BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 318 (2023)

Control System Laboratory

Final Project Report

Section: A1 Group: 06

Fan Speed Control Using temperature and Humidity Sensor

Course Instructors:

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Signature of Instructor: ____

Academic Honesty Statement:

IMPORTANT! Please carefully read and sign the Academic Honesty Statement, below. Type the student ID and name, and put your signature. *You will not receive credit for this project experiment unless this statement is signed in the presence of your lab instructor.*

"In signing this statement, We hereby certify that the work on this project is our own and that we have not copied the work of any other students (past or present), and cited all relevant sources while completing this project. We understand that if we fail to honor this agreement, We will each receive a score of ZERO for this project and be subject to failure of this course."

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1 Abstract

This project presents designing and implementing an Automatic room temperature control system using the Arduino and DHT22 sensor. The fan speed control system has also been proposed. Here, the user sets the minimum and the maximum reference temperature range from the keypad. The DHT22 sensor senses the surrounding room temperature and gives the result in degrees Celsius. Both the reference and the measured values are displayed on the Liquid Crystal Display (LCD). The Arduino microcontroller, being the processing unit of the system, gets the sensor's measured value and compares it with the set threshold. The results are: when the measured room temperature is less than the minimum of the threshold value; then, the microcontroller turns on the heater. If the measured room temperature is greater than the maximum threshold value, then the fan triggered on. The speed of the fan will be controlled by the pulse width modulation (PWM) technique based upon the temperature difference between the sensor reading and the maximum threshold. The larger the temperature difference, the larger the fan's duty cycles, and the faster its speed. Finally, if the room's measured temperature is between the setpoint range, all the loads are turned off. That means the room temperature is maintained normal.

2 Introduction

With the gradual advancement of technology, automation has become part of human life. In this regard, modern technologies have brought several innovations that automatically implement particular task. Among these discoveries, microcontroller plays a vital role in the smart system of the electronic world. A microcontroller is a control system on a single chip that makes possible for the automation of the designed system and control process and produces precise results [1,2]. Among all places occupied by a human being, a home is the most important and needs to be maintained in the proper temperature. Nowadays, keeping living and working places at a conducive temperature is not only crucial to be healthy and productive, but also maintaining the room at average temperature helps to prevent spoiling of foods, medicine, and other goods in the room. Commonly, people use the manually controlled system, air-condition (AC), to regulate the temperature in their living environment. However, this manually operated system has notable limitations. The drawback is that if the user forgets to switch on or adjust the AC when the temperature becomes abnormal, children, disabled persons, and perishable items could be affected. The other problem with the mechanical AC system is, sometimes even if the air condition (AC) is still working, it is difficult to maintain the room temperature. Furthermore, if not appropriately managed, it may result in unnecessary expense and power usage. In general, its operations always require the user to turn it on and off regardless of the room temperature condition. Therefore, to address these drawbacks, the Automatic Room Temperature Control System is proposed. An automatic room temperature control system is a self-automated temperature control system [3] that can control the speed of the fan depending on the current room temperature. It comprised of a control unit (MCU), temperature sensor (DHT22), heater, fan, and keypad (3x4) to monitor the room temperature. According to the value of the ambient temperature, the microcontroller compares sensor temperature reading with a set value. Then the microcontroller makes a decision in accordance. This system's main advantages are easy to use, less energy usage, economical, more convenient to control temperature, and user-friendly.

3 Design

3.1 Problem Formulation

Problem Formulation: Automatic Fan Speed Control by Temperature Sensor

1. **Problem Statement:** Design and implement a system for automatic fan speed control based on input from a temperature sensor. The goal is to maintain a comfortable and energy-efficient environment by adjusting the fan speed according to the detected temperature.
2. **Background:** Modern buildings and electronic equipment often incorporate temperature sensors and fans to regulate temperature and prevent overheating. This project aims to create an intelligent system that optimizes fan speed based on real-time temperature data.
3. **Objectives:**
   - Develop a system that continuously monitors the temperature using a temperature sensor.
   - Control the speed of a fan (or multiple fans) based on the temperature readings.
   - Ensure that the fan speed adjustments are smooth and responsive to temperature changes.
   - Achieve energy efficiency by minimizing fan speed when cooling is not required.
   - Ensure user-friendliness through easy setup and monitoring options.
4. **Components and Requirements:**
   - Temperature sensor (e.g., thermistor, DS18B20, LM35) for measuring ambient temperature.
   - Fan(s) with variable speed control.
   - Microcontroller or single-board computer (e.g., Arduino, Raspberry Pi) to process sensor data and control fan speed.
   - User interface (e.g., LCD display, web-based interface) for monitoring and manual control (if needed).
   - Real-time clock (optional) for scheduling fan speed adjustments.
   - Wiring and connections for sensor and fan integration.
5. **Functionality:**
   - Read temperature data from the sensor at regular intervals.
   - Calculate the desired fan speed based on predefined temperature thresholds.
   - Adjust the fan speed gradually to prevent sudden changes and maintain comfort.
   - Implement a hysteresis mechanism to prevent frequent fan speed changes near the threshold.
   - Provide a manual override option for users to adjust the fan speed if necessary.
   - Log temperature and fan speed data for analysis and energy usage monitoring.
6. **Safety Considerations:**
   - Ensure that the system does not compromise safety or cause discomfort due to excessive temperature fluctuations.
   - Implement fail-safes to prevent overheating or overcooling in extreme conditions.

