A SURVEY OF EFFECTIVE GLAUCOMA DETECTION SYSTEM IN HRF IMAGE USING CLASSIFICATION AND SEGMENTATION MODEL

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Abstract: Glaucoma is the major cause of blindness in working population. Glaucoma is characterized by increased intra-ocular pressure inside the eye leading to changes in the optic disc and optic nerve. It does not reveal its symptoms until later stage. Hence, regular screening of the patients is required to identify the disease, thus demanding high labor, time and expertise. Thus, computational techniques are sought for their analysis. In existing system work involves segmentation of blood vessels, segmentation of optic disc through proposed maximum voting of three segmentation algorithms (K-Means, Wavelet and Histogram based), segmentation of optic cup through intensity thresholding, feature extraction from these segmented structures, feature selection to identify significant features, hybrid model involving Naive Bayes to remove noise in data followed by ensemble classification of Reduced Error Pruning Tree. The proposed framework is evaluated on HRF image dataset. The dataset consists of 30 images, out of which 15 are normal images and 15 are Glaucoma affected images. The implementation of the proposed work was done through Matlab 2013a. The result of first project is efficiency of optic disc segmentation. Then, results show the Glaucoma detection without eliminating instance with AN-fish algorithm. Then the classification accuracy obtained after eliminating instances through AN-fish are reported. The SVM classification results are reported on features with and without feature selection.

Keywords: Glaucoma, segmentation, optic disc, HRF image, classification.

I.INTRODUCTION

Glaucoma is a disease associated with human eyes and second conducting movement of blindness across the globe if eyes are not treated at preliminary stage. Glaucoma normally occurs with increased intra-ocular pressure (IOP) in eyes and gradually damages the vision field of eyes. The term ocular-hypertension is related to those people in whom IOP increases consistently and does not damage the optic nerve. Glaucoma has different types such as open-angle, close-angle, congenital, normal tension and etcetera.

Normal tension glaucoma affects vision field and damages optic nerve as well. The term angle means the distance between iris and cornea; if this distance is large it is referred to as open-angle glaucoma and similarly if the distance between iris and cornea is short than this is called close-angle glaucoma. Open-angle glaucoma is common as compared to close-angle glaucoma. Close-angle glaucoma is very painful and affects vision field of eyes quickly as compared to open- angle glaucoma.

In this project, Glaucoma is characterized by increased intraocular pressure inside the eye leading to changes in the optic disc and optic nerve. It does not reveal its symptoms until later stage. Hence, regular screening of the patients is required to identify the disease, thus demanding high labor, time and expertise. Thus, computational techniques are sought for their analysis.

In this project, identification of Glaucoma is carried out through computational techniques namely image processing and data mining. As the changes in the profile of optic disc act s a biomarker for the onset of the disease, optic disc is segmented through image processing techniques. Optic disc is the brightest part portrayed as oval structure in the retinal fundus image. It encompasses optic cup, which is the brightest central part, optic rim, the surrounding pale part and the blood vessels. All these structures are segmented and their properties are elicited. Then, properties of the disc, cup and blood vessels within optic disc are mined to design a learning model for prediction of Glaucoma.

II. RELATED WORK

Glaucoma is one of the major causes for blindness. Automated identification of Glaucoma can be of great help to the Ophthalmologists and the society. The existing approaches towards Glaucoma diagnosis is concisely presented here. Generally, the process of Glaucoma detection involves the extraction of optic disc and cup followed by elicitation of its properties such as cup to disc ratio and ISNT ratio to distinguish normal images from Glaucoma affected images.

Automatic Identification of Glaucoma plays a major role in retinal image analysis it could prevent vision loss in many patients when detected at the appropriate time. The existing methodology consists of namely image processing phase.

Some of the approaches are briefed here. In 2009, Nayak et al [4] used Neural networks with Cup to disc ratio and ISNT ratio, computed from the extracted optic disc and blood vessels as features and achieved a sensitivity and specificity of 100% and 80% respectively.

