WWW.IJRPR.COM

**International Journal of Research Publication and Reviews**

Journal homepage: www.ijrpr.com ISSN 2582-7421

# Temperature and Humidity Controller with Real Time Set Point using DHT11 with Arduino

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ABSTRACT :

This project focuses on developing a Temperature and Humidity Controller with real-time set-point adjustment using an Arduino and a DHT11 sensor. The system monitors temperature and humidity levels, allowing users to define desired thresholds dynamically. It responds to deviations by activating control mechanisms to maintain optimal conditions. The design emphasizes simplicity, cost effectiveness, and adaptability, making it suitable for applications in indoor environments, greenhouses, and storage facilities. This work demonstrates the potential of Arduino-based solutions for real-world environmental control challenges.

**Keywords:** Temperature and Humidity Controller; Real-time Set-point Adjustment; Arduino; DHT11 Sensor; Threshold Monitoring; Control Mechanisms; Environmental Monitoring; Indoor Environments; Greenhouses; Storage Facilities Simplicity; Cost Effectiveness; Adaptability; Arduino-based Solutions;Environmental Control Challenges

## 1. INTRODUCTION :

Maintaining precise control over temperature and humidity is critical in various applications, including indoor environments, agricultural facilities, and storage spaces. Deviations from optimal conditions can adversely affect plant growth, product quality, or overall comfort. Traditional climate control systems are often costly, complex, or tailored for specific environments, limiting their accessibility for smaller-scale uses. This project explores the design and development of a cost-effective Temperature and Humidity Controller using an Arduino microcontroller and a DHT11 sensor. The system not only monitors environmental parameters in real-time but also enables users to define adjustable set points for maintaining desired conditions. Leveraging the Arduino platform, the solution is modular, user friendly, and highly adaptable, making it suitable for educational and practical implementations. The DHT11 sensor is chosen for its reliable performance and simplicity in measuring temperature and humidity, while the Arduino provides a robust platform for implementing control logic and user interaction. This project highlights how low-cost embedded systems can address real-world challenges by combining sensor technologies, automation, and user input to create a scalable and efficient solution.

## 2. LITERATURE REVIEW :

Temperature and humidity control is essential in various fields like agriculture, manufacturing, and indoor climate management. Arduino-based systems have gained popularity for their cost effectiveness, open-source nature, and compatibility with sensors, making them ideal for real-time environmental monitoring and control applications. The DHT11 sensor, known for its reliability and low cost, is widely used in small-scale projects requiring basic temperature and humidity monitoring. Set-point-based control systems, which allow users to define thresholds, provide a practical solution for maintaining stable conditions. While advanced methods like PID control offer precision, simpler on/off mechanisms are more suitable for compact, low-power setups.

## 3. SYSTEM ARCHITECTURE :

The system architecture for the Temperature and Humidity Controller consists of key components working together to monitor, process, and control environmental parameters based on user-defined set points. The design ensures simplicity, modularity, and adaptability for various applications.

**1) Sensors**

- The DHT11 sensor is the primary component for measuring temperature and humidity. It provides digital output, simplifying data acquisition.

**2) Microcontroller**

- An Arduino board serves as the central processing unit. It reads data from the DHT11 sensor, compares it against user-defined thresholds, and executes control actions accordingly.

**3) User Interface**

- A simple input mechanism, such as push buttons or a potentiometer, allows users to set desired temperature and humidity thresholds.
- Feedback is displayed via an LCD or an LED indicator to inform the user about current environmental conditions and system status.

**4) Control Mechanisms**

- Output devices, such as relays or transistors, control external actuators like fans, heaters, or humidifiers. These actuators are activated when sensor readings deviate from set points.

**5) Power Supply**

- The system is powered by a stable DC supply, ensuring uninterrupted operation of the Arduino, sensors, and actuators.

**6) Logic Flow**

- Sensor data is read continuously and compared with user-defined set points.
- If deviations are detected, control signals are sent to the respective actuators to restore the desired conditions.

## 4. WORKING MECHANISM :

The Temperature and Humidity Controller operates using the following components and steps:

**1. Sensor Data Acquisition:** The DHT11 sensor measures environmental temperature and humidity. It generates digital data representing these values, which is sent to the Arduino for processing.

**2. User Input for Set Points:** A potentiometer allows the user to adjust the desired temperature and humidity thresholds dynamically. The potentiometer outputs an analog signal, which the Arduino converts into digital data to update the set points.

**3. Data Processing by Arduino:** The Arduino processes data from the DHT11 sensor and compares it with the user-defined set points from the potentiometer. If the measured values deviate from the set points, control signals are generated.

**4. Control Logic and Actuator Operation:**

- **DC Motor:** If the temperature exceeds the set point, the Arduino activates a DC motor (e.g., for driving a fan) to cool the environment.
- **Lamp:** If the temperature falls below the set point, the Arduino turns on a lamp as a heating element.
- **BC547 Transistor:** The BC547 transistor acts as a switch, amplifying signals from the Arduino to control the lamp and DC motor efficiently.
- **AC Voltage Source:** The AC power supply is used to power devices like the lamp, while the Arduino controls their operation indirectly via the BC547.

**5. Feedback to the User:** The LCD Display shows the current temperature, humidity, and set points, providing real-time feedback. It also indicates the status of connected devices (e.g., whether the lamp or motor is active).

**6. Continuous Monitoring:** The system operates in a continuous feedback loop. It reads sensor data, processes user inputs, adjusts the actuators, and updates the display. This ensures that temperature and humidity remain within the desired thresholds.

