THERMOFLOW: INTELLIGENT TEMPERATURE-RESPONSIVE FAN CONTROL SYSTEM

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project **"THERMOFLOW: INTELLIGENT TEMPERATURE RESPONSIVE FAN CONTROL SYSTEM"** is the bonafide work of **"JERIN BS"** and **"JERPHY MIRACLIN BACKIA D"** who carried out the project work under my supervision.

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

ABSTRACT

Effective thermal management is essential in the age of smart technologies to guarantee lifetime and peak performance in a variety of applications. Understanding this necessity, we present an Internet of Things (IoT)-based expert system that has been carefully designed to transform temperature-responsive fan speed control. Through the seamless integration of state-of-the-art sensors, and microcontrollers, ThermoFlow creates a real-time dynamic fan speed modulation system that adapts to changing ambient temperatures. ThermoFlow's intelligence and flexibility are its greatest assets. It is outfitted with high-precision temperature sensors that are placed strategically in target locations. This allows it to continuously monitor the thermal landscape and collect data in real-time to help it make judgments. The core of ThermoFlow's functionality is its powerful microcontrollers, which receive these data streams and coordinate exact fan speed adjustments.

However, ThermoFlow surpasses being only a set of automatic responses; it serves as a symbol of effectiveness and environmental friendliness. ThermoFlow achieves optimal thermal performance and minimizes energy consumption by adjusting fan speed based on environmental conditions in a precise and controlled manner. The impact of this extends beyond only improving operating efficiency. It also plays a role in prolonging the lifespan of equipment, guaranteeing dependability and cost-effectiveness in the long term. ThermoFlow has established itself as a symbol of innovation. The usefulness and adaptability of this product are demonstrated in a wide range of applications, including data centres and industrial complexes. ThermoFlow is leading the way in IoT-enabled thermal management. Our technology is flexible and adaptive and has the potential to revolutionize intelligent thermal regulation.

ACKNOWLEDGEMENT

We express our sincere thanks to our beloved and honourable chairman **Mr. MEGANATHAN S** and the chairperson **Dr. THANGAM MEGANATHAN M** for their timely support and encouragement.

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JERIN B S (210701095)
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LIST OF ABBREVIATIONS

ABBREVIATION	DEFINITION
IOT	Internet of Things
IDE	Integrated Development Environment
LDR	Light Dependent Resistor

CHAPTER I

INTRODUCTION

1.1 DESCRIPTION

In an age where technology integration dominates every element of our daily lives, the hunt for effective thermal management solutions has emerged as an essential commitment. Our project aims to meet this urgent requirement by designing and executing a complete system that not only monitors the surrounding temperature but also adjusts the speed of the fan in response to changes in the environment. Central to our system's design is the inclusion of user-controlled ventilation choices, enabling users to modify airflow according to their requirements.

Fundamentally, our system consists of a constellation of carefully chosen parts, each of which is essential to the coordination of temperature control. The DHT11 sensor makes it easier to monitor temperature and humidity in real time, which provides the fundamental information needed to make decisions for our system. The visual interface, in the meantime, is the SSD1306 OLED display, which provides users with instant access to important system data and status updates.

The addition of the LDR (light dependent resistor) to these fundamental components gives our system the capacity to adjust lighting levels in accordance with external circumstances. By regulating light utilization, this function not only improves user comfort but also helps save energy.

Above all, our system is powered by the Arduino Uno R3 microcontroller, which is the real brains behind the scenes. The Arduino Uno R3 is the hub that connects all of the parts of our system together, allowing it to collect sensor data, carry out control algorithms, and receive and process user inputs.

Our technology represents an evolution in thermal management that is defined by flexibility, efficiency, and user-centric design by combining these elements into a unified framework. Our system will bring in a new era of customized comfort and environmental stewardship, offering performance never seen before, whether it is installed in residential, commercial, or industrial settings.

1.2 SCOPE OF WORK

The project sets off on an ambitious path that includes an extensive inquiry into user-centric ventilation management and temperature-responsive fan speed control. The DHT11 sensor for temperature and humidity monitoring in real time, the SSD1306 OLED display for user-friendly interfaces, the LDR for light intensity sensing, the potentiometer for manual control options, the DC motor for fan speed regulation, and the Arduino Uno R3 microcontroller acting as the central processing unit coordinating system operations are all crucial hardware components that are carefully integrated into our endeavour. In order to ensure smooth compatibility and interaction between these disparate pieces and build the groundwork for an effective and coherent system design, this integration process requires considerable thought.

This project dives into the world of user-controlled ventilation solutions, equipping individuals with the opportunity to modify airflow according to their personal demands and comfort preferences. Users may easily switch between automatic and manual control modes and precisely change fan speed thanks to the straightforward interfaces that make use of the SSD1306 OLED display and potentiometer. Further adding to our system's functionality is the integration of light intensity detecting capabilities via the LDR, which enables dynamic illumination level modification in response to ambient lighting circumstances.

These processes cover a broad range of performance metrics, including the efficacy of temperature regulation, the responsiveness of fan speed, the satisfaction of users with manual control options, and overall energy efficiency. We work to push the limits of ventilation control and thermal management laying the groundwork for a day when sustainability, efficiency, and comfort coexist peacefully in both industrial and smart home settings.

