



AUTOMATIC HUMIDIFIER

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Abstract : This study has been undertaken to investigate that controlling relative humidity is critical, but traditional manual methods risk hardware failure from dry-running. This paper proposes a low-cost, closed-loop Automatic Humidifier System using the Arduino Uno R3. It integrates a DHT22 sensor for real-time data and activates an ultrasonic mist maker via a relay when humidity falls below 40%. A critical fail-safe uses an analog water sensor. If the water level drops (below 100), the system interrupts misting, triggers an audible alarm, and displays "No Water" on a 16X2 LCD. Experimental results show the system effectively stabilizes humidity and the safety protocols successfully prevent hardware damage, offering a reliable solution.

Index Terms - Arduino Uno R3, Automatic Humidifier, DHT22 Sensor, Ultrasonic Mist Maker, 16x2 LCD, Relay Module

1. INTRODUCTION

The textile industry, from raw fibre processing to final garment assembly, is fundamentally dependent on precise environmental control. At the heart of this necessity lies humidity. Textile fibres, whether natural (like cotton or wool) or synthetic (like polyester), are highly hygroscopic, meaning they readily absorb or release moisture based on the surrounding air.

In many textile facilities, especially those with heating or high-friction machinery, the air becomes too dry. Low humidity has critical negative impacts: **Quality Degradation:** Fibres lose their natural moisture, becoming weaker, brittle, and less elastic, leading to increased yarn breakages and product imperfections. **Production Stoppages:** Dry environments significantly increase static electricity build-up, causing fibres to cling, machines to jam, and forcing a reduction in machine operating speeds. **Economic Loss:** Lower moisture content directly results in product weight loss, impacting sales and profit margins since textile yarns are sold by weight.

An Automatic Humidifier System is indispensable for mitigating these issues. These systems integrate sensor technology to continuously monitor and regulate the Relative Humidity (RH) to maintain the optimal range (often between 50% and 85% RH, depending on the material).

This project focuses on developing a cost-effective, prototype automatic humidifier based on the Arduino platform. By utilizing a DHT22 sensor for accurate humidity readings and an ultrasonic mist maker for moisture introduction, the system provides a reliable, self-regulating solution. When humidity drops below a critical threshold (e.g., 40% RH), the system automatically activates, ensuring the fibres maintain their vital moisture content, thus preserving yarn quality, maximizing machine efficiency, and boosting overall production yield.

2. LITERATURE REVIEW

[1]Karthik Ajit and team(2025) this paper shows progress in developing next-generation polymer-based humidity sensors is focused on achieving superior performance in sensitivity, stability, and fast response by utilizing advanced materials and structural strategies. This includes the incorporation of composite materials and MOFs (Metal-Organic Frameworks), as well as sophisticated fabrication techniques like interface engineering and the creation of hybrid structures. These advancements aim to meet the demanding requirements for future humidity sensing applications.

[2]Yashoeng zhu and team(2024) this indicates that environmental conditions, particularly temperature and humidity, are critical factors that significantly impact the quality of cotton fiber in major cotton-producing regions of Turkey. This influence is especially pronounced during the key growth stages of the cotton plant, highlighting the necessity of effective climate monitoring and control in these agricultural areas.

[3]Ajay Beniwal and team(2024) the paper describes the successful development of an eco-friendly, biodegradable, textile-based humidity sensor. This sensor demonstrates high performance and long-term stability, and it has been effectively used for successful

multimode wireless monitoring. These characteristics make it suitable for diverse healthcare applications, specifically mentioning the sensing of respiration and skin moisture.

[4]R.K.Bhagat and team(2024) this paper states that integrating the use of Bluetooth for remote control enhances the device by adding a crucial layer of convenience and modern functionality, ultimately resulting in a product that is more user-friendly.

[5]Muppuri Venkatalaxman and team(2023) this paper confirms that a device's automated functions (humidifier and dehumidifier switching) successfully restored the room's humidity to a normal level during testing. The overall performance, however, was observed to depend on two key external factors: the size of the room and the weather temperature.

