



# **Automatic Localisation of Blood Vessels, Optic Disc and Optic Cup using Selfish Gene Algorithm**

R.Abirami<sup>1</sup>, S.Velmurugan<sup>2</sup>, J.Ezhilarasi<sup>3</sup>

Associate Professor, Dept. of ECE, Krishnasamy College of Engg. and Technology, Cuddalore, Tamilnadu, India<sup>1</sup>

Assistant Professor, Dept. of Mechanical Engg, CK College of Engg. and Technology, Cuddalore, Tamilnadu, India<sup>2</sup>

PG Student [EST], Dept. of EEE, Krishnasamy College of Engg. and Technology, Cuddalore, Tamilnadu, India<sup>3</sup>

**ABSTRACT:** Automated fundus image analysis plays an important role in the computer aided diagnosis of ophthalmologic disorders. Many important eye diseases as well as systemic diseases manifest themselves in the retina. The most prevalent causes of blindness in the industrialized world are age-related macular degeneration, diabetic retinopathy, and glaucoma. Glaucoma is an eye disease which occurs due to the increased fluid pressure inside the eye. The pressure inside the normal eye is below 21mm of Hg. When the pressure inside the eye(s) increases more than 21mm of Hg, the optic nerve get damaged. This can permanently damage the vision in the effected eye(s) and can lead to blindness, if left untreated. The aim of this paper is to segment and locate the blood vessels, optic disc and optic cup for identifying glaucoma. The blood vessels are segmented by using prewitt edge detection. The optic disc and optic cup are segmented by using gradient algorithm. The features like shape, area and size of optic disc and optic cup are extracted and the cup-to-disc ratio(CDR) is calculated. To detect glaucoma, the CDR of normal person image and CDR of affected person image is calculated and compared. If the CDR of input person image exceeds the CDR of normal person image, then it is confirmed that the person is affected by glaucoma. Then the level of glaucoma is identified.

**KEYWORDS:** optic disc, optic cup, blood vessels, CDR, glaucoma.

## **I. INTRODUCTION**

Glaucoma is one of the normal explanations for visual deficiency with about 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 fibers and leads to structural changes of the optic nerve head, which is also referred to as optic disk, the nerve fiber layer and a simultaneous functional failure of the visual field. Since, glaucoma is asymptomatic in the early forms and the associated vision loss cannot be restored, its early detection and subsequent treatment is essential to prevent visual damage. 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 be an effective screening tool because glaucoma can be present with or without increased IOP. Color fundus imaging (CFI) is another modality that can be used for glaucoma evaluation. It has risen as a favored 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 a non-invasive manner which is suitable for large scale screening. To handle this, morphological-based preprocessing step is employed to suppress the vessel prior to template matching. The optic nerve is one of the most important organs in the human retina. The central retinal arteries are going from the central vein of the retina through the optic nerve, by the outer layers of the retina with the blood. The optic nerve also works as intermediate for the flow of information between the eye and the brain. The optic nerve can be examined in a visualization of retinal images. The Retinal image is an interior surface of the eye, including the retina, optic disc and macula etc. Retinal imaging is a common clinical procedure used to record a visualization of the retina. The image can be used for diagnosis, treatment, evaluation and maintenance of medical history.



# International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 4, April 2015

Optic Disc connects eye and brain acts as a conduit, transmitting visual information from light sensitive cells of retina to brain. It is also the entry point of major blood vessel that supplies blood to retina. Glaucoma and Diabetic retinopathy are sight threatening diseases which in severe stage causes blindness. So, optic disc detection is an important step for diagnosis of these two diseases as well as some other diseases related to retina. Changes in optic disc shape and area may indicate disease progression. In case of glaucoma detection, the optic cup-to-disc ratio (CDR) determines whether the person is suffering from glaucoma or not. The risk of glaucoma increases dramatically with age, but it can strike any group, even newborn infants and fetuses.

## GLAUCOMA DEFINITION

Glaucoma is a term describing a group of ocular (eye) disorders resulting in optic nerve damage or loss to the field of vision, typically caused by a clinically characterized pressure buildup in regards to the fluid of the eye (intraocular pressure-associated optic neuropathy). Glaucoma has been called the silent thief of sight.