In 2011, Acharya et al [5] incorporated texture and Higher Order Spectra features after z-score normalization and feature selection, and classified with a random-forest classifier, correctly identifying the glaucoma images with an accuracy of more than 91%. Again in 2011, Ganesh abu and Shenbagadevi [6] proposed the usage of K means clustering for extraction of optic disc and hence in CDR calculation revealing 90% match with clinical CDR.

Yet another attempt in 2011, Ho et.al, [7] proposed a system that involved vessel detection, vessel in painting, CDR calculation and neuroretinal rim for ISNT rule. K-Nearest Neighbor, SVM and Bayes Classifier with CDR and ISNT ratio yielded a classification accuracy of 95%.. In 2014, GeethaRamani et al [8] proposed a framework based on image features to detect Glaucoma.

The methodology incorporated Conversion to various color spaces, channel extraction, statistical, histogram, GLCM based feature extraction and classification through Grafted C4.5 yielding an accuracy of 86.67% on HRF images with cross validation of 3 folds. Again in 2014, Vijapur [9] proposed a data driven workflow for detection of Glaucoma through extraction of energy features from detailed co-efficient images obtained through application of daubechies, symlets and bioorthogonal wavelet filters and computation of cup to disc ratio feature through optic disc attained through disc prediction and cup.

III. METHODOLOGY

Glaucoma is one of the major problems of modern ophthalmologic medicine. Currently, about 15-20% of patients with glaucoma, even with adequate treatment, are exposed to blindness. It is estimated by the person, but only half aware of this diagnosis, and an even smaller percentage receives adequate treatment. At least 9 million glaucoma patients suffer from blindness in both eyes, and the number is steadily increasing.

3.1 CUP-TO-DISC RATIO

The number of patients suffering from glaucoma in the world is over 100 million. Glaucoma is a multi-factorial disease in which, Primary open-angle glaucoma - a chronic eye disease characterized by an increase in the intraocular pressure (IOP) levels, damaging the optic nerve, causing a violation of the visual fields and leads to irreversible blindness if untreated quickly. Early detection of glaucoma can limit the progression of disease. The ratio of the size of the optic cup to the optic disc, also known as the cup-to-disc ratio (CDR), is one of the important clinical indicators of glaucoma, and is currently determined manually by trained ophthalmologists, limiting its potential in mass screening for early detection

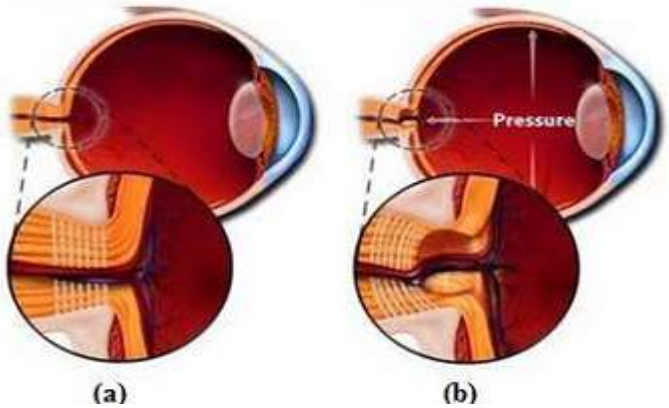


Figure 3.1: (a) Normal Eye (b) Glaucoma Eye

Primary glaucoma has three basic forms:

- a)Closure form
- b) Open form
- c) Mixed form

Closure form of glaucoma is characterized by a narrow or closed structure of the angle of the anterior chamber. The main link in the pathogenesis of primary angle-closure glaucoma is an indoor unit drainage system of the eye, which is blockage of the

anterior chamber angle of the iris root. Open-form of glaucoma, as the name implies, it has an open profile or a wide angle of the anterior chamber and the free access of aqueous humor drainage to the area.

