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EXPERT SYSTEM FOR ASSESSING DYNAMIC CHANGES IN BIOMEDICAL TUMOR IMAGES IN BREAST CANCER

Abstract. Main directions of the application of the mathematical methods in medical diagnosis are analyzed, their drawbacks are evaluated, and principles of diagnosis, based on fuzzy logic are formulated. Mathematical models and algorithms, formalizing the process of diagnostic decisions making on the base of fuzzy logic at quantitative and qualitative parameters of the patient state are developed; mathematical models of the membership functions, formalizing the presentation of quantitative and qualitative parameters of the patients state in the form of the fuzzy sets, used in the models and algorithms of diagnosis and determining the diagnosis in case of breast cancer. The purpose of these investigation is to develop a fuzzy expert system based on the analysis of biomedical images for the diagnosis of oncological diseases using the example of breast cancer.

Key words: information expert system, control-method of fuzzy sets, sensors, medical diagnostics, of breast cancer.

Introduction

Scientists estimate that by 2040 the number of annual new cases of cancer will increase by 47 percent and reach 28.4 million. The vast majority of these statistics occur in countries with a low and medium human development index. In many of them, risk factors that affect morbidity, such as smoking, unhealthy diets, obesity and a sedentary lifestyle, will also rise significantly. Cancer incidence and mortality will be affected by changes in the structure of the population and living conditions of people, as well as the level of health systems' ability to control the situation [1, 2, 3].

Currently, one of the most urgent problems of oncology is the prevention of breast cancer (BC). Diagnosis of breast cancer is a complex research method, which consists of a fairly large list of various diagnostic methods used in modern medicine [4, 5, 6]. Promising in this direction are the assessment of individual risk and the formation of groups of increased risk of breast cancer in the regions of Kazakhstan based on the identification of a complex of risk factors that affect the incidence of breast cancer.

The purpose of these investigation is to develop a fuzzy expert system based on the analysis of biomedical images for the diagnosis of oncological diseases using the example of breast cancer.

Principles for the implementation of fuzzy medical information systems for the diagnosis of breast cancer. A feature of the characteristics of medical information systems is that they are united by a medical decision support system in a fuzzy indefinite environment. The diagnosis of a disease involves several levels of uncertainty and fuzziness.

Uncertainty, at present, is of great importance for science and fuzzy logic, being a way of modeling and communicating using natural language. Obviously, at present, the number of applied artificial intelligence systems has significantly increased not on the basis of symbolic processing, but on the basis of fuzzy computing, etc [7, 8, 9].

The theory of artificial intelligence is widely used today in a wide variety of areas of human activity, including medicine. In this area, many Decision Support Systems such as Aaphelp, Internist I, Mycin, Emycin, Casnet/Glaucoma, Pip, DXplain, Concise Medical Manual, Isabel, Refiner Series System and RMA have been developed to help physicians in the diagnosis and treatment of various diseases. Many DSSs for cancer treatment have been developed as ONCOCIN,

OASIS, Lisa. There are many medical applications using fuzzy logic such as CADIAG, MILORD, DOCTORMOON, TxDENT, MedFrame / CADIAG-IV, Fuzzy Exper system and MDSS. For the diagnosis of breast cancer, DSS is very important as this diagnosis is the most common cause of death for women worldwide. Analyzing the capabilities of these systems, we can say that fuzzy logic is a high-quality computational approach [10, 11, 12].

Method. The Kirsch filter works with a 3×3 2D aperture (the part of the image that the filter is working on directly at a given time). In addition, if we are talking about a window, which is a series of image elements ([*X*][*X*][*X*]), then such a transformation is called one-dimensional; accordingly, there is also a two-dimensional transformation [5].

The aperture looks like this:

A_0	A_1	A_2
A_7	F	A_3
A_6	A_5	A_4

$$S_i = A_i + A_i(+)1 + A_i(+)2$$

$$T_i = A_i(+)3 + A_i(+)4 + A_i(+)5 + A_i(+)6 + A_i(+)7.$$

First, in the loop, all values of the variables S_i and T_i are calculated according to the above formulas, in which "(+)" means adding modulo 8.

Next, find the values of the modules of the difference $|5 \cdot S_i - 3 \cdot T_i|$ for each i from 0 to 7 and the value of the maximum among these modules [6, 7]:

$$F' = \max_{i=0...7}(|5 \cdot S_i - 3 \cdot T_i|).$$

The final value of F' is entered into the F element, after which the working window is shifted. The result of processing a biomedical image of a tumor in breast cancer based on the use of a Kirsch filter is shown in Fig. 1.

