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Jini Cheriyan (Department of Electronics and Communication Engineering, TKM Institute of Technology)

Hema P Menon, K. A. Narayanankutty (Department of Electronics and Communication Engineering, Amrita School of Engineering)

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Author(s)

Jini Cheriyan
Department of Electronics and Communication Engineering, TKM Institute of Technology, Kollam, India
Email: ssj.jinu@gmail.com

Hema P Menon
Engineering,Amrita School of Engineering,Coimbatore, India
Email: p_hema@cb.amrita.edu

K.A Narayanankutty
Communication Engineering, Amrita School of Engineering,Coimbatore.
Email:ka_narayanankutty@cb.amrita.edu

Abstract

A major imaging technique for the eye is the fundus camera, and images obtained from this camera are 2D in nature**.** 2D image of retina does not give a realistic effect .3D modelling of the retina helps the surgeons to design an appropriate treatment plan and procedures prior to actual retinal surgery. Fundus image is a 2D data and OCT give intraretinal layer information. Fusing the depth information of OCT in to the fundus image, requires OCT data in to it. We have illustrated an ellipsoid based method to generate 3D visualization of the retina to view retinal surface exactly as a 3D image.

Keywords*:* 3D modelling, Fundus image, Optical coherence tomographic image, Image fusion, Texture mapping

Introduction

The key benefit of medical image processing is that it makes diagnosis possible in a non-invasive way. Medical imaging systems take input signals which arise from various properties of the body of the patient. The challenge is to obtain an output image that is an accurate representation of the input signal., and then to analyze it and extract as much as diagnostic information from the image as possible. A visual image is rich in information. 3D visualization technique is suitable for the display of complex structures, Kitara Kadhim(2009). The doctors can visualize a portion or area suspected to be infected by the disease in 3D view to examine the spread of the disease. Accurate diagnosis often requires a 3D image of retina. The analysis of the 3D shape of retinal fundus is required for identifying lesions and estimating the intensity of lesion. The produced 3D model of the eye can be used for studying the anatomy of the eye diagnosis of retinal disease, treatment planning and for educational purposes. A fundus camera is used to photograph the interior surface of the eye. Fundus image of human retina Provides physio-pathological information.and is used to detect exudates and haemorrhages. The observation of the fundus is useful not only for diagnosis of eye diseases but also for checking whole body conditions.

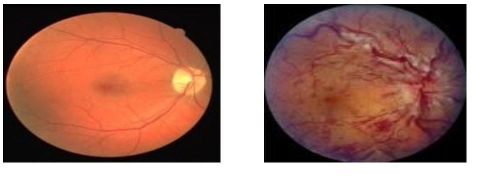

Figure-1 Fundus Images of Human Retina

The next section gives an idea about the existing algorithms available for enhancement purpose, section 3 describes the proposed methodology, section 4 presents the result/Analysis, The last section concludes the paper and outlines future work.

Background Study

Existing literature reveals that atleast a pair of retinal images are required for 3D reconstruction of the retinal image. In Choe et al (2006) paper, they have proposed a method which is a computer vision based approach that extracts the location of vessels bifurcation .For extracting vessel bifurcation plane and parallax method is used. Then estimates the fundamental matrix for nearly planar surface, the retinal fundus. The use of mutual information criteria is used for the estimation of the dense disparity maps, where the matched Y-features are used for estimating the bounds of the disparities range space. Y-feature is the most commonly used feature since it is easy to detect and well distributed in fluorescein images.

For reconstructing the 3D surface information of the human retinal fundus using a sequence of fluorescein angiograms is presented in F**.** Lalibertéa et al(2009) and K.Deguchi (2000) paper. And these angiograms are taken with an uncalibrated camera. The reconstructed 3D information indicates the 3D distribution of the fluorescein within the fundus of eye. This approach provides a way to extract 3D fluorescein distribution without using a stereo image acquisition setup. But this also require multiple views of fundus.

