A hybrid algorithm for recognizing pathology of the retina from an image using neural network modeling.

Badalova Maftuna Shukhratovna

Assistant of the department "Software engineering" of the Samarkand branch of the Tashkent University of Information Technologies
Samarkand, Uzbekistan
(e-mail: maftunabadalova009@gmail.com)

A B S T R A C T

This paper presents studies of the method for determining the pathology of the retina by neural network modeling.

Relevance of the topic. To date, neural networks have taken on the widest scope in use, and artificial intelligence has increasingly begun to be used in medicine, construction, the industrial sector, etc. Recent years of research show that the demand for neural networks is increasing. A special place is occupied by neural networks in healthcare. Let us analyze the use of neural network modeling for recognizing pathologies of the retina of the fundus.

Health is the most important thing a person has. It is easy to lose it, but it can be saved if you notice the problem in time. Nowadays, cases of diseases associated with the retina of the eye are becoming more and more frequent in the Republic of Uzbekistan. The main task of the healthcare field is to look into the future and prevent the irreparable in the early stages. Every day, new methods of identifying the causes of diseases come out. Making a correct diagnosis is an important step for a doctor. In this he uses a lot of information. Naturally, he cannot store all the information in his head. In this, artificial intelligence helps him in everything. The database and database management systems help us to store, process, analyze, transfer and use all this data. Artificial intelligence also helps us to identify a suspicion of a disease and how human health will change in the coming days based on the data received.

Today, much attention is paid to the development of medicine. Research is being conducted to improve the quality of medical care services. On the way of ongoing work in this area, the involvement of specialists from different industries is required. In particular, much attention is paid to the field of ophthalmology. This area of medicine in the Republic of Uzbekistan is little studied and is beginning to gain momentum in research. When examining the fundus, one examination by a doctor is not enough, since there is a human factor that can distort important information.

In the diagnosis of vascular diseases of the eyes, geometric indicators of the retina are used. However, these indicators are not enough to analyze the data. Images of the retina of the eyes are used as input, and this data is processed using recognition algorithms. To determine diseases and determine the pathology of the retina of the eyes, certain parameters and indicators of the eyes are used. Algorithms have been developed for finding the diameter of the disc of the optic nerve. This article was based on the dissertation works of Tanaeva E. G. In her work, she cited methods for determining vessels in the image of the fundus. According to her, this process is divided into several stages, but the main one among them is the detection of the length of line curves by the formula:

$$R_k = \sqrt{(\tau_{изм} - \tau_k)^2 + (\Delta_{изм} - \Delta_k)^2}$$

Where (τmeas, Δmeas) are the parameters of the border of the optic nerve head of the analyzed image. To assess the color of the optic disc, the following classification was used: 1) pale, 2) pale, 3) gray, 4) with a gray tint, 5) pale pink, 6) hyperemic (reddish), 7) waxy. For analysis, 43 images of the optic nerve fundus were selected, for which the classification by the color of the optic nerve fundus was carried out by expert doctors. Based on these images, seven training samples C1, C2, C3, C4, C5, C6 and C7 corresponding to the given colors were formed. For each sample Ck , k=1,2,…,7, the distances between the colors of the ONH images in the RGB space are calculated.

In addition, to determine the pathology of the image, the morphological parameters of the vessels, the separation of veins and arteries are examined, the morphometric characteristics of the vessels are formed: the ratio of the diameter of the arteries to the diameter of the veins, tortuosity of the vessels, local changes in the diameter of the vessels.

The developed information-analytical decision-making model for identifying a risk group for the development of primary open-angle glaucoma during screening ophthalmological examinations has a two-level structure. Algorithms of the first level, based on the results of distinguishing the border of the ONH and tracing the vessels on the image of the fundus, evaluate the morphological parameters of the ONH and vessels. At the second level, a risk group is identified for the development of primary open-angle glaucoma, classified as "Suspicious for glaucoma" according to the international classifier of diseases ICD-10. To solve the problem of identifying a risk group for the development of POAG during screening ophthalmological examinations, decision rules were used, which are linear classification functions in the form of linear equations, developed by methods of discriminant analysis based on training information.

Based on the analyses performed, the information and analytical model revealed several results:

• A method has been developed to highlight the border of the optic nerve head on the image of the fundus, which makes it possible to implement the procedure for the diagnostic description of the optic disk and provides an accuracy of 0.98 in the assessment of the border of the optic disk.

• A method has been developed for detecting and isolating vessels in the fundus image, which differs by taking into account the peculiarities of the shape of vessel images. The method is implemented using the developed algorithms for detecting and tracking vessels in the fundus image and allows you to implement the procedure for the diagnostic description of vessels.

• An algorithm for estimating the morphological parameters of the optic nerve head on fundus images based on the use of cluster analysis of the results of measurements of the parameters of the optic nerve head has been developed.

• An algorithm for estimating the morphological parameters of blood vessels in the fundus image based on the method of contour image analysis has been developed.

• The developed information-analytical model makes it possible to ensure the accuracy of decision-making when identifying a risk group for the development of primary open-angle glaucoma with a sensitivity index of 0.825 during screening ophthalmological examinations.

• An experimental study of the proposed methods and algorithms for morphological assessment of the state of the optic nerve head and blood vessels on images of the fundus was carried out. The influence of parameters on the efficiency of the optic disc isolation method was studied.

The results of the research can be used in the development of intelligent decision support systems based on the analysis of fundus images.

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