Information System for assessing the Physical Condition of Pets

Elizar Nosulya, Liudmila Nechvoloda

Abstract— This work is devoted to revealing the problem of assessing the physical condition of pets. The relevance of the work is due to the lack of software on the market that would allow ordinary users to assess the condition of the animal and obtain information about the need to provide qualified assistance. The peculiarity of the work is the use of image recognition system to determine the condition of the animal

Keywords— Hopfield neural network, pets, pattern recognition, mathematical methods.

I. Introduction

Today, veterinary medicine is a very relevant topic in the modern world. More and more people are willing to get pets, but along with the number of animals grows the need for care for them, including the provision of qualified medical care. In order to identify the need for such assistance to the animal in a timely manner, its owner must promptly notice the animal's health problems.

The problem of assessing the physical condition of pets is quite important, because the physical condition of the pet is one of the indicators of the health of the animal, and its deterioration can signal the presence of disorders in the body. Often, the abnormal physical condition of the animal itself can cause the animal's health to deteriorate and cause serious problems.

As for the automation and computerization of this area, it is at an average level. In the software market, there are several examples of programs that allow you to automate certain aspects of veterinary clinics, such as paperwork, accounting, customer service, and so on.

There is plenty of theoretical information and guidance on the Internet to maintain a pet's good condition and determine its deterioration, but there is no system to automate the process of assessing a pet's physical condition, make it simpler and clearer for the average user who sometimes needs to identify the need to provide qualified assistance to the animal.

The aim of the research is to simplify the process of pet care through the introduction of an information system for assessing the physical condition of pets on the basis of modern neural network mathematical methods.

II. Literature Analysis

The creation of image recognition systems using neural networks was considered in the works of S.V. Aksyonov, N.N. Matkasim, O.A. Shushina,
S. Haykin and others. However, these works are mostly theoretical in nature and do not consider in detail the use in creating image recognition systems of specific types of neural networks.

In the work of O.E. Lepsky and O.G. Bronevych mathematical methods of pattern recognition and principles of neural networks on which they are based are considered. This information makes it possible to find the optimal mathematical method for the task [1].

The study of image recognition methods was also presented in the works of A.M. Prokhorov, E.A. Ermeeva, L.N. Chaban.

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"Mushroom Book & Identification" (Fig. 1) is a program that allows to perform mushroom species recognition. A neural network was used for recognition. One and a half thousand samples of photographs for each species were used for training. The application is able to recognize 172 species of mushrooms. Dato ML is responsible for the development of the recognition algorithm in this program [2].

Fig. 1 Mushroom Book & Identification

Im2Calories (Fig. 2) is a program that allows to calculate the calorie content of a product from its image. This program also uses an internal pattern recognition system. It uses the preliminary work of DeepMind, a startup that Google acquired last year. This mobile application, firstly, will help to clarify some aspects of nutrition, and secondly, it will help to organize a more healthy and balanced diet [3].

Fig. 2 Im2Calories main form

III. Object, Subject And Methods Of Research

As a mathematical model of the system uses the Hopfield network. The Hopfield network shows how can be organized to remember in a network with elements that are not very reliable. Experimental data show that with an increase in the number of broken neurons to 50%, and the reliability of the correct answer is close to 100%.

The network is created from *N* artificial neurons, the axon of each neuron is connected to the dendrites of other neurons, creating feedback. The network architecture is shown in Figure 3 [4].

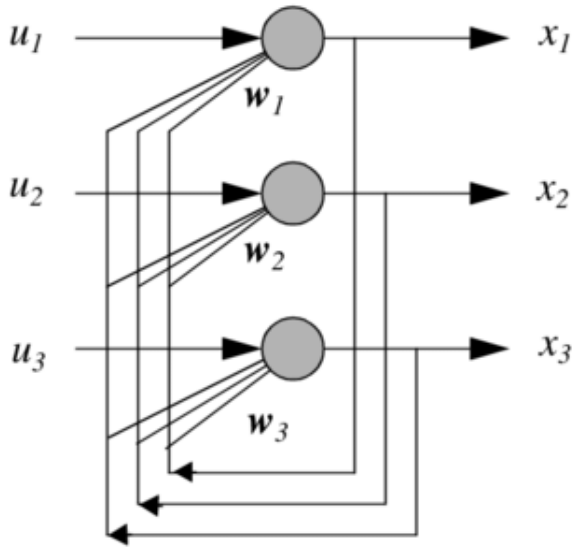

Fig. 3 Hopfield neural network architecture

As input for the network is used certain parameters of the animal whose condition is to be determined. These parameters include the age of the animal, its weight, torso girth, fatness and body temperature.

