Wind Park Performance Evaluation Strategies On The Basis Of Raw SCADA Data

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PAPER

In this paper the results of a collaborative research project between Ventus Energía and University of Republic in Montevideo are presented. The project focuses on a development of wind park monitoring strategies and performance evaluation on the basis of SCADA data and is financed by ANII (Agencia Nacional de Investigación e Innovación).

Keywords: *Renewable energy, O&M, Performance, SCADA.*

INTRODUCTION

The project goal is to implement a clear and efficient methodology for SCADA data analysis that would help O&M engineers in predictive maintenance of the wind turbines. The methodologies should also lower the costs of the overall turbine performance evaluation and decision making.

The result of the analysis are the clear KPIs that indicate the performance change and the evolution of the turbine performance over time. Any SCADA variable can be processed in search of unusual deviations. The KPIs can be used as clear indicators of change in turbine behavior including pressure variables, temperatures alarms and power production. This allows for an early identification of these changes without contracting expensive power curve tests or nacelle LiDAR campaign tests.

METHOD 1

The first method focuses on a pure dependency of power and wind speed measured by a nacelle anemometer. The implementation of this method consists of calculating a Moving KPI on a weekly basis and comparing it to the Basis KPI that is only calculated once for a 3 week period. The KPI itself is a second eigenvalue of the value associated with a speed and power variables of the wind turbines.

An example of such relationship is demonstrated on a figure below.

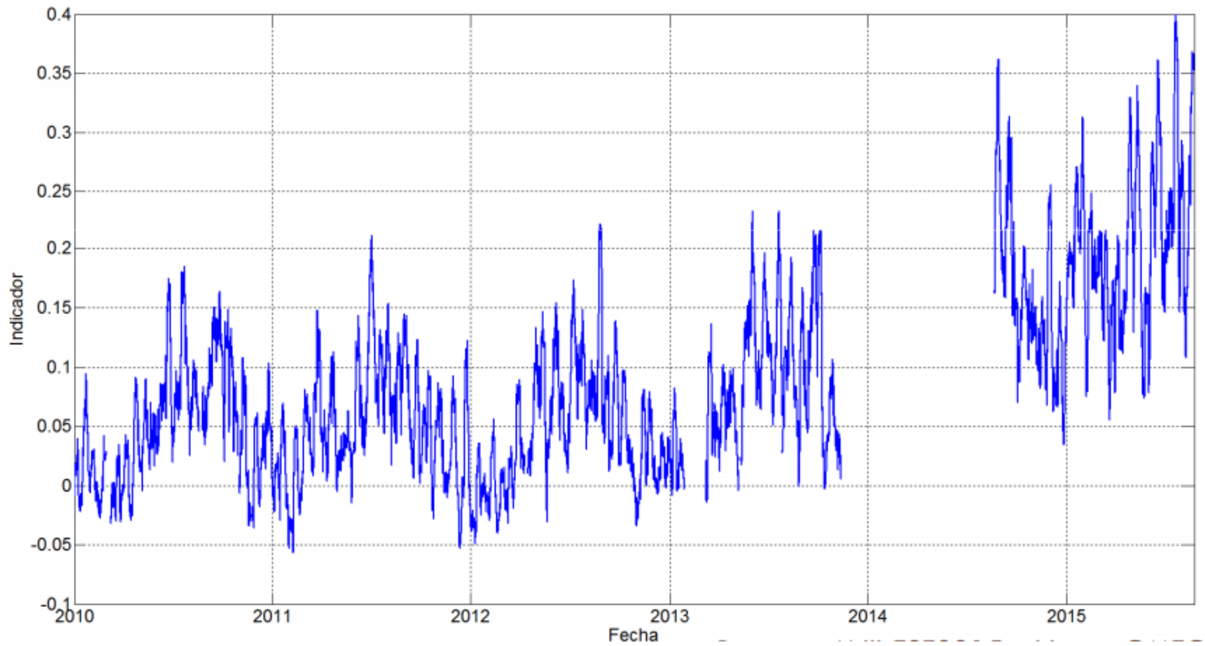

Figure 1 – Method 1 KPI evolution over time

On Figure 1 we can observe the result of the implementation of the Method 1 in analysis of 1 wind turbine in Uruguay that has been in operation for 7 years. It is clearly seen that after July 2014 the behavior of the whole wind turbine has changed with respect to the previous years. That is primarily reflected in the power-velocity relationship and therefore in the Indicator values.