1.3 PROBLEM STATEMENT

The traditional fan speed control paradigms have not been able to keep up with the complex demands of modern settings in the field of thermal management. Current approaches, which usually depend on static fan speeds or manual changes, can lead to a series of inefficiencies and poor performance. There is a chance that equipment will overheat or not receive enough cooling since these systems are unable to dynamically adjust to the constantly changing ambient conditions. The fact that existing solutions are generally rigid and cannot adapt to the varied tastes and comfort needs of users exacerbates these problems.

Therefore, the necessity to address these urgent concerns gives rise to our proposal. The acknowledgement of the following important problems is essential to our effort: the widespread prevalence of inefficiencies and poor performance, the restricted flexibility and adaptability of current systems, the scarcity of user-centric control options, and the imminent threat of energy waste and environmental impact. Our initiative aims to bring in a new era of dynamic, user-centric thermal management solutions by redefining the fan speed control landscape.

The integration of cutting-edge sensor technology is the foundation of our suggested methodology. Our system seeks to deliver outstanding insight and control over ambient conditions by utilizing the power of state-of-the-art sensors, such the SSD1306 OLED display for smooth user interaction and the DHT11 sensor for real-time temperature and humidity monitoring. Additionally, our approach attempts to bring together the manual and automatic control paradigms by providing users with a range of control options that are customized to meet their own comfort levels and preferences.

Our initiative wants to be a shining example of environmental care and sustainability. Our solution seeks to decrease energy usage and lower the carbon footprint associated with conventional thermal management techniques by regulating fan speed in real-time depending on dynamic ambient circumstances. We want to showcase the revolutionary potential of our solution by means of practical implementation, opening the door for a more sustainable and user-focused method of heat control in the digital era.

1.4 AIM & OBJECTIVE

Our initiative is driven by the unwavering goal of redefining the thermal management environment by introducing dynamism, flexibility, and user-centricity. The main objective of our project is to create a complete system that surpasses the capabilities of traditional fan speed control systems. To achieve this goal, we outline the following goals:

Enhanced Thermal Management: Our main goal is to design a system that can effectively control fan speed in reaction to temperature changes that occur in real-time. Through the utilization of cutting-edge sensor technology, our goal is to guarantee the maintenance of ideal thermal conditions in a variety of situations, from residential areas to commercial complexes.

User-Centric Control Options: Our goal is to provide consumers with a range of alternatives that are specific to their comfort levels and individual preferences. Our technology seeks to provide users with unparalleled control over their thermal surroundings by including both physical control methods, such as potentiometers, and SSD1306 OLED display. This will hopefully increase users' feelings of empowerment and contentment.

Seamless Integration: The goal of our project is to combine user interfaces, and hardware parts into a unified system. In order to provide a smooth user experience from setup to operation, we strive to produce a system that is not only durable and dependable but also intuitive and user-friendly through careful hardware design and development.

Energy Efficiency and Sustainability: We want to create a system that minimizes energy consumption and lowers the carbon footprint associated with conventional thermal management techniques, understanding the importance of environmental sustainability. Our solution seeks to support energy reduction and environmental stewardship by adjusting fan speed in real-time depending on dynamic environmental circumstances.

Our ambitious initiative is dedicated to exploring the frontiers of thermal management. We aspire to create a new era of sustainability, efficiency, and user-centric design by utilizing cutting-edge technology and innovative techniques. Our mission is to shape the future by harmoniously aligning environmental responsibility with thermal comfort through uncompromising innovation. We are committed to surpassing the boundaries of what is possible and to lead the way towards a brighter, more sustainable future.

CHAPTER II

LITERATURE SURVEY

In [1] The literature surrounding automatic room temperature control systems utilizing Arduino and DHT11 sensors encompasses various aspects. Researchers focus on algorithm design for efficient temperature regulation, often integrating PWM techniques for fan speed control. User-friendly interfaces, typically featuring LCD displays, facilitate interaction and feedback. Studies compare sensor performance, control algorithms, and hardware configurations. Ongoing research explores adaptive control and wireless connectivity to enhance system flexibility and efficiency. Challenges include optimizing responsiveness, minimizing energy consumption, and ensuring reliability. Future work aims to refine control strategies, improve user experience, and integrate with broader home automation frameworks.

In [2] The study presents a novel power conversion circuit topology for single-phase DC to AC boost conversion employing sinusoidal pulse-width modulation (SPWM). Unlike conventional converters, this approach circumvents the need for a transformer, potentially offering enhanced efficiency and cost-effectiveness. The circuit integrates a DC to DC boost converter and a full bridge converter, ensuring low distortion AC output voltage regulation. Notably, the proposed technique minimizes switching losses, contributing to higher efficiency. Implementation of a low pass filter further reduces total harmonic distortion (THD). The research successfully designs a transformer-less converter with low THD, suitable for electronic applications. MATLAB/SIMULINK simulations validate the theoretical framework, demonstrating the feasibility and efficacy of the proposed approach.

In [3] The paper presents a sophisticated speed control mechanism for electric fans, leveraging the combined capabilities of ESP8266 and Arduino circuits. Through the integration of these technologies, users gain the ability to control fan speed remotely via their Android or iOS devices. Central to this innovation is the utilization of Wi-Fi connectivity, which facilitates seamless communication between the fan, ESP8266 board, and the user's smartphone. By transforming conventional fans into smart devices, this system introduces a new level of convenience and accessibility. Particularly, it addresses the needs of individuals with limited mobility, such as senior citizens and those with disabilities, by allowing them to adjust fan settings without physical effort. This enhanced accessibility contributes to a more comfortable living environment and promotes independent living. The proposed method offers a straightforward approach to smart fan control, making it accessible to a wide range of users. However, it also presents opportunities for further refinement and enhancement in future iterations. This could involve the integration of additional features, such as voice control or scheduling capabilities, to further enhance user experience and functionality. Overall, the paper highlights the potential of smart technology to improve everyday devices and enhance quality of life for users.