[6]Z He et al(2022) the sensor described is suitable for smart textiles and health monitoring applications. It can accurately detect environmental humidity and respiration, and its design allows it to integrate well into wearable textiles, confirming its utility for comfortable, continuous physiological tracking.

[7]Md Nazmus sakib and team(2021) the paper describes a humidity control system that effectively increases humidity when levels fall below a set comfort threshold. The device is applicable in sensitive environments like hospitals, museums, cold storage, and art galleries, and it conserves energy by operating only when needed.

[8]Julie Ann B Susa and team (2020) the paper confirms that the device's automated functions specifically the humidifier and dehumidifier turning on and off—were successful during testing, managing to bring the room's humidity to a normal level. However, the overall performance of the system was found to be conditional, depending on external factors, namely the size of the room and the weather temperature. This highlights a limitation regarding the system's scalability and environmental resilience.

[9]Saravan Yuvaraja and team (2020) the document highlights the effectiveness of MOF-based textile sensors in providing reliable humidity sensing. Consequently, these innovative materials hold significant potential applications for integration within the growing fields of wearable electronics and smart textiles, paving the way for advanced, fabric-integrated sensing solutions.

[10]Li Ma and team (2019) the sensor provides effective and reliable humidity sensing and is highly applicable in advanced technological fields, including wearable electronics, smart textiles, and Human-Machine Interfaces (HMI). However, the document concludes that further research is needed to specifically enhance the sensor's stability and durability for widespread, long-term use in these demanding applications.

3. METHODOLOGY

The system begins with the DHT22 humidity and temperature sensor. Its primary function is to accurately sense the current relative humidity level and air temperature within the environment. The sensor converts these physical measurements into a digital signal, which is then transmitted to the central processing unit for interpretation. This real-time data input is essential, as it provides the necessary feedback for the system to decide whether humidity control is required.

The Arduino Uno serves as the system's central processing unit (CPU). It receives the digital signal from the DHT22, processes the data, and executes the control logic. The Arduino's core function is to read the measured humidity value and compare it against a predefined optimal humidity range stored in its code. Based on this comparison, it determines the required action: activating or deactivating the humidifier to maintain the desired environmental conditions.

A 16x2 LCD (Liquid Crystal Display) is integrated into the system to provide the user with a visual, real-time interface. Its function is solely to display the current humidity and temperature readings. This allows for immediate and continuous monitoring of the environment, enabling the user to verify the system's operation and the effectiveness of the control logic at a glance.

The SPDT (Single-Pole, Double-Throw) 5V relay module is a critical safety component. Its primary function is to act as an electrically controlled switch that safely bridges the low-power Arduino output with the high-power humidifier circuitry. The relay's terminals—COM (Common), NO (Normally Open), and NC (Normally Closed)—are crucial for this. The low-voltage signal from the Arduino activates the relay, which in turn switches the high-voltage circuit for the humidifier, protecting the sensitive Arduino electronics from the higher power requirements of the appliance.

The automated mist-ultrasonic humidifier is the system's final output or actuator. Its function is to efficiently produce a fine mist to increase the ambient humidity. It is controlled by the relay based on the Arduino's logic. Specifically, the humidifier is activated when the system determines the humidity value is less than 40% (the low threshold). It remains on until the humidity returns to the optimal set range, actively correcting the environment's moisture deficit.

The Analog Water Sensor serves as the system's primary safety input mechanism. Its primary function is to continuously monitor the water level within the humidifier's reservoir to prevent dry-running. The sensor operates by measuring the electrical conductivity of the water, converting the physical water level into an analog voltage signal. This signal is read by the Arduino and mapped to a digital value. The microcontroller continuously compares this value against the specific safety threshold of 100. If the reading drops below this value, the system interprets it as an empty reservoir, allowing the Arduino to take immediate protective action by cutting power to the mist maker.

The Active Buzzer acts as the system's auditory warning interface. Its primary function is to provide an immediate, audible alert to the user when critical operating conditions are not met. Unlike the visual data provided by the LCD, the buzzer ensures the user is notified of errors even without direct line-of-sight to the device. It is controlled directly by the Arduino's safety logic; specifically, when the water sensor reading falls below the threshold of 100, the Arduino sends a high signal to the buzzer component. This generates a distinct sound, signalling that the reservoir requires refilling and that the system has entered a safety halt mode.

