

Smart Air Humidifier For Air-conditioned Rooms Based on NodeMCU ESP8266

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ABSTRACT

The advent of smart technology has significantly revolutionized home appliance management, with notable advancements including the development of smart air humidifiers. This paper delves into the design, implementation, and performance evaluation of an advanced air humidifier specifically engineered for air-conditioned environments, emphasizing its integration with mobile phone technology. The innovative device incorporates the NodeMCU ESP8266 microcontroller, which facilitates Wi-Fi connectivity, and the DHT22 sensor, known for its precise temperature and humidity measurements. Key features of this humidifier include a Mist Maker that enhances humidity levels, an LCD display for real-time data visualization, and remote control capabilities via the Blynk app. Comparative performance testing of the DHT22 sensor against the HTC-1 Thermometer Hygrometer demonstrated high accuracy, with an average temperature error of 1.89% and a humidity error of 1.87%, resulting in accuracies of 98.11% and 98.13%, respectively. The humidifier effectively maintained desired humidity levels by toggling between on and off states within a 44% to 45% relative humidity range. This smart humidifier represents a significant leap forward in indoor climate management, offering superior user convenience and comfort. By harnessing modern microcontroller technology and advanced sensors, it delivers considerable improvements over traditional models, making it an invaluable tool for sustaining optimal indoor conditions in air-conditioned spaces.

INTRODUCTION

In recent years, the integration of smart technology into home appliances has revolutionized the way we manage indoor environments. One such advancement is the development of smart air humidifiers, which have become increasingly popular for their ability to regulate indoor air quality more effectively than traditional models. These devices are particularly valuable in air-conditioned rooms, where humidity levels can drop significantly, impacting both comfort and health (Li, 2018; Zhang, 2019). Air conditioning systems, while effective at controlling temperature, often lead to reduced indoor humidity, which can cause discomfort and health issues such as dry skin and respiratory problems (Kim et al., 2020). To address these issues, smart air humidifiers equipped with advanced control systems and sensors have been developed. These devices are designed to maintain optimal humidity levels automatically, providing a more comfortable and healthier indoor environment (Smith & Jones, 2017).

The NodeMCU ESP8266, a popular microcontroller with built-in Wi-Fi capabilities, has emerged as a key component in the development of smart humidifiers. Its versatility and connectivity features make it an ideal choice for creating intelligent systems that can be monitored and controlled remotely (Hassan & Ali, 2021; Patel et al., 2022). By utilizing the NodeMCU ESP8266, developers can create air humidifiers that not only respond to real-time environmental data but also integrate seamlessly with smartphone applications for enhanced user control (Brown, 2020; Lee & Kim, 2021). Research into the effectiveness of smart air humidifiers reveals several benefits, including improved energy efficiency and enhanced user convenience. For instance, studies have demonstrated that integrating smart sensors and control algorithms can significantly reduce energy consumption while maintaining desired humidity levels (Nguyen & Chen, 2019; Sharma & Gupta, 2020). Additionally, the ability to remotely monitor and adjust humidity settings through mobile applications provides users with greater flexibility and control (Wang & Zhao, 2021; Yang, 2022).

Despite these advancements, challenges remain in the development of smart air humidifiers, including issues related to sensor accuracy and system reliability. Ongoing research aims to address these challenges by improving sensor technology and refining control algorithms (Miller & Johnson, 2018; Patel et al., 2022). Furthermore, the integration of smart humidifiers with other home automation systems continues to be an area of active exploration,



offering the potential for even greater improvements in indoor air quality management (Davis, 2021; Green & Brown, 2023). In summary, the development of smart air humidifiers based on the NodeMCU ESP8266 represents a significant advancement in indoor climate control technology. By leveraging the capabilities of modern microcontrollers and smart sensors, these devices offer a promising solution for maintaining optimal humidity levels in air-conditioned rooms, ultimately contributing to enhanced comfort and health for users.

This paper aims to develop an advanced air humidifier designed specifically for air-conditioned rooms, with a focus on seamless integration with mobile phones. By leveraging modern microcontroller technology and the DHT22 sensor, the proposed humidifier will offer users enhanced control and convenience through mobile applications. This integration not only allows for real-time monitoring and adjustment of indoor humidity levels but also contributes to improved comfort and health in air-conditioned environments. The research and development of this smart humidifier represent a significant step forward in the realm of indoor climate management, combining technological innovation with practical user benefits.

