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Recognition of Conductive Objects Based on the Characteristics of Reflected Electromagnetic Wave

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Abstract—The problem of electromagnetic wave diffraction by the metal objects has been solved using integral equation technique. The diagrams of backward scattering have been plotted for four different objects. Based on the feature vector, which has been constructed by applying wavelet packet signal decomposition, a neural network has been trained. We have performed the testing of ability of the neural network to recognize the object depending on the noise level. Various methods of the feature vector forming have been considered.

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INTRODUCTION

At present time the inverse diffraction problems, having solved which one determines the structure of the irradiated body based on the parameters of reflected wave, are relevant [1–3]. Such problems arise in medicine, biology, non-destructive testing, radiolocation, geology etc. In most cases, the problem consists in determination of the presence of a particular object and in its recognition [2, 3].

Neural networks find increasingly widespread application to the recognition problems. Their advantage is the ability to train and to perform self-maintained determination of the characteristic features that define the object. Furthermore, to some extent neural networks are able to suppress the noise and to carry out the object identification based on its noise characteristics [4]. However, in this case the network requires a significant number of elements in the training sample. Since the results of the actual physical experiments always contain noise, and sometimes they are impossible or expensive, in this paper a neural network was trained based on the theoretically calculated characteristics of the object's backward scattering.

A separate issue is the construction of the feature vector, which is applied to the input of the neural network during its training and implementation. The construction of this vector using a particular algorithm allows one to lower the noise level and reduces the length of the reference feature vectors, which facilitates their storage and processing in the automatic recognition systems. In this paper the construction of the feature vector is performed using adaptive wavelet packet decomposition (AWPD) of the signal [5].

DIFFRACTION PROBLEM SOLUTION

The problem consists in the recognition of one of four objects based on its diagram of backward scattering. The following perfectly conducting shapes were selected as the scattering objects: a sphere, a cylinder, a flat disc and a square. In [6] the authors have demonstrated slight variation of backward scattering pattern of the metal body, which has a finite conductivity, when applying the model of a perfectly conducting body. The geometrical dimensions of the shapes are as follows: radius of the sphere and of the disc $R = 25$ mm, side of the square $d = 50$ mm, height of the cylinder $H = 50$ mm, radius of the cylinder $r = 10$ mm.

The purpose of this paper is the development of an algorithm of metal body recognition based on the structure of the reflected electromagnetic wave. The mentioned hereinabove types of reflectors and their parameters are chosen as test ones. During the practical application of this algorithm the corresponding feature vector can be obtained for any object. Analysis of possible restrictions on the structure of the recognizable body is the subject of further investigations.