Independent Wind Turbine Performance Analysis and Optimization using IoT sensing devices

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BACKGROUND

The way we monitor wind farms nowadays is limited by the available data and its quality. SCADA data gives a correct overall information on how the wind turbine is operating but from its low time resolution, precision, and availability it is not possible to have a continuous and reliable monitoring of operating wind turbines.

In this poster, a new approach is presented that is based on the combination of IoT sensing devices that are installed on wind turbines and remote computing capacities based on cloud servers. An example of an IoT sensing device installed on a wind turbine is shown in Fig 1. High frequency data is acquired and transmitted from the wind turbine to the cloud servers where data analysis algorithms will identify potential improvements on the operation of the equipped wind turbines: yaw static misalignment and rotor imbalance detection for example.

The results are made available in real-time through an online dashboard to allow the wind farm owners, operators and maintenance teams to access the information and decide the best strategy for their maintenance schedule.

This end-to-end solution was applied to over 100 operating wind turbines allowing the definition of multiple axes of optimization increasing the AEP of wind turbines of up to 5%.

OBJECTIVE

The objective of this poster is to present a new cost-effective solution to monitor operating wind turbines that provides a broad view on how the wind farms are operating and that allows wind farm owners and operators a deeper and real-time monitoring of their assets.

The statistics from over 100 wind turbines are shown to present the impact that the defaults detected present in terms of AEP improvements, components lifetime preservation and overall monitoring capacities.

METHODS

An IoT sensing device is installed on the wind turbines with multiple embedded sensors such as accelerometers, anemometer and magnetic compass. This device has its own computing capacities allowing it to perform a part of the data analysis on-site, reducing the quantity of data to be transmitted, at the same time that it has data transmission capacities (through the GSM, 3G or LTE networks) to communicate the acquired and pre-processed data to a cloud server. Cloud servers are used to store the data sent from the sensing devices. Specially developed data analysis algorithms are applied to identify underperformance, defaults and non-optimal parameters on the equipped wind turbines.

Figure 1 - Windfit box installed on a Vestas V90-3.0MW wind turbine. The box is attached mechanically to the anemometer mast on top of the nacelle.

RESULTS

The results of this approach are automated diagnosis obtained from the data acquired from the IoT sensing devices and the cloud data analysis algorithms. Combined, together they provide an end-to-end solution called Windfit.

An example of the results provided is shown on Figure 2 for a wind farm where 11 wind turbines were equipped with the IoT sensing device.

The different results can be classified into 3 groups, results that allow:

- An increase in the AEP, such as yaw static and dynamic misalignment and aerodynamic rotor imbalance detection ;
- To preserve the lifetime, such as vibration analysis, foundations integrity monitoring and mass rotor imbalance detection ;
- To monitor operation, such as overall performance based on both independent and SCADA data.

Detailed results on a Gamesa G97-2MW turbine yaw misalignment detection and correction are shown on figure 3.

Figure 2 - Example of the results made available to the wind farm owners and operators. In this example, the wind turbine V-08 presents a medium aerodynamic imbalance: the estimated AEP gain after the correction is 1.5%.

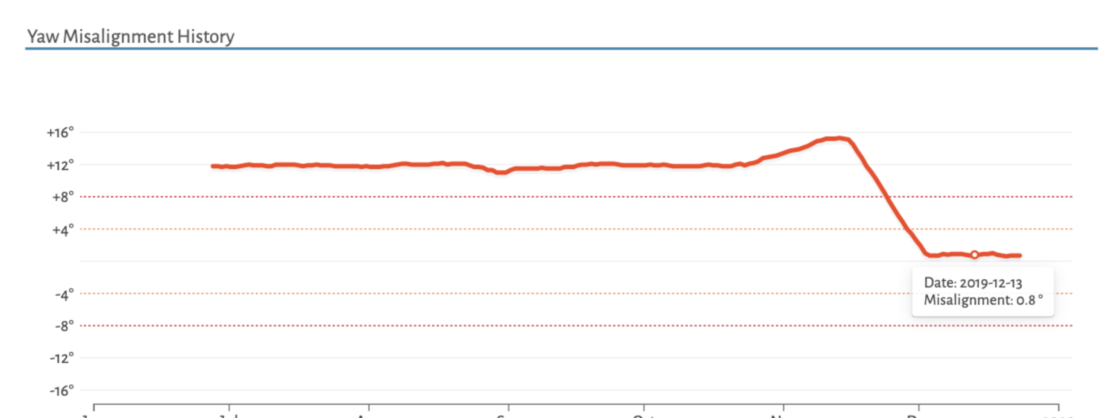

Figure 3 – Yaw misalignment history on an equipped wind turbine. Detection of a yaw static misalignment of 12 degrees, first correction on-site by the OEM team done in November on the wrong direction: yaw misalignment aggravated. Final correction on-site in the end of November. Performance increase after the correction: 4% AEP gain.

CONCLUSIONS

This poster presents a new approach on the analysis of operating wind turbines. IoT sensing devices were installed on over 100 operating wind turbines from which high frequency data was acquired. The analysis of this data (acceleration, wind speed and direction, power production, etc.) allowed the detection of defaults and optimization strategies that increased the AEP of up to 5%.

No human intervention is required and all diagnosis are automated making the solution cost-effective. All information is made available in real-time which allows the operators of the wind farm to optimize their maintenance schedule from the results obtained.

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