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RESEARCH ARTICLE

Use of Fuzzy System in the Eye Images

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Abstract

In this Article, fuzzy neighbors rules are exploited to detect blood vessels in eye image. Images used in this article are chosen from eye image bank of DRIVE database including 20 retinal images. A fuzzy system consists of four segments: Fuzzy rule base, fuzzy inference engine, fuzzifier and defuzzifier. In fact, to interpret fuzzy rules set inputs need to be fuzzified which means that input variables should take a value between 0 and 1. We know that most of the images are in RGB format. Results from other researchers show that using G channel leads to better results, thus we use the same channel. Obtained results demonstrate that proposed algorithm has suitable performance. The average of accuracy parameter of 20 images is derived 92.8 %.

Keywords— fuzzy system, eye image, drive data base, accuracy parameter

I. INTRODUCTION

This The human eye and n is considered as the most important part of a human body after the heart and that is why it is of great importance. Before surgery, the ophthalmologist must take a picture of the eye to determine its vessels; because it is possible to not draw some of the vessels correctly or accurately therefore we do this by fuzzy systems. First, we examine the structure of the eye. Different parts of the human eye include the eyelids, conjunctiva, cornea, limbal, sclera, iris, pupil, lens, anterior chamber, choroidal, posterior vitreous cavity, retina, optic nerve and eye muscles.

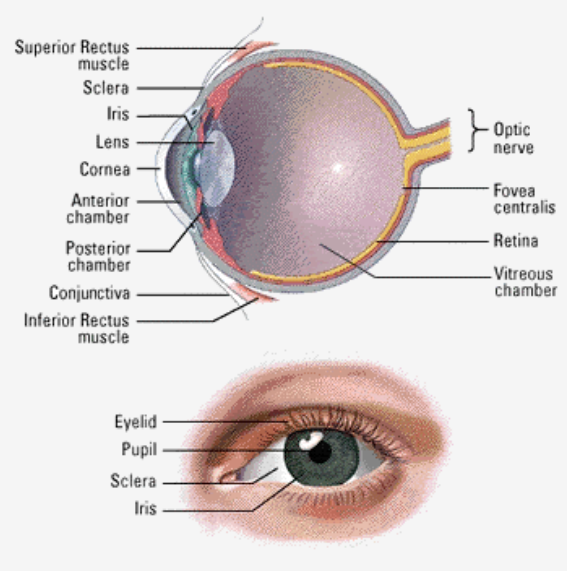
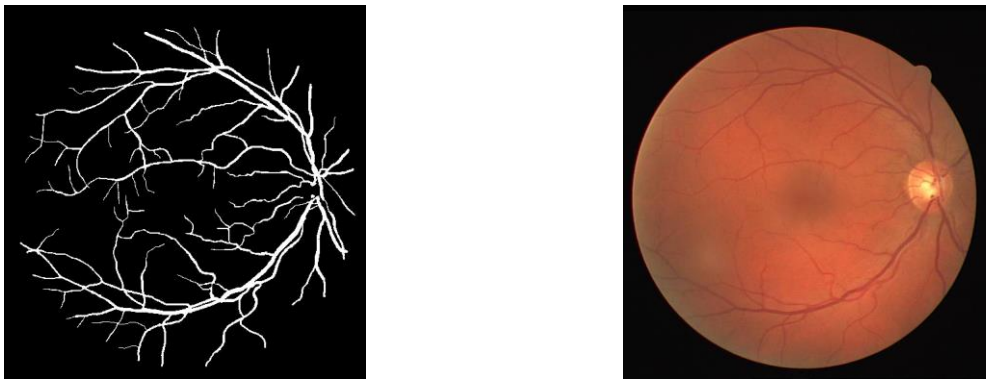


Figure 1: The human eye and its components

Images that have been used in this article were driven from the eye images bank of the DRIVE database [1]. It is important to note about images of DRIVE database that the vessels in the images of this bank have been manually identified by an expert. Figure 2 shows the image number 20 of this database and the segmented image by an expert.



b a

Figure 2: image number 20 DRIVE database, (a) Original image, (b) manually segmented image by an expert.