It has been later confirmed that the cause of this change is a major one. Specifically a wind blade had been heavily damaged and later on repaired, which in this case is strongly reflected in the evolution of the Indicator.

Using this method on other turbines has revealed sudden performance changes in different wind parks across Uruguay no necessarily associated with a major corrective maintenance. The owners of the wind parks are currently investigating the cause.

This method can be applied to any wind turbine to evaluate sudden performance changes when they are not so obvious from only evaluating the basic power curve values from the SCADA data. The methodology is capable of indicting the performance changes that could not be visible using standard manufacturers´ KPIs available publicly.

The disadvantage of this method is strong dependency on the seasonal air density pattern, which can be seen on figure 1 in ears 2010-2014. Ventus is working with the Facultad de Ingenieria and ANII to improve the methodology.

METHOD 2

This method successfully implemented during the project consists of the modeling different SCADA variables using the Gaussian Process, having previously trained the program with at least 1 year of SCADA data. After the program has been trained, the modelled data is compared with the real one, variable by variable. The deviations are characterized in order to reveal the unusual patterns in the data.

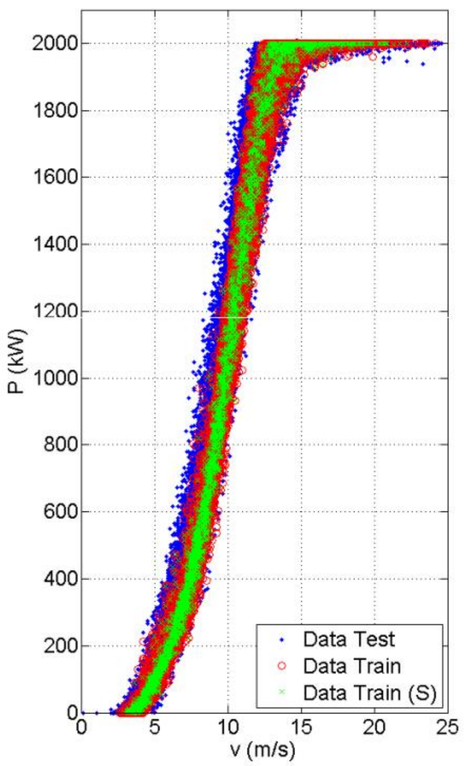

Figure 2 – Method 2 applied to power curve values

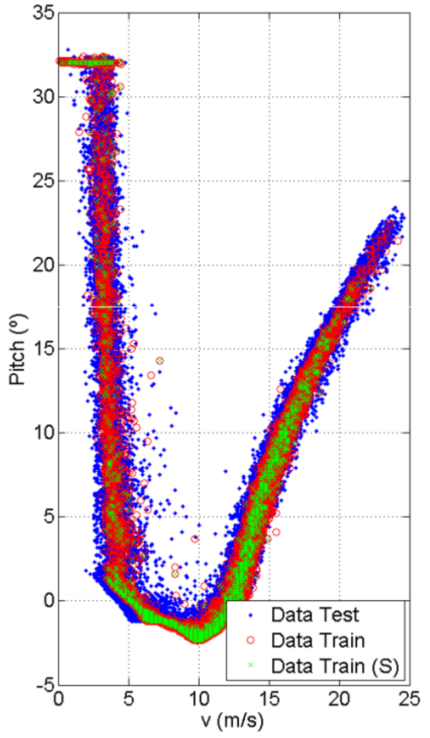

Figure 3 – Method 2 applied to pitch values

The advantage of this method is that it can be applied to any variable of the SCADA data. Therefore a deeper analysis can be performed with regards to different parts of the turbine and more faults can be detected.

In the following figures the results of the methodology are presented for the same wind turbine as used in Method 1.