In [4] The paper addresses the escalating demand for electrical energy, particularly within the buildings sector, where significant energy waste occurs due to ineffective heating and cooling controls. Highlighting poor controls and lack of feedback information as primary contributors to this issue, the study introduces a novel management system designed to mitigate energy consumption. Central to this system is an Arduino microcontroller equipped with temperature sensors, RF modules, and actuators for air conditioning control. By monitoring room temperatures and wirelessly transmitting data to a main control unit, the system optimizes energy usage by activating only one air conditioner at a time in occupied rooms. Preliminary evaluations demonstrate the system's efficacy in reducing electricity costs across various test cases.

In [5] The paper outlines a comprehensive smart Home Energy Management System (HEMS) architecture designed to optimize energy consumption and generation simultaneously. Key components include ZigBee-based energy measurement modules for monitoring appliance and lighting consumption, along with a PLC-based renewable energy gateway to track renewable energy generation. A central home server collects and analyzes consumption and generation data, adjusting energy usage schedules to minimize costs. Additionally, a remote energy management server aggregates data from multiple home servers, facilitating statistical analysis. By integrating consumption and generation data, the proposed architecture aims to maximize energy efficiency and reduce home energy costs.

CHAPTER III

SYSTEM SPECIFICATIONS

3.1 HARDWARE SPECIFICATIONS

- Arduino UNO R3
- AC Motor
- 10KΩ Potentiometer
- LDR (Light Dependent Resistor)
- DHT11 Sensor (for temperature and humidity sensing)
- SSD1306 I2C OLED Display
- PWM AC Dimmer

3.2 SOFTWARE SPECIFICATIONS

- Arduino IDE V2.3 +

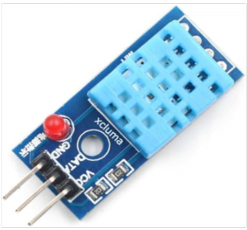
CHAPTER IV

SYSTEM COMPONENTS

4.1 SSD1306 I2C OLED Display:

This display module provides a visual interface for providing information such as temperature readings, fan speed, or system status to the user. It promotes user engagement and feedback, making the system more intuitive and user-friendly.

4.2 DHT11 Sensor:



The environment's temperature and humidity are measured via the DHT11 sensor. It offers temperature data in real time, which is essential for figuring out the ideal fan speed depending on the surrounding circumstances.

4.3 LDR (Light Dependent Resistor):

The ambient light levels in the surroundings are measured using the LDR. Its precise use in temperature-based fan speed control might not be immediately apparent, but it can be used to modify the behaviour of the system in response to light.

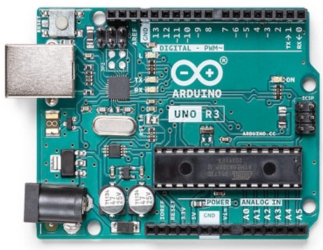
4.4 10KΩ Potentiometer (POT):

The potentiometer functions as an input control that allows the user to manually change parameters like temperature thresholds or fan speed. It provides a straightforward and user-friendly interface that allows customers to personalize the system to suit their need.

4.5 AC Motor:

The AC motor powers the fan to adjust airflow based on temperature conditions measured by sensors. This is a critical function of the AC motor in ventilation regulation.

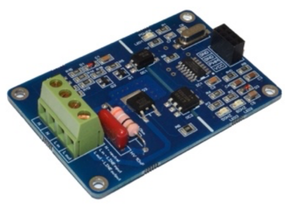
4.6 Arduino Uno R3:



The Arduino Uno R3 functions as the system's central processing unit. Using a potentiometer, it interprets human inputs, receives data from sensors, and regulates the motor to change the fan speed appropriately and communicates with the SSD1306 OLED display to give the user feedback in real time.

