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# WIND MILL AUTOMATION USING ARDUINO AND SCADA SYSTEM

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**ABSTRACT:** The requirement to harness renewable energies like SOLAR, WIND, TIDEL in the recent decades are increasing, so these fields need lot of innovation to get maximum results. A lot of concern regarding the problems faced in harnessing them like maintenance and continuous monitoring of those systems. Here in this project we automate the Wind Turbine by using ARDUINO which provides a control over the wind turbine like orientation to the wind, propeller control and fail safe conditions. And also, to monitor number of wind turbines collectively in a particular area from a remote locality with the use of SCADA Systems.

**KEYWORDS:** arduino, wind sensor, motor shiel, potentiometer, voltage swnsor module.

## 1 INTRODUCTION

Since past two decades, there have been many energy related crises experienced due to depletion of fossil fuels e.g. coal and oil; and environmental concerns resulting from the fuel consumption. The most effective utilization of renewable energies, like wind and solar energy etc. are highly anticipated instead of the fossil fuels like petroleum and coal [4].

A windmill is a setup that converts the energy of wind into rotational energy by means of sails or blades. The majority of modern windmills take the form of wind turbines used to generate electricity.

Today's wind turbines are manufactured in a wide range of vertical and horizontal axis types. The smaller turbines are used for applications such as battery charging for auxiliary power for boats to power traffic warning signs. A wind turbine used for charging batteries may be referred to as a wind charger. Slightly larger turbines can be used for making small contributions to a domestic power supply while selling unused power back to the utility supplier via the electrical grid. Many large turbines, known as wind farms, are becoming an increasingly important source of renewable energy and are used by many factions as part of a strategy to reduce their dependency on fossil fuels.

In 1919, by the German physicist Albert Betz proposed Betz's law which indicates the maximum power that can be extracted from the wind, independent of the design of a wind turbine in open flow. Basedon Betz's law, no turbine can capture more than 16/27(59.3%) of the kinetic energy in wind. The factor 16/27 (0.593) is known as Betz's coefficient. Practical utility-scale wind turbines achieve at peak 75% to 80% of the Betz limit.

In order to achieve the maximum Betz limit, the windmill should be oriented towards the incoming wind and control the blades based on the wind speed. A nacelle is the center hub of a wind turbine, with blades attached to it, and it is a key component to be controlled to ensure that the wind turbine face the incoming wind to capture the energy. Ideally, the nacelle orientation and the wind course should be opposite to each other. In this era of huge energy demands and shortage of the existing conventional energy sources, wind energy is one of the most established and cost-effective renewable energy sources.

Wind power, as an alternative to fossil fuels, is plentiful, renewable, extensively distributed, no greenhouse gas emissions during operation and uses minimal land.

## 2 EXISTING

According to the research, a non-effective control system may not be able to adjust the nacelle to its proper position, which can be a soft failure; or, in the worst-case scenario like a shaft failure, the nacelle orientation is completely hooked at one direction since the turbine is shut down, which is a hard failure. In the SCADA (supervisory control and data acquisition) data set of wind turbines, there are lots of measurement variables, on ambient weather conditions, power, other electrical measures, and some mechanical measures. They have observed that the nacelle alignment exhibits a much more irregular or volatile pattern than the other variables, but the relationship between the wind course and nacelle alignment is still effective to indicate an abnormal health state [1]. A research was going on about a monitoring wind turbine wirelessly using Arduino. They have employed an Arduino based wireless system that measures and transmits the different electrical and mechanical parameters of the turbine. The parameters that were monitored are current, voltage, speed and vibration in the turbine. Moog Industries has made this setup of windmill orientation based on various parameters by using separate motion controllers. They have their own pitch system, yaw system with separate motion controllers [2].

Providing an automation solutions for the wind sector which is used to monitor and diagnose the wind farms. Provide automation solutions for wind farms (at farm and at remote levels) using Symphony Plus platform

- S+ Operation as SCADA solution for the remote-control center
- S+ Operations and PLC for SCADA and control system at the farm level Monitor relevant signals and diagnose the wind farms to minimize downtime of turbines and improve their efficiency

Providing a software solution to increase the value of renewables in order to turn renewables into a reliable generation basis. Provide control abilities and aggregation in (larger) virtual power plants to enable the integration of renewables into the power system planning and operations through flexible control and forecasting of power production Provide amplified control, predictive service and maintenance solutions to reduce the cost of renewable energy [3].

