Automatic Fan Speed Controller with Temperature Sensor

1. Abstract and Keywords

- **Abstract**

a) The goal of this project is to develop an Automatic Fan Speed Controller that adjusts the speed of the fan automatically depending on the temperature change.
b) When the temperature rises above the set value, the fan speed increases and slows when temperature decreases automatically.
c) Arduino is the core computer system that has been used.
d) DHT11 Sensor is used for sensing the temperature and is connected to Arduino.
e) Arduino programming language is used to implement speed change by temperature detection.
f) Arduino Uno, jumper wires, DHT11 Sensor, DC fan, transistor, resistor, LCD, breadboard**,** solar panel are used to form the IOT.

The project is aimed at controlling the speed of the fan automatically using Arduino, temperature, and humidity sensors. Fan speed needs to be manually controlled every time but by using this idea the speed of the fan will be automatically adjusted according to the surrounding environment. The project is based on the concept of the Internet of Things (IOT). A simple strategy to automatically control the speed of fan using DHT11 sensor. According to the temperature sensed by temperature and humidity sensor the resistance of the fan will be adjusted to change the fan speed. It's fairly straightforward to use, however, needs a careful arrangement to grab information. The temperature will automatically control. DHT11 sensor is used to sense the temperature and then the speed of the fan is adjusted accordingly using PWM. Here Arduino code is used.

- **Keywords**

a) IOT
b) Arduino Code
c) PWM
d) Arduino
e) Temperature Sensor
f) Jumper Wires
g) Breadboard
h) DHT11 Sensor
i) Solar Panel
j) Duty cycle

2. Introduction

- The project aims at designing an advanced automatic system using Arduino.
- The temperature sensor circuit using a thermistor exploits the property of a sensor to operate the fan or any other device. This circuit also controls the temperature of any device according to the requirement of an industry. The main idea of a temperature sensor circuit is to control the speed of a fan by heating a thermistor. And the speed of a fan depends upon the temperature of any device like a PC, Laptop, etc.
- Automation is the most frequently spelled term in the field of electronics. The hunger for automation brought many revolutions in the existing technologies. These can be used as a replacement for the currently used switches which has a tendency to create sparks and result in fire accidents in few situations.
- Temperature sensor DH11 senses the temperature and converts it into an electrical (analog) signal, which is applied to the microcontroller of the Arduino UNO Board. The analog value is converted into a digital value. Thus, the sensed values of the temperature and speed of the fan are displayed on the LCD. When the temperature exceeds 20°C the fan starts rotating.
- A low-frequency pulse-width modulation (PWM) signal, whose duty cycle is varied to adjust the fan's speed is used. An inexpensive, single, small pass transistor-like 2N222 or BD139 can be used here. It is efficient because the pass transistor is used as a switch.

2.1 Problem Statement

- Automatic Speed Controller can save human energy and time which they spend on changing the speed of the fan. It can also prevent fire in few cases when the sparks are generated due to repeatedly pressing of switches.
- The main objective of this research is to design and implement a cheap and open-source automatic speed controller that is capable of controlling the speed of the fan.
- The proposed system can be used in homes, industries.
- It will help in saving energy.
- It will also help assist people who are disabled to adjust the fan speed automatically.

2.2 Description of the Present System

Existing System that is manual circuit board:

- In the existing system, the work is done only manually but in the proposed system we have automated the work.
- It is more time consuming.
- It has more risk of short circuit.
- Need to operate manually. We need to change the speed of the fan by using the regulator.

Some of the existing systems are:

- Development of a system to control air conditioner's airflow for spot cooling (ICE2T 2017)
- Controlling the operating conditions in an operating room (ISEP 2014)
- Design of small smart home system based in Arduino (EECCIS 2014)
- Real-time based temperature control using Arduino (IJIET 2017)

2.3 Background /Limitations

Background

- This project is based on IoT.
- The Internet of Things (IoT) refers to a system of interrelated, internet connected objects that can collect and transfer data over a wireless network without human intervention. The personal or business possibilities are endless.
- The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects, animals, or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.
- A thing in the internet of things can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built in sensors to alert the driver when tire pressure is low, or any other natural or man-made object that can be assigned an Internet Protocol (IP) address and can transfer data over a network.
- An IoT ecosystem consists of web-enabled smart devices that use embedded systems, such as processors, sensors, and communication hardware, to collect, send and act on data they acquire from their environments. IoT devices share the sensor data they collect by connecting to an IoT gateway or other edge device where data is either sent to the cloud to be analysed or analysed locally. Sometimes, these devices communicate with other related devices and act on the information they get from one another. The devices do most of the work without human intervention, although people can interact with the devices -- for instance, to set them up, give them instructions or access the data.

Limitations

- It can only be maintained by technical person. Thus, it becomes difficult to be maintained.
- Due to temperature variation, after sometimes its efficiency may decrease.

Limitations of Existing Systems

- The problem faced is using multiple ultrasonic sensors in the same environment. Multiple sensors operational at the same time initiate interference, one sensor can receive information sent by another sensor.
- It takes comparatively more time to process.
- It requires many devices for operation.
- There is need for external clock.
- Development system is required for programming.
- Circuit size becomes wide.
- Programming Control Block making becomes complex, difficult and heavy.

2.4 Aim & Objectives

- The aim of this project is to design an advanced automatic system using Arduino.
- The temperature sensor circuit using a thermistor exploits the property of a sensor to operate the fan or any other device. This circuit also controls the temperature of any device according to the requirement of an industry. The main idea of a temperature sensor circuit is to control the speed of a fan by heating a thermistor. And the speed of a fan depends upon the temperature of any device like a PC, Laptop, etc.
- Automation is the most frequently spelled term in the field of electronics. The hunger for automation brought many revolutions in the existing technologies. These can be used as a replacement for the currently used switches which has a tendency to create sparks and result in fire accidents in few situations.

2.5 Project Motivation

The motivation behind this project is:

- People would save their time and energy.
- This will help in saving the energy.
- To monitor the environment that is not comfortable, or possible, for humans to monitor especially for extended periods of time
- Prevents waste of energy when it’s not enough for a fan to be needed.
- To assist people who are disabled to adjust the fan speed automatically.

3. Description of Proposed Work

3.1 Number of modules

- **setSpeed( ):** This module will set the speed of the fan according to the detected temperature.

- **lcdDisplay( ):** The recorded temperature, humidity and the current fan speed is set up to be displayed on the lcd screen.

- **setup( ):** The setup() function is called when a sketch starts. It is used to initialize variables, pin modes, start using libraries, etc. The setup() function will only run once, after each powerup or reset of the Arduino board.

