WEB OF SCIENTIST: INTERNATIONAL SCIENTIFIC RESEARCH JOURNAL
ISSN: 2776-0979, Volume 4, Issue 6, June, 2023

DIAGNOSTIC BASED ON FRACTAL DIMENSION OF BLOOD VESSELS IN THE RETINA

Z. E. Ibrohimova
Samarkand Branch of TATU named after Muhammad al-Khorazmi
Zuli117@mail.ru

V. A. Asatov
Samarkand Branch of Pecialized Scientific-Practical Eye Microsurgery Center

F. U. Ibodullayeva
Samarkand Branch of TATU named after Muhammad al-Khorazmi

Sh. A. Amonkulova
Samarkand Branch of TATU named after Muhammad al-Khorazmi

Abstract
The question of determining the fractal dimension of body organs with a fractal structure of the human body in medicine, which is currently developing at a rapid pace, is considered in this article. In addition, it is important to provide practical support for early detection and treatment of various diseases in humans [1-5]. Therefore, the article deals with the issues of determining and diagnosing the fractal dimensions of the human body. Cell counting methods were used to determine the fractal dimensions of human body parts by comparing the fractal dimensions of tree branches. According to R.V. Genny and other world scientists, the fractal dimension of the human lung was determined by the method of vectors [2-7], and in this work, the fractal dimension of the human retina was determined by the cell counting method. Knowing that the arrangement of vessels has a fractal structure, fractal dimensions of the vascular systems of the human retina have been determined.

Keywords: Fractal, fractal dimension, tree-like fractals, vascular system.

Introduction

Due to the complexity and multilevel repetition of the human vascular network, no clear idea has been given about what parameters should be used to describe the structure of blood vessels. In addition, the criterion of normal development is necessary for the diagnosis of diseases. To solve these problems, several fractal analyzes have been performed to evaluate the circulatory systems of various healthy and diseased individuals [8,9]. Human vascular systems do not have a strict fractal structure, because they are infinitely distributed, but have similar properties, so the diffusion process is uniform. Therefore, human blood vessels have fractal properties and can be considered to form a fractal structure [10].

Problem Setting and Solution Methods

Vascular systems in the retina with a fractal structure improve blood circulation in the eye, nourish it, and prevent functional disorders. Human eye blood vessels also have a fractal structure like the above fractal images, and the fractal dimension has been determined. For this, blood vessels in the retina are separated and removed. It is extracted based on the following scheme, that is, the existing image is loaded and the boundary measurements are determined.

