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Automatic Air Humidifier for Dust Allergy Patient

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Abstract:Free dust particles in the air are a major cause of dust allergy among many patients. Dry air is one of the major reasons for free dust particles suspended in the air.As the humidity or water content in the air increases the adhesive force among various particulate matter freely suspended in the air also increases.Thus, it is an important task for the patient to ensure that the amount of dust particles in the air are below a certain limit. For this it is necessary to control the amount of humidity in the air. If the water content in the air is high it leads to suppression of freely suspended dust particles in the air.

This project aims to tackle this exact problem by maintain the amount of humidity in the air at the user specified level. The components used in this project include an Arduino Uno microcontroller, DHT11 temperature and humidity sensor, Ultrasonic humidifier and a MOSFET.The amount of relative humidity in the air is measured by the DHT11 sensor. The data output of the sensor pin is connected to the input pin of the Arduino UNO. The output pin of the Arduino is connected to the gate of the MOSFET. TheMOSFET is used to switch on or off the ultrasonic humidifier. If the humidity is below the specified level the Arduino gives a HIGH signal to the MOSFET which thus turns on the humidifier. As a result, the humidity in the air is increased. The humidity data is displayed with the help of Arduino IDE Serial Plotter.

Keywords — (Arduino IDE, Arduino Uno, DHT11 Temperature Humidity Sensor, Humidifier, Humidity)

I. INTRODUCTION

Air pollution has become one of the major problems in developing countries. In countries like India where new construction projects are rapidly going on it leads to creation of excessive amounts dust. This dust gets spread in the surroundings when it gets carried away by the wind. In areas of low humidity these particles tend to be freely suspended in the air. These dust particles may carry allergens which trigger allergic reactions like sneezing and coughing among patients. This dust is also one of the reasons dust allergies and other respiratory problems have significantly gone up among people.

This project tries to tackle this problem by increasing the humidity in the air in order to suppress the dust particles in the air. Thus, making it more breathable for dust allergy patients. The project uses the DHT11 temperature humidity sensor to measure the relative humidity in the air. The microcontroller used is the Arduino UNO. It processes the data from the sensor and is used to control the operation of the ultrasonic humidifier. A MOSFET is used to regulate the power to the ultrasonic humidifier. In order to visualize the change in the humidity the serial plotter of the Arduino IDE was used.

LITERATURE REVIEW:

[1] J. A. B. Susa et al.“Automatic Room Humidifier and Dehumidifier Controller using Arduino Uno”. In this project a device was created to control the humidity in the air by humidifying or dehumidifying the air. Input of relative humidity was taken from the DHT11 sensor and then processed by Arduino UNO to turn on or off the humidifier. The output was displayed on a

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LCD display. The humidifier was controlled with the help of a relay.

[2] Ejodamen Pius Uagbaeet al.”Arduino-Based Weather Monitoring System”. In this project a weather monitoring system was created with the help of Arduino UNO and DHT11 temperature humidity sensor. The DHT11 sensor was used to measure temperature and relative humidity in a 20 metrearea. The Arduino UNO was used to process the data from the humidity sensor and then display it on a LCD screen.

[3] M.Mahesh et al."Performance Evaluation of Portable Mist Humidifier”. In this a portable mist humidifier was created and its performance was evaluated. The humidifier was designed by placing spray nozzles onto holes made in a copper pipe which is fitted over a frame of an axial fan. One end of the copper pipe is connected to a water pump. When the pump is turned on water flows in the pipe and a mist spray is created by the spray nozzles to increase humidity.

[4] Feresu ZTT et al."DHT11 Based Temperature and Humidity Measuring System”. In this project measurement of temperature and humidity was done with the help of DHT11 temperature humidity sensor. The sensor was able to measure relative humidity between 20 and 80% with an accuracy of ± 5% and temperature in range of 0 to 50°C with an accuracy of ± 2°C.Data was sent from DHT11 sensor to the Arduino using serial single wire communication.

[5] Pedro Martínez et al."Experimental study of an ultrasonic mist generator as an evaporative cooler” In this experiment a mist generator using ultrasonic transducers was designed, built and tested for its behavior and performance. Its performance was analyzed by testing it in a wind tunnel.

[6] Putra I.D.G.A.T. et al."Investigation on application of ultrasonic humidifier for air conditioning system”. In this experiment an ultrasonic humidifier was studied. High frequency surface vibrations were created with the help of ultrasonic piezoelectric transducer leading to atomization of water into mist. The humidification process was found to be effective at water layer thickness of 3.5 – 4.5 cm and air mass flow rate about 0.0186 kg/s.

[7] Ruiz J. et al."Numerical Characterization of an Ultrasonic Mist Generator as an Evaporative Cooler”. In this study a numerical model was developed for aultrasonic mist generator as an evaporative cooler. The numerical model was validated with the help of experimental data obtained in a wind tunnel experiment. Maximum value of 0.654 was obtained for water-to-air mass flow and air-to-air mass flow ratio.

