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GLAUCOMA DETECTION IN OPTICAL COHERENCE TOMOGRAPHY BASED ON FUZZY C-MEANS CLUSTERING

K.Venkatraman*,
Assistant Professor, Department of Biomedical Engineering, Bharath University, Chennai, India.
Email: venkatraman.bme@bharathuniv.ac.in

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Abstract

Retinal vessel segmentation is the fundamental component of retinal disease screening system. Usage of OCT in the proposed paper would help in evolving a non-invasive, better resolution and real time retinal screening system. A spectral-domain OCT scanner capable of acquiring volumetric data of the retina is becoming an increasingly important modality in ophthalmology for the diagnosis. In the existing paper, the extraction of features consumes more time. The disadvantages such as neural canal opening and low visibility in the optic nerve head centre and time consumption can be overcome by the proposed work. The paper proposes an efficient methodology to segment retinal vessels allowing extraction of mandatory features to analyse and diagnose health conditions like diabetic retinopathy. The proposed method uses the Fuzzy c-Means algorithm to segment the retinal blood vessels of normal fundus image and OCT image. The proposed method uses the complimentary information obtained from the fundus photography and SD-OCT images. Extraction of mandatory features would result in a less time consuming and efficient retinal vessel segmentation. The proposed work would form a basis of an accurate test for many of the diseased conditions.

Key Words: Retinal vessels, Spectral domain-OCT, Fuzzy C Means technique.

I. Introduction

Optical Coherence Tomography (OCT) has many uses in medicine and biology. It is a non-invasive technique of looking at the layered structures of tissue like skin, the retina and teeth. The scanning of retinas to reveal defects in the underlying layers has been done extensively and stand-alone units are now sold for this purpose. Optical coherence tomography (OCT) is a highly sensitive interferometric technique that measures light reflected from within tissue. Nearly all OCT systems are based on time-domain (TD) OCT. The length of the reference arm in an interferometer is rapidly scanned over a distance that corresponds to the imaging-depth range. An alternative to

scanning the reference arm is to measure the cross-spectral density at the detection arm of the interferometer by means of a spectrometer. In spectral domain (SD) OCT, also known as Fourier-domain OCT, no mechanical scanning of the reference arm is required. The analysis of retinal blood vessels can be important not only in the diagnosis of various retinal diseases like diabetic retinopathy or glaucoma; it may also be an important tool to align different images taken from patients at different clinical visits. In addition, the RNFL thickness measurement can be made more accurate if the vessels are separated from the actual nerve fibres by a reliable segmentation method. However, manual segmentation of small retinal structures like blood vessels is extremely time consuming, and reliability is limited due to inter- and intra-grader variability. Due to the huge amount of data to be analysed in a C-scan, it is practically impossible to perform segmentation tasks by an expert in clinical routine.

The human eye is a complex anatomical device that remarkably demonstrates the architectural wonders of the human body. Like a camera, the eye is able to refract light and produce a focused image that can stimulate neural responses and enable the ability to see. The human eye is a slightly asymmetrical sphere with an approximate sagittal diameter of 24 to 25 mm and a transverse diameter of 24 mm. the visual system allows us to organize and understand the many complex elements in our environment. The visual system consist of an eye that transforms light into neural signals, the related parts of the brain that process the neural signals and extract necessary information.[`1,2] The retina lines the interior of the posterior portion of the globe and is where images are formed.

Initial processing of the image occurs at this highly specialized sensory tissue. Vitreous is the clear gel that fills the posterior segment and serves to provide for light transmission through the eye and to protect the retina. The retina is a mostly transparent thin tissue designed to capture photons of light and initiate processing of the image by the brain. The average thickness of the retina is 250 μm and it consists of 10 layers.[9-12]

Blood vessel is one of the most important features in eye for detecting retinal vein occlusion, grading the tortuosities for hypertension and early diagnosis of glaucoma. The segmentation of blood vessels is an important pre-processing step for the early detection of retinal diseases. Because of multifarious nature of the vascular network, the manual vessel segmentation is very difficult and time consuming, so the researchers have proposed several automated methods for retinal vessel segmentation which are grouped as supervised and unsupervised based on the vessel classification techniques. In this project Fuzzy c-means method of segmentation is proposed.[3,4]

II. Methods

In the existing methods many techniques are used to segment the retinal vessels for diagnosing the diseases, but all

these existing methods have drawbacks. The processing time for the diagnosing the diseases is very high. Approximately the processing time is 11 minutes for the diagnosing the diseases.

