Heart Vessel Extraction using Motion based Heart Area Extraction

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Abstract—**In this paper, a new method for heart vessel extraction based on heart area segmentation in angiogram image sequences is presented. One of the difficulties in vessel extraction in angiogram images is the detection of ribs and spins as vessels. Therefore, to cope with this problem, we utilize motion information to segment heart area. Then a two-stage vessel extraction algorithm is utilized to extract heart vessels efficiently. The vessel extraction algorithm, firstly extracts thick vessel, then the vessel extraction is completed by utilizing a new morphology based algorithm. Experimental results show that the proposed algorithm extracts heart area precisely using motion based segmentation, and hence vessel extraction accuracy of 95.16% is obtained.**

Keywords-vessel extraction; motion estimation; heart area extraction

I. INTRODUCTION

Heart vessel extraction in angiogram images is one of the challenging tasks in clinical practice. Many vessel extraction algorithms and techniques have been presented where a comprehensive review of them can be found in [1]. In [1] vessel segmentation techniques are categorized into six main categories: 1-pattern recognition techniques, 2- tracking-based approaches,3- model-based approaches, 4-neural network-based approaches, 5- artificial intelligence-based approaches, and 6- miscellaneous tube-like object detection approaches. In[2] a method for vessel extraction was presented that was based on the level set approach. The method was designed to be robust to image non-uniform illumination. In [3] an approach was described for vasculature extraction from angiography images by using wave propagation and traceback mechanism. The method propagated a digital wave through the image from the base of vascular tree. The wave "washed" over the vasculature, ignoring local noise perturbations.Lam and Yan detected blood vessel-like objects using the Laplacian operator and noisy objects were pruned according to the centerlines, which were detected using the normalized gradient vector field [4]. Truc et al. proposed a vessel enhancement filter for angiography images [5]. The method applies a directional filter bank to obtain accurate Hessian analysis in noisy environment and thus can correctly detect small and thin vessels. In [6] a method for coronary vessel extraction using a simple and fast fabrication of DDFB (called FDFB) was proposed. The method doesn't need downsampling and resampling stages which is employed in DDFB approach.

Although different algorithms and techniques have been presented for heart vessel extraction in angiogram images, most of them detects ribs and spins as vessels. Some of them also need the human user to select some initial points in the vessel areas.

To handle the problem of detecting ribs and spins as vessels in angiogram images, we utilize a method to extract heart area in the images. Then the vessels are only extracted in the heart area. The method completely removes spins and ribs. To segment heart area in the sequence of angiogram images, we use the motion information for image segmentation. In angiogram image sequences, heart area has a periodic motion, while the spins and ribs area has no motion or move in translational manner. We use this difference in motion as a clue to extract heart area, when the heart area is detected; we extract heart vessels by using a novel vessel extraction algorithm.

This paper is organized as follows. In Section II, the proposed method is described. Experimental results appear in section III and we conclude the paper in section IV.

II. THE PROPOSED METHOD

The proposed algorithm contains two steps. In the first step the heart area is extracted by estimatingand segmenting heart motion. When the heart area is segmented, we extract vessels in the heart area. The algorithm for vessel extraction is also a two-stage algorithm. In the first stage thick vessels are extracted, and then thin vessels are extracted by utilizing the output of previous stage.

A. Extracting Heart Area

As mentioned before, in angiogram image sequences, heart area has a periodic motion, while the spins and ribs area has no motion or move in translational manner. We use the difference in motion model as a clue to extract heart area. Different methods have been proposed to calculate motion vectors in the image sequences, including optical flow methods [7], active contours [8], active meshes [9] and the feature matching algorithms [10, 11] to name a few. Feature matching algorithms calculate motion vectors for some robust features of the images. They are computationally inexpensive and robust against aperture problem, image noise and illumination change. We use Good Feature to Track (GFTT) [10] algorithm for feature extraction in angiogram image sequences. The GFTT features are then matched using recursive and multi-resolution implementation of KLT algorithm [11] to calculate motion