



Study of Labeling Technique for Coronary Arteries in Angiogram Images

Vijayan T

Asst professor, Dept of E&I, Bharath University, Chennai – 600073, India

ABSTRACT: Automatically segmenting the coronary arteries in X-ray angiogram images has been an active area of research over the past several years and is an important task in medical imaging. Here mathematical morphological operations are used for segmenting the arteries. This method was implemented for a variety of clinical images. The results indicate the feasibility of achieving robust and consistently accurate image segmentation through this method.

KEYWORDS: Angiography, mathematical morphology, segmentation.

1. INTRODUCTION

Coronary angiogram imaging is done by injecting a dye through a catheter in the femoral artery, which is opaque to X-rays so that the blood vessels can be made visible to our eyes as blood vessels are not visible in ordinary imaging technique. Automatic segmentation of coronary arteries in X-ray angiograms has been an active area of research over the past several years. This effort is motivated by the desire to standardize the assessment of stenosis, which suffers from significant variance between observations and to quantitatively characterize the arterial structure. For instance, the segmentation process must address the problems associated with the presence of noise, artifacts, competing structures, and missing or misleading cues. Moreover, human arterial vasculature is a dynamic, inherently complex, and torous structure. Further complexity is added by the fact that this moving structure is projected onto static 2-D planes.

Several research groups have worked on various aspects of this problem, producing approaches that differ dramatically. The approaches differ in the technique used to discover a good or acceptable segmentation. In addition, a multitude of different low-level vision mechanisms for segmentation, feature extraction, and grouping have been explored. The coronary arterial tree description along with quantitative information for the artery dimension and assignment of coded labels. The stages of the method are, coronary arterial tree tracking and detection, artery skeleton and border estimation, feature graph creation and artery labeling by graph matching. Frank et al (1999), in this paper a method has been developed for making a contiguous series of blood vessel diameter estimates from digitized images. The method also included the generation of measurement estimation error, which was important in determining total vessel patency as well as providing a basic measure of diameter estimate accuracy. Hiblegard Kochler et al (2005), in this paper they have proposed a reliable method for extracting the main vessels and most notably also fine ramifications in noisy angiographies with uneven background. They have structured the extracted centerlines in a graph obtaining thus information about the depth of branching-out and the number of visible vessels in the coronary tree.

While many innovative solutions to the arterial segmentation problem have been developed, they generally suffer from the inability to accurately and consistently segment the arteries in which there is a significant feature ambiguity. This is most common when there is overlap of arterial segments in the image, bifurcation (or trifurcation) lies approximately within a plane that is perpendicular to the image, or if there is vessel foreshortening in a particular view. With this in concern a method has been developed to detect and trace the branch and branch points using the knowledge of connectivity and orientation of neighborhood pixels from the centerline extracted from the coronary structure. In this work I have applied a process to support the diagnostic, quantitative interpretation of the image. And presents the technical details and experimental results associated with the computational implementation of this algorithm.

II. SYSTEM PROCESSING

The architecture of the segmenting system consists of three main stages: Segmentation, Centerline extraction and Feature Extraction. This section gives detail description of the system architecture and initial process of segmentation and feature extraction.



2.1 Segmentation

Pre-processing is an important task before starting any processing on the image. Before any application or analysis is done on an image first the image has to be processed so that the resulting image is more suitable than the original image for that specific application. There is many a chance for any data to be corrupted with noise and irrelevant details. So before doing segmentation of the arteries in x-ray angiogram images the image needs to be smoothed to reduce sharp transitions in the gray level because random noise typically consists of sharp transitions in gray levels and to reduce false contours that result from using an insufficient number of gray levels.

2.2 Morphological operators

The word morphology commonly denotes a branch of biology that deals with the form and structure of animals and plants.[1] Mathematical morphology is used as a tool for extracting image components that are useful in the representation and description of region shape, such as boundaries and skeletons. Most of the morphological algorithms are based on two primitive operations are *Dilation* and *Erosion*. Set theory is the language of mathematical morphology. The two operations dilation and erosion can be explained easily using set theory. Sets in mathematical morphology represent objects in an image

Erosion:

With A and B as sets in Z^3 where every element in the set Z^3 is a tuple containing the coordinates of the pixels and the gray values of the pixels, the erosion of A by B is the set of all structuring element origin locations where the translated B has no overlap with the background of A.

Structuring Elements:

The structuring element used for the segmentation of coronary arteries is an octagon of size 24 as the width of blood vessels varies from a maximum of 3 pixels to 24 pixels.

2.3 Extraction of the Coronary Structure

The structuring element is created and dilation and erosion operations are performed one after the other on the filtered image.[2] As result of this operation the background of the image alone is obtained.

The difference image obtained by subtracting the background image from the filtered image contains the arteries alone. To make the thin vessels also get segmented Gaussian smoothing is done here. The Gaussian window is of size 3 x 3 and the standard deviation is kept less than one. The difference image obtained appears dark and so the obtained difference image is enhanced to clearly view the arteries. A clear-segmented image can be obtained by choosing an optimum threshold value such that pixels with intensity below the threshold value belong to the background and the pixels with intensity value greater than the threshold belongs to the arteries.

We have proposed a algorithm which identifies the reference image by subtracting the background image from the original image. Automatic threshold is calculated from the image features and applied to get segmented output as binary image. The Labeling of the arteries are obtained by Coordinate comparison and 8 – element Connectivity of neighboring Pixel ranges, finally the tabulation of the labeling of arteries are evaluated.

2.4 Centerline Identification

On the segmented image a morphological thinning procedure [3] is applied to extract the centerlines of the vascular network. This procedure iteratively deletes boundary points of a region subject to the constraints that the deletion of these points (1) does not remove end points, (2) does not break connectedness, and (3) does not cause excessive erosion of the region. This procedure is repeated until no changes are further made in the image that is the procedure is repeated until the detected skeletons are exactly one pixel in width so that it could be used to detect the bifurcation or trifurcation points of the arteries. The one pixel width centerline is used for the identification of the branching points and end points of the vascular network.

2.5 Detection Of The Branch Points

The branch points are found by considering the neighborhood pixels of each pixel on the centerline image. Here 3 by 3 neighborhood pixels of each centerline pixel are considered.



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If two of the eight neighborhood pixels have value one then the artery is continuous at that point.[4] If three of the eight neighborhood pixels have value one then the artery branches at that point. If more than four of the eight neighborhood pixels have value one then the artery has reached the terminating point.

2.6 Feature Extraction

The important features traced out here to diagnose [4] the coronary artery disease are the length of each artery branch, diameter and orientation. This is done using simple mathematics. The length and orientation of the arteries were detected by considering the branch points. The length of each artery branch is detected by finding the distance between the branch points. The orientation of arteries is also found using the branch points by finding the tangent of the branch. The diameter of the arteries were detected by finding the distance between the borders of the artery .By detecting these features from the segmented images the Coronary artery diseases and the severity of those diseases can be diagnosed correctly.

2.7 Labeling of Arteries

The vascular structure of the coronary arteries and the overlapping points are also detected as branch points and these points are deleted by deleting the points whose distance with their 8 – connectivity neighborhood is less than an appropriate value. Using these branch points , the coordinates with the reference model of the coronary structure the artery branches are labeled.

III. CONCLUSION

Morphological dilation and erosion serves to be an efficient method to segment the arteries from the complex non-uniform intensity distribution. Detection of the Branch points and the features extracted from these branch points can be used to diagnose the coronary artery disease and the severity of their extent. The work of this project can be extended to label the coronary structure to quantitatively characterize the structure of the coronary arteries and to also make diagnosis of diseases more efficiently.

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