4.7 PWM AC Dimmer:

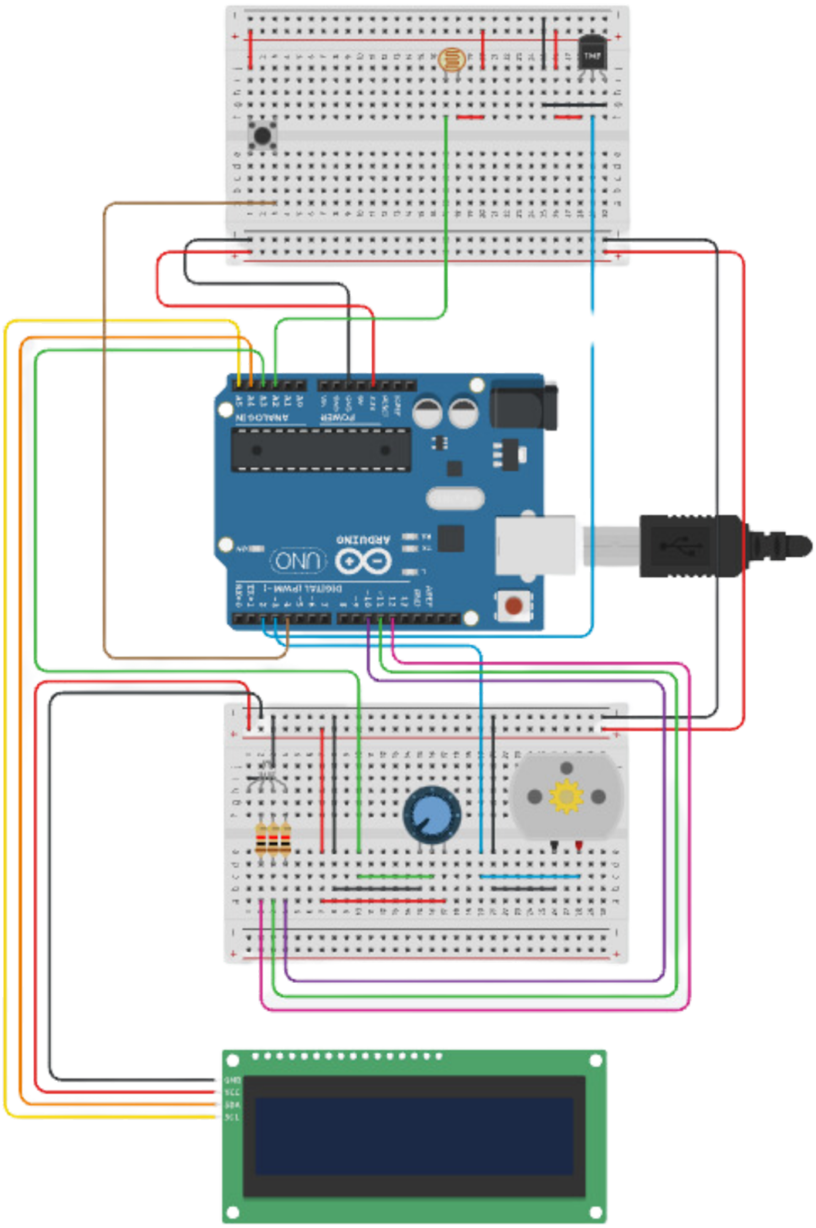
PWM AC dimmers quickly turn on and off the AC motor to regulate the power sent to it. This makes it possible to precisely manage the motor's speed, which permits more exact fan speed adjustments to correspond with certain heat conditions.



