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INTEGRATED INTELLECTUAL DIAGNOSTIC SYSTEM

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Abstract. *The task of integrated intellectual diagnostic system design is considered. This system is used for the diagnosis of tumour. The apparatuses of computer tomography and supersonic researches are used as the components of integrated intellectual diagnostic system. The results of computer tomography and supersonic researches diagnostics are used as inputs of artificial neuron net.*

Keywords: integrated intellectual diagnostic system; artificial neuron net; computer tomography; supersonic researches.

Introduction

Ukraine is the second largest cancer diseases country in Europe. Every day in Ukraine get sick about 450 people and 250 people die from this disease.

According to the data of the Cancer Institute in 2009 961,183 person were officially registered in oncology centers. It is just officially registered, and how many people die from cancer without the proper diagnosis for one or another reason.

In last ten years the number of cancer patients increased by 25 % and every year this disease is steadily increasing by 2.5 – 3 %, and in addition cancer gets younger. It turns out that for life every fourth person gets cancer.

Early diagnosis of cancer is impossible without screening. Ideology of screening is based on the fact that the usual clinical research does not provide the detection of cancer at early stages. Therefore it is clear and reasonable to use such tools and diagnostic means which would be found tumour so early as it possible.

Currently, diagnosis of cancer on radiographs and photographs ultrasound research (USR) is the best known method. However, due to the fact that images can be large working area, about 10 – 30 % of the visible cancer tumorscan be unnoticed or be incorrectly identified as a result of the influence of human or technical factors.

There are two common methods of digital fluorography. The first method, as well as normal chest *X*-ray, uses photographs image on the fluorescent screen, but instead of *X*-ray film used charge-coupled device (CCD). The second technique uses a stratified cross-scan of the chest fan-shaped *X*-ray beam to the detection of transmitted radiation linear detector (similar to a conventional scanner for paper documents, where the linear detector moves along a sheet of paper). The second method allows you to use much smaller doses of radiation. Some lack the second method – more time imaging.

Tomography is the process of *X*-ray imaging, which is the most important method for the detection of pathologies. According to most researchers percentage reliability tomography in the diagnosis of cancer is 70 to 90 %.

X-ray computed tomography is a tomographic method study of human internal organs using *X*-rays.

Ultrasound (US) is a non-invasive study of the human body by means of ultrasonic waves.

Of particular interest is the use in the diagnosis of the Doppler effect. The essence of the effect is to change the frequency of the sound due to the relative motion of the source and receiver sound. When the sound is reflected from a moving object, the frequency of the reflected signal varies (there is a frequency shift.

General structure of cancer diagnosis system

Generalized structure of the system is shown in Fig. 1. It includes two subsystems: subsystem of computed tomography image analysis and image analysis subsystem of supersonic image analysis. Both subsystems have the image processing stage and as a result give the processed image indicating areas of concern (pathology), if there any. Further there is a complexing of results and eventually it is preliminary diagnosed. As ultrasound image processing subsystem was used ready solution that was developed for the detection of thyroid pathology.

Threshold method for determining the suspicious areas to reflect the classes tissue density

This method [1], [2] is based on separating the histogram into several sections. This process occurs as follows.

Find the main peak in the histogram. It meets the following requirements

$$H_M = H(I_M) = \max_{I=0}^{255} H(I),$$

where the maximum point on the histogram.

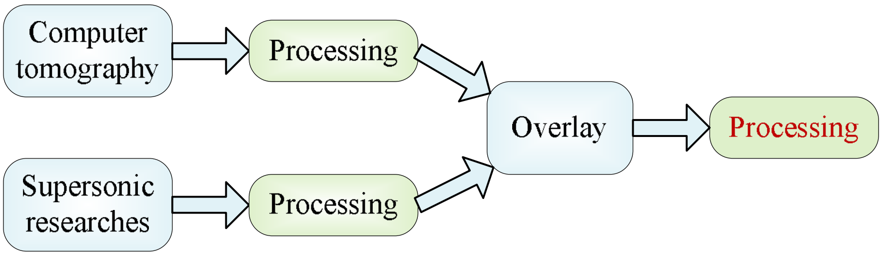

Fig. 1. The generalized structure of the diagnostic system

Find the points h_1 and h_2

$$h_1 = \max_{I=0}^{255}(I), \quad \text{if} \quad H(I) > 0;$$

$$h_2 = \max_{I=I_M}^{255}(I), \quad \text{if} \quad H(I) = 0.$$

Then the area bounded histogram segment $[h_1, h_2]$ is defined as the main information interval.