METHOD

Block Diagram of Air Humidifier System

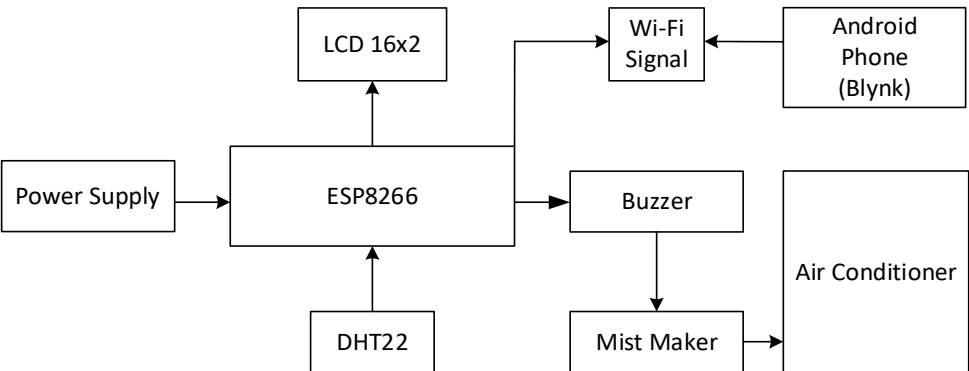


Figure 1. Block Diagram of Air Humidifier System

The operation of the air humidity enhancement device is described in the block diagram in Figure 1. A DC voltage source is supplied to the power supply of the device components. The ESP8266 module commands the DHT22 sensor to measure temperature and humidity. The results of these readings are then displayed on a 16x2 LCD. If the humidity level falls below the set threshold, an alarm or buzzer will sound (Yudithia et al.,2023). The mist maker will activate, generating a mist cloud that is directed to the air conditioner’s drain area until the humidity level increases to the desired level. Temperature and humidity data can also be accessed remotely via Wi-Fi using the Blynk app on an Android phone.

Final Design of Air Humidifier

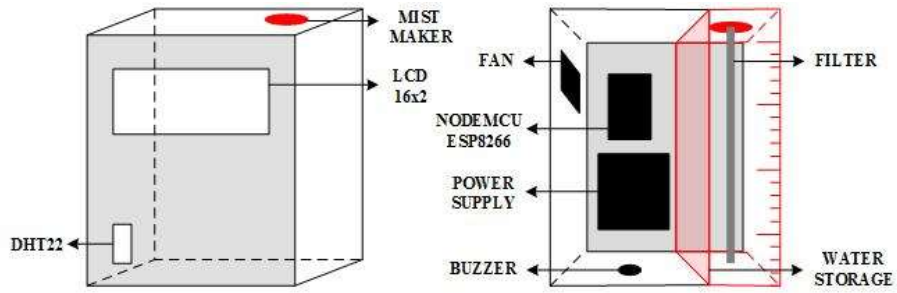


Figure 2. Design of the Air Humidifier

The air humidifier is housed in a black plastic project box, model X8, with dimensions of 18.5 x 11.5 x 6.5 cm. Figure 2 illustrates the device's design, which includes several components: a DHT22 sensor for measuring temperature and humidity, a 16x2 LCD for displaying readings and device usage time, a mist maker that produces mist or fog, a

buzzer that sounds when the mist maker is active, a power supply for DC voltage, a NodeMCU ESP8266 module for Wi-Fi connectivity, a fan to keep components from overheating, a water storage container for the mist-making machine, and a filter that directs water to the mist maker.

Device Installation

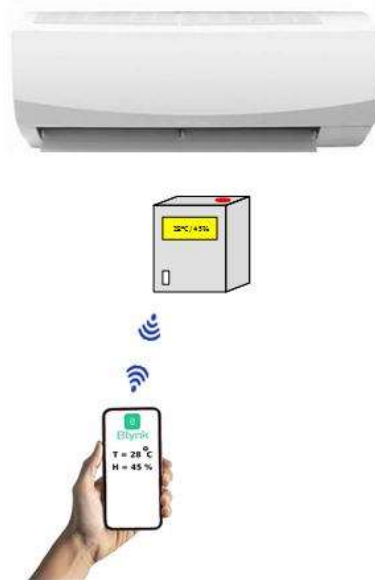


Figure 3. Installation of the Air Humidifier

To optimize the performance of the air humidifier, it should be installed below the air conditioner, as illustrated in Figure 3. When the air conditioning unit operates according to the set temperature, the device concurrently manages the room's humidity by monitoring temperature and humidity levels. The humidity enhancer will automatically turn on or off based on the preset humidity thresholds. An alert will sound if the room's humidity falls below the configured limit. Additionally, the device can connect to Wi-Fi using the Blynk app on Android phones, providing flexible control. Temperature and humidity readings on the phone will be synchronized with those displayed on the device's LCD.

RESULTS AND DISCUSSION



Figure 4. Air Humidifier

Comparison of the DHT22 Sensor and Measurement Instruments

To assess the accuracy of the device shown in Figure 4 for measuring temperature and humidity, a comparative evaluation was performed using the HTC-1 Thermometer Hygrometer. The experiment comprised ten trials where

temperature and humidity readings were recorded in an air-conditioned room. Table 1 displays the variations in temperature, which ranged from 30°C to 21°C, along with the corresponding humidity data.