In all the methods available for the diagnosis of diseases, Segmentation is the first and foremost step. So for the segmentation several algorithms were available. The simple and accurate algorithm Fuzzy c means was considered here. If segmentation is proper, we can get the better result for diagnosis of diseases.

III. Segmentation Using Fuzzy C Means Clustering

Clustering can be classified as either hard or fuzzy depending on whether a pattern data belongs exclusively to a single cluster or to several clusters with different degrees, In hard clustering, a membership value of zero or one is assigned to each pattern data, whereas in fuzzy clustering, a value between zero and one is assigned to each pattern by a membership function.[7,8]

Fuzzy-C-Means (FCM) clustering was developed by Bedeck. It can be described as follows: Let $X = \{x1, x2 \ldots xn\}$ denoted a set of n objects to be partitioned into C clusters, where each xj has d features. The FCM algorithm minimizes the objective

Function defined as follows:

$J=\sum_{i}^{c}$

uij represents the membership degree of jth object in the ith cluster,

vi represents the ith cluster center,

D represents a distance metric (generally the square of Euclidian distance) that measures the similarity between an object and a cluster center,

m ,the degree of fuzzyfication.[12]

The FCM algorithm can be summarized in the following steps:

Step 1: Fix the cluster number and initialize the centres by random points from data set.

Step 2: Update the membership degrees by using $Uij=(\sum^{c}(D(xjvi)/(D(xkvi)1/m\_1))\hat{}-1$

$k=1$

Step 3: Update centres using

$Vi=\sum^{n}(uij)\hat{}m(xj)/\sum^{n}(uij)\hat{}m$

$j=1$ $j=1$

Step 4: Repeat steps 2 and 3 until convergence. The convergence of this algorithm will be reached when the change

in membership values is less than a given threshold.

By considering the algorithm, the images can be classified into different clusters and the different parts of the images can be segmented. The obtained results have shown a significant improvement, especially regarding the robustness face to noise and the accuracy of the edges between regions.[5,6]

IV. Feature Extraction

The feature extraction is used to classify the normal and abnormal images.

The feature extraction may be extracted in two ways, 1.Morphological parameters.

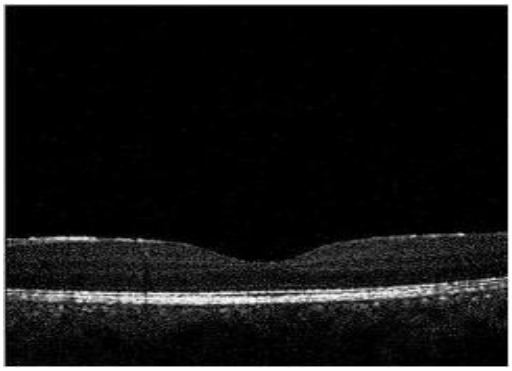
2. Statistical parameters.

In the proposed project, the parameter width is calculated to find the thickness of the retinal blood vessels.

V. Results

In this section, the results of the application of FCM algorithm over the image of retinal vessels of SD-OCT were presented.

This FCM algorithm was the extension of the K means algorithm. The membership function was mainly discussed in this algorithm. This insensitivity to the noise will provide a better result than the k means algorithm. In this case also the number of iterations will provide better results.



The above shown is the spectral domain-optical coherence tomography image of eye which is to be segmented using FCM technique. From this the retinal vessel is segmented using FCM technique.

The above Figure shows the result of applying FCM to the original image using as a clustering criterion the grey levels. This can resolve the problem such as sensitivity to cluster centroid and noise in the k means algorithm.

VI. Conclusion

Segmentation is the first and foremost step in the diagnosis of diseases. By this process the retinal blood vessels were segmented. The segmentation methods presented here provided segmentation of retinal blood vessels of human eye as a precursor to measure the diseases like glaucoma and diabetic retinopathy. Comparatively, the FCM segmentation provides a better result than the k means segmentation. It shows the difficulty in the choice of cluster centres and this was overcome by the FCM. The obtained results from FCM have shown a significant improvement of the performance compared to the k means algorithm.

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Corresponding Author:
K.Venkatraman*,
Email: venkatraman.bme@bharathuniv.ac.in