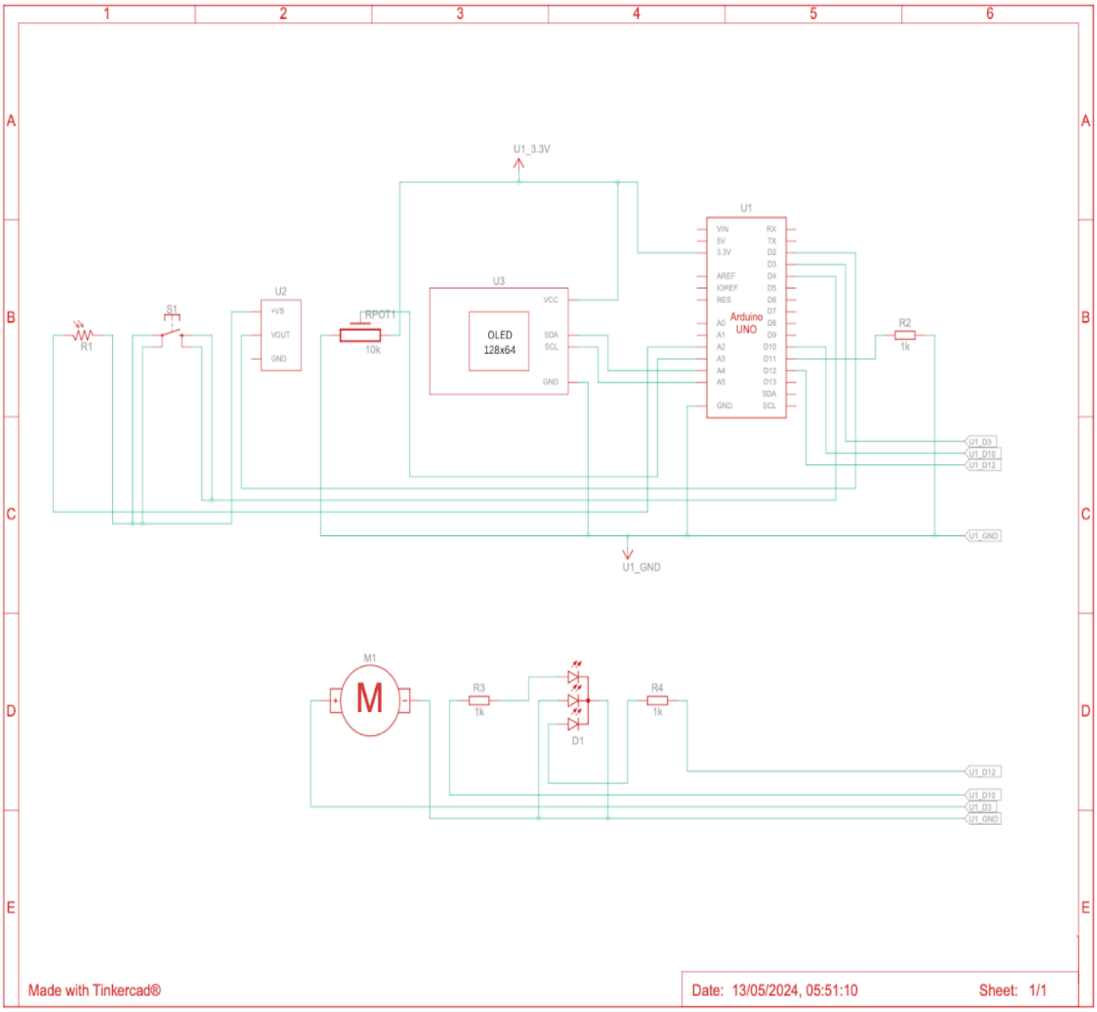
CHAPTER V

SYSTEM DESIGN

5.1 FRITZING DIAGRAM



5.2 CIRCUIT DIAGRAM



CHAPTER VI

SYSTEM OPERATION

6.1 AUTO MODE

- When the system is in automated mode, it runs smoothly and maintains ideal temperature conditions. It uses the DHT11 sensor, a dependable sensor that measures temperature and humidity with accuracy, to continually check the temperature.
- The technology dynamically modifies the fan speed based on temperature data to provide effective thermal regulation. By using an adaptive method, the system can adjust quickly to changes in the surrounding temperature, maximizing comfort and reducing energy usage.
- The LDR (Light Dependent Resistor) is used by the system to simultaneously detect light intensity and change lighting settings accordingly. The integrated function improves the comfort of the surroundings by adjusting the lighting according to the ambient brightness.

6.2 MANUAL MODE

- The potentiometer interface allows users to regulate the fan speed when operating in manual mode. With the manual override, users may adjust the fan speed to suit their needs or particular tastes.
- The users can easily transition between automated and manual modes, offering flexibility and customization choices suited to their needs.
- Notably, light intensity control stays automated in this mode even when human control of fan speed is available. This guarantees that the system will keep up with modifications in ambient illumination, hence increasing user comfort and convenience.
- Users may customize and control the thermal management process by manually adjusting temperature setpoints in manual mode. By defining their own preferred temperature thresholds, users may customize the system's behaviour to meet their own comfort needs and environmental constraints.

CHAPTER VII

SOURCE CODE

```
#include <SPI.h>
#include <Wire.h>
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h>
#include <DHT11.h>

#define SCREEN_WIDTH 128
#define SCREEN_HEIGHT 64

#define OLED_RESET     -1
#define SCREEN_ADDRESS 0x3C

#define POT A3
#define LDR A2
#define FAN 3
#define DHT 2
#define MODESW 4
#define LED_BLUE 10
#define LED_GREEN 9

class DisplayControl {
  public:
    void printText(char*, int, int);
    void printDegree(int, int);
    void printLevel(int);
    void printDHTData(int, int);
    void changeMode(bool);
    void init();
};

Adafruit_SSD1306 display(SCREEN_WIDTH, SCREEN_HEIGHT, &Wire,
OLED_RESET);
DHT11 dht11(DHT);
```

```
DisplayControl oled;

int temperature_reading = 0, humidity_reading = 0, previous_temp = 0,
previous_humidity = 0;
float light_intensity = 0;
bool state = true;

void setup() {
  Serial.begin(9600);
  if(!display.begin(SSD1306_SWITCHCAPVCC, SCREEN_ADDRESS)) {
    Serial.println(F("SSD1306 allocation failed"));
    for(;;);
  }

  pinMode(POT, INPUT);
  pinMode(LDR, INPUT);
  pinMode(FAN, OUTPUT);
  pinMode(MODESW, INPUT);
  pinMode(LED_BLUE, OUTPUT);
  pinMode(LED_GREEN, OUTPUT);
  oled.init();
}

void loop() {
  if(digitalRead(MODESW) == 1) {
    state = !state;
    oled.changeMode(state);
    oled.printLevel(0);
    delay(1000);
  }
  light_intensity = analogRead(LDR);
  if(light_intensity > 300) {
    analogWrite(LED_GREEN, 0);
    analogWrite(LED_BLUE, 0);
  } else {
    analogWrite(LED_GREEN, int(calculatePerNum(675 - light_intensity, 675,
255)));
```

```
    analogWrite(LED_BLUE, int(calculatePerNum(675 - light_intensity, 675,
255)));
  }
  if(!state){
    oled.printLevel(int(calculatePerNum(analogRead(POT), 685, 52)));
    analogWrite(FAN, int(calculatePerNum(analogRead(POT), 687, 255)));
    Serial.println(analogRead(POT));
  }
  int result = dht11.readTemperatureHumidity(temperature_reading,
humidity_reading);
  if (result == 0 && (previous_temp != temperature_reading ||
previous_humidity != humidity_reading)) {
    oled.printDHTData(temperature_reading, humidity_reading);
    if(state) {
      oled.printLevel(int(calculatePerNum(temperature_reading - 25, 10, 52)));
//minTemp = 25, maxTemp: 35 (25 - 25: 10), default
      analogWrite(FAN, int(calculatePerNum(temperature_reading - 25, 10,
255)));
    }
    previous_humidity = humidity_reading;
    previous_temp = temperature_reading;
  } else if(result != 0) {
      Serial.println(DHT11::getErrorString(result));
  }
}


float calculatePerNum(int what, int per, int of){
  float temp = what;
  temp /= per;
  temp = temp * of;
  return temp;
}


void DisplayControl::printText(char* text, int x, int y) {
  display.setTextSize(1);      // Normal 1:1 pixel scale
  display.setTextColor(SSD1306_WHITE); // Draw white text
  display.setCursor(x, y);     // Start at top-left corner
  display.cp437(true);         // Use full 256 char 'Code Page 437' font
  display.write(' ');
```

```
  for(int i = 0; i < strlen(text); i++){
    display.write(text[i]);
  }
  display.display();
}

void DisplayControl::printDegree(int x, int y) {
  display.drawCircle(x, y, 2, SSD1306_WHITE);
  display.display();
}

void DisplayControl::printLevel(int level){
  static int prevlevel = level;
  if(prevlevel == level){
    return;
  }
  display.fillRect(71, 1, prevlevel, 5, SSD1306_INVERSE);
  display.fillRect(71, 1, level, 5, SSD1306_INVERSE);
  display.display();
  prevlevel = level;
}

void DisplayControl::init(){
  display.clearDisplay();
  oled.printText("FAN SPEED:", 0, 0);
  display.drawRect(70, 0, 54, 7, SSD1306_WHITE);
  display.drawLine(0, 10, 128, 10, SSD1306_WHITE);
  oled.printText("TEMPERATURE:   .0  C", 0, 15);
  oled.printDegree(113, 16);
  oled.printText("HUMIDITY   :   .0 %", 0, 25);
  oled.printText("MODE : AUTOMATIC", 0, 35);
  oled.printLevel(0);
}

void DisplayControl::printDHTData(int temperature, int humidity){
  display.fillRect(83, 15, 12, 20, SSD1306_BLACK);
  display.setTextColor(SSD1306_WHITE);
  display.setCursor(90, 15);
```

```
  display.write((char)((temperature % 10) + 48));
  temperature /= 10;
  display.setCursor(84, 15);
  display.write((char)((temperature % 10) + 48));
  display.setCursor(90, 25);
  display.write((char)((humidity % 10) + 48));
  humidity /= 10;
  display.setCursor(84, 25);
  display.write((char)((humidity % 10) + 48));
  display.display();
}

void DisplayControl::changeMode(bool state){
  display.fillRect(40, 35, 80, 20, SSD1306_BLACK);
  if(state){
    oled.printText("AUTOMATIC", 42, 35);
  } else {
    oled.printText("MANUAL", 42, 35);
  }
}
```

