FLOATING PLATFORM MOORING LINE ANOMALY DETECTION THROUGH NATURAL PERIOD ESTIMATION

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Objectives

The ocean bed has been a source for oil extraction with floating platforms that rely on mooring systems whose integrity is critical for the security of the production and crew members [1]. This work aims to develop a system that monitors the low-frequency natural period of oscillation of the platform and automatically detects a mooring line failure. The hypothesis is that, if there is a failure, the natural period changes. Detecting disparities between the estimated natural period for platforms without failures and the natural period estimated in the real situation, failures in the mooring system can be inferred.

Methods and Procedures

With data provided from the DGPS and IMU installed onboard, time series are retrieved, corresponding to the platform's center of gravity position. The architecture of the system is composed of three main blocks (see Fig. 1).

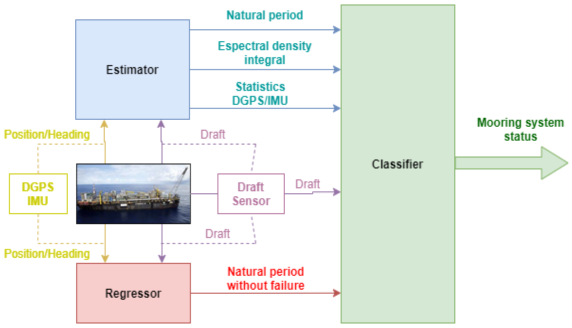

Figure 1: Architecture of the proposed system.

Estimator: processes the time series with a band-pass filter and the Welch method [2]. Firstly, the series goes through a coordinate system change. Then, a band pass filter is applied to the signal. The filter band is determined by a window of periods surrounding a central value, determined by a previous analysis of the average periods on each draft of the platform (see Fig. 2).

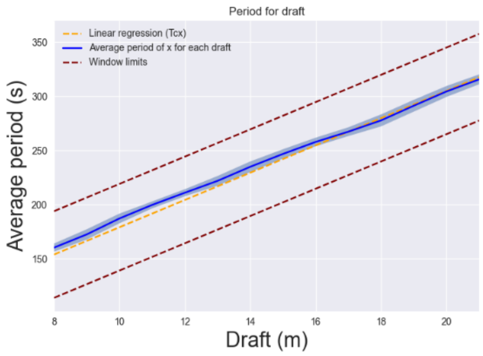

Figure 2: Average low-frequency natural period of longitudinal motion for each draft.

The resulting spectrum of the series on the transversal axis is subtracted from the spectrum on the longitudinal axis, decoupling the movements (see Fig. 3). The spectrum after making the difference is then inverted back to time domain and the Welch method is applied. The natural period is determined by the period with the highest value in the transform produced by the Welch method on each axis (see Fig. 4).

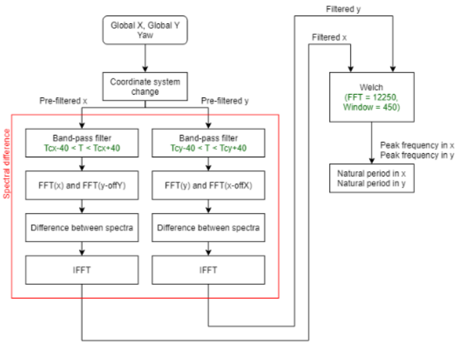

Figure 3: Spectral difference diagram.

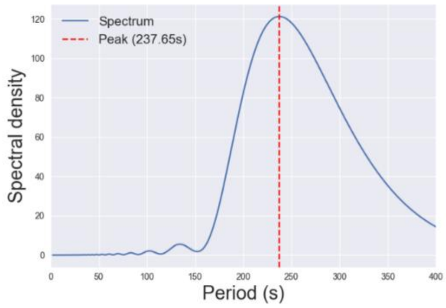

Figure 4: Example of estimated natural period.

Regressor: with heading, position and draft data obtained from numerical simulations of the platform *without* broken lines, and the desired outputs provided by the Estimator under these conditions, a regressor is trained to predict the natural period in a fault-free situation.

***Classifier**:* compares the predictions of the *Regressor* with the outputs of the *Estimator*, also making use of other data, such as the integral of the spectral density produced by the Welch method, and other statistics of the DGPS and IMU, in order to detect disparities that indicate whether or not there was a breakage on the mooring system.

Results

The average absolute difference between the period predicted by the *Regressor* and the output of the *Estimator*, for cases without breakage, is of 2,75s. However, there is an average difference of 4,89s in the platform period when there is a line break (see Fig. 5). Thus, it is expected that the *Classifier* is able to detect breakages of lines given the difference between the Estimator and the Regressor predictions.

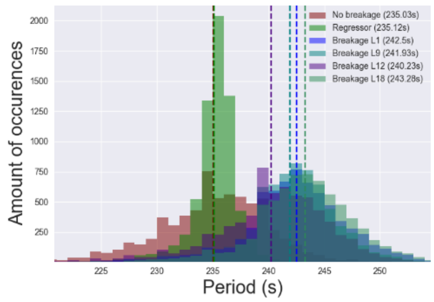

Figure 5: Histogram of periods.

Conclusions

With the breakage of a mooring line, there is an alteration in the natural period of the platform, which, along with other information, can be used to detect mooring system failure. The classifier module has not yet been implemented. Furthermore, there is also a possibility of using the classifier module to determine not only if there is a broken line, but also to detect which group of lines (see Fig. 6) the broken line belongs to.

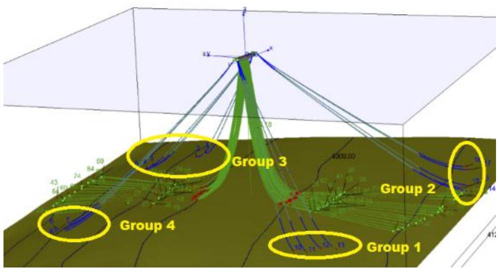

Figure 6: Groups of mooring lines in the offshore platform.

Bibliographical References

[1] Gauthier S. and Elletson E. (2014). Mooring Line Monitoring to Reduce Risk of Line Failure. Int. Ocean and Polar Eng. Conf., p. 388-393.

[2] P. Welch (1967). The use of fast Fourier transform for the estimation of power spectra: A method based on time averaging over short, modified periodograms, IEEE Trans. on Audio and Electroacoustics, 15(2), p. 70-73.