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BLOOD VESSEL SEGMENTATION IN ANGIOGRAMS USING MORPHOLOGICAL TECHNIQUES AND FIS

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Abstract

The disease has been one of the main threats to human health. Coronary angiography is taken as the gold standard for the assessment of coronary artery disease. However, sometimes the images are difficult to visually interpret because of the crossing and overlapping of vessels in the angiogram. Also due to the low contrast of the image between the backdrop and the small blood vessels, the blurred and fuzzy background of coronary artery image, a new blood vessel segmentation method using morphology is presented in this paper. Firstly, the original angiogram image is preprocessed using Top hat operator which enhances the contrast of the image. Then the morphological close operation is used for vessel segmentation. After thresholding, the blood vessels of a coronary angiogram are extracted. Using this method, both the coronary artery trees and most of the smaller distal vessels could be extracted clearly.

Keyword: Morphological operations, Blood Vessel Segmentation, Image processing, FIS.

1. Introduction

According to the World Health Organization, cardiovascular diseases such as coronary heart disease are the first worldwide cause of death Cardiovascular disease takes away more than 12 million lives each year [1]. It is often caused by coronary artery stenosis and blockage. Coronary artery plays an extremely important role in the supply of blood to the heart and coronary atherosclerosis is the main reason of heart damage and myocardial infarction [2]. A coronary angiogram is a special X-ray test done to find out if your coronary arteries are blocked or narrowed, where and by how much. Vessel extraction from X-ray angiograms has been a challenging problem for several years. There are several problems in the extraction of vessels including: weak contrast between the coronary arteries and the background, unknown and easily deformable shape of the vessel tree and strong overlapping shadows of the bones. X-ray Coronary angiography is taken as the best for visualizing the morphology and the assessment of coronary artery disease. In order to improve the level of clinical diagnosis, the extraction and segmentation of coronary artery from X-ray angiographic images is very necessary. At the same time extracting distinct vascular patterns is a crucial premise to vascular quantitative analysis.

2. Blood vessels Segmentation:

Segmentation of blood vessels is one of the essential medical computing tools for clinical assessment of vascular diseases. It is a process of partitioning an angiogram into non-overlapping vascular and background regions. Based on the partitioning results, surfaces of vasculatures can be extracted, modeled, manipulated, measured and visualized [1]. Edge detection is an essential task in computer vision. It covers a wide range of application, from segmentation to pattern matching. It reduces the complexity of the image allowing more costly algorithms like object recognition object matching [4], object registration [5], or surface reconstruction from stereo images to be used. Their detection is interesting for different goals. They can be used to measure parameters related to blood flow or to locate some patterns in relation to vessels in angiographic images. They can also be used as a first step before registration [8] [9]. Conventionally edge is detected according to some early brought forward algorithms like sobel algorithm, prewitt algorithm and Laplacian of Gaussian operator. But in theory they belong to the high pass filtering, which are not fit for noise medical image edge detection because noise and edge belong to the scope of high frequency. In real world applications, medical images contain object boundaries and object shadows and noise. Therefore, they may be difficult to distinguish the exact edge from noise or trivial geometric features. In this paper, we novel a fuzzy inference system and morphology filters for vessel edge detection or vessel segmentation. Figure1 depicts the applied process [10].

3. Fuzzy sets and fuzzy membership functions definitions:

The system implementation was carried out considering that the input image I and the output image obtained after defuzzification are both 8-bit quantized; this way their gray levels are always between 0 and 255. These values define the working interval of the output variable and the input variable G (the other input variables are not guaranteed to be less than 255). Besides, three fuzzy sets were created to represent each variable's intensities; these sets were associated to the linguistic variable "low", "medium" and "high" [11].

The adopted membership functions for the fuzzy sets associated to the input G and to the output were Triangular functions with means 0, 127.5 and 255, as shown in Figure 2. For the sets associated to the other input images, Triangular functions were also adopted for the linguistic variables "low" and "medium", but for the variable "high" a sigmoid function was chosen Figure (1), since in this case we cannot guarantee that the input values will be restricted to the interval [0,255].

