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IMPULSE RESPONSE MEASUREMENT TECHNIQUE IN THE MONITOORING CONDITION OF THE EQUIPMENT

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Abstract

Creation of monitoring system will improve technical resources of mining equipment. The tasks relevant to accuracy of monitoring must be resolved, since the accuracy is very important in analysis of impact impulses and vibration, which provide for diagnostics of bearings, appears in the problems with reduction gears, unbalances, misalignments in mining engineering. Algorithmic correlation technique must be applied to achieve maximum quality of the signal and definite spectrum for further analysis. The task of determination of elasticity characteristics of high-capacity synthetic mining ropes is actual. Precision is the most important and decisive product-quality index. When solving the tasks of diagnostics the requirements to the precision of measuring devices are tighten by 1.5-1.6 times every year. In this connection measuring systems integrated into the net-communications of the mining in Estonia, become more and more necessary. Risk analysis in the mining industry is very important, but it is difficult oneself to limit only to the theoretical approaches considered in the article [1–3]. The problem that is a difficult decision for most companies is when to buy their own equipment, when to use outside contractors. It is difficult to choose diagnostic equipment to increase the efficiency of technical resources. The purpose of this paper is to give a practical idea of how to determine the need for predictive maintenance investments through actual observations on site.

Keywords: Impact, Accuracy Measurement, Approach to Monitoring, Bearing Fault, Fractal Geometry.

System for the condition monitoring: Creating of the system for the condition monitoring of the equipment in the mining industry will be ensure the reliability of technical resources and the quality of the maintenance. When one considers maintenance options for such important establishment as water purification plant an option of periodical measurements of all machines seems inevitable, and in the long run, it is. However, by correct assembly of couplings and careful following of maintenance requirements machines don't need to be checked very often, which effectively means that although we have very expensive machines on our hands we only need to check their vibration levels 2 or 3 times per year. Therefore allowing the use of outside contractors and postponing actual investments to diagnostics equipment.

The basic step join research proposal on Fault Prediction of Low Speed Bearings is also a new challenging topic and being interested by industrial companies in Estonia. Especially there are still lack of combined algoritms for active vibration for mining equipment.

It is necessary to developing software, thereby applying information technology in mining industry.To collect diagnostic information one can use a vibrating stand (see Fig.1) for recognition of equipment node state [4]. When processing experimental data, can use the graphical interface of the System Identification Toolbox. All the known methods of bearing failure checks are based on the analysis of data recorded with a time interval equal to $\Delta\tau$=1s. If the shaft rotates at a frequency of n=200 rpm, then the shaft will make a 3.(3) turns in the time interval $\Delta\tau$=1s. At some point in time, the recording equipment does not detect the shock load. If the expected frequency of vibration at a given speed is 11.9 Hz, then the duration of one rotation of the shaft (300 ms) is 3.57 times the vibration signal time. At this sampling frequency of vibration signals, it is difficult to diagnose faults in bearings. For more accurate registration of impact loads at low shaft speeds a program was created that allows recording the impact load every millisecond (see Fig.2, 3).

The bearing was considered as a resonant system, in which its own frequencies were calculated [5,6]. This paper compares the methods of checking the state of rolling bearings for high-frequency vibration. The power of high-frequency bearing vibration was monitored; analysis of the form of high-frequency vibration excited by short shock pulses; spectral analysis of fluctuations in the power of high-frequency vibration was made too. The relative error in determining the characteristic frequencies of the arising defects at the rotational speeds of the shaft from 200 rpm to 1500 rpm did not exceed 0,10 %.