This database is widely used by scholars and researchers in the field of detecting vessels in retinal images. In this database, in addition to the original retinal image, there are the images of vessels segmentation by two experts as manually and the images related to the results of other researchers. Many researchers, including Niemeijer [2], chaudhuri [3], jiang [4], zana [5] and staal [6] work on retinal images whose results are located on the DRIVE database. Dua et al proposed a technique based on edge detection for vessel detection [7]. Estabridis et al utilized local Radon transform for detection [8]. Many papers have been presented on eye image processing [9-12] which researchers can compare their works work with the results of these papers.

II. THE PRESENTED ALGORITHM

Block diagram of the problem solving algorithm is as follows:

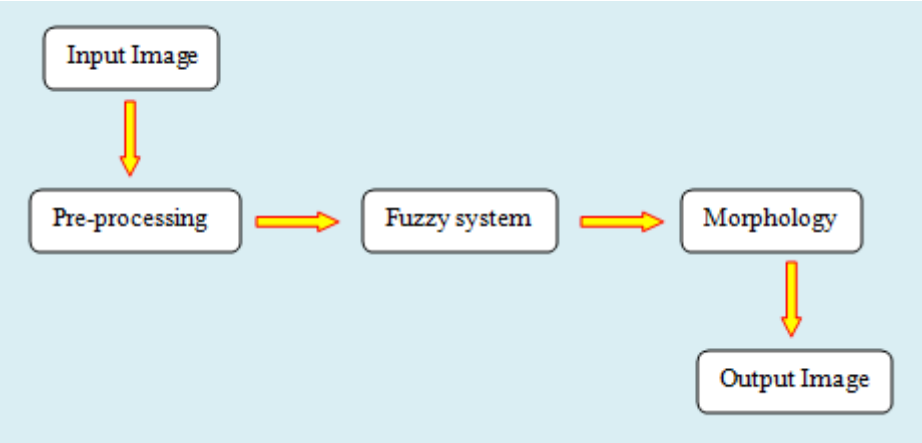


Figure 3: Block diagram of the problem solving algorithm

In a more general case, the block diagram below can also be used.

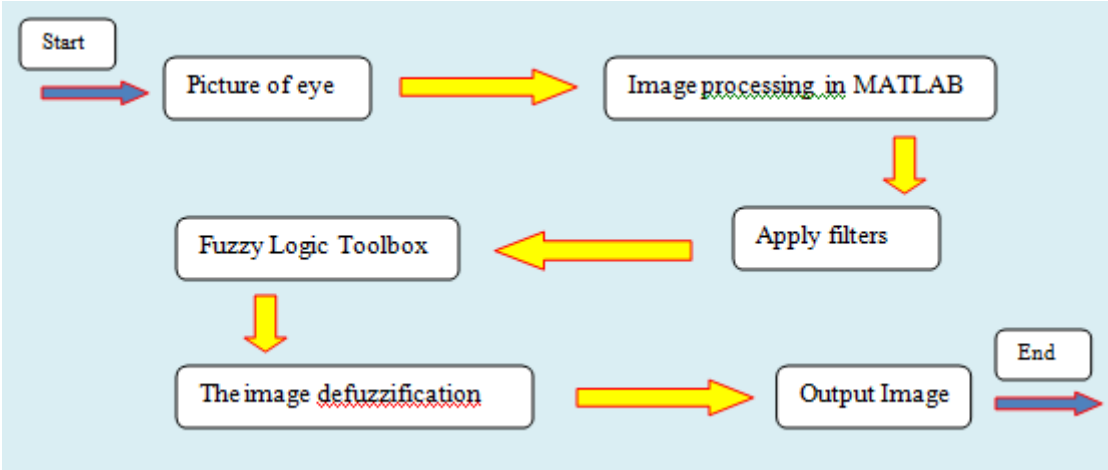


Figure 4: The presented algorithm

1) II.1 Input image:

We choose the input images from the DRIVE database of the eye images.

