Application of Neural Networks to Diagnostics of Pumping-Rod Units

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***Abstract*— The paper is devoted to carrying out of diagnostics defects occurring in deep-well pumping-rod by means of neural networks. Here the problem is reduced to finding of dynamograms corresponding to different defects and this is carried out by means of neural networks.**

***Keywords*— neural networks; dynamograms; diagnostics**

I. Introduction

Deep well pumping-rods are widely used in operation of oil wells. As different factors influence operating condition of such type pumps, the control of operation condition of pumps, discovery and programming of their defects in time is very important. It should be noted that violations (sand bridge, gassing, break of rods) occurring in operation condition is the reason for destruction of oil recovery decrease and as a result for destruction of deep well pump and on the whole for destruction of the well itself. Therefore, discovery and prognostication of defects in deep well pumps is one of the important problems in oil recovery industry[1].

It should be noted that detection of defects before a deep well pump is brought to the well surface, is very important. One of these detection methods is the dynamometry method that stipulates automatic record of general power variable influencing on balance head of in instrument in full operation period of deep well pumps by means of a dynamo graph.

Many papers were devoted to diagnostics problems of pumping-rod, units by means of dynamo gramms obtained from records. Notice that in the book the dynamograms recorded in different real oil wells were given and appropriate defects were explained.In numerical methods were suggested for constructing dynamograms corresponding to normal and defective operation condition important for diagnostics of pumping-rod units.

In computer diagnostics methods of one-stage pumping-rod units in semi-automatic condition are given.

Here, though the data base of dynamograms defining the defects of pumping-rod units is created, definition and analysis of these defects visually is conducted by specialists, and this reduces to the fact that subjective factors play an important part. In order to remove such subjective factors, a problem on automatic recognition of defects according to dynamograms must be resolved and this may be realized by different methods.

In this paper, data base was created on the base of dynamograms corresponding to some defects, and diagnostics problems of these defects were considered by means of neural networks. The suggested method may take into account increase of the amount both of defects and dynamograms corresponding to each defect. At the 1st we input images of defects to pattern generator. Secondly the result of this program uses for entry of neural network program and finally the results of these programs classify output image for diagnostics defect.

II. Problem Statement

As it was noted above, an appropriate dynamogram associates with each defect arising in operating oil wells by pumping-rod units. Wide analysis of these dynamograms was given in. Data base of some dynamograms was created in. Creation of this data base and its use rules are given in. Here, we give short analysis of some of them.

At first, we consider a normal dynamogram of a deep well pump. In this case, theoretical dynamogram is in the form of a parallelogram. Under the action of different forces, the forms of dynamograms differ in a certain extent and their recognition is very important. We have 15 images in 3 differend group or figure, in these images, the description of dynamograms corresponding to normal operation of deep well pumps is given.

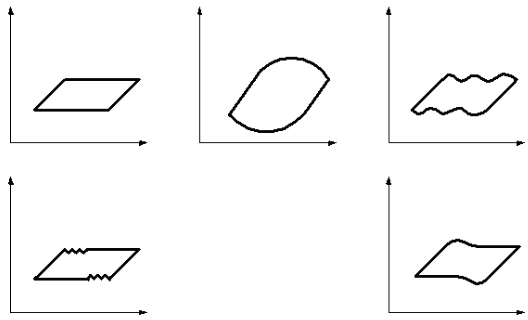


Figure 1.

Now consider dynamograms that correspond to fluid flow from the sucker part of a pump. These diagrams may be in the following form:

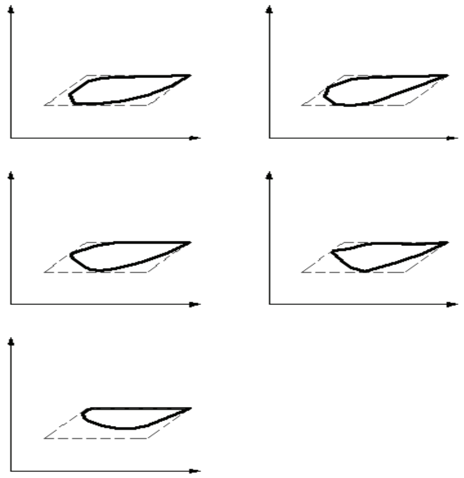


Figure 2.

