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Extraction of Coronary Artery Blood Vessels Using Morphological Operators

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Abstract: Extraction of coronary artery from coronary angiography is an important goal to improve the diagnosis and treatment of coronary artery disease. This paper presents the extraction of coronary artery blood vessels using Morphological operators. The paper involves two stages. The first stage involves the application of the basic Morphological operator in which the brightness of the arteries was improved using the dilation operator. The second stage presents the background correction using thresholding technique followed by advanced morphological operations whereby the unwanted background particles were removed and the blood vessels of the coronary arteries are extracted. Simulation results show the efficiency of the extraction of coronary artery by the proposed method. The simulation is implemented using Laboratory Virtual Instrumentation Engineering Workbench (Lab VIEW) version 13.0.

Index Terms: Coronary artery, image Enhancement, angiography, morphological operator

1. INTRODUCTION

Coronary heart disease (CHD) is a narrowing of the small blood vessels that supply blood and oxygen to the heart. Coronary heart disease is also called coronary artery disease. Coronary heart disease is the leading cause of death the United States for men and women. Coronary heart disease is caused by the buildup of plaque in the arteries to your heart. This may also be called hardening of the arteries. Fatty material and other substances form a plaque build-up on the walls of your coronary arteries. Segmentation is essential for diagnosis and prognosis of coronary arterial stenosis in X-ray angiography images. Furthermore, it is significant to distinguish the foreground structures from the background tissues to detect the normal and abnormal arteries. For the delineation of anatomical structures and other regions of interest image segmentation are becoming increasingly important in diagnosing exact radiological tasks. Therefore, an appropriate method of segmentation must be chosen for diagnostic accuracy of an abnormal problem. Non-invasive cardiac imaging acts as an invaluable tool for the treatment and diagnosis of cardiovascular disease (CVD).

For understanding of normal and diseased anatomy these imaging technologies have greatly increased. A wide range of applications including quantification of volume, computer-aided diagnosis, localization of pathology, and image-guided interventions are done with cardiac image segmentation.Since the manual description of coronary artery is tedious, time-consuming, and is sensitive to the initialization and the results are not always reproducible, it is decisive to develop an optimal, precise, and reproducible segmentation method. There are many image segmentation methods used to extract the coronary arteries. The proposed method applies the Morphological operators followed by thresholding and advanced morphological techniques to extract the blood vessels for the easy diagnosis of the diseases.

2. PROCESS FLOW DIAGRAM

According to the capturing rate the angiography video images are converted into image slice. The images are subjected to image enhancement technique to increase the quality of the image. The morphological operators are imposed on the enhanced images. The morphological operators involved are dilation, erosion. A comparative analysis is done for various filter size with 3x3, 5x5, 7x7 filters to obtain the optimal filter size of an enhanced image. Morphological operators are followed by thresholding with a kernel size of 64x64. Thresholding is followed by a advanced morphological operation which removes the unwanted particles and smoothens the contour of the object with a 3x3 structuring element and the artery subjected to stenosis alone are extracted. The complete process flow of the proposed method is shown in Figure 1.