7. **Testing and Evaluation:**
    - Conduct extensive testing to validate the system's accuracy and responsiveness.
    - Evaluate energy savings and environmental impact compared to constant-speed fan operation.
    - Gather user feedback to assess the system's ease of use and effectiveness.
8. **Documentation and Maintenance:**
    - Document the system's design, components, and code for future reference.
    - Establish a maintenance plan to address hardware or software issues and updates.
9. **Budget and Resources:**
    - Estimate the budget required for components and development.
    - Identify the necessary human resources and expertise for design and implementation.
10. **Timeline:**
    - Define a project timeline with milestones to track progress and completion.

By formulating the problem in this manner, you can guide the development of an automatic fan speed control system that efficiently responds to temperature changes, ensuring comfort and energy savings

3.1.1 Identification of Scope

- **Temperature Range:**
    - Define the specific temperature range within which the system will operate. For instance, the system might activate the fan when the temperature exceeds a certain threshold and deactivate it when the temperature falls below another threshold.
- **Number of Fans:**
    - Specify whether the system will control a single fan or multiple fans. If multiple fans are involved, determine if they will operate in tandem or independently.
- **Fan Types:**
    - Specify the types of fans that the system will support, such as axial fans, centrifugal fans, or other fan designs. Ensure that the system's hardware and software can accommodate the selected fan type(s).
- **Control Algorithm:**
    - Decide on the control algorithm to be used for adjusting the fan speed. Common approaches include proportional-integral-derivative (PID) control, linear control, or custom algorithms tailored to specific needs.
- **User Interface (if applicable):**

- Determine the extent of user interface and control options. Decide if the system should have a physical interface (e.g., buttons, knobs) or a digital interface (e.g., web-based, mobile app) for monitoring and manual control.

- **Feedback Mechanism:**
  - Specify whether the system will provide feedback to users about temperature readings, fan speed, and system status. Decide on the format and frequency of feedback (e.g., real-time display, notifications).

- **Safety Features:**
  - Identify essential safety features, such as temperature limits, error handling, and emergency shutdown procedures, to pro

3.1.2 Literature Review

3.1.3 Formulation of Problem

3.1.4 Analysis

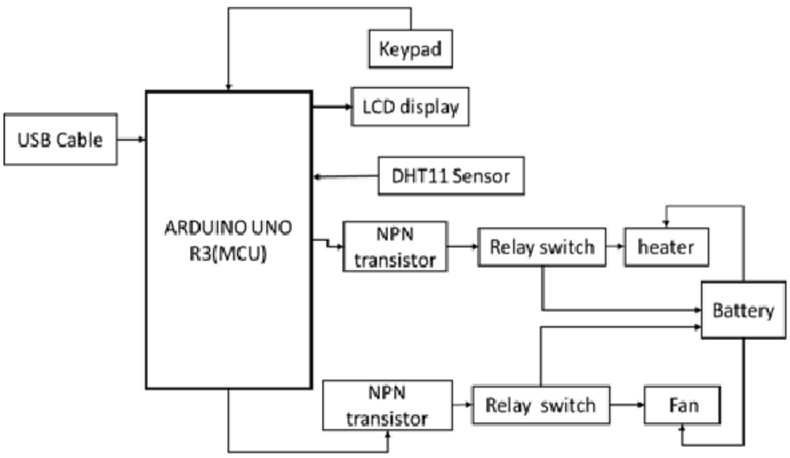
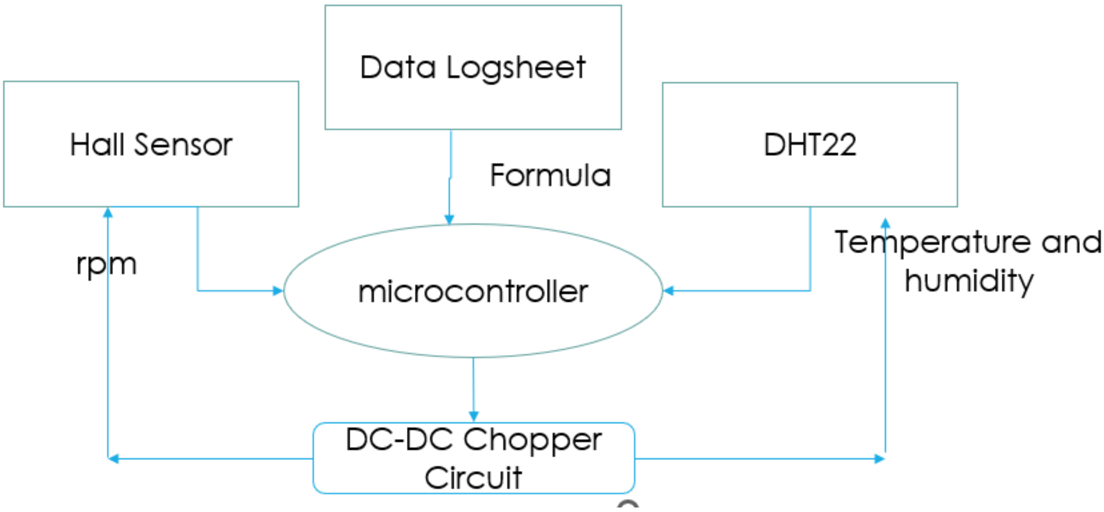


