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IMAGE PREPROCESSING METHOD FOR ASSESSING DYNAMIC CHANGES IN BIOMEDICAL TUMOR IMAGES IN BREAST CANCER

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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.

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

Анотація

Проаналізовано основні напрями застосування математичних методів у медичній діагностиці, оцінено їх недоліки та сформульовано принципи діагностики на основі нечіткої логіки. Розроблено математичні моделі та алгоритми, що формалізують процес прийняття діагностичних рішень на основі нечіткої логіки за кількісними та якісними параметрами стану пацієнта; математичні моделі функцій приналежності, що формалізують представлення кількісних і якісних параметрів стану пацієнтів у вигляді нечітких множин, що використовуються в моделях і алгоритмах діагностики та визначення діагнозу при раку молочної залози.

Ключові слова: інформаційна експертна система, метод керування нечіткими множинами, сенсори, медична діагностика, рак молочної залози.

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].

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].

Image preprocessing method

Today, optoelectronic systems are predominantly used in breast cancer imaging studies, which are based on the analysis of local determination of tumor size. Clinically important indicators that make a significant contribution to assessing the degree of pathology and the likelihood of developing diseases, there are other statistical parameters: diameter, curvature, etc. Therefore, for diagnostic equipment, there are increased requirements for reliability, accuracy, speed of image processing, and the like. Modern diagnostic systems used in oncology rarely provide such an opportunity. In addition, the level of requirements for medical diagnostic equipment used in this area is constantly increasing, which requires the use of new information methods and modern tools for its implementation [1,2,3].

Unlike the so-called deterministic distortions, which are often described by element-by-element functional transformations of the input image, additive, impulse, and multiplicative noise models are used to describe random effects. To improve the quality of biomedical image processing, the Kirsch, Roberts, Sobel, Wallace, and SUSAN algorithms are usually used [3, 4, 5].

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, 13,14].

The aperture looks like this:

0	1	2
7		3
6	5	4

$$Si = Ai + Ai(+)1 + Ai(+)2$$
$$Ti = Ai(+)3 + Ai(+)4 + Ai(+)5 + Ai(+)6 + Ai(+)7.$$

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

Next, find the values of the modules of the difference |5·Si – 3·Ti| 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. 3.

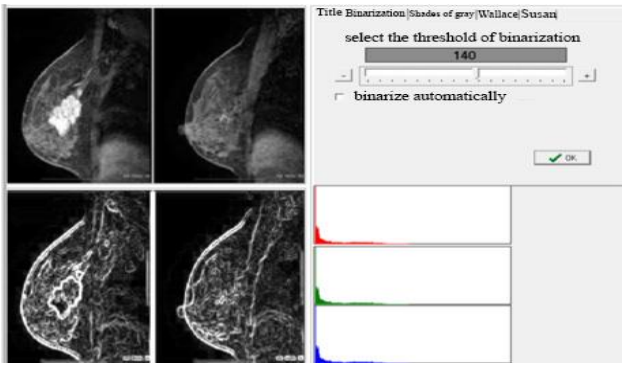

Figure 1. Application of the Kirsch filter for processing oncological images of tumors in breast cancer

Conclusions

Method of the application of fuzzy sets for the realization of the information expert system for the solution of the problems of medical diagnostics, in particular for Breast Cancer diagnosis was further developed.

Main directions of mathematic methods application in medical diagnostics were analyzed, their drawbacks were evaluated, and principles of diagnostics, based on fuzzy logic were formulated.

Mathematical models and algorithms, formalizing the process of diagnostic decisions making on the base of fuzzy logic, taking into account quantitative and qualitative parameters of patient`s state were developed; mathematical models of the membership functions, formalizing the presentation of the quantitative and quantitative parameters of the patient`s state in the form of fuzzy sets, used in the models and algorithms of diagnostics and determining the diagnosis in case of breast cancer were developed.

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