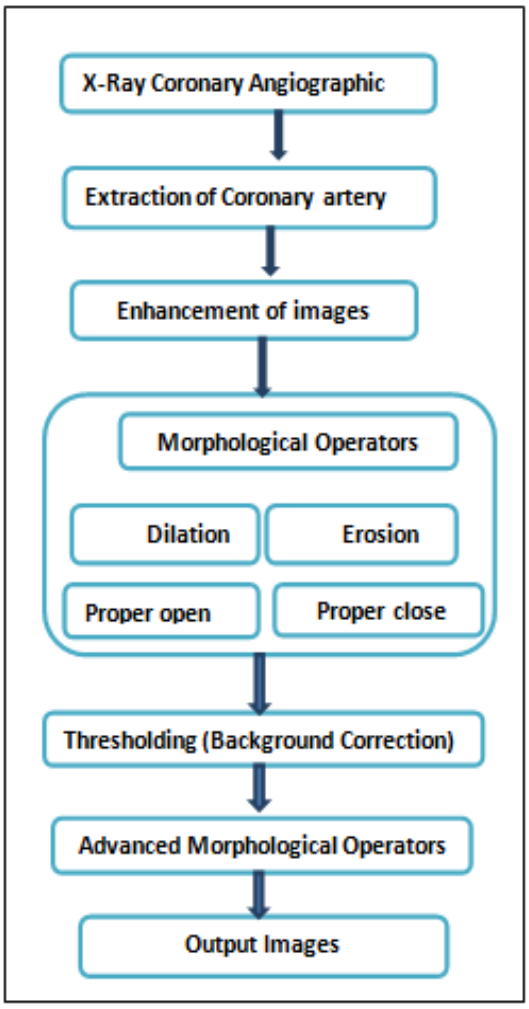

Figure 1. Process flow diagram of the Proposed method

3. MORPHOLOGICAL OPERATORS

Morphological image processing consists of a set of operations that transform images according to rules of set theory. The bog standard idea in binary morphology is to probe an image with a simple, pre-defined shape, called the structured element, drawing conclusions on how this shape fits or misses the shapes in the image. The value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbours. By choosing the size and shape of the neighbourhood, we can construct a morphological operation to extract the vessel pattern that is sensitive to specific shapes in the input image . Vessel fancy pattern is detected based on mathematical morphological operations and curvature evaluation algorithm only limited to the eye and can be used for other general images rather than medical images. Dilation and erosion are two fundamental morphological operations. Dilation adds pixels to the boundaries of objects in an image, whilst erosion removes pixels on object boundaries. The number of pixels added or removed from the objects in an image depends on the size and shape of the structuring element used to process the image. Dilation and erosion are often used in combination to implement image processing operations. Morphological operations are generally neighbourhood based (the new value of the pixel under inspection (PUI) is determined from the values of its neighbouring pixels). Morphological operations are very similar to filters, except the kernels used are dependent on the original value of the PUI. The bog standard morphological operation used in our approach is properly open .It removes wee particles and smoothes the contour of objects based on the structuring element. The structuring element used is 5x5.It is a finite and dual combination of openings and closings. Standard morphological operation is followed by advanced morphology .It Perform high-level operations on particles in binary images such as removing wee particles from an image, labelling particles in an image, or filling holes in particles with specified iterations.

4. THRESHOLDING

Thresholding according to intensity/brightness is a simple technique for images which contain solid objects on a background of different, but kit, brightness. Each pixel is compared to the threshold: if its value is higher than the threshold, the pixel is considered to be “foreground” and is set to white, and if it is less than or equal to the threshold it is considered “background” and set to black. The success of thresholding depends critically on the selection of an appropriate threshold. Segments pixels in grayscale images. There are different types of thresholding. Manual threshold operation enables to select ranges of grayscale pixel values. Local threshold operations select pixels using a locally adaptive thresholding algorithm. It is used in applications whose images exhibit non- kit lighting ,changes that may result from a strong illumination gradient or shadows. The proposed method performs a background correction with a kernel size of 64x64 to eliminate non- kit lighting effects and then performs thresholding using the interclass variance thresholding algorithm.

5. RESULT AND SIMULATION

The dataset used for the evaluation consist of sequences of 512x512 images and has a gray value resolution of 8bit and the grey values varied from 0-255, i.e. 256 grey level. The proposed method has

been validated both on synthetic data and real time DSA and has been applied to test set of 15 DSA drawn from clinical practice For the purpose of analysis we have considered two different patient images. The Figure 2 shows the original coronary angiography images. The arrow mark shown in the figure depicts the stenosis (Narrow downing of arteries).