- **loop( ):** Loops are used to control the flow of a program. In a loop, a block of code is executed over and over again. Each cycle of the loop is called an iteration of the loop. Depending on certain conditions that you can define in the code, you can control whether the program enters the loop or not.

3.2 Algorithm

Algorithm used for fan speed

```
1) Start
2) Set temperature = 0 and fanSpeed = 0
3) temperature = DHT. Temperature
4) Now compare the value of temperature with range of temperatures and set the fanSpeed
   according to that
   a) if temperature < 10 °C then, fanSpeed = 0 duty cycle (Fan is off)
   b) if temperature < 15 °C then, fanSpeed = 25 duty cycle (Lowest speed)
   c) if temperature < 20 °C then, fanSpeed = 51 duty cycle (Low speed)
   d) if temperature < 22 °C then, fanSpeed = 76 duty cycle (Low speed)
   e) if temperature < 24 °C then, fanSpeed = 102 duty cycle (Medium speed)
   f) if temperature < 25 °C then, fanSpeed = 127 duty cycle (Medium speed)
   g) if temperature < 26 °C then, fanSpeed = 153 duty cycle (Medium speed)
   h) if temperature < 28 °C then, fanSpeed = 178 duty cycle (Good speed)
   i) if temperature < 29 °C then, fanSpeed = 204 duty cycle (Good speed)
   j) if temperature < 30 °C then, fanSpeed = 229 duty cycle (High speed)
   k) if temperature > =30 °C then, fanSpeed = 255 duty cycle (Highest speed)
5) End
```

3.3 Working

- Following components are used for this project.
  1) Arduino Uno
  2) Few Jumper Wires
  3) DHT11 Sensor
  4) DC Fan
  5) Transistor
  6) Resistor**s**
  7) 16*2 LCD
  8) Breadboard
  9) Solar Panel

- In this Arduino based project, I have built a temperature-controlled fan using Arduino. With the circuit, it is able to adjust the fan speed in our home or office according to the room temperature and also show the temperature and fan speed changes on a 16x2 LCD display.

- To do this we will be using an Arduino UNO Board, LCD, DHT11 sensor Module, and DC fan.

- This topic consists of three sections. One senses the temperature by using humidity and temperature sensor namely DHT11.

- The second section reads the dht11 sensor module's output and extracts temperature value into a suitable number in Celsius scale and control the fan speed.

- And last part of system shows humidity and temperature on LCD and Fan driver.

- Connections of this temperature-controlled fan circuit is very simple, here a liquid crystal display is used for displaying temperature and Fan speed Status.

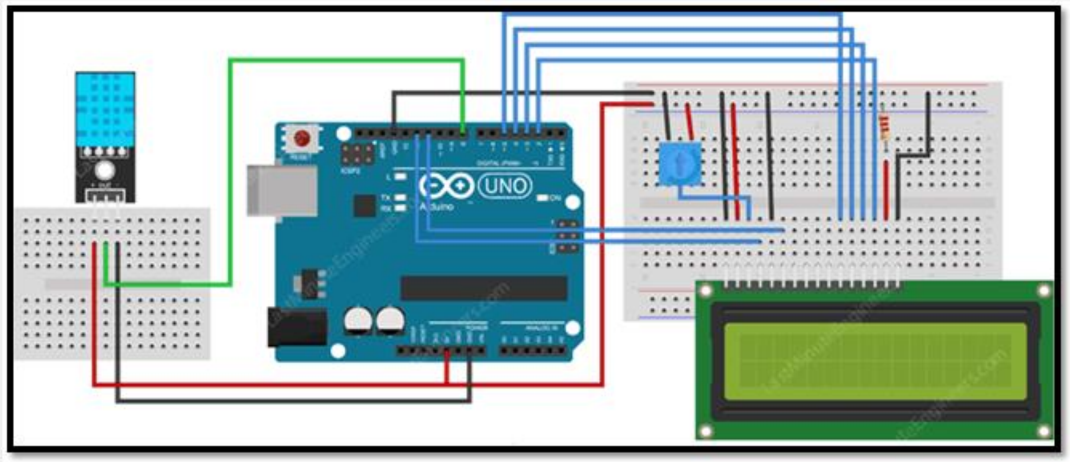
- LCD is directly connected to Arduino in 4-bit mode.

- Pins of LCD namely RS, EN, D4, D5, D6 and D7 are connected to Arduino digital pin number **12**, **11**, 5, 4, 3 and 2. And a DHT11 sensor module is also connected to digital pin **7** of Arduino.

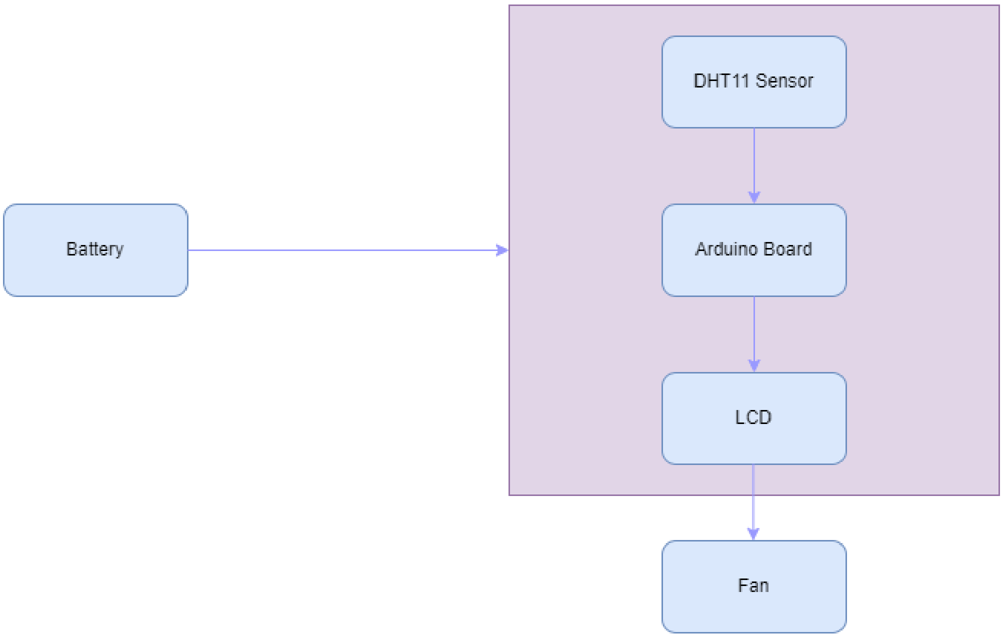
- Digital pin 9 is used for controlling fan speed through the transistor.

