1. Introduction
Humidity is the concentration of water vapor present in the air. Water vapor, the gaseous state of water, is generally invisible to the human eye. Humidity indicates the likelihood for precipitation, dew, or fog to be present. Humidity depends on temperature and the pressure of the system of interest. The same amount of water vapor results in higher humidity in cool air than warm air. A related parameter is the dew point [1]. However, there are also a number of variables and individuals, which overlap, making it difficult and challenging to construct a proper humidifier unit [2]. Many instances may also be associated with breathing disorders, including hypertension, and some may result from depression. Besides,
patients often will hyperventilate, triggering symptoms of, among many others, loss of feeling, light-headedness, and lack of concentration [3]. Air conditioning also decreases the temperature and reduces humidity, decreasing discomfort in the summer [4]. Studies suggest because when temperature rise is preserved around 35%-55%, individuals typically feel relaxed. Water evaporates very quickly from the body whenever the weather is clean, creating a sensation of coldness at temperatures of 23.89 °C or even more [5]. Because the psychological health of relative humidity (RH) is sometimes viewed as a difference in temperature, through adequate humidity regulation throughout cooler altitudes, pleasant environments can be achieved [6]. During winter, once cold outdoor weather is warmed inside, the moisture can decrease as low as 10-20 % [7]. The dry air can cause health problems through dried away respiratory tract, including the nasal passages and mouth, and heart failure. That since the body's low humidity dampens moisture, the convection of tissues can arise [8]. The moist equilibrium may also be disrupted by low humidity and causing irritation and even droopy eyelids [9]. Dry air influences hardwood floors, allowing the joint to weaken and detach or parts to break. If moisture is insufficient, textbooks, documents, and works of art can even be compressed or warped and become fragile [10]. Lower temperatures can cause various problems, namely health issues, widespread destruction, and machinery harm [11]. The effect of low humidity on the human body is shown in Figure 1.

![Image of low humidity effects](image_url)

**Figure 1.** Effect of low humidity on the human body [12].

To avoid spikes that can destroy information technology (IT) machinery, the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) has proposed a range of 45-55 % RH in data centres [13]. In museums and art galleries, humidifiers are available to protect fragile artworks and museum rooms at which inflammatory acne induced by warming is minimized for tourists' convenience and during winter [14]. Among several other exogenous conditions, weather, hygiene, wind
speed, and heat flux, the need for moisture is known to become very necessary to note that humidity is probably the least apparent to sensory consciousness. Most individuals respond faster to fluctuations in climate, odors, or dense particles throughout the wind, draughts, or thermal gradient. During which humidity levels interact with all these factors, this becomes an integral component of the climate's complete regulation. In terms of developing reliable, inexpensive, and trouble-free thermal management, appropriate humidification devices, and devices may well be beneficial [15]. The developed system can also be used to remove low humidity observed in different ways, maintaining the climate conditions at the necessary level of human health [16,17]. For those countries where humidity is slightly lower than the comfort zone, the system is more useful [18]. The system is much more critical for maintaining continuous thermal comfort throughout the winter regional countries to remove such problems [19]. Its most humidity levels rise, the harder it becomes to raise moisture steadily [20]. In Bangladesh, as humidity is higher in any season than in the winter countries, it is less useful for Bangladesh than other nations. And it can be used in certain areas, such as labs, raising livestock, clinics, etc.

The above studies show acceptable performance to detect humidity but still has some limitations discussed. The objective of this research is to detect humidity in the weather automatically. Humidity problems in weather envelopes can develop from six different sources: use of wet materials in construction, the capillary rise of ground moisture, leakage of rainwater or melted snow, condensation of vapor, persistent high humidity conditions, and leakage of piped water. This paper is concerned with condensation caused by dew point temperatures occurring on or within the weather and closely related phenomena.

