# Design and Development of Low Cost Anemometer

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*Abstract*— Wind speed and direction are the two key parameters to characterize wind direction. Their accurate measurement is essential for the efficient operation of wind turbines. Estimating wind speed and direction in outdoor areas with high precision and resolution requires a large numbers of anemometer. Our aim is to design an anemometer using smaller windmills and electret microphones. Smaller windmills and microphones are used for detecting the wind blow direction. The design is more efficient & cost efficient along with the model is windmill type. The design is developed and implemented on Arduino board. Motor driver module L293D is used for interfacing of Arduino and motor. The obtained results are accurate and agree well

***Index Terms*—Arduino, Anemometer, Renewable, Wind**

## I. INTRODUCTION

Electricity generation is the process of generating electric power from sources of primary energy. For the electric power sector, coal-fired plants accounted for 53% of generation, nuclear 21%, natural gas 15%, hydroelectricity 7%, oil 3%, geothermal and other 1%.

There are two types of energy resource, renewable and non-renewable. A non-renewable resource (also called a finite resource) is a resource that does not renew itself at a sufficient rate for sustainable economic extraction in meaningful human time-frames. Non-renewable comes out of ground as liquids, gases and solids. These resources are crude oil (petroleum), natural gas, propane and coal. Petroleum, coal, propane and natural gas are considered fossil fuels because they formed from fossils (remains or impressions of organisms of past geologic ages). Another non-renewable source is nuclear fission power. Non-renewable energy sources cannot be replenished in a short period. They include fossil fuels such as oil, natural gas, coal, and uranium used for nuclear energy.

The main advantages of non-renewable energies is that they are abundant and affordable. For example, oil and diesel are still good choices for powering vehicles. Non-renewable energy is cost effective and easier to product and use. There are reservoirs of non-renewable energy sources throughout the world.

On the other side are the disadvantages to non-renewable energy, that once sources of non-renewable energies are gone they can't be replaced or revitalized. The mining of non-renewable energy and the by-products they leave behind causes damage to the environment. A major disadvantage of non-renewable energy is the challenge of breaking humans of their habit of leaning on it. When fossil fuels are burned, nitrous oxides causes photochemical pollution, sulphur dioxide creates acid rain, and greenhouse gases are emitted. The burning of fossil fuels continues to rise producing high levels of carbon dioxide ($CO_2$) which climatologists believe is a major cause of global warming.Natural resources, known as renewable resources, are replaced by natural processes and forces persistent in the natural environment. There are intermittent and reoccurring renewables, and recyclable materials, which are utilized during a cycle across a certain amount of time, and can be harnessed for any number of cycles. Renewable resources are not subject to depletion in a human timescale. These sources include the solar, waves, rivers, tides, wind, biomass and the heat from radioactive decay in the Earth's core.

## II. BACK GROUND

In 2014,Study of anemometer for wind power generation by Wang Lihua and YUE Dawei describes the application anemometer in wind farms and analyzes the impact of measure error on the total power generation. Then, the comparison of ultrasonic anemometer and hemispherical cup anemometer is present. Finally, different wind conditions are simulated in laboratory. Because there is no real wind farm data sources, the accurate value of power generation affected by the measure error of anemometer cannot be figured out [9].

In 2016, A Remote Anemometer based on hybrid power system by Chun-Liang-Yang presents a remote anemometer considering both optical pumping and wind power system, which can realize a tiny wind speed monitoring system by incorporating an optically pumped laser diode. The proposed remote anemometer can operate effectively at lower wind speed under insufficient wind power energy. This scheme can operate under different wind speeds for sites which need long-distance data transmission but constrained to electricity power [10].

