2d.

Both FFT and Wavelet transform methods will be used to determine the features of the performance on raw sensor data. Reading a stream of FFT data and detecting abrupt changes, if any, in vibration amplitude can potentially indicate the transition between healthy (low amplitude) and faulty (high

amplitude) states.

Here we need to determine the water flow getting choked (leading to smaller values in the sensor reading).

(Initially the values are rounded by multiplying 10)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 6 | 7 | 8 | 4 | 3 | 3 | 6 | 6 |

Lets apply the Haar Wavelet Transformation,

High Pass filter (1/2, 1/2) and Low Pass Filter (1/2, -1/2) and Down sampling ratio of 2

|  |  |  |
| --- | --- | --- |
| Rounds | Approximation Coefficients (Low Pass Filter) | Detail Coefficients (High Pass Filter) |
| 1 Filter applied | 6.5, 7.5, 6,3.5,3,4.5, 6 | -0.5, -0.5, 2, -0.5, 0, -1.5, 0 |
| Down sampling | 6.5, 6, 3, 6 | -0.5, 2, 0, 0 |
| 2 Filter Applied | 6.25, 4.5, 4.5 | 0.25, 1.5, -1.5 |
| Down sampling | 6.25, 4.5 | 0.25, -1.5 |
| 3 Filter applied | 5.375 | 0.875 |

Wavelet Coefficients are [.5375, 0.0875, 0.025, -.15, -0.05, .2, 0, 0]

As we can see from the readings above, there is a sudden drop in the frequency indicating the water being choked (highlighted in pink).

2e.

CNN is used for classification purpose.

There are 2 inputs,

1. Water level sensor data
2. Robot Vision Data

Water level sensor data – time series data, so by using the Conv1D, kernel slides along one dimension of the sensor data

Robot Vision Data - could be an image or video. If Image, 2D CNN model can be used. Else if Video then 3D CNN model is used.

Water level Sensor data -1D CNN

Inference

Single Feature Vector

Image captured by Robot vision -2D CNN

Hand Selected features

In feature vector classifier, hand-selected features from each modality are combined into a single feature vector presented to a classifier (such as Adaboost, SVM, Random Forest) for detection across all features. As shown above, the 2 modalities are studied by the 2 different Models and the resulting features are fed to the Single feature vector. Based on this information, the necessary inference is derived on whether to take an action or not.