## TYPES

1. Closed angle glaucoma
2. Primary open angle glaucoma (chronic glaucoma)
3. Low-tension glaucoma
4. Pigmentary glaucoma

## SIGNS AND SYMPTOMS

### Primary open-angle glaucoma

- Peripheral vision is gradually lost. This nearly always affects both eyes.
- In advanced stages, the patient has tunnel vision.

### Closed angle glaucoma

- Eye pain, usually severe
- Blurred vision
- Eye pain is often accompanied by nausea, and sometimes vomiting
- Lights appear to have extra halo-like glows around them
- Red eyes
- Sudden, unexpected vision problems, especially when lighting is poor.

## RISK FACTORS LINKED TO GLAUCOMA

- Certain ethnicities: Glaucoma is six to eight times more common in African-Americans than in Caucasians.
- Mexican-Americans, Asian-Americans and Japanese-Americans are also at an increased risk.
- Over 60 years old
- Chronic diseases
- Family history
- Eye injury and nearsightedness
- Use of corticosteroids

## PREVENTIVE MEASURES

- Get regular eye care
- Treat elevated eye pressure
- Eat a healthy diet
- Wear eye protection glass

## II. GENERAL TERMINOLOGY

**Selfish Gene Algorithm:** It act selfish in taking only the necessary for it from the algorithms in order to achieve high efficiency, throughput and accuracy.

**Gradient Algorithm:** To improve intensity of an image for segmentation.

# International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 4, April 2015

**Cup to Disc Ratio:** To compare the features of the Optic Disc and Optic Cup for detecting the presence of glaucoma.

### III. RELATED WORK

In Year 2010, Zhuo Zhang performed a work, "ORIGA-light : An Online Retinal Fundus Image Database for Glaucoma Analysis and Research"[8]. Author present an online dataset, ORIGA-light, which aims to share clinical retinal images with the public. Author had updated the system continuously with more clinical ground-truth images. In Year 2012, Nilan jan Dey performed a work, "Optical Cup to Disc Ratio Measurement for Glaucoma Diagnosis Using Harris Corner"[11]. In this paper, CDR is determined using Harris Corner. Harris corner detector measures the local changes of the signal with patches shifted in different directions by a small amount. It is based on the local auto-correlation function of a signal. In Year 2012, R. Geetha Ramani performed a work, "Automatic Prediction of Diabetic Retinopathy and Glaucoma through Retinal Image Analysis and Data Mining Techniques"[5]. This paper proposed a novel approach for automatic disease detection. Retinal image analysis and data mining techniques are used to accurately categorize the retinal images as either Normal, Diabetic Retinopathy and Glaucoma affected. In the proposed system, prewitt edge detection, gradient algorithm and cup-to-disc ratio are used to overcome this problem and accuracy is more when compared to the existing system.

### IV. PROPOSED SYSTEM

There are about 20 images are taken. The various sizes of RGB images are resized universally into 512\*512 size images, and converted into gray scale and then binary image. From the binary image, the blood vessels are segmented by using prewitt edge detector.

