Introduction to Vibration Analysis on Wind Turbine

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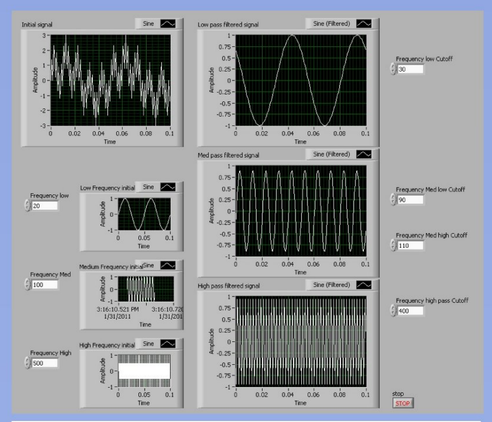
Abstract

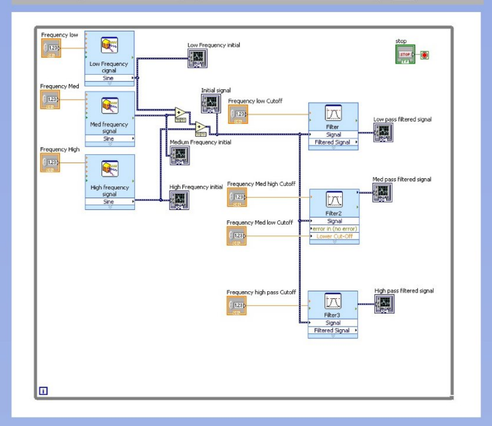
With new sensors smart sensors available to researchers, and with the processing power of microprocessor, vibration analysis grew very fast in the last 20 years. It can be extended to many industries. More specifically, the wind turbine market can benefit from vibration analysis and monitoring. On a drive train containing blades, bearings, a gear box, couplings and generators, many failures can happen. Signs of theses failures can be an unbalanced condition, ice on the blades, wear out of the bearings and degradation of oil. When situated in remote locations or close to houses, such failures of wind turbines can have important health and economic consequences. Using different vibration sensors, it is possible to analyze the vibration of various parts in the wind turbine and discover the problems in real time. This project was about reviewing the current knowledge applicable to wind turbine, propose new applications to be tested and implement a system that will be used for research on wind turbine vibration monitoring.

Literature review

The dynamics of rotating system is well known. Studies are now developing processes to reduce the number of run-down needed to calibrate multiple parameters at the same time. Very powerful tools have been developed such as wavelets; envelop analysis, empirical mode decomposition.

Vibration analysis has application in most part of the turbine. Applications such as balancing, correcting misalignment and finding a broken tooth on a gear are already well known. The technology on sensors themselves is evolving fast. For example, researchers are installing sensors into the blades. This means strain gauges as well as accelerometers. However, most research did not develop much vibration analysis from data in the blades. Oil monitoring is also a new field. It can predict when the oil needs to be changed, but also tell how much the gears inside the gearbox worn out. Finally, a review of the sensors available was done: many models were bought, as they have a different frequency response range.





Top: Simulated signal containing three frequency. In a real system, the lowest frequency represents the unbalanced signal. Bottom: Code used for the Fast Fourrier transform. LabView was choosen for its fast implementation of algotithms.

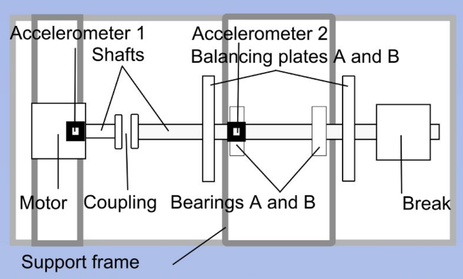
Results

In collaboration with fourth years engineering students, an Arduino board with and Atmega32 controller was tested. The author first introduced the project to them and explained the basic of vibration analysis. Indeed, many tools used in vibration analysis come from electrical engineering. It was discovered that the Arduino is fast enough for testing the low frequency spectrum, but too slow for high frequency vibration analysis. There were also some concerns about the resolution and the speed of data transmission to a computer.An analysis our need for laboratory experiment needs was performed, using the information gather in literature. As various parameter had to be taken (including rotational speed, analog and or digital signal from vibration sensors and strain gauges), a system allowing many input was needed. More specifically, for vibration monitoring, we that a restriction was a high resolution and a high frequency rate of acquisition. On a more practical side, our team needed a system allowing a fast and easy to modify code, with enough library and material. After the evaluation, a NI USB-6363 acquisition was chosen and bought. The platform Labview will be used for the code as it is powerful and allows fast development. It also contains most of the filters needed. The author also learned to use the software LabView.

A photogate and two accelerometers used in the project.

Right: The board was tested on a generated signal and a drive train containing a motor, a generator and two bearings. It appeared that the system used needs a better base for more precise mesurement. A new setup was built by the author after this project.

NI USB-6363 used for data acquisition.



The UROP projet lead to an undergraduate thesis on a closely related subject. This concept drawing represents testing equipment to mesure vibration propagation trough magnetic coupling, which could be used in wind turbines.

Future projects

The projetc will continue at a more fundamental level by studying vibration propagation in a magnetic coupling. Magnetic couplings have many advantages in wind turbine such as reducing the starting torque on the generator and be used as breaks. However, they have not been studied in term of vibration propagation reduction. It would be a great advantage for magnetic coupling, as they could isolate a part of the drive train from vibrations. This An extensive research will also be performed in summer 2011 on vibrations that may cause health problems to people living close to wind turbines, as well as ways to reduced them. If this future study gets positive results, it may have an impact on the health of people living close to wind turbine, as health issues are a big concern when implementing a wind turbines in communities.