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STUDY OF ANATOMICAL STRUCTURES CONTOURS IN PROBLEMS OF MORPHOMETRIC ANALYSIS

Abstract. *The work deals with the contours of anatomical structures, namely, the lateral ventricles of the brain. We have analyzed the contours of the lateral ventricles at different horizontal sections of tomographic images. We have shown the possibility and the need to use geometric data of these structures geometry while analysing tomographic images.*

Key words: *brain, computed tomography, contour analysis, lateral ventricles*

Introduction. The study of morphometric characteristics of anatomical structures is an important part both in statistical diagnosis of structural abnormalities [1-3], and in determining their morphological characteristics, and, consequently, the formation of understanding the causes of modification and the consequences to which it leads or may lead. In addition, the morphometric study is not only a source of knowledge for health professionals, but also for technicians who develop tools for analyzing introscopic images, development of computer systems planning, and more.

Thus, the study of morpho metrical structural features and both personalized and ethno-personalized peculiarities is an important medical and technical task [4-5].

Objective: based on the above, the purpose of the paper is to analyze the possibility of using computational methods for morphometric analysis of anatomical structures, the example of which are the lateral ventricles of the human brain.

Materials and methods. The study was conducted at the Department of operative surgery and topographical anatomy of Kharkiv National Medical University. As the input data we used CT sections of the human brain that are presented in the format DICOM, obtained from a computer tomograph Toshiba Aquilion 16. Tomographic imaging was conducted at a supply voltage on the tube - 120 kV and current - 300 mA. The distance between the sections was 4 mm.

The input section is a matrix of x-ray intensity (Fig. 1).

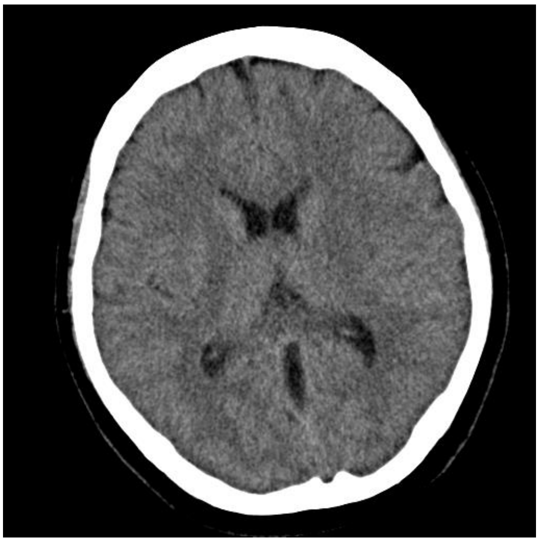


Fig. 1. A sample of the experimental tomographic section of the brain

The structure under study (the left lateral ventricle of the brain), on the tomographic cut was selected and presented as a connected contour [6]:

$$C = \left\{ P_1, P_2, \ldots, P_n \middle| P_i \in \mathbb{R}^2 \right\}, \qquad (1)$$

where C is the contour;

P_i – contour vertex;

n – number of vertices in the contour.

Figure 2 shows the contours of the structure under study and the corresponding tomographic sections. Depending on the required details, we used n of vertices for encoding in the corresponding section.

