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ENHANCED GLAUCOMA DETECTION ON RETINAL FUNDUS IMAGES THROUGH REGION GROWING ALGORITHM

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ABSTRACT

Glaucoma is a chronic eye disease which leads to vision loss. As it is very difficult to cure, detecting the disease in time is important, in fact it saves human life. Current tests of testing intraocular pressure (IOP) are not sensitive enough for population based glaucoma screening. Optic nerve head assessment in retinal fundus images is both more promising and superior. The work in this paper proposes optic disc and optic cup segmentation using region growing and men shift algorithm for glaucoma screening. A performance analysis has been performed based on the time of classification and based on amount of noise added into the images.Surround statistics, the location information is also included into the feature space to boost the performance. The proposed segmentation methods have been evaluated in a database consisting both healthy and glaucoma images with optic disc and optic cup boundaries manually marked by trained professionals. Experimental results are expected to show a better performance.

Keywords–*Fundus image, Classification, Region growing, Segmentation, ANN*

I. INTRODUCTION

Glaucoma is the name for a group of eye conditions in which the optic nerve is damaged at the point where it leaves the eye. This nerve carries information from the retina (the light sensitive layer in the eye) to the brain where it is perceived as a picture. The damage to the optic nerve in glaucoma is usually caused by increased pressure within the eye. This squeezes the optic nerve and damages some of the nerve fibres which leads to sight loss. Peripheral vision is the first area to be affected. But if glaucoma is left untreated, the damage can progress to eventual loss of central vision

In some cases of glaucoma, eye pressure may be within normal limits but damage occurs because there is a weakness in the optic nerve. This is known as normal or low tension glaucoma.

High pressure within the eye does not always result in glaucoma. A common condition is ocular hypertension, where eye pressure is above normal level but there is no detectable damage to the field of vision. This condition may simply be monitored or may be treated depending upon the consultant's view of the risk of developing glaucoma.There are two main types of glaucoma – chronic and acute. The most common is chronic, more

Formally known as primary open angle glaucoma. Here the channels that drain fluid from the eye become blocked over many years. The pressure in the eye rises very slowly and there is no pain to indicate that there is a problem. However, the optic nerve is being damaged and the field of vision gradually becomes impaired. Usually the damage does not occur in the same part of the field of vision in both eyes. One eye compensates for the other and a great deal of damage will have been done before the person realizes there is a problem with their sight.

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The second type of glaucoma, acute, is much less common. More formally known as primary angle closure glaucoma, this develops when there is a sudden and more complete blockage of aqueous fluid within the eye ad the pressure rises sharply. This tends to be very painful because the rise in pressure happens suddenly. It must be treated and in most cases a person's vision recovers completely. However, if treatment is delayed, there will usually be permanent damage to the eye.

Early detection is a particular problem in African/African Caribbean communities where fewer people have regular eye tests than in white communities. This applies particularly to older people who are at an even higher risk of developing the condition. Only 38 per cent of African/African Caribbeans over the age of 60 have a regular eye test against 68 per cent of the general population. [4].

In computer vision, segmentation refers to the process of partitioning a digital image into multiple regions (set of pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc) in images.

The result of image segmentation is a set of regions that collectively cover the entire image, or a set of contours extracted from the image. Each of the pixels in a region is similar with respect to some characteristic or computed property such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic.

Image segmentation is used in multimedia services for explicit information about content so that human observers can interpret images clearly by highlighting specific regions of interest. For example, if segmentation of important regions from the background areas can be automated, the subsequent quantizer can be optimized to allocate more resources in areas of interest..

II. EXISTING SYSTEM

The RNFL and SAP data vectors were processed further to generate the feature vectors. For each eye, the difference between the baseline RNFL and SAP data vectors (obtained by the first exam date) and each follow-up RNFL and SAP data vector were calculated. This way, we obtained a longitudinal time series of features for each subject's eye. For instance, if the data are collected from a subject at baseline and at 4 follow-up visits, the longitudinal data set for this subject has four time points and each time point has a corresponding 7-D RNFL and a 54-D SAP (threshold values at 52 test points, MD, and PSD) feature vector. This is shown in Fig. 2 in more detail. Fig. 2(a) shows sample RNFL and SAP measurements and indicates how the data vectors are formed. Fig. 2(b) shows the longitudinal data vectors for a single subject. The longitudinal feature vectors, which are the norm 1 difference between the baseline and follow-up data vectors, are displayed in Fig. 2(c).