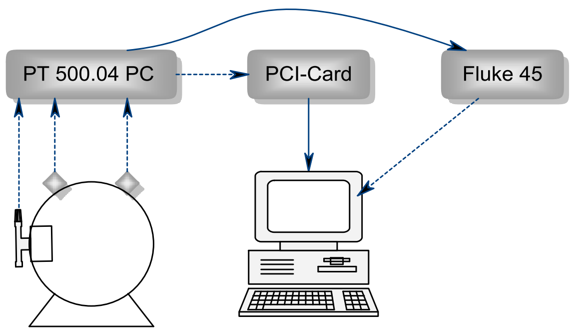
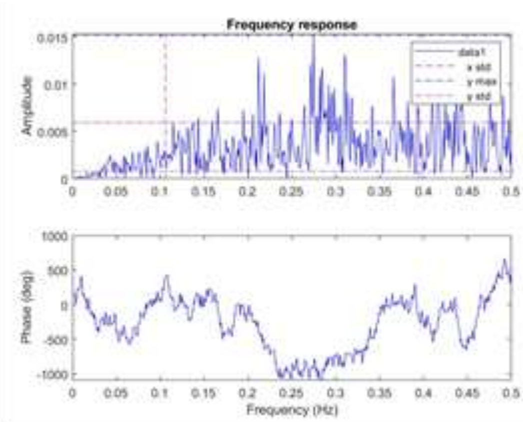


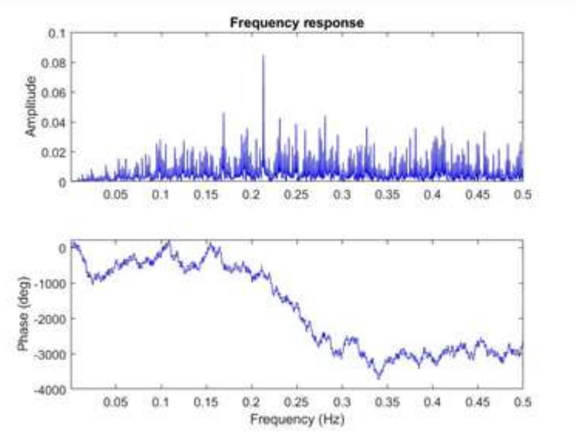
Fig.1. Representation of the vibrating stand

Fig.2. Measurements data input screen

The measured damage index for a etalon roller bearing without damage is shown in Table 1.



a) n=100 rpm



c) n=300 rpm

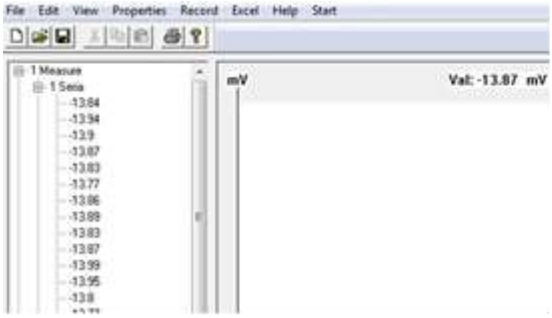
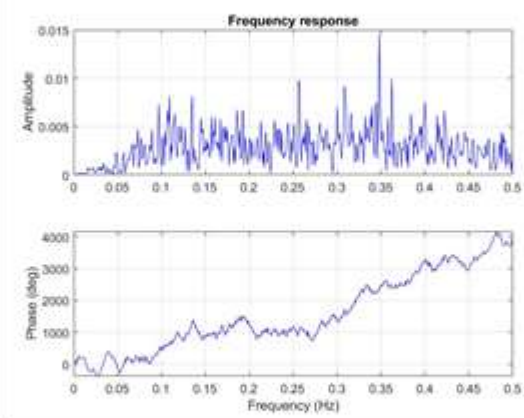


Fig 3. Project input screen. C++, Microsoft Foundation Classes

Table 1

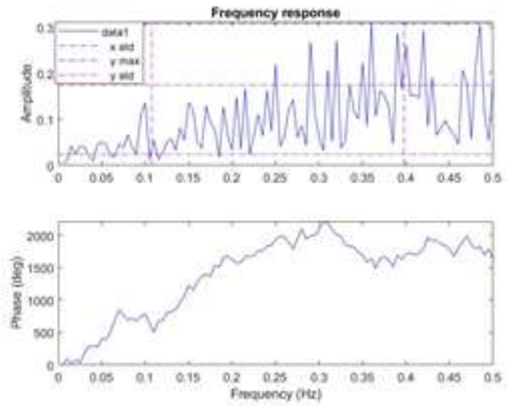
Information about the etalon roller bearing