3.4 Design/Block diagram/flow chart/graph/deployment diagram/Architectural Design

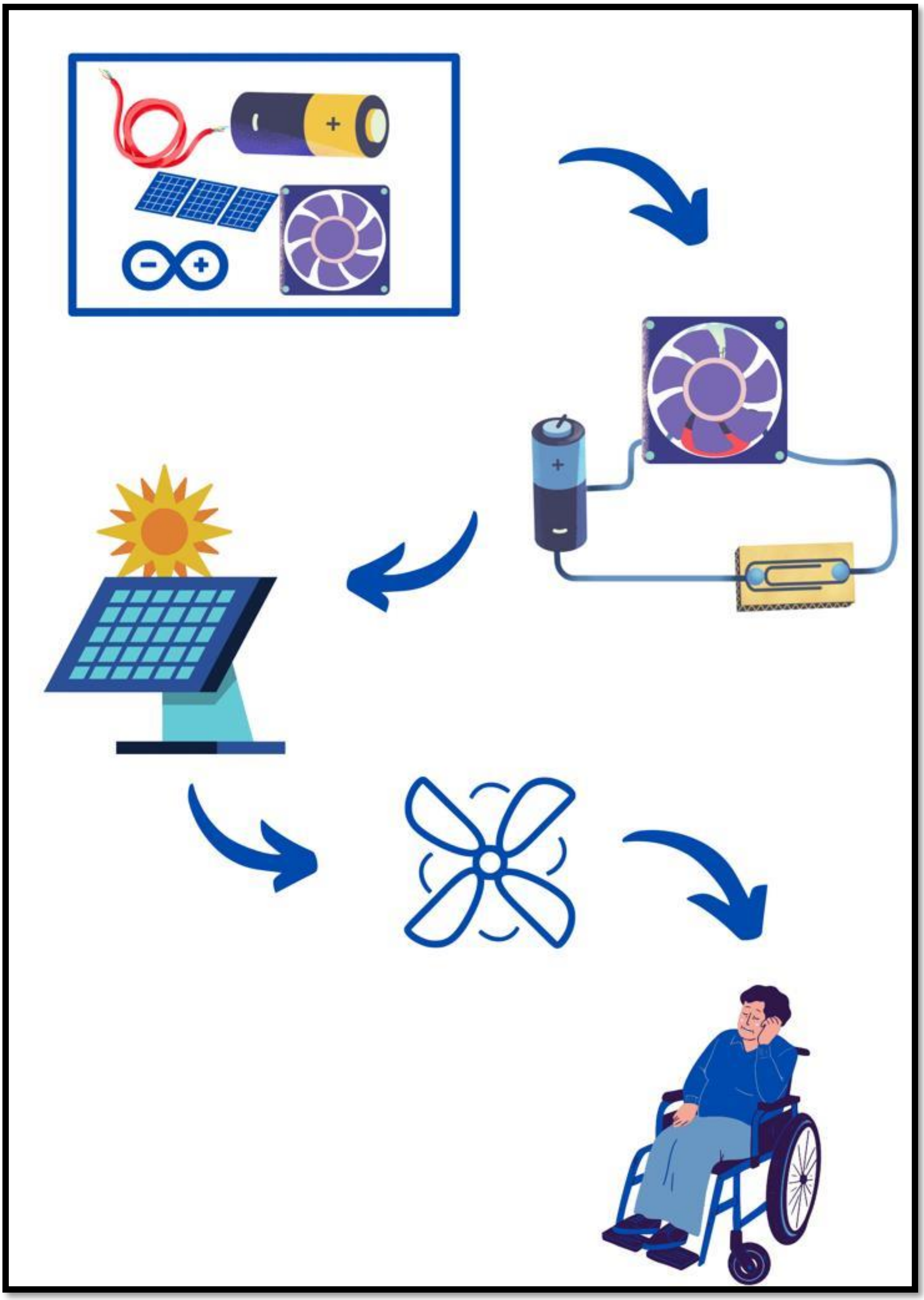
- **Circuit Diagram**



- **Work Flow**



- **Flow Chart**



- **Architectural Design**

This part covers the architecture modules and the architecture

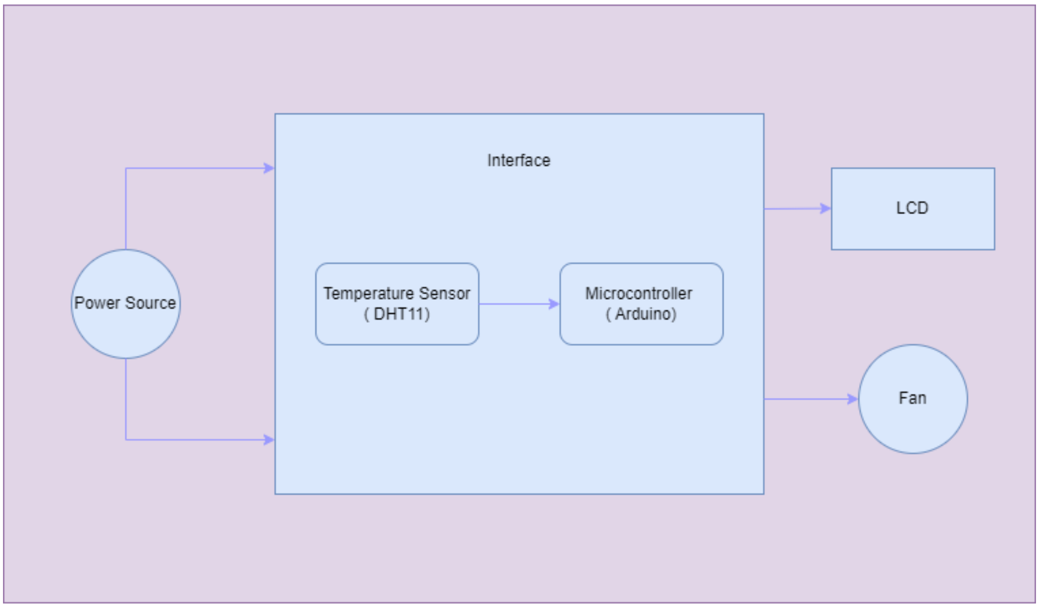
a. **Power Source**
This is the first module which is going to give power all the other modules i.e. Temperature sensor, Arduino, Lcd, Fan.

b. **Temperature Sensor(DHT11)**
This is another module which will be detecting the temperature and will pass the values of temperature to microcontroller and Arduino.

c. **Arduino Board and Microcontroller**
This module will be controlling the speed of the fan based on the room temperature sensed by the sensor with the help of the code done in Arduino board.

d. **Lcd**
This module will be displaying the speed of fan-like 0%, 10%, 20%, etc.

e. **Fan**
This module is to be controlled using all the other module.