Different combinations of the RNFL and SAP features were fed to the machine learning classifiers to assess their effectiveness and power in detecting glaucoma progression patterns and separating stable from progressed eyes over time.

III. PROPOSED METHOD

Region-growing algorithm

Segmentation is the subdivision of an image into separated regions. For many years, image segmentation has been a main research focus in the area of image analysis. Many different approaches have been followed, and each of them has its advantages and disadvantages. Region-growing is one of the most popular methods of image segmentation. Region growing algorithm is a bottom-up region-merging technique starting with one-pixel object. In numerous subsequent steps, smaller image objects are merged into bigger ones. Throughout this pairwise clustering process, the underlying optimization procedure minimizes the weighted heterogeneity of resulting image objects. The definition

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of heterogeneity consists of two parts: spectral heterogeneity and shape heterogeneity. The spectral heterogeneity is the sum of the standard deviations of spectral values in each layer weighted with the weights for each layer w_c.

$$h = \sum_c w_c x \sigma_c \quad (1)$$

The shape heterogeneity also consists of two parts:

smoothness and compactness.

Heterogeneity as deviation from a compact shape is described by the ratio of the border length l and the square root of the number of pixels forming this image object. Smoothness describes shape heterogeneity as the ratio of the border length l and the shortest possible border length b given by the bounding box of an image object parallel to the raster.

$$h = \frac{l}{b} \quad (2)$$

The spectral criterion is the change in heterogeneity that occurs when merging two image objects. The shape criterion is a value that describes the improvement of the shape with regard to compactness and smoothness of the resulting image object. The overall fusion value f is computed based on the spectral heterogeneity hcolorand the shape heterogeneity hshapeas follows:

$$f = wxh_{color} + (1-w)\, xh_{shape} \quad (3)$$

where w is the user defined weight for color (against shape) with 0≤w≤1.

In each step of merging, that pair of adjacent image objects is merged which stands for the smallest growth of the defined overall heterogeneity. If the smallest growth exceeds the threshold defined by the scale parameter, the process stops. Doing so, region-growing algorithm is a local optimization procedure . The overall heterogeneity measure includes both spectral and spatial information of image objects.However, many clustering based segmentation methods do not fully consider spatial information. A popular clustering technique, mean shift, is reviewed in the next section.

Mean shift algorithm

Feature space analysis is a widely used tool for solving low-level image understanding tasks. Given a color image, the RGB values of pixels are usually extracted as the feature vectors. The major problem in feature space analysis is finding the clusters in the feature space. Estimate of a cluster center is called in statistics the multivariate location problem. Numerous clustering techniques were proposed. Mean shift algorithm is an effective tool for the estimate of cluster centers. Mean shift algorithm has been successfully applied to image analysis by many researchers recently. Mean shift procedure is a nonparametric technique for estimation of the density gradient .

The proposed segmentation method

Although region-growing algorithm takes advantage of spatial information of image object effectively, it is a local optimization procedure as stated above. While mean shift technique is based on clustering in a global feature space. It is typically not able to separate different objects of interest of the same cluster in feature space. The information on which clustering can act is limited to spectral. Therefore, we can combine region-growing with mean shift clustering to make good use of their advantages. The combined method is composed of two steps.

First of all, an initial mask is defined by the user to start the region-growing algorithm is performed. Since the procedure involves spatial information of image objects, it may merge pixels that do not belong to the same cluster in feature space. This is beneficial to yield homogeneous image objects, which is difficult for clustering technique in feature space analysis. In order to determine the outcome of the region-growing segmentation algorithm, the user can define the scale parameter, which defines the break-up criterion. This

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process in done manually in our paper. The scale parameter is a measure for the maximum change in heterogeneity that may occur when merging two image objects . In the proposed segmentation method the scale parameter is set to a possible extent small value. The task of region growing is not to achieve the resulting segmented image.

Actually, after the process of mean shift we determine the region growing contour and we obtain an image that has homogeneous image objects. The generated image object primitives are handled in the sequent clustering process. In the second step, the final segmented image will be plotted in iteration based process.