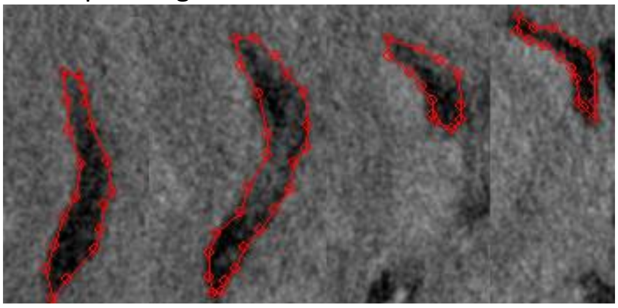
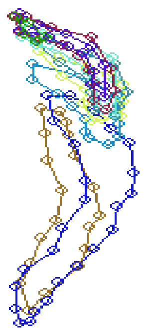
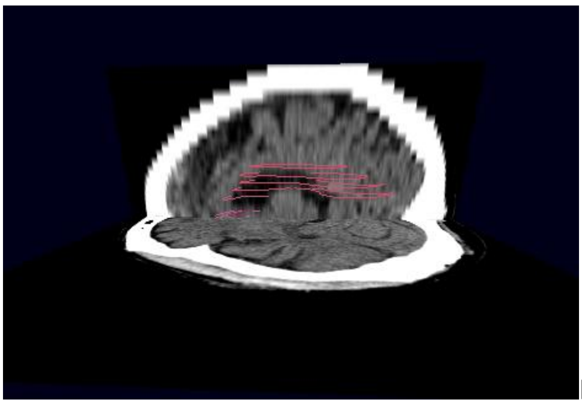


Fig. 2. Sample contours of the structure under study

In order to show the relative position of the contours, Fig. 3 presents the contours one behind the other. As you might guess from the picture, the center of ventricular gravity shifts . We also present the three-dimensional visualization below (Fig. 3 b).



A



B

Fig. 3. Visualization of the left ventricle contours: a – visualization overlay; b – three-dimensional visualization

Based on the above, a calculation of the center of mass (M) was carried out according to the following expression: :

$$M = \frac{\sum_{i=1}^{n} P_i}{n}, \qquad (1)$$

Fig. 4 shows an example of the center of mass of an experimental structure in different sections

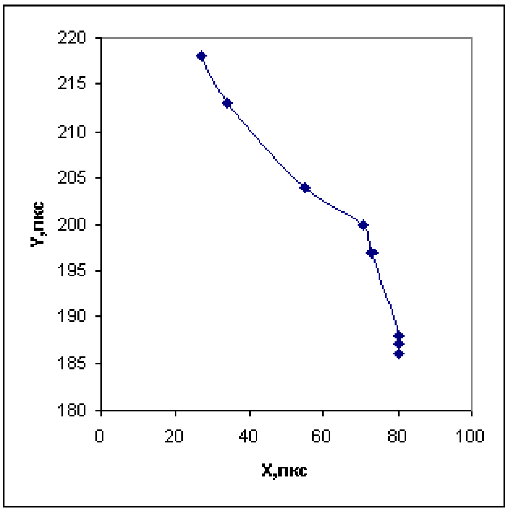


Fig. 4. Example of the coordinates of the center of the left ventricle offset

We also discovered, by means of contours differentiation, that with the angle of curvature of about 120 ° ± 10% the contour passes in the anterior horn. In addition, the ratio of width to height of the contour is decisive in determining the level of a cut. For instance, the ratio in the anterior horn is 1: 1 ± 10%.

Results and discussion. Thus, we carried out an analysis of the contours of the lateral ventricles of the human brain based on 20 cases. The results of the study indicate the possibility and feasibility of using computational methods to analyze geometrical parameters of the contours of anatomical structures.

Conclusions. 1. The efficiency of the use of computational methods in the study of the contours of anatomical structures on the example of the lateral ventricle of the brain has been shown.

2. The results are indicative of the limited spatial location of the lateral ventricle. In moving from the top downwards the center of gravity gets shifted laterally and rostrally. These

data should be used in the implementation of specialized methods of analysis and segmentation of tomographic data, namely, in determining the initial contours, which grow longer later.

3. Using morphometric techniques combined with computational methods for tomography research findings is a very effective and informative source that allows us to apply them in the analysis of spatial and morphometric parameters both in separate structures, and in their agregations.

Prospects for further research. A promising area of future research is the isolation of countours in all brain structures and development of a generalized model of reciprocal positioning of these structures, taking into account both ethnicity and age data. Another important element of the study is to analyze not separate contours, but three-dimensional structures that should be taken into account. In addition, the use of this model for automated segmentation of the structures of the human brain is to increase the quality of both diagnosis and computer planning of neurosurgical interventions.

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