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Portable Smart Humidifier with ESP32

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Abstract: *The Portable Smart Humidifier with ESP32 combines cutting-edge technology with practicality to enhance the user's comfort in diverse environments. This device integrates a portable form factor with the powerful ESP32 microcontroller, a versatile and efficient platform known for its connectivity and processing capabilities. The smart humidifier is designed to be compact, making it easy to carry and suitable for various settings, such as offices, homes, or travel. The ESP32 microcontroller enables seamless connectivity, allowing users to control the humidifier remotely through a dedicated mobile application. This not only enhances user convenience but also facilitates real-time monitoring of humidity levels.*

The device incorporates intelligent features, such as automated humidity adjustments based on ambient conditions, ensuring an optimal and personalized environment Furthermore, the ESP32's low-power capabilities contribute to energy efficiency, extending the humidifier's operational life on a single charge. The integration of sensors provides precise humidity measurements, while the portable design ensures flexibility in placement. The smart humidifier aligns with the growing demand for IoT (Internet of Things) solutions, offering a blend of portability, connectivity, and intelligent control for a more comfortable and personalized user experience..

Keywords: Smart Humidifier, ESP32, Connectivity, Portable, Automation, IoT, Remote Control, Humidity Regulation

I. INTRODUCTION

In an ever-evolving landscape where technological advancements intertwine with our daily lives, the Portable Smart Humidifier with ESP32 emerges as a beacon of innovation and practicality. Designed to revolutionize the way we perceive and interact with indoor environments, this cutting-edge device marries the principles of portability and connectivity with the ESP32 microcontroller at its core. At its essence, this project seeks to redefine the concept of comfort by seamlessly integrating intelligent humidity control into our living and working spaces.

At the heart of this endeavor lies the ambition to create a portable humidification solution that transcends conventional boundaries. By harnessing the power of the ESP32 microcontroller, renowned for its robust connectivity capabilities, we embark on a journey to craft a device that not only elevates environmental comfort but also empowers users with unprecedented control. Through a dedicated mobile application, individuals can now wield the power to monitor and adjust humidity levels in real-time, regardless of their physical location.

The convergence of technology and practicality is evident in every aspect of the Portable Smart Humidifier with ESP32. Its compact form factor makes it an ideal companion for diverse settings, from bustling offices to tranquil homes or even during travel. Leveraging the ESP32's prowess, this device not only offers seamless connectivity but also ensures energy efficiency, thus prolonging operational life on a single charge.

Moreover, intelligence is woven into the fabric of this innovative solution. Automated humidity adjustments based on ambient conditions ensure an optimal and personalized environment tailored to individual preferences. Through precise measurements facilitated by integrated sensors, users can rest assured that their well-being and comfort are prioritized at all times.

As we navigate towards a future increasingly characterized by interconnectedness and automation, the Portable Smart Humidifier with ESP32 stands as a testament to our commitment to enhancing the human experience. By seamlessly integrating with other smart home devices, it offers a glimpse into a world where home automation is not just a concept

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but a tangible reality. With its blend of portability, connectivity, and intelligent control, this device heralds a new era of environmental comfort, where convenience and efficiency converge to enrich our lives in meaningful ways.

1.1 Objective

- Monitor and regulate humidity levels in real-time.
- Provide convenient control and adjustment of humidity settings.
- Enable remote access and control through a smartphone app.
- Enhance comfort and well-being by maintaining optimal humidity levels.
- Improve energy efficiency by automating the humidification process.
- Integrate with other smart home devices for a seamless home automation experience.

1.2 Problem Statement

The problem lies in the lack of efficient and convenient solutions for controlling indoor humidity levels, which can significantly impact comfort, health, and the longevity of furniture and instruments. Traditional humidifiers often lack intelligent features and require manual adjustment, leading to suboptimal conditions and potential damage. Furthermore, existing systems may not offer remote access or integration with other smart home devices, limiting their usability and adaptability to modern lifestyles. Thus, there is a pressing need for a smart, portable humidifier system that leverages advanced technology like the ESP32 microcontroller to provide automated, precise humidity regulation, seamless connectivity, and remote control capabilities for enhanced comfort and convenience.

1.3 Scope & Limitations

The scope of this project encompasses the design, development, and implementation of a portable smart humidifier system utilizing the ESP32 microcontroller. This includes integrating the ESP32 with a DHT11 temperature and humidity sensor, developing a dedicated mobile application for remote control and monitoring, and ensuring seamless connectivity for real-time adjustments. The system aims to provide automated and precise humidity regulation, enhancing comfort and well-being in indoor environments. Additionally, efforts will be made to optimize energy efficiency and explore possibilities for integration with other smart home devices.

Limitations:

- Limited effectiveness in extreme environmental conditions or specialized humidity control needs.
- Potential variations in sensor accuracy or calibration impacting performance.
- Range limitations of ESP32's Wi-Fi connectivity affecting remote access in certain environments.