### POWER FROM WIND TURBINE

The power rises as cube of the wind velocity and can be calculated with respect to area in which the wind and wind velocity is available. When wind is in motion, the energy produced is kinetic energy. Hence the power from turbine is related to the kinetic energy produced.

Kinetic Energy = 1/2 MV2.

The volume V' flowing in unit time through an area A, with wind speed V is denoted by AV and mass M is the product of Volume V' and density ρ so: M = ρAV

putting the M in equation of kinetic energy we get: Kinetic Energy = 1 2 (ρAV)V2 = 1 2 (ρAV3)

But Power is nothing but the kinetic energy generated by the turbine. Hence, Power = 1 2 (ρAV)V2 = 1 2 (ρAV3)

Where: Air Density ($\rho$) = 1.225 kg/m3 Area (A) = Swept Area of turbine blades Velocity (V) = wind speed in m/s.

### GENERATOR

The generator converts mechanical energy of the shaft into electrical energy output. While designing the axial flux generator observation can be noted that the operating capacity of generator depends on permanent magnet alternators. For these generators air gap is arranged in perpendicular direction to rotating axis and hence produces magnetic fluxes in parallel direction to rotating axis.

### HOW POWER IS GENERATED

Wind turbines serve as a means to transform the kinetic energy of wind into power. This process begins when wind contacts the turbine blades and transfers some of its kinetic energy to them, forcing them to rotate. Since the blades are connected to the main shaft through the rotor, the shaft rotates as well, creating mechanical energy. The main shaft is usually connected to a gear box which rotates a parallel shaft at about 30 times the rate of the main shaft. At high enough wind speeds, this amplification creates sufficient rotational speeds for the generator electrical output. Generators generally used in turbines are off-the-shelf and use electromagnetic induction to produce an electrical current. In these generators permanent magnets are arranged surrounding a coil. The shaft connects to the magnet assembly, spinning it around the stationary coil of wire and creating a voltage in the wire. The voltage is what drives the electrical current out of the wire and into power lines to be distributed [5].

### ARDUINO (REV C) ATMEGA328P

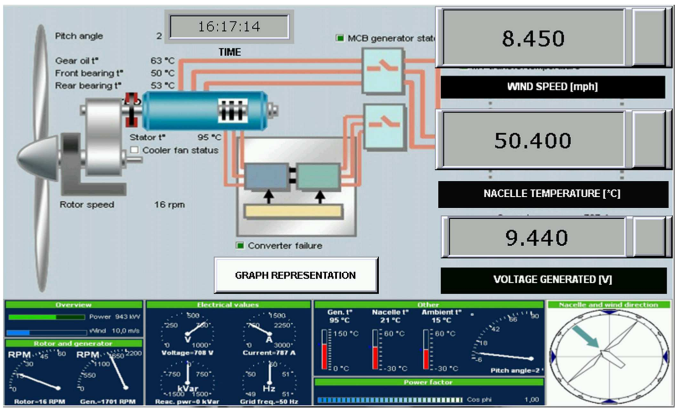
Arduino/Genuino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform. The ATmega328 on the Arduino/Genuino Uno comes preprogrammed with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol.

### SERVOMOTORS

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors. The motor is paired with some type of encoder to provide position and speed feedback. In the simplest case, only the position is measured. The measured position of the output is compared to the command position, the external input to the controller. If the output position differs from that required, an error signal is generated which then causes the motor to rotate in either direction, as needed to bring the output shaft to the appropriate position. As the positions approach, the error signal reduces to zero and the motor stops.

### WIND SENSOR

Wind sensor rev C is used here. The Wind Sensor is a thermal anemometer based on a traditional technique for measuring wind speed. The technique is called the “hot-wire” technique, and involves heating an element to a constant temperature and then measuring the electrical power that is required to maintain the heated element at temperature as the wind changes. The sensor can be switched off to save power, but at start-up needs to be allowed to warm up about 10 seconds to thermally stabilize for best accuracy. This time interval allows the sensing thermistor to heat up to operating temperature. The Wind Sensor includes a small trim pot that is used to calibrate the sensor for zero wind. Calibration is simple. Simply put a glass over the sensor to block any breeze and adjust the pot for the desired zero level. We calibrate the sensors roughly for .5V of output at zero wind with a six-volt supply, but you are free to calibrate as desired. A lower calibration point, say .2 V will result in a little more sensing capability at the high end. Using a higher voltage supply will require recalibration. Do not use supplies higher than about 10 volts. A regulated supply is highly recommended.