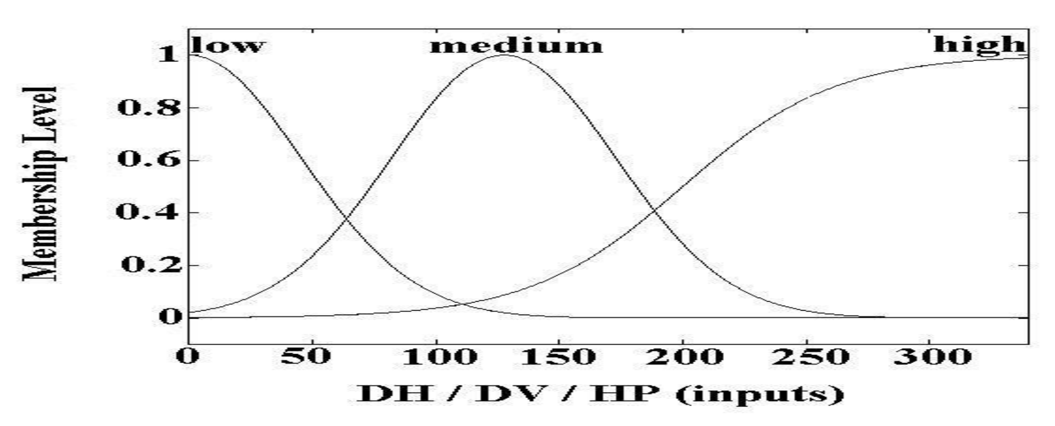

Figure (1) membership functions for the fuzzy sets

4. Proposed Work

4.1 Block Diagram:

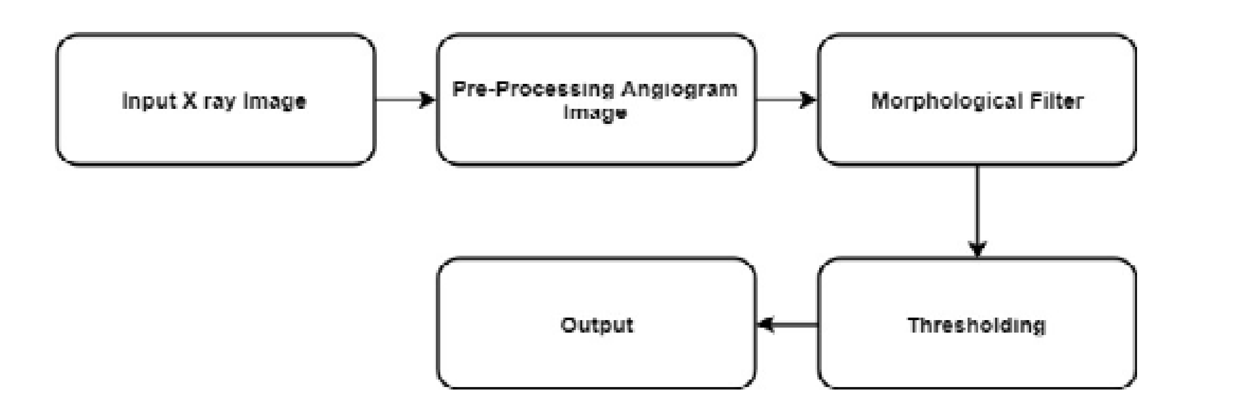

Figure (2) the block diagram for proposed algorithm

4.2 Pre-Processing Angiogram Image:

It's necessary to have quality images without any noise to get accurate result. Noisy image may lead your algorithm towards in accurate result. Hence it becomes necessary to de-noise the image. Image de noising is an important image processing task, both as a process itself, and as a component in other processes. Very many ways to de noise an image or a set of data exists. The main properties of a good image de noising model are that it will remove noise while preserving edges. Traditionally, linear models have been used. To de-noise the image we can use median filter. Median filter does the work of smoothening of image.