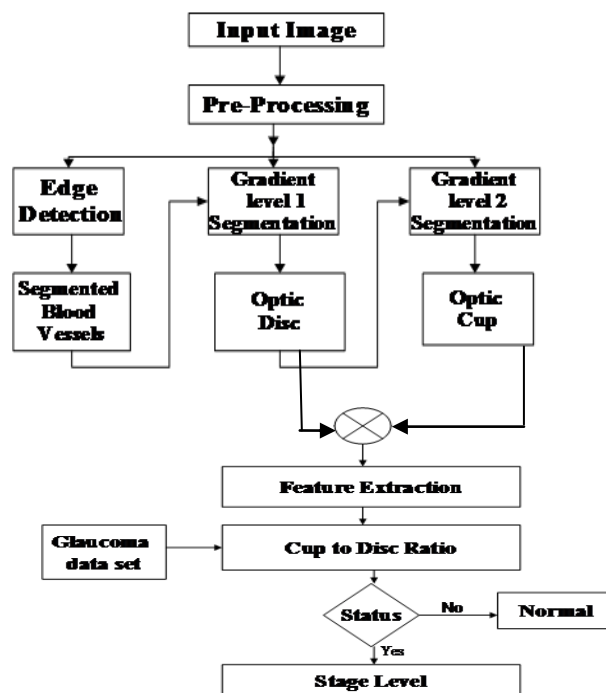


Figure 1 Flowchart of the proposed system

Figure shows the flowchart of the proposed system which is used to find the glaucoma disease.

# International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 4, April 2015

There are about 20 images are taken. The various sizes of RGB images are resized universally into 512\*512 size images, and converted into gray scale and then binary image. From the binary image, the blood vessels are segmented by using prewitt edge detector. The threshold level is set for the intensity level of the binary image.

Because the optic disc is in yellowish colour. To avoid the confusion, threshold level is set to segment optic disc and optic cup. The region segmentation algorithm is used to segment the region of optic disc and optic cup. By using gradient level, the optic disc and optic cup are segmented. From the segmented image, the features like size, shape and area of optic disc and optic cup are extracted. The cup to disc ratio is calculated by using these features. C/D ratio is measured by using the cup edge and disc region. The normal cup-to-disc ratio is 0.3. The ratio will be high for the glaucoma affected image. This ratio is compared with the database which consists of cup to disc ratio for normal and glaucoma images. If the status is yes, the output is, the given image has glaucoma stage level. Then the three levels of glaucoma are to find. Otherwise, it gives the output as, the image is normal.

## V. WORKING OF THE ALGORITHM

### SELFISH GENE ALGORITHM (SGA)

In 1998, Corno has proposed the selfish gene algorithm (SGA) where the survival of the fittest is considered a battle fought by genes not between individuals. The population here is like a storeroom of genes denoted by virtual population. The algorithm evolves reproducing its effect on the statistical parameters of a virtual population related with allele's frequencies in the same gene group. Some authors proposed a novel class of evolutionary algorithms denoted by estimation of distribution algorithms (EDAs) together with the selfish gene theory. In these approaches the new candidate solutions are generated by sampling from statistically promising solutions without using mutation and crossover operators. The learning procedure is based on mutual information of genes performance.

### BLOOD VESSELS SEGMENTATION

#### Prewitt edge detection

The Prewitt filter is a discrete differentiation operator. It is a correct way to estimate the magnitude and orientation of an edge in given image. Prewitt edge detection is simpler to implement computationally than Sobel edge detection. The compass edge detection obtains the direction directly from the kernel with highest response. The gradient edge detection of Prewitt is limited to eight possible directions. The operator uses two 3x3 kernels. Also, the edge detection is estimated in these 3x3 neighborhood for eight directions. The kernels of Prewitt are convolved with the original image to calculate approximations of the derivatives.

-1	-1	-1
0	0	0
1	1	1

1	0	1
-1	0	1
-1	0	1

Figure2 Prewitt mask used for detecting edges

Figure shows the prewitt mask used for detecting edges of the input image.

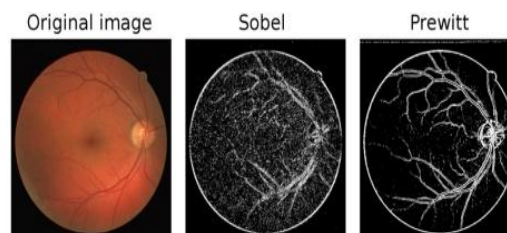


Figure 3 Comparison of sobel and prewitt edge detector

Figure shows the edge detection images of sobel and prewitt edge detection methods.