#### VOLTAGE SENSOR MODULE

This module is based on resistance point's pressure principle, and it can make the input voltage of red terminal reduce 5 times of original voltage.

The max Arduino analog input voltage is 5 V, so the input voltage of this module should be not more than 5 V x 5 = 25 (if for 3.3 V system, the input voltage should be not more than3.3Vx5=16.5V). Because the Arduino AVR chip have 10 bit AD, so this module simulation resolution is 0.00489 V (5 V / 1023), and the input voltage of this module should be more than 0.00489 V x 5 = 0.02445 V.

1. Voltage input range: DC 0-25 V
2. Voltage detection range: DC 0.02445 V-25 V
3. Voltage analog resolution: 0.00489 V
4. DC input interface: red terminal positive with VCC, negative with GND.

It will sense the voltage which was generated by the windmill and it shows the voltage generated.

#### POTENTIOMETER

A potentiometer is an instrument for variable potential (voltage) in a circuit. Before the introduction of the moving coil and digital volt meters, potentiometers were used in measuring voltage. In this arrangement, a fraction of a known voltage from a resistive slide wire is compared with an unknown voltage by means of a galvanometer. The sliding contact or wiper of the potentiometer is adjusted and the galvanometer briefly connected between the sliding contact and the unknown voltage. The deflection of the galvanometer is observed and the sliding tap adjusted until the galvanometer no longer deflects from zero. At that point the galvanometer draws no current from the unknown source, and the magnitude of voltage can be calculated from the position of the sliding contact. This null balance measuring method is still important in electrical metrology and standards work and is also used in other areas of electronics.

## 3 PROPOSED SYSTEM

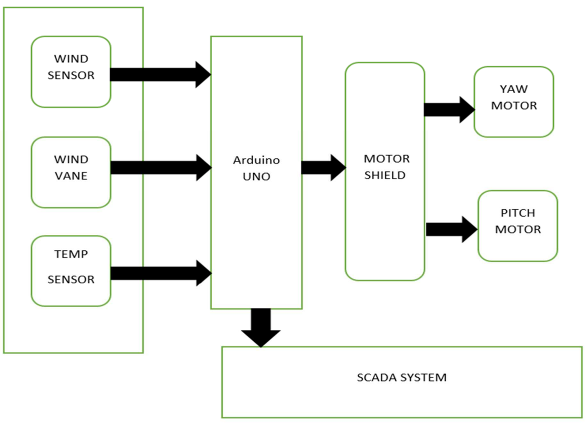
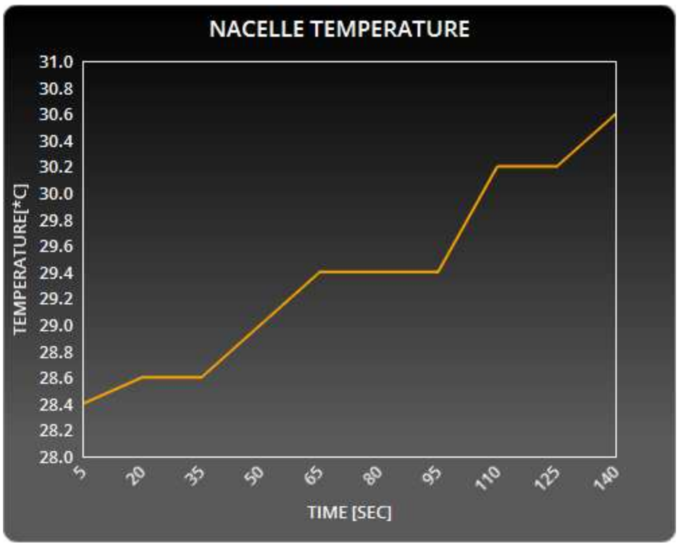



***Fig.1 Block Diagram Representation of the System***

Wind sensor is at the transmitter side to sense the speed of the wind and send the signal to the Motor shield through the Arduino UNO. Arduino UNO is at intermediate stage to control the process. Wind vane is to determine the wind direction, a wind vane spins and points in the direction from which the wind is coming and it generally has two parts or ends: one that is usually shaped like an arrow and turns into the wind and the other end is wider so that it catches the breeze. Temperature sensor senses the temperature of the nacelle and sends the signals to the Arduino UNO.