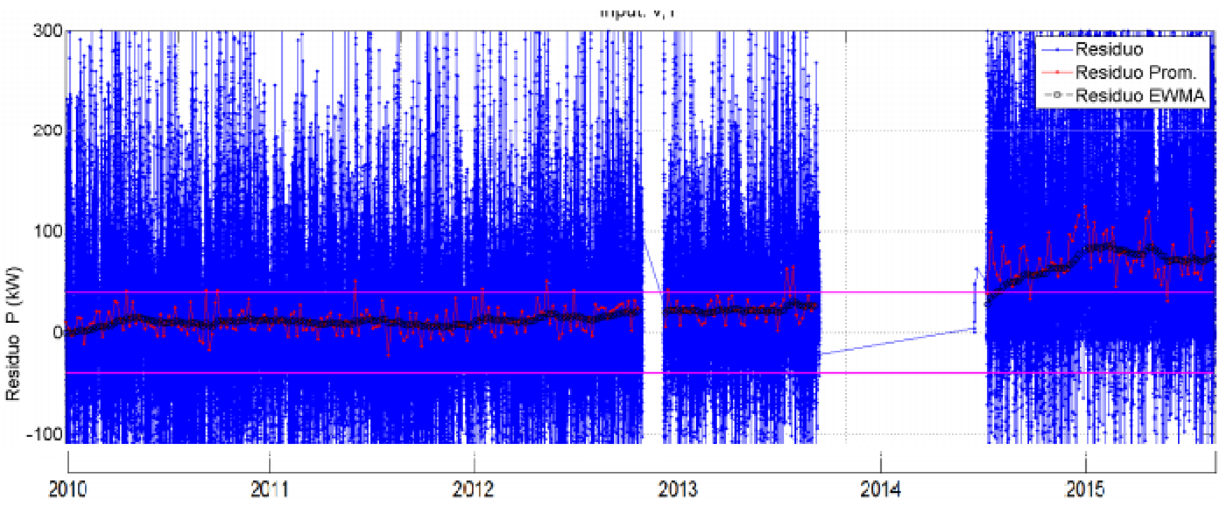

Figure 4 – Method 2, analysis of the power KPI over time

The Figure 4 clearly demonstrates the change in the behavior of the power KPI after the blade repair. To achieve a similar result using a traditional power curve method and expensive test would need to be contracted, either according to an IEC standard or with a nacelle LiDAR. Here on Figure 4 we can clearly observe the increase in power production which is confirmed by the client as well.

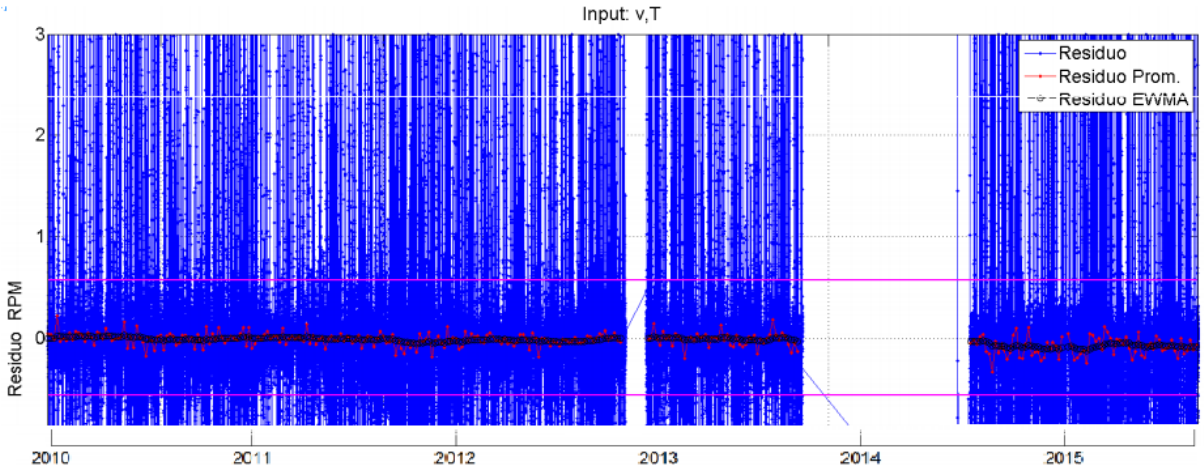

Figure 5 – Method 2, analysis of the RPM KPI over time

On Figure 5 we can observe that no change in the behavior of the RPM KPI was introduced after the blade repair.