# International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 4, April 2015

## OPTIC DISC AND OPTIC CUP SEGMENTATION

The presence of blood vessels that run on the outline of the optic disc makes accurate extraction of its outline difficult. The optic disc region tends to be comparatively brighter. Thus, the approximate region of the optic disc was extracted by using the gradient level segmentation method on each red, green, and blue component image, and the optic disc region was determined by using an image combining these three binary images. Then, the area of the 512\*512 pixel image, centered on the optic disc thus determined was extracted as the region for analysis. An RGB color image was converted to an intensity image, and the pixel values were normalized. The change in intensity (brightness) is usually high at the outline of the optic disc; thus region segmentation is used to detect the edges of optic disc and optic cup.

The algorithm is described as follows:

1. First take input image as jpeg format for segmentation and localization of optic nerves of retinal image.
2. Apply Euler remapping or Gaussian function as smoothing filter for removing noise and blur reassembling.

$$e^{j\theta} = \cos \theta + j \sin \theta$$

$$G(x, y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

Where,  $\sigma$  is standard deviation of Gaussian distribution,  $x$  is distance from the origin in horizontal axis,  $y$  is distance from the origin in vertical axis,  $e$  is Euler no.

3. Define initial level contour for introducing curve around the object to be detected.

$$\{ (x) \ \emptyset \ (x; t = 0) = 0 \}$$

### Steps of gradient algorithm

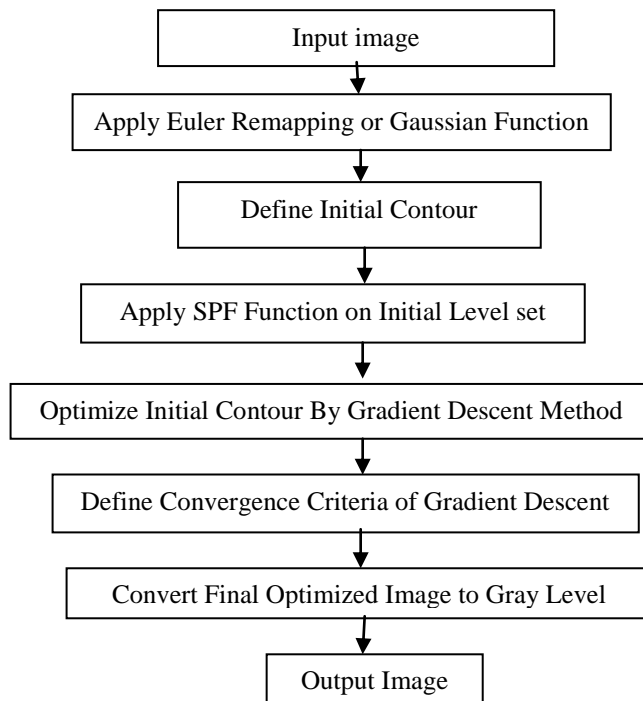


Figure 4 Steps of gradient algorithm

Figure shows the step by step procedure of gradient algorithm for optic disc and optic cup segmentation.

# International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

**Vol. 4, Issue 4, April 2015**

4. Apply SPF function on initial level set for modulates the sign of pressure force inside and outside the region of interest based on minimizing and maximizing the energy function of curve.

$$SPF(I(x)) = \frac{I(x) - \frac{C1 + C2}{2}}{\text{Max}\left(|I(x) - \frac{C1 + C2}{2}|\right)}$$

$$\text{Min}(I(x)) < \frac{C1+C2}{2} < \text{Max}(I(x)), x \in \Omega$$

$$\frac{\partial \phi}{\partial t} = SPF(I(x)) \cdot \left[ \text{div} \left( \frac{\nabla \phi}{|\nabla \phi|} \right) + \alpha \right] |\nabla \phi| + \nabla SPF(I(x)) \cdot \nabla \phi, x \in \Omega$$

Where, C1 and C2, are two constants which are the average intensities inside and outside the contour,  $\Omega$  is planer curve.

