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A Fundamental Study and Factor Analysis on System Health Monitoring of Wind Turbines Using SCADA

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Abstract:

Wind turbines are the major driving force to produce renewable energy and an effective means to reduce CO2 emissions. They achieve this by converting kinetic energy into electrical energy, but by doing so, the physical friction gradually damages internal equipment. This may cause internal equipment, such as the gear box to fail, which in term results in stopping the wind turbine for a long period of time and causes substantial losses to the turbines owner. Therefore, It is important to detect the fault symptoms of the wind turbine as soon as possible and notify at which time to apply the appropriate maintenance. In this paper, we present a low-cost analysis method which uses the data collected by **S**upervisory **C**ontrol **A**nd **D**ata **A**cquisition(SCADA) system as the data source to evaluate the system health of the wind turbines, without using the data collected by an additional system such as Condition Monitoring System(CMS). When we use only SCADA data, we are limited to low resolution data and unable to use the vibration data which is sensitive to minor damages of the internal equipment. Therefore, it is necessary to select the appropriate analysis method that matches the characteristics of the SCADA data. Specifically, we regard the wind turbine as a macro energy conversion device to build a model which represents the performance condition of the wind turbine using SCADA data and machine learning. We evaluate the residual between the prediction value and the actual value of time series SCADA data. The prediction value is generated by the regression model using the SCADA data taken during normal operation as the training data. We obtain the correlation result between the change point of operating performance and the period in which the wind turbine has failed.

Key Performance Indicators for Wind Farm's Operation and Maintenance: a sistematic literature review and proposal of a conceptual model for implementation

Marllen Aylla Teixeira Dos Santos, Thaysa Da Silva Barbosa, Andressa Medeiros Santiso, Lara Luana Cirilo Silva, Marrison Gabriel Guedes Souza and Mario Orestes Aguirre González

Federal University of Rio Grande do Norte

Abstract:

Brazil has experienced serious energy crisis due to water scarcity in many regions, given that thepredominant source in the national energy matrix is hydroelectric. In order to reduce this risk, an investment on the diversification of the matrix through additional sources is required, such as wind energy, which has had an explosive development in the country in recent years. Considering this scenario, and in order to improve the performance of the Brazilian wind farms, the application of performance measurement is required to enable gains in generation efficiency, making it possible to increase the competitiveness of the wind power source. This paper proposes a set of key performance indicators that can be used to provide relevant information in support of decisionmaking processes involving the operation and maintenance of wind farms, enabling the redefinition of strategies and promoting a reformulation of policies effective to this sector to support the improvement of the generation. A systematic literature review in the literature on the characteristics of a performance measurement system and the Brazilian wind energy market, as

well as the performance indicators that are currently used in power plants was performed. It was found that several studies have been using data envelopment analysis to evaluate the performance of the plants. In addition, the Balanced Score Card applications and specific mathematical models have also been used. The indicators identified in the research were grouped by the organizational perspective to which they are related. The proposed conceptual model consists of 30 performance indicators divided on the perspectives: Capacity Management, Maintenance Management, Workers Management and Financial Management.

Lowering Cost of Energy by expanding the live time of wind turbines – live time extension from a certification and manufacturing perspective

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Abstract:

Usually, regulations and certification requirements state, that ""the design life of the wind turbine is accepted with at least 20 years.""1 And as a rule, onshore wind turbines have been sized for an operating time of exactly 20 years, because every design life greater than 20 years would theoretically led to increased manufacturing costs and thus higher prices. However, the design lifetime is a theoretical assumption and is also referred to as the scheduled service life. For this period, evidence on performance and serviceability are given. After that time, there is an economic and ecological interest to continue turbine operation instead of dismantling (e.g. scrapping) it after reaching the planned life time. With improvements in efficiency, process control and continuous optimization strategies in manufacturing, the quality of turbines had increased considerably in recent years. As a result, aspects of certification and support schemes in regard to turbine live time extension are in discussion and new regulations have been released, with different intensity depending on the country and its indicative trajectory of wind energy.

The authors provide an overview on the current discussion and insights on manufacturing and certification strategies in regard to that issue, with focus on Germany.

References

Weise, F. (2015): Das Signal geht an alle Hersteller. In: Windindustrie in Deutschland.

Fraunhofer IWES (2014): Windenergie Report Deutschland 2014. Fraunhofer Verlag, Stuttgart.

Fraunhofer ISE (2013): Levelized Cost Of Electricity Renewable Energy Technologies. Fraunhofer Verlag, Stuttgart.

Technologies for the structural health management of Hitachi-wind turbine system

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Abstract:

Ensuring the reliability of the wind turbine system is the most important task not only for the safe operation but also maximizing the profit of operators. Hitachi has been promoting the development of technologies for visualizing and improving the reliability of Hitachi-wind turbine system. In this talk, our technologies related to the structural health evaluation for wind turbine components such as the tower and the blade will be focused on. One of the key technologies is a wireless strain measurement system. The biggest difficulty of measuring strain on rotating components such as rotor blades is the establishment of electric connections. Although a slip ring system provides the connection including data signal transmission and power supply, the limitations are the number of channel and the complexity of the cable arrangement, which is directly related to the cost of the implementation. To overcome these problems, we have developed a wireless strain measurement system consisting of a power saving-sensor nodes, wireless gateways and a central controlling personal computer which is connected to the internet. We have confirmed the feasibility of this setup in our 5MW downwind turbine in Kashima, Ibaraki, Japan. In case of rotor blades, sensor nodes were attached to the internal side of blades composed of glass fiber-resin composite material and the gateways were fixed to the nacelle. It was confirmed that strain signal from rotating blades could be captured successfully using this system and the signal was revealed to be same as strain observed by a optically wired strain measurement system, which is already well known methodology for wind turbine blades. As well as sensing technologies as indicated above, we developed a cloud computing-based data analytics platform called as DIRMA (Data-Inspired Risk MAnagement). Obtained data like strain, vibration and SCADA data are transferred to this platform on-line and analyzed to visualize the true reliability of the wind turbine system in every few minutes. DIRMA provides a risk-based structural health management solution to the operator. The risk is defined as the product of the failure probability and resulting loss-cost. It means users will be able to know the present and future risks of their wind turbines in price. A main part for calculating the failure probability in DIRMA is based on the physical models and databases related to the damaging of materials or structural elements such as welded joints. This approach enables a quantitative reliability evaluation from the beginning phase of the operation of wind turbine system which would not exhibit any abnormal signals while almost all of the other SHM or CMS solutions highly rely on the anomaly diagnostic approach. In parallel with the sophistication of the risk management as mentioned above, we are advancing developments for easy access and operation. A demonstration of graphical user interface of DIRMA working in a web application will be performed in the presentation.

Hitachi will provide a reliable wind turbine system with integrating technologies cultivated in the field of manufacturing of other hardware and the information and communication technology.

Condition Based Maintenance of Wind Turbines by 24 / 7 Monitoring of Oil Quality, Oil Aging and Additive Consumption: Identification of critical operation conditions & determination of the next oil exchange

Mauntz Manfred and Peuser Jörn

cmc Instruments GmbH

Abstract:

A new oil sensor system is presented for the continuous, online measurement of the wear in industrial gears, turbines, generators, transformers and hydraulic systems. The detection of change is much earlier than existing technologies such as particle counting, vibration measurement or recording temperature. Thus, targeted, corrective procedures and/or maintenance can be carried out before actual damage occurs. Efficient machine utilization, accurately timed preventive maintenance, a reduction of downtime and an increased service life and can all be achieved.

The oil sensor system measures the components of the complex impedances X of the oils, in particular the electrical conductivity, the relative dielectric constant and the oil temperature. All values are determined independently from each other.

Inorganic compounds occur at contact surfaces from the wear of parts, broken oil molecules, acids or oil soaps. These all lead to an increase in the electrical conductivity, which correlates directly with the wear. In oils containing additives, changes in dielectric constant infer the chemical breakdown of additives. A reduction in the lubricating ability of the oils, the determination of impurities, the continuous evaluation of the wear of bearings and gears and the oil aging all together follow the holistic approach of real-time monitoring of changes in the oil-machine system. By long-term monitoring and continuous analysis of the oil quality, it is possible to identify the optimal time interval of the next oil exchange – condition based. This results in enormous cost reduction, when the oil is still stable and fully functional.

An application example from the wind energy sector will be presented.

Development and Evaluation of Vibration-based Anomaly Detection System Using Actual Wind Turbine Data

Jun Ogata[1], Masahiro Murakawa[1] and Makoto Iida[2]

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Abstract:

Wind energy is one of the most important renewable energy sources and has gained much attention due to the recent energy crisis. However, as wind turbines become increasingly large and more complex in order to provide reliable power generation, their maintenance and repair becomes more difficult. The focus of this research carried out under Japan’s national “Smart Maintenance for Wind Energy” project is the development of a reliable and cost-effective condition monitoring system (CMS) to maintain the availability and improve the reliability of wind turbines. The main task of CMS is to detect mechanical failures at an early stage such that maintenance can be carried out in a timely manner. Typical condition monitoring techniques for wind turbine include vibration analysis, acoustic emission, oil analysis, strain measurement, ultrasonic analysis, and thermography. One of the more popular tools in the condition monitoring of rotating machinery is vibration analysis.

In this paper, we present the development and evaluation of vibration-based anomaly detection system for wind turbine condition monitoring. The system developed here is based on artificial intelligence approaches that achieve multi-dimensional data analysis without deep knowledge about the mechanical behavior. The key modules that influence the performance of the detection system are feature extraction and unsupervised learning. For feature extraction, the predominant characteristics of the wind turbine vibration signals are extracted by applying Fourier local autocorrelation (FLAC) features. At the anomaly detection stage, we employ an unsupervised clustering approach based on Gaussian mixture models in consideration of the wind turbine’s dynamic operating conditions.

In the “Smart Maintenance for Wind Energy” project, CMS data including the vibration signals of the main components have been continuously measured and collected from 41 2MW-class wind turbines actually working in Japan. For evaluation of CMS, we have been constructed the database of actual wind turbine failures. In this work, we evaluated the abovementioned methodology using the database where the 20 failure cases were collected so far. We compared the accuracy of anomaly detection by our system with several conventional methods. The experimental results showed the effectiveness of using the FLAC features, particularly in the case of the low-speed main bearing where the conventional method with traditional features cannot detect the anomalies.

Life Time Extension: How to maximize the return of investment

Santiago Lopez Camblor
UL International GmbH

Abstract:

Currently there are two methods applied within the industry to calculate the Remaining Useful Life (RUL): analytical and/or practical.

The analytical component is to calculate the RUL with the aid of mathematical models. This mathematical analysis can be based on a completely new calculations or can be based by updating an existing calculation done in the past. By applying this method the remaining useful life of a wind turbine is calculated after the actual damage has been established. New or additional calculations for the wind turbine are made, taking into account site-specific boundary conditions, such as wind loads. The structural integrity of a certain turbine is verified for extreme and fatigue loads. The output of this approach will be an expert statement with a stipulation of RUL

The practical component takes the form of on-site inspection of the relevant Wind Turbines. This inspections are recommended to be done by an accredited company according to ISO/IEC Standard 17020. The focus of these inspections is to verify the output from the analytical part and proofs on the basis of the actual conditions on the wind Turbines under consideration.

Based on the results of the analytical and practical components, it is possible to make statements about any potential RUL and/or about the inspection interval to be complied with.

However this analysis must not be carried without due regard to aspects of structural safety.

Failure rate and downtime analysis for wind turbine by using failure and accident survey

Hirotaka Okumoto, Hideki Kato and Keiji Nijima
E&E Solutions Inc

Abstract:

Since 2004, failure and accident survey have been conducted by NEDO and carried out for owner of ind generating in Japan to improve the availability and share the information of failure and accident.

In NEDO failure and accident survey collects only failures which results in downtime of over 72 hours. owever, it is said that half of the failures result in downtime of under 72 hours. Here, we recalculated the failure rates of on-shore wind turbines in Japan taking into account the failures of downtime under 72hours, which, gave a figure of 1.0 failure/WTG/yr, which is similar to that of the figure in Europe. Simultaneously, we confirmed that the results of the NEDO survey can be used to calculate the real failure rate. However, for the data before 2011, because of the timing at which the survey was conducted does not represent the annual data, the failure rate of those years are not reliable, so care must be needed upon using the data of those years.