and trend analysis.
- 2. Mobile App Control:**
Developing a companion mobile app can make it easier for users to access real-time sensor data, receive alerts, and even control connected appliances based on temperature/humidity thresholds.
- 3. IoT Automation and Smart Home Applications:**
The system can be integrated into smart home networks to automate fans, air conditioners, humidifiers, or dehumidifiers. This enables automatic climate control based on real-time sensor data.
- 4. Multiple Sensor Support:**
Adding support for multiple sensors across different rooms or environments can help create a distributed sensing network. This is useful for large-scale environmental monitoring like greenhouses, warehouses, or industrial settings.
- 5. Battery Power and Energy Optimization:**
Future versions can be optimized for low power consumption and run on batteries or solar panels, enabling use in remote or outdoor environments.
- 6. Advanced Web Interface and Analytics:**
The basic web server can be enhanced with features like graphical data charts, downloadable reports, user authentication, and device settings, improving the usability and functionality of the system.
- 7. Integration with AI/ML:**
Incorporating basic AI models for predictive analytics (e.g., forecasting humidity or temperature changes) can make the system more intelligent and proactive in controlling the environment.

Output:

Breadboard connection:



Web server interface:

```
sketch_apr16a | Arduino IDE 2.3.6
File Edit Sketch Tools Help
NodeMCU 1.0 (ESP-12E)
sketch_apr16a.ino
1 #include <ESP8266WiFi.h>
2 #include <ESP8266WebServer.h>
3 #include <DHT.h>
4
5 // Wi-Fi credentials
6 const char* ssid = "nodemcu";
7 const char* password = "12345678";
8
9 // DHT setup
10 #define DHTPIN 5 // D1 = GPIO5
11 #define DHTTYPE DHT22 // DHT11 if using that
12 DHT dht(DHTPIN, DHTTYPE);
13
14 // Web server
15 ESP8266WebServer server(80);
16
17 // Wi-Fi connection
18 void connectionWifi() {
19   WiFi.mode(WIFI_STA);
20   WiFi.begin(ssid, password);
21   Serial.print("Connecting to Wi-Fi");
22 }
23
24 void setup() {
25   Serial.begin(115200);
26   connectionWifi();
27   while (!WiFi.isConnected()) {
28     delay(1000);
29   }
30   Serial.println("Wi-Fi Connected!");
31   IP Address: 192.168.107.217
32   Web server started.
33 }
34
35 void loop() {
36   server.handleClient();
37   delay(1000);
38 }
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Web interface of PC

Priyadarshini J. L. College of Engineering
Dept. of Electronics & Telecommunication
Temperature & Humidity Sensor

Temperature
38.3 °C

Humidity
26.0 %

Student Details

Name	Roll No.
Reshma Satpute	06
Vedant Pathrabe	28
Lavanya Gabhane	40

Web interface of mobile

Priyadarshini J. L. College
of Engineering
Dept. of Electronics &
Telecommunication
Temperature & Humidity Sensor

Temperature
38.5 °C

Humidity
25.2 %

Student Details

Name	Roll No.
Reshma Satpute	06
Vedant Pathrabe	28
Lavanya Gabhane	40

Conclusion:

This project successfully demonstrates how to use the ESP8266 microcontroller and a DHT sensor to create a standalone web-based temperature and humidity monitoring system. It serves as a practical foundation for more advanced IoT applications such as home automation, weather stations, or cloud-based data logging.