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Pattern Recognition of 1D and 2D Signals Using Normalization and Normal Transformation

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Abstract—Different classification methods for 1D signals using the normalization, including normalization in terms of level and in terms of step and the normal transformation, have been proposed. Normal filtering is a variant of special matched filtering. The application of normalization in terms of level and normal transformation for 2D signals was also considered. The filter formation and classification algorithms for the considered variants were presented. An algorithm for direct formation of the matrix operator of normal transformation for 1D signal was described. Case studies were used to illustrate the application of above methods. The possibility of a variable scale of input signals was also taken into account.

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1. INTRODUCTION

Solving the problem of recognition (classification) of signals and images acquires the ever increasing importance. This problem can be solved by a variety of methods [1, 2]. The problem of signals classification is often performed by using the matched filtering [3] or orthogonal transformation [4, 5].

The classical matched filtering does not provide numerical estimates of similarity between the signal under investigation and reference signal, since it only registers the presence or absence of the reference signal against the background of white noise. Orthogonal transformations (OT) make it possible to obtain such numerical estimates for the cases when one of the basic functions of OT coincides in shape with the reference signal. For example, the harmonic coefficient calculated from the Fourier spectrum for the signal under investigation "similar" to a harmonic. Thus, the recognition with a numerical estimate of similarity of signals depends on the presence of normal transformation [4].

Solving the problem of recognition involves the need of finding the spectrum of test signal using the normal OT. Comparison the reference signal spectrum with the spectrum of test signal provides a numerical estimation of their degree of similarity.

The numerical estimation procedure of the difference between the reference signal and test signal can be interpreted as matched multichannel filtering [4], where the number of filter channels is equal to the order of the matrix operator of discrete orthogonal transformation (DOT). Thus, the classification based on such filtering, which is the variant of special matched filtering, involves the need of developing methods of building OT where one of the basic functions coincides with the reference signal. There are several variants of solving such problem:

1. Normalization in terms of "level" implies the selection of reference signal in accordance with the basic function of selected known OT [6–8].

2. Normalization in terms of "step" implies the selection of basic function of arbitrary known OT in accordance with specific reference signal [9].

3. Normal transformation implies the creation of a new OT where one of the basic functions with an accuracy to a constant factor coincides with the reference signal [4, 5, 10].

Section 2 of this paper deals with the issue of implementing the normalization in terms of level for 1D and 2D signals. Section 3 deals with the normalization in terms of level. Section 4 describes the method of