2. Methodology

2.1. Automatic ultrasonic humidifier

And use a concrete esophagus pulsing at an ultrasonic level, an ultrasonic humidifier produces water molecules leaving the Humidifier in the form of cold mist. A small fan blows the fog typically, but there are no filters for specific ultra-mini models. To produce a high relevant acts amplitude in a liquid droplet, ultrasonic air purifiers use a piezoelectric material. This has an incredibly thin layer of particles about such a micrometer in size that evaporates rapidly into air circulation. Many attachments like Grove Temperature and Humidity sensor, Arduino Uno R3, Grove Water Atomizer, Matrix Membrane Keypad, Breadboard, LCD module, Buzzer, Potentiometer, hop wire and therefore on it should be operational efficiency to control the ultrasonic Humidifier [21]. Initially, the humidity sensor, keyboard, LCD monitor, Arduino UNO, and ultrasonic transducer must be linked through a hop cable to a circuit board. First, the proposed system has to set the input value and then need to read the humidity value. After reading the humidity value, it should check whether it is lower than the setting value or not. If no, then again, need to read the humidity value (besides, it will show not activated). If yes, then the system will be activated. The Arduino algorithm/code has been used to develop the system. Developing and running the Arduino algorithm/code needs to download Arduino software (which is open-source software) and need USB cable to connect between PC and Arduino to upload the code to Arduino. On USB boards, the wire between the USB and the power plugs selects the power source. Place the wire on the two pins closest to the USB plug to power the USB port's board (good for controlling low power devices like LEDs). Place the wire on the two pins closest to the power plug to power the board from an external power supply (needed for drive systems and other high current devices). Connect the board to a computer's USB port the other way. The proposed control system workflow of a humidifier is shown in Figure 2.
Figure 2. The proposed control system workflow of a humidifier.

A pre-designed computer program (Arduino IDE 1.8.13 software has been used to develop the code) for the microprocessor must be used to automate the computer to operate the machine correctly. The keyboard will define that settings function since turning mostly on the computer. The surrounding air's existing moisture is determined by a humidity sensor and shown on a liquid crystal display (LCD). The sensor produces an alarm condition to the Arduino unless the humidity is lower than that of the establishing level of humidity initially signed mostly on storage [22]. The sensor is accessed, and the procedure of humidifying begins the sensor, after which recognizes the consistent moisture performance of the total climate periodically. Unless the spatial moisture attains the developing design, the Humidifier will immediately shut down. Finally, the proposed experimental system setup of the humidifier control system is shown in Figure 3.
Figure 3. The proposed experimental system setup of the humidifier control system.

3. Results and discussion
All the data related to the project and paper were taken for a couple of months in April and May of 2018, at Khulna University of Engineering and Technology, Thermal Lab. Data has been taken inside the room to avoid the air motion outside. Due to the weather change, it has been recorded 5 to 10 days interval. From the thermal lab, with the help of a Fluke 971 Handheld hygrometer, we found dry bulb temperature (DBT) °C, actual relative humidity (RH) in %. At the same time, we recorded the sensor RH. Table 1 is formed by the different values of the various parameters from 10th April to 16th of May 2018. Data were taken at different times of the day has shown in table 1, due to the relative humidity change with the change of sunlight intensity and position. It was helpful to train the system for all conditions. The last column of the table showed the sensor’s deviation and the actual value of relative humidity. The sensor showed a deviation range from 0.5 to 2.70. The average value of the deviation is 1.38, which justifies that the sensor is quite acceptable to the operation. Due to manual setup and frequent air temperature reading changes, the sensor produces some deviation values than actual. Sensor RH value depends on the motion of the air and atmospheric pressure. So, it can deteriorate due to the absence of a controlled atmosphere in the lab.
Some experiments were conducted in various situations to evaluate the Humidifier's efficiency. The Humidifier's overall efficiency can be enhanced by using a useful humidity sensor and comprehensive airflow control. The system operated adequately from the tests performed, and the system raised the humidity of the atmosphere to the anticipated level. Figure 4 represents the relationship between actual and sensor %RH value. Due to six seasons in Bangladesh, the relative humidity value changes 45% to 83% round the year. We recorded 57.50% to 80.50% and changed the RH value very sharply. But the actual and sensor vale of RH so good consistency. The consistency of the humidity curve proves the sensor's effectivity, which enhances humidifier efficiency.