5. Optimize initial contour of Gradient Descent method for local minimization of function.

$$b = a - r \nabla f(\phi)$$

$$f(\phi) = \alpha(x_i - y_i)^2 + \beta(y_i - y_{i+1})^2 + \beta(y_i - y_{i-1})^2$$

6. Define Convergence criteria of gradient descent through convergence ratio

$$\nabla \phi(t_n) = \frac{\phi(t_{n+1}) - \phi(t_n)}{\Delta t}$$

7. Convert final optimized image to gray level set

$$\phi(I) = \frac{1}{1 + (|\nabla I| * \phi).2}$$

$|\nabla I| * \phi$  = difference of smoothened image

8. Finally obtained output image

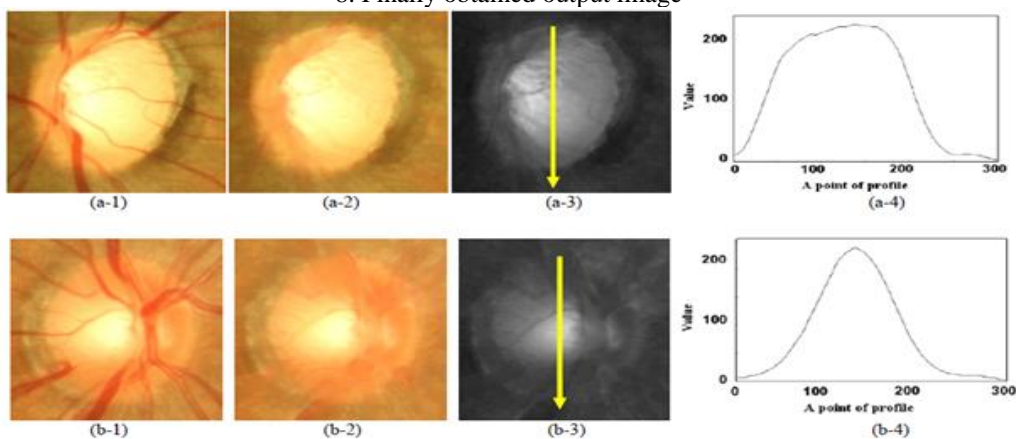


Figure 5 Output image

Figure (a-1,2,3,4) shows glaucoma affected image, (b-1,2,3,4) shows normal image and the arrow shows the location of the obtained profile

# International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 4, April 2015

## DETERMINATION OF CUP-TO-DISC RATIO

The vertical C/D ratio is most important factor for diagnosis of glaucoma, because the contrast of the cup region and the rim one was high. Here, glaucoma cases tend to have enlarged cup regions as against the normal cases. (In other words, the bright region is extended in many cases.) Thus, while comparing the optic disc profiles, the profile for normal cases tend to appear as a narrow mountain with long skirts, while that for glaucoma cases appears as a broad mountain with short skirts, as shown in Figure. The images were preprocessed before obtaining the profile. First, a blood-vessel-erased image was created. Since there is high contrast between the cup and disc regions in the blue channel of a color image, a blue component was used for subsequent analysis. Thus, the fundus image is classified into the right and left image by comparing the pixel value in right and left side of an optic disc region, because the nose side of an optic disc was then averaged so that the result would not depend on the specific line selected. This profile was smoothed as shown in Figure (b), and impulses if any were removed, in order to reduce the effect of noise and remaining blood vessels. After that, we determined the skirt region of the profile as the rim region. The skirt region was determined by the empirical threshold value of profile (as shown in Figure (c)). The edge of the skirt region and mountain one was determined as the cup edge. Finally, C/D ratio was measured by using the cup edge and disc region. CDR is the ratio between the Vertical Cup Diameter (VCD) & Vertical Disc Diameter (VDD).

$$CDR = VCD/VDD$$

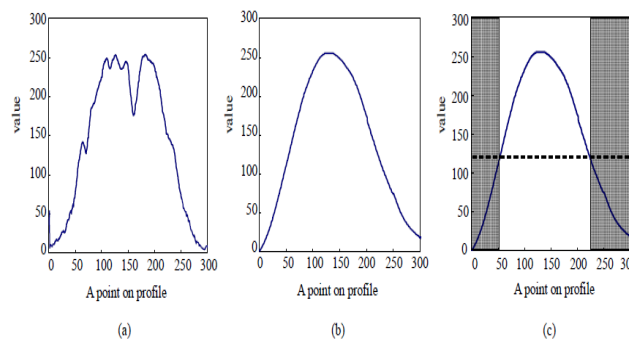


Figure 6 An analysis of profile. (a) Original profile. (b) Smoothed profile. (c) Determination of cup edge.