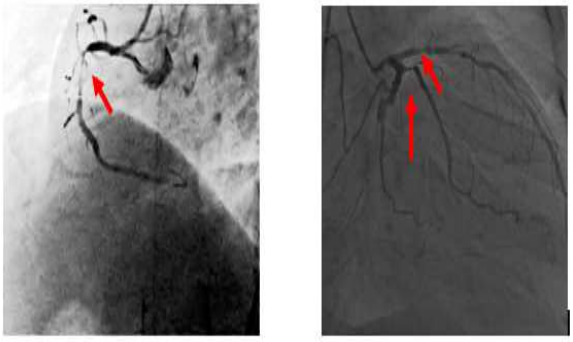

Figure 2. The Original Coronary angiographic image

These images are subjected to morphological operators erosion, dilation, proper open and proper close for various filter sizes of 3x3,5x5,7x7. From the analysis it was found that the dilation process for a filter size of 3x3 gives the best enhanced image and it is shown in the Figure 3. Thresholding is applied to the processed image. The background correction

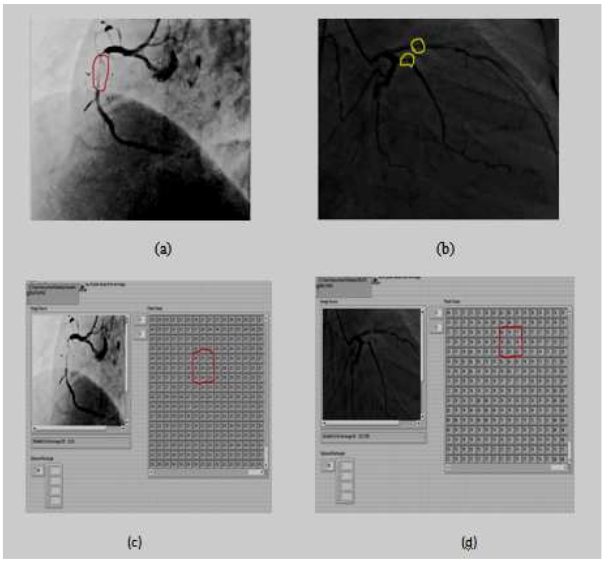

Figure 3. (a),(b),(c),(d) Dilated Process for a 3×3 filter and its corresponding pixel values

thresholding technique is used to separate the foreground object from the background structures. Here in the proposed method the thresholding technique was used to extract the coronary artery blood vessels alone to detect the presence of stenosis and it is shown in the Figure 4.Even though the arteries were extracted some unwanted particles appears in the background image. In order to eliminate the unwanted particles ,the image was further subjected to advanced morphology and it is shown in the Figure5.

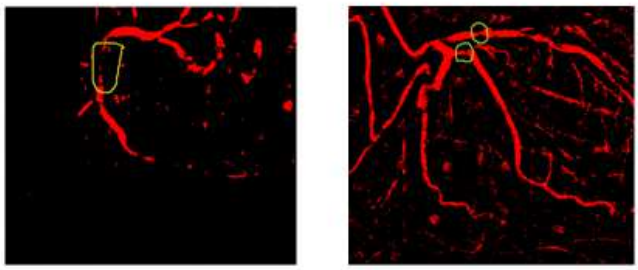

Figure 4. Output image after Thresholding

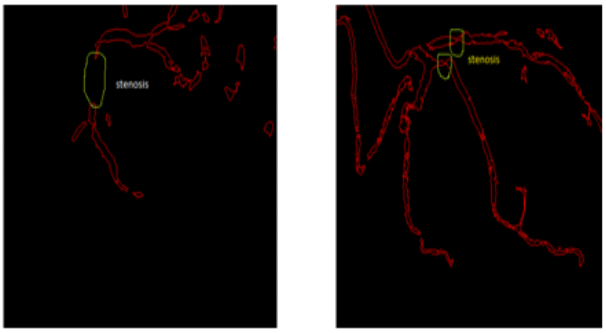

Figure 5. Output image after advanced morphological analysis

5. CONCLUSION

This paper presents the extraction of coronary artery blood vessels using morphological operators. The small particlecs present in the background structures are removed by advanced morphological operartors. The advanced morphological opertors eliminates the small holes present in the structure thereby extracting the blood vessels alone.

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