If the interval $[h_2, 255]$ there are nonzero values, then we call it external information interval.

If there is a local minimum on $[h_2, 255]$ interval,

$$v = \min_I, \quad \text{if} \quad \begin{cases} H(I) < H(I+1); \\ H(I) < H(I-1), \end{cases}$$

the main information interval is divided into two intervals . In this case, the threshold which separates the first and second information intervals is v. If the gap $[h_1, h_2]$ does not contain minimum point, then the threshold $v = h_2$. The distribution of these parameters in the histogram shown in Fig. 2.

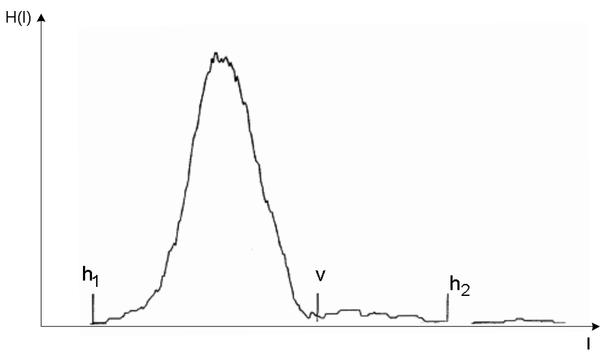

Fig. 2. The histogram of the brightness distribution of the tomographic image

This method [3]–[5] is based on the fact that the image is split into 3 classes: 0 is the image no pathologies; class 1 is image contains pathology and local threshold is v; class 2 is image contains pathology and local threshold is h_2.

Area under the curve corresponding to the first interval, a_2

$$a_2 = \sum_{I=v+1}^{h_2} H(I),$$

area under the curve corresponding to the external information interval, a_3

$$a_3 = \sum_{I=h_2+1}^{h_{\max}} H(I),$$

where $h_{\max}$ is the highest gray level value represented by the image.

The ratio of the histogram at the minimum value to the maximum point, *vtpr*

$$vtpr = \frac{H(v)}{\max \text{ of } H(x) \text{ in } [h_1, h_2]}.$$

In case, if the interval $[h_1, h_2]$ does not contain the local minimum, then, *vtpr* is assigned the value zero.

Contrast medium values of the first and second information intervals, $\text{con}_{1,2}$

$$\text{con}_{1,2} = \frac{m_2 - m_1}{m_2 + m_1},$$

where

$$m_1 = \frac{1}{a_1}\sum_{I=h_1}^{v} I \cdot H(I), \quad m_2 = \frac{1}{a_2}\sum_{I=v+1}^{h_2} I \cdot H(I).$$

The ratio of the first dispersion and second information intervals $\sigma_{1,2}$

$$\sigma_{1,2} = \frac{\sigma_1}{\sigma_2},$$

where

$$\sigma_1 = \sqrt{\frac{1}{a_1}\sum_{I=h_1}^{v} H(I)\cdot(I - m_1)^2};$$

$$\sigma_2 = \sqrt{\frac{1}{a_2}\sum_{I=v+1}^{h_2} H(I)\cdot(I - m_2)^2}.$$

Based on empirical observations, the range of brightness distribution of pixels belonging to the pathologies normally greater than that of normal tissues. Parameter $\sigma_{1,2}$ gives information about the relative bursts.

Subsystem of objects formalization on the image

As a mechanism for the formalization of objects on the image was selected mechanism of contour analysis. As a result of contour analysis, each object on the image can be represented as autocorrelation function plus the average value of the object color. This allows to relate object on the image to a certain class and then apply the corresponding numerical marker of this class to the neural network.

