Integration of Sensors on the UNH Wind Turbine

Andrew Hearn
Mechanical and System Engineering
Dr. Maria-Isabel Carnasciali, Mechanical Engineering
Dr. Sam Daniels, Mechanical Engineering, PE

Abstract

Though wind energy is seen as a main source for renewable energy, implementation of wind turbines is not as prevalent as other forms of renewable energy, such as solar panels. Research is underway to understand small-scale wind turbines that may be suitable for residential installations. The Mechanical Engineering department has a small wind turbine for students to conduct research on. The turbine is currently mounted on the roof of the Tagliatela College of Engineering building. The purpose of this 2014 SURF project was to integrate sensors on the turbine enabling data to be collected. It is important to collect data, such as wind speed, atmospheric pressure, air temperature, etc. to facilitate an understanding of the performance of the wind turbine. Data is collected using various sensors such as, a weather station, which has barometric sensors, temperature sensors, and wind sensors. Another type of sensor implemented was a current sensor, which is used to measure the current being produced by the turbine, once a load was placed on the turbine. The data being collected will be analyzed through data acquisition software, in particular with the use of LabView™.

Introduction

A common renewable source of energy is wind energy. A wind turbine is a common way to harness wind energy and convert it into electrical energy. The wind turbine is made up of a nacelle, blades, tower, and base; these parts are labeled in Figure 1. Inside the nacelle there is a generator that has an input shaft connected to the blades. As wind travels over the blades the generator is transforming wind energy into mechanical energy.

There are two common types of wind turbines, the Vertical Axis Wind Turbine (VAWT) and the Horizontal Axis Wind Turbine (HAWT).

In a HAWT the rotation axis is horizontal to the ground. The turbine being used for this study is a small scale HAWT. The turbine is made by Sunforce® and is rated for 600W. The blades measure in length 22.5 inches each.

Figure1: Sketch depicting the various parts of a Horizontal Axis Wind Turbine [4].

Sensors Integrated

The first task was to integrate sensors that will provide RPM, voltage and current data. A weather station with a PC interface is being used to gather data on wind speed, wind direction, humidity, barometric pressure, and the amount of rain over a period time.

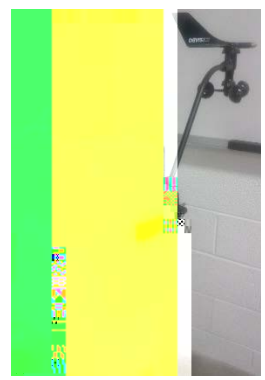

Figure 2: Depicts the weather station and the display

We are also using current sensors to measure the current being supplied by the turbine. A similar setup had been implemented for a solar panel data collection setup; the circuitry was replicated for the turbine station.

The last device being used to gather data is a Data Acquisition Card (DAQ Card) connected to the PC. This collects the data for frequency, voltage and current sensor outputs. The integration of the DAQ Card via LabView™ is critical to collect data. With the data collected we will be able to better understand small wind turbines under different environmental conditions. These sensors are important in that, they will allow us monitor the turbine and draw different analysis based on performance. This will generate a set of baseline data. If any chang

In order to measure the RPM of the turbine we need to measure and record the frequency using a DAQ Card. The DAQ Card measurements can be analyzed through a program called LabView™.

The peak voltage has to be less than +/-10 volts in order to be wired to the DAQ Card. Since, the turbine output measurement needed to be high impedance, we connected 6 resistors in series then wired the two leads of the resistors between two phase outputs of the 3 phase AC turbine. At that point the DAQ Card could be connected to one of the 6 resistors dropping the voltage to 1/6th of the actual voltage coming out of the turbine. This idea is based on Kirchhoff's Voltage Law. In order to test this, the peak and RMS voltages were measured before adding any resistors and then measured again using a new resistor circuit. Measurements were taken by using a digital multi meter (DMM).

Results

Figure 3 shows the series of resistors used to scale the peak voltage down. The two leads of the oscilloscope are attached across one of the resistors such that we could analyze its wavelength. Figure 3 displays the scaled down peak voltage across two of the three legs. The potential difference (Peak Voltage) between those two legs was in between +/-10 volts.

Figure 3: Depicts the series of resistors used to drop the peak voltage

Figure 4: Screen shot of oscilloscope

that peak differential voltages are under 10 volts, we can wire a DAQ Card to the system. These DAQ measurements will allow for the creation of a LabView™ PC interface. We can now have one interface to display the weather station data as well as the turbine RPM and voltage output along with the readings from the current sensor.