In 2016, Wearable anemometer for 2D wind detection by Shuai Zhao, Peng Jiang, Rong Zhu, and Ruiyi Que presents a small wearable anemometer for detecting two dimensional wind vector by using a micro thermal flow sensor incorporated with a wireless mobile device.
The flow sensor consists of three roundabouts Pt hot-wires uniformly distributed in a circle fabricated on a flexible polyimide substrate using micromachining technique. The anemometer integrates the thermal flow sensor, a miniaturized conditioning circuit with a low power Bluetooth module packaged in a watch-like case, and a personal mobile device that wirelessly acquires sensor data and extracts wind velocity and direction by using an improved algorithm [11].
In 2016, Design & implementation of an efficient windmill anemometer for wind speed measurement using microcontroller by Sree Bash Chandra Debnath; Biki Barua; Rezaul Karim; Muslim Uddin Faisal uses microcontroller PIC 18F2550 to control the circuit that's making the design more efficient & cost efficient along with the model is a windmill type. A wind sensor is used to sense the wind speed and it is fixed to the shaft with a segmented wheel. When the wind blows, the wind sensor sense the wind and the shaft start to rotate continuously relative with wind speed. In the practical environment, our design shows the improved & efficient result. The measurement of wind speed and direction is highly sensitive to flow distortion by obstacles [12].

## III. PROPOSED BLOCK DIAGRAM

The Proposed Block diagram is shown below

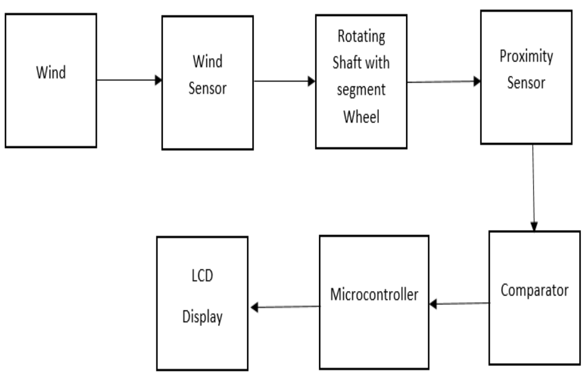



**Fig.1.Block Diagram**

The types of anemometer are
1.Cup Anemometer:
A simple type of anemometer was invented in 1845 by Dr. John Thomas Romney Robinson, of Armagh Observatory. It consisted of four hemispherical cups mounted on horizontal arms, which were mounted on a vertical shaft. The air flow past the cups in any horizontal direction turned the shaft at a rate that was proportional to the wind speed. Therefore, counting the turns of the shaft over a set time period produced a value proportional to the average wind speed for a wide range of speeds. On an anemometer with four cups, it is easy to see that since the cups are arranged symmetrically on the end of the arms, the wind always has the hollow of one cup presented to it and is blowing on the back of the cup on the opposite end of the cross.

**Fig.2. Cup Anemometer**

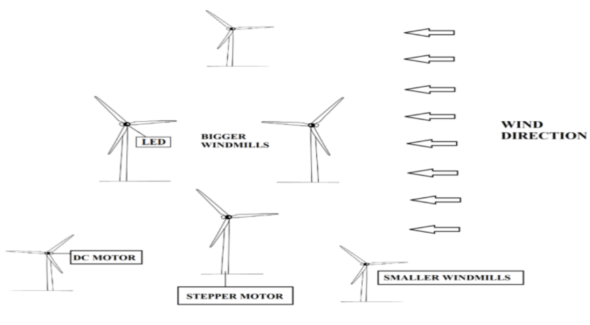
2. Vane Anemometer

One of the other forms of mechanical velocity anemometer is the *vane anemometer*. It may be described as a windmill or a propeller anemometer. Unlike the Robinson anemometer, whose axis of rotation is vertical, the vane anemometer must have its axis parallel to the direction of the wind and therefore horizontal. Furthermore, since the wind varies in direction and the axis has to follow its changes, a wind vane or some other contrivance to fulfill the same purpose must be employed.