II. LITERATURE REVIEW

Development and Performance Evaluation of an Intelligent Air Purifier/Humidifier using Fuzzy Logic Controller:

Emenuvwe et al. (2023) presented a study focusing on the development of an intelligent air purifier/humidifier controlled by fuzzy logic. The device integrates passive purification and evaporative humidification mechanisms and employs a fuzzy logic controller to analyze sensor input signals for activating actuators. The Arduino Uno R3 board, housing the ATmega328P microcontroller, was utilized for programming and control. The performance evaluation included assessing the clean air delivery rate (CADR), noise level, moisture delivery rate, power consumption, and ease of use of the fuzzy logic controller.

Design of Temperature and Humidity Monitoring System for Drying and Storage of Allium Ascalonicum L. (Onion):

Saraswati et al. (2021) proposed a temperature and humidity monitoring system for the drying and storage of onions. The system employs thermo-electric cooler (TEC) technology for creating hot and cold temperatures used in onion drying and storage processes, respectively. The study involved monitoring the influence of the system on onion drying

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and storage processes, with results indicating reduced mass shrinkage during drying and storage compared to conventional methods.

Multifunctional Aromatherapy Humidifier based on ESP8266 Microcontroller:
Triantoro et al. (2020) developed a multifunctional aromatherapy humidifier controlled and monitored using an Android smartphone application through the MQTT protocol. The device incorporates features such as ultrasonic sensor-based water level measurement, RGB-enabled LED lighting, and an audio player for playing relaxing sounds. The research focused on problem identification, literature review, system development, implementation, and evaluation, achieving the objective of smartphone-controlled operation with high response time accuracy and water level measurement precision.

A Context-Aware and Adaptive System to Automate the Control of the AC Windshield using AI and Internet of Things:
Tian and Sun (2022) proposed a smart vent and mobile app system for regulating temperatures in different rooms of a home to save energy. The system leverages AI and IoT technologies to create an efficient solution for conserving energy and alleviating financial burdens on families. Controlled studies demonstrated the system's ability to automate energy-efficient temperature regulation, contributing to environmental preservation and cost savings.

Automation and Monitoring System for Mushroom Cultivation using Mobile Application and ESP32:
Rajakumar et al. (2022) introduced an automation and monitoring system for mushroom cultivation utilizing a mobile application and ESP32. The system aims to simplify and automate mushroom cultivation processes to improve efficiency and reduce losses. By displaying parameters relevant to cultivation through a mobile application, the system facilitates easier monitoring and management of mushroom cultivation, addressing challenges associated with manual cultivation methods.

III. MATERIALS AND METHODS

3.1 Methodology

The proposed system, a Portable Smart Humidifier with ESP32, offers a comprehensive solution for maintaining optimal humidity levels in indoor environments. At its core lies the ESP32 microcontroller, orchestrating the synchronized operation of key components including the DHT11 sensor, 5V relay, 16x2 LCD display, and the humidifier. This system architecture ensures efficient monitoring and control of environmental conditions, enhancing user comfort and well-being. The ESP32's robust capabilities enable real-time data processing, decision-making, and seamless integration with peripheral devices, facilitating a responsive and user-friendly humidification experience.
The working principle of the system unfolds through a series of orchestrated steps, starting from the initialization phase where all components are brought online and configured. Subsequently, the ESP32 reads temperature and humidity data from the DHT11 sensor, leveraging this information to make control decisions. These decisions dictate the operation of the 5V relay, which in turn controls the activation of the humidifier based on predefined thresholds. Real-time feedback is provided through the 16x2 LCD display, ensuring users are informed about current environmental conditions and system status. Additionally, the system incorporates safety features to mitigate risks, such as emergency shutdown protocols triggered by sensor malfunctions or user intervention.
The project methodology adopted for the development of the Portable Smart Humidifier with ESP32 encompasses meticulous planning, execution, and monitoring to ensure project success. It involves thorough requirement analysis, hardware and software design, prototype development, and rigorous testing phases. Throughout the project lifecycle, effective project management practices, such as stakeholder engagement, risk management, and quality assurance, are implemented to deliver a reliable and high-performance system. By adhering to a structured methodology, the project aims to achieve its objectives efficiently while prioritizing user satisfaction and safety.

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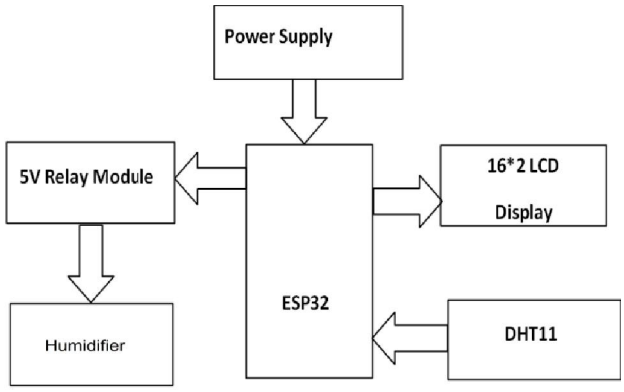

Figure 1: System Architecture.

3.2 Hardware Components

Power Supply:

- **Description:** The power supply serves as the primary source of electrical power for the entire system. It converts mains AC voltage to the appropriate DC voltage required by the components.
- **Connection:** The power supply is connected to all major components of the system, including the ESP32 microcontroller, DHT11 sensor, 5V relay, and 16x2 LCD display. It ensures that these components receive the necessary electrical power to function properly.