Channel 1	data
Speed [1/min]	1507,56
Frequency [Hz]	25,14
Of Means	4,00
Damage index	0,233011
Damage index [rms]	0,04

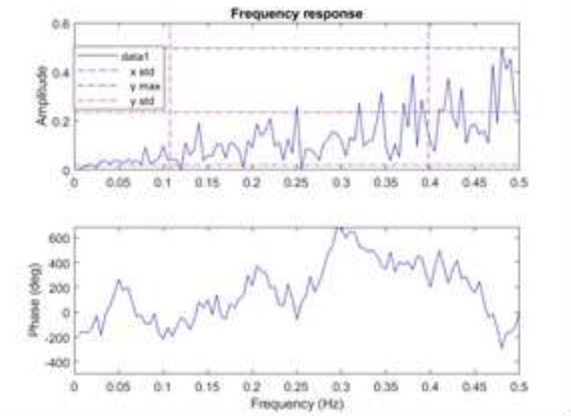


b) n=200 rpm

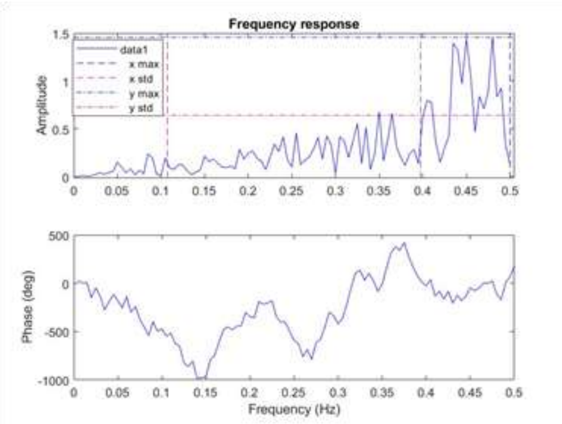
Fig. 4 a,b,c is shown the spectrum for a type 6004 Roller bearing with damage to the outer ring, frequencies occuring due to damage depending on the speed n in rpm



