International Journal of Engineering Research and General Science Volume 3, Issue 1, January-February, 2015
ISSN 2091-2730

GLAUCOMA SCREENING USING SUPER PIXEL CLASSIFICATION BASED ON OPTIC DISC AND OPTIC CUP SEGMENTATION

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Abstract-Fundus imaging could be a common clinical procedure used to record a viewing of retina. The manual examination of optic disk (OD) could be a standard procedure used for detecting glaucoma. During this project, we have a tendency to describe a process to automatically locate the optic nerve in a retinal image. The optic nerve is one of the most important organs in the human retina. Locating the OD position in fundus image is sort of vital for several reasons. Abundant vital retinal pathology may affect the optic nerve. Since the OD could also be simply confounded with large exudative lesions by image analysis techniques. The method is predicted on the preliminary detection of the main retinal vessels. All retinal vessels begin from the OD and their path follows an analogous directional pattern (parabolic course) in all images. Glaucoma detection typically considers the medical history, intra-ocular pressure and field of vision loss tests of a patient together with a manual assessment of the OD, through ophthalmoscopy. Since enlargement of the cup with regard to OD is an vital indicator of glaucoma progression, various parameters are estimated and recorded to assess the glaucoma stage.

I INTRODUCTION

Glaucoma is one of the normal explanations for visual deficiency with concerning 79 million in the world likely to be afflicted with glaucoma by the year 2020. It is characterized by the progressive degeneration of optic nerve fibres and ends up in structural changes of the optic nerve head, which is additionally referred to as optic disk, the nerve fibre layer and a simultaneous functional failure of the visual field. Since, glaucoma is asymptomatic in the early forms and therefore the associated vision loss cannot be restored. Early detection and treatment of retinal diseases are crucial to avoid preventable vision loss. Digital colour fundus (retinal) image (CFI) has emerged as a most well-liked imaging modality for large scale eye screening programs due to its non invasive nature. The optic disk (OD) one among the most component of retina, is an crucial indicator for *glaucoma* which is one of the most common causes of blindness.

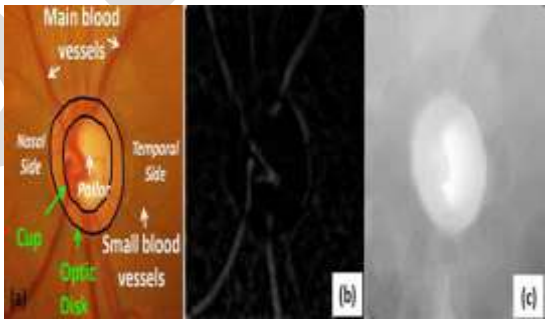

Fig 1: Retina image a) A sample cropped CFI region, b) A max image obtained by morphological closing, c) A vessel-free smooth image.

However, several glaucoma patients are unaware of the disease until it has reached its advanced stage. In Singapore, quite ninetieth of patients are unaware that they have this condition. In Australia, regarding five hundredth of individuals with glaucoma are

undiagnosed. Since glaucoma progresses with few signs or symptoms and also the vision loss from glaucoma is irreversible, screening of people at high risk for the malady is vital.

The glaucoma are classified by the appearance of the iridocorneal angle. There are open-angle, closed-angle, and developmental categories, which are further divided into primary and secondary types. Primary open angle glaucoma can occur with or while not elevated intraocular pressure; the latter is typically known as normal- tension glaucoma. Primary open-angle glaucoma includes each adult onset disease (occurring after 40 years of age) and juvenile-onset disease (occurring between the ages of 3 and 40 years of age). Samples of secondary open-angle glaucoma's embody those associated with exfoliation or pigment dispersion syndrome. Closed-angle glaucoma are often primary (e.g., papillary block) or secondary (e.g., inflammatory or neovascular causes). Developmental forms of glaucoma include primary congenital glaucoma and glaucoma associated with syndromes (e.g., aniridia or the AxenfeldRieger syndrome). Primary open-angle glaucoma, the predominant form of glaucoma in Western countries, most likely comprises several clinically indistinguishable diseases.

