ANEMOMETER-
PROJECT REPORT

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***Abstract*—This report contains the aim, working principle, procedure and results of the electric project-Anemometer. An Anemometer is a device used to detect the speed of the wind. This report shows the graphs and electric model of the Anemometer. The project will involve the use of microcontrollers and programming to collect and process data, as well as the construction of a user-friendly interface for displaying the measured values. The completed anemometer will be a useful tool for various applications, including weather forecasting, wind energy production, and aviation.**

I. AIM

The aim of our project is to detect the speed of wind with the help of a curve-fitting graph which is the basis of the relationship between wind speed and the voltage generated by rotating the blades of an anemometer. This allows to measure wind speed accurately and provide valuable information for various applications, such as weather forecasting..

II. THEORY

The working principle of our anemometer is that we give the flow of wind of known values and rotate the blades of the anemometer which is attached to a DC motor. This DC motor acts as a Dynamo and generates a voltage which is fed into a Python code to predict a relationship between wind speed and voltage generated by it. The testing phase of our project includes that when we blow the wind of unknown values, a corresponding voltage is generated and then by putting the voltage value in the equation of the curve fitting graph, we can find the unknown values of wind.

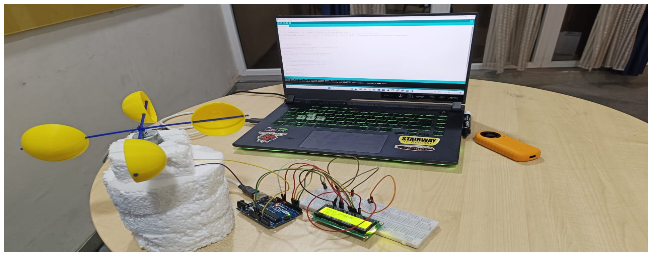


Fig1: Anemometer

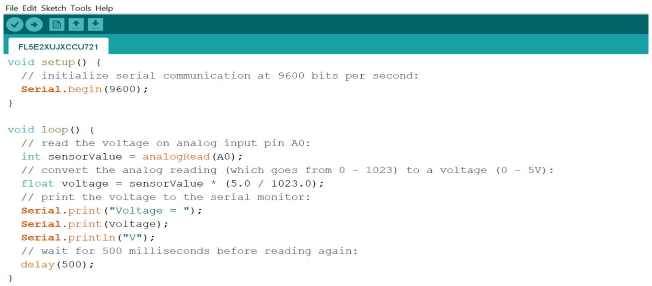
III. INSTRUMENTS REQUIRED\

The following are the instruments required for the making of an Anemometer:

- Arduino UNO
- Breadboard
- Calibrated Anemometer
- 16*2 LED Display
- DC Motor
- 3D Printed Cups of Anemometer
- Jumper Wire
- Resistor
- Hair Dryer

IV. PROCEDURE

Firstly, we start with the training phase of our project that is getting the data for calibration.. We hold the hair dryer at a distance from the Calibrated Anemometer and measure the speed of the wind. Then, we hold the hair dryer at the same distance from our anemometer and the blades of the anemometer start rotating. Due to the movement of the DC motor, it acts as a Dynamo and voltage is generated. We can obtain these values of voltage with the help of Arduino code. The code is:



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```
void setup() {
  // initialize serial communication at 9600 bits per second:
  Serial.begin(9600);
}