As the wind sensor senses the speed of the wind it gives signals, if the speed of the wind is more than 40 miles/hour the Arduino gives the input to the pitch motor such that the pitch control is activated and the blades rotate into 90 degrees to avoid the damage for blades. The pitch control always serves the essential purpose of setting wind turbine blades at the best angle to the wind to turn the rotor.

As the wind vane determines the direction of the wind with the help of a potentiometer, the signals of the potentiometer are sent to the Arduino UNO by which yaw motor orients the nacelle towards the wind direction to ensure that wind turbine always faces exactly into the incoming wind.

The signals from wind sensor, wind wane and the temperature sensor are sent to the Arduino UNO and from this it is sent to SCADA to monitor the turbines parameters to form a single platform. By using SCADA a lot of functions can be performed from a remote locality.

## 4 RESULT AND DISCUSSION

From the natural resources we can obtain an electricity through windmill. Automated windmill provides centralized system, controlled and monitoring that far from a distance which are in remote location, this is possible by the help of SCADA system. SCADA which informs the windmill details like speed of the windmill, nozzle temperature, voltage which is regulated by the windmill through this we can monitor the windmill from the centralized area.

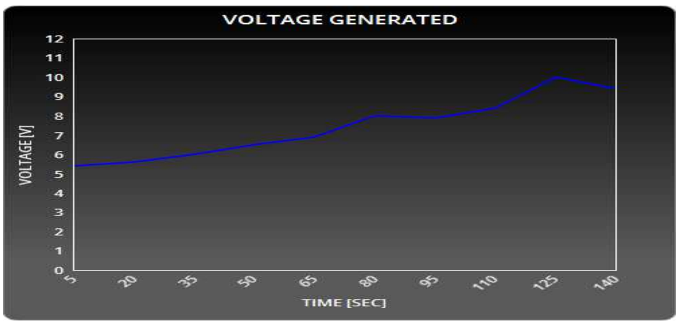



***Fig 2 VOLTAGE SENSOR GRAPH***

From the fig.2 the Voltage values indicated in the SCADA system through the voltage sensor module which is been generated from the wind mill in a graphical manner.

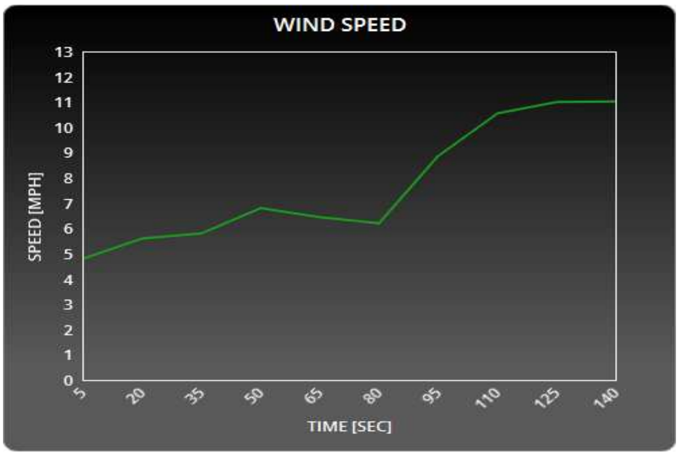



*Fig 3 WIND SENSOR REV C GRAPH*

Fig.3 labels the wind speed, SCADA which indicates the speed of windmill in a graphical chart which is provided by the wind sensor REV C is used for the pitch control of the wind mill.

## 5 Conclusion

In recent decades automation has taken over each and every industry to obtain maximum output with minimal human interference. So, automating the windmill will provide various advantages. Most of the windmills used are partially automated with various controllers. Automating with monitoring becomes very convenient if it is centralized and controlled from a remote locality, implementing a centralized system collectively for numerous windmills or a wind farm will be economical and more informative.

Employing the automation system based on Arduino and SCADA system will harness more energy from the wind with proper orientation to the wind with good safety features. Centralized SCADA system for a whole wind farm will make all the windmill to be in a single controlled structure. Advancement in the windmill industries are most welcomed as there is more necessity to harness green energy in order to tackle global warming and depleting fossil fuels. It also provides effective change in the windmill industries at effective cost and in an efficient manner. Thus the work results in designing better automated and efficient windmills.

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