But the mechanism of contour analysis has its disadvantages in the form of an incorrect definition of contours at visible "breaks" of the object, and also there is a need to spend a few preparatory work with the image before applying the algorithm of contour analysis. Namely, edge detection on the image.

To eliminate the "gaps" before allocating boundaries is used noise reduction on the image and subsequent segmentation.

To reduce the noise and allocate of the boundary parts on the image Kuwahara's filter is used.

For image segmentation is used a modified functional of Mammforda Shah.

To isolate the boundaries is used Sobel operator.

As classifier is used classifier by precedents.

As a result the subsystem of objects formalization is looks as follows.

Software Structure

Primary goal of most image processing algorithms is to increase the signal/noise ratio. For adequate implementation of this task, you must determine what on mammographic images is a signal and what is a noise.

The main purpose of diagnostics is to find pathologies in their minimum size. Thus, for example, for mammographic images signals are images of pathologies. Background of mammograms, fat and glandular breast tissue adjacent muscle tissue, blood and milky vessels – in this case considered as interference. So the task of primary processing is maximally separate noise from possible pathologies.

To implement the software was chosen programming language Python library for image processing – OpenCV.

Block diagram of the interaction of the system units is presented in Fig. 3. Reading of image and histogram construction is performed by built-in library OpenCV. The library contains algorithms for processing, cleaning and reconstruction of images, recognition of images, video capture, object tracking, camera calibration, etc. The implementation of the algorithm of threshold processing and classification by the Gavriledis algorithm performed manually with the help of Python scripts.

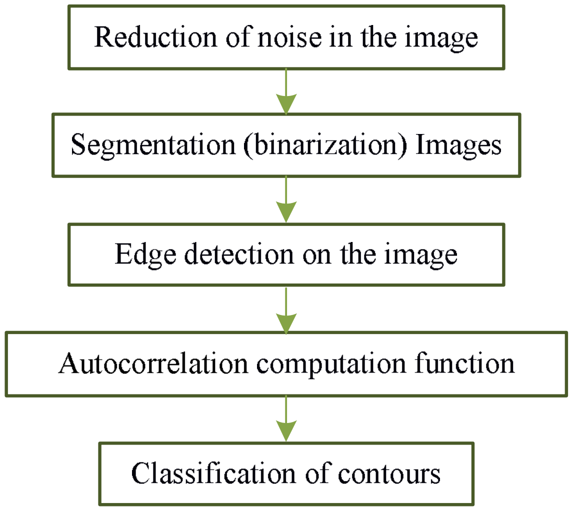

Fig. 3. Generalized diagram of the structure of the system of formalization of objects

Conclusions

It is determined the structure of integrated intelectual diagnostic system. This system realizes two approaches to diagnose: with help of computer tomography and supersonic researches. It helps to improve the reliability of the diagnosis in many cases, for example during diagnosing cancer of mammary gland.

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О. І. Чумаченко. Інтегрована інтелектуальна діагностична система

Розглянуто задачу побудови інтегрованої інтелектуальної діагностичної системи, яка використовується для діагностики ракових пухлин. У якості технічних засобів такої системи використовуються апарати комп’ютерної томографії та ультразвукових досліджень. Результати комп’ютерної томографії та ультразвукової діагностики використовуються у якості входів штучної нейронної мережі.

Ключові слова: інтегрована інтелектуальна діагностична система; штучна нейронна мережа; вузькополосний модем; розподіл байтів; програмний продукт обробки та візуалізації даних.

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Е. И. Чумаченко. Интегрированная интеллектуальная диагностическая система

Рассмотрена задача построения интегрированной интеллектуальной диагностической системы , которая используется для диагностики раковых опухолей. В качестве технических средств такой системы используются аппараты компьютерной томографии и ультразвуковых исследований . Результаты компьютерной томографии и ультразвуковой диагностики используются в качестве входов искусственной нейронной сети.

Ключевые слова: интегрированная интеллектуальная диагностическая система; искусственная нейронная сеть; узкополосный модем распределение байтов; программный продукт обработки и визуализации данных.

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