There are three methods to detect glaucoma:

(1) Assessment of raised intraocular pressure (IOP),

(2) Assessment of abnormal visual field,

(3) Assessment of damaged optic nerve head.

The IOP measurement using non- contact tonometry (also known as the"airpufftest") is neither specific nor sensitive enough to start effective screening tool because glaucoma can be present with or without increased IOP. Color fundus imaging (CFI) is another modality that may be used for glaucoma analysis. It has risen as a favoured modality for large-scale retinal disease screening and has already been established for large-scale diabetic retinopathy screening. It is possible to acquire fundus images in an exceedingly non invasive manner which is suitable for large scale screening. To handle this, morphological based pre processing step is employed to suppress the vessel prior to template matching. Assessment of the damaged optic nerve head is each extra guaranteeing, and higher than IOP estimation or visual field testing for glaucoma screening.

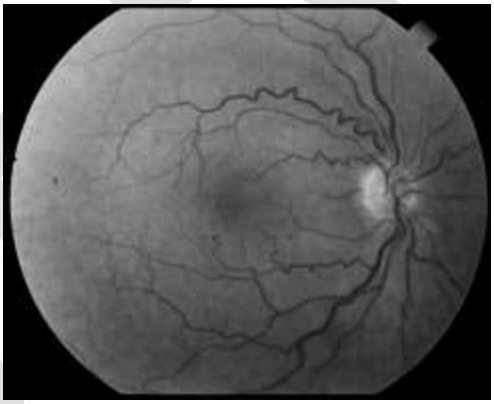

Fig 2: Retinal fundus image with vessels and OD (bright round shape on the right-hand side).

The optic disc (OD), which in fundus images typically appears as a spherical region brighter than the surrounding, is the image of the optic nerve. From it, the central retinal artery and vein emerge, to cover, with most branching, most of the retinal region. Locating the OD position in fundus images is quite vital reasons. Much important retinal pathology might have an affect the optic nerve. Since the OD could also be easily confounded with large exudative lesions by image analysis techniques, its detection is additionally important to exclude it from the set of potential lesions. Moreover, OD detection is fundamental for establishing a frame of reference inside the retinal image and is, thus, important for any image analysis application.

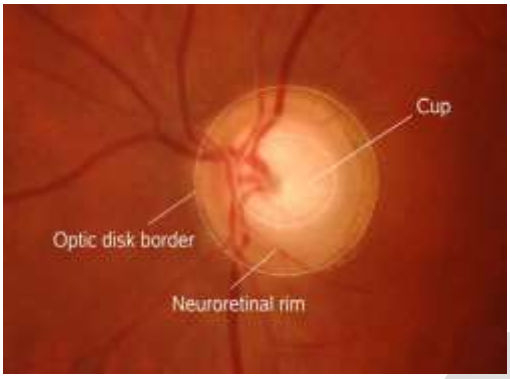

Fig 3: Major structures of the optic nerve head that are visible in color fundus photographs

The optic disk is margined by the optic disk border and may be divided into major zones:

(i)The neuro retinal rim is consist of astrocytes and nerve fibres whereas

(ii) The brighter cup or excavation completely consists of supporting tissue.

One strategy for automatic optic nerve head assessment is to use image features for a binary classification between glaucomatous and healthy subjects. These features are usually computed at the image-level. In these ways, choice of features and classification strategy is difficult and challenging [10]. The opposite strategy is to follow the clinical indicators. Several glaucoma risk factors are thought-about, such as the vertical cup to disc ratio (CDR) disc diameter], ISNT rule, peri papillary atrophy (PPA), notching, etc. Though different ophthalmologists have different opinions on the quality of those factors, CDR is well accepted and commonly used. A larger CDR indicates a better risk of glaucoma. There has been some analysis into automatic CDR measurement from 3-D images. Moreoever, because 3-D images are not easily available, 2-D color fundus images are still referred to by most clinicians.Moreover, the high cost of obtaining 3-D images makes it inappropriate for a large-scale screening program. This paper focuses on automatic glaucoma screening victimization CDR from 2-D fundus images. The optic nerve head or the optic disc (in short, disc) is the location wherever ganglion cell axons exit the attention of the eye to form the optic nerve, through which visual information of the photo receptors is transmitted to the brain. In 2-D pictures, the disc may be divided into two distinct zones; specifically, a central bright zone called the optic cup (in short, cup) and a peripheral region referred to as the neuroretinal rim.

