

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 6, June 2017

Image Enhancement and 3-D Reconstruction of Coronary Artery from Multiple Cardiac Angiograms

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ABSTRACT: The cardiac X ray angiogram images are very much important for the diagnosis of cardiac images. The delineation of blood vessels in medical images is an essential step in the computer aided diagnosis of cardiac vessels diseases. The noise content in the angiographic images make it harder for analysis. Usage of linear filters are not useful in the analysis of such images. In this paper we discuss different image filtration methods like Gabor Filter and Frangi Vesselness Filter in order to detect the vascular map for the real clinical angiograms. Three-dimensional (3-D) reconstruction of the coronary artery is important for the diagnosis and interventional treatment of cardiovascular diseases. In this paper, a novel mean composited external force back-projective composition model is proposed and integrated into the deformable model framework for the 3-D reconstruction of coronary arteries from multiple angiograms. The parametric snake evolves toward the real vascular centerline in 3-D space based on the integrated internal energy and composited external energy. In addition, a polynomial function is constructed to determine the diameter of the cross section of the vascular segments, which fully utilizes the back-projection information of multiple angiograms.

KEYWORDS: Delineation, Deformable Models, Vascular Centerline, catheterization procedure.

I. INTRODUCTION

An angiogram is an X-ray test that uses a special dye and camera to take pictures of the blood flow in artery (such as the aorta) or vein such as the vena cava. An angiogram can be used to look at the arteries or veins in the brain, arms, heart, leg, back or belly.

A coronary angiogram is a procedure that uses X-ray imaging to see heart's blood vessels. The test is usually done to see whether there is a restriction for blood flow to the heart. Coronary angiogram is a part of general group of procedures known as cardiac catheterization. Cardiac catheterization procedures can diagnose and treat heart as well as blood vessel conditions. Coronary angiogram is the most common type of cardiac catheterization procedure. During coronary angiogram, a type of radio opaquedye that's visible by an X-ray machine is injected into the blood vessels of human heart. The X-ray machine rapidly takes a series of images (clinical angiograms), offering a look at the blood vessels

Angiography is the gold standard technique used to evaluate abnormalities or at deposition occurred in blood vessels, providing images with good spatial and temporal resolution. In digital images, the image processing filtration techniques can be easily used. The simplest methods include the thresholding and the histogram operations which imply human intervention. The automatic approaches are difficult to implement due to different vessel scales and organ shadows Filter in order to detect the vascular map for the real clinical angiograms.

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Three-dimensional (3-D) reconstruction of the coronary artery is important for the diagnosis and interventional treatment of cardiovascular diseases. The proposed EFBPCM-based methods greatly improve the calculation efficiency for the 3-D reconstruction of the coronary arteries.



Figure 1: clinical angiogram

II. RELATED WORK

In this paper we have digital subtraction angiography in its linear and logarithmic version and more complicated nonlinear filtering such as Gabor and Frangi vessel filters which includes histogram operations together with Hessian-based method for delineating the vascular map of clinical images and thresholding. Matlab R2014a is used as the implementation software.

In image processing, a **Gabor filter**, named after Dennis Gabor, is a linear filter used for edge detection in digital images. The Frequency and orientation representations of Gabor filters are similar to those of the human visual system,

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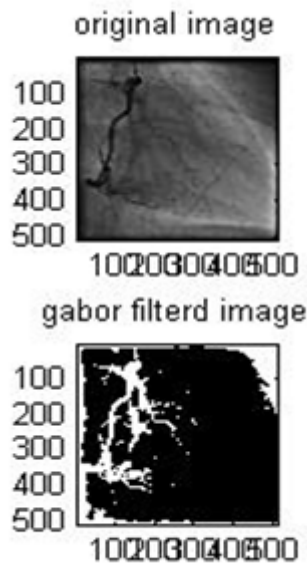


Figure 2 gabor filtered image

and they have been found to be particularly appropriate for texture representation and discrimination. In the spatial domain, a 2D Gabor filter is a Gaussian kernel function modulated by a sinusoidal plane wave. The Gabor filter uses the directionally selective band pass filters which are successfully applied for oriented line detection.

The multiscale version offers a possibility to be adapted for different frequencies. By tuning these filter frequencies, the noise is eliminated and the vessel centerline is enhanced, making the method ideal for the low contrast images with a blurring background. In the image complement, the vessels have positive contrast so they are brighter than background and need only the real kernel. A set of Gabor filters with different frequencies and orientations will be helpful for extracting useful features from an image.