In figure, gray regions show rim regions, and a dashed line shows a thresholding value of determination of cup edge. The minimum distance between two gray region was cup diameter. Although C/D ratios of an ophthalmologist and a proposed method were similar in normal cases, the errors of an ophthalmologist and a proposed method were high in glaucoma cases.

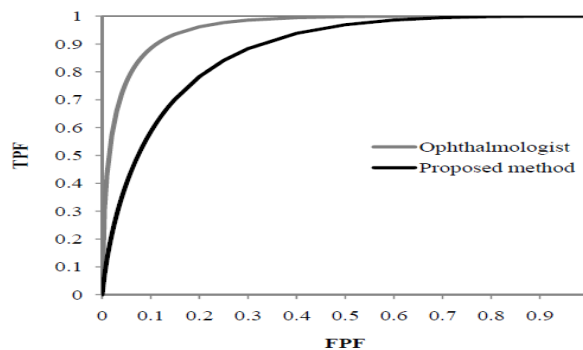


Figure 7 Comparison of ROC curves of ophthalmologist and proposed method

Figure shows the ROC curves for the ophthalmologist method and the proposed method for observing the accuracy.

# International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 4, April 2015

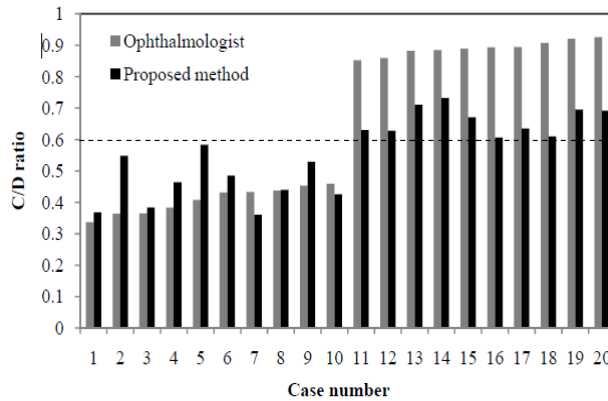


Figure 8 Comparison of C/D ratio measured by an ophthalmologist and the proposed method

In figure, Case 1-10 shows normal cases, and case 11-20 shows glaucoma cases. Horizontal dashed line shows a threshold value for determination of glaucoma. A threshold value of determination of glaucoma was set 0.6.

## RESULT OF GLAUCOMA

This method was useful in the extraction of disc regions with a concordance rate of 86%, which expresses the area of intersection as a percentage of the area of union. This method correctly extracted on average 96% of the disc regions determined by the ophthalmologist, whereas it over extracted 11% of the disc regions. In contrast, the concordance rate using previous method was 63% when the extraction rate was 83% and the over-extraction rate was 28%. Although the previous method mis-extracted slightly in the top of the disc region, it could extract the approximate disc region. Compared with the previous method, this method can be useful for detecting the optic disc in glaucoma examinations.

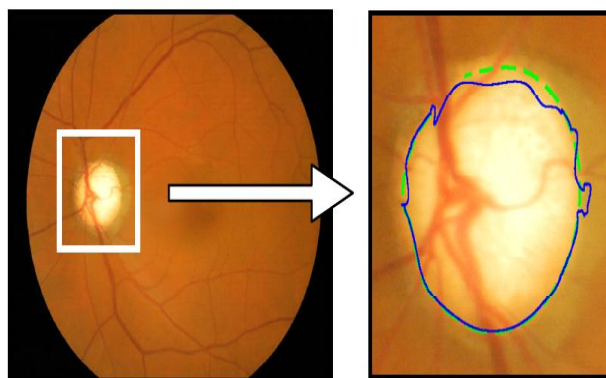


Figure 9 Result of an optic disc extraction

In figure, solid line shows the result of the proposed method. Dashed line shows a sketch by an ophthalmologist.