**Fig. 3.Vane Anemometer**

## IV.IMPLEMENTATION

The proposed method is shown in fig below



In this method small windmills are used to identify the direction of the wind. DC motors are installed at the apex of the turbine blades. Whenever dc motor rotates back EMF gets generated (Len's law) which induces the current. The amount of current indicates the direction of wind. This information is passed to Arduino. MC will send signal to the stepper motors which are installed at base of the blades. The stepper motor rotates the bigger windmills towards the direction of wind flow

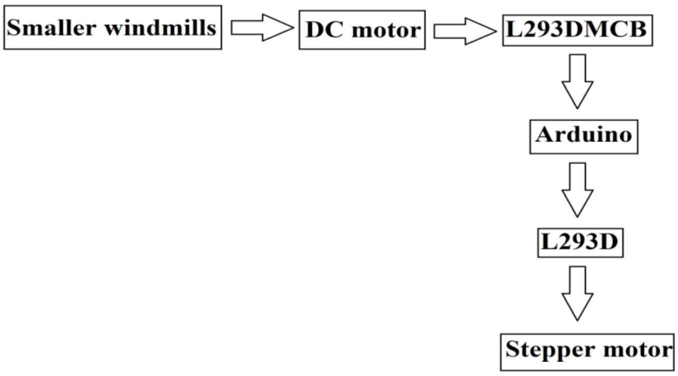



**Fig.5. Block Diagram using small wind mill**

The block diagram consists of smaller windmills, Dc motor, L293D motor driver, Arduino and Stepper motor. The Arduino controls all the operation of the system. The L293D motor control board is used to interface Arduino to stepper motor and Dc motor. L293D allow voltage across the load to be flown in either direction allowing motor to rotate both in clockwise and anticlockwise direction.

Using Electrets Microphone:

In this method Electret microphones are installed at the apex of the turbine blades. Whenever the wind blows, the incoming sound is sensed by the microphone. The incoming sound has to be processed to find out the direction of the wind. This information is passed onto Arduino. Then the microcontroller will pass the signal to the stepper installed at the base of stepper motor which rotates the bigger windmill to the direction of wind.

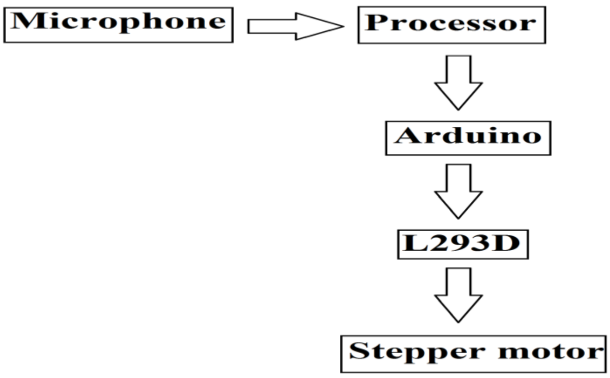



**Fig.6.Block Diagram of Anemometer using Electret Microphone**

Block diagram consists of electret microphone followed by Arduino, L293D and stepper motor. Electret Microphone is a type of electro-static based microphone which eliminates the need for polarizing the supply voltage by using permanently charged terminals. L293D motor control board is used to interface stepper motor to Arduino.

## V.RESULTS

DC motors outputs

```
M1= 32  M2= 29  M3= 221  Current= 1  destination= 1
M1= 32  M2= 29  M3= 221  Current= 1  destination= 1
M1= 33  M2= 29  M3= 222  Current= 1  destination= 1
M1= 32  M2= 29  M3= 222  Current= 1  destination= 1
M1= 32  M2= 29  M3= 222  Current= 1  destination= 1
M1= 32  M2= 29  M3= 222  Current= 1  destination= 1
M1= 32  M2= 29  M3= 222  Current= 1  destination= 1
M1= 32  M2= 29  M3= 222  Current= 1  destination= 1
M1= 32  M2= 28  M3= 215  Current= 1  destination= 1
M1= 32  M2= 29  M3= 222  Current= 1  destination= 1
M1= 32  M2= 29  M3= 205  Current= 1  destination= 1
M1= 32  M2= 29  M3= 222  Current= 1  destination= 1
M1= 32  M2= 29  M3= 222  Current= 1  destination= 1
M1= 32  M2= 29  M3= 199  Current= 1  destination= 1
M1= 32  M2= 29  M3= 222  Current= 1  destination= 1
M1= 32  M2= 30  M3= 203  Current= 1  destination= 1
M1= 32  M2= 29  M3= 223  Current= 1  destination= 1
M1= 31  M2= 28  M3= 202  Current= 1  destination= 1
```

