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Blockage Analysis in Angiography Images

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***Abstract:-* Accurate visualization and quantification of an angiography images is very important for a number of clinical procedures. Grading of stenosis is important in the diagnosis of vascular disease since it determines the treatment therapy. Bypass operation or interventional procedures such as the placement of prosthesis in order to prevent aneurysm rupture require an accurate insight into the vessel architectures. Different techniques such as CTA, MRA are employed for this purpose. CTA and MRA provide volumetric data but images are noisy and having a maximum intensity projection.**

The main drawbacks of maximum intensity projections are the overlap of non-vascular structures and the fact that small vessels with low contrast are hardly visible. It is difficult to analyze blockage in such images. This paper presents the detection of blockage from such angiography images. In the first step image preprocessed for denoising and it is equalized by histogram technique. The second order derivatives are implemented to detect or extract the vessels structure in an image. Morphology is used to extract features based on shape and Blockage is analyzed from the output image.

Keywords:- Angiographic image, Hessian Matrix, Frangi 2D filter, Morphology, Segmentation.

1. INTRODUCTION

The vessel structure is one of the most complex structures of the blood circulatory system in human body. Blood vessel anatomy provides important insight into the circulatory anatomy, helping us to understand the causes, evolution and outcome of several vascular diseases. Nowadays, vascular diseases are the most vital problem for human health. Heart and cerebrovascular diseases are the first and third cause of death respectively. Malignant tumors growth is directly associated with vessel and angiogenesis, which is the second cause of death.

Nowadays, the generation of accurate patient specific geometric is possible due to medical imaging technology which provides high resolution images of the vessel structures. Image based vessel analysis provides important information for planning and navigation during surgical procedures, both to avoid damaging vital structures as well as to use vessels as anatomical landmarks for orientation and localization of structures of interest. In past decades, a measureless variety of methods and approaches has emerged which deals with vascular extraction, analysis and modeling with increasing complexity.

Angiography is performed to find out any blockage in the flow of blood within the blood vessels. Hence the detection or extraction of the blood vessels is very important and must be very accurate. In a real world practical environment, it is very difficult to detect the edges and the noise as these images belong to the range of high frequency. The angiography images are of high intensity which contain shadows, noise and object boundaries. Hence, it may be difficult to distinguish the exact structure of vessels from the noise.

Segmentation is an important step in the field of image processing which performs partitioning of given image into several non-overlapping regions. This aspect of segmentation is used to find tumors, regions of interest, edges of blood vessels and much more information for the given image.

So in this paper, we are presenting the method for analysis of the blockage in angiography images.

2. BACKGROUND

The proposed approach combine the idea from wavelet Denoising and vesselness. Wavelet denoising is used to remove noise from image while preserving characteristics of images regardless of its frequency content [8]. Hessian matrix provides the most curvature and consequently a greater likelihood with vasculature [1]. The method based on hessian Eigen value analysis and frangi 2D filter is capable of detecting not only tubular structures, but also blob-like and sheet like structure within image [3]. Hessian matrix is used to obtain the vessel feature map and vessel direction map from original angiogram image

3. PROPOSED METHOD

The proposed algorithm consists of three main steps, namely:

Step 1: Pre processing
Step 2: Segmentation
Step 3: Post processing

In Preprocessing, first the denoising of input image is done for the reconstruction of an image from the noise and gray level values are equalized by using histogram equalization. The Hessian matrix analysis and the Frangi 2D filter are used to extract the vessels structure. Then the morphological operations are done to segment the detected angio vessels from the background image. Finally, after thresholding the width of the segmented angio vessel is analyzed to detect the blockage.

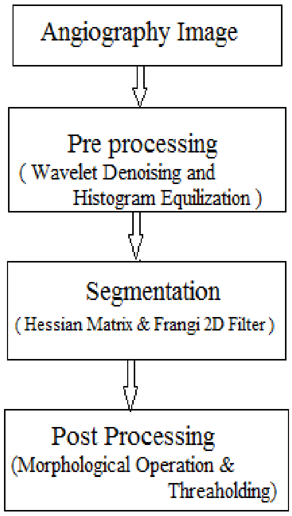

Fig 2: Flow Diagram of the proposed method

Thus, the above mentioned algorithm is used to analyze blockage from the given angiographic image.

3.1 Pre processing

An image is often corrupted by noise during its acquisition or transmission. In this step, we are using wavelet denoising to remove noise present in image while preserving image characteristics regardless of its frequency content. In wavelet denoising the input image is decomposed into horizontal, vertical, and diagonal components by using wavelet decomposition. The decomposed components are denoised by using Bayes thresholding. Small threshold may yield result close to input, but result may be still noisy. The Bayesian threshold strategy is consistent with human visual system which is less sensitive to presence of noise in vicinity of edges. Finally these decomposed components are reconstructed using wavelet reconstruction.

After denoising, the histogram equalization on input image is performed. Histogram manipulation is basically modifies the histogram of an input image so as to improve the visual quality of the image. In this, the gray levels in an image are spread out evenly across their range so that brightness value in an image is reassigned.

3.2 Segmentation

This step is used to extract the vessels using the Frangi 2D filter and the Hessian matrix is used to provide the enhancement of the input angiogram image. Image enhancement process consists of a number of techniques to improve the visual appearance of an image. The basic aim of this step is to make the image look better. The objective of this technique is to process an image so that the result is more suitable than the original image for a particular application.

The Hessian matrix used is a simple second order Gaussian derivative function.The Hessian matrix analysis is done to find the vessel structures from the original angiography image. The Eigen values of the Hessian are the principal curvatures and their product is the Gaussian curvature, which is the determinant of the Hessian.

Thus, for the Hessian matrix, the Eigen vectors form an orthogonal basis which shows the direction of curve of vessels structure.

- If both the Eigen values are positive, then it is a local minima,
- If both the Eigen values are negative, then it is a local maxima,
- If the Eigen values have mixed sign, then it is a saddle point.

First the Eigen values and the Eigen vectors of Hessian Matrix are calculated and are sorted by their absolute values. The Frangi 2D filter uses the Eigen vectors of the Hessian matrix to compute the likeness of an image region to vessels.

Secondly, the matrix with the scales on which the maximum intensity of every pixel is found and the matrix with the directions of the pixels is also found. Then the direction of the minor Eigen vector and the similarity measures are calculated. Finally the output image is computed.

Thus the image obtained at the output of the Frangi 2D filter is an enhanced image, which means that the pixel is the maximum found in all scales.

3.3 Post processing

In post processing, first we are using Morphology process which deals with the shape and structure of the objects. Morphology is done to process and analyze the images. Erosion and dilation are two basic operations involved in this process. After the segmentation the width of extracted vessel is expanded. In this step, we are using erosion in which the grayscale image is converted to a binary image. Then the holes in the binary image are filled, complemented and eroded. The morphological operations are done to detect the edges of the angiogram images and at the same time to denoise the image.

Binary image is having better visibility for the analysis of angiography images. The blockage is analyzed based on the width of the extracted vessels and discontinuity present in it. Length of blockage can be determined by using image tools.

4. EXPERIMENTAL RESULTS

The proposed algorithm was tested on the real images acquired from4 patients. All the algorithms were implemented in MATLAB R 2010a on a computer. A Graphical User Interface is created with two push buttons, one to select the input image, next to perform various operations on angiography image.

The performance of the proposed algorithm was evaluated in two stages.The first stage involves denoising and histogram equalization. In Second stage, Hessian matrix and the Frangi 2D filter extract the vessel structure from input image. The third stage erosion is done by deriving the shrinking image from extracted image. In fourth stage the length of blockage in angiography vessel is measured.

Here, input angiogram images are taken for processing and their various stages results are shown in this paper.

Figure 4.2 shows the denoised, histogram equalized image in which noise is removed from input image by wavelet denoising and gray levels of input images are equalized by histogram equalization. In fig 4.3 vessels from denoised image are extracted by using Eigen values of hessian matrix and frangi 2D filter. The vessels are swelled which are shrink by using erosion shown in fig 4.4. Thresholding is used to analyze the blockage from eroded images shown in fig 4.5. By observing the width of vessels and discontinuities present along it shows the blockage in vessels shown in fig 4.6

Input Image

Fig 4.1 Input image

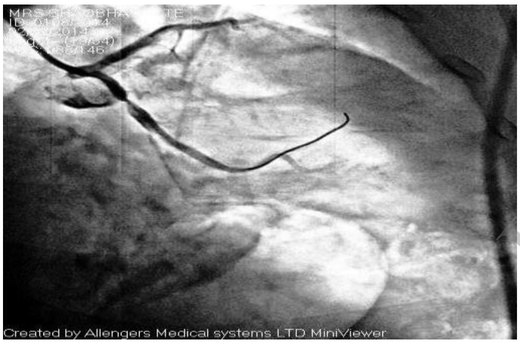

Fig 4.2 Denoised and Histogram Equalized Image

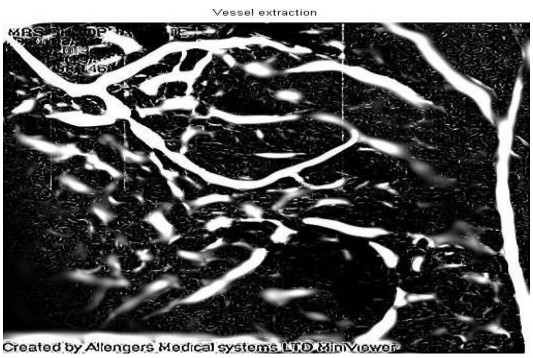

Fig 4.3 Extracted Vessels

Output Images for Different Stages

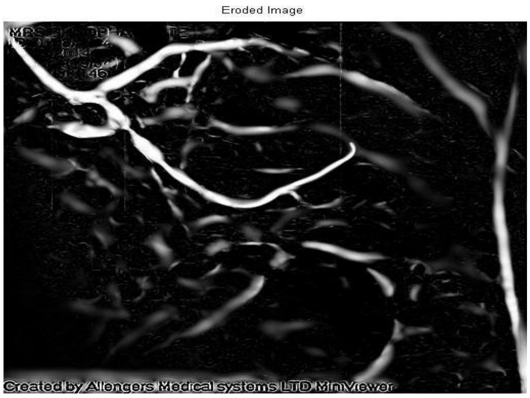

Fig4.4 Eroded Image

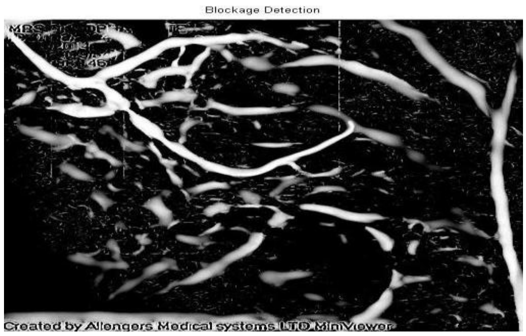

Fig 4.5 Blockage Analysis

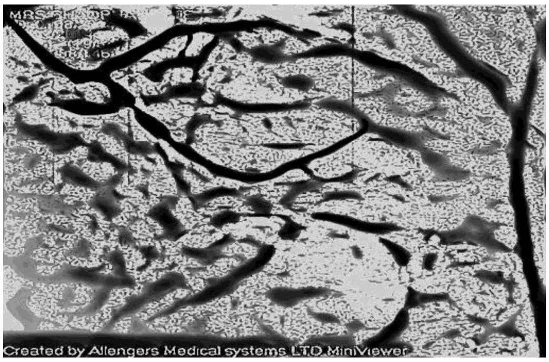

Fig 4.6 Blockage Length measurement tool

4. CONCLUSION

In this paper the angiography image is denoise and equalize, the proposed algorithm extracts the blood vessels from the given angiogram image from which we can analyze the blockages. Also from these images we can measure the length of blockage in vessels.

The results show that the proposed algorithm is unique in nature and gives better results.

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