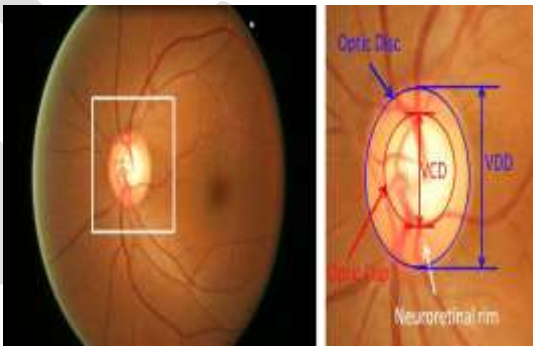

Fig4: Major structures of the optic disc.

Figure1.4 shows the foremost structures of the disc. The region fencelike by the blue line isthat the optic disc; the central bright zone enclosed by the red line is that the optic cup; and also the region between the red and blue lines is the neuroretinal rim.

The CDR is computed because the quantitative relation of the vertical cup diameter (VCD) to vertical disc diameter (VDD) clinically. Accurate segmentations of disc and cup are essential for CDR measurement. Several methods have been proposed for

automatic CDR measurement from 2-D fundus images. This paper proposes super pixel classification based disc and cup segmentations for glaucoma screening. Aidentcal concept has been used for vessel segmentation.

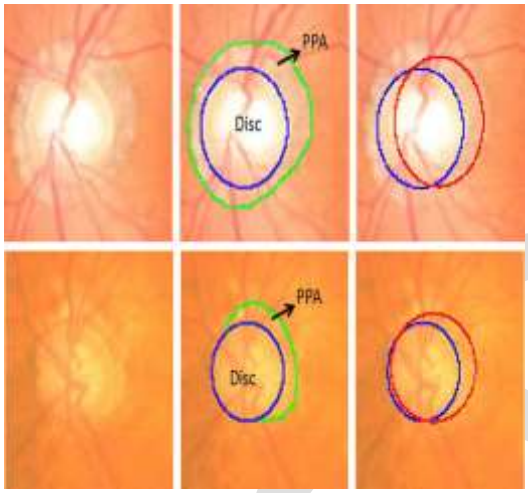

Fig 5: Challenge in disc segmentation.

Blue lines: manual disc boundary; red lines: automated disc boundary within the first and second example, respectively; green lines: the PPA boundary.

We compute center surround statistics from super pixels and unify them with histograms for disc and cup segmentation. We tend to incorporate previous information of the cup by including location information for cup segmentation. Based on the segmented disc and cup, CDR is computed for glaucoma screening. In addition, the proposed method computes a self-assessment reliability score for its disc segmentation result. Self-assessment is an crucial issue that has previously seldom been discussed in disc segmentation. In practice, an automated segmentation method might work well for most images whereas operating poorly for the rest. Therefore, it is important to have self-assessment where users are warned of cases with potentially large errors.