The initial data are determined by the system of the physical condition of the animal.

Each neuron can be in one of two states:

$$S(t) \in (-1;+1), \tag{1}$$

where *S(t)* is the state of the neuron at time *t*.

The excitation of a neuron corresponds to +1, and the inhibition of −1. The discreteness of the neuron states reflects the nonlinear limit character of its functioning (known as "All or nothing").

The state dynamics in time of the *i*-th neuron in a network of *N* neurons is described by a discrete dynamic system:

$$S_i(t+1) = sign[\sum_{j=1}^{N} J_{i,j} S_i(t)], i, j \in (1,...,N), \tag{2}$$

where $J_{i,j}$ – matrix of weights that describe the interaction of the dendrites of the *i*-th neuron.

Learning the Hopfield network source images ζ_μ^{in} is reduced to calculating the values of the elements of the matrix $J_{i,j}$.

Formally, it can be described the learning process as follows: let it be necessary to teach the neural network to recognize M images marked $\{\zeta_{\mu}^{in}, \mu = (1,...,m)\}$ Input image $\overline{\zeta_{\mu}^{in}}$ is $\overline{\zeta_{\mu}^{in}} = \zeta_{\mu}^{in} + \zeta'$, where ζ' — noise superimposed on the original image ζ_{μ}^{in}.

In fact, neural network learning is the definition of norm in image space $\left\|\zeta_{\mu}^{in} - \overline{\zeta_{\mu}^{in}}\right\|$. Then, cleaning the input image from noise can be described as minimizing this expression.

An important characteristic of the neural network is the ratio of the number of key images M that can be stored to, the number of neurons in the network N:

$$\alpha = \frac{M}{N}. \tag{3}$$

For the Hopfield network, the value of α does not exceed 0.14.

The calculation of the square size matrix for key images is performed according to the Hebb rule:

$$J_{i,j} = \frac{1}{N} \times \sum_{\mu=1}^{M} [\zeta_{j,\mu}^{in} \times \zeta_{j,\mu}^{i,n}], \tag{4}$$

where $\zeta_{j,\mu}^{in}$ – each j-th element of the image ζ_{μ}^{in}.

It should be noted that due to the commutative nature of the multiplication operation, equality is observed $J_{i,j} = J_{j,i}$.

The input image, which is presented for recognition, corresponds to the initial data for the system, which is the initial condition for a dynamic system (5):

$$S_i = \overline{\zeta_{\mu}^{in}}. \tag{5}$$

Equations (1) - (5) are sufficient to determine the artificial Hopfield neural network and we can proceed to its implementation [5].

The Hopfield network learning algorithm differs significantly from such classical learning algorithms as the error correction method or the error propagation method. The difference is that instead of successively approaching the desired state with the calculation of errors, all the coefficients of the matrix are calculated by one formula, in one cycle, after which the network is immediately ready for operation.

Some authors refer to the Hopfield network as a network with so-called "teacherless learning." But this is not true, because teaching without a teacher implies a lack of information about which classes it needs to include incentives. For the Hopfield network without this information it is impossible to adjust the weights, so here we can only say that such a network can be classified as a class of optimizing networks (filters). A distinctive feature of the filters is that the matrix of weights is adjusted by a deterministic algorithm once and for all, and then the weights no longer change.

There is feedback in the Hopfield network and therefore the problem of sustainability needs to be addressed. The weights between neurons in the Hopfield network can be considered as a matrix of interactions. It is known that a feedback network is stable if its matrix is symmetric and has zeros on the main diagonal. There are many stable systems of another type, for example, all direct distribution networks, as well as modern recurrent networks of Jordan

and Elman, for which it is not necessary to fulfill the condition of symmetry. But this is due to the fact that other restrictions are imposed on feedback. In the case of the Hopfield network, the condition of symmetry is necessary, but not sufficient, in the sense that the achievement of a stable state is also influenced by the mode of operation of the network. It is also known that only the asynchronous mode of operation of the network guarantees the achievement of a stable state of the network, in the synchronous case may be infinite switching between two different states (this situation is called a dynamic attractor, while the stable state is called a static attractor) [6].