The main resistance to outflow is directly in the most profound ways of outflow - trabeculae, scleral sinus, and collector channels intrascleral plexus. Mixed form of glaucoma combines a narrow structure of the anterior chamber angle (liquid difficulty of access to the drainage system of the eye) and the deterioration of the permeability for ocular moisture filtration zone.

In addition to primary glaucoma significantly rarer congenital, vascular, hypersecretory, low and high pressure form of secondary glaucoma. Clinically, the diagnosis of Glaucoma can be done through measurement of CDR. It is defined as the ratio of the vertical height of the optic cup to the vertical height of the optic disc. A CDR value that is greater than 0.65 indicates the high glaucoma risk.

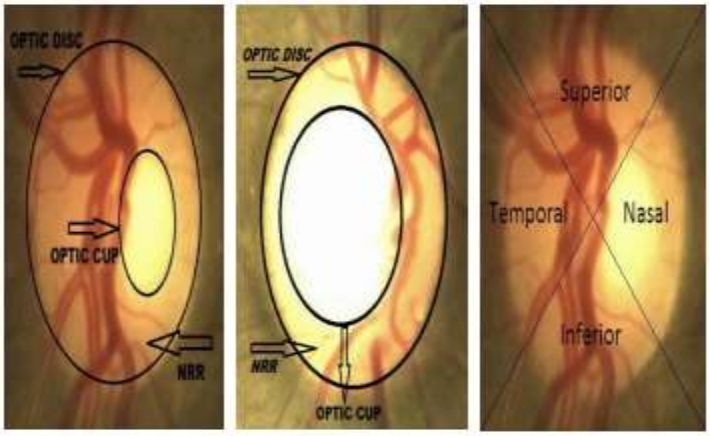


Fig 3.2 L to R: Normal Disc (CDR<0.5), Glaucoma Optic Disc (CDR>0.5), ISNT Quadrants [1]

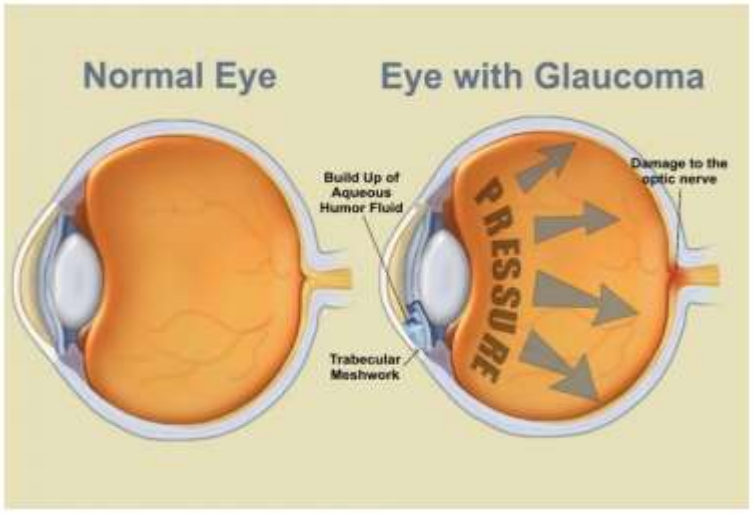


Fig 3.3 Comparison of Normal eye and eye with Glaucoma

3.2 OPTIC DISC AND CUP SEGMENTATION

The K-means algorithm is an iterative technique that is used to partition the ROI image into K clusters. The ROI covers mainly the entire optic disc, optic cup and a small portion f other regions of the image. Hence the K value is chosen as 3. From the three clusters as shown in Figure 1(a), the optic disc cluster has to be identified as follows. The cluster which contains the border region belongs to the other region of the ROI image that does not contain the optic disc and optic cup. Hence, the cluster is removed for the extraction of optic disc and the remaining two clusters form the optic disk region which is shown in Figure 1(b).