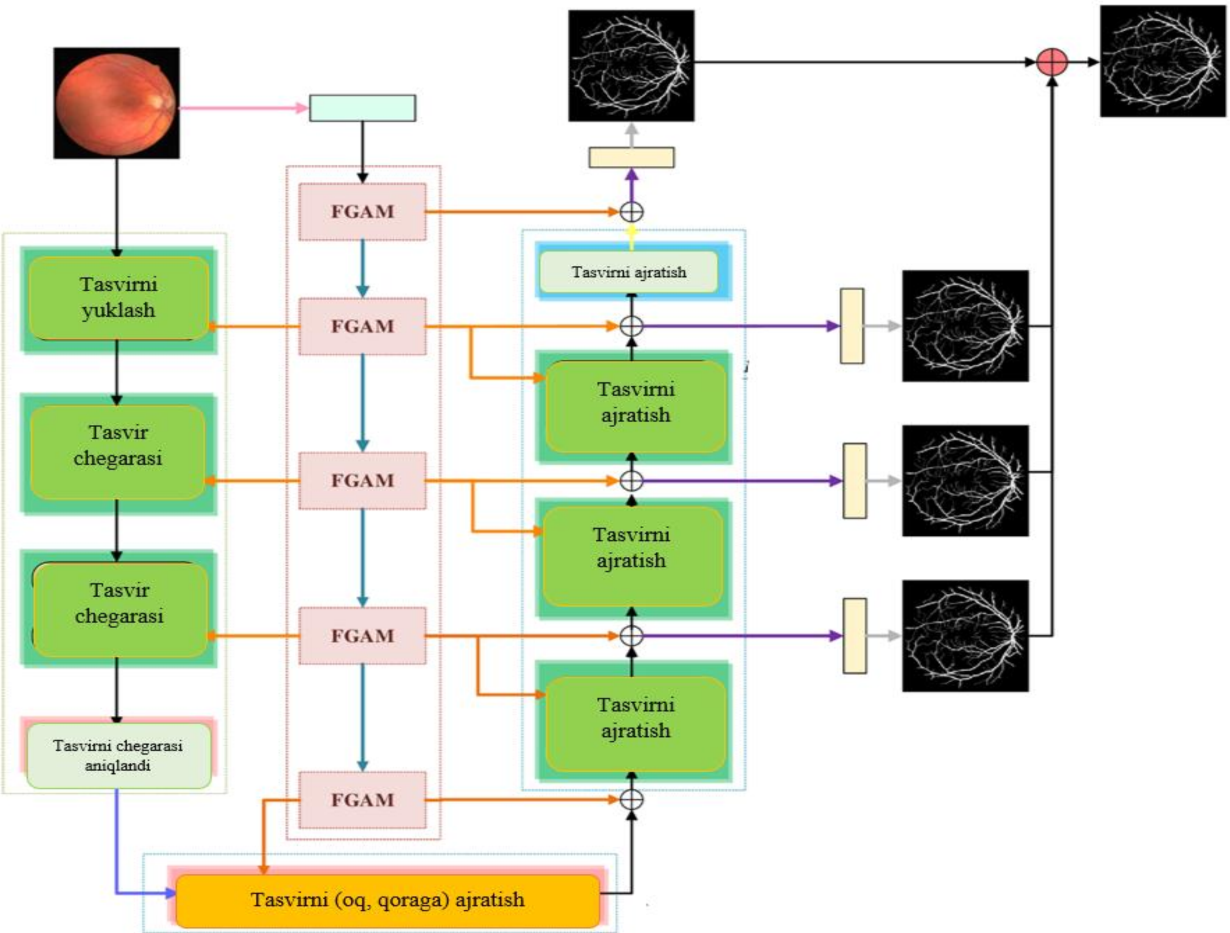

Figure 1. Scheme of extracting images of blood vessels in the retina

For this purpose, three $N_1 = 6$ different sizes of cells were drawn on the retinal image and the following were determined: $a = 48$ The number of cells in yellow $N_2 = 24$ is , and the number of cells in blue is $N_3 = 116$.

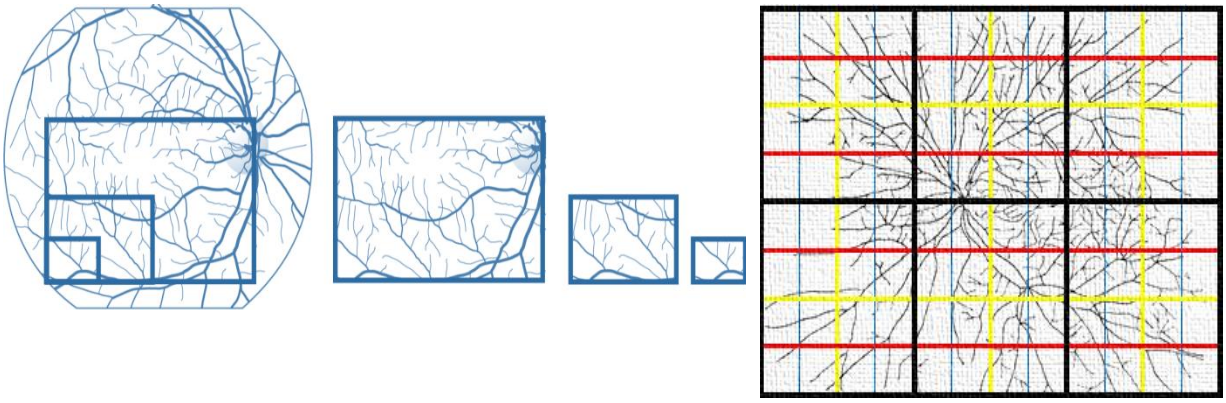

Figure 2. Application of the cell counting method in determining the fractal dimension of the vascular systems in the retina

The Results Obtained

Based on the data in Figure 1, the fractal dimension of retinal vascular systems was determined as follows:

Table 1 Parameters for determining the fractal dimension of vascular systems in the retina

Cell size a	**9**	**16**	**48**
Number of cells N	116	2 4	6
$y = \ln N$	4,753 6	3.1780	1.7917
$x = \ln a$	2,1972	2,772 6	3.8712

Based on the data presented in Table 1 above, the fractal dimension of the vascular systems in the human retina was calculated using the cell counting method.

$$D = \frac{\sum_{i=1}^{n} x_i \sum_{i=1}^{n} y_i - n\sum_{i=1}^{n} x_i y_i}{n\sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2} = 1{,}7021. \qquad (1)$$

One of the unique features of the blood vessels in the retina of a person is that the blood vessels in the retina grow as a person grows older.