2) II.2 Pre-processing:

In the pre-processing stage, the optical disc area should be eliminated or reduced. This step is very important because if it is properly designed and implemented, we will be closer to achieving acceptable results. We know that most of the images are in RGB format. Results from other researchers show that using G channel leads to better results, thus we use the same channel.

3) II.3 Fuzzy system:

The presented algorithm is based on the rules of fuzzy neighborhood and accordingly detects the vessels of the eye. Neighborhood rules for a 3 × 3 matrix can be expressed as follows.

M_1	M_2	M_3
M_4	0	M_6
M_7	M_8	M_9

A_1	A_2	A_3
A_4	A_5	A_6
A_7	A_8	A_9

Figure 5: 3 * 3 Matrix of the image

In the above matrix, Mi can be calculated from the following equation.

$M_i = A_i - A_5$

The rules of fuzzy neighborhood are explained as follows.

If M1 is zero & M2 is zero & M3 is zero Then A5 is 'White'
If M1 is zero & M4 is zero & M7 is zero Then A5 is 'White'
If M7 is zero & M8 is zero & M9 is zero Then A5 is 'White'
If M3 is zero & M6 is zero & M9 is zero Then A5 is 'White'
Else A5 is 'black'

4) II.4 Morphology:

To improve the segmentation of vessels, we use a series of operations called the morphology operations.

III. SIMULATION RESULTS

We run the presented algorithm on the DRIVE database images and compare the obtained results with the results from other researchers.

