Describing the Failure of Vacuum Pumps using Fourier Transformed Accelerometer Data

Topic Overview:

Drinking water, the cooling systems for nuclear reactors, and many other applications all rely upon the use of water pumps to make the water flow and flow at the correct rate. Many of these applications are mission-critical, meaning that any lapse in the functioning of the pump can jeopardize the whole operation. For this reason, being able to predict the failure of a vacuum pump is important so that in the case of a failing pump, a replacement can be ordered or maintenance can be performed before the failure occurs and no interruption will occur. To achieve this will require hardware that is capable of taking data and then making a prediction about the status of the pump and whether the pump is likely to fail soon.

The first step to creating such hardware is the analysis of data to determine what data is useful to predict the failure of the water pumps. Accelerometer data from the water pumps, measuring the acceleration of the pump casing in the x, y, and z directions was collected. However, due to technical limitations, this was exported and recorded as Fourier transformed frequency data rather than raw acceleration values. Analysis on the covariance matrix and the distribution of the data will allow for any trends in the accelerometer data over the lifetime of the pump to be detected and quantified. Specifically, we hypothesize that this will allow for the predicting the failure of a water pump. In addition to achieving the primary objective of securing water pumps from malicious actors, this will also allow for the ordering of replacement parts before failure occurs when normal operation occurs.

Research Plan:

Research for this project will begin over the summer with a review of selected chapters and sections from statistics textbooks. The review will be focused on the normal distribution, and other relevant continuous distributions such as the gaussian mixture models as advised by the thesis director. Additionally, new material such as clustering, multivariate continuous distributions, and covariance matrices will be researched over the summer. Any additional information needed will be learned either from coursework in Fall 2018, or as needed from reference sources (textbooks, research papers, etc).

Meetings:

I will meet with my thesis director every other week during his office hours to discuss the progress that had occurred, as well as the next steps that need to be taken. Additional meetings with my thesis director and meetings with the other advisors will occur on an as needed basis.

Timeline:

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| Date: | Task: |
| Sept 7 | Begin bi-weekly meetings with director. Review plan for thesis. |
| Sept 14 | Unpack data |
| Sept 28 | Present Covariance Matrix |
| Oct 12 | Present preliminary separated covariance matricies (for possible usage of a Gaussian mixture model) |
| Oct 26 | Make final decision on Gaussian mixture model |
| Nov 9 | Present preliminary descriptive statistics and various statistical tests |
| Nov 23 | Present final descriptive statistics and various statistical tests |
| Dec 1 | Complete a draft of thesis |
| Mid January | Add additional statistics and tests as needed |
| Early Feb | Make revisions to thesis, expand where necessary |
| Late Feb | Complete Thesis |
| Mid-late March | Thesis Defense |
| April | Revise and submit thesis |