void loop() {
  // read the voltage on analog input pin A0:
  int sensorValue = analogRead(A0);
  // convert the analog reading (which goes from 0 - 1023) to a voltage (0 - 5V):
  float voltage = sensorValue * (5.0 / 1023.0);
  // print the voltage to the serial monitor:
  Serial.print("Voltage = ");
  Serial.print(voltage);
  Serial.println("V");
  // wait for 500 milliseconds before reading again:
  delay(500);
}
```

Fig 2: Code to get Voltage value.

We repeat this task several times and note down the values of wind speed and voltage generated by it. The values were as follows:

Wind Speed (m/s)	Voltage Generated (in Volts)
5	0.84
3	0.45
2.4	0.34
2.5	0.44
4.2	0.68
9.6	1
10	1.09
10.5	1.087
11.1	1.26
11.5	1.3
11.6	1.4
11.8	1.6
6.8	0.85

Now, we feed these values into Python code to predict the relationship between wind speed and voltage. We changed the order of the curve fitting graph method to 1,2,3 and so on. We finally stopped when we got the most optimized solution with a minimum error percentage. Thus we get the equation which relates the wind speed and voltage.The python code is :

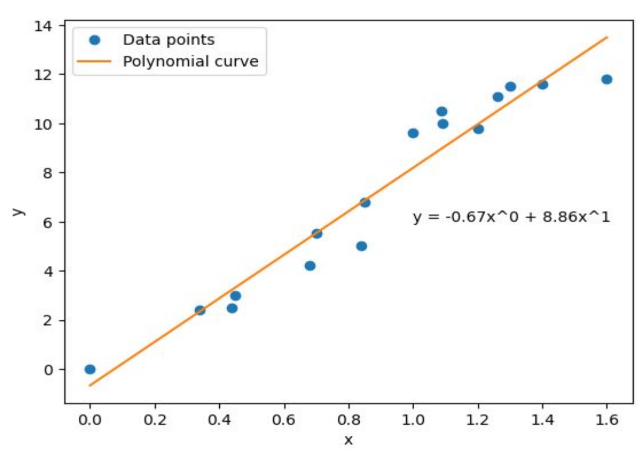

Fig 3: Calibration Curve Wind Speed (m/s) VS Voltage(V)

Now we enter the testing phase of our project. The parameters of the equation are fed into another code to give the wind speed. The code is as follows:

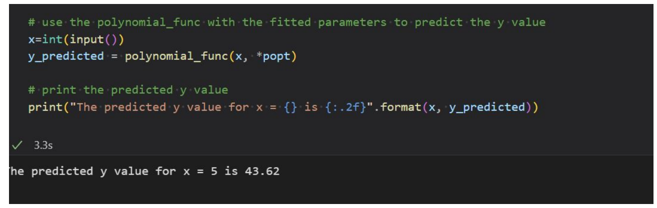

Fig 4: Predicted value of maximum measurable wind speed in our circuit.

We give the blow of wind with unknown values and the corresponding voltage is generated. These voltage values are put in the equation and unknown values of wind are shown in the LED display. The code for this is :

Fig 5: Arduino code that display the wind speed on LCD using the calibration curve.

We can justify that the wind speed which we calculated is correct with the help of a Calibrated Anemometer.

Thus, in this way, we can find the speed of the wind.

V. RESULTS

The curve fitting method helped to establish a relationship between wind speed and the voltage generated by the DC motor. We can use this relation to find wind speed in real-time world.

VI. DISCUSSION

A drawback which may lead to inaccuracies is the use of manually calibrating the anemometer using a hairdryer. The stream of air using a hair dryer is not the same across the whole area and is prone to human error, e.g. when the hand moves.

Also we have used first order curve fitting as the data was proving to be nearly linear and the root mean squared error (rmse) was nearly one.. Fitting higher order like a third degree polynomial brought down the rmse even further but was inaccurate to predict new values as it was overfit. Example we wanted to calculate the theoretical limit for the max wind speed it can possibly measure, that is when the input voltage becomes 5V. the input voltage, we get a negative wind speed which doesn't make any sense. The resulting graph can be seen below.

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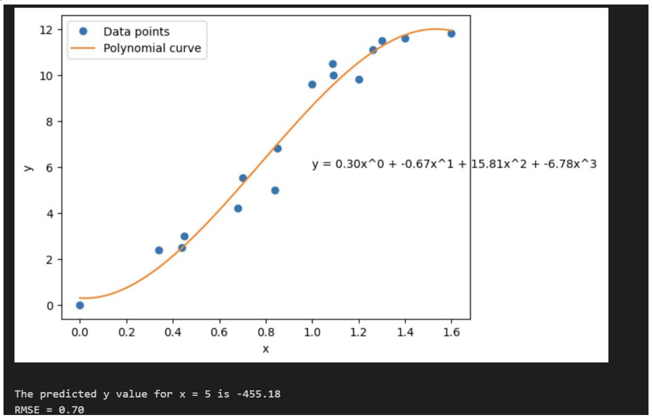

Fig 5: Calibration Curve for a 3rd order polynomial(Over Fitting)

The product's limitation lies in its inability to accurately forecast wind speeds below 2m/s. This is because the weight of the plastic cup-like structures creates more resistance than a wind of 2m/s or less can overcome. As a result, values below this threshold cannot be measured.

VII. REFERENCES

[1] M. Hasan, "Arduino Interfacing With LCD Without Potentiometer," Instructables, May 5, 2019. [Online]. Available: https://www.instructables.com/Arduino-Interfacing-With-LCD-Without-Potentiometer/