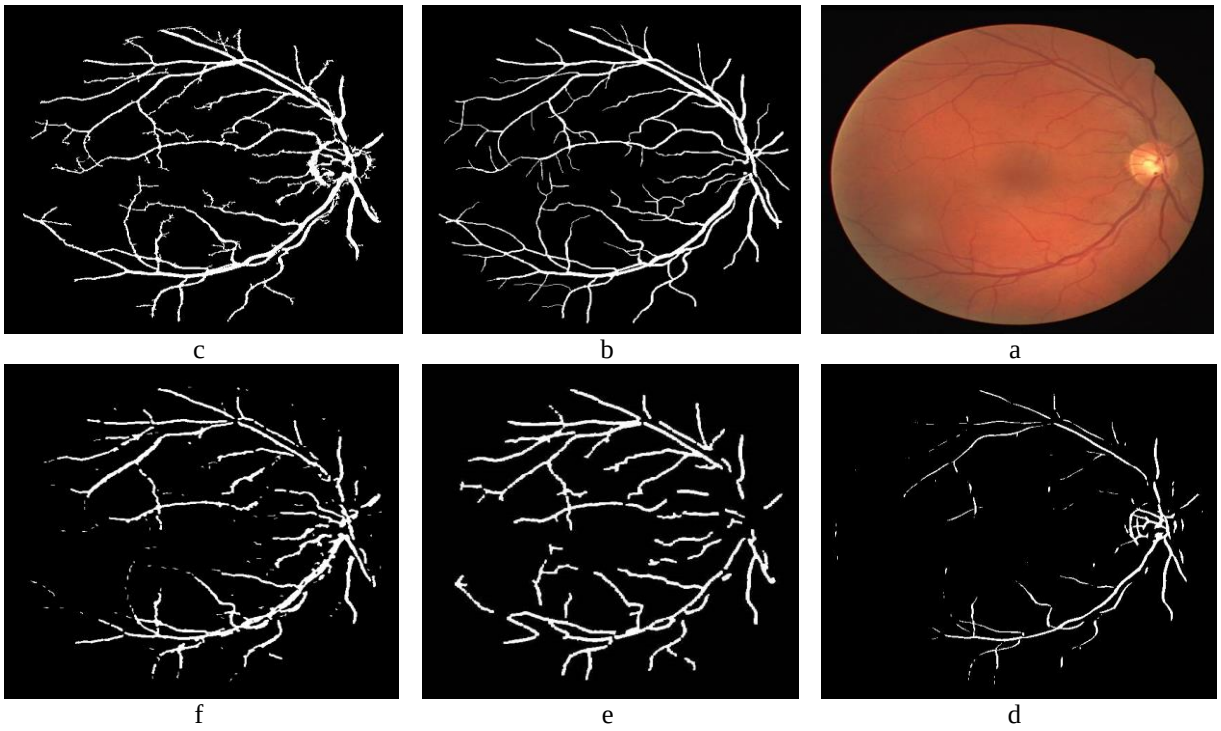


Figure 6: (a) image No.20 of DRIVE database, (b) manual method, (c) perez method, (d) Chaudhuri method, (e) jiang method, (f) fis method (fuzzy)