Fig.1 Block diagram of the proposed system

3.2 Design Method

Component List: Mosfet, LCD Display, Breadboard, Resistors, DC fan, Magnet Square, Temperature and Humidity Sensor, 9V Battery, Hall effect Sensor.

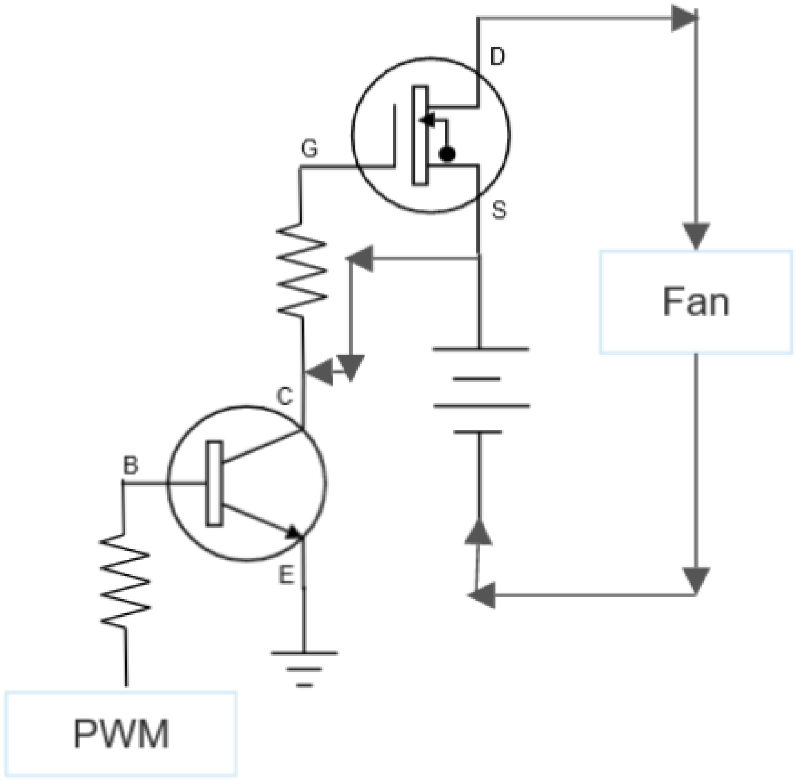


Here, We tried to take the logsheet come from any specific industry. Then from the industry based datasheet helps us to make a formula which can actually predict the future or any upcoming desires of the industry. By this mean, we got the formula which main parameter is basically the temperature and humidity.

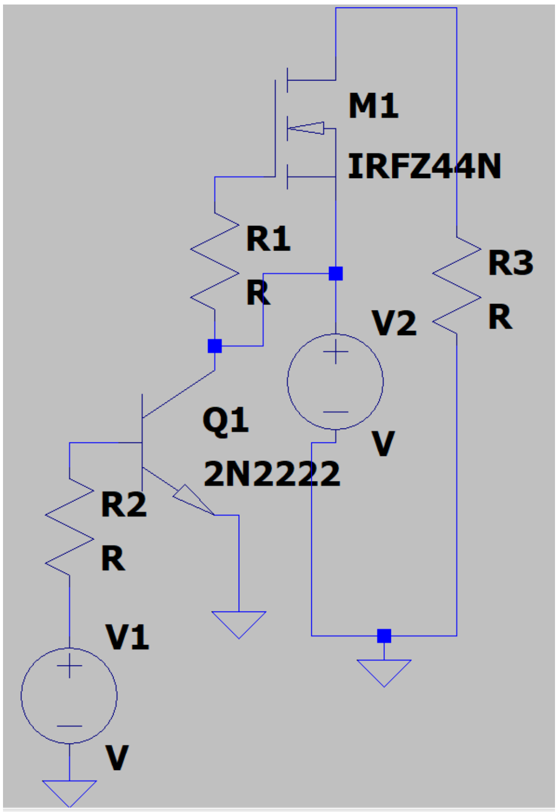
Then, our temperature sensor DHT22 and the humidity sensor takes the current value of temperature and humidity at that condition. If once we can get the current value of the weather parameters like temperature and humidity as well as the desired value of them by which we can make a feedback to reach the desired value as fast as possible and as accurate as possible.