- **Experimental results and evaluation**
  The temperature and humidity sensor senses the temperature and the data is displayed on the LCD. The speed of the fan is controlled by PWM technique according to the temperature sensed. process analog signals using a digital converter.

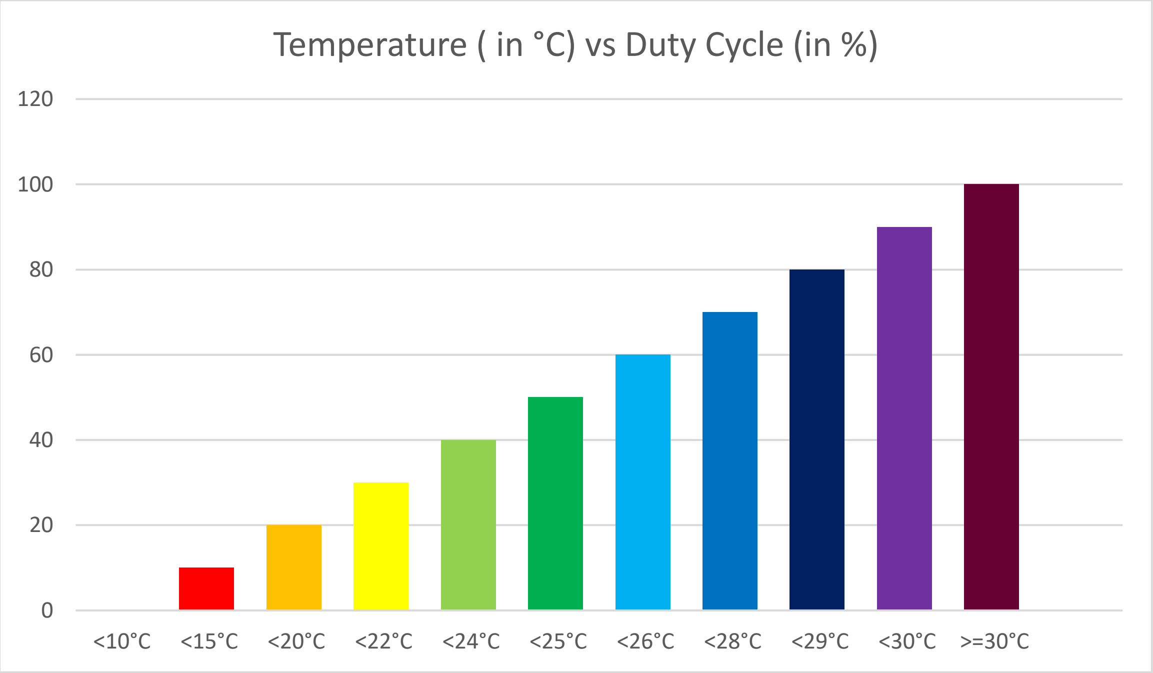
  The microcontroller used has inbuilt Pulse Width Modulation module which is used to control the speed of the fan by changing the duty cycle. According to the readings from the temperature sensor duty cycle is changed automatically thus controlling fan speed. Table shows the relationship.

Duty Cycle and Temperature

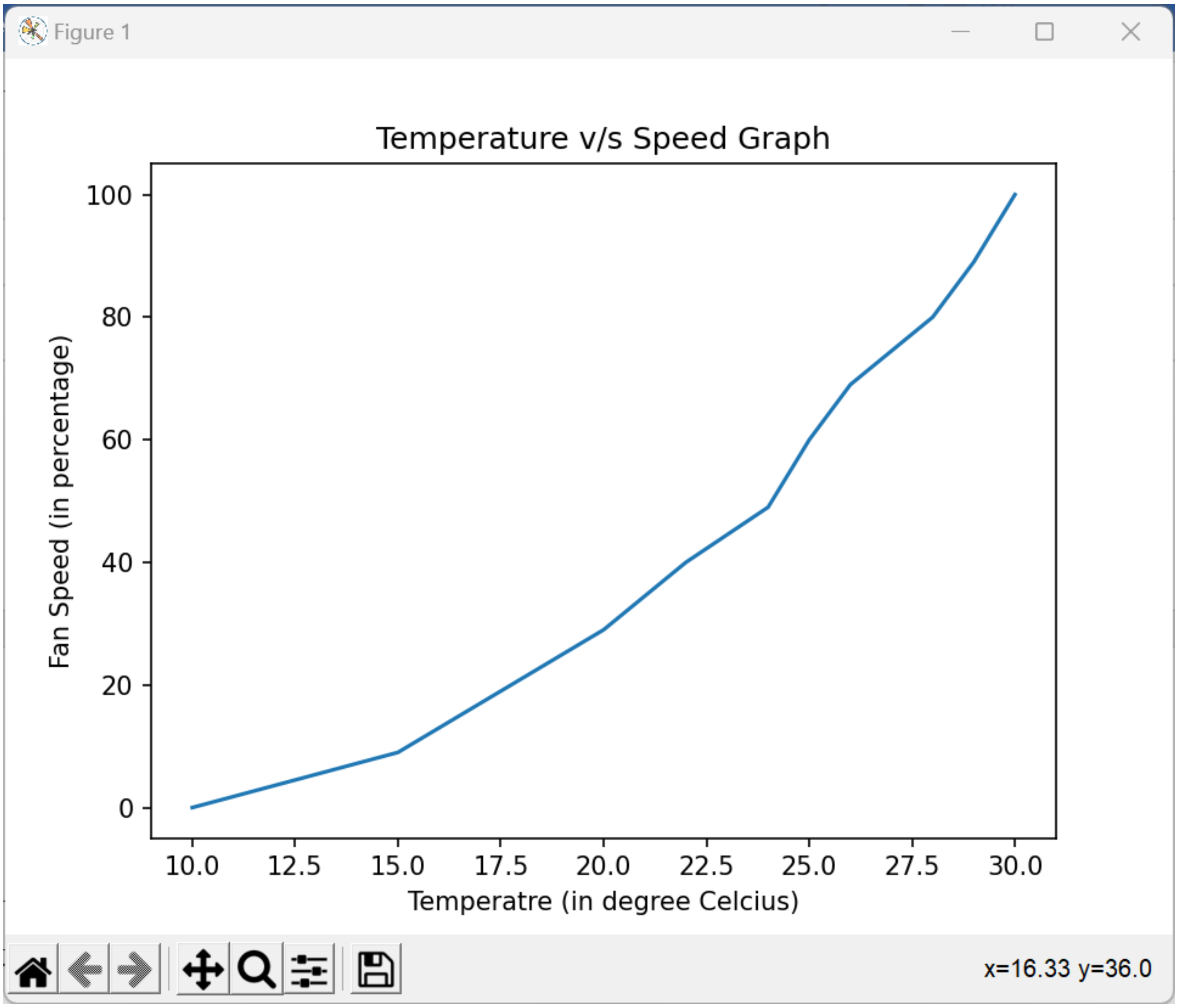
SR. No	Temperature (In °C)	Duty Cycle (In %)
1.	Lesser than 10 °C	0 %
2.	Lesser than 15 °C	10 %
3.	Lesser than 20 °C	20 %
4.	Lesser than 22 °C	30 %
5.	Lesser than 24 °C	40 %
6.	Lesser than 25 °C	50 %
7.	Lesser than 26 °C	60 %
8.	Lesser than 28 °C	70 %
9.	Lesser than 29 °C	80 %
10.	Lesser than 30 °C	90 %
11.	Greater than or equal to 30 °C	100 %

