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Multi-scale single-channel linear tracking method for segmentation of retinal blood vessels (MSLTA)

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Abstract— **Described in the text of a vascular retinal image segmentation and extraction of network algorithms, known as multi-scale single-channel linear tracking (MSLTA). Retinal fundus imaging is widely used for eye examinations. The acquired images provide a unique view on the eye vasculature. The analysis of the vasculature has a high importance especially for detecting cardiovascular diseases. We present a multiscale algorithm for automatic retinal blood vessel segmentation, which is considered as a requirement for the diagnosis of vascular diseases. This algorithm from the select part of a seed pixel in the image began tracking, tracking pixels that meet the criteria in the process gives a higher confidence level. After the end of the track to quantify confidence in all points matrix acquired after the initial network of blood vessels, then median filtering, blood vessels to this network are repaired and noise reduction.**

Keywords-***Vessel segmentation, multi scale, linear tracking algorithm.***

I. INTRODUCTION

In medical diagnostics and medical research, blood vessels are very important biological tissue. Occurs when the eye organ Visual diseases, retinal diameter, color and the degree of bending exception occurs.

Therefore, detection and extraction of blood vessels in retinal images are a very important research questions. Located in the fundus of posterior vitreous detachment of the retina, is concave shaped, get local on the clinical images, obvious characterized by uneven illumination, Central light, surrounded by dark, contrast is too strong, contrast disadvantages such as weak. This article takes a rapid method

from the seed extract linear tracking, as well as in several channels repeat results will eventually be used to assess a multiscale confidence pixel belongs to the vascular network, And then quantify median filter for noise removal, and increases the accuracy of confidence matrix.

The images of the eye background provide the unique opportunity to in vivo examine the human vasculature. The sight of the vessel structure facilitates the detection of substantial vascular abnormalities e.g. aneurysms, artery/vein ratio [1]. Most of the automatic and semiautomatic methods to analyze the vessel structure rely on vessel segmentation.

Segmentation of blood vessels is a research area since years, the current algorithms usually use some kind of vessel enhancement or feature extraction before the Thresholding, or vessel tracking [2].

The methods with the highest accuracy also have high computational needs if thick vessels are present. The use of the proposed resolution hierarchy makes it possible to detect these vessels faster, while preserving a high accuracy.

The retina is the only location where blood vessels can be directly captured non-invasively in vivo. Over the past decade, the retinal image analysis has been widely used in medical community for diagnosing and monitoring the progression of diseases [3, 4].

And retinal blood vessels are important structures in retinal images. The information obtained from the examination of retinal blood vessels offers many useful parameters for the diagnosis or evaluation of ocular or systemic diseases.

For example, the retinal blood vessel has shown some morphological changes such as diameter, length, branching angles or tortuosity for vascular or nonvascular pathology, such as hypertension, diabetes, cardiovascular diseases [5]. Blood vessels are also used as landmarks for registration of retinal images of a same patient gathered from different sources. Sometimes, retinal blood vessel must be excluded for easy detection of pathological lesions like exudates or microaneurysms. In all cases, proper segmentation of retinal blood vessel is crucial.

Actually, automatic detection of the blood vessels in retinal images is a challenging task. The contrast of retinal image diminishes as distance of a pixel from the center of the retinal image. And the presence of noise, the variability of vessel width, the presence of some pathological lesions, all make the task more difficult.

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Images of the ocular fundus tell us about retinal, ophthalmic, and even systemic diseases such as diabetes, hypertension, and arteriosclerosis.

A central feature in such diagnoses is the appearance of blood vessels in ocular fundus. The development of an efficient and effective computer based approach to the automated segmentation of blood vessels in retinal images would allow eye care specialists to screen larger populations for vessel abnormalities. However, automated retinal segmentation is complicated by the fact that the width of retinal vessels can vary from very large to very small, and that the local contrast of vessels is unstable, especially in unhealthy ocular fundus.

There are three basic approaches for automated segmentation of blood vessel:

Thresholding method, tracking method and machine trained classifiers. In the first method, many of different operators are used to enhance the contrast between vessel and background, such as Sobel operators, Laplacian operators, Gaussian filters which model the gray cross-section of a blood vessel [6].

Then the gray threshold is selected to determine the vessel. And this gray threshold is crucial, because small threshold induces more noises and great threshold causes loss of some fine vessels, so adaptive or local threshold is used to different sections of an image.

Vessel tracking is another technique for vessel segmentation, whereby vessel centre locations are automatically sought along the vessel longitudinal axis from a starting point to the ending point [7].

This method may be confused by vessel crossings and bifurcations.

