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B. S. Akhmetov[1], A. I. Ivanov[2], Zh. K. Alimseitova[3]

[1]Kazakh national pedagogical university named after Abai, Almaty, Kazakhstan,
[2]Penza state university, Penza, Russia,
[3]Kazakh national research technical university named after K. I. Satpayev, Almaty, Kazakhstan.
E-mail: zhuldyz_al@mail.ru

TRAINING OF NEURAL NETWORK BIOMETRY-CODE CONVERTERS

Abstract. There are considered theoretical and practical issues of training of neural network biometric parameters converters into the key code on the example of the handwriting dynamics. The researches were carried out in the simulation environment of the «NeuroTrader» in the modes of manual and automatic training. Analysis of research results has shown that for sustainable learning there is a need in a large number of examples or the use of a composite adder. The resulting neural network container allows safely and anonymously to store a biometric pattern.

Key words: neuron, neural network converter, training, weight coefficient, adder.

Introduction. The development of information technology, informatization of society leads to an increase in the requirements for information security systems, including protection against unauthorized access. The reason for this is an increase in the volume of stored and transmitted information, the number of electronic services, the possibility of distance access to information, distance learning, and etc.

Analysis of the existing modern authentication systems shows that most systems use a password authentication. The obvious disadvantage of this system is long passwords, which are hard to remember. As a consequence, they are recorded, that leads to their loss, divulgence, theft. Alternative to password authentication are biometric systems which use the unique biometric parameters of a particular user as a key.

The advantages of biometric authentication include the possibility of implementation on computer hardware, the complexity of compromising, substitution, the possibility to authenticate at entering the system and during its operation. As biometric parameters there are used finger- and palmprints, geometric parameters of hands, face, ears, drawing of the eye iris or its retina, features of handwriting or keyboard handwriting, voice.

In recent years a widespread distribution has received the authentication based on handwriting, the prospect of which is confirmed by the fairly wide distribution of such authentication tools, as well as a large number of relevant theoretical and practical researches [1-6]. At the same time, their use is limited by relatively low recognition accuracy, a significant development time, insufficient adaptation to many features of modern IT, which predetermines the relevance of researches in this direction.

Problem statement. The analysis of works devoted to biometric user authentication show that this process can be divided into several stages, for example, such as reading a biometric parameter, highlighting of features and a biometric pattern forming, adding a pattern to the database. The resulting biometric pattern should be unique and protected. Obtaining of a biometric pattern from a biometric parameter leads to the question of image recognition. This problem is successfully solved by using artificial neural networks.

Purpose and objectives of the research. In accordance with the general problem of the researches in the field of neural network systems of biometric user authentication, the main purpose of the research is the training of artificial neural networks for the handwriting recognition.

Training of a neural network converter. In accordance with GOST R 52633.0 [7] the neural network converter of biometry-code must be trained in advance to convert the secret biometric image of "Own" into a user's private key. Training should be carried out automatically (without human intervention in the process of selecting the parameters of an artificial neural network), the user must have assurance that his long password (key) involved in training will not be compromised.

The general scheme for training of the neural network biometric parameters converter into the key code is shown in figure 1 [8].

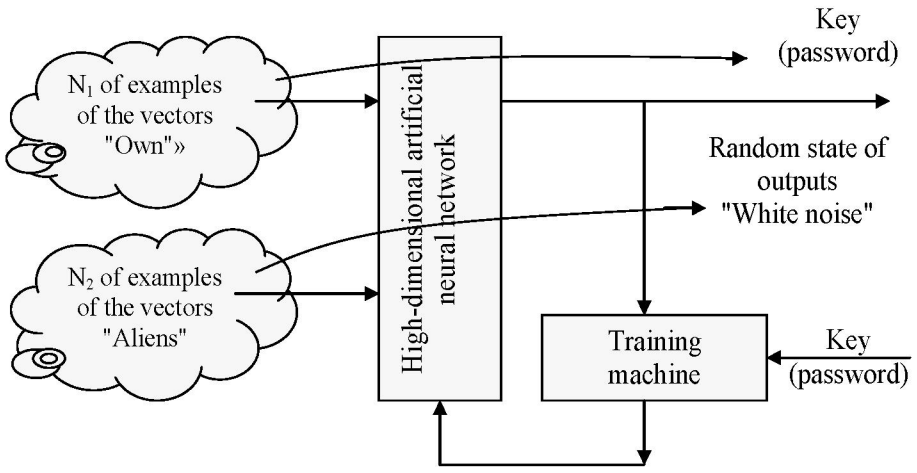

Figure1 – The structural scheme of training of the neural network biometric parameters converter into the key code (password)