The representation of the duty cycle with temperature (in Celsius)

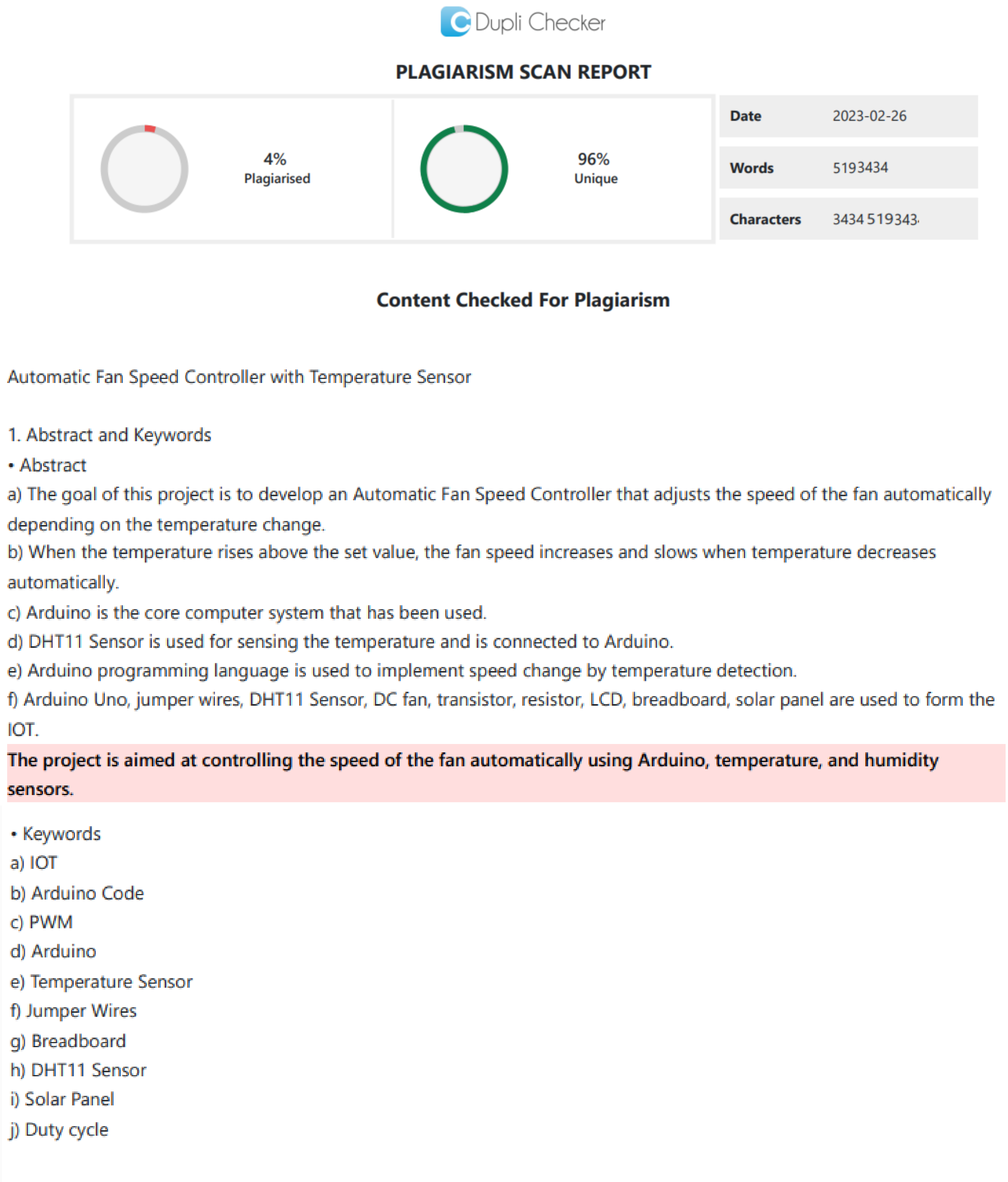
X-Axis : Temperature Y-Axis: Duty Cycle



The representation of duty cycle with temperature, recorded from the project. The duty cycle is changing according to the temperature and speed is controlled respectively.



3.5 Plagiarism report



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The project is aimed at controlling the speed of the fan automatically using Arduino, temperature, and humidity sensors.