## 5. TECHNOLOGIES USED :

The Temperature and Humidity Controller employs a combination of hardware and software technologies to achieve real-time monitoring and control. Below is an overview of the key technologies used:

**1. Microcontroller Technology**

• Arduino Uno: The heart of the system, Arduino Uno, provides a flexible platform for processing data from the DHT11 sensor, managing user inputs, and controlling output devices like the motor and lamp. Its simplicity and versatility make it ideal for this project.

**2. Sensing Technology**

• DHT11 Sensor: This sensor measures temperature and humidity levels with sufficient accuracy for basic environmental monitoring. It uses a capacitive humidity sensor and a thermistor for data acquisition.

**3. User Input Technology**

• Potentiometer: Used as an analog input device, the potentiometer allows users to set desired thresholds for temperature and humidity. Its value is read by the Arduino to dynamically adjust the system's behaviour.

**4. Output Control Technology**

- **DC Motor:** Functions as a cooling mechanism, controlled by the Arduino to regulate temperature when it exceeds the user-defined set point.
- **Lamp:** Acts as a heating element, activated to increase temperature when it drops below the threshold.
- **BC547 Transistor:** Works as a switching device to control the motor and lamp, amplifying the Arduino’s control signals.

**5. Power Technology**
• AC Voltage Source: Powers the high-energy components like the lamp and motor. The Arduino ensures safe and efficient operation by controlling these components via transistors.

**6. Display Technology**
• LCD Display: Provides real-time feedback to the user, displaying current temperature, humidity levels, and the status of actuators.

**7. Software Technology**
- Arduino IDE: The software used to write, compile, and upload the code to the Arduino board. It enables the implementation of logic for sensor reading, data processing, and actuator control.
- C/C++ Programming: The code for this project is written in Arduino's programming language, which is based on C/C++.

## 6. BENEFITS :

The Temperature and Humidity Controller offers several notable advantages. The five most significant benefits are:

**1. Cost-Effectiveness:** The use of affordable components like the DHT11 sensor and Arduino makes the system accessible and economical for small-scale applications.

**2. Real-Time Monitoring and Control:** The system continuously monitors environmental conditions and adjusts actuators dynamically, ensuring immediate response to deviations.

**3. User-Friendly Interface:** With intuitive controls like a potentiometer and clear feedback via an LCD display, the system is easy to operate, even for non-technical users.

**4. Adaptability:** The modular design allows the system to be customized for different environments, including greenhouses, storage facilities, or home automation.

**5. Energy Efficiency:** Actuators are activated only when necessary, conserving energy and reducing operational costs.

## 7. CHALLENGES :

Despite its benefits, the Temperature and Humidity Controller faces several challenges that could affect its implementation and performance:

**1. Sensor Limitations:** The DHT11 sensor has a limited accuracy range (±2°C for temperature and ±5% for humidity), which may not be suitable for applications requiring high precision.

**2. Response Time:** The DHT11 has a sampling rate of one reading per second, which may cause slight delays in system response to rapid environmental changes.

**3. Scalability Constraints:** While the system is modular, integrating additional components or scaling up for large-scale applications may require more advanced microcontrollers or higher quality sensors.

**4. Power Dependence:** The reliance on an AC power source for the lamp and DC motor makes the system less suitable for off-grid or portable applications unless paired with a battery backup or alternative power source.

**5. Component Durability:** Prolonged use of low-cost components like the DHT11 and BC547 transistor may lead to wear and reduced reliability in long-term or demanding environments.

**6. Limited Control Sophistication:** The on/off control logic used in this system lacks the precision of more advanced methods like PID or fuzzy logic, which could improve performance in maintaining stable environmental conditions.

## 8. FUTURE ADVANCEMENTS :

To enhance the performance and expand the capabilities of the Temperature and Humidity Controller, several advancements can be implemented:

**1. Integration of IoT Technology:** Enabling remote monitoring and control via smartphones or web apps would increase convenience and functionality, allowing users to track environmental conditions and make adjustments from anywhere.

**2. Upgraded Sensors:** Replacing the DHT11 with more accurate sensors like the DHT22 or SHT31 would enhance measurement precision, especially in applications that require high accuracy.

**3. Advanced Control Algorithms:** Implementing PID (Proportional-Integral-Derivative) or fuzzy logic control would improve the system's ability to maintain stable environmental conditions, reducing fluctuations and improving overall performance.

**4. Energy Optimization:** Integrating solar power or low-power components would make the system more energy-efficient and suitable for off-grid applications, increasing sustainability.

**5. Multi-Sensor Integration:** Adding sensors for additional environmental factors like air quality, light, or soil moisture would broaden the system's applicability, especially for agricultural and smart home environments.

**6. Data Logging and Analysis:** Incorporating data logging and analysis features would allow users to track environmental trends over time, helping optimize settings and improve efficiency based on historical data.

## 9. CONCLUSION :

The Temperature and Humidity Controller developed using an Arduino microcontroller, DHT11 sensor, and associated components demonstrates an effective solution for real-time environmental monitoring and control. By integrating user-friendly features such as a potentiometer for set-point adjustment and an LCD display for real-time feedback, the system strikes a balance between functionality, simplicity, and affordability. This project provides a practical platform for maintaining optimal environmental conditions in applications such as greenhouses, storage facilities, and home automation. While the system is effective for basic requirements, its limitations, such as sensor accuracy and control sophistication, highlight opportunities for future improvements. Upgrading to more precise sensors, implementing advanced control algorithms, or incorporating IoT capabilities could further enhance its performance and scalability.

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