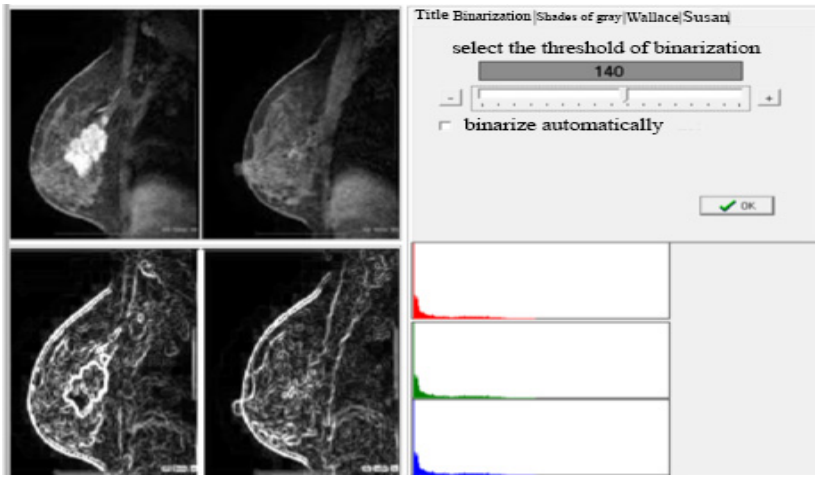

Fig. 1. Application of the Kirsch filter for processing oncological images of tumors in breast cancer

Practical realization of the medical expert system for the assessment of breast cancer. For the realization of the operation of the blocks of adjustment, membership functions storage, fuzzy processing and output of the expert system principles of obtaining the valid diagnosis on the base of fuzzy logic were provided as the basis.

Basic ideology of the information medical expert system operation for the assessment of the breast cancer severity, on the base of the introduction of fuzzy logic blocks for the assessment of the severity stage in case of breast cancer is shown in Fig. 2.

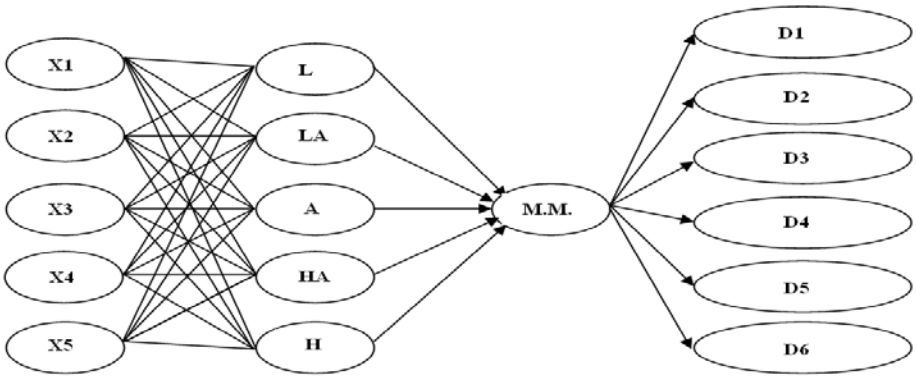

Fig 2. Fuzzy logic blocks for the assessment of the severity stage

The result of realization of the given blocks was the developed programming shell, in this case, the user is proposed after the launching of the program to introduce the value of the low and upper scale of values, that is in the data base of certain pathology, in our case, we introduce the values which are basic for the determination.

Result of the realization of the given blocks was the programming shell that operates in the following way.

1. After the launching of the program the user is suggested to introduce the value of the upper and low scale of values, that is in the database on a certain, on the base of blood gases indices, pathology, in our case we introduce the values which are the basic for determination.

2. To continue the work with the program, after filling all the fields it is necessary to press “save”, for the restoration of the previous data, which were input before, the user must press “retire”.

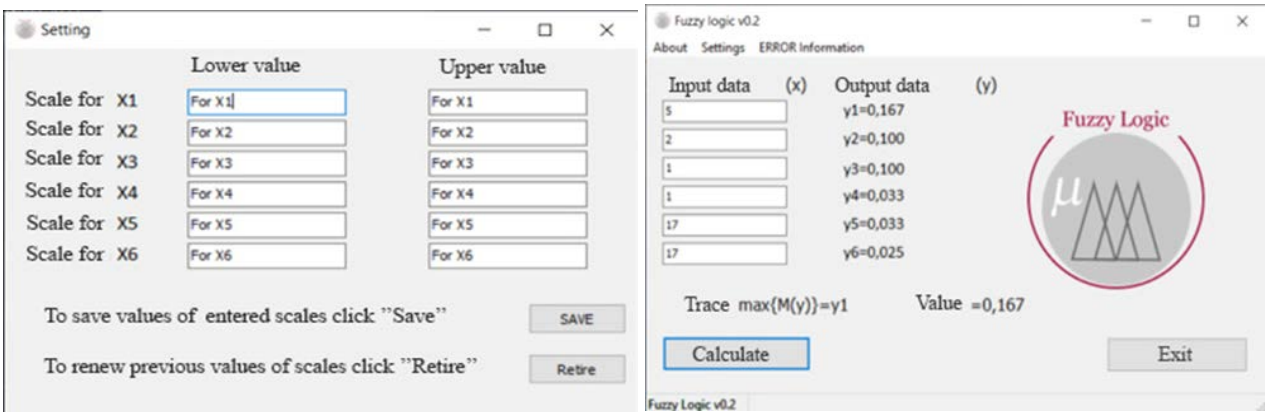

Fig. 3. Example of the dialog window of the program

Conclusions

Practical value of the research is the possibility of the application of the automated expert system for the solution of the problems of medical diagnostics on the base of fuzzy logic for the classification of the severity degree of Breast Cancer. Program shell on the base of fuzzy expert system is created. This shell can be used as a tool for the design of the object-oriented systems, necessary for the intelligent support of diagnostic decisions in different branches of medicine, including clinical practice and doctors training. Characteristic feature of the shell is that it enables to create expert diagnostic systems without special training in the sphere of programming and fuzzy sets.

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