**Fig.7.Serial monitor output**

Case1- From the above figure we can observe that initially M1,M2 &M3 are zero. Hence forth the current and destination will be 1. When the wind flow towards the motor 1 the value sensed by the motor will be displayed in the serial monitor and the current and destination will be equal to 1.

```
M1= 0  M2= 345  M3= 0  Current= 3  destination= 3
M1= 0  M2= 499  M3= 0  Current= 3  destination= 3
M1= 0  M2= 499  M3= 0  Current= 3  destination= 3
M1= 0  M2= 467  M3= 0  Current= 3  destination= 3
M1= 0  M2= 471  M3= 0  Current= 3  destination= 3
M1= 20  M2= 461  M3= 0  Current= 2  destination= 2
M1= 3  M2= 460  M3= 0  Current= 3  destination= 3
M1= 0  M2= 453  M3= 0  Current= 3  destination= 3
```

**Fig.8.Serial monitor output**

Case 2- We can observe that when the wind flows towards motor 2 the value sensed by the motor will be displayed in the serial monitor and current and destination will be 3.

```
M1= 0  M2= 0  M3= 553  Current= 5  destination= 5
M1= 0  M2= 0  M3= 745  Current= 5  destination= 5
M1= 0  M2= 0  M3= 168  Current= 5  destination= 5
M1= 0  M2= 0  M3= 76  Current= 5  destination= 5
M1= 0  M2= 0  M3= 73  Current= 5  destination= 5
M1= 0  M2= 0  M3= 50  Current= 5  destination= 5
M1= 0  M2= 0  M3= 35  Current= 5  destination= 5
```

**Fig.9.Serial monitor output**

Case 3- We can observe that when the wind flows towards motor 3 the value sensed by the motor will be displayed in the serial monitor and current and destination will be 5

.

```
M1= 206  M2= 0  M3= 537  Current= 6  destination= 6
M1= 180  M2= 0  M3= 613  Current= 6  destination= 6
M1= 54  M2= 0  M3= 599  Current= 6  destination= 6
M1= 42  M2= 0  M3= 619  Current= 6  destination= 6
M1= 25  M2= 0  M3= 638  Current= 6  destination= 6
M1= 12  M2= 478  M3= 650  Current= 6  destination= 6
```

**Figure 10.Serial monitor output**

Case 4- We can observe that when the wind flows towards motor 1 and motor 3 the value sensed by the motors will be displayed in the serial monitor and current and destination will be 6.

```
M1= 0  M2= 606  M3= 639  Current= 4  destination= 4
M1= 0  M2= 489  M3= 589  Current= 4  destination= 4
M1= 0  M2= 481  M3= 581  Current= 4  destination= 4
M1= 0  M2= 490  M3= 162  Current= 4  destination= 4
M1= 0  M2= 484  M3= 111  Current= 4  destination= 4
M1= 174  M2= 480  M3= 80  Current= 4  destination= 4
M1= 32  M2= 475  M3= 45  Current= 4  destination= 4
M1= 179  M2= 461  M3= 31  Current= 4  destination= 4
M1= 207  M2= 471  M3= 14  Current= 4  destination= 4
```

**Fig.11. Serial monitor output**

Case 5- We can observe that when the wind flows towards motor 2 and motor 3 the value sensed by the motors will be displayed in the serial monitor and current and destination will be 4.

```
M1= 174  M2= 480  M3= 80  Current= 4  destination= 4
M1= 32  M2= 475  M3= 45  Current= 4  destination= 4
M1= 179  M2= 461  M3= 31  Current= 4  destination= 4
M1= 207  M2= 471  M3= 14  Current= 4  destination= 4
M1= 191  M2= 454  M3= 0  Current= 2  destination= 2
```

**Fig.12. Serial monitor output**

Case 6- We can observe that when the wind flows towards motor 1 and motor 2 the value sensed by the motors will be displayed in the serial monitor and current and destination will be 2.