Calculation of Euclidean distance is as follows.

$$EC = (x_1 - x_2)^2 - (y_1 - y_2)^2 \qquad (4)$$

The next step involves the calculation of the phi values with which we sort the pixels with the Euclidean distance between the values -1.2 to 1.2. Along with these values interior mean and exterior mean is calculated with phi less than 0 and greater than 0. This information is used to find out the force from the image information as follows

$$F = (I(idx) - u)^2 - (I(idx) - v)^2 \qquad (5)$$

where*u* is interior mean and *v* is exterior mean.

The neighbour pixels are then now sorted out for each pixel. In this way we find about 8 pixels nearby each pixel, as follows. Top, bottom, top left, top right, bottom left, bottom right, right and left Using this we find the rate of change of curvature shape is detected. A conventional mean shift clustering technique uses a fixed size search window to entire feature space. Using single bandwidth is not adaptive to a complex feature space with different distributions. To avoid the drawback of clustering using single bandwidth for the whole feature space, we utilize the adaptive mean shift algorithm improved by involving the neighborhood information of samples.The proposed segmentation method reduces the effect of local character of region-growing algorithm when segmenting image at a large scale. On the other hand, the method overcomes the shortcomings not fully using spatial information of clustering based segmentation techniques. Integrating region growing with mean shift clustering, the proposed method segments various images with convincing results.

IV. OUTPUTS

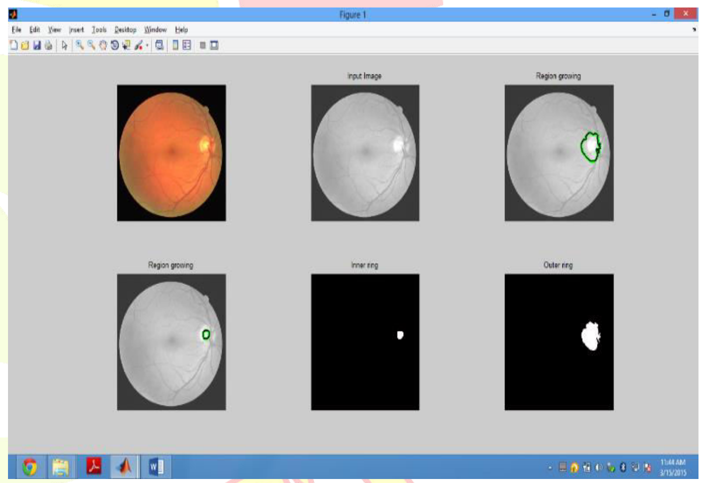

Figure1 : Over all segmented outputs

SNAPSHOT OF COMMAND WINDOW

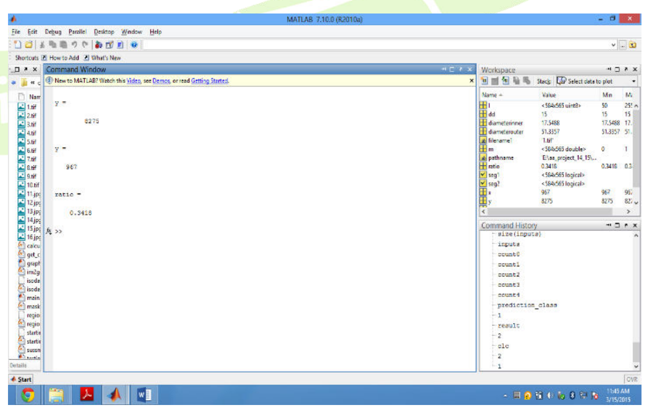

Figure2 : Snapshot of command window

V. CONCLUSION

Employing region growing in discriminating stable from progressing glaucoma eyes using structural retinal fundus image measurements is promising. Using the diameter of cup and disc, the ratio of cup to disc value will be a valid method of detecting glaucoma with just two features. To obtain high diagnostic accuracy and higher sensitivity at high specificity, we suggest RBF based classifier for positive and negative findings. Our experiments would reveal that this method will be highly suitable for diagnosis. Thus the project shows an efficient result can be detected using the optical cup and disc in texture based retinal image content. The trained values are then tested against a real time input image, for which our algorithm responds as “Healthy” or “Glaucoma”.

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