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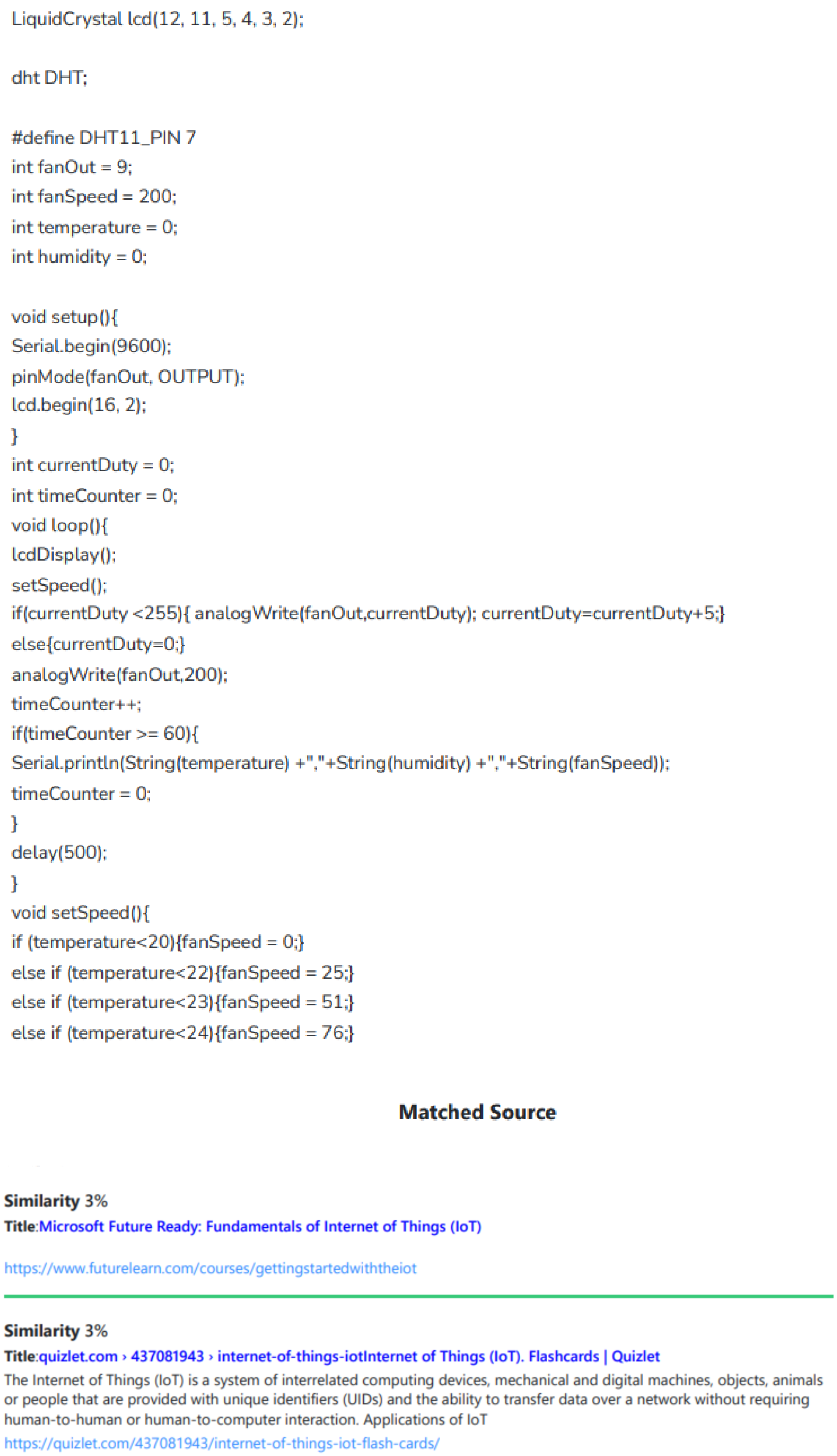
f) Jumper Wires

g) Breadboard

h) DHT11 Sensor

i) Solar Panel

j) Duty cycle



```
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);

dht DHT;

#define DHT11_PIN 7
int fanOut = 9;
int fanSpeed = 200;
int temperature = 0;
int humidity = 0;

void setup(){
Serial.begin(9600);
pinMode(fanOut, OUTPUT);
lcd.begin(16, 2);
}
int currentDuty = 0;
int timeCounter = 0;
void loop(){
lcdDisplay();
setSpeed();
if(currentDuty <255){ analogWrite(fanOut,currentDuty); currentDuty=currentDuty+5;}
else{currentDuty=0;}
analogWrite(fanOut,200);
timeCounter++;
if(timeCounter >= 60){
Serial.println(String(temperature) +","+String(humidity) +","+String(fanSpeed));
timeCounter = 0;
}
delay(500);
}
void setSpeed(){
if (temperature<20){fanSpeed = 0;}
else if (temperature<22){fanSpeed = 25;}
else if (temperature<23){fanSpeed = 51;}
else if (temperature<24){fanSpeed = 76;}
```

Matched Source

Similarity 3%
Title:Microsoft Future Ready: Fundamentals of Internet of Things (IoT)

https://www.futurelearn.com/courses/gettingstartedwiththeiot

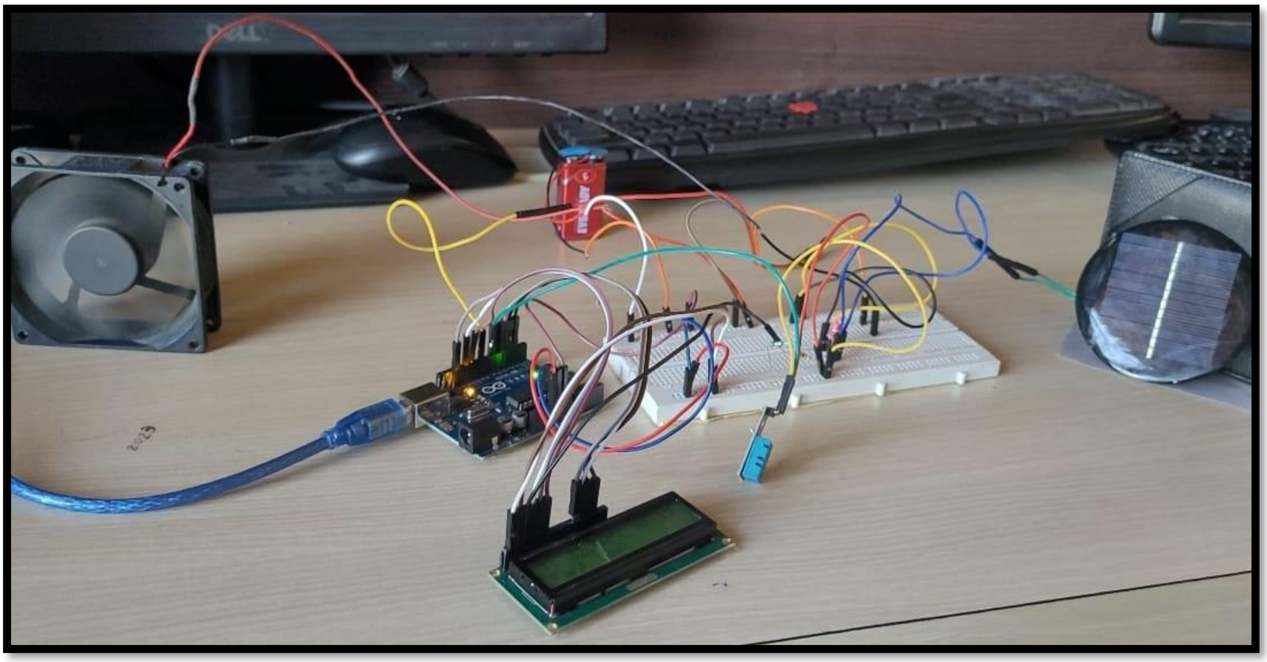
Similarity 3%
Title:quizlet.com › 437081943 › internet-of-things-iotInternet of Things (IoT). Flashcards | Quizlet
The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. Applications of IoT
https://quizlet.com/437081943/internet-of-things-iot-flash-cards/