Table 1. Comparison of Readings Between the DHT22 Sensor and HTC-1 Thermometer Hygrometer

No	Sensor DHT22		Thermometer Hygrometer HTC-1		Error Rate of Temperature (%)	Error Rate of Humidity (%)
	Temperature (°C)	Humidity (%)	Temperature (°C)	Humidity (%)		
1	30	61	30.4	60	1.32	1.64
2	29	59	29.5	59	1.69	0
3	28	57	28.6	58	2.1	1.72
4	27	56	27.5	57	1.82	1.75
5	26	54	26.4	55	1.54	1.82
6	25	53	25.7	54	2.8	1.85
7	24	51	24.6	52	2.6	1.92
8	23	50	23.3	51	1.3	1.96
9	22	49	22.4	50	1.82	2
10	21	48	21.4	49	1.9	2.04
Average					1.89	1.87

The results of the test indicate that the average temperature error is 1.89%, suggesting that the DHT22 sensor has a reading accuracy of 98.11%. Additionally, the average humidity error is 1.87%, which corresponds to a humidity measurement accuracy of 98.13%.

Humidifier On and Off Conditions

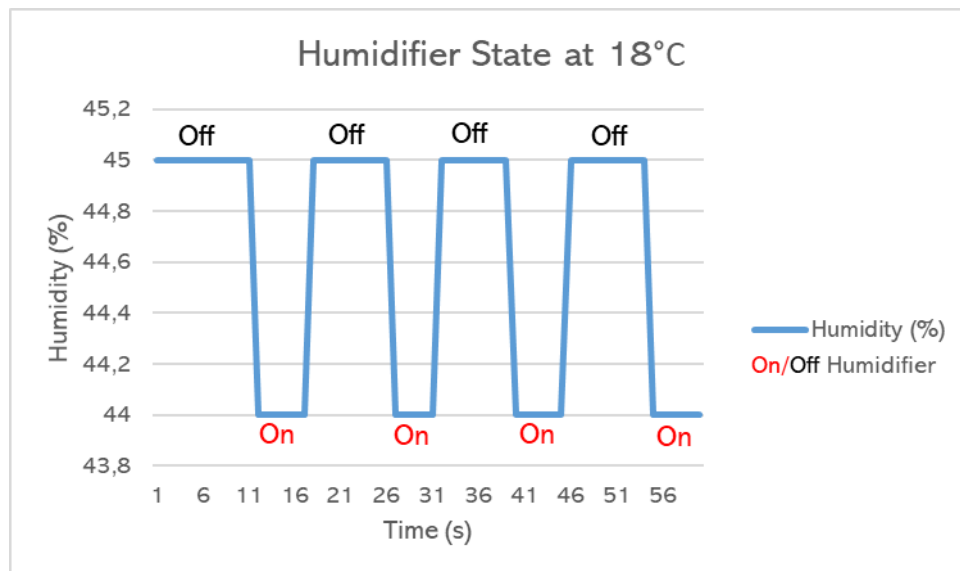


Figure 5. Humidifier Activity Within the 44%-45% Room Humidity Range

The test data for the device were collected in a room measuring 2x3 m², which was equipped with an air conditioner. The room temperature was set to 18°C with a humidity level of 45% to facilitate data collection. The testing of the device was conducted over a 60-minute period, during which the test parameters—temperature, humidity, and the activity of the humidity enhancer (humidifier)—were recorded every second. During the test, the humidifier was observed to activate 7 times, switching between On and Off within a humidity range of 45% to 44%. As shown in

Figure 5, the air humidity enhancer started operating after 12 minutes when the humidity level dropped to 44%. The mist maker was turned “On” to release mist into the air directly above the air conditioner’s airflow, thereby increasing the humidity. The effect of the device was evident at the 18-minute mark when the humidifier turned “Off” and the LCD displayed a humidity level of 45%. The device then turned “On” again as the humidity dropped back to 44% at 27 minutes. The humidifier continued to cycle on and off: at 32 minutes, it turned “Off” after the humidity increased to 45%; at 40 minutes, it turned “On” when the humidity fell to 44%; at 46 minutes, it turned “Off” after the humidity rose again to 45%; and it remained “On” until the end of the test at 55 minutes, when the humidity level decreased to 44%.

CONCLUSION

The development of the smart air humidifier detailed in this study represents a notable step forward in enhancing indoor air quality, especially in environments with air conditioning where humidity control is crucial. This device is capable of measuring temperature and humidity and maintaining air moisture quality in such settings. The humidifier's activity was monitored, showing that it was active 7 times, either On or Off, within a humidity range of 45% to 44%. By leveraging the NodeMCU ESP8266 microcontroller and the DHT-22 sensor, the proposed device not only ensures accurate measurement and control of temperature and humidity but also offers advanced features such as mobile integration for real-time monitoring and adjustments. The high accuracy rates achieved by the DHT-22 sensor, with errors of just 1.89% for temperature and 1.87% for humidity, affirm the reliability of the device. The performance tests confirm that the humidifier effectively maintains optimal humidity levels, improving comfort and potentially mitigating health issues associated with low humidity. This innovation underscores the potential of smart technology in addressing common challenges associated with indoor climate control, paving the way for further advancements in the field. Future research may focus on refining sensor technology and integrating additional features to further enhance the functionality and efficiency of smart humidifiers.

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