Thus, the Hopfield neural network makes it possible to organize a simple, but quite accurate pattern recognition algorithm with preliminary network training.

IV. Results

Consider the work of an information system for assessing the physical condition of pets on the basis of the above-described neural network of Hopfield.

An information system for assessing the physical condition of pets was developed in the object-oriented programming language C #.

C# is an object-oriented language, but also supports component-oriented programming. The development of modern applications increasingly requires the creation of software components in the form of stand-alone packages that implement certain functionalities. The main feature of such components is that they are a programming model with properties, methods and events. They have attributes that provide declarative information about the components.

Among the advantages of C# is also a large number of libraries, which simplifies the process of developing and finding solutions to certain issues.

After starting the program, the main working window of the program opens in which the user will assess the physical condition (Fig. 4).

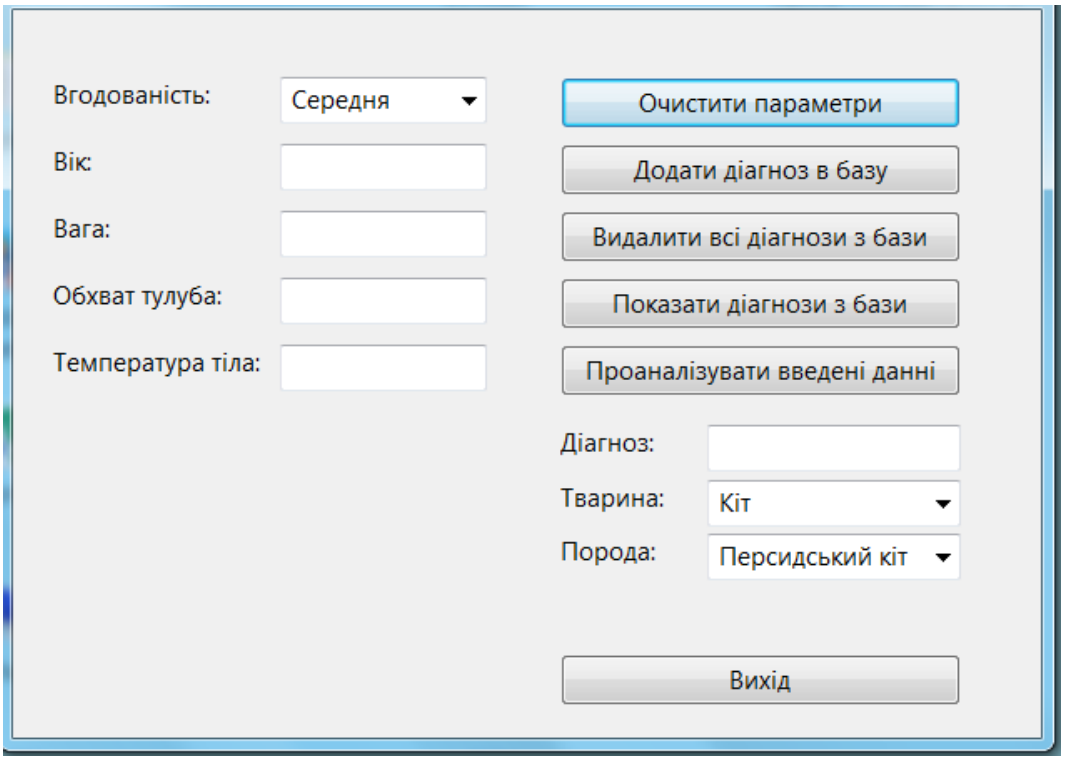

Fig. 4 The main program window

The program interface is divided into several zones. The first is the area of selection of user animal parameters (Fig. 5). Here the user can enter the image of his animal by entering the parameters of his animal. Among the parameters that must be entered are fatness (complexion), age, weight, girth of the animal, body temperature.