## Microphone outputs

Case1- From the above figure we can observe that initially M1, M2 &M3 are zero. Hence forth the current and destination will be 1. When the wind flow towards the microphone 1 the value sensed by the motor will be displayed in the serial monitor and the current and destination will be equal to 1.

```
M1= 32  M2= 28  M3= 30  Current= 1  destination= 1
M1= 32  M2= 27  M3= 29  Current= 1  destination= 1
M1= 31  M2= 28  M3= 29  Current= 1  destination= 1
M1= 32  M2= 28  M3= 29  Current= 1  destination= 1
M1= 32  M2= 28  M3= 29  Current= 1  destination= 1
M1= 32  M2= 28  M3= 29  Current= 1  destination= 1
M1= 32  M2= 28  M3= 29  Current= 1  destination= 1
M1= 32  M2= 28  M3= 29  Current= 1  destination= 1
M1= 1018  M2= 28  M3= 30  Current= 1  destination= 1
```

**Fig.13. Serial monitor output**

```
M1= 32  M2= 1017  M3= 29  Current= 3  destination= 3
M1= 32  M2= 28  M3= 28  Current= 3  destination= 3
M1= 32  M2= 28  M3= 29  Current= 3  destination= 3
M1= 32  M2= 28  M3= 29  Current= 3  destination= 3
M1= 32  M2= 28  M3= 30  Current= 3  destination= 3
M1= 31  M2= 28  M3= 29  Current= 3  destination= 3
```

**Fig.14.Serial monitor output**

Case 2- We can observe that when the wind flows towards microphone 2 the value sensed by the motor will be displayed in the serial monitor and current and destination will be 3.

```
M1= 31  M2= 28  M3= 1016  Current= 5  destination= 5
M1= 32  M2= 28  M3= 29  Current= 5  destination= 5
M1= 32  M2= 28  M3= 30  Current= 5  destination= 5
M1= 31  M2= 27  M3= 1017  Current= 5  destination= 5
M1= 32  M2= 28  M3= 30  Current= 5  destination= 5
```

**Fig. 15. Serial monitor output**

Case 3- We can observe that when the wind flows towards microphone 3 the value sensed by the motor will be displayed in the serial monitor and current and destination.

## CONCLUSION

The ultimate target that has been met is to build an efficient & cost effective windmill type anemometer. The proposed anemometer is easier to use than the existing Anemometer. The average cost (market cost) for conventional anemometer is around 60$ to 300$ with different function any attachment. But on that contrary our design cost 30$, that's cheaper than market prices. Finally, the proposed method rotates the windmills towards the direction of wind.

## REFERENCES

[1] T. W. W. E. Association, "2014 half year report," Bonn, Germany, Tech. Rep., 2014, reference.

[2] S. S. Soman, H. Zareipour, O. Malik, and P. Mandal, "A review of wind power and wind speed forecasting methods with different time horizons,"in North American Power Symposium (NAPS), 2010. IEEE, 2010, pp.1–8.

[3] G. K. K. Reddy, S. V. Reddy, and T. K. Ramkumar, "Development of Hall sensor propeller anemometer for measuring wind speed using embedded controller," in Communications, Devices and Intelligent Systems (CODIS), 2012 International Conference on, 2012, pp. 484-487.

[4] J. Laconte, B. Rue, J.P Raskin, and D. Flandre, "Fully CMOS-SOI compatible low-power directional flow sensor", Sensors,2004.Proceedings of IEEE, 2004, vol.2, p 864 – 867.

[5] S.M. Ferdous, Muhammad Rokonuzzaman, Syedus Salehin, ArifaFerdousi, Tanvin Hossaine "Design and Implementation of a Linear IC Based Low Cost Digital Tachometer for Laboratory and Industrial Application (MIEI0-104)" International Conference on Mechanical, Industrial and Energy Engineering 2010, 23-24 December, 2010, Khulna, Bangladesh.