Many kinds of classifiers, such as Bayesian classifier, neural networks, support vector machine, have been employed for improved discrimination between vessel and non vessel. Feature extraction and parameters selection of a classier are critical. All pixels in images are classified into vessel or non-vessel through the classifier [8,9]. *Realization of multi-scale single-channel linear tracking algorithms*- realization of algorithm of multiscale singlechannel linear tracking methods are used in this article under the green channel to process images, because the green channel image have higher vascular contrast.

Figure (2). Retinal green channel image

A. Image Acquisition

The first stage of any vision system is the image acquisition stage. After the image has been obtained, various methods of processing can be applied to the image to perform the many different vision tasks required today. However, if the image has not been acquired satisfactorily then the intended tasks may not be achievable, even with the aid of some form of image enhancement.

B. Linear tracking seed selection:

How much seed would affect confidence in accuracy of the matrix. If you select a very small amount in a very narrow area of the histogram of the seeds, some vascular line therefore cannot be obtained; the accuracy of the algorithm will eventually be reduced. In contrast, selecting large numbers of seeds within a very wide area of the histogram will greatly increase and computational time. I (x, y) representing the image (x, y) pixel grayscale, Vs selected seed sequences.

$$Vs=\{(x,y): Tlow<I(x,y)<Thigh\} \quad (1)$$

Tlow and Thigh is expected under the image in the image gray level histogram vascular area estimates receive two limits. Below the limit Tlow points, their confidence in the dark background of higher higher limit Thigh points, which belong to the lighter in the retinal tissue and injury higher confidence in the region. Tlow used in the text and value of the Thigh and 30% respectively, which is derived from the results separated by hand. Linear tracking process, the scale under w, each pixel belongs to the vascular network of confidence are stored in sequence in the Cw. Confidence high one of the elements in the matrix represents its belonging to the relatively high probability of blood vessels. At first, Confidence all of the elements in the matrix of 0:

$$Cw(x,y):=0 \quad (2)$$

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Step 2.2 and 2.3 Ts times a cycle (t=1: Ts), for all of the pixels in the Vs and under all conditions of scales
Ts=length (Vs)

C. Linear track initialization: k:=1,
Vc(k):=Vs(t), Cc:={}

T where Vc is the current loop variable pixel tracking under sequence, Cc is the new sequence of tracking pixels.

Estimated new tracking pixels

Pixel of the current track is the last one to enter Vc object, Cc is a sequence consisting of a candidate pixel, which candidates points to the current tracking recent 8 pixels around pixel points remove included in the Vc resulting from the point.

Cc=N8 (Vc(k))-Vc (3) For all Cc candidate pixel parameters of Vl, by the Figure (3):

Vl=I(bac1)+I(bac2)-2I(cand) (4) curtrac

Is the current track points，bac1 Background cand w(w=(W-1)/2) Background pixel by bac2 is the background points at the same distance in the opposite direction. Cand candidate pixel is in the Cc.

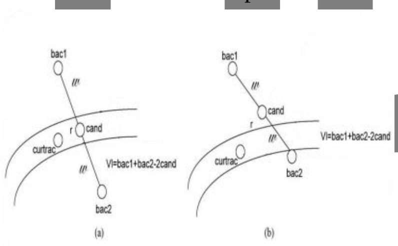

Fig 3

If the pixel belongs to the vascular network of candidates, then Vl will have a large positive value; on the contrary, if you belong to the background, the BAC1,bac2 brightness of pixels and C and close, Vl therefore parameter values close to 0. When the Vl much greater than t, join the current tracking pixel to Vc:

k:=k+1,Vc(k):=(x,y) (5)

Therefore, the confidence level matrix Cw updates:

Cw(x,y) :=Cw(x,y)+1,(x,y) := (x_c, y_c) (6)

Search for a new program starting from 2.3 loops of track points. If the equation (5) all parameter value is less than t, the algorithms from 2.2 begins with the next seed points (t: =t+1). Limit t is set to 10, whose role is to eliminate noise. *D. Multi-scale linear track:*

For all the seed points, an MSLTA algorithm is applied in accordance with the measure of a certain number of repeat. Scale is the number of detected by the retinal image to be determined by the width of the vessels, vessels with a large variability in the image corresponds to the multiple number of scales.

For the secondary processing of retinal image, proven W=3, 5, 7,9,11 is appropriate.

E. Vascular network in its original estimate

Here, vascular network in its original estimate is obtained by mapping quantitative, this is a quick, simple method of selecting, replacing a widely known local neighborhood limit law. Initial vascular network is by the confidence level in the matrix value is greater than the limit T_c Pixel building, usually T_c Value is equal to the scale W the value of. In some cases, noise, non-vascular points are also tracking access on all scales, and mistakenly use them as part of the vascular network. But mapping quantitative pixel this selection method can significantly reduce noise in the incidence of vascular network.

F. Original vascular network of the median filter Role of median filter:

a. To re-establish connections between several blood vessels.
b. Displays the pixel that hides belonging to the vascular network.
c. Some of the surplus by removing the image noises pixel points to reduce the error detection rate.

After the median filter, vascular network segmentation accuracy improves.

G. Algorithm

a. MSLTA Algorithms, as well as the early handler summary.
b. Having access to the original images on the median filter processed images.
c. Parameters that are involved in the program

description:

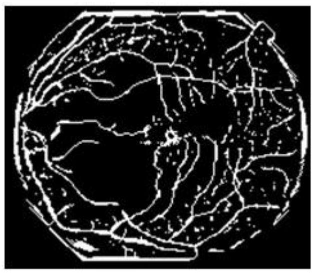

Fig 7.Scaling of Original Data for M=3 for segmenting vascular diameter

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a. M scales, vascular diameter that w is to be measured to determine the minimum and maximum value.
b. In this algorithm, we set the distance r to 1, because r<10 for segmentation of algorithm exact rate has little effect.
c. Limit t is set to 10.

II. RESULTS

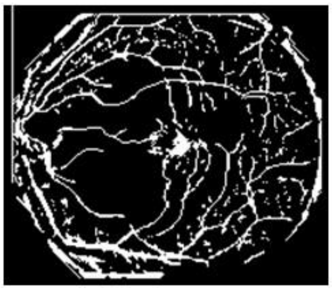

Fig 8.for M=5

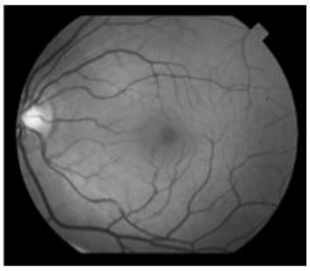

Fig 4. Original Retinal green channel image

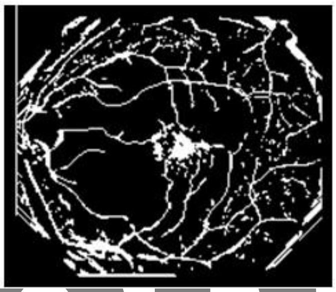

Fig 9.for M=7

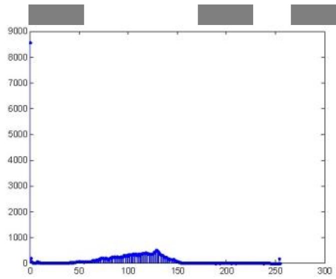

Fig 5. Seed Point Selection Plot for Original Image

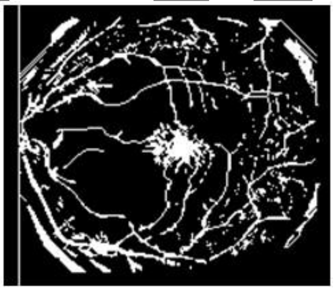

Fig 10.for M=9

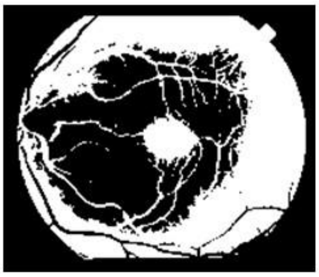

Fig 6.Initial Scaling of Original Data for M=1 for segmenting vascular diameter

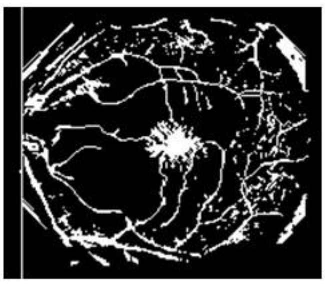

Fig 11.for M=11

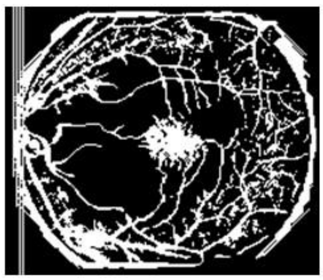

Fig 12.Final Separated Output Extracted

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III. CONCLUSION

This work will takes a rapid method for the extraction of multiscale vascular network determines, under adverse conditions above can be split effective and quick on the retina. It contains the following modules: image acquisition, channel selection, access to seeds, starting from the seed extract linear tracking, as well as in several channels repeat results will eventually be used to assess a multiscale confidence pixel belongs to the vascular network. And then quantify median filter for noise removal, and increases the accuracy of confidence matrix. During the earlier period processing for image enhancement, further in the post processing filter can achieve better results. This method can also be applied mesh texture segmentation.

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