[8] Li B. et al."Design of the intelligent air humidifier”. In this project a humidifier system was designed with the help of STC89C52RC SCM microcontroller board and AM2302 temperature and humidity sensor. The system can measure the humidity in the air and accordingly turn on or off the humidifier. The humidifier was turned on or off with the help of a relay.

[9] Sakib et al. "Smart solution for low humidity problems using automatic ultrasonic humidifier (AUH)”. In this project an Arduino UNO,Grove Water Atomizer, DHT11 sensor was used to create an automatic ultrasonic humidifier. When the humidity is below the user specified level the humidifier is turned on.

[10] J.Roberts et al."Research, Development and Application of Dust Suppression Technology”. In this study various techniques to suppress airborne dust particles are described. The most prominent among these techniques is the use of high-energy micro-mist sprays modelling and simulation has been used for improving high-efficiency dust suppression systems and model spray dispersion of the mist.

[11] S. Baldacci et al."Allergy and asthma: Effects of the exposure to particulate matter and biological allergens". In this research various effects of particulate matter in the air on human respiratory health that can trigger allergies or certain reactions has been studied. The pollution caused by rapid urbanization and industrialization

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is one of the factors responsible for rapid rise in respiratory diseases.

Few shortcomings were observed in the reviewed literature: Few of the reviewed projects had implemented a mechanism of water pump and a spray nozzle to create a water mist in order to increase the humidity. But the power consumption in such a setup is very high. In order to turn on or off the humidifier an electromagnetic relay was used. The power consumed by the relay during switching is high and thus not suitable for battery powered application. Also, an electromagnetic field is created which may interfere with the electronics.
These shortcomings were overcome in the following ways: An ultrasonic humidifier using a piezoelectric transducer was used which is very compact and portable. It also consumes very low power (2.5 watts). The relay was replaced with a N channel MOSFET which consumes very low power during switching thus making it more suitable for battery powered applications. These changes have helped in making the project compact, portable and power efficient.

II. METHODOLOGY

COMPONENTS USED:

1. Microcontroller used: Arduino Uno
The Arduino UNO is a microcontroller based on the ATmega328P IC. It runs the main embedded C program.It is used to read the data from the DHT11 sensor and send an output signal to the MOSFET.

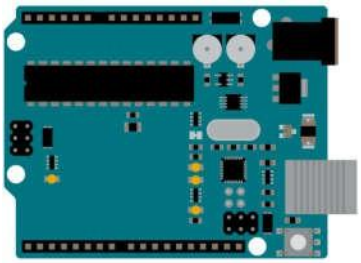

Figure 1-Arduino Uno

2. Sensor used: DHT11 Temperature Humidity sensor
The DHT11 sensor is a NTC based sensor with an integrated 8-bitmicrocontroller enabling it to output the temperature and humidity data as a single line serial data which can be read by the Arduino with the help of the dht11 library.

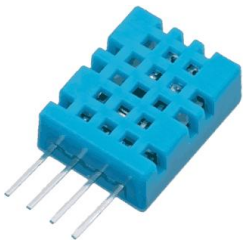

Figure 2-DHT11 Temperature Humidity sensor

3.MOSFET used: IRFZ44N N channel MOSFET
The MOSFET is used to regulate the flow of electricity to the humidifier. It has 3 pins: GATE - which is used to control the MOSFET, SOURCE - which is connected to the ground and DRAIN - which is the output of the MOSFET.

Figure 3-IRFZ44N N-Channel MOSFET

4.Humidifier used: Ultrasonic Piezoelectric Transducer
The humidifier consists of 2 main devices. The first is an ultrasonic frequency oscillator which generates the required ultrasonic sine waves. The second is the piezoelectric transducer which is connected to the output of the oscillator thus making it oscillate at ultrasonic frequencies. When the transducer oscillates at ultrasonic frequencies it atomizes water in water molecules thus generating a fine mist. This mist helps in increasing the humidity of the air by increasing its water content.

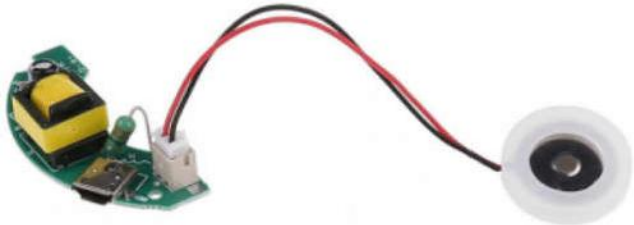

Figure 4-Ultrasonic air humidifier

CIRCUIT DIAGRAM:

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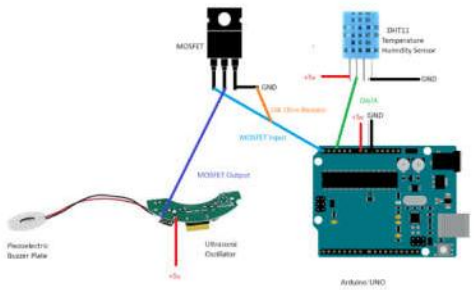

Figure 5-Circuit Diagram

The output of the DHT11 sensor is connected to the input pin of the Arduino Uno. The output of the Arduino is connected the Gate of the MOSFET. The Source of the MOSFET is connected to Ground. The Ground of the Humidifier oscillator is connected to the Drain of the MOSFET. A 10-kilo ohm resistor is connected between the Gate and Source of the MOSFET so that in absence of any input signal the MOSFET does not turn on.