In Bangladesh, the average annual relative humidity is 65.8%, and the average monthly relative humidity ranges from 45% in March to 80% in June. The American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc (ASHRAE) provides guidelines intended to satisfy most building occupants wearing an average amount of clothing while working at a desk. The ASHRAE guidelines recommend a relative humidity (RH) of 30 to 60 percent [23]. For the project, we collected data in April and May 2018, shown in Table 2, and we set the standard value of 60% RH in April, while in May, we selected 62% RH. Few values showed lower than expected value than Humidifier active, but for the higher value, it was disabled.

### Table 1. Data for calibration of temperature and humidity with and without sensor.

| Obs. | Date of test | Time   | DBT °C | Sensor Reading %RH | Actual %RH | Difference between actual VS sensor reading %RH |
|------|--------------|--------|--------|--------------------|------------|-----------------------------------------------|
| 1    | 10th April   | 11:00 pm| 30.00  | 54.80              | 57.50      | 2.7                                           |
| 2    | 10th April   | 11:10 pm| 32.90  | 54.00              | 56.70      | 2.7                                           |
| 3    | 10th April   | 11:25 pm| 33.80  | 57.30              | 58.00      | 0.7                                           |
| 4    | 17th April   | 12:25 am| 32.00  | 63.00              | 65.00      | 2                                              |
| 5    | 17th April   | 12:35 pm| 33.50  | 63.40              | 64.90      | 0.5                                           |
| 6    | 17th April   | 12:40 pm| 34.40  | 61.00              | 62.00      | 1                                              |
| 7    | 2nd April    | 3:05 pm | 35.00  | 61.50              | 63.00      | 1.5                                           |
| 8    | 2nd April    | 3:15 pm | 34.90  | 62.00              | 63.00      | 1                                              |
| 9    | 2nd April    | 3:30 pm | 35.20  | 61.50              | 62.00      | 0.5                                           |
| 10   | 3rd May      | 3:00 pm | 34.50  | 76.50              | 77.50      | 1                                              |
| 11   | 3rd May      | 3:10 pm | 34.20  | 74.50              | 76.50      | 2                                              |
| 12   | 3rd May      | 3:30 pm | 34.00  | 74.30              | 76.50      | 2.2                                           |
| 13   | 3rd May      | 1:00 pm | 35.10  | 73.20              | 74.50      | 1.3                                           |
| 14   | 10th May     | 1:10 pm | 34.70  | 71.30              | 73.00      | 1.7                                           |
| 15   | 10th May     | 1:25 pm | 34.95  | 72.00              | 73.50      | 1.5                                           |
| 16   | 10th May     | 11:00 am| 35.40  | 78.30              | 79.00      | 0.7                                           |
| 17   | 16th May     | 12:15 pm| 35.50  | 78.60              | 80.00      | 1.4                                           |
| 18   | 16th May     | 12:30 pm| 35.50  | 80.00              | 80.50      | 0.5                                           |
Figure 4. Difference between actual and sensor reading of %RH.

Table 2. Data for Humidifier activity with respect to setting humidity.

