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Intelligent machinery condition monitoring based on adaptive measurements

Kostyukov V.N.^a, Kostyukov A.V.^a, Boychenko C.H.^{a*}

^a*Dynamics SPC, 108/1 Rabinovicha st., Omsk 644007, Russian Federation*

Abstract

The present work describes the structure and operational concept of the system for machinery condition monitoring using adaptive measurements. The work reveals the results of adaptive measurements procedure of the system illustrated by trends of centrifugal pump vibration signs. The work objective is to increase validity of machinery condition monitoring results through providing high spectral resolution. The spectral resolution is essential for separating defects in the vibration signal spectrum and retaining high speed of vibration measuring. This is required in order to eliminate the omission of defects with minimal expenses on hardware.

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1. Introduction

Vibration analysis of the machinery casing is one of the basic techniques of machinery condition monitoring. Vibration converts into electrical signals, which parameters are used by the automatic expert system that issues messages about machinery condition. The condition monitoring system should carry out measurements of vibration and other parameters on a periodic basis. The periods depend on maximum change rates of the machinery condition.

* Corresponding author. Tel.: +7-381-225-4244; fax: +7-381-225-4372.

E-mail address: post@dynamics.ru

The changing period in a particular point for multichannel monitoring systems depends on the system's architecture (parallel, serial, hybrid, [4]), time of signal measurement and its processing.

In order to identify particular types of defects, the expert system requires measuring vibration signals using long selections - up to ten seconds. In that case, the length of vibration measurement period may become unacceptable for condition monitoring. For example, to separate electrical and mechanical components of induction motor defects due to different rotor shaft spinning frequency and stator electric field, it is required to make spectrum analysis of signals with resolution more than 0.1 Hz. In this regard the measurements of vibration signals shall be conducted for signals longer than 10 sec. When number of channels is 180 (45 standard centrifugal machines, 4 channels per machinery) the sampling time of a channel is more than 30 min. This might cause the omission of fast-evolving defects. Time of the defect's development from "Acceptable" condition to "Unacceptable" may take less than 5 sec [1].

To eliminate the increase of measurement period, the parallel architecture of measuring tools may be used, although, it leads to steep increase of system cost.

Therefore, the development of the procedures and techniques for the machinery condition monitoring systems with high spectrum resolution and high measuring speed and minimum expenses is an urgent task.

2. Intelligent monitoring based on adaptive measurements

In order not to increase the sampling time while saving measurements with high resolution (long selection), the operating procedure of the system may be changed. For example, the measurements with long selection may be conducted more rarely than the ones with regular parameters.

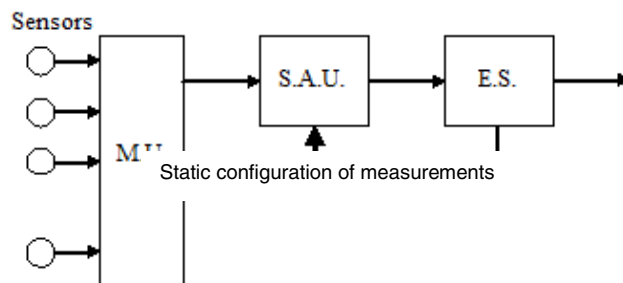
The period of vibration measurement also depends on the machinery condition. For the machinery that is in "Acceptable" condition, the measurement period may be longer than in "Action Required" condition, which is, in turn, longer than "Unacceptable" condition measurement period.

Therefore, the problem of changing parameters and procedure of a measurement unit according to the expert system results appears.

Regular multichannel measurement units have static configuration of measurement tools. The configuration is determined during the system development period and is not changed during its operation. In this case the expert system operates only analyzer unit in order to obtain the required information about machinery condition (Fig. 1-a).

The need of changing the parameters and configurations of a measurement unit during the operation requires the creation of an additional connection with the expert system in order to provide dynamic and intelligent properties (Fig. 1-b).

In this case, the measuring channel parameters (sample rate, discretization frequency, amplification constant), sampling procedure of channels, hardware configuration of measurement part of the system (degree of parallelism) change according to the expert system signals, depending on machinery condition. Moreover, the required period of measurement is provided. This period is determined by the expert system automatically according to the type of machinery and its condition.



a)

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