4.2 Morphological Filter:

Morphological treatment of the image and determine the final version of the background texture. The area opening stage consists of removing the "small" objects from the binary image to clean the background texture. To follow the transition regions more approximately, edge smoothing is performed by a sequential process of dilation followed by erosion using a square mask of dimensions 9×9. Finally, isolated background pixels are connected by filling the holes within the background texture. Once this process has been completed, a binary image containing the background texture mask is available for further stages. The background texture mask obtained at the end of this stage is only a partial result that will be used for further processing.

4.3 Result:

This section details the results Blood Vessel Segmentation in Angiograms using Morphological techniques and FIS shown in figure (3) below:

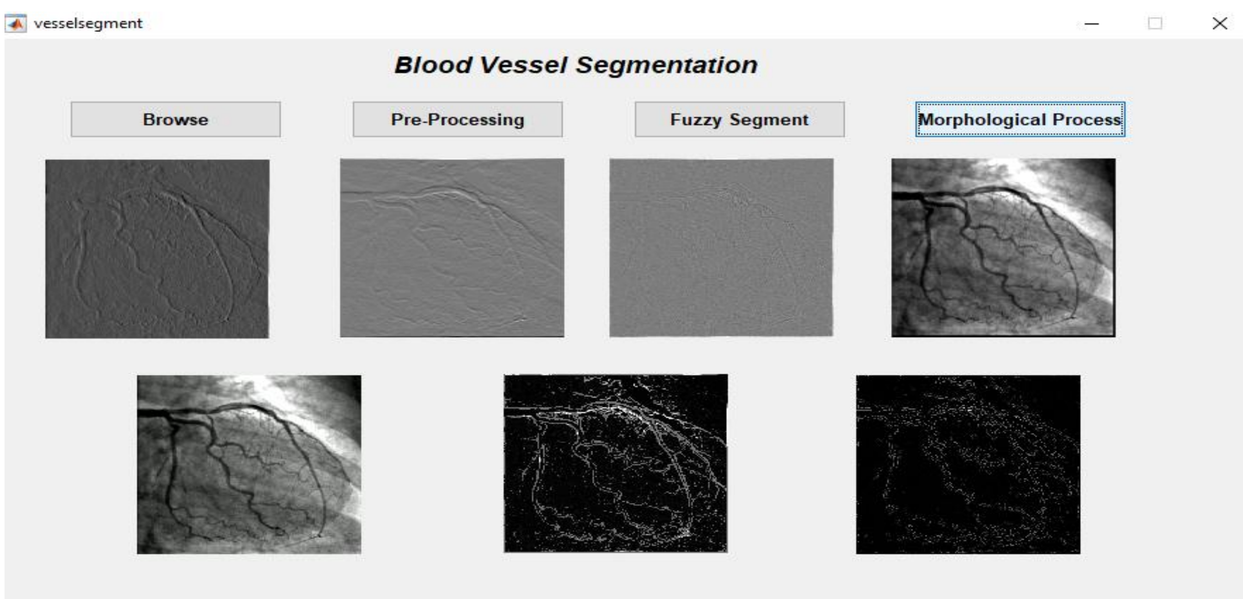

Figure (3) Result of proposed algorithm

4.4 conclusion:

Blood vessels of coronary angiogram are segmented using morphology. The method is performed on ten images for each image Jaccard index, standard deviation and variance is calculated. We know that, lowest Jaccard index indicates better segmentation. Experimental result shows that segmentation using morphology gives Jaccard coefficient lower so segmentation is good. As the value of standard deviation is lower, it is near to mean which indicates good performance of segmentation. In our experimental result standard deviation is up to 0.35 which is low. Also, from graphical representation, variance is up to 0.12. As the value of variance is lower, it is near to mean which indicates good performance. It is a simple and easier method performing expected segmentation. It becomes easy to analyze the morphology of the coronary artery with reduced operator's work and the method will be useful for the quantitative analysis of coronary arteries.

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