Features of use wavelet transforms for processing and analysis of rail fault detection signals

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Abstract – **In this paper the features of use continuous and discrete wavelet transforms for processing and analysis of experimental signals of rail fault detection are considered.**

Keywords – **Continuous wavelet transform, discrete wavelet transform, signals of rail fault detection.**

I. INTRODUCTION

The process of analysis of signals of rail fault detection is usually carried out in the semimanual mode on the basis of visual expert evaluations, that causes comparatively low productivity of work of operator-expert. For the increase of efficiency this work it is necessary to carry out automations of analysis of signals. The purpose of this work is research of possibilities and features of application of continuous and discrete wavelet transforms for detection and classification of fragments of signals which can potentially correspond to defects, first of all to defect as a transversal crack.

II. RECEIPT AND PRELIMINARY PROCESSING OF SIGNALS OF FAULT DETECTION

For research the experimental signals, which were obtained by magnetodynamical method by the monitoring apparatus of flaw detector car – soft hardware "Defectoscope", developed by SCF "Logic", Kyiv, were used [1].

In the process of motion of flaw detector car along some section of rail the experimental data, which contain the values of samples for each of two rails, are obtained. In Fig. 1 the fragment of signal for one rail of section railway Lviv - Sambir – Chop, on which at 36 km there is a defect as a transversal crack is represented.

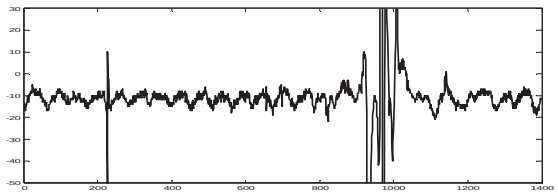

Fig. 1. Example of experimental signal

In this Fig. 1 one can see, that signal contains some "background" constituent, provided by sleeper linings, to which rails are fixed, and also regular impulses of large amplitude and certain form, which are predefined by joint gaps between the segments of rails.

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The preliminary processing of signals consists in determination of general parameters of signals, for example, of mean value of signal, lower and upper threshold values of signal, exceeding of which determines the fragments of signal, which correspond to possible defects, and also in selection of fragments of signals which correspond to rail joints [2].

III. METHODS OF RESEARCH OF SIGNALS OF FAULT DETECTION

One of usable methods for the selection of fragments of signal of fault detection of distinctive form and classification of these fragments as such which correspond to the certain types of defects, there is a method of continuous wavelet transforms (CWT). As wavelet function for CWT either experimental signals for defect section or family of the modelled signals with different parameters are used:

$$\mathrm{cwt}[x(t);\psi(t),a,b] = 1\Big/\sqrt{|a|}\int_{-\infty}^{\infty} x(t)\psi((t-b)/a)dt\,. \qquad (1)$$

In the version of Wavelet Toolbox MATLAB 7.0 system and more high there is a function of building of new wavelet functions for CWT on the basis of pattern, specified by sequence of samplings, however, as a result of absence of software tools for using wavelet functions as an arbitrary sequence of sampled data, the functions for carrying-out of CWT of signals with an arbitrary wavelet function in MATLAB environment were built.

Because of enough computational costs of CWT the analysis of features of application of discrete wavelet transform for the calculation of coefficients of approximation $a_j[p]$ and details $d_j[p]$ was carried out. Comparison of the use of different orthogonal wavelet bases for detection of defects of type a "transversal crack" in the signal is carried out. In addition, the different variants of construction of tree of decomposition in different scale ranges were considered.

IV. CONCLUSION

The diagnostic signals of fault detection of rails are differed by certain features, that causes specific of its processing. This processing consists of a few stages, on first from which preliminary processing is worked out with the purpose of determination of fragments of signals, which can correspond to defects. On the next stages continuous or discrete (or both) wavelet transforms for identification of the selected fragments and its classification are used.

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