Detection of Glaucoma through Optic Disc and Cup Segmentation Using K-Mean Clustering

P. Ramya Lakshmi[#1], Dr. P. Revathy[#2]

[#1]*PG Scholar, Applied Electronics, Einstein College of Engineering, Tirunelveli-12, Tamil Nadu, India*
[#2]*Associate Professor, department of ECE, Einstein College of Engineering, Tirunelveli-12, India*

***Abstract:-*In digital image processing, image segmentation plays a major role in segmenting the image. In the field of medical imaging to find diseases many segmentation techniques has been used. One of the primary cause of blindness is glaucoma. It is diagnoised by examination of size, structure, shape of optic disk and optic cup. In glaucoma patient affected eye, the cup size increases while disc area remains the same hence cup to disc ratio (CDR) increases in glaucoma patient. CDR is the ratio of optic cup area to optic disc area, which provides basis for the diagnosis of glaucoma. K- mean clustering is most popular image segmentation method when compared with existing segmentation techniques. It is one of the simplest unsupervised learning algorithm that solve the well known clustering problem. It is hugely based on partial differential equations which could not programmed enough. This algorithm is easier to code and huge number of medical images can be tested in this algorithm in short span of time which was harder in existing method. The proposed method gives better CDR error compared to correlation coefficient and area under curve. Cup to disc ratio (CDR) is the main factor in the detection of glaucoma.**

Keywords-Glaucoma, K-mean clustering, CDR

I. INTRODUCTION

Glaucoma is a complicated disease in which damage to the optic nerve leads to progressive, irreversible vision loss. Glaucoma is the second leading cause of blindness. Glaucoma has been called the "silent thief of sight" because the loss of vision often occurs gradually over a long period of time, and symtoms only occur when the disease is quite advanced. Once lost, vision cannot normally be recovered, so treatment is aimed at preventing further loss. Worldwide, glaucoma is second-leading cause of blindness after cataracts. It is also the leading cause of blindness among Africans Americans. Glaucoma affects one in 200 people aged 50 and younger, and one in 10 over the age of 80. If the condition is detected early enough, it is possible to arrest the development or slow the progression with medical and surgical means.

II. LITERATURE SURVEY

Vijaya Shanthini. K, Vinothini. K. R [1], has proposed k-mean and morphological clustering method. The main goal is to detect some diseases such as diabets some diabets by analysis of retinal blood vessel condition. Segmentation has used three algorithm. They are edge detection algorithm, region based algorithm, region merging algorithm. Morphology is employed to enhance and smooth the retinal images. K-means clustering is applied to segment the vessels. Blood vessels are detected from retinal images

Suman Sedai, Pallab K.ROY [2], has proposed automatic regression based method, the main aim is to segment optic disc and cup using circular hough transform. Segmentation model consists of cascade of non linear regressors by minimizing the shape alignment error. Each regressor using gradient boosting regression. This method gives high segmentation accuracy (F-score of 0.85 for OC and 0.95 for OD).

Reza Kharghanian and Alireza Ahmadyfard [3], has proposed gabor wavelet and line operator techniques. The main goal is to compare baysian and SVM classifier. Combination of gabor and line feature provides good performance for vessel segmentation. The result of vessel segmentation for two images from DRIVE database. SVM performs better than baysian classifier.

Dr. Anand Sudhalkar, Dr. Ravi Gulati [4], has proposed glaucoma can characterized by changes in optic nerve head(ONH) structure and retinal nerve fibre layer(RNFL). The main goal is to calculate Inferior Superior Nasal Temporal (ISNT) measurement. We can concluded that glaucoma have structural changes on ONH and its features. The research can be done by analyzing textural changes of RNFL which results in detection of glaucoma in its very early stage.

Huazhu Fu, Jun Cheng [5], has proposed deep learning architecture and polar transformation techniques. To calculate CDR value using ORIGA and SCEs datasets ONH techniques are used. ONH measurements are vertical cup to disc ratio (CDR), rim to disc area ratio (RDAR), disc diameter. The main segmentation technique include color and contrast thresholding, boundary detection and region segmentation method. For improving segmentation result we also introduced polar transformation to transfer original image to polar coordinate system which produces state-of-the-art segmentation result on ORIGA dataset.

Prakash. H. Patil, Seema.V.Kamkhedkar[6], has proposed K-mean clustering and simple linear iterative

clustering algorithms are used. In this paper existing method used three modules. 1. Assessment of increased pressure inside the eyeball. 2. Assessment of abnormal vision. 3. Assessment of damage to the head of the optic nerve. Naka rushton and adaptive histogram equalization method used. We concluded that for detection and diagnosis of glaucoma, firstly optic disc need to be segmented after image acquisition, preprocessing is done by applying thresholding, illumination and histogram equalization. AHEM gives better performance, high processing speed.

Elisa Ricci, Renzo Perfetti [7], has proposed line operator and support vector machine. Line detector used in mammography. Multiscale analysis is performed on the image using gabor wavelet transform. STARE and DRIVE database are using through ROC analysis.SVM identifies the optