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Design of MPPT for Wind Power System

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Abstract

Wind energy, even though abundant, varies continually as wind velocity varies in magnitude and direction over a time period. As the wind turbine's rotation depends upon the availability of wind force and if the wind turbine axis is not completely aligned with the wind velocity a significant amount of wind energy is left un-extracted. Our idea is to implement the object sensor in windmill which would sense the wind's direction and align the turbine axis with it. At present they are using anemometer for controlling the direction of the windmill. Compared to that our system would be more effective for controlling the direction, while the anemometer is replaced by object sensor. The microcontroller directly communicates with the object sensor and it is programmed in such a way that it can trace out where the wind flow is occurring. And on the basis of that, the microcontroller would rotate the wind turbine hub using servomotor or stepper motor.
Keywords- MPPT, Wind Power System

I. INTRODUCTION

In this globalizing world, there has been such a contrivance in the electrical discipline. In recent time, there has been such an exploration of renewable energy and manipulate that renewable energy sources into a generation of electricity. By the way, of illustration solar energy, wind energy etc. hence it becomes significant to acquire that maximum energy into a generation of electricity.

Therefore, this project is based on obtaining maximum power for the windmill. Wind direction or wind plane does not always remain in the one direction there is a lot of movement according to the weather. In this project when the turbine axis is parallel to the direction of maximum wind velocity, the maximum energy of the wind can be extracted.

Therefore, the MPPT system would sense the direction of highest wind velocity and align the turbine axis with that. In this way, turbine axis would always be aligned with the direction of maximum wind velocity. Here in the projected sensor will sense the direction of maximum wind velocity and provide the s/g to the microcontroller in response microcontroller generate the code on the.

II. AIM AND OBJECTIVE

The basic motive for adoption this project is to acquire maximum energy from renewable sources such as wind into a generation of electrical energy. There are many ways to get maximum power, but in this project with the use of a sensor, which detects where the maximum wind velocity is and according to that servomotor rotates and that is how maximum energy is manipulated into the generation of electrical energy.

III. PROBLEM SPECIFICATION

In the previous ten years, there has been such adoption of renewable energy sources for generation of electricity. However, their efficiency is very low because of fluctuation in weather. Therefore, it cannot generate maximum power, so it is significant to utilize the more renewable energy sources. Therefore, this project is to obtain maximum power and thus increasing efficiency. The table given below shows data of windmill of one day. [1]

Table 1: The graph illustrates change in wind speed throughout the day

Date	Time	Wind Low	Wind Avg	Wind Max	Avg Direction
8 Jun	21:30	7	10	15	S (167°)
8 Jun	21:00	7	11	13	S (195°)
8 Jun	20:30	7	11	14	S (200°)
8 Jun	20:00	8	11	14	S (173°)
8 Jun	19:30	8	11	14	SE (148°)
8 Jun	19:00	8	11	14	S (164°)
8 Jun	18:30	7	11	14	S (195°)
8 Jun	18:00	7	11	14	S (177°)
8 Jun	17:30	8	12	14	SE (152°)
8 Jun	17:00	6	12	13	SE (139°)

8 Jun	16:30	7	10	13	S (178°)
8 Jun	16:00	7	11	13	S (194°)
8 Jun	15:30	6	11	13	S (193°)
8 Jun	15:00	8	10	13	SW (206°)
8 Jun	14:30	8	10	12	SE (157°)
8 Jun	14:00	8	11	11	SE (151°)
8 Jun	13:30	7	11	14	S (184°)
8 Jun	13:00	6	10	13	S (176°)
8 Jun	12:30	7	10	13	S (182°)
8 Jun	12:00	7	11	13	S (182°)
8 Jun	11:30	7	10	13	S (167°)
8 Jun	11:00	8	10	13	S (191°)
8 Jun	10:30	8	10	12	S (161°)
8 Jun	10:00	8	10	13	SE (135°)
8 Jun	09:30	8	11	14	S (196°)
8 Jun	09:00	6	10	13	E (105°)
8 Jun	08:30	8	11	14	S (180°)
8 Jun	08:00	7	11	15	SE (150°)
8 Jun	07:30	6	10	13	S (185°)
8 Jun	07:00	7	11	13	S (159°)
8 Jun	06:30	8	12	14	W (261°)
8 Jun	06:00	6	12	14	S (186°)
8 Jun	05:30	7	12	14	SE (125°)

Fig. 1: Variation of wind speed throughout one day [2]

IV. PROPOSED SOLUTION

Our system is based upon object sensor and weathervane. The weathervane immediately aligns itself in the direction of maximum wind velocity, and the object sensor (IR sensor) detects this change immediately and gives this signal to microcontroller. In microcontroller program is loaded which is the response of servomotor with respect to the IR proximity sensor. This is how servomotor gets signal through microcontroller and rotates the wind blade plane to the direction of maximum wind speed. Here IR sensor detects maximum wind velocity in microsecond, which is significantly lower than the present system, this makes our system ultra-responsive.

V. BLOCK DIAGRAM & FLOWCHART

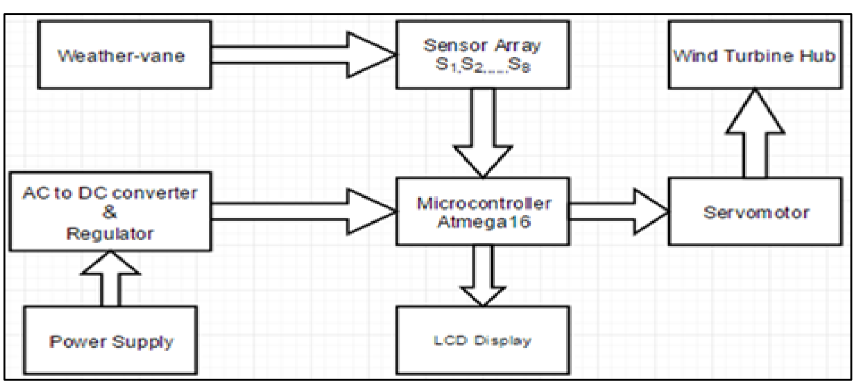


Fig. 2: Block-Diagram

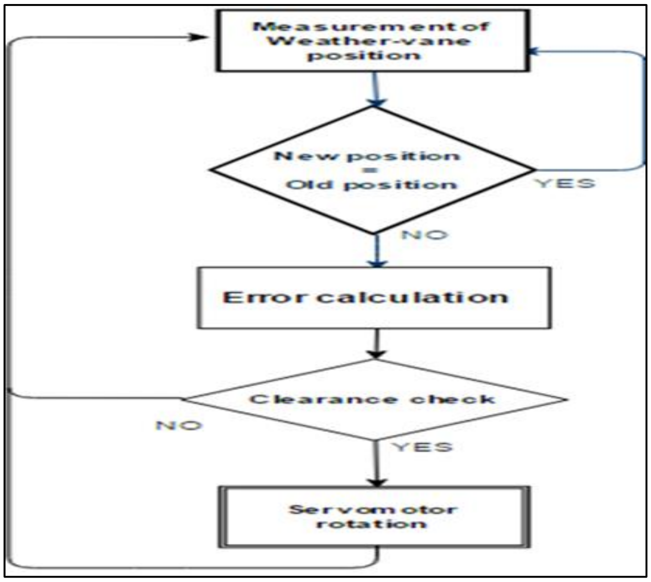


Fig. 3: Flowchart

VI. SIMULATION

We have used Proteus 8 Professional for designing the electrical circuit and simulating it. All the parts of the electrical system are first designed and simulated in Proteus before constructing it on the GPB (general purpose board). The following electrical components are designed and simulated in Proteus: [3]

A. Power Supply

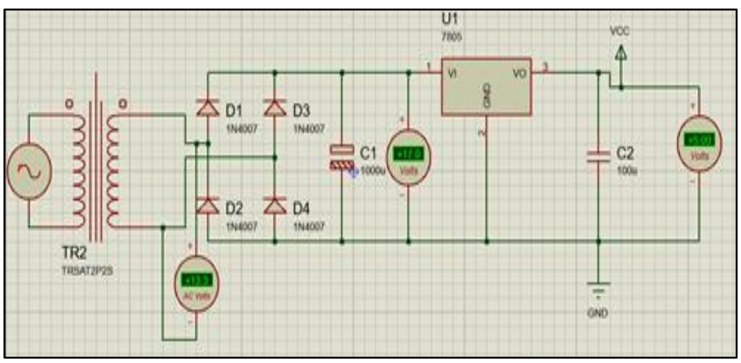


Fig. 4: Simulation of Power Supply

We have used Proteus 8 Professional for designing the electrical circuit and simulating it. All the parts of the electrical system are first designed and simulated in Proteus before constructing it on the GPB (general purpose board). The following electrical components are designed and simulated in Proteus:

B. Microcontroller and IR-Sensor

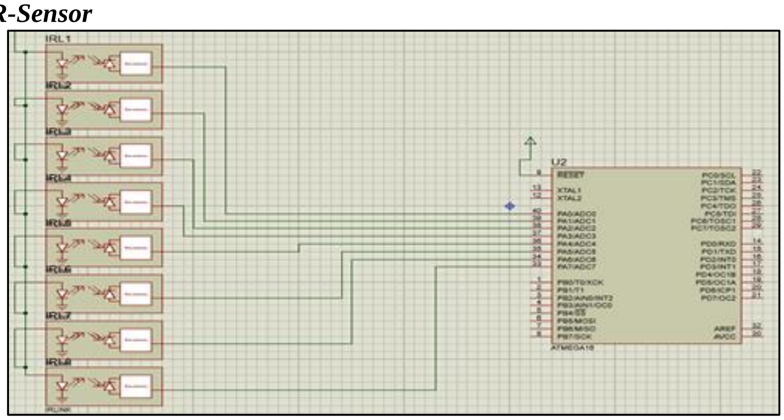


Fig. 5: Simulation Microcontroller and IR-Sensor

The IR proximity sensors are connected to the controller and a test program is loaded into the controller to see whether it is reading the input from the IR proximity sensor.

C. Microcontroller and Servomotor

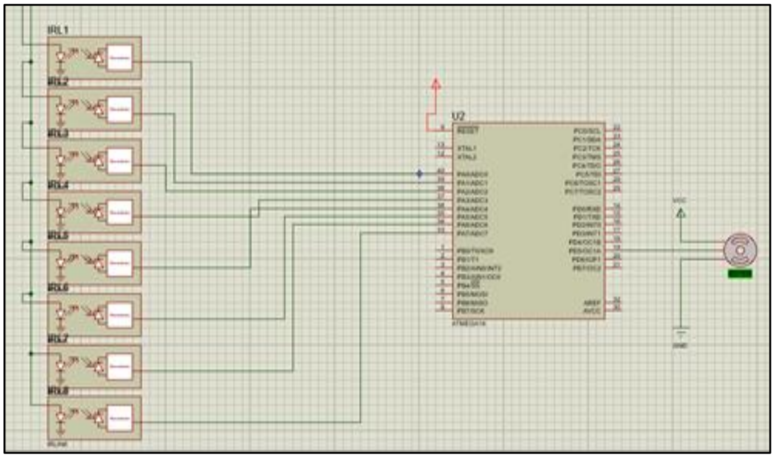
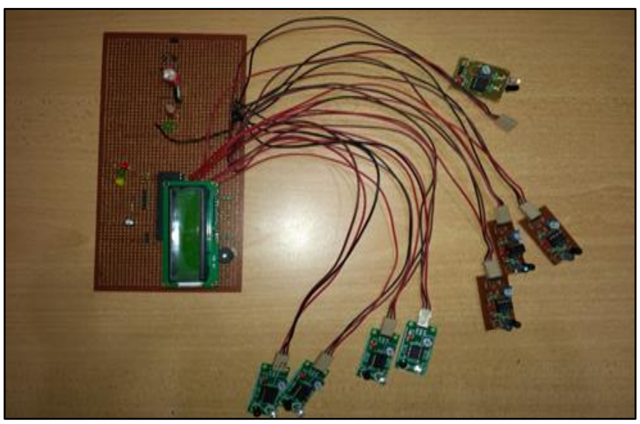
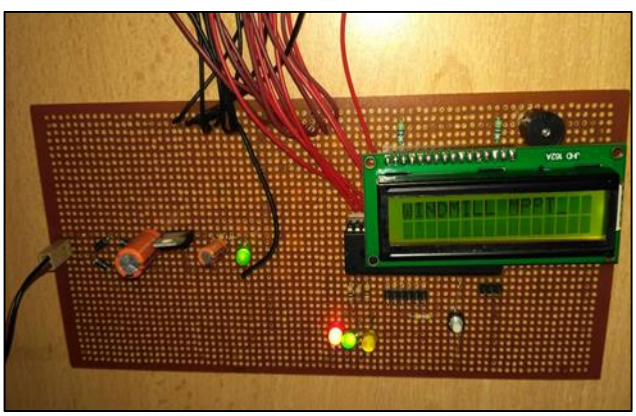