3.1 COMPONENTS REQUIRED BLOCK DIAGRAM

- Humidity and temperature sensor (DHT22)
- Arduino uno R3
- Ultrasonic humidifier
- 5V SPDT relay module
- Arduino cable
- LCD (16X2)
- Analog Water sensor
- Active buzzer
- Bread board
- Jumper wires

3.2 BLOCK DIAGRAM

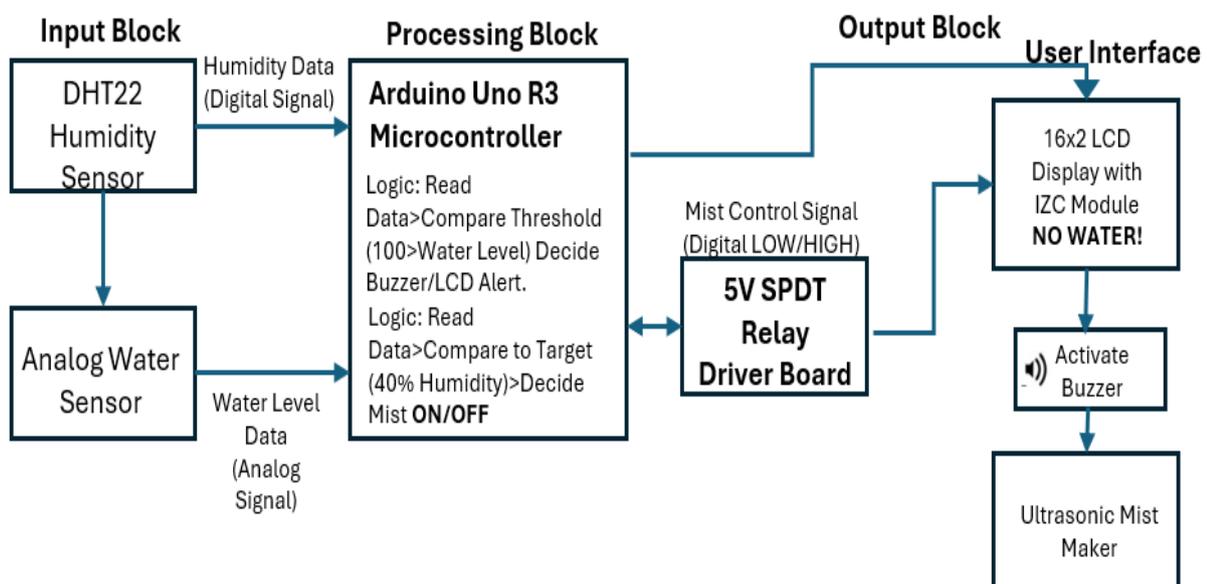


fig: block diagram

3.3 FLOW CHART

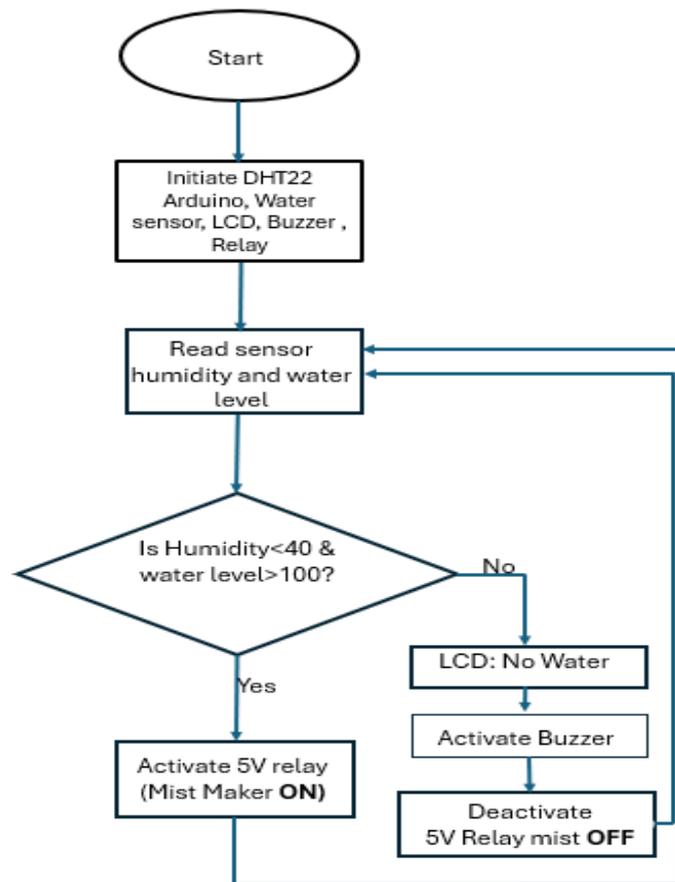


fig: flow chart

4. RESULTS

- When humidity levels were above the 40% threshold, the system remained in a passive monitoring state with the relay deactivated, ensuring zero unnecessary power consumption.
- The 16x2 LCD accurately displayed real-time Temperature and Humidity readings received from the DHT22 sensor.
- The system successfully detected when relative humidity dropped below the critical setpoint of 40%.
- The mist maker operated continuously until the sensor feedback confirmed humidity levels returned to the optimal range, demonstrating effective automated environmental control without manual intervention.
- The analog water sensor continuously monitored reservoir levels. When the sensor value dropped below the safety threshold of 100, the system prioritized safety over humidity control.
- The LCD screen interrupted the standard display to show the warning message "No Water".
- The active buzzer was successfully triggered to provide an immediate audio warning to the user.