## VI. RESULTS AND DISCUSSION

The blood vessels, optic disc and optic cup in the retinal images are segmented by using prewitt edge detection and gradient algorithm. Glaucoma is checked by comparing the cup to disc ratio of normal and glaucoma images.



# International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 4, April 2015

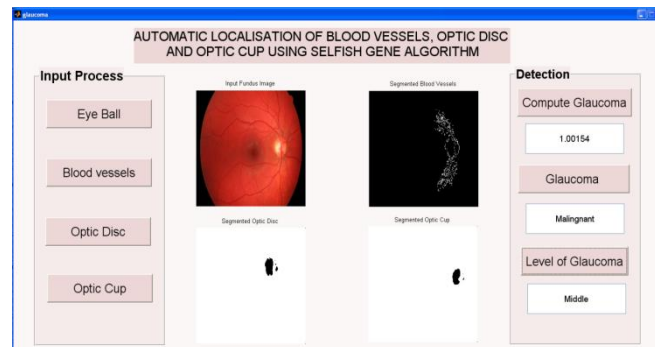


Figure 10 Result of glaucoma identification

Figure shows that the level of glaucoma is identified as middle level for the given input image.

## VII. CONCLUSION AND FUTURE WORK

In this paper, simulation is carried out for extracting the features like size, area and shape of the optic disc and optic cup. The glaucoma disease for the 20 input images is detected by comparing these features with the features of database images using MATLAB 7 software. In the future, the glaucoma disease can be identified for more images and its accuracy can be improved and the hardware implementation can be done.

## REFERENCES

- [1] A. Hoover, V. Kouznetsova, and M. Goldbaum. "Locating blood vessels in retinal images by piecewise threshold probing of a matched filter response" IEEE 2000
- [2] F. Zana and J.-C. Klein. "Segmentation of vessel-like patterns using mathematical morphology and curvature evaluation" IEEE 2001
- [3] J. Staal, M. D. Abramoff, M. Niemeijer, M. A. Viergever, and B. van Ginneken. "Ridge-based vessel segmentation in color images of the Retina" IEEE 2004
- [4] Aquino, M. E. Gegúndez-Arias, and D. Mar. "Detecting the optic disc boundary in digital fundus images using morphological, edge detection, and feature extraction techniques" IEEE 2010
- [5] R. Geetha Ramani, "Automatic Prediction of Diabetic Retinopathy and Glaucoma through Retinal Image Analysis and Data mining techniques"
- [6] A. G. Salazar-Gonzalez, Y. Li, and X. Liu. "Retinal blood vessel segmentation via graph cut" IEEE 2010
- [7] A. Salazar-Gonzalez, Y. Li, and X. Liu. "Optic disc segmentation by incorporating blood vessel compensation" IEEE 2011
- [8] Zhuo Zhang, "ORIGA-light : An Online Retinal Fundus Image Database for Glaucoma Analysis and Research", 32<sup>nd</sup> Annual International Conference of the IEEE EMBS Buenos Aires, Argentina, August 31 - September 4, 2010
- [9] WWW.MEDICALNEWTODAY.COM
- [10] A. M. Mendonca and A. Campilho "Segmentation of retinal blood vessels by combining the detection of centerlines and morphological reconstruction" IEEE 2006
- [11] Nilanjan Dey, "Optical Cup to Disc Ratio Measurement for Glaucoma Diagnosis Using Harris Corner", ICCNT12
- [12] R. Chrastek, M. Wolf, K. Donath, H. Niemann, D. Paulus, T. Hothorn, B. Lausen, R. Lammer, C. Y. Mardin, and G. Michelson. "Automated segmentation of the optic nerve head for diagnosis of glaucoma" IEEE 2005.
- [13] J. Lowell, A. Hunter, D. Steel, A. Basu, R. Ryder, E. Fletcher, and L. Kennedy. "Optic nerve head segmentation" IEEE 2006.
- [14] S. Garg, J. Sivaswamy, and S. Chandra "Unsupervised curvature-based retinal vessel segmentation" IEEE 2007.