3.3Circuit Diagram

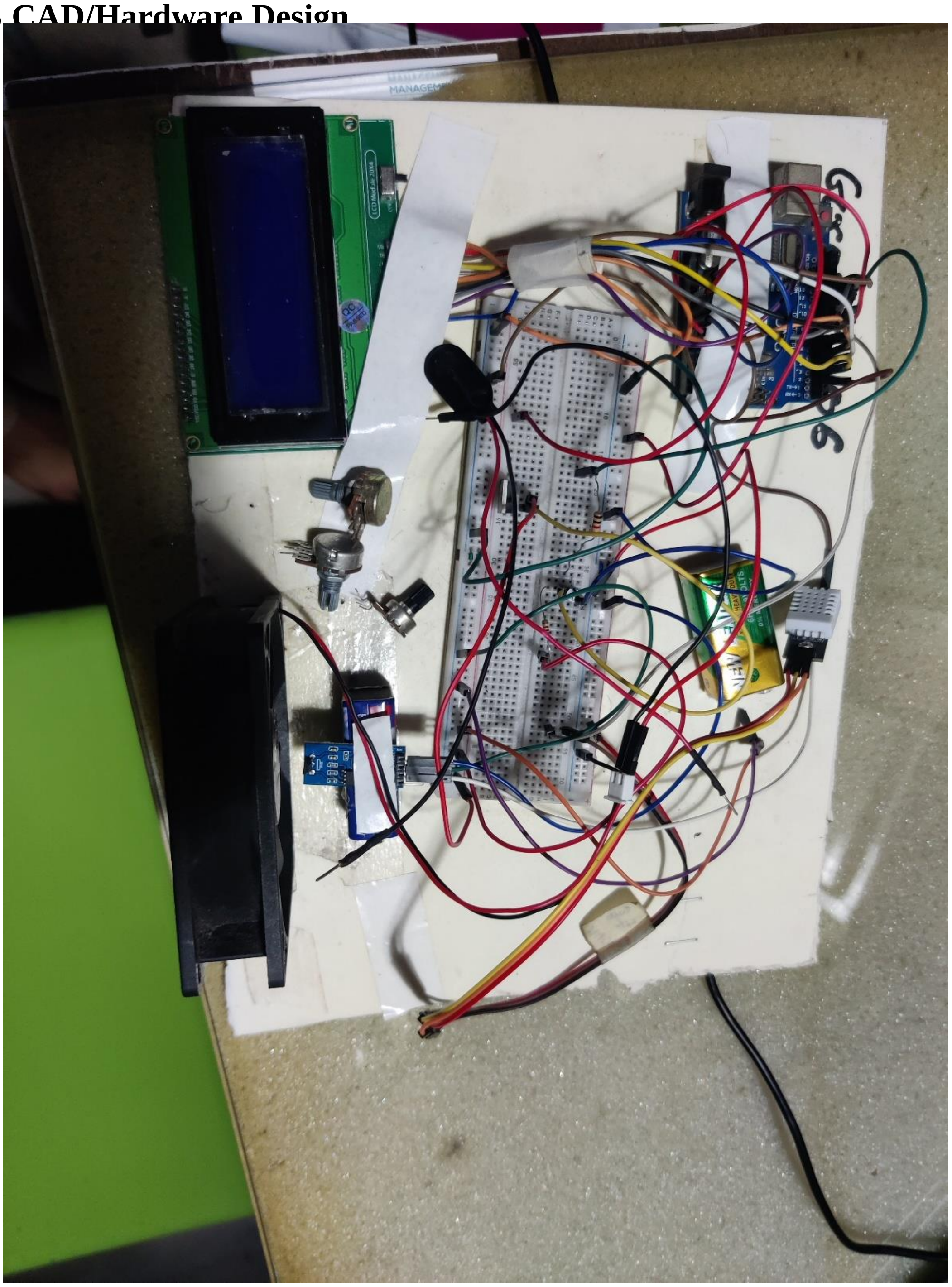
Here the circuit is drawn by the smartdraw and the circuit consists of the mosfet, BJT, resistors, sensors, DC source, fan etc. Here the most important semiconductor device is MOSFET which is basically a switching device. To drive this device, proper gate voltage has to be applied. So, a BJT works here as a MOSFET gate driver. We used IRFZ44N and BC589 as Mosfet and BJT respectively.