CHAPTER VIII

IMPLEMENTATION

8.1 HARDWARE SETUP

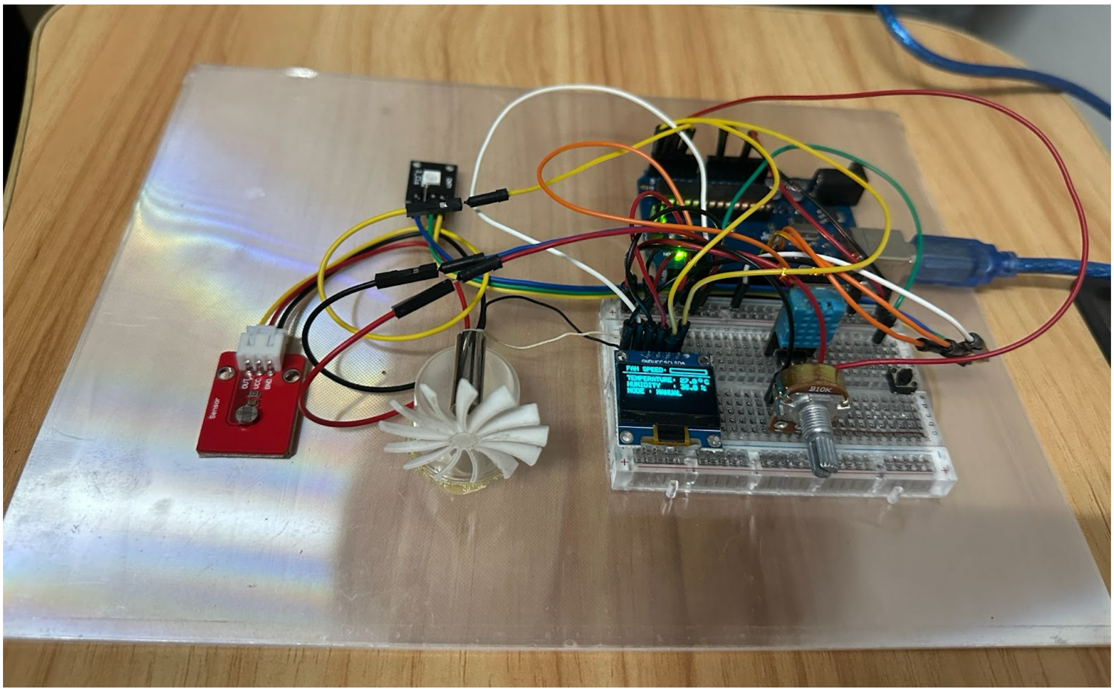
- In order to give real-time temperature and humidity data, the DHT11 sensor is included into the hardware configuration and interfaces with the Arduino Uno.
- In a similar vein, the system's capacity to adjust to shifting environmental circumstances is improved by the LDR's connection to the system for light intensity monitoring.
- By acting as a user interface component, the potentiometer enables human control over the regulation of fan speed. Because of its connectivity, customers may customize ventilation settings to suit their tastes, adding another degree of system adaptability.
- The main component of the hardware configuration is the DC motor, which the Arduino Uno controls and allows for temperature-based fan speed change.