In document image processing, Gabor filter features are ideal for identifying the script of a word in a multilingual document. Gabor filters with different frequencies and with orientations in different directions have been used to localize and extract text-only regions from complex document images (both gray and color), since the text is rich in high frequency components, whereas pictures are relatively smooth in nature. It has also been applied for facial expression recognition. Gabor filters have also been widely used in pattern analysis applications. For example, it has been used to study the directionality distribution inside the porous spongy trabecular bone in the spine. The Gabor space is very useful in image processing applications such as optical character recognition, iris recognition and fingerprint recognition. Relations between activations for a specific spatial location are very distinctive between objects in an image. Furthermore, important activations can be extracted from the Gabor space in order to create a sparse object representation.

The function of real Gabor filter kernel oriented in the angle ϕ ,

$$\phi = -\pi/2 \text{ is } g(x,y) ;$$

$$g(x,y) = \frac{1}{2\pi S_x S_y} \exp \left\{ -\frac{1}{2} \left[\left(\frac{x}{S_x} \right)^2 + \left(\frac{y}{S_y} \right)^2 \right] \right\} \cdot \cos(2\pi \theta x)$$

Where θ is the central spatial frequency, S_x and S_y control the spatial extending horizontally and vertically related to frequency and the orientation band, S_x/S_y is the aspect ratio that is a measure of the filter's asymmetry.

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III. FRANGI VESSELNESS FILTER

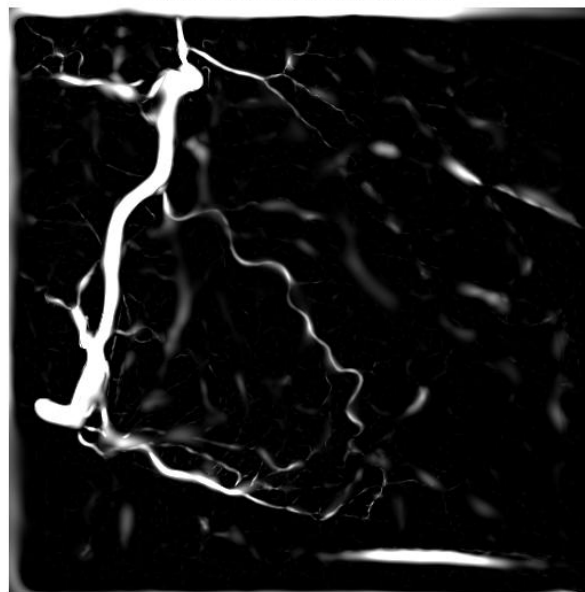
Frangi proposed an enhancement filter based on analysis of the eigenvalues of the Hessian matrix of the intensity image (coronary artery). Every element of the matrix is constructed with the aid of second-order Gaussian derivatives which offers the possibility to measure the contrast in the direction of the derivative between the image regions outside and inside the scale range

Given as $(-s, s)$

$$HG = \begin{bmatrix} hxxhxy \\ hyxhyy \end{bmatrix}$$

Where subscripts indicate the image gradients and hxy is the convolution of the image J with the scaled version of the second-order Gaussian derivative $g(x,s)$:

image enhancement using Frangis vessel filter



$G(x,s)=$ Figure 3 image enhancement using Frangis filter(simulation result)

$$\frac{1}{2\pi s^2} e^{-\left(\frac{x^2}{2s^2}\right)}$$

IV. RESULTS

The main concept of the MC-EFBPCM is that the external forces are normalized and integrated from all angiographic images into the predefined world coordinates based on their projection geometry. The deformable model is then directly constructed in 3-D space by defining the integrated back-projective and composited forces as the external energy. In contrast to the EFPIM-based method wherein the curve is deformed in projection images, the parametric snake evolves in 3-D space based on the combined internal and the external force back-projected from 2-D angiograms. Once the geometrical relationship between the angiograms at different imaging angles is determined, the external energy map in space can also be determined. Hence, the proposed MC-EFBPCM-based method effectively avoids the nonstrict matching problem. The general EFBPCM is appropriate to 3-D reconstruction of coronary arteries using two

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angiographic images. It is obvious that if more images involved for the 3-D reconstruction, the more accurate will be the reconstruction result.