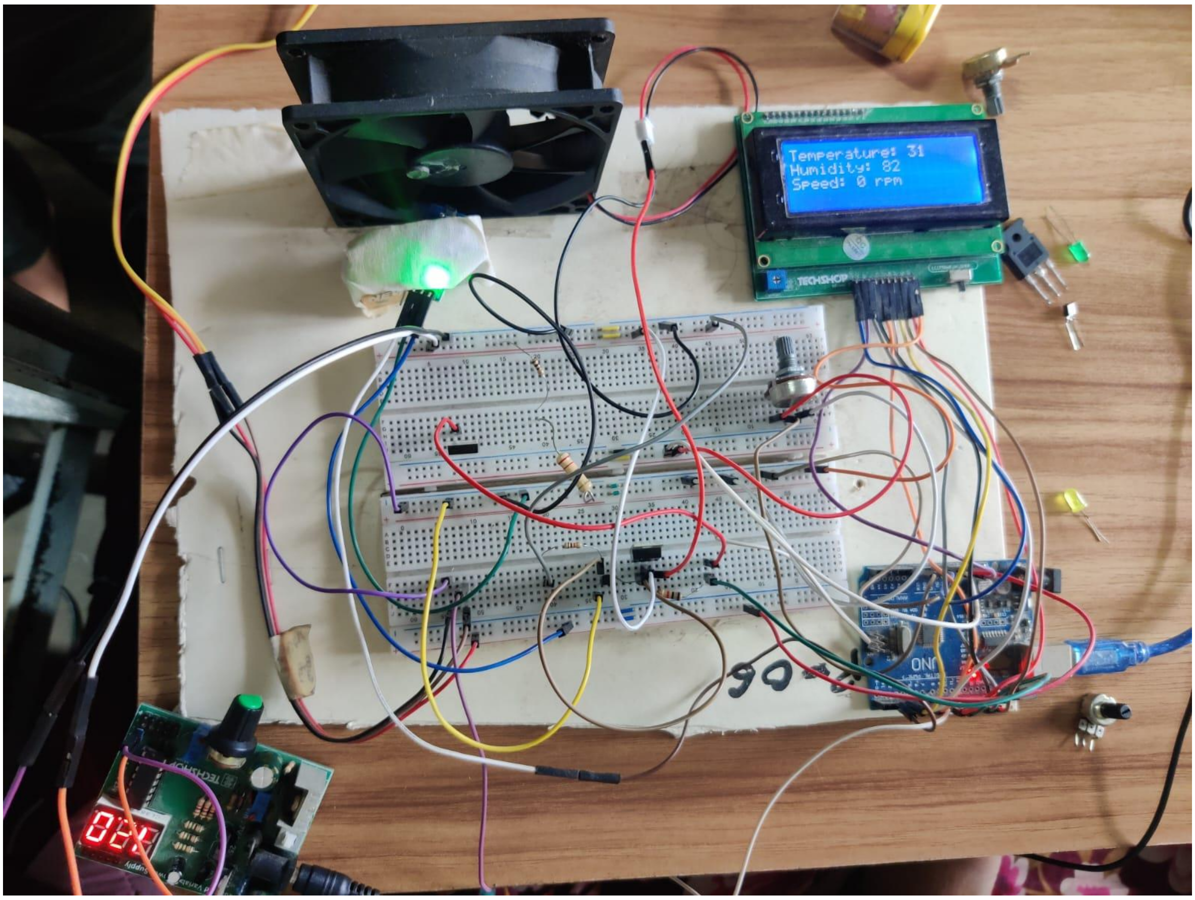


3.4 Simulation Model



3.5 CAD/Hardware Design





3.6Full Source Code of Firmware

Use small font size, Consolas Size 7, double column	

```
Test
#include <DHT.h>
 #include <Wire.h>
 #include "GyverPID.h"
#include <LiquidCrystal.h>
#include<TimerOne.h>
const int rs = 12, en = 11, d4 = 5, d5 = 4, d6 = 3, d7
= 13;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7); //Constants
#define DHTPIN 7
 #define DHTTYPE DHT22
#define PWM_MAX 1023
#define PWM_MIN 0
const int pwmPin = 9; // Choose the PWM pin DHT
dht(DHTPIN,DHTTYPE); //Variables
int h; int t; const int hallPin = 2; // Hall effect
sensor output pin unsigned long startTime;
unsigned long endTime;
volatile unsigned long pulseCount = 0;
unsigned int fanSpeed = 0;
int ref_Speed=1000;
#include<TimerOne.h>
 int duty=700;
void setup() {
 Serial.begin(9600);
pinMode(hallPin, INPUT);
pinMode(pwmPin, OUTPUT);
attachInterrupt(digitalPinToInterrupt(hallPin),
countPulse, FALLING);
lcd.begin(16,4);
Timer1.initialize(20000);
Timer1.pwm(pwmPin,duty,20000);
Serial.println("Temperature and Humidity Sensor Test");
pinMode(A0,INPUT);
 dht.begin();
}
void loop() {
startTime = millis();
 while ((millis() - startTime) <1000) {
 } endTime = millis();
fanSpeed = (pulseCount * 60)/((endTime-
startTime)/1000);// Calculate RPM
pulseCount=0;
h=dht.readHumidity();
t=dht.readTemperature();
ref_Speed=(100*(t-15)+300)*(h/100.0);
set_Speed(); Serial.print("Humidity: ");
Serial.print(h);
 Serial.print(" %, Temp: ");
Serial.print(t); Serial.print(" ° Celsius");
Serial.print(" Ref Speed: ");
Serial.print(ref_Speed);
Serial.print(" Fan Speed: "); Serial.print(fanSpeed);
Serial.print(" RPM "); Serial.println(duty);
lcd.display(); lcd.setCursor(0,0);
lcd.print("Temperature: "); lcd.print(t);
lcd.setCursor(0,1); lcd.print("Humidity: ");
lcd.print(h); lcd.setCursor(4,2); lcd.print(" ");
lcd.setCursor(4,2); lcd.print("Speed: ");
lcd.print(fanSpeed); lcd.print(" rpm ");
lcd.setCursor(4,3); lcd.print("Ref Speed: ");
lcd.print(ref_Speed); lcd.print(" rpm "); } void
countPulse() { pulseCount++; } void set_pwm(void)
{ if(duty>PWM_MAX) duty=PWM_MAX-10; else
if(duty<PWM_MIN) duty=PWM_MIN+10;
Timer1.pwm(pwmPin,duty,20000); } void set_Speed(void)
{ if(abs(fanSpeed-ref_Speed)<=40){ duty=duty; } else
if(fanSpeed<ref_Speed) { duty = duty-10; } else
if(fanSpeed>ref_Speed) { duty = duty+10; }
Serial.print(duty); set_pwm(); }
```