8.2 SOFTWARE SETUP

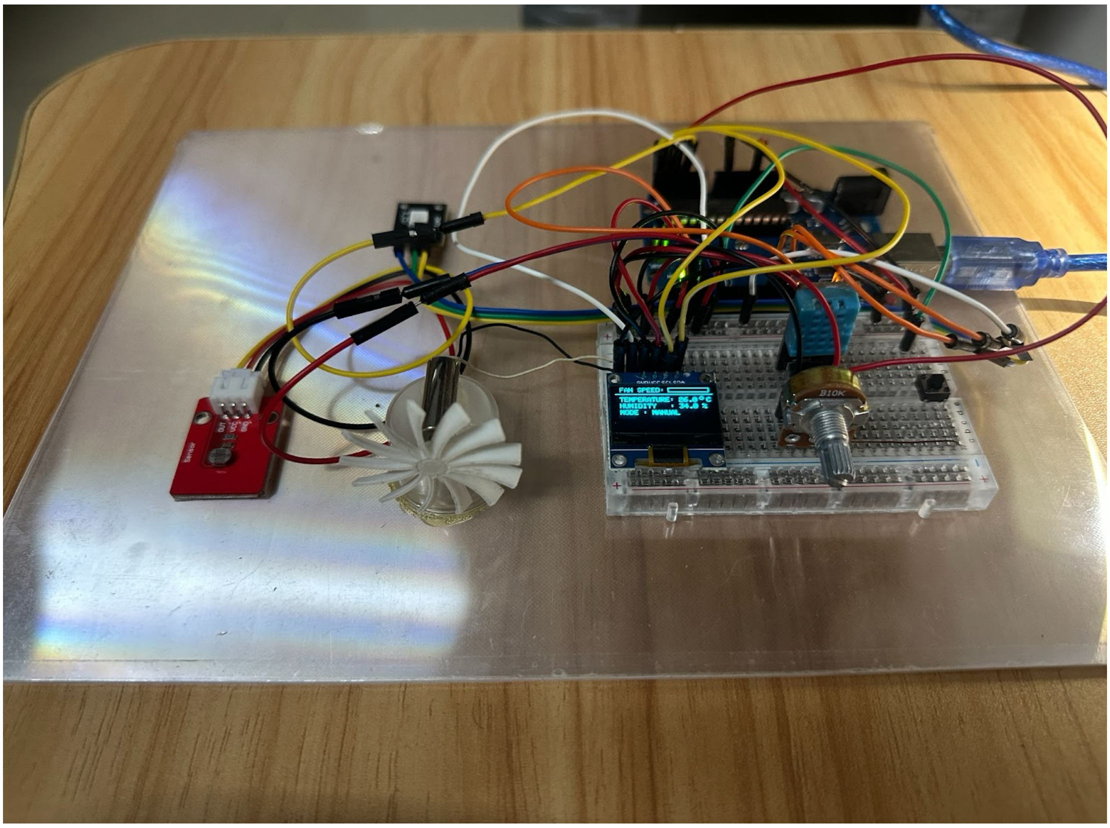
- The system's software is painstakingly designed to manage the user interface, process sensor data, and carry out control logic.
- In order to maintain ideal temperature conditions, Arduino code is built to receive sensor data from the DHT11 sensor and modify the speed of the DC motor correspondingly.
- Furthermore, the software permits users to override the automated fan speed regulation whenever they'd like by enabling manual mode control using the potentiometer interface.
- The OLED display shows the temperature and condition of the system in real time, giving users insightful information about how the system is operating.
- The program processes light intensity measurements from the LDR to dynamically modify lighting levels, therefore augmenting environmental flexibility and user comfort.

