1.10.34. EQUIPMENT DIAGNOSTIC EXPERT SYSTEM

Boichenko S.N., SPC “Dynamics”, Omsk, Russia

Ensuring safe operation of equipment production complexes are not conceived without a means of monitoring its technical condition. Just knowing and observing the condition of the equipment can be carried out timely repairs, ruled accidental, the operation managed to do. Equipment condition monitoring of industrial complex is based on the systems, using a set of non-destructive methods (NDM). Typically, here are used online or offline systems of parameters monitoring, associated with any of NDM and delivery of the alarm signal at excess of parameter of preset values.

However, in practice of real operation of the equipment the diagnosis is necessary for putting in the shortest time, without attraction of highly paid experts, in conditions of the incomplete information on designs of the equipment, and at absence of the reference equipment. Generalized structure of the monitoring system is shown in fig. 1. The signals from sensors installed on the equipment (SB) first arrive to the input of harmonization block (HB) where they’re gained strength and filtered, and then to the input of identification tract (RT) which includes the serial connected units of signal analyzer (SA), diagnostic signs formation block (DSFB), decision block (DB), alarm and registration block (ARB). Thus the set of diagnostic reports on the base of diagnostic signs values which is delivered to the personnel by warning means is formed. Expert messages are displayed for each object of monitoring on the screen of system, and also are accompanied by the corresponding speech message by means of the block of a speech conclusion.

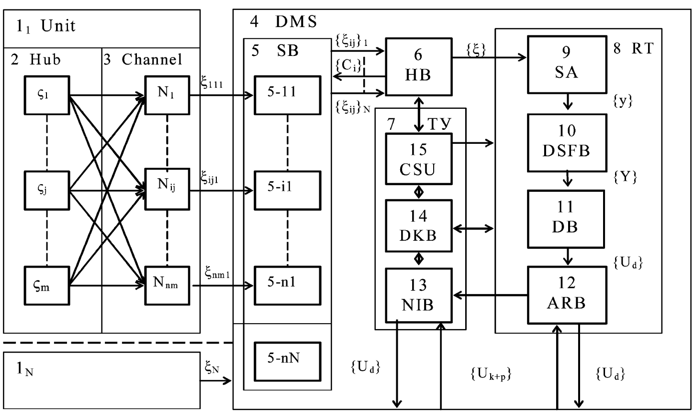


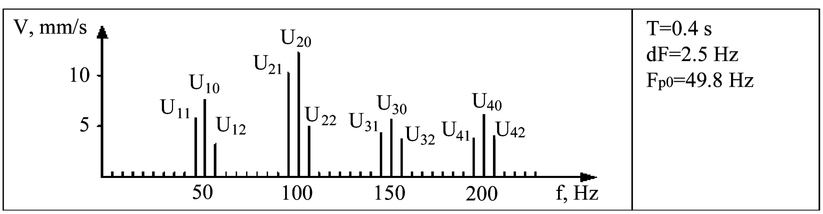
Fig. 1. Generalized structure of the monitoring system:
11, …, 1*N* – *N* – units; 21, …, 2*m* – *m* – diagnosed components in the unit; 31, …, 3*n* – *n* – channels of signals distribution *m* from the sensors to components *n*; 4 – diagnostics and monitoring system (DMS); 5 – sensors block (SB); 6 – harmonization block (HB); 7 – control tract (CT); 8 – identification tract (RT); 9 – signal analyzer (SA); 10 – diagnostic signs formation block (DSFB); 11 – decision block (DB); 12 – alarm and registration block (ARB); 13 – net interface block (NIB) (Intranet/Internet); 14 – information data and knowledge base (maintenance and system configurations, signals and events archives, knowledge base) (DKB); 15 – control and synchronization unit (CSU)

The main function of the expert system, part of the monitoring system – an automatic diagnosis of the equipment in real time. Time of statement of diagnosis – tens milliseconds, using a rapid structural description language expert rules (CDPL). CDPL language allows a logical expression and the rule has been operating in the library on a large set of standard features and functions of digital signal processing.

Another important feature of expert system is to provide diagnostic equipment in terms of a priori uncertainty of construction equipment and its mode of operation. In the implementation of monitoring systems for existing production equipment design parameters are often unknown or differ from those given in the documentation. This leads to an error of diagnosis configuring system-specific parameters. Through the use of a specially selected area of invariant features of the findings of diagnostic expert system does not depend on the design features of equipment and mode of its work. With the introduction of diagnostic expert systems for an undisclosed equipment raises the question of the formation of a reference sample with a known good state in which the conclusion is made on the status of other specimens. The proposed expert system uses the model free method of diagnosis, when the self-diagnosed equipment serves as a model.

The same system has a low, practically zero error of condition definition. The main diagnostic methods used in expert systems, a frequency analysis of vibration signals. The actual measurement of vibro-acoustic signals are limited in time, the duration of the measured signal frequency determines the accuracy of the estimation of harmonic signal in its spectrum $dF = 1/T$, where T – length of the measured signal. From this expression suggests that to reduce the error of evaluation of the frequency harmonics is necessary to increase the duration of the signal.

But when you use this method to multipoint systems, diagnostics, sequential points, increasing the length of the measured signals will lead to an increase in the overall cycle of measurements that may lead to passage of the defect and also reduces the accuracy of diagnosis. In order to clarify the assessment of frequency, with a limited sample of the signal using the interpolation method the values of unknown frequency, located within the width of the discrete spectrum of values of the neighboring side spectral components, determined by type of used Window weighing – fig. 2.



	U_{11}	U_{10}	U_{12}	U_{21}	U_{20}	U_{22}	U_{31}	U_{30}	U_{32}	U_{41}	U_{40}	U_{42}
Vi, mm/s	4.46	7.29	2.63	9.74	12.7	3.44	4.56	5.12	2.71	2.38	6.34	5.7
Ki	-0.1386			-0.3055			-0.4132			0.4203		
F0i, Hz	50.00			100.00			150.00			197.50		
Fiy, Hz	49.65			99.24			148.97			198.55		
Fi/i, Hz	49.65			49.62			49.66			49.64		
Fpy, Hz	49.64											

Fpo=49.8 Hz, Δ= Fpy - Fpo=49.64 - 49.8= - 0.16 Hz

Fig. 2. An example of calculating periodic frequency component of signal

This method of diagnosis for each of the selected components is a periodic deviation of actual values of the frequency of each periodic component of the calculated values and also includes it in a diagnostic vector. In doing so, the actual value of the frequency of periodic components is defined as the average of the actual frequency of its harmonics, given by the first harmonic, with an amendment to the correction factor, defined by type of function the window Fourier transform. The use of expert systems in monitoring systems dramatically improve the operating efficiency of equipment. Owing to the listed properties to monitoring systems of the equipment start to trust and they really provide safe, resource-saving operation of the equipment of modern technological complexes.

References:

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2. **RF Patent 2322666**, MKI G01N 29/00, G01M 15/00 Method of machines vibro-acoustic diagnostics / Kostyukov V.N., Boichenko S.N.