Table: Source Code for the main program

4 Implementation

4.1Description

This section comprises with the step of the algorithm and the hardware setup. The hardware is designed on the breadboard and the project is placed on a pvc board. The rest of the part of this project is coding. The coding is related to the Arduino coding. As a microcontroller we used an Arduino uno.

4.2 Experiment and Data Collection

At temperature 30 degree and humidity 66% fan speed = 70%

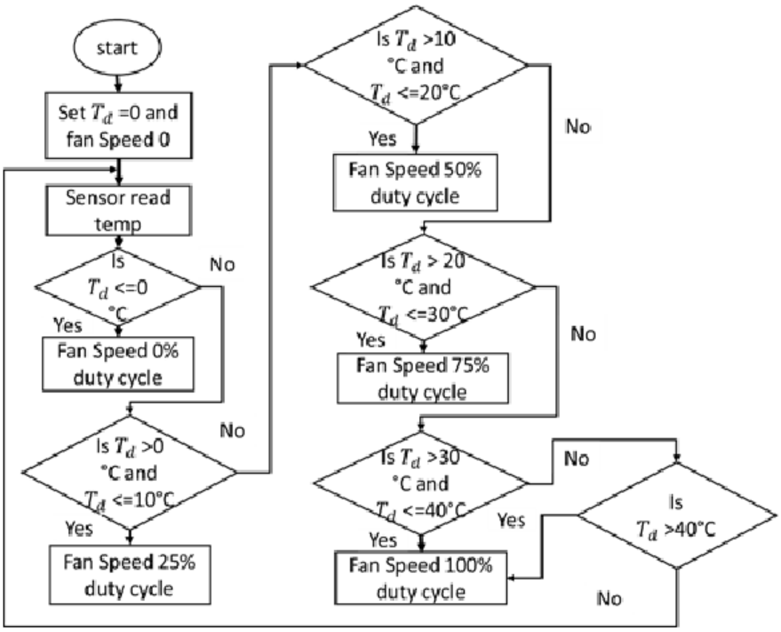
At temperature 40 degree and humidity 99% fan speed = 98%

4.3 Data Analysis

In our code, we tried to manipulate the data such that whenever temperature gets increased fan speeds up and same case for humidity.

4.4 Results

5 Design Analysis and Evaluation



Here is our algorithm designed.

5.1 Novelty

Our project can automatically change the speed of fan with the change of temperature. It can be a great feature in the residence of an elderly person and in nursing homes. Also, this feature can be added in the smart home automation system.

5.2 Design Considerations

5.2.1 Considerations to public health and safety

As electrical components are used and we are working with humidity, we have to make sure all the parts and wire are properly insulated.

5.2.2 Considerations to environment

Our project will increase energy efficiency and reduce carbon footprint. So, this project will help to build greener energy.

5.2.3 Considerations to cultural and societal needs

5.3 Investigations

5.3.1 Literature Review

5.3.2 Experiment Design

5.3.3 Data Analysis and Interpretation

In this paper, an automatic room temperature control system using Arduino and DHT11 sensor has been designed and constructed. The system used an Arduino microcontroller, keypad and DHT11 sensor to control and monitor both the heater and the fan simultaneously. The DC fan is on when the room temperature is higher than the reference temperature, and its speed is controlled based upon the room temperature. When the room temperature is lower than the minimum of the reference temperature, then the heater lamp is turned on while the DC fan triggered off. When the roomtemperature is within the reference range, al the loads are automatically off. The main advantages of this system are for its low cost, ease of installation, simplicity, low power consumption, small size, and user-friendly. This project efficiently optimizes energy consumption in a room while keeping the room at a comfortable temper

5.4 Limitations of Tools

6 **Sensor Accuracy:** Temperature and humidity sensors may have limitations in terms of accuracy. Cheaper or lower-quality sensors may provide less precise data, which can affect the overall performance of the fan controller.