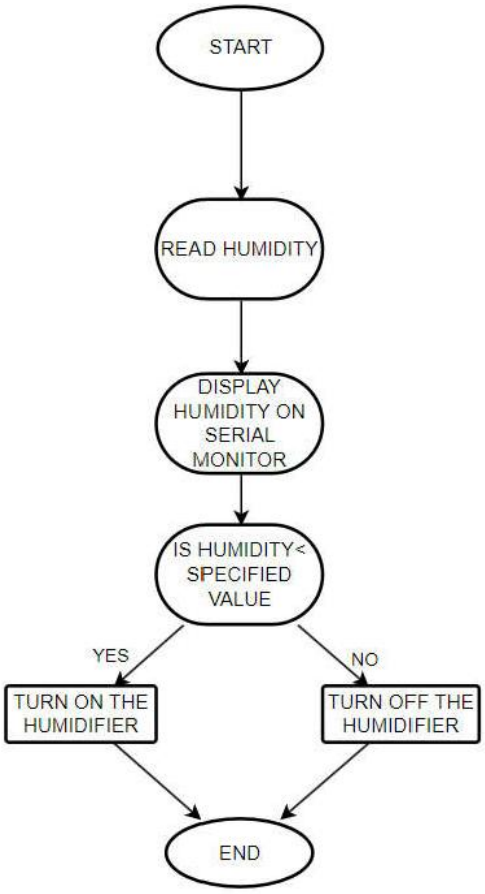

Figure 6- Flowchart of the Project

The code for the entire system was written in Embedded C using the Arduino IDE. The data was displayed on the Serial Plotter of Arduino IDE. The power to the humidifier was given separately using 5volt USB connection as the Arduino can output only a small amount of current.

III. RESULTS AND DISCUSSIONS

The device was tested in a 4 m^2 room. The DHT11 Humidity Sensor was accurately able to measure amount of relative h midity in the air. The humidifier turns on if the humidity is below the specified level. The humidifier was able to increase the humidity in the air.After the humidity was above the specified level the humidifier turned off.

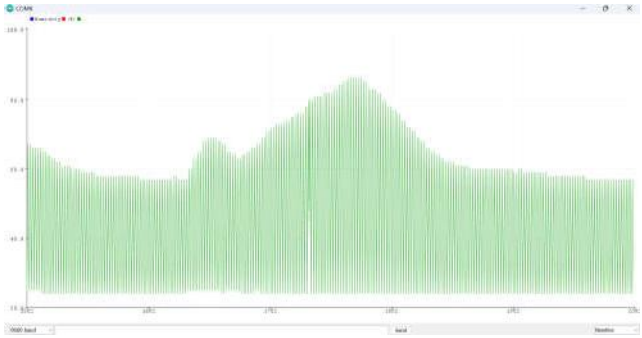

Figure 7- Arduino IDE Serial Plotter Output

Figure 7 shows the output of the DHT11humidity sensor in a graphical format using the Arduino IDE's Serial plotter.

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Date	Time	Specified value of humidity	Humidity level	Humidifier State
4-Dec-23	21:43	70%	57%	ON
	21:47		59%	ON
	21:51		64%	ON
	21:55		67%	ON
	21:59		71%	OFF
	22:03		70%	OFF
	22:07		68%	ON
7-Dec-23	19:11	80%	54%	ON
	19:15		57%	ON
	19:19		62%	ON
	19:23		65%	ON
	19:27		70%	ON
	19:31		72%	ON
	19:35		77%	ON
	19:39		82%	OFF
	19:43		80%	OFF
	19:47		77%	ON

Figure 8- Humidity data collected

Figure 8 shows the data collected manually of the relative humidity in the air in a tabular format. The data shows the time at which the humidifier was turned on and the relative humidity at that point of time. Data was collected every 4 minutes. The operational state of the humidifier was also noted.2 tests were done on 2 different days with 2 different values of user specified humidities. It was observed that the humidity was increased at the rate of 0.957% relative humidity per minute. It has to be noted that the amount of time may vary depending upon the size of the room and other environmental conditions.

IV. Conclusion

The device works as designed and is suitable in places of low humidity where the humidity has to be increased. It also ensures that the humidity is maintained at that specific level. The device can be used in places with high amounts of air and dust pollution where it can help suppress the freely suspended particulate matter by increasing the humidity in the air. The device can also find use cases in the medical, agriculture and food industries where it is necessary to maintain a fixed value of humidity. The device being compact is only effective in a small closed area. For implementation in a larger area, it may be necessary to use a larger transducer or place multiple such devices in different corners of the room.

V. Acknowledgment

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