The training is carried out by alternately presenting of the "Own" and "Alien" images to the learning machine with an intermediate selection of the coefficients of the artificial neural network [9-11]. The weight coefficients should be selected in such a way when during the appearance at the inputsof the artificial neural network of the "Own" vector elements there appears a long password (key) at the outputs of the artificial neural network. During the appearance at the inputs of the artificial neural network of data vectors corresponding to the images "Alien", at the outputs of the artificial neural network there should appear random states – "white noise" [12].

Let's consider the training process using the example of a degenerate neural network converter biometry-code with one output [13, 14], shown in figure 2.

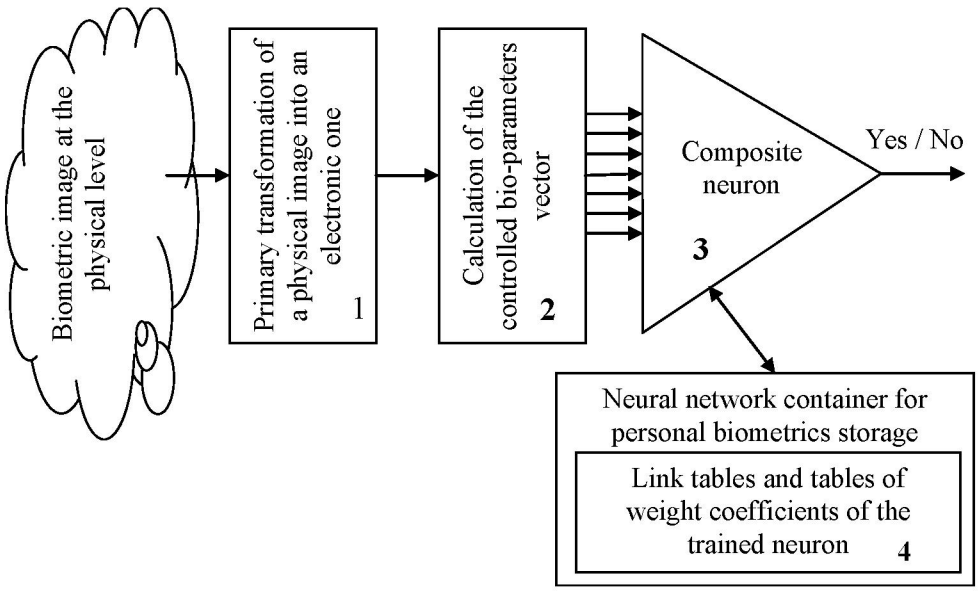

Figure 2 – A degenerate neural network converter biometry-code with one composite neuron

It is clear that the training of one neuron does not represent a particular difficulty, and for this purpose there can be used any of the hundreds of currently known learning algorithms [15-20].

In order to illustrate the training process we will use the "NeuroTrader"'s modeling environment. As a biometric image we will select the handwriting dynamics, will form a training sample from several examples of "Own" and from several examples of "Alien".

As examples of the image of "Own" we will use 13 handwritten images of the word "Almaty", reproduced by the same person (figure 3).