7

8 **Limited Range:** Sensors may have a limited sensing range, meaning they may not be suitable for extreme temperature or humidity conditions. Extreme conditions could lead to inaccurate readings or sensor failure.

9

10 **Response Time:** The response time of the fan controller may not be instantaneous due to delays in reading and processing sensor data. Achieving a balance between responsiveness and accuracy can be challenging.

5.5 Impact Assessment

5.5.1 Assessment of Societal and Cultural Issues:

- **Improved Comfort and Well-being:** The automated fan speed control system enhances indoor comfort by maintaining optimal temperature and humidity levels. This improves the well-being of individuals, particularly in regions with extreme climates, contributing to better health and productivity.

- **Energy Savings:** Reduced energy consumption due to more efficient fan operation can lead to lower electricity bills for users, promoting financial stability and reducing energy-related stress.

- **Accessibility:** The system's automated nature ensures that people with mobility issues or disabilities can easily control their environment, promoting inclusivity and independence.

5.5.2 Assessment of Health and Safety Issues

- **Improved Indoor Air Quality:** By optimizing air circulation and maintaining suitable temperature and humidity levels, the system can contribute to better indoor air quality. This can reduce the risk of respiratory issues, allergies, and other health problems caused by poor air quality.

- **Reduced Heat-Related Illnesses:** In hot climates, the automated cooling provided by the system can help reduce the risk of heat-related illnesses such as heat exhaustion and heatstroke, which can have severe health consequences.

- **Comfort and Sleep Quality:** The system's ability to create a comfortable indoor environment can improve sleep quality, contributing to overall physical and mental well-being.

- **Energy Savings:** Lower energy consumption can lead to reduced air pollution and greenhouse gas emissions, indirectly benefiting public health by mitigating the impact of climate change on health.

5.5.3 Assessment of Legal Issues

- **Data Privacy and Security:** The system does not have a camera. So, the privacy of individuals is protected.

- **Compliance with Regulatory Standards:** The system has met or exceed all applicable traffic safety and accessibility standards set forth by local and national authorities.

5.6 Sustainability and Environmental Impact Evaluation

This system can change the fan speed with the variation of temperature. So, when the temperature reduces, the speed of fan also gets reduced. Thus it helps to reduce the energy emission and carbon footprint.

5.7Ethical Issues

Our Project does not harm any cultural or regional ethical values.

6 Impact Assessment

6.1 Assessment of Societal and Cultural Issues

Cultural factors can influence the adoption, design, and usage of automatic fan speed control systems based on temperature sensors in various ways. Here are some cultural impacts to consider:

1. **Climate and Weather Preferences:**
    - Cultural norms and preferences regarding temperature comfort can significantly impact the design and use of these systems. In regions with hot climates, there may be a greater demand for efficient cooling systems, leading to more advanced and widespread adoption of such technology.
2. **Energy Efficiency Awareness:**
    - Cultures that prioritize sustainability and energy conservation are more likely to embrace and appreciate automatic fan speed control systems. These cultures may have a higher willingness to invest in and adopt energy-efficient technologies.
3. **Traditional Cooling Practices:**
    - In some cultures, traditional cooling practices like natural ventilation, architectural design, or the use of specific materials may be deeply rooted. Automatic fan speed control systems could face resistance or slow adoption in such contexts due to cultural attachment to traditional me

6.2 Assessment of Health and Safety Issues

Occupant Feedback and Control: Provide occupants with feedback on temperature changes and fan speed adjustments. Also, consider offering manual control options, allowing users to override the system settings when necessary to meet their comfort needs.

7 Safety in Case of System Failures:

7.1 Plan for system failures and ensure that they do not compromise safety. For instance, if the temperature sensor or controller malfunctions, there should be fail-safe mechanisms in place to prevent extreme temperature conditions.

8 **Noise Control:**

8.1 Fan speed control systems can produce noise, especially at higher speeds. Ensure that noise levels are within acceptable limits to avoid disturbing occupants, especially in residential settings.

9 **Energy Efficiency and Cost-Effectiveness:**

9.1 Balance energy efficiency with safety and comfort. Extremely aggressive energy-saving strategies can lead to discomfort or health issues, so it's essential to strike a balance.

10 **Accessibility and Inclusivity:**

10.1 Ensure that the system is accessible to all occupants, including those with disabilities. Consider inclusive design principles to accommodate a diverse range of users.

11 **Data Privacy and Security:**

11.1 Protect the privacy of occupants by ensuring that any data collected by the system, such as temperature readings, is secure and used only for its intended purpose. Comply with data protection regulations and inform users about data handling practices.

12 **User Education and Training:**

12.1 Provide clear instructions and training to users on how to operate and interact with the system safely. Ensure that they understand how to adjust settings and recognize any warning signs of potential issues.