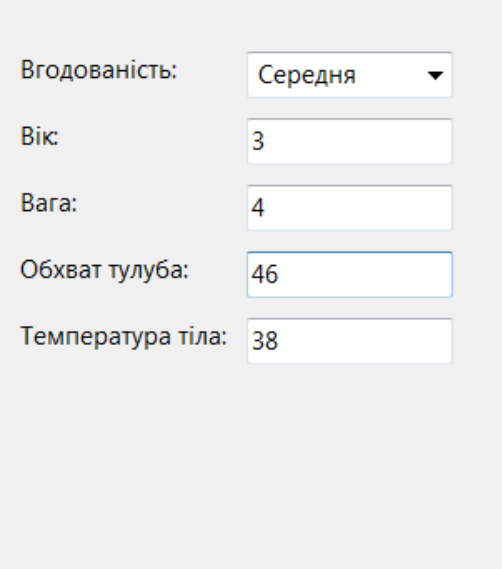

Fig. 5 Area of selection of animal parameters

The second element of the program is the action menu with the entered image (Fig. 6). The user is offered the following actions here:

– clear the data entry form again;
– analysis of entered data.

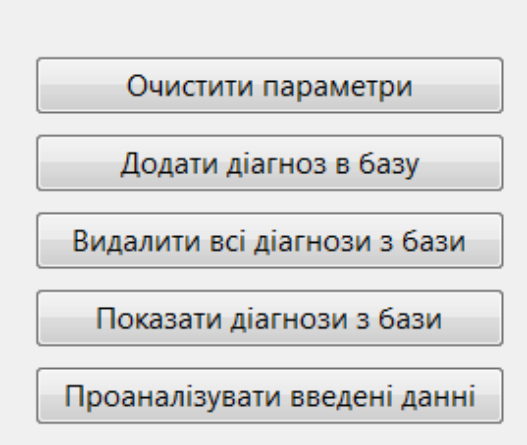

Fig. 6 Action menu with the entered image

Because the Hopfield neural network learns on the principle of "Learning with a teacher", before the start working with recognition, the program must include several images for example, according to which the network will begin to learn. To do this, the program has fields for entering the state and the function of adding the state (diagnosis) to the database, clearing the database of diagnoses and viewing all entered diagnoses.

For user convenience, there is also a separate button to exit the program. Given the prospects for the development of the program, test functions of animal and breed selection have also been added. In general, the menu of program functions has the following form (Fig. 7).

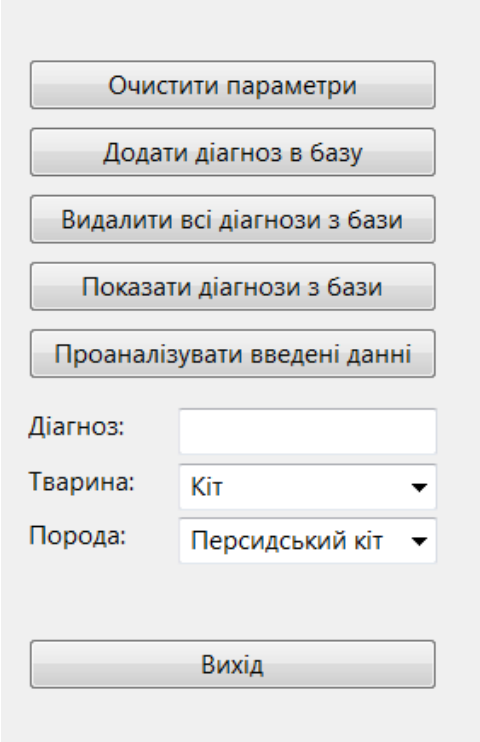

Fig. 7 General view of the program functions menu

As described earlier, the Hopfield network requires training for the most accurate pattern recognition. In our case, the program should give examples of each of the animal's conditions. The introduced primary examples will be the basis for further learning of the network and better recognition.

Consider an algorithm by which the average user will be able to determine the condition of his pet.

Before beginning the evaluation process, the user must take from his pet all the measurements that the program needs for recognition.

After all measurements are received, the user should enter them accordingly in the corresponding fields (fig. 8).