CHAPTER IX

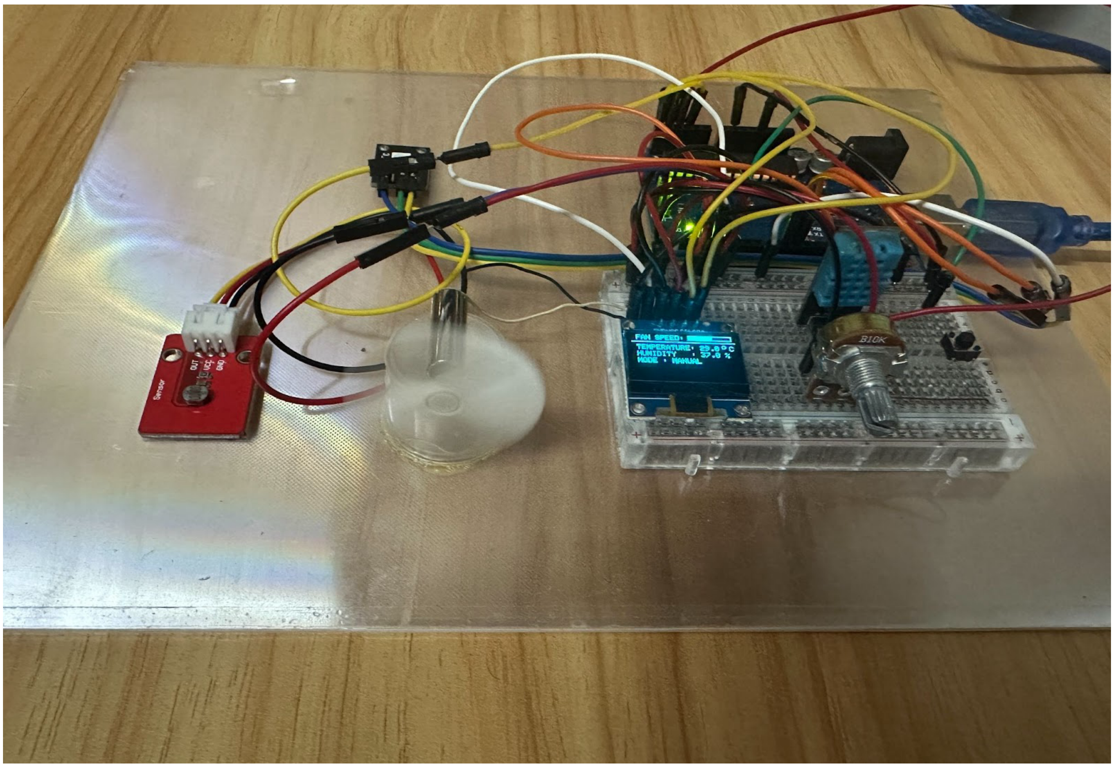
SAMPLE OUTPUT



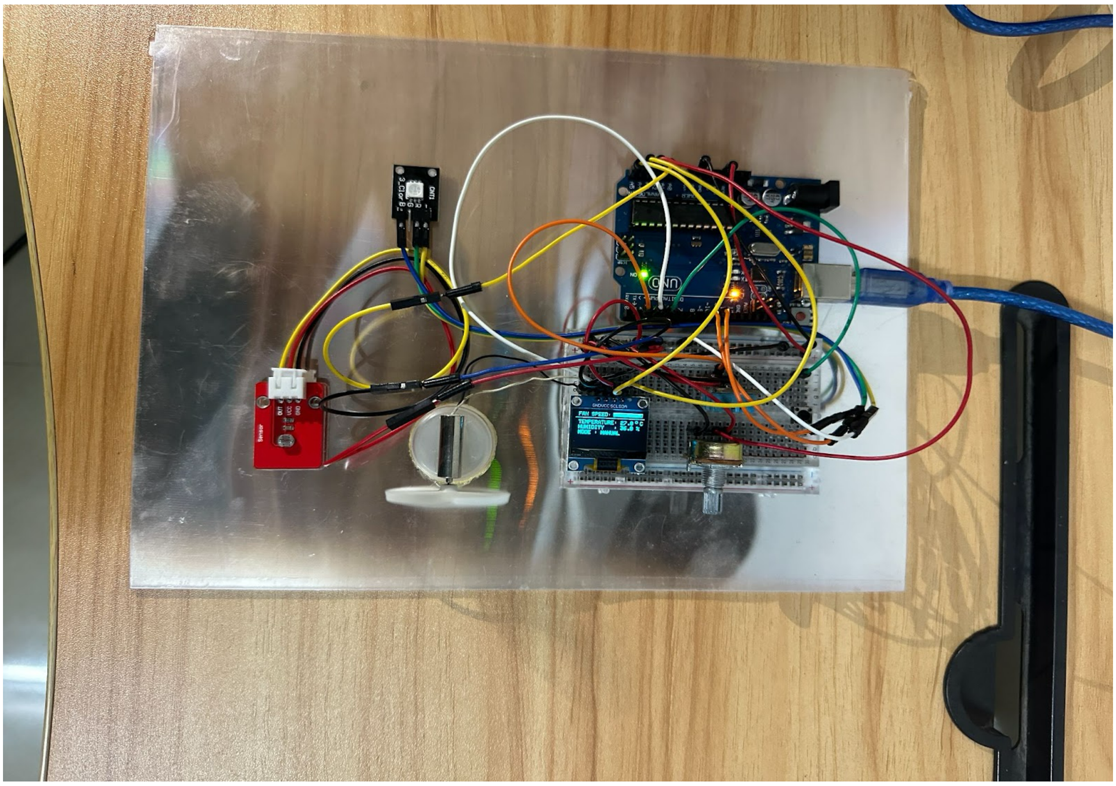
8.1 Circuit Setup



8.2 Auto mode



8.3 Manual Mode - Medium Speed



8.4 Manual Mode - High Speed

CHAPTER X

CONCLUSION & FUTURE ENHANCEMENTS

To sum up, our solution is a major step forward in user-centric ventilation management and temperature-responsive fan speed control. By combining cutting-edge sensor technology, and user-friendly interfaces, our system has shown to be remarkably effective at controlling temperature and giving users control options that are personalized to their tastes. Our solution guarantees excellent thermal management and improves energy efficiency and user comfort by dynamically altering fan speed in response to real-time ambient circumstances. Our project's success serves as evidence of the possibility for creative ways to deal with the difficulties associated with contemporary thermal management.

There are several opportunities for future advancements and expansions while looking ahead. The inclusion of remote control features, which would enable users to modify fan speed and keep an eye on environmental conditions via a smartphone or online interface, is one possible improvement. This would improve accessibility and convenience, especially in situations where users are not physically present at the system's location.

To further improve environmental monitoring, adding more sensors might increase the system's functionality. Insights about interior air quality might be gained from sensors such carbon dioxide (CO_2) detectors and air quality sensors, which would allow the system to modify ventilation settings appropriately and preserve a healthy indoor atmosphere.

Furthermore, investigating the incorporation of machine learning techniques may open up new avenues for energy optimization and predictive temperature control. Through the analysis of past data and user preferences, the system can predict temperature swings and adjust fan speed in advance, therefore improving efficiency and user comfort.

To put it briefly, the goal of next improvements is to increase the system's usefulness and adaptability while utilizing cutting-edge technology to deliver even more efficiency, convenience, and user experience. The objective of our project is to stay at the forefront of thermal management solutions in the digital era by means of constant innovation and adaptation to changing demands.

CHAPTER XI

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