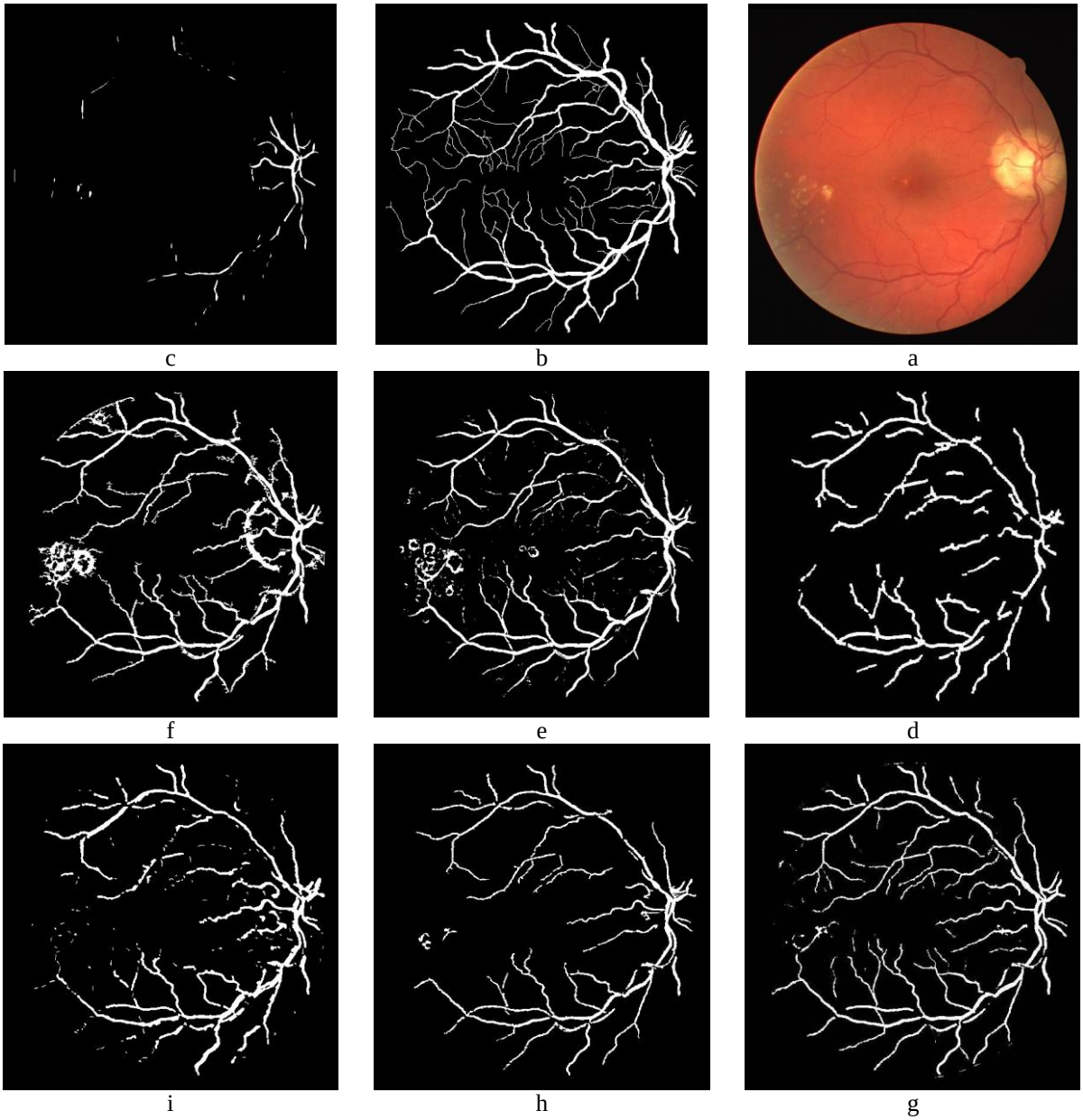


Figure 7: image No. 8, (a) Original image (b) reference segmented image, (c) Method Chaudhur Method, (d) Jiang method, (e) Niemeijer Method, (f) Perez method, (g) Staal method, (H) Zana method (i) FIS method

Researchers usually use accuracy parameter for evaluation. This parameter illustrates how much the researcher was successful in vessel detection. In the ideal conditions, when segmentation exactly matches reference segmentation, this parameter will equal to 1 (ACC=1).

Table 1: Comparison **Accuracy** of the results obtained from the fuzzy method with results from other researchers

Number of figure	human 2	Chaudhuri	Jiang	Niemeijer	Perez	Staal	Zana	FIS
1	0.949	0.903	0.918	0.939	0.939	0.946	0.949	0.921
2	0.949	0.899	0.923	0.947	0.938	0.949	0.944	0.932
3	0.941	0.881	0.91	0.932	0.924	0.932	0.924	0.914
4	0.949	0.893	0.924	0.948	0.925	0.947	0.937	0.934
5	0.947	0.907	0.926	0.94	0.924	0.942	0.933	0.923
6	0.936	0.853	0.916	0.934	0.847	0.936	0.928	0.931
7	0.945	0.908	0.928	0.943	0.919	0.943	0.931	0.936
8	0.943	0.885	0.924	0.931	0.914	0.941	0.932	0.928
9	0.946	0.88	0.936	0.939	0.923	0.944	0.933	0.926
10	0.948	0.925	0.932	0.945	0.923	0.945	0.941	0.934
11	0.947	0.823	0.919	0.939	0.918	0.942	0.931	0.932
12	0.951	0.886	0.916	0.943	0.923	0.945	0.936	0.925
13	0.939	0.878	0.915	0.938	0.919	0.939	0.927	0.927
14	0.955	0.896	0.928	0.943	0.928	0.946	0.946	0.932
15	0.945	0.923	0.909	0.937	0.854	0.938	0.941	0.938
16	0.95	0.886	0.926	0.944	0.925	0.949	0.94	0.927
17	0.949	0.876	0.922	0.938	0.928	0.942	0.941	0.928
18	0.949	0.895	0.925	0.943	0.931	0.948	0.941	0.929
19	0.954	0.881	0.919	0.957	0.929	0.958	0.953	0.912
20	0.945	0.911	0.928	0.953	0.932	0.951	0.946	0.934
Average	0.947	0.889	0.922	0.942	0.918	0.944	0.938	0.928

IV. CONCLUSIONS

In this paper, we used the neighborhood fuzzy rules to detect blood vessels of the eye. The presented algorithm was investigated at 3 stages of Pre-processing, fuzzy and morphology. The results obtained at the preprocessing phase indicate that the optical disk and the image contrast are improved. We run the presented algorithm in MATLAB software on 20 Images of the DRIVE database. The results show that we have been successful in detecting the vessels to 92.8%, thus the proposed algorithm can be used for edge detection and processing of medical images with high accuracy.

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