II. PROPOSED SYSTEM

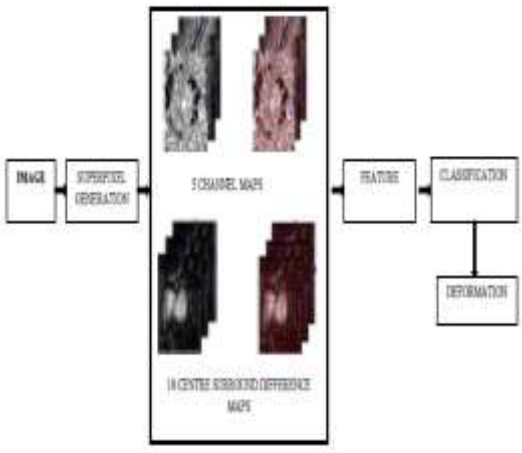

Fig 6: Superpixel based optic disc segmentation. Each image is divided into superpixels. From 18 center surrounded difference maps and five channel maps the features computed are used to classify the superpixels as disc or non-disc. In the feature map the jth column corresponds to the feature for the jthsuperpixel.

III. IMAGE SEGMENTATION

The next stage deals with segmentation. Segmentation partitions associate degree input image into its small constituent parts or objects. In general, autonomous segmentation is one among the foremost difficult tasks in digital image processing. On the one hand, a rugged segmentation procedure brings the process a long way towards the successful solution of an imaging drawback. On the other hand, weak or erratic segmentation algorithms virtually guarantee eventual failure. In terms of character recognition, the key role of segmentation is to extract individual characters and words from the background.

IV.SUPER PIXEL GENERATION

This paper uses the simple linear iterative clustering algorithm (SLIC) to aggregate nearby pixels into super pixels in retinal fundus images. Compared with other super pixel methods, SLIC is fast, memory efficient and has excellent boundary adherence. SLIC is additionally easy to use with just one parameter, i.e., the quantity of desired super pixels. Here we give a brief introduction of the SLIC algorithm while more details of the algorithms will be found within the SLIC.

SLIC uses the similar compactness parameter for all super pixels within the image. If the image is smooth in certain regions but highly rough-textured in others, SLIC produces smooth regular-sized super pixels in the smooth regions and highly irregular super pixels in the textured regions. So, it become tough choosing the right parameter for every image. The benefits of high boundary recall and low under segmentation error over SLIC super pixel on small numbers super pixels.

V. OPTIC DISC SEGMENTATION

The localization focuses on finding a disc pixel, very often the center. It has been extensively studied for applications in diabetic screening [23], [24]. Our work focuses on the segmentation drawback and therefore the disc is located by our earlier method in which works well in our data set for glaucoma screening as there are few white lesions to confuse disc localization as compared to diabetic screening. The segmentation estimates the disc boundary, that been a challenging task due to blood vessel occlusions, pathological changes around disc, variable imaging conditions, etc. The deformable model technique through reduction of the energy function:

- Image intensity,
- Image gradient, and
- Boundary smoothness.
- A level set is employed to estimate the disc followed by an ellipse fitting to smooth the boundary.

A) TEXTURE FEATURES

- Edge detection and
- Circular Hough transform are combined with an active shape model to extract the disc.

In addition, we have a tendency to conjoint a super pixel classification based approach using histograms.

- Super pixel Generation

B) FEATURE EXTRACTION

CONTRAST ENHANCED HISTOGRAM

Many features like color, appearance, gist, location and texture will be extracted from super pixels for classification. Since color is one of the main differences between disc and non-disc region, color histogram from super pixels is an intuitive alternative.

CENTER SURROUND STATISTICS

As we tend to delineated earlier, the PPA region appearance to be close to the disc. It is vital to incorporate features that reflect the distinction between the PPA region and the disc region.

The histogram of each super pixel does not work well because the texture variation within the PPA region is often from a larger area than the super pixel. This is because the super pixel often consists of a group of pixels with similar colours. Inspired by these observations, we tend to propose center surround statistics (CSS) from super pixels as a texture feature.

The center surround statistics (CSS) consists of the

- Mean and
- Variance

C) FINAL FEATURE

Since the texture feature from the PPA region is usually involved in a large region, the features from neighbouring super pixels are also considered in the classification of the present super pixel.

V. OPTIC CUP SEGMENTATION

Detecting the cup boundary from 2-D fundus images without depth information is a difficult task as depth is that the primary indicator for the cup boundary. In 2-D fundus images, one landmark to determine the cup region is that the pallor, defined as the area of maximum color contrast inside the disc.