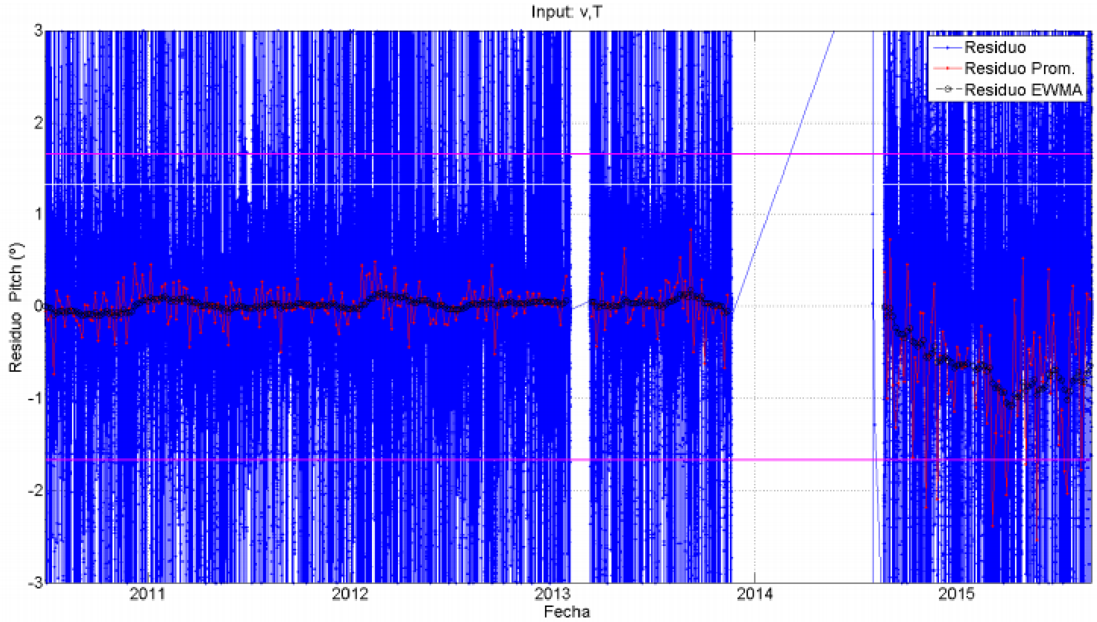

Figure 6 – Method 2, analysis of the Pitch KPI over time

The behavior of the Pitch KPI has change after the blade repair. Although it is not the only factor, but it clearly correlates with the increased power production and power KPI demonstrated in Figure 4.

FURTHER APPLICATIONS

Using a combination of both Method 1 and Method 2 a deeper analysis of SCADA data can be performed and changes in its performance can be identified very clearly. Method 1 is more generic and focuses on power-velocity relationship, while Method 2 goes into more detail and allows for a deeper analysis on the basis of each variable. Combining both methods allows for a faster and cheaper identification of turbine behavior changes over time.

The methods can be used for relative power performance evaluation of wind turbines after certain adjustments are made, such as blade repairs, anemometer changes, controller firmware updates, orientation correction, etc. Consequently, expensive tests can be avoided at least before it is clearly proven that the turbine behavior has changed.

FURTHER WORK

Although methodologies developed have been proven to work across different wind parks and manufacturers in Uruguay, further developments can improve the results. In the next months the team will put focus on mitigating the seasonality in the results and fault prediction algorithms. It is expected to show the results of these developments by August 2017.

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BIOGRAPHIES

Vasilii Netesov was born in Kamchatka, Russia on July 29, 1988.

He earned a master´s degree in Renewable Energy Sources and Renewable Engineering form Bauman Moscow State University in 2012. He has been working in the field since 2012. In 2016 he was an invited speaker in 2nd international wind energy congress in Montevideo. He has also presented in Brazil Wind Power 2016 on nacelle LiDAR measurement campaigns and performance optimization of wind turbines.

Mr. Netesov was an invited speaker for the wind energy project optimization courses taught by UL in Buenos Aires and in Santiago de Chile in 2016.