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Different Approaches for Edge Detection of Angiogram Images

Shrutika Patil[1], Mrs. A. G. Andurkar[2]
Research Student[1], Assistant Professor[2]
Department of Electronics &Telecommunication,
Government College of Engineering,
NMU, NH-6, Jalgaon,
Maharashtra-India

ABSTRACT

Edge detection is an important technique in the area of image processing with wide applications in medical imaging. Angiography is an image technique used to locate the position of blood vessels of different parts of human body. X-ray, Computed Tomography (CT scan) and Magnetic Resonance (MR) are the medical imaging techniques which are used for visualization of blood vessels of human body. Many edge detection methods have been proposed over many years. Researchers use classical edge detection process for different applications, but these methods does not prove efficient for edge detection of angiogram images. Hence improved edge detection algorithm is proposed to determine fine edges of blood vessels. The proposed algorithm involves very simple steps and provides more accuracy. In this article, we give an overview of the angiogram image based edge detection techniques using the features developed recently.

Keywords:- Image processing, edge detection, segmentation, angiography.

I. INTRODUCTION

Angiogram images are degraded by blur and noise from medical imaging systems [1]. Edge detection is difficult task in noisy images, as both the noise and the edges contain high frequency components. Attempts have been made to reduce the noise which results in blurred and distorted edges. There are a variety of operators used on such images, so they can average sufficient data to discount localized noisy pixels. The result is less accurate in relation with localization of the detected edges. Quite few edges involve a step change in intensity. Visual effects such as poor focus or refraction may result in objects with boundaries defined by a gradual change in intensity. The operator needs to be chosen to be responsive to such a gradual change in those cases. So, there are problems of false edge detection, missing true edges, edge localization, high computational time and problems due to noise etc. Therefore, the objective is to compare various edge detection techniques and analyze the performance of these techniques in different conditions. There are number of ways to perform edge detection [4, 11]. However, most of these methods may be grouped into two categories:

1) Gradient based edge detection

The gradient method involves edge detection by looking for the maximum and minimum in the first derivative of the target image [4].

2) Laplacian based edge detection

It aims to build a morphing algorithm which automatically operates on the features extracted from target image. It can be considered as a good beginning in order to find the edges in the target image [11]. To find the edges of the target image the Laplacian method searches for zero crossings in the second derivative of the image. An edge has the 1D shape of a ramp and calculating the derivative of the image can clearly highlight its location [4].

A. Edge Detection Techniques

Various edge detection methods have been developed over the years. As edge detection is fundamental step in computer vision, it is necessary to point out the true edges to get the best results from the matching process. That is why it is important to choose edge detectors which best fits the application [12]. There are different edge detection techniques available the compared ones are as follows

1) Sobel Operator

Sobel operator is one of the pixel based edge detection algorithm. It is most commonly used edge detectors [11]. It detects edges by calculating partial

derivatives in 3 x 3 neighborhoods. The reason for using this operator is that it is not sensitive to noise and has relatively small mask in images [12].

2) Robert Cross operator

The Robert cross operator performs a simple and quick two-dimensional spatial gradient measurement on an image. This operator consists of a pair of 2 x 2 convolution kernels [12].

3) Prewitt Detector

The Prewitt operator is very similar to the Sobel operator. It is used for detecting vertical and horizontal edges in an image [12]. Unlike the Sobel operator, Prewitt operator does not place any emphasis on pixels that are closer to the center of masks [11]. The Prewitt edge detector is the most probable way to estimate the magnitude and orientation of an edge. This operator is limited to eight possible orientations and is estimated in 3 x 3 neighborhood for eight directions [12].

4) Canny's Edge Detection

The Canny edge detection is known as the optimal edge detector. The Canny edge detector is an edge detection operator that uses a multi-stage algorithm to detect a wide range of edges in images and it was developed by John Canny in 1986 [14]. The Canny edge detection algorithm has the following steps:

Step 1: First step is to remove noise [14] and smooth the image with a Gaussian filter [10].

Step 2: Compute the edge gradient magnitude and orientation using finite-difference approximations for the partial derivatives.

Step 3: Apply nonmaxima suppression to the gradient magnitude; this will give a thin line in the output image. Use the double thresholding algorithm to detect and link edges [14].

The Canny algorithm contains a number of adjustable parameters such as the size of guassian filter and thresholds, which can affect the computation time and effectiveness of algorithm [10].

II. PREVIOUS RESEARCH

Various methods and algorithms are proposed for the edge detection of angiogram images. Many methods have been used to visualize blood vessel structures in the human body [9]. Some of them are explained here.

Jinn-Kwei Guo et al. [1998] presented a reconstruction process to build the 3D structure of blood vessels from a pair of DSA images. To segment the vessels from the background, both the local thresholding as well as global thresholding was used to bilevel the input image. Thinning process along with the B-Spline curve were applied to extract and smooth the skeleton of the vessels. The skeleton was tracked in order to find the branch points which were used for matching. For each feature point the epipolar constraint and the property of feature points were incorporated to find its correspondence on the other image. From the DSA machine structure the real 3-D location of the skeleton can be calculated by using least-squares-error estimation [2].

Kayikcioglu T et al. [2002] later on proposed a surface-based method for detection of left and right coronary boundaries suitable for analysis of poor quality X-ray images. Coronary artery is modeled with a 3D generalized cylinder with an elliptic cross-section [3]. Generalized cylinders are used to represent cylindrical objects. Technically generalized cylinders are parametric methods [5]. Based on this model, they developed a 2D surface function for the projection intensity distribution of a part of vessel. The parameters associated with vessel borders were estimated from this model. The model takes into account parameters such as noise, blurring, local background intensity. In real experiments over a range of imaging conditions, this method consistently provide low estimation error and variability in detecting edges [3].

Guodong Wang et al. [2009] put forward a versatile nonlinear diffusion method to visually enhance the angiogram images for improving the clinical diagnosis. Earlier used nonlinear diffusion has been shown very effective in edge preserved smoothing of images. However, the existing nonlinear diffusion models have many drawbacks such as sensitivity to the choice of the conductance parameter, the sensitivity to the selection of evolution time, limited range of edge enhancement. The new anisotropic diffusion proposed by Wang is based on facet model which can solve the issues mentioned above adaptively. This method uses facet model for fitting image to reduce noise, and at the same time uses the sum square of eigen values of Hessian. The capability of dealing with noise and conductance parameter can change adaptively in the whole diffusion process. Moreover, this method is insensitive to the choice of evolution time. Thus the main feature of this method is the powerful noise removing and edge preserving [7].

Mengko T R et al. [2009] put forth an alternative methods to obtain a proper visualization of the crucial angiographical information, with the most commonly used imaging devices. The proposed methods are based on digital image processing techniques and are equipped with PC interface. There are two image processing approaches presented in this paper, they are the image enhancement of standard colour -fundus images and the image restoration of FAF images.

Mei Wang et al. [2010] proposed a new edge detection method based on the information measure, and applied this method to the coronary angiogram. Firstly, by using the square template, the blood vessel path points were found and using the minimum gray scale criteria and the smoothing technique the quasi-center curve of the vessel segment was obtained. Then the orientation information measure concept of an image was introduced, and the l values of the information measures of the l points in the same row or the same column were calculated using the quasi center curve. Finally, the point with the maximum information measure is defined to be the edge point and then the edge curve is obtained. The edge points and noise points can be effectively differentiated by using the concept of image orientation information measure. This new method possesses strong noise immunity [8].

Wischgoll T [2013] describes an improved segmentation technique which was based on a hybrid approach between isovalue and image-gradient segmentation and a center line extraction method using 3D vector field topology analysis. Based on the center lines of the blood vessels found in the angiogram, the quantitative measurements were computed that can prove helpful in the diagnostic process. This algorithm is based on a topological analysis of a vector field derived from the configuration of the point set. Due to the fact that it is not so necessary to compute the vector field on a multitude of points but instead only for points on the object's boundary the proposed algorithm is faster than other vector-field-based approaches while still preserving a high accuracy of extracted curve-skeleton. For a CT angiogram data set, the algorithm needed more than an hour to determine the curve-skeleton of vasculature and extract the measurements [13].

III. PROPOSED SYSTEM

The proposed algorithm aims to overcome the limitations using the classical image processing techniques as shown in the flow diagram.

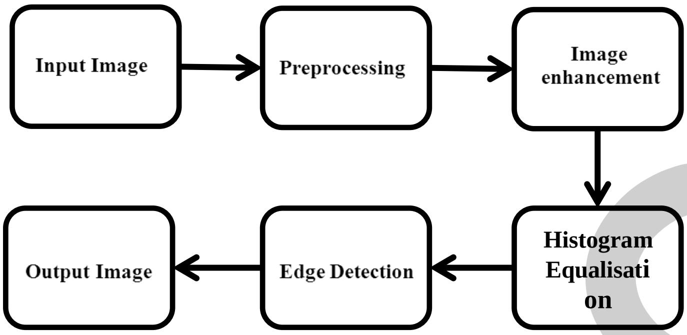

Fig. 1 Example of an unacceptable low-resolution image

In fig. 1 first the input image is preprocessed using a suitable filter to remove noise and then the histogram of the input angiogram image is obtained. Then by a technique called histogram linearization, uniform histogram of that image is obtained. Again, the histogram of histogram equalized image is obtained. Thus, finally the edges of the vessel from the given angiogram image is obtained [10].

IV. CONCLUSION

The edge detection is the primary step in identifying an image object, it is very essential to know the advantages and disadvantages of each edge detection technique. Since edge detection is in the forefront of image processing, it is important to have a good understanding of edge detection techniques. In this paper we have tried to cover both early and recent literature related to blood vessel edge detection algorithms. Our aim is to introduce an efficient edge detection technique for proper visualization of blood vessels. Since the quality of angiographic images spans wide range, any detection technique must consider first the image quality. The method presented in this paper has been developed for accurate detection of vessel borders in poor quality angiogram.

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