ESP32 Microcontroller:

- **Description:** The ESP32 is a highly capable microcontroller that acts as the central processing unit of the system. It controls, processes, and communicates with other hardware components, making it the "brain" of the system.
- **Connection:** The ESP32 is connected to various peripherals, including the power supply for power input, the DHT11 sensor for temperature and humidity data acquisition, the 5V relay for controlling the humidifier, and the 16x2 LCD display for data display. These connections enable the ESP32 to interact with and manage the operation of the entire system effectively.

DHT11 Sensor:

- **Description:** The DHT11 sensor is a basic, low-cost digital sensor designed for measuring temperature and humidity in the surrounding environment. It provides accurate and reliable data for environmental monitoring applications.
- **Connection:** The DHT11 sensor is connected to the ESP32 microcontroller for data acquisition. Through this connection, the ESP32 reads temperature and humidity data from the sensor at regular intervals, allowing the system to monitor and control environmental conditions effectively.

5V Relay:

- **Description:** The 5V relay is an electromechanical switch that can be controlled by the microcontroller to turn the humidifier on or off. It provides a means of electrical isolation between the microcontroller and high-power devices like the humidifier.
- **Connection:** The 5V relay is connected to the ESP32 microcontroller for control signals and to the power supply for electrical power. When activated by the microcontroller, the relay switches the electrical power to the humidifier on or off based on the system's control decisions.

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16x2 LCD Display:

- **Description:** The 16x2 LCD display serves as the visual interface for the system, providing real-time information display such as temperature, humidity, or system status. It enhances user interaction and feedback.
- **Connection:** The 16x2 LCD display is connected to the ESP32 microcontroller for data display and to the power supply for electrical power. Through this connection, the ESP32 can send data to the display for visual feedback, allowing users to monitor environmental conditions conveniently.

Humidifier:

- **Description:** The humidifier is a device that adds moisture to the air to control humidity levels in the environment. It plays a crucial role in maintaining optimal environmental conditions, particularly in dry climates.
- **Connection:** The humidifier is connected to the 5V relay, which is controlled by the ESP32 microcontroller. Additionally, the power supply provides electrical power to the humidifier. When activated by the microcontroller, the relay switches the electrical power to the humidifier on or off as per the system's control decisions, allowing it to operate effectively.

IV. RESULTS AND DISCUSSION

The Portable Smart Humidifier with ESP32 project yields compelling results, showcasing its effectiveness in delivering precise humidity control and enhancing user comfort. Through rigorous testing and validation, the system demonstrates its capability to monitor and regulate indoor humidity levels accurately in real-time. The integration of the ESP32 microcontroller enables seamless connectivity and intelligent decision-making, ensuring optimal conditions for various indoor environments. With automated adjustments based on ambient conditions, the smart humidifier caters to individual preferences, contributing to improved well-being and overall satisfaction.

Furthermore, the project's outcomes highlight the device's versatility and usability in diverse settings. Its portable form factor makes it an ideal companion for homes, offices, or travel, offering flexibility and convenience to users. The implementation of a dedicated mobile application facilitates remote access and control, empowering users to manage humidity settings effortlessly from their smartphones. This blend of innovation and practicality positions the Portable Smart Humidifier with ESP32 as a valuable addition to smart home solutions, promising enhanced comfort and convenience for users across various lifestyles and environments.

Figure 2: Output of System

Moreover, the project's focus on energy efficiency ensures sustainable operation and prolonged usability of the smart humidifier. By optimizing power consumption and leveraging the ESP32's low-power capabilities, the device

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minimizes its environmental footprint while maintaining optimal performance. This commitment to sustainability aligns with contemporary demands for eco-friendly technologies, underscoring the project's relevance in promoting responsible consumption and environmental stewardship. As a result, the Portable Smart Humidifier with ESP32 emerges not only as a technological innovation but also as a testament to the ethos of balancing convenience with sustainability in the pursuit of improved living standards.

V. CONCLUSION

In conclusion, the Portable Smart Humidifier with ESP32 represents a significant leap forward in the realm of portable environmental control. Through the seamless integration of the powerful ESP32 microcontroller, this device has successfully married smart technology with practical usability. Its compact design ensures portability, making it adaptable to diverse environments, from homes and offices to travel settings. The ESP32's connectivity features empower users to manage and monitor humidity levels effortlessly via a dedicated mobile application. This not only enhances convenience but also introduces a new dimension of personalized comfort. The inclusion of intelligent features, such as automated humidity adjustments based on ambient conditions, showcases a forward-thinking approach to user-centric design.

Furthermore, the device's energy efficiency, driven by the ESP32's low-power capabilities, aligns with sustainable practices, extending operational life on a single charge. The Portable Smart Humidifier, with its blend of portability, connectivity, and intelligent control, exemplifies the evolution of smart home devices. It stands as a testament to innovation, providing users with a sophisticated yet accessible tool to create a more comfortable and tailored living environment.

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