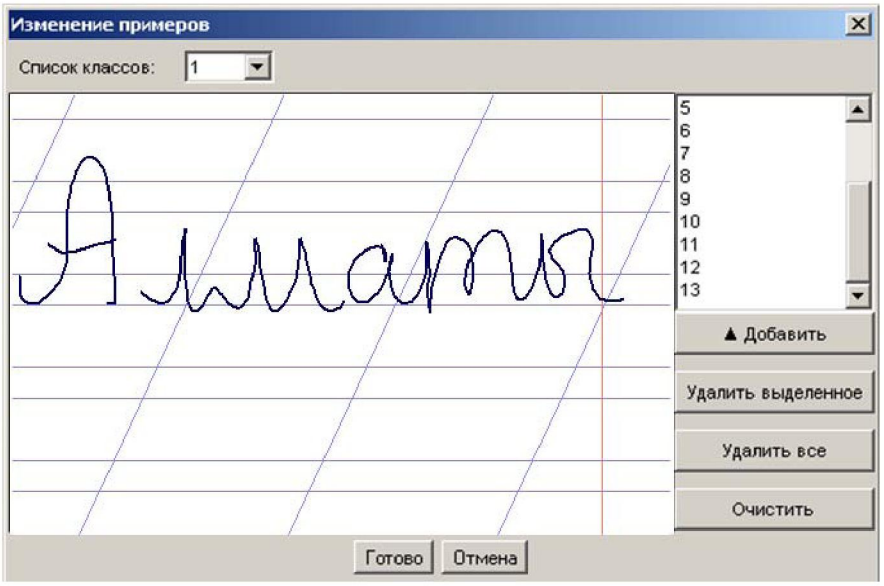

Figure3 – The screen entering form of the examples of the handwritten password "Own" in the "NeuroTrader" modeling environment

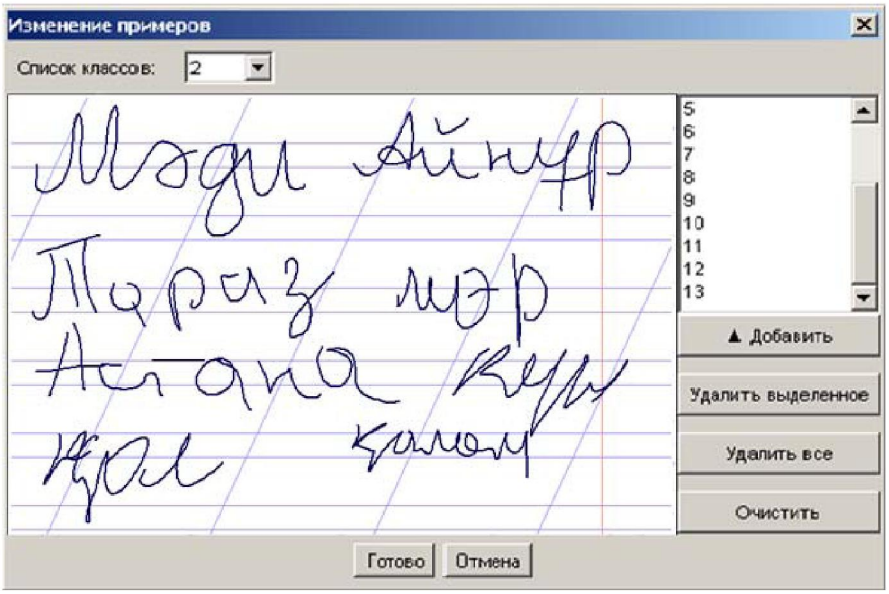

Figure 4 – The screen entering form of the examples of the handwritten images "Aliens" in the "NeuroTrader" modeling environment

As images of "Aliens" there were used the words "Madi", "Ainur", "Taraz", "mor", "Astana", "kun", "kol", "kalam" (figure 4), reproduced handwritten by different people. Therefore, at training a neuron it is necessary to select its weight coefficients in such a way that the set of images "Alien" and the set of examples of one image of "Own" were as much as possible spaced at the output of the adder of the neuron. As a rule, as an euron there is considered an adder with some nonlinear element at the output.

As analyzing parameters the modeling environment "NeuroTrader" uses the Fourier coefficients of the pen oscillations resulting from the handwritten reproduction of the analyzed words. Figure 5 showsan example of such oscillations.

