Guardians of the Gears: Pioneering Smarter Machine Maintenance

Humans use machines for just about everything: transport, entertainment and even making toast! However, machines need a bit of love and care so they can keep up the good work. In our project we investigate how we can keep our machines healthy and prevent them from breaking down.

When machines start to show signs of failure, it's important to take care of them as soon as possible. Perhaps something that is easy to fix now (like a small crack or a loose screw) could become a much bigger problem if it goes untreated. The practice of monitoring machines and fixing them before they break is called **predictive maintenance**. It is made possible by putting sensors in our machines and monitoring the signals for signs of faults.

This study of signals from machine sensors is already done around the world, but did you know signals can be "decomposed" into pieces which are components of the original signal? These components themselves can then be studied for signs of faults, and this may be more revealing than studying the signal as a whole. It's a bit like reverse engineering an ice cream (or milkshake) to analyze each scoop of the ice cream individually. In our project we are using Singular Spectrum Decomposition (let's just call it SSD) to take signals from machines and decompose them into components.

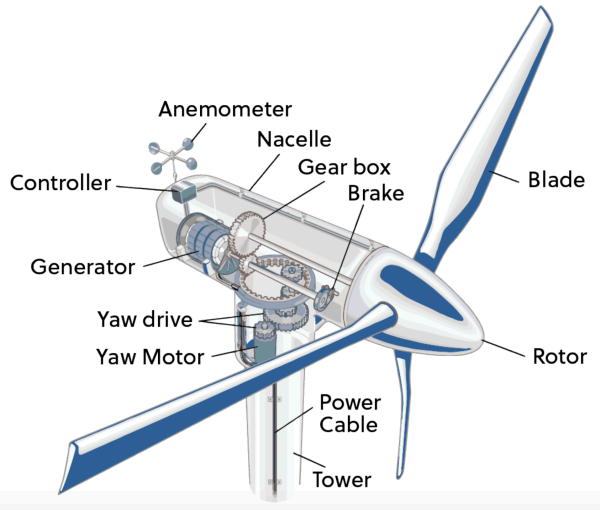

Figure 1: Wind turbine schematic diagram(1)

Generating Data

In our project, we focus on wind turbine gearboxes (some sort of pile of gears). This part of the machinery boosts the rotor speed to maximize electricity generation. Keeping the gearbox in good condition is key to profitability. Vibrations inside the gearbox can be measured to assess its "health." However, it is difficult to have hands on a wind turbine and collect vibration data ourselves (as you can imagine). Hence, we simulate them and potential signs of degradation (or even breakdowns) using a sophisticated model that mimics real-life conditions.

(1) Source: Lynn, Paul A. 2012. Onshore and Offshore Wind Energy. United Kingdom: John Wiley & Sons, Ltd

Monitoring App

What's better than the possibility to explore and analyze data by visualizing it? This is why we implemented an interactive app in MATLAB[(2)]. You can slide over the data with a window to view component plots and their spectrograms. Adjust various parameters to see how they impact the visibility of developing faults. In the future, the app will be capable of analyzing data streams step by step, window by window.

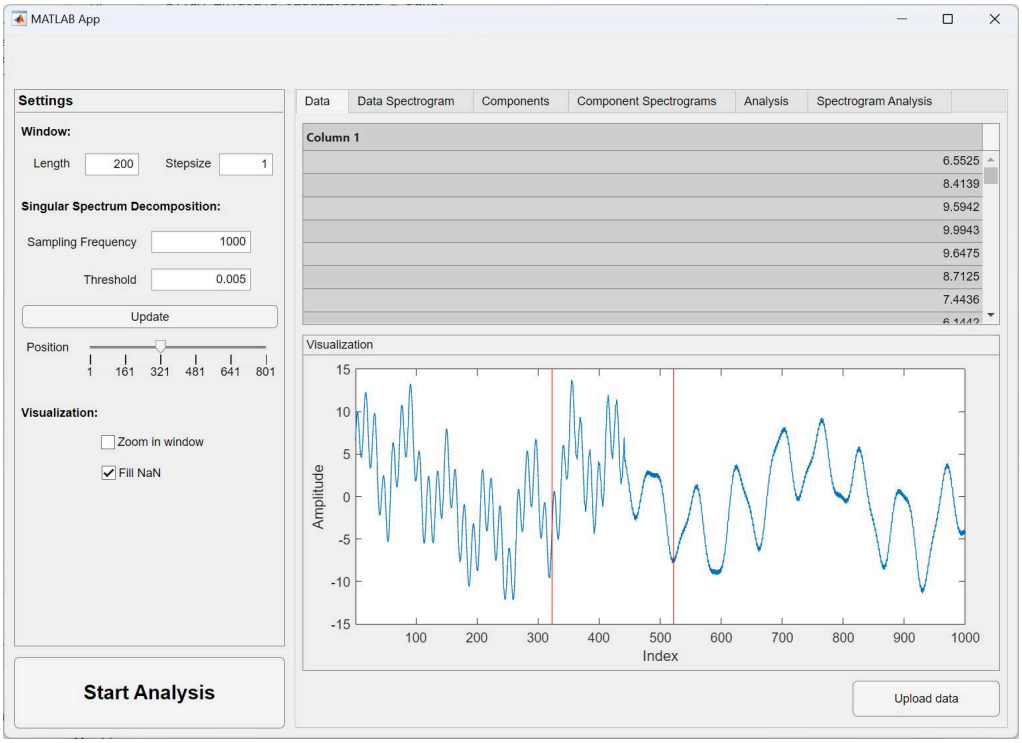

Figure 2: Matlab App main window

Experiments

Finally, we would like to see whether our method of predictive maintenance (using SSD components) is better than the rest. This is why we will use our datasets to try and spot faults in both the raw generated signals, and their decomposed counterparts using all sorts of fancy techniques like neural networks and the very fancy sounding spectrogram analysis! In the end, we can compare the results from both methods, and see if SSD helped us create better fault predictions.

(2) Link: https://nl.mathworks.com/products/matlab.html