Fig. 6: Simulation of Controller Circuit

The servomotor is added to the circuit and again a test program is loaded to check the response of servomotor with respect to the IR proximity sensor. Due to unavailability of the mechanical components like weathervane and reflector, the actual output of the system cannot be verified in the software simulation. Nevertheless, as the electrical simulation works as per our requirement, so we constructed it on the GPB. Once the electrical system is constructed, it is assembled with the mechanical system and the hardware test is conducted.

VII. HARDWARE





The above shows the electrical hardware and its' testing use a test program. The power supply, microcontroller, IR proximity sensor and LCD display is been connected.

The above figure shows the whole project assembled. The weathervane, PVC shaft and the reflector for the IR proximity sensor forms the mechanical system. The IR proximity sensor, microcontroller and power supply system forms the electrical system. The servomotor is not shown in the figure because it is not connected as a part of this system. It is connected separately with a wind-turbine dumpy on its shaft to show the rotation of the wind turbine.

VIII. CALCULATION OF MPPT

$$P = \frac{E}{t}$$

(1.1)

Where,
E = Kinetic Energy
T = Time
P = Power

$$\text{WIND POWER} = 0.5 * A * \rho * V^3 \quad [4]$$

(1.2)
From equation (1.1)

$$E = P * t$$

Putting equation (1.2) in (1.1)

$$E = 0.5 * A * \rho * V^3 * t$$

(1.3)
Calculating for 30 minuet interval of time
Amenometer takes two to three minutes for detection and changing the direction of wind. On the other hand our system takes microseconds for the same process.
Let us take wind speed v = 15 m/s for the 30 minutes time interval.
In equation (1.3)

$$0.5 * a * \rho = K(\text{constant})$$

Therefore,

$$E = K * V^3 * t$$

Here let we assume wind direction changes one time for this duration.
Amenometer consume two minutes for reacting the change. So let say for that two minutes the speed of wind is around 12m/s.
For 28 minutes

$$E_1 = K * 15^3 * 28$$
$$E_1 = 94500K$$

For 2 minutes

$$E_2 = K * 12^3 * 2$$
$$E_2 = 3456K$$

So, the total energy for anemometer would be,

$$E = E_1 + E_2$$
$$E = 94500K + 3456K$$
$$E = 97956K$$

This system works with microcontroller so its reaction time is very high. For that reason the wind speed remain same for 30 minutes.
So, the total energy for this system would be,

$$E = K * 15^3 * 30$$
$$E = 101250K$$

IX. CONCLUSION

As per our calculation, anemometer generate 95976K power and this project can generate 101250K power which is 5.49% more power than anemometer. So this project can improve efficiency. The present wind turbine generator used is not more than 2MW, for them, the wind velocity is usually of not that concern because it is already more than enough to rotate the turbine at maximum speed. However, many companies are nowadays building a generator rating as high as 4-6MW, which would require the turbine to be aligned with the direction of maximum wind speed. Therefore, in the future, there would be a requirement of wind direction system to be very accurate and highly responsive, to aid the higher rated generators.

REFERENCES

[1] https://www.ncdc.noaa.gov
[2] http://climate.weather.gc.ca
[3] http://www.circuitstoday.com/proteus-software-introduction
[4] https://www.raeng.org.uk/publications/other/23-wind-turbine