a) n=900 rpm

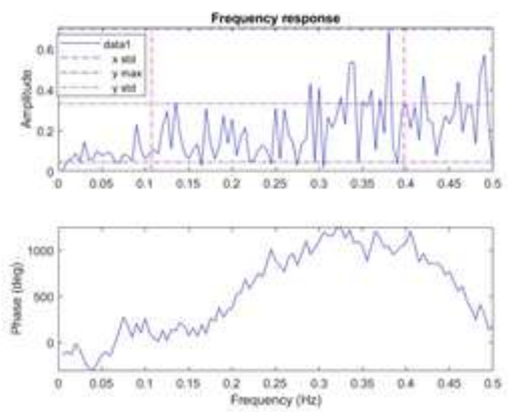


b) n=1000 rpm

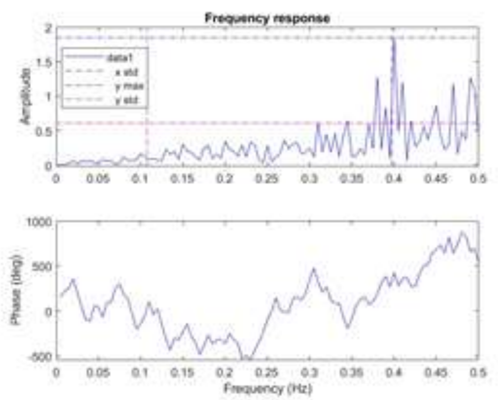


c) n=1100 rpm

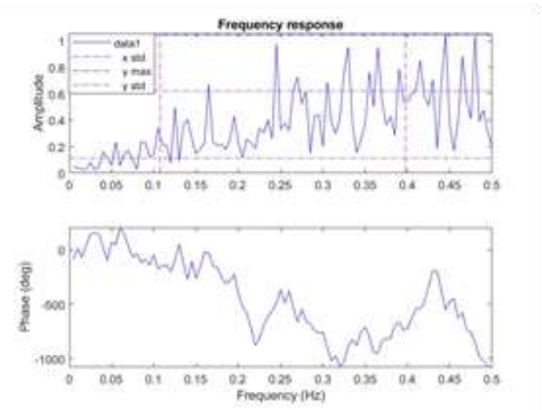
Fig.5. a,b,c is shown the spectrum for a type 6004 Roller bearing with damage to the outer ring, frequencies occuring due to damage depending on the speed n in rpm



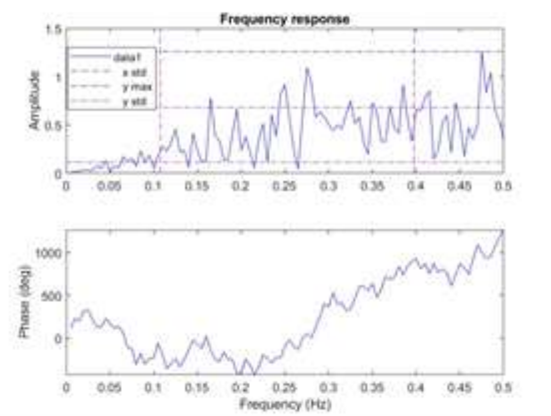
a) n=1200 rpm



b) n=1300 rpm



c) n=1400 rpm



d) n=1500 rpm

Fig.6. a,b,c,d is shown the spectrum for a type 6004 Roller bearing with damage to the outer ring, frequencies occuring due to damage depending on the speed n in rpm.

In Fig. 6 d) is shown spektrum for bearing with damage to outer race (fundamental frequency is 89,5 Hz and rotation frequency 25 Hz).
At a speed of n in rpm, the following frequencies f in Hz occur:

$$f_1 = 0{,}019 \cdot \frac{n}{60} \quad (1)$$

$$f_0 = 3{,}58 \cdot \frac{n}{60} \quad (2)$$

f_0–damage frequencies or error frequency of outer ring

Table 2
Information about the etalon roller bearing (see Fig.4-6)

n	Frequency	Outer ring	
In rpm	response, f_1 in Hz	f_0 in Hz	f_0 in rpm
100–1100	small speeds of rotation	–	–
1200	0,38	71,6	4294
1300	0,4113	77,5	4652
1400	0,443156	83,5	5010
1500	0,475	89,5	5367

Using parameters of vibration signal (vibration displacement, vibration velocity and vibration acceleration) is not efficient for small and very high speeds of rotation, with no shock charge or for a very high frequencies of vibrations (see Fig.4 and 5).

Conclusion: The main task is to provide for more accurate forecast of the mining equipment safety of operation based on the modern methods of diagnostics application. We demonstrate the possibilities offered by differential algebra method to enhance the information from noisy vibration signal. We show that it is possible to use the (standard) Operational Cal-culus methods to estimate the derivatives of fractional order of very noisy and fast signals.
The basic step join research proposal on Fault Prediction of Low Speed Bearings is also a new challenging topic and being interested by industrial companies in Estonia. Especially there are still lack of combined algoritms for active vibration for mining equipment.
Estimation of the outcomes will be aimed on the monitoring accuracy of the impact impulses and vibration when having problems with reduction gears, unbalance and misalignment.
For further analysis algorithmic correlation methods will be applied to achieve maximum quality of a signal and definite spectrum.
Search for effective methods of the rotor type of quarry engineering state monitoring in the breakdown and pre-crash periods is actual. Especially it is important formining-haulage systems [7–20]. In the given project a system of quarry engineering state monitoring using SPM tools with measurement technique HD will be designed. That equipment is table to mechanical impact and environmental inf-luence. Evaluation of the monitoring accuracy will take into account the degree of equipment stability to external mechanical impacts. Contact less sensors will be fixed on the equipment with the help of which we can get the biggest diagnostic worth.

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