WEB OF SCIENTIST: INTERNATIONAL SCIENTIFIC RESEARCH JOURNAL
ISSN: 2776-0979, Volume 4, Issue 6, June, 2023

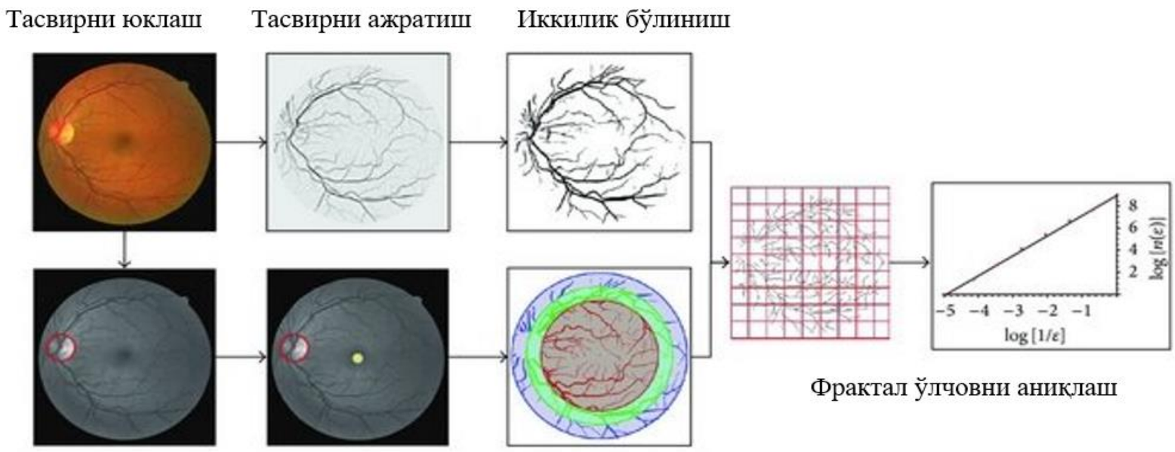

Figure 3. Application of the cell counting method in determining the fractal dimension of the vascular systems in the retina

Conclusion:

This suggests that the blood vessels in the human retina change their fractal dimension over time. However, the value of the fractal dimension does not change much compared to the original dimension. That is, the results of the research show that the area of change of the fractal dimension of the blood vessels in the human retina differed between ±0.073 s [11].

References:

1. Азевич А.И. Фракталы: геометрия и искусство // Математика в школе. 2005. № 4. С. 76-78.
2. Akhter N., Rajput Y., et al., Fractals for Complexity Analysis of Diabetic Retinopathy in Retinal Vasculature Images, International Journal of Research in Engineering and Technology 3 (2014), no. 3, 680-685.
3. Бирючинская Т.Я. Моделирование фрактальных структур в задачах многомерной классификации // Автореф. дис... канд.ф.-м.н. Воронеж, 2013, 18 с.
4. Бондаренко Б.А. Generalized Pascal Triangles and Pyramids, their Fractals, Graphs, and Applications – USA, Santa Clara: Fibonacci Associations, The Third Edition. 2010. – 296 p.
5. Дмитриева И.Н. Структура биоразнообразия долгоносикообразных жуков (Coleoptera, Curculionoidea) севера лесостепи Приволжской возвышенности: Автореферат дис. канд. биол. наук. Н. Новгород: ННГУ, 2006. 24 с.

6. Жаббаров Ж.С. Юрак қон томир тизимларининг фрактал ўлчов. // Дифференциал тенгламалар ва анализнинг турдош масалалари. Республика илмий-техник анжуманининг 2021 йил 04-05 ноябрь. 386 б. 349-351 б.
7. Жаббаров Ж.С., Амонова А.О. Катакчаларни санаш усули асосида фрактал ўлчовларни аниқлаш. // Замонавий ахборот, коммуникация технологиялари ва ат-таълим татбиқи муаммолари мавзусидаги Республика илмий-амалий анжумани маърузалар тўплами 2022 йил 9-апрель 309 б. 28-30 б.
8. Зинчик А.А., Музыченко Я.Б., Смирнов А.В., Стафеев С.К. Расчет фрактальной размерности регулярных фракталов по картине дифракции в дальней зоне. // Научно-технический вестник Санкт-Петербургского государственного университета информационных технологий, механики и оптики, 2009, № 2(60) 17-23 с.
9. Зеленый Л.М. Фрактальная топология и странная кинетика: от теории перколяции к проблемам космической электродинамики / Зеленый Л.М., Милованов А.В. // УФН. – 2004. – Т. 174. – №8.
10. Иудин Д.И., Копосов Е.В. Фракталы: от простого к сложному. // Монография. Нижний Новгород ННГАСУ 2012. С.185
11. Иванов А.В., Короновский А.А., Минюхин И.М., Яшков И.А. Определение фрактальной размерности овражно-балочный сети города Саратова. Изв. вузов. «ПНД». Т.2014. №2 С. 64-74.