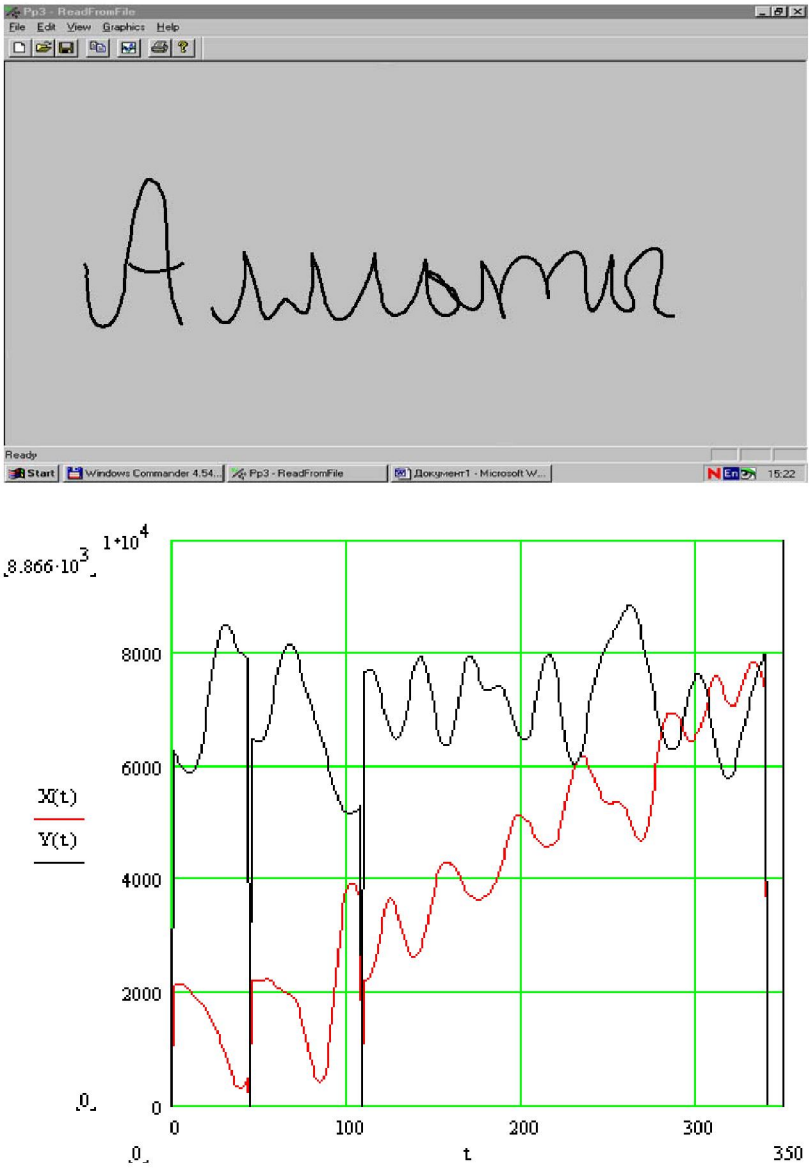

Figure 5 – Example of the pen oscillations Y(t) and X(t) at the handwritten reproductionof the word-password «Almaty»

Practice has shown that for handwritten words of 4, 5, 6 letters it is sufficient to take into account about 24 of cosine and sinus coefficients of the Fourier series (k = 1,2,3, ..., 24). Then taking into account two coordinates makes it possible to obtain a vector from 96 biometric parameters (1-4):

$$\nu_k = \frac{1}{T}\int_0^T Y(t)\cdot\cos(k\frac{2\pi}{T}t)dt, \quad (1); \qquad \nu_{2k} = \frac{1}{T}\int_0^T Y(t)\cdot\sin(k\frac{2\pi}{T}t)dt \quad (2);$$

$$\nu_{3k} = \frac{1}{T}\int_0^T X(t)\cdot\cos(k\frac{2\pi}{T}t)dt, \quad (3); \qquad \nu_{4k} = \frac{1}{T}\int_0^T X(t)\cdot\sin(k\frac{2\pi}{T}t)dt \quad (4);$$

where T – full time for entering a signature (handwritten word-password).