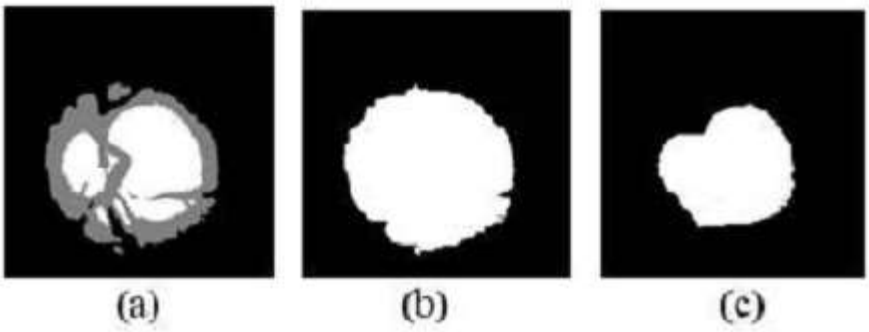


Fig 1(a) K means clustering Image (b) Optic disc (c) Optic cup

Since it is clearly known that the optic cup is inside the optic disc, the cluster in the center of the image forms the optic cup which is shown in Figure 1(c). Finally, the morphological operation is performed to fill the holes and small region inside optic disc clusters and optic cup cluster.

After extracting optic disc, connected components technique is applied to form the rectangle that contains the whole disc region and cup region as shown in Figure 2 (a) and 2 (b) respectively. From the centre of the rectangle an ellipse is drawn that is inscribed in the rectangle.

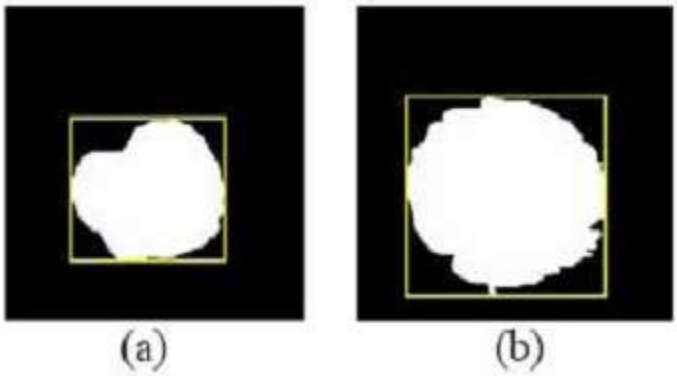


Figure 2: (a) Rectangle for Optic disc region (b) Optic cup region

3.3 OPTIC DISC SMOOTHING

The disc boundary detected from the above step may not represent the actual shape of the disc since the boundary can be affected by a large number of blood vessels entering the disc. Therefore morphological features are applied to reshape the obtained disc boundary. Optic Cup smoothing after the cup boundary detection, morphological feature is again applied to eliminate some of the cup boundary's sudden changes in curvature.

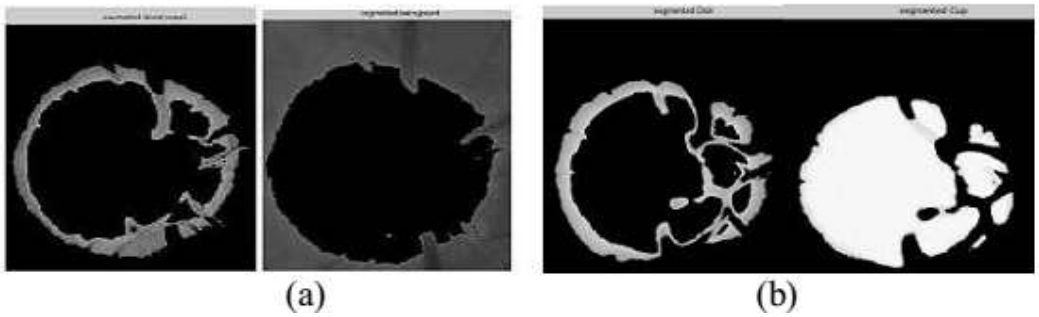


Figure (a): segmented blood vessel & background using K-Means clustering
Figure (b): Segmented disc & cup using K-Means clustering

3.4 CUP TO DISC RATIO (CDR) CALCULATION

The cup-to-disc ratio (often notated CDR) is a measurement used in ophthalmology and optometry to assess the progression of glaucoma.