A) FEATURE EXTRACTION

The feature extraction method is summarized above. After obtaining the disc, the minimum bounding box of the disc is employed for cup segmentation. The histogram feature is computed similarly to that for disc segmentation, except that the histogram from the red channel is not any longer used. This is because there is little information regarding the cup in the red channel.

B) SUPER PIXEL CLASSIFICATION FOR OPTIC CUP ESTIMATION

A mean filter is applied on the decision values to calculate smoothed decision values. Then the smoothed decision values are used to acquire the binary decisions for all pixels. The largest connected object is obtained and its boundary is used as the raw estimation.

VI. CUP TO DISC RATIO

After obtaining the disc and cup, various features can be computed. We have a tendency to follow the clinical convention to compute the CDR. As mentioned in the introduction, CDR is a very important indicator for glaucoma screening computed as.

$$CDR = \frac{VDD}{VCD}$$

The computed CDR is employed for glaucoma screening. When CDR is greater than a threshold, it is glaucomatous.

VII. RESULT

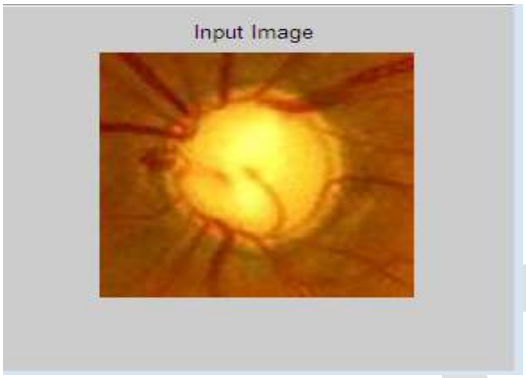

Fig 7: Input Image

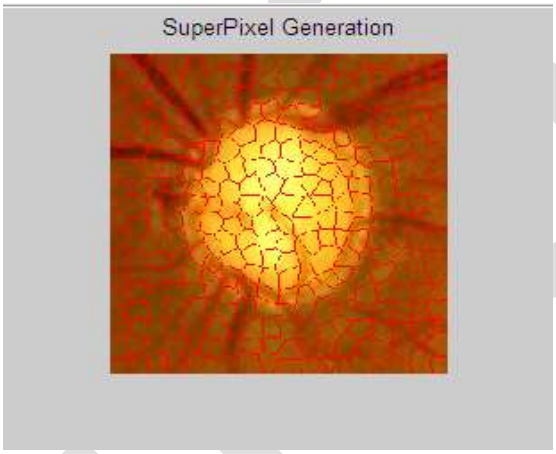

Fig 8: Superpixel Generation

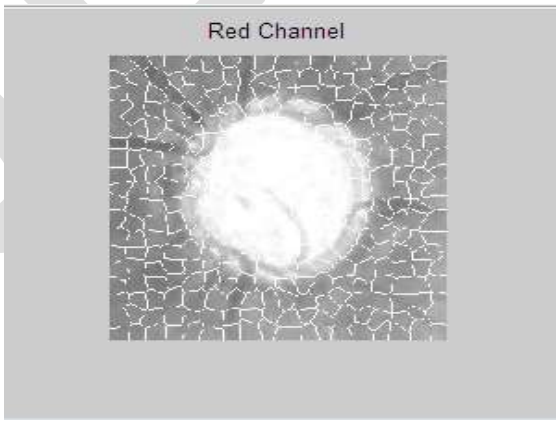

Fig 9: Red Channel

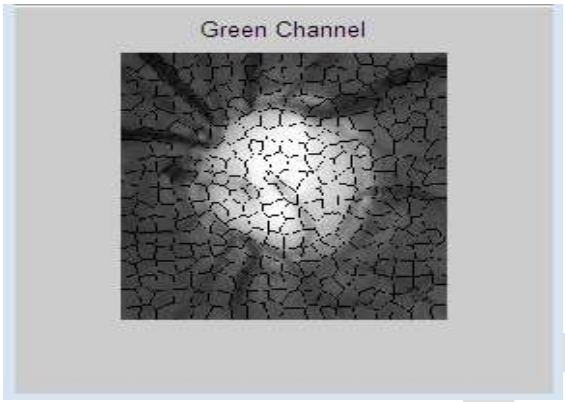

Fig 8: Green Channel

Fig 9: Blue Channel

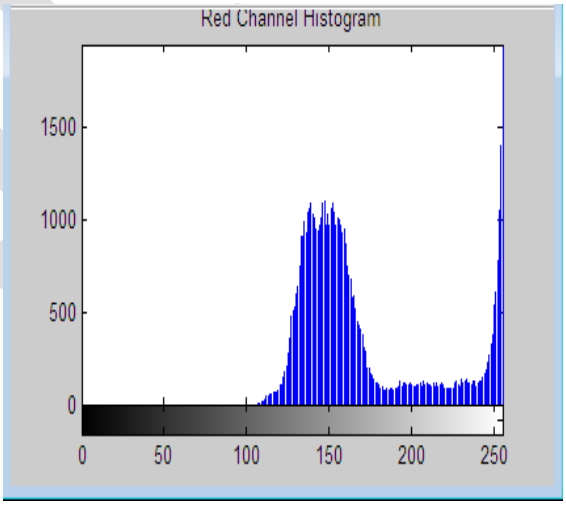

Fig 10: Red Channel Histogram

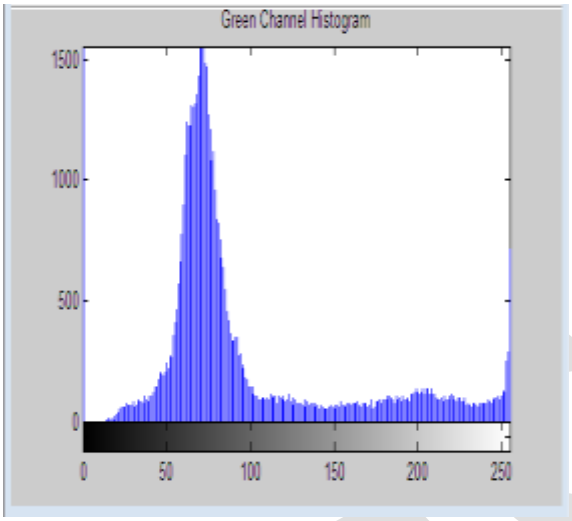

Fig 11: Green Channel Histogram

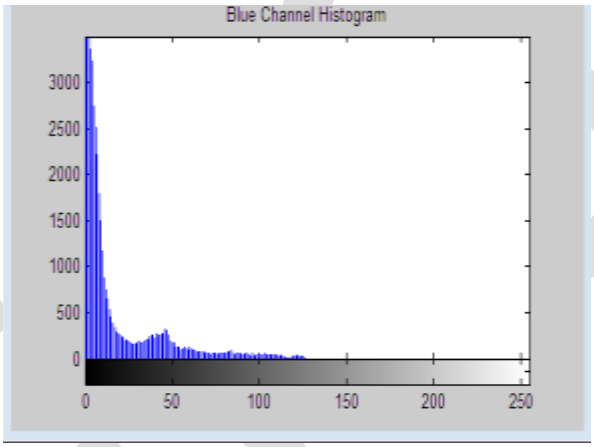

Fig 12: Blue channel Histogram

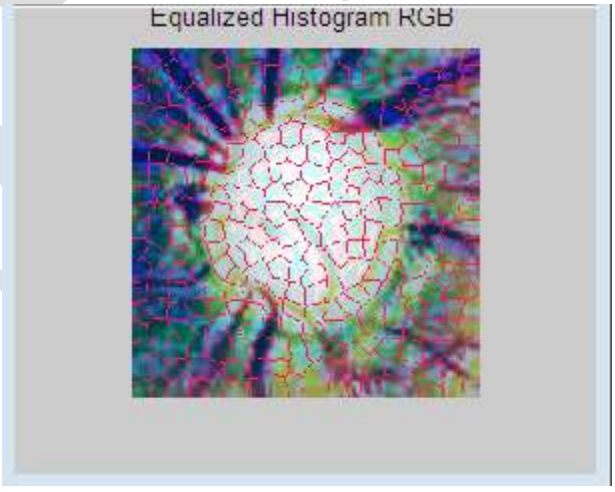

Fig 13: Equalized Histogram RGB

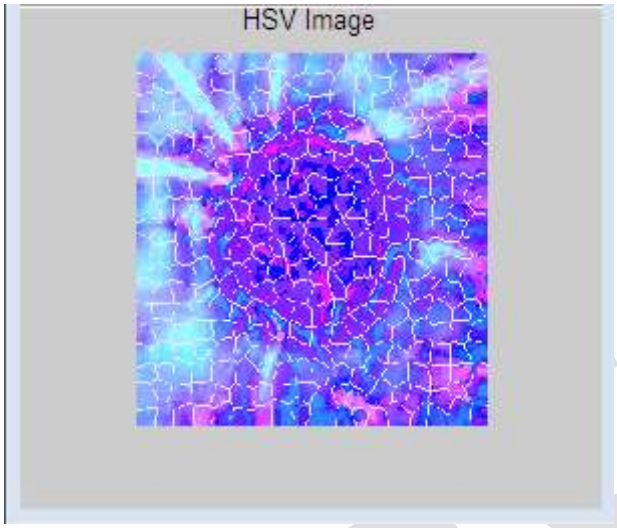

Fig 14: HSV Image

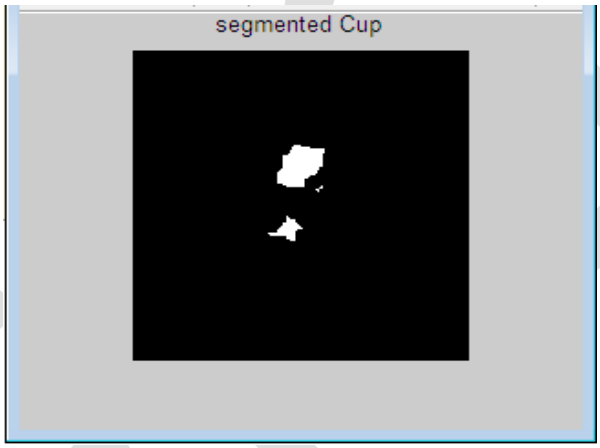

Fig 15: Segmented Cup

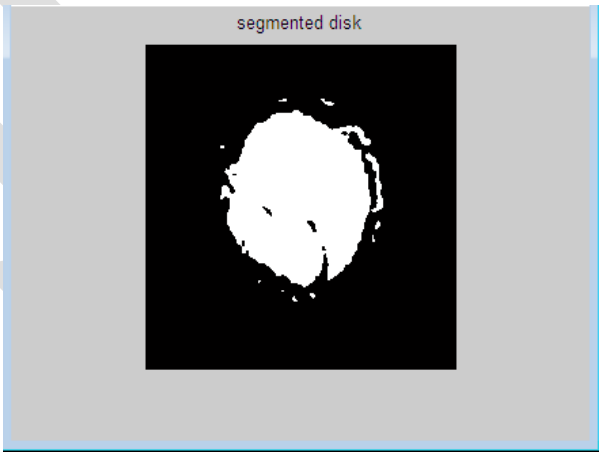

Fig 16: Segmented Disk

VIII. CONCLUSION

Based on the super pixel classification Optic disc and Optic cup are segmented for Glaucoma screening. Thus the image is segmented and equalized to determine the Optic disc and Optic cup value. To find the optic disc and optic cup value from the optic disc segmentation and optic cup segmentation respectively. Using optic disc value and optic cup value cup to disc ratio are going tol be evaluated and the glaucoma disease will be determined automatically.

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