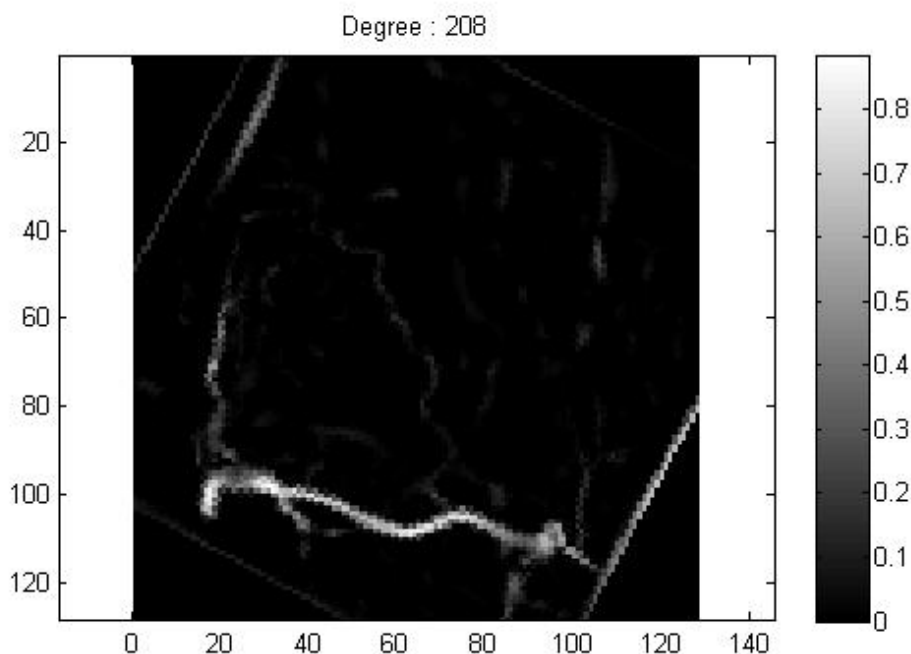


Figure 4 3-D Reconstructed Image (simulation result)

Once the 3-D centerline of the coronary artery tree is recovered, the diameter of each sampling point on the centerline should be estimated. Majority of current algorithms assume that the cross section of a vascular segment is a regular circle. However, this regular circle is not true for real angiograms, specifically for a vessel segment with unilateral stenosis. In such a case, the detected diameter in the angiogram will be larger than the true width of the stenosis if the imaging angle of the C-arm is not perpendicular to the narrowest view of the vessel. Hence, the size of the stenosis cannot be accurately estimated.

V. CONCLUSION

By digital image processing, image subtraction, image filtration and thresholding we were able to reduce the noise effects in coronary artery angiogram image. The Frangi filter image provided the more detailed less noisy format. The digital subtraction angiography eliminates the unwanted background structures and produces an output image with the blood vessels only. The problem resides in contrast decreasing which makes almost impossible for the visualization of the small vessels.

This paper also proposes a novel EFBPCM for the 3-D reconstruction of coronary artery by using multiple angiographic images. The proposed EFBPCM-based methods greatly improve the calculation efficiency for the 3-D reconstruction of the coronary arteries. In addition, the diameter information of the vascular structures in 3-D space can be effectively calculated by ellipse fitting of the back-projected intersections.

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REFERENCES

- [1] Weijian Cong, Jian Yang "Quantitative Analysis Of Deformable Model Based 3-D Reconstruction Of Coronary Artery From Multiple Angiograms", iee transactions on biomedical engineering, vol. 63, Yang 7, JULY ,2016
- [2] Irina AndraTache, "Vessel Enhancement in X-ray Angiograms" The 5th IEEE International Conference on E-Health and Bioengineering - EHB 2015
- [3] Q. Yang, K. Li, X. Liu, X. Bi, Z. Liu, J. An, A. Zhang, R. Jerecic, and D. Li, "Contrast-enhanced whole-heart coronary magnetic resonance angiography at 3.0T. A comparative study with X-ray angiography in a single center," J. Amer. College Cardiol., vol. 54, pp. 69–76, 2009.
- [4] Olena Tankyevych. (2010) "Filtering of thin objects : applications to vascular image analysis". Other[cs.OH]. Universit_e Paris-Est. English..
- [5] N. E. Green, S. Y. J. Chen, A. R. Hansgen, J. C. Messenger, B. M. Groves, and J. D. Carroll, "Angiographic views used for percutaneous coronary interventions: A three-dimensional analysis of physician-determined vs. computer-generated views," Catheterization Cardiovascular Interventions, vol. 64, no. 4, pp. 451–459, 2005.
- [6] R. R. Gollapudi, R. Valencia, S. S. Lee, G. B. Wong, P. S. Teirstein, and M. J. Price, "Utility of three-dimensional reconstruction of coronary angiography to guide percutaneous coronary intervention," Catheterization Cardiovascular Interventions, vol. 69, no. 4, pp. 479–482, 2007.
- [7] P. A. Dorsaz, L. Dorsaz, and P. A. Doriot, "The effect of image distortion on 3-D reconstruction of coronary bypass grafts from angiographic views," IEEE Trans. Med. Imag., vol. 19, no. 7, pp. 759–762, Jul. 2000.