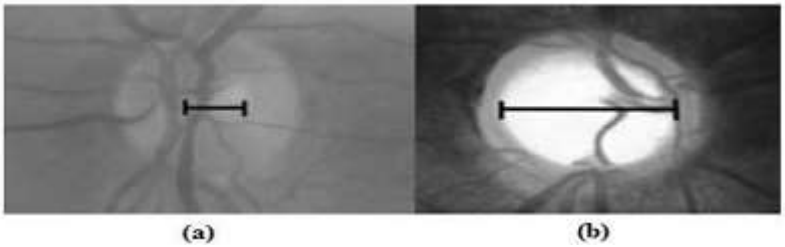


Figure 3: (a) Normal optic nerve head with small optic cup. b) Glaucomatous optic nerve head.

Currently, an important indicator of glaucoma is CDR, defined as the ratio of the vertical height of the optic cup to the vertical height of the optic disc. Optic nerve cupping progresses as the cup becomes larger Fig 3(b) in comparison to the optic disc as shown in Fig 3(a).

CDR Calculation: To calculate the vertical cup to disc ratio (CDR), the optic cup and disc first have to be segmented from the retinal images. The evaluation of the performance of our approach is divided into 3 parts, which are the performance of the optic disc boundary detection, the performance of the optic cup boundary detection, and the vertical cup-to-disc ratio (CDR).

3.5 OPTIC CUP SEGMENTATION

The cup is present inside the disk region. It was segmented by using morphological operations such as morphological opening, closing, dilation and erosion. Dilation-technique used to expand the pixel area in the image. Erosion-used to erode/reduce the pixel area

3.6 RESULTS OF CDR DETECTION

The normal cup to disc ratio is 0.3. A large cup ratio may imply glaucoma or other pathology. The cup-to-disc ratio compares the diameter of the "cup" portion of the optic disc with the total diameter of the optic disc. The cup-to-disc ratio of normal subjects is typically around 0.2 to 0.3.

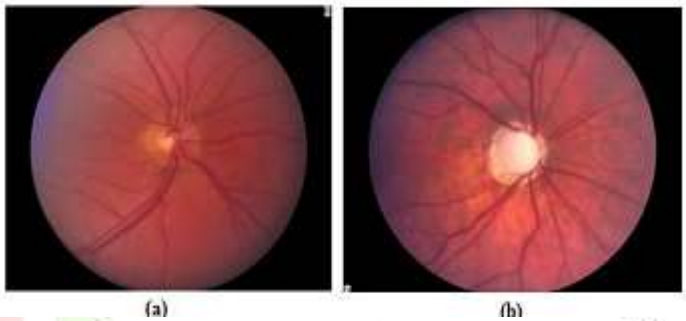
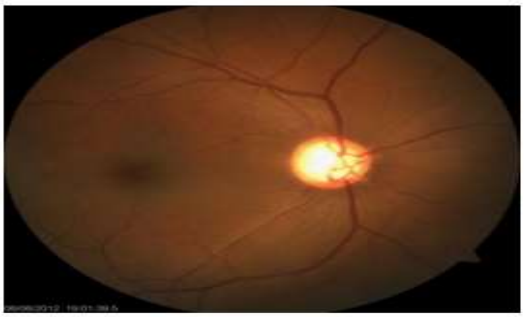


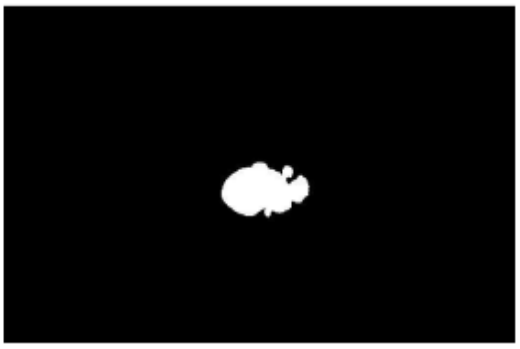
Figure 4: (a) Normal optic nerve - 0.3 C/D ratios (b) Glaucomatous optic nerve – 0.9 C/D ratios.