- Most importantly, the system instantly cut power to the relay (deactivating the mist maker) during low-water conditions, effectively preventing permanent damage to the ultrasonic module.

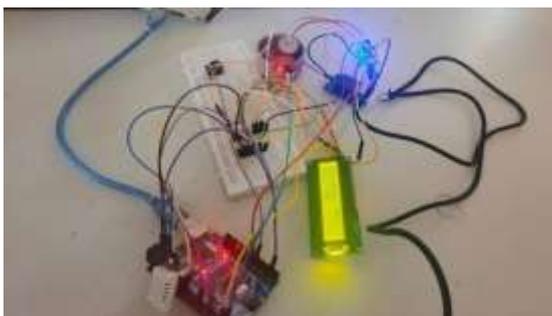


fig: mist is on when the humidity < 40



fig: LCD display when mist off and humidity > 40

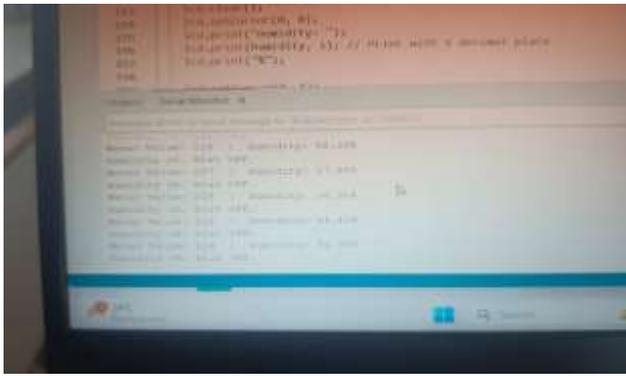


fig: serial monitor output



fig: LCD when waterlevel<100

5.CONCLUSION

The project successfully designed and implemented an Automatic Humidifier System tailored for environmental control applications such as the textile industry. By integrating the Arduino Uno R3 with the DHT22 sensor, the system achieved precise, real-time monitoring of ambient temperature and humidity. The closed-loop control logic effectively maintained humidity levels above the critical 40% threshold by automatically actuating the ultrasonic mist maker via a relay. Furthermore, the incorporation of the analog water sensor and active buzzer provided a robust fail-safe mechanism. This ensures the longevity of the hardware by preventing dry-running conditions and alerting the user immediately through the "No Water" display and auditory alarm. In conclusion, the proposed system offers a cost-effective, reliable, and energy-efficient solution for automating humidity regulation, minimizing manual intervention, and ensuring operational safety.

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