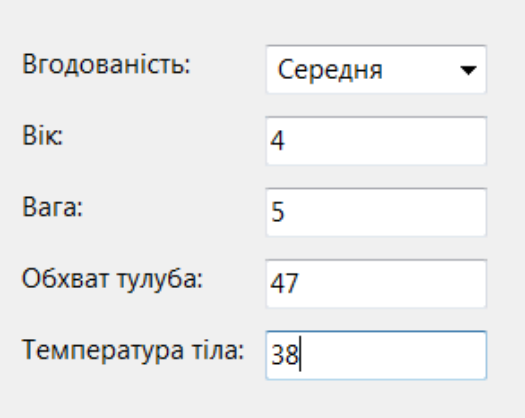

Fig. 8 Data entry according to animal measurement results

Once all the parameters have been entered, the user only has to select the "Analyze entered data" function in the menu. Hopfield network, will carry out the process of recognizing the imported image and display the result to the user (Fig. 9).

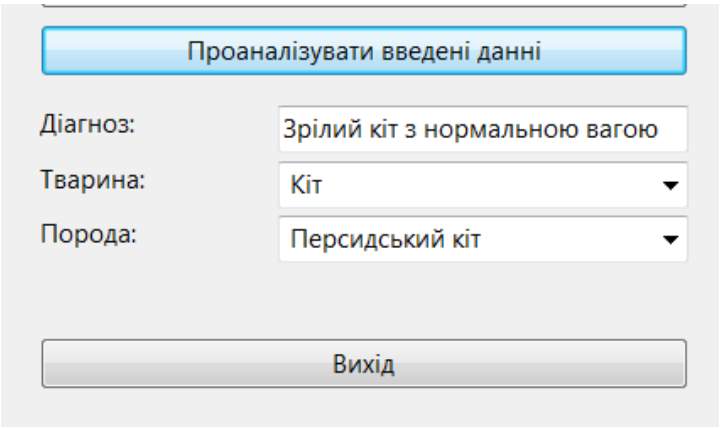

Fig. 9 Displays to the user the result of determining the condition of the animal

The user also has the opportunity to choose the breed of animal whose condition will be assessed. This process will look like this.

First, the user enters the measurements of his animal (Fig. 10).

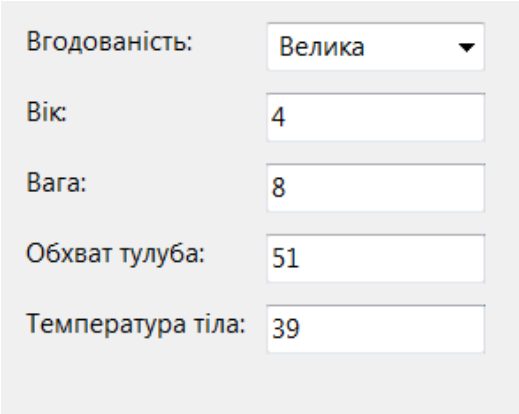

Fig. 10 The parameters of an animal of another breed are entered

After entering all the parameters of the animal, the user must select the breed in the appropriate list (Fig. 11)

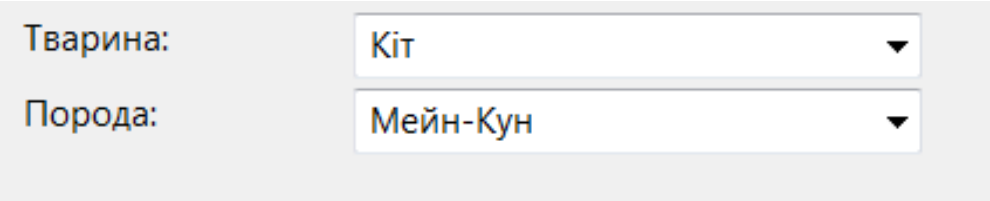

Fig. 11 Animal breed selection menu

Then the user performs the same actions as in the previous case, and selects the analysis of the selected data in the menu. The system recognizes the image and indicates the condition of the animal (Fig. 12).