13 **Regulatory Compliance:**

13.1 Ensure that the system complies with relevant safety and building codes, standards, and regulations specific to the region or jurisdiction in which it is installed.

14 **Emergency Procedures:**

14.1 Develop emergency procedures in case of system failures or extreme weather events. This may include clear instructions for evacuating the building or seeking alternative sources of heating or cooling.

15 **Maintenance and Servicing:**

15.1 Establish a regular maintenance schedule to ensure the system functions safely and efficiently. Qualified professionals should perform maintenance and repairs.

By addressing these social safety considerations, you can create an automatic fan speed control system that not only provides energy efficiency and comfort but also prioritizes the health and safety of occupants in residential, commercial, or industrial settings.

15.2 Assessment of Legal Issues

15.3 Sustainability and Environmental Impact Evaluation

15.4 Ethical Issues

Write in details, how you applied ethical principles to solve this project. Write any issues where you faced ethical challenges and how you mitigated them.

16 Reflection on Individual and Team work

16.1 Individual Contribution of Each Member

Student ID No.	***Contribution in Project***
1906018	**Helped in modelling and algorithm**
1906024	**Constructed the circuit**
1906025	**Implemented the code and testing**
1906027	**Implemented the code and embedded it**
1906028	**Implemented the code and testing**

16.2 Mode of Team Work

We did our project during 3rd week to 11th week and all of our team members contributed respectively to their work . We started the task by modeling and making our work procedure .Then we constructed the circuit but due to some of our hardware obstacles including sensor problem and fan not working we had to change our components. Then we developed our code and algorithm on which out output depends. After that we embedded it and tested our output.

16.3 Diversity Statement of Team

Student ID no.	Statement
1906018	**Committed in doing homework**
1906024	**Leader in hardware implementation**
1906025	**Problem solver and decision maker**
1906027	**Leader in software and embedding tasks**
1906028	**Committed hard worker with good leadership capabilities**

16.4 Log Book of Project Implementation

Date	Milestone achieved	Individual Role	Team Role	Comments
20-7-23	Modelling	1906018 modelled and found resources for the project	Helped in developing the model	Everyone contributed in groupwork
3-8-23	Hardware Implementation	1906025 and 1906028 made the hardware setup and built the circuit	Helped in debugging the circuit	Everyone contributed in groupwork
18-8-23	Software implementation	1906027 created the software code in Arduino and set the algorithm.	Helped in debugging the code and improving it	Everyone contributed in groupwork
25-8-23	Software implementation And embedding	1906024 embedded the hardware and software part	Tried the make the best possible output from the project	Everyone contributed in groupwork

9-9-23	Testing	1906028 tested the circuit	All of us helped in testing and making the output more practical	Everyone contributed in groupwork

17 Communication

17.1 Executive Summary

[Dhaka, 9 August,2023] – Our team proudly introduces a cutting-edge project that promises to transform the way we experience comfort and energy efficiency. Leveraging smart technology, we've developed a fan speed control system that responds dynamically to temperature and humidity levels in real-time.

Traditional fans run at fixed speeds, often leading to discomfort and energy wastage. Our project harnesses the power of sensors to adjust fan speed, keeping you cool when it's hot and conserving energy when conditions are favorable. This innovation represents a significant step toward sustainability and personal comfort, making eco-friendly living accessible to all.

Join us in embracing a more efficient, sustainable, and comfortable future. Stay tuned for updates on our project's development and availability. Together, we're redefining the way we stay cool while being kind to the planet.

For media inquiries, please contact:
Progna Dipto Saha
Email:1906027@eee.buet.ac.bd
Your Phone Number: 01304372354

17.2 User Manual

Step 1 : Initializing the fans speed with equation that depends on temperature and humidity

Step 2: Turn of the switch button to turn the fan on and you can get the speed at which you want to run the fan

18 Project Management and Cost Analysis

18.1 Bill of Materials

Component List	Quantity	Unit Price	Price
12V DC Fan	1	100	100
9V Battery	2	50	100
Arduino Uno R3	1	625	625
Mosfet(IRF540N)	1	18	18
Potentiometer(10K)	1	20	20
Resistors(100,220,1k)	4	25	25
Magnet Square	1	100	100
Hall Effet Sensor	1	150	150
LCD Display	1	530	530
Breadboard	2	120	240
DHT22	1	50	50
		Total	1918

19 Future Work

Embedding the Algorithm with human body's comfort:

Human body is kept cool in a certain way. So according to a persons comfort several data can be taken to train a machine learning model and it can be applied to get the desired speed.

Advanced Control System:

We controlled the project in very simple linear algorithm. If anyone can create an algorithm that is suitable for any industry or home automation it can be very helpful for controlling the output speed.

20 References

✓ **https://www.researchgate.net/publication/332574596_Temperature_Based_Speed_Control_of_Fan_Using_Arduino**

- ✓ **https://www.researchgate.net/publication/348127837_Design_of_Multisensor_Automatic_Fan_Control_System_Using_Sugeno_Fuzzy_Method**