3.6 Coding

```
#include <dht.h>
#include <LiquidCrystal.h>
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);
dht DHT;
#define DHT11_PIN 7
int fanOut  = 9;
int fanSpeed = 0;
int temperature = 0;
int humidity = 0;
void setup(){
  Serial.begin(9600);
  pinMode(fanOut, OUTPUT);
  lcd.begin(16, 2);
}
int currentDuty = 0;
int timeCounter = 0;
void loop(){
  lcdDisplay();
  setSpeed();
  if(currentDuty <255){  analogWrite(fanOut,currentDuty); currentDuty=currentDuty+5;}
  else{currentDuty=0;}
  analogWrite(fanOut,200);
  timeCounter++;
  if(timeCounter >= 60){
    Serial.println(String(temperature) +","+String(humidity) +","+String(fanSpeed));
    timeCounter = 0;
  }
  delay(500);
}
```

```
void setSpeed(){
  if (temperature<10){fanSpeed = 0;}
  else if (temperature<15){fanSpeed = 25;}
  else if (temperature<20){fanSpeed = 51;}
  else if (temperature<22){fanSpeed = 76;}
  else if (temperature<24){fanSpeed = 102;}
  else if (temperature<25){fanSpeed = 127;}
  else if (temperature<26){fanSpeed = 153;}
  else if (temperature<28){fanSpeed = 178;}
  else if (temperature<29){fanSpeed = 204;}
  else if (temperature<30){fanSpeed = 229;}
  else if (temperature>30){fanSpeed = 255;}
  analogWrite(fanOut,fanSpeed);  }
void lcdDisplay(){
  int chk = DHT.read11(DHT11_PIN);
  temperature = DHT.temperature;
  humidity = DHT.humidity;
  lcd.setCursor(0,0);
  lcd.print("T: ");
  lcd.print(DHT.temperature);
  lcd.print((char)223);
  lcd.print("C");
  lcd.print(" H: ");
  lcd.print(DHT.humidity);
  lcd.setCursor(0,1);
  lcd.print("Fan: ");
  int fanPercent = fanSpeed/2.55;
  lcd.print(fanPercent);
  lcd.print("%");
  }
```

3.7 Model

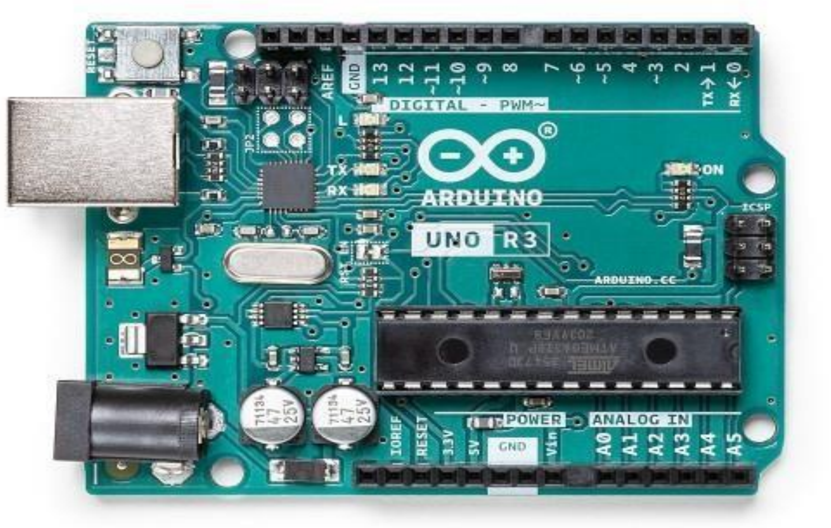


4. Technology/Language/Development Tools/Hardware/Software

Hardware

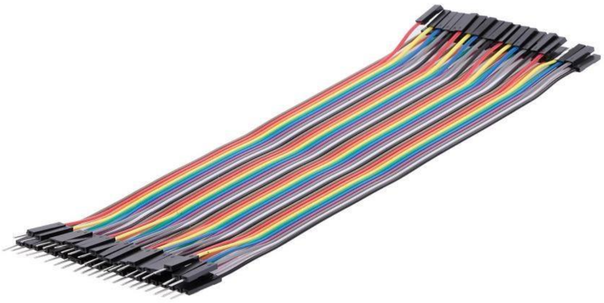
1) Arduino Uno

- Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino board scan read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online.
- You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language(based on Wiring), and the Arduino Software (IDE), based on Processing.
- Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.



2) Jumper Wires

Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points without soldering. Jumper wires are typically used with bread boards and other prototyping tools to make it easy to change a circuit as needed. Fairly simple. It doesn’t get much more basic than jumper wires.



3) DC FAN

- The direct current fans, or DC fans, are powered with a potential of fixed value such as the voltage of a battery.
- Typical voltage values for DC fans are, 5V, 12V, 24V and 48V.
- In contrast, the alternating current fans, or AC fans, are powered with a changing voltage of positive and of equal negative value.
- In our project basically, the fan speed will be controlled.

4) **Transistor**

- A transistor is a semiconductor device used to amplify or switch electrical signals and power.
- The transistor is one of the basic building blocks of modern electronics.
- It is composed of semiconductor material, usually with at least three terminals for connection to an electronic circuit.

5) **Resistor**

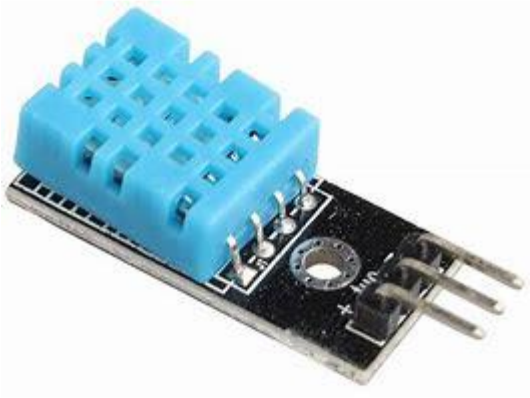
- A resistor is an electrical component that limits or regulates the flow of electrical current in an electronic circuit.
- Resistors can also be used to provide a specific voltage for an active device such as a transistor.

6) **Breadboard**

- A breadboard is used to build and test circuits quickly before finalizing any circuit design.
- The breadboard has many holes into which circuit components like Ics and resistors can be inserted. The long top and bottom row of holes are usually used for power supply connections.
- The rest of the circuit is built by placing components and connecting them together with jumper wires.