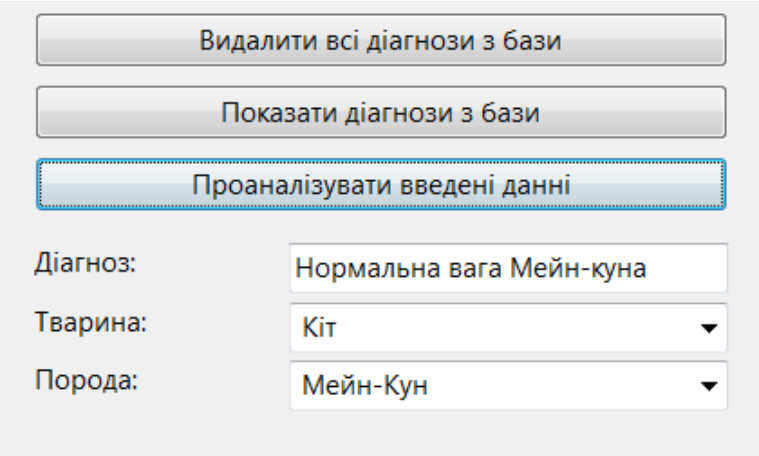

Fig. 12 The result of the evaluation of an animal of another breed

Consider the case where the user's animal parameters do not correspond to normal physical condition. To do this, enter the measurements corresponding to the overweight animal (Fig. 13)

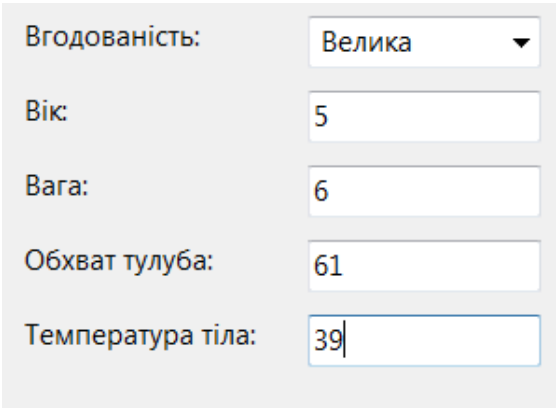

Fig. 13 The parameters of the overweight animal are entered

It gived the system a standard recognition command in the menu and get the recognition result, which will indicate the disappointing condition of the animal (Fig. 14).

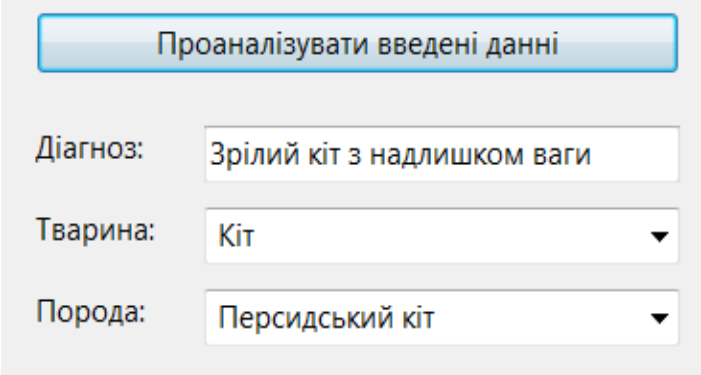

Fig. 14 The result of the evaluation of an animal with a disappointing condition

The developed software system is self-learning and makes it possible to expand the base of the studied animals, their breeds and species.

The accuracy of the system will increase with use due to filling the base for training the neural network.

V. Conclusions

The work found that assessing the condition of pets is one of the important aspects of veterinary medicine, and to simplify this process for ordinary users it would be important to use a pattern recognition system based on neural network methods.

At the stage of literature analysis, the latest research in the field of using neural networks to create image recognition systems was considered.

It was decided to use the Hopfield neural network to create an image recognition system, as it works on the principle of associative recognition and learns on the principle of "learning with the teacher", which allows at the stage of setting up the information system to make a number of ready images for further recognition of new images. introduced. In general, after several stages of training, such a network will be accurate enough for error-free recognition of these images.

The information system was developed in the C # programming language, as it has a number of significant advantages, such as object-oriented approach, a large number of ready-made syntactic constructions, the presence of three-dimensional libraries.

The innovation of this system is to use an image recognition system to determine the condition of the animal. This simplifies the process of assessing the status of the average user, and saves his time.

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