The form of dynamograms that correspond to fluid flow from the supercharging part of a pump is given in figure 3.

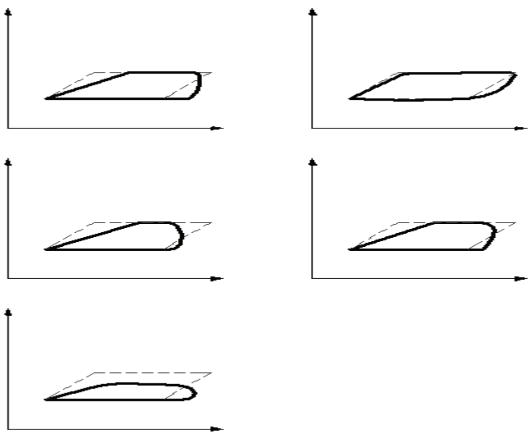


Figure 3.

Neural networks and their application to recognition of dynamograms [2].

We transform all different images to matrix digits by means of some programs.

There are some such programs that we can work with all of them. These programs in general are said to be pattern generator. These programs can divide each image into 64 parts and save them in 8×8 -dimensional matrix. This matrix consists of 64 digits.

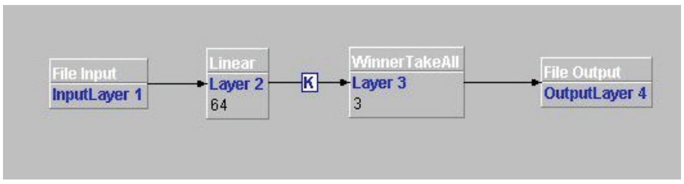
These digits have only 0 or 1 variants.

Now, our digits are ready and we can use them as input of neural network. We have 15 images and we want to divide them into 3 parts by means of neural network. There are many programs for constructing neural networks and we use one of them.

Step I: We must make one input layer and say that there should be 64 neurons in this layer and they must pass to the next layer.

Step II: We must create and train a linear layer containing in put digits at each matrix. Therefore, this linear layer consists of 64 neurons.

Step III: Now, we need an output layer. There are several types (logarithmic, Delay-Contex -Gaussian) of layers and each of them were constructed for a certain aim. There is a layer called (Winner talk all) among these layers and in this paper we call it WTA. Its main function if to divide the digits or images from the input. After constructing this layer we train it to divide the input of our network into three parts (to several parts due to the work). Now, we must make relations between the parts of the network. In fact, we make relation between input, linear and output layers. The main relation must be made between the linear part and WTA layer. There are some ways to do it (Full Synapse, Direct, Sanger,). Among them we select KOHONEN synapse. Because this program is more suitable to WTA program for making relation between the input, output layers.



Step IV: In training level, the repetition of the network (Epochs) is given 10000 times and we should select 15 images for training patterns. After that we use this network in the program. Then we save the result of the network in a new folder. We can see that the network can divide the images in the matrix form into three parts.

0.0;0.0;0.1	0.0;0.1;0.0	0.1;0.0;0.0
0.0;0.0;0.1	0.0;0.1;0.0	0.1;0.0;0.0
0.0;0.0;0.1	0.0;0.1;0.0	0.1;0.0;0.0
0.0;0.0;0.1	0.0;0.1;0.0	0.1;0.0;0.0
0.0;0.0;0.1	0.0;0.1;0.0	0.1;0.0;0.0

The digits given in the output show that the network divided all the images into 3 parts and recognized them.

REFERENCES

[1] Belov M.G. Investigation of operation of deep well pumps by a dynamograph. M.GOSTEKHIZDAT, 1960.

[2] Sckakoff R.J. Artificial Neural Network. Mebraw-hill. 1997.