| Observation No | Date for Test | Setting value Relative humidity (%RH) | Sensor Reading Relative humidity (%RH) | Humidifier Action |
|----------------|---------------|----------------------------------------|----------------------------------------|-------------------|
| 1              | 10th April    | 60                                     | 54.80                                  | Activated         |
| 2              | 10th April    | 54.00                                  | 54.00                                  | Activated         |
| 3              | 17th April    | 62                                     | 63.00                                  | Activated         |
| 4              | 17th April    | 62                                     | 63.40                                  | Activated         |
| 5              | 17th April    | 61.00                                  | 61.00                                  | Activated         |
| 6              | 17th April    | 61.50                                  | 61.50                                  | Activated         |
| 7              | 2nd April     | 62                                     | 62.00                                  | Activated         |
| 8              | 2nd April     | 61.50                                  | 61.50                                  | Activated         |
| 9              | 2nd April     | 62                                     | 62.00                                  | Activated         |
| 10             | 2nd April     | 62                                     | 76.50                                  | Activated         |
| 11             | 3rd May       | 62                                     | 74.50                                  | Activated         |
| 12             | 3rd May       | 62                                     | 74.30                                  | Activated         |
| 13             | 3rd May       | 62                                     | 73.20                                  | Activated         |
| 14             | 10th May      | 62                                     | 71.30                                  | Activated         |
| 15             | 10th May      | 62                                     | 72.00                                  | Activated         |
| 16             | 10th May      | 62                                     | 78.30                                  | Activated         |
| 17             | 16th May      | 62                                     | 78.60                                  | Activated         |
| 18             | 16th May      | 62                                     | 80.00                                  | Activated         |
| 19             | 16th May      | 62                                     | 75.50                                  | Activated         |
| 20             | 21st May      | 62                                     | 73.00                                  | Activated         |
| 21             | 21st May      | 62                                     | 73.50                                  | Activated         |
This study's proposed aims were to develop a microcontroller-based system to identify and eliminate such low humidity problems. We developed an ultrasonic Humidifier with attachments of Grove Temperature and Humidity sensor, Arduino Uno R3, Grove Water Atomizer, Matrix Membrane Keypad, Breadboard, LCD module, Buzzer, Potentiometer, and hop wire. The Arduino algorithm/code has been used to operate the system. Initially, we try to measure the sensor efficiency shown in table 1 and figure 1. The sensor was suitable to perform the relative humidity reading according to the efficiency standard. Our project was in the middle of April and May 2018; data were taken at the Khulna region of Bangladesh, where the temperature and relative humidity are relatively high. So very few data were collected below the setting value and which activated the system. The authors proposed that this system is suitable for the winter region where temperature and relative humidity are below the standard value. It will reduce the low damage humidification problems like human skins, electronics, and so on.

4. Conclusion
The system helps increase the amount of humidity inside predetermined significant stress. Computers, document suppliers, microelectronics companies, patient hospital beds, cold storage areas, museums and art galleries, exhibition galleries, and where a specific level of humidity are to be preserved must be considered. During the winter and then when the humidity is smaller than the sufficient amount, the system is often useful. A country like Bangladesh recorded a higher value of relative humidity rather than standard. Our study is appropriate in the winter season or areas where humidity is lower than that of standard. Using sprinklers rather than atomizers and incorporating features for continuous operation, using specific temperature and humidity sensors can be improved.

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References
[1] Imam S A, Choudhary A and Sachan V K 2016 Design issues for wireless sensor networks and smart humidity sensors for precision agriculture: A review International Conference on Soft Computing Techniques and Implementations, ICSCTI 2015 (Institute of Electrical and Electronics Engineers Inc.) pp 181–7
[2] Khan N, Khattak K S, Ullah S and Khan Z 2019 A low-cost IoT based system for environmental monitoring Proceedings - 2019 International Conference on Frontiers of Information Technology, FIT 2019 (Institute of Electrical and Electronics Engineers Inc.) pp 173–8
[3] Vinothkannan M, Kim A R, Gnana Kumar G and Yoo D J 2018 Sulfonated graphene oxide/Nafion composite membranes for high temperature and low humidity proton exchange membrane fuel cells RSC Adv. 8 7494–508
[4] Rahmah N and Wonorahardjo S 2020 Critical Review of Advanced Material for Transit-Oriented Development in a Hot-Humid Climate IOP Conference Series: Earth and Environmental Science vol 532 (IOP Publishing Ltd) p 012015
[5] Castano L M and Flatau A B 2014 Smart fabric sensors and e-textile technologies: A review Smart Mater. Struct. 23 053001
[6] Zougmore T W, Malo S, Kagembega F and Togueyini A 2018 Low cost IoT solutions for agricultures fish farmers in Africa: A case study from Burkina Faso ICSCC 2018 - 1st International Conference on Smart Cities and Communities (Institute of Electrical and Electronics Engineers Inc.)
[7] Bucci G, Faccio M and Landi C 2000 New ADC with piecewise linear characteristic: case study - implementation of a smart humidity sensor IEEE Trans. Instrum. Meas. 49 1154–66
[8] Sheth M and Rupani P 2019 Smart Gardening Automation using IoT with BLYNK App Proceedings of the International Conference on Trends in Electronics and Informatics, ICOEI 2019 vol 2019-April (Institute of Electrical and Electronics Engineers Inc.) pp 266–70