- For the below given input retinal image the obtained result is as follows:
- Area of Optic Disc:3470
- Area Of Optic Cup:2390
- Cup to Disc Ratio:0.6888

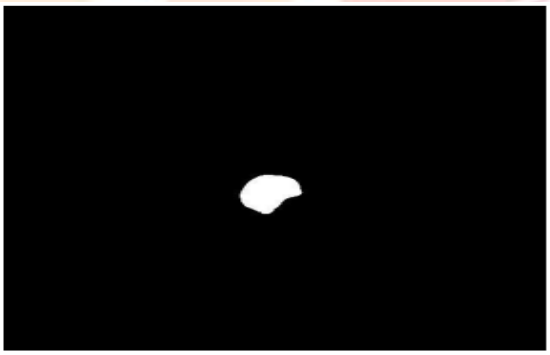
Step 1: Input Image



Step 2: Extract Disk



Step 3: Extract Cup



IV RESULTS AND DISCUSSION

The proposed framework is evaluated on HRF (25) image dataset. The dataset consists of 30 images, out of which 15 are normal images and 15 are Glaucoma affected images. The implementations of the proposed work and the steps in image processing phase were done through Matlab 2013a. The result of first project is efficiency of optic disc segmentation. Then, results show the Glaucoma detection without eliminating instance with K-mean clustering. Then the classification accuracy obtained after eliminating instances through SVM are reported. The classification results are reported on features with and without feature selection**.**

Table 4.1 Performance Table

Image	Existing Rate	Proposed Rate
1.jpg	0.7994	0.6658
2.jpg	0.8223	0.6982
3.jpg	0.7126 0.5535	0.5535
4.jpg	0.8870	0.7969
5.jpg	0.8248	0.7018

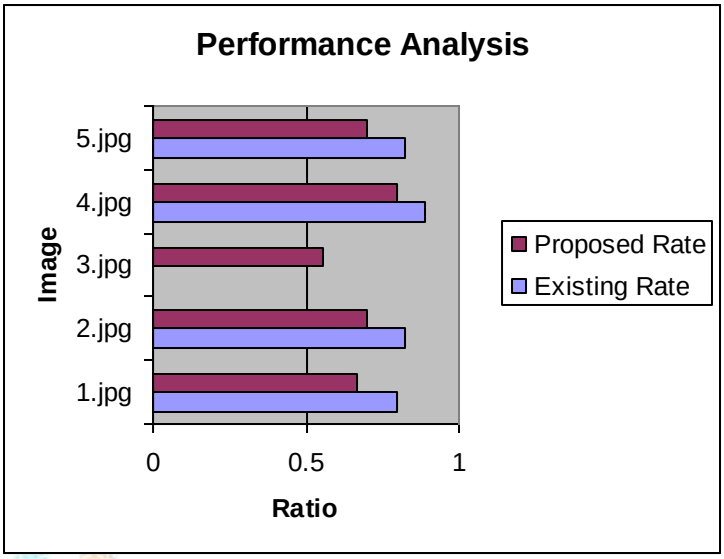


Fig 4.1 Performance Table chart

V. CONCLUSION

Glaucoma is a major cause of blindness in the society. Computational techniques are sought for detecting Glaucoma. This work involves extraction of blood vessels through symmlet wavelet transformation, extraction of optic disc through maximum voting of three segmentation algorithms, cup segmentation through intensity thresholding, extraction of blood vessels within the optic disc, elicitation of features associated with these structures, feature selection, classification through hybrid model involving SVM followed by ensemble classification of Reduced Error Pruning tree reporting an accuracy of 95.42%. The methodology serves the society.

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