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Comparative Study: Coronary Blood Vessel Segmentation in Angiogram Images

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Abstract**—**Coronary blood vessels can be visualized using various angiogram methods. It is difficult to analyze if images with low contrast and small blood vessels. So blood vessels are preprocessed and segmented for better medical analysis. In this paper we discuss about various techniques to segment coronary blood vessels.

Keywords—*Coronary Blood Vessels, Angiography Images, Preprocessing, Segementation*

I. INTRODUCTION

World Health Organization informed, there are more than 12 million deaths due to cardiovascular disease, caused by coronary artery stenosis and blockage[12]. In medical research, angiography is a procedure to visualize blood vessels. There are many medical imaging methods like X-ray, Magnetic Resonance and Computed Tomography.

Interpretation to an angiogram is very difficult because of noise, foreshortening of vessels, small blood vessels and vessel overlap. Partitioning an angiogram image into vascular and background regions is the vital role of segmentation. There for developing accurate image segmentation methods for angiography are the challenges of research group.

There are various method to segment blood region from background such as thresholding, region based, clustering, level set, watershed, edge detection, centreline detection, match filter and classification.

II. METHODOLOGY

A. Pre-processing:

In Paper [10], image is pre-processed using Hessian matrix analysis and Frangi 2D filter. Coronary vessel structure found through Hessian matrix analysis. From Hessian matrix, Gaussian curvature is calculated by multiplying Eigen values. The Eigen vector shows the direction of curve. Frangi's 2D filter uses Eigen vectors to calculate likeness of region to vessel.

In paper [3], authors use Noise Adaptive Fuzzy Switching Median (NAFSM) filter to enhance angiographic images.

NAFSM [7] is used to remove salt and pepper noise from angiogram. Only noise pixel is identified by histogram in detection phase of NAFSM. In next phase it is replaced by its correlation term. That is from local information in the filter maximum absolute luminance difference is calculated. Fuzzy reasoning is applied to get maximum absolute luminance difference. This helps the filter to get accurate correlation term.

Based on Eigen vectors of Hessian matrix, Frangi's vessel detection technique is used to extract vessel branches.

In paper [4], low contrast images are preprocessed by using morphological top hat technique [5,13]. Top hat filtering technique computes the morphological open operation on image and then subtracts it from original image. It detects logical elevation on arbitrary background which can be used to enhance vessel part.

In paper [6], color image is convert to gray scale image. This gray scale image is feed into adaptive histogram equalization. Median filter with 75 x 75 is applied to subtract background from foreground.

B. Segmentation:

In paper [10], morphological operation is used to detect edges of vessel region of interest [2]. Firstly preprocessed image is converted into binary image then the image is filled, complemented and erode.

In paper [4], region growing is used to segment vessels from angiogram[8,9]. Authors have used input from Frangi's vessel detected image. They manually selected seed from desired region. They used region growing for its efficiency.

In paper [6], thresholding is applied to extract vessel from background. Authors have used Otsu's thresholding, because its complexity is low.

In paper [6], image segmentation is by Fuzzy C-Means (FCM)[1] algorithm. FCM computes cluster centres or centroids by minimizing the dissimilarity function with the help of iterative approach. By updating the cluster centres and the membership grades for individual pixel, FCM shifts the cluster centres to the "right" location within set of pixels.

III. EXPERIMENTED RESULT

Figure 1: Original Result

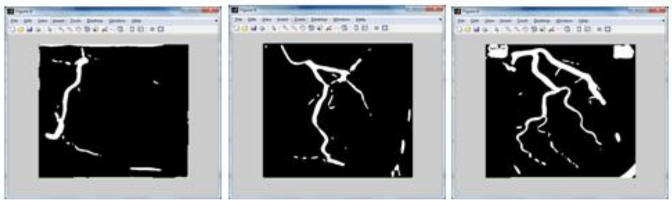

Figure 2: Result of paper [10]

Figure 3: Result of paper [3]

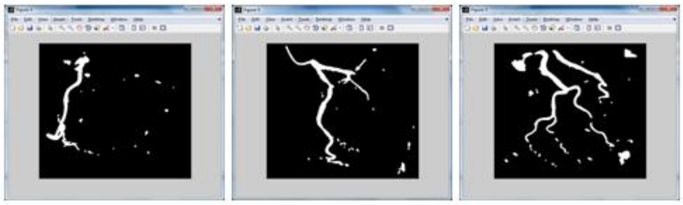

Figure 4: Result of paper [4]

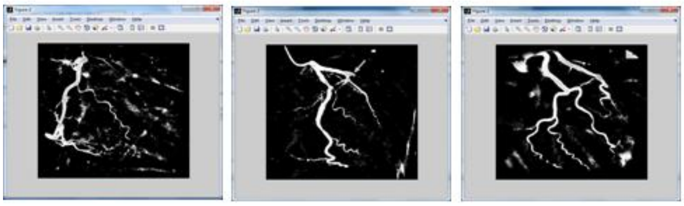

Figure 5: Result of paper [6]

Table 1: Result of Jaccard Coefficents of Various Segmentation Techniques

Image Sample	Paper[10] Jaccard coeff.	Paper[3] Jaccard coeff.	Paper[4] Jaccard coeff.	Paper[6] Jaccard coeff.
1	1	0.919	1	0.9208
2	0.9713	0.9073	0.991	0.9893
3	0.9826	0.8207	0.9911	0.9881
4	0.9987	0.9064	1	0.9986
5	0.9752	0.9192	0.9475	0.4125
6	0.9838	0.837	0.9983	0.662
7	0.9944	0.8313	0.9992	0.9986
8	0.9654	0.7826	0.993	0.9845
9	0.9605	0.8764	0.9816	0.9773
10	0.9479	0.8862	0.9578	0.8069
11	0.9995	0.8615	1	0.904
12	0.9755	0.7909	1	0.9729
13	0.9783	0.7601	0.9732	0.9743
14	0.9816	0.8473	0.979	0.52
15	0.975	0.9151	0.9928	0.9797
16	0.9727	0.9422	0.9896	0.9919
17	0.963	0.8749	0.9941	0.6194
18	0.9959	0.838	0.986	1
19	0.9913	0.7023	1	0.9953
20	0.9855	0.7472	0.9972	0.9896
21	0.991	0.8875	1	1

CONCLUSIONS

Jaccard similarity coefficient is the one among method to calculate segmentation performance. Jaccard similarity coefficient lies between value 0 and 1. A value of 0 indicates that there is no similarity whereas a value of 1 indicates a similarity. For each image, jaccard coefficient is calculated. We know that, highest jaccard coefficient indicates better segmentation.

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