7) Temperature sensor

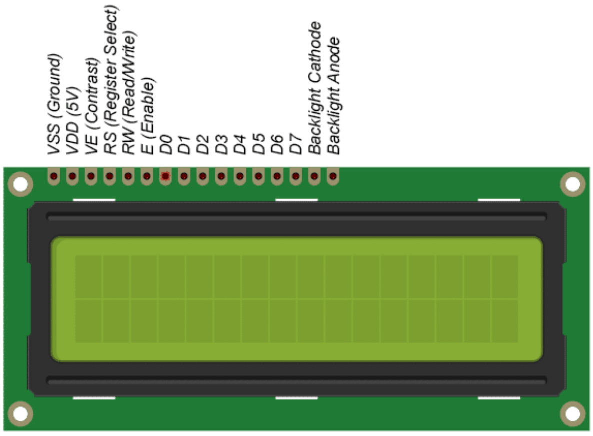
The DHT11 is a commonly used Temperature and humidity sensor that comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. The best thing of this sensor is you can only get new data from it after every 2 seconds, so when using library, sensor readings can be made up to 2 seconds old.



DHT11 Pinout Configuration

No	**Pin Name**	Description
1.	**VCC**	**Power supply 3.5V to 5.5V**
2.	**Data**	**Outputs both Temperature and Humidity through serial Data**
3.	**Ground**	**Connected to the ground of the circuit.**

8) 16*2 LCD



16x2 LCD Pin out Configuration

LCD is a device used for the purpose of displaying. As the name is Liquid Crystal device is uses Liquid crystals and it does not emit light-waves directly, instead of using a reflector to produce footage in colour. It connects from the sensor and Arduino board. It will show the output.

Pin No	Pin Name	Description
1	**Vss (Ground)**	**Ground pin connected to system ground**
2	**Vdd (+5 Volt)**	**Powers the LCD with +5V (4.7V – 5.3V)**
3	**VE (Contrast V)**	**Decides the contrast level of display. Grounded to get maximum contrast.**
4	**Register Select**	**Connected to Microcontroller to shift between command/data register**

5	**Read/Write**	**Used to read or write data. Normally grounded to write data to LCD**
6	**Enable**	**Connected to Microcontroller Pin and toggled between 1 and 0 for data acknowledgement**
7	**Data Pin 0**	**Data pins 0 to 7 forms a 8-bit data line. They can be connected to Microcontroller to send 8-bit data.** **These LCD’s can also operate on 4-bit mode in such case Data pin 4,5,6 and 7 will be left free.**
8	**Data Pin 1**	
9	**Data Pin 2**	
10	**Data Pin 3**	
11	**Data Pin 4**	
12	**Data Pin 5**	
13	**Data Pin 6**	
14	**Data Pin 7**	
15	**LED Positive**	**Backlight LED pin positive terminal**
16	**LED Negative**	**Backlight LED pin negative terminal**

9) Solar Panel

The 6-Watt 6 Volt solar panel is lightweight, waterproof, and designed for long term outdoor use in any environment. High-efficiency monocrystalline solar cells. UV- and scratch-resistant coating. Ideal for IoT applications.

- **Pulse width modulation**
  Pulse Width Modulation is a way where the width of cyclic sequence pluses with changed according to the baseband signal. The forefront of the pulse is constant and also the change in pulse width with the signal is measured with respect. PWM is additionally called Pulse Duration Modulation. The purpose of Pulse Width Modulation is to manage power delivery, particularly to mechanical-electrical devices. The on-off behaviour changes the typical power of the signal. Output signal alternates between on and off among a specific amount of time. when signal switches between on and off, faster than the load, then the load isn't overdone with the switching. Another use of PWM is to cipher data for transmission. In PWM, the pulse width is proportional to the amplitude of the signal. By changing the duty cycle of the pulse, the speed of the fan will be controlled. The duty cycle can be outlined because the quantity of your time in a very explicit amount throughout that the pulse is active or high. The speed is formed slow, medium, fast, in no time and 0 by having totally different duty cycles.

Software Used

Arduino

- The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

- Arduino is an open-source electronics platform based on easy to use hardware and software. Arduino boards are able to read inputs light on sensors, a finger on button, or a Twitter message - and turn it into an output activating a motor, turning on an LED, publishing something online. The user can tell the board what to do by sending a set of instructions to the Arduino microcontroller on the board.

- Arduino was born at the lvrea Integration Design Institute as on easy tool for fast prototyping, aimed at students without a background in electronics and programming.

5. <u>Conclusion & Future Scope</u>

Conclusion

- Nowadays the Internet Of things (IoT) is broadly used in worldwide, this system will display the data of the temperature and fan speed.
- Our proposed system with IoT and Arduino-based Smart Fan speed Controller system has been designed and executed successfully. The output of the system was checked by setting the temperature at different levels and it was recorded that the fan speed changes accordingly.
- This device is a perfect choice for handicapped people. This proposed circuit can be used not only in Fan but also in many practical applications, where the circuit can be connected to a device for whose temperature has to be controlled at a particular value.
- Moreover, this designed circuit helps in preventing the waste of energy when it is not hot enough to use a fan and assists the disabled to switch on or off fan automatically.
- The model also promotes the use of real-time monitoring system through the developed web-based application and SMS notification system as an easy medium in disseminating information particularly in the remote areas. By allowing the system in two way communication, it gives more flexibility in providing important information.
- To conclude, the proposed method has been successfully implemented and satisfied results are obtained. Care has been taken to make the circuit simple, practical and economical with high reliability. The proposed method has achieved the main objective i.e. to control the speed of the fan using temperature sensor.

Future Scope

- We can monitor more parameters like humidity, light and at the same time control them.
- We can send this data to a remote location using mobile or internet
- We can draw graphs of variations in this parameter using computers.
- When temperature exceeds the limit, a call will be dialled to the respective given number by an automatic Dialler system.
- This project can be enhanced in terms of area and power.

6. References

- https://circuitdigest.com/microcontroller-projects/automatic-temperature-controlled-fan-project
- https://www.semanticscholar.org/paper/Smart-Fan-Speed-Controller
- https://bitelectronicsystem.com/wp-content/uploads/2021/07/Smart-speed-control-of-fan
- (PDF) Automatic Room Temperature Controlled Fan Speed Controller Using PT-100[(researchgate.net)
- Internet of Things Education Kit – Arm®
- Automatic Speed Control and Turning ON/OFF for Smart Fan by Temperature and Ultrasonic Sensor | published in IOP Conference Series Materials Science and Engineering (researchgate.net)
- In-Depth: Interface DHT11 Module With Arduino (lastminuteengineers.com)
- www.IJARIIT.com