[9] Boutsika L G, Enotiadis A, Nicotera I, Simari C, Charalambopoulou G, Giannelis E P and Steriotis T 2016 Nafion® nanocomposite membranes with enhanced properties at high temperature and low humidity environments Int. J. Hydrogen Energy 41 22406–14

[10] Gozuoglu A, Ozgonenel O and Karagol S 2019 Fuzzy Logic Based Low Cost Smart Home Application ELECO 2019 - 11th International Conference on Electrical and Electronics Engineering (Institute of Electrical and Electronics Engineers Inc.) pp 64–8

[11] Molina-Lopez F, Briand D and De Rooij N F 2012 All additive inkjet printed humidity sensors on plastic substrate Sensors Actuators, B Chem. 166–167 212–22

[12] Anon The Effects of Low Humidity and How to Deal With it | ThermoPro

[13] Feng Y, Cabezas A L, Chen Q, Zheng L R and Zhang Z Bin 2012 Flexible UHF resistive humidity sensors based on carbon nanotubes IEEE Sens. J. 12 2844–50

[14] Iacovidou E, Purnell P and Lim M K 2018 The use of smart technologies in enabling construction components reuse: A viable method or a problem creating solution? J. Environ. Manage. 216 214–23

[15] Khan F A, Ibrahim A A and Zeki A M 2020 Environmental monitoring and disease detection of plants in smart greenhouse using internet of things J. Phys. Commun. 4 55008

[16] Halder S and Sivakumar G 2018 Embedded based remote monitoring station for live streaming of temperature and humidity International Conference on Electrical, Electronics, Communication Computer Technologies and Optimization Techniques, ICEECCOT 2017 vol 2018-Janua (Institute of Electrical and Electronics Engineers Inc.) pp 284–7

[17] Chekired F, Houtti S, Bouroussis C A, Rahmani A, Tilmatine A and Canale L 2020 Low Cost Automation System for Smart Houses based on PIC Microcontrollers Proceedings - 2020 IEEE International Conference on Environment and Electrical Engineering and 2020 IEEE Industrial and Commercial Power Systems Europe, EEEIC / I and CPS Europe 2020 (Institute of Electrical and Electronics Engineers Inc.)

[18] Ticci S, Less B, Walker I and Sherman M 2015 Development of a Seasonal Smart Ventilation Controller to Reduce Indoor Humidity in Hot-Humid Climate Homes Effective ventilation in high performance buildings pp 851–61

[19] Bencheikh M A and Boukhenous S 2019 A low Cost Smart Insole for Diabetic Foot Prevention Proceedings of the 2018 International Conference on Applied Smart Systems, ICASS 2018 (Institute of Electrical and Electronics Engineers Inc.)

[20] Tang R, Wang S and Shan K 2018 Optimal and near-optimal indoor temperature and humidity controls for direct load control and proactive building demand response towards smart grids Autom. Constr. 96 250–61

[21] Zhang Y, Wu Z, Zhang M, Mai J, Jin L and Wang F 2018 Smart indoor humidity and condensation control in the spring in hot-humid areas Build. Environ. 135 42–52

[22] Mekonnen Y, Namuduri S, Burton L, Sarwat A and Bhansali S 2020 Review—Machine Learning Techniques in Wireless Sensor Network Based Precision Agriculture J. Electrochem. Soc. 167 037522

[23] Sharmin S, Glass K, Viennet E and Harley D 2015 Interaction of Mean Temperature and Daily Fluctuation Influences Dengue Incidence in Dhaka, Bangladesh ed M Kasper PLoS Negl. Trop. Dis. 9 e0003901