Another method for 3D reconstruction which is based on registration is discussed in paper Koichiro Deguchit et al (2000) .In this method first extract feature points from fundus images and find the correspondences between them. Then, those corresponding pairs are registered on a quadratic surface. Then find the parameters of the quadratic surface on which the registrations will be achieved. The positions and viewing directions of fundus camera to take the individual images are identified inorder to produce best of the corresponding point pairs. From the parameters of quadratic surface ,reconstruct the optical system of the single lens and the fundus sphere. Finally, the fundus patterns are back projected from the multiple images onto the reconstructed fundus sphere.

All methods available require multiple fundus images for processing. But a set of fundus does not give much information. In this paper ,a novel method for reconstruction of retinal image from single fundus image has been proposed.

Implementation Details

Data Set

This method was tried on 20 images taken from the DRIVE database. The size of the images are 565 x 584.

System Design

Given a single fundus image the proposed method generates a 3D ellipsoid model of retina which can be rotated in any directions for analysis. This method is based on the texture mapping of retinal fundus in to an ellipsoid surface generated by using the ellipsoid equation. The system diagram for the method is given in Figure2.

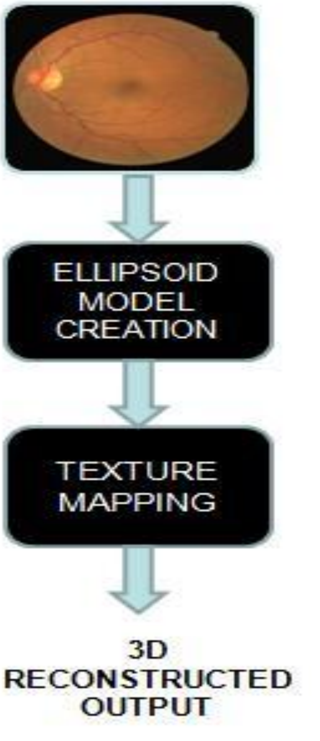

Figure-2: System Diagram

Ellipsoid is generated by using the equation(1)

Xc, Yc, Zc are the centers and Xr, Yr, Zr are semi- axis lengths

$$\frac{(X-Xc)^2}{Xr^2} + \frac{(Y-Yc)^2}{Yr^2} + \frac{(Z-Zc)^2}{Zr^2} \quad \text{--(1)}$$

Texture mapping is a method of mapping the surface texture or color to a 3D model. Here the texture of retinal fundus image is mapped on to the 3D ellipsoid model.

Algorithm

1. Set the surface face colour of fundus to texture map
2. Ellipsoid generates a surface mesh
3. Surf creates 3D shaded surfaces

Surf is a function used in matlab for creating 3D shaded surfaces.
This algorithm is implemented and executed in MATLAB version 7.10.0.

Results

Different views of the 3D reconstructed model is shown in Figure 4.

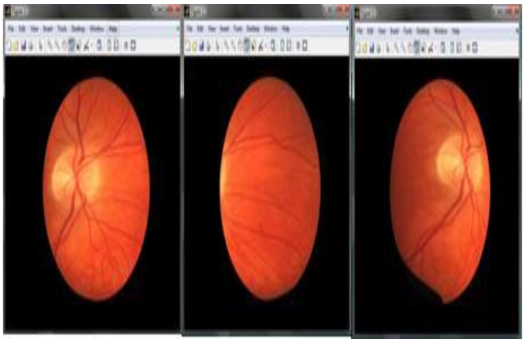

Figure -3: Rotated views of retinal fundus

Conclusion and Future works

3D reconstruction of retina from a single fundus image is a challenging task. In this paper 3D shape reconstruction of the retinal image based on texture maping of the fundus image in to an ellipsoid model has been implemented. The proposed method is fully automatic and it is possible to rotate the 3D model in any direction for getting all the views. Future work is focused on extracting the depth information of intraretinal layers from OCT image and fuse this depth information in to the produced 3D model.

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