ESTIMATING BOTTOM PROPERTIES WITH A VECTOR SENSOR ARRAY DURING MAKAIEX 2005

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Abstract

Nowadays, vector sensors which measure both acoustic pressure and particle velocity begin to be available in underwater acoustic systems, normally configured as vector sensor arrays (VSA). Such a system was used during the Makai 2005 experiment, off Kauai I., Hawai (USA) to receive precoded signals in a broad frequency band from 900 Hz up to 14 kHz.

The spatial filtering capabilities of the VSA can be used, with advantage over traditional pressure only hydrophone arrays, to estimate acoustic field parameters such as ray arrival time and angle, which could give rise to simplest and/or more reliable methods in bottom estimation. An additional motivation for this work was to test the possibility of using high frequency probe signals (say above 2 kHz) as a potential for reducing size and cost of actual sub bottom profilers and current geo acoustic inversion methods.

This work studies the bottom related structure of the VSA acquired signals, regarding the emitted signal waveform, frequency band and source-receiver geometry in order to estimate the bottom properties, specially bottom reflection coefficient characteristics. The agreement between the observed and modelled acoustic data is addressed. Preliminary results on the bottom reflection estimation will be also discussed.

T^2 CHART APPLIED TO LNG CARRIER TURBO-GENERATOR SYSTEM CONTROL

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1. Introduction

Industrial process control generally involves monitoring a set of correlated variables. Such correlation confounds the interpretation of univariate procedures run on individual variables.

One method of overcoming this problem is to use a Hotelling´s T2 statistic; which is based on the concept of statistical distance.
It consolidates the information contained in a multivariate observation to a single value, namely, the statistical distance the observation is from the mean point. Desirable characteristics for a multivariate control chart include ease of application, adequate signal interpretation, flexibility, sensivity to small process changes, and software solutions.

In this application we have choosed a turbo-generator system onboard [3] of LNG carrier in which six parameters are monitorized. The input to this system is fuel in form of natural gas that is used to produce steam in the boiler, the 60 Kg/cm2 high –pressure steam is used to turn the turbine which is engaged to synchronous generator that produces electricity (in megawatts-hour). The warm low-pressure vapour from the turbine is moved to the vacuum condenser, where is converted into liquid state for pumping to the boiler.
A T2 control procedure was developed to monitor efficiency by detecting significant changes in any of the six monitored variables
We first implemented the Historical Data Set (HDS) where 28 observations were done about the six variables. After, we sampled 16 new incoming values and the T2 statistic was computed for each of one.

2. Results and Discussion

It was detected that some observations in the 16 new incoming group did not conform to the HDS for a upper control limit (UCL) fixed in 43.91 with = 0.001 [1]. Those observations there was a T2 value falling outside (T2 >43.91) its control region were namely signals. This implied that conditions have changed from the historical situation, although an isolated signal can be due to a chance occurrence of an upset conditions multiple signals often imply a definite shift in the process.

After we needed to interpret the signals on a T2 component using a MYT [2] decomposition and know who of the six parameters have been the responsible of out of control of the process.
Finally, it was proved that the variations of pressure and the sea water temperature in the vacuum condenser leaded to shift the process control.

3. Conclusions

Although many different multivariate control procedures exist, it's our belief that a control procedure built on T2 is the best method for implementing a predictive maintenance management on board.

Signal interpretation requires a procedure for isolating the contribution of each variable and/or a particular group of variables. As with univariate control, out of control situations can be attributed to individual variables being outside their allowable operational range; e.g, main vacuum condenser temperature is too high. A second cause of a multivariate signal may be attributed to a fouled relationship between two or more variables, e.g., the pressure is not where it should be for a given temperature reading.

4. References

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