Wind Turbine Drive Train Condition Monitoring and Fault Diagnosis/ Prognosis Technologies

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- Algorithm that analyzes the signal measured from main components of the wind turbine to analyze/assess their health in real–time and provides information required for operation and maintenance(O&M).
- It is based on the condition monitoring system (CMS) for real–time diagnosis of the wind turbine system. While conventional CMSs only detect existences of the fault, this technology provides the fault diagnosis of main components and also predicts the remaining useful life(RUL) of the components.
- For the fault diagnosis and prediction of RUL in this technology, big data processing and AI/machine learning techniques (neural network, extended hidden Markov model) are applied to improve the accuracy of fault diagnosis to 99%, and with the statistical inferences including the Bayesian method and Monte Carlo simulation, the error in estimated RUL was reduced to 10% or lower.
- The fault diagnosis and RUL prediction for main components can be effectively continued during the varying load due to the natural wind.

Client / Market

- Wind turbine, power plant, chemical plant, aircraft and railroad vehicle using power train system

Necessity of this Technology

- To consider economic aspects, a large capacity wind power generation system is built in a large complex and increase of the length of the blades for higher output leads to increase in the load working on the tower and the blades itself, which increases the risk of wind power generation system damage. Therefore, the developments of diagnosis and maintenance technology to reduce breakdown time and increase availability are critical to guarantee profitability of the plants.
- There is a need in offshore wind farm for technology development to monitor, diagnose and predict the conditions of main components including blades, gearbox, and the generator considering SCADA simultaneously in order to maximize availability.
- More than 40% of the faults in wind turbines installed in Europe in the past 20 years were caused by faults of machines and components. But majority of wind turbines installed in Korea are experiencing a serious difficulty with O&M due to contract–related or technical issues, and this is the results of inexperienced operation techniques and insufficient condition monitoring technologies.
- Conventional CMS only detects whether the measured signal exceeds the normal value or whether a fault has occurred. Therefore, prediction technology for faults is necessary to enable active risk management of the target system.

DESIRED PARTNERSHIP — Technology Transfer | Licensing | Joint Research | Other

TECHNOLOGY READINESS LEVEL [TRL]

Research, basic explanation | Project concept or idea development | Technology idea verification | Prototype development | Trial product production/ evaluation in similar environment | Pilot field demonstration | Development and optimization of commercial model | Commercial product demonstration | Mass production and initial market launch

Technical Differentiation

- Reliable condition monitoring and fault diagnosis through a distinctive 2–stage alarm system
- Existing industrial complexes have been operated for over 20 years and are in urgent need of safety management. Through systemized risk management, an active risk management technology can be applied to allow highly efficient, low–cost maintenance and life extension, which can be expanded to related fields.
- From the long–term aspect, diagnosis and condition–based maintenance (CBM) technology is needed to guarantee the system soundness and reliability.
- Apply Algorithm and signal system that fulfills international standards (DNV · GL, IEC 61400–25)

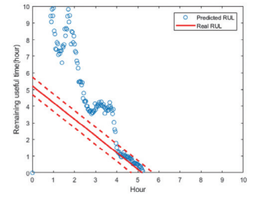
Excellence of Technology

- Fault diagnosis and prognosis algorithms verified by using the wind power generation simulator
- Accuracy of fault diagnosis over 99%, RUL prediction error below 10%
- The fault diagnosis and RUL prediction for main components can be effectively continued during the varying load due to the wind (characteristics of wind turbine operation), and the applicability and performance of this technology has been confirmed with the data from an actual wind turbine.
- Acquirement of condition monitoring system (CMS) and monitoring body certifications from KR and GL.
- CMS installed and operated by 17 units in Complex 1 and 2 at Yeongheung wind power plant of Korea South–East Power Co., Ltd.

KIMM Wind Power Turbine Simulator

KIMM Bearing Simulator

Example for RUL(remaining useful life) Prediction



Gear Box Used for Testing and Fault Mode Diagnosis Result

	No. of Data Case	Diagnosis Accuracy (No. of Success/%)
1 (Normal)	100	100/100
2 (Crack)	100	100/100
3 (Partial Damage)	100	95/95
4 (Even Wear)	100	98/98
5 (Damaged Tooth)	100	100/100
Total	500	493/98.6

Fault mode diagnosis result
Gear box for wind power generation simulator for testing

Yeonghueng Wind Power Turbine Complex and Condition Monitoring Control Room

KR (Korean classification) certificate on the Monitoring Body for Wind Power Turbine
GL(German classification) Certificate on the Monitoring Body for Wind Power Turbine
GL(German classification) certificate on the Condition Monitoring System

Current Intellectual Property Right Status

PATENT

- Condition Monitoring Apparatus and Condition Monitoring Method for Machinery System (KR1166871)
- Fault Diagnosis of Wind Turbine by Using Active Bin (KR1420846)
- Decimation Method for Measurement Data of Wind Turbine Condition Monitoring System Using Active Bins (KR1398072)
- A Method of Setting Alarm Levels for Condition Monitoring and Fault Diagnosis of Wind Turbine Generator (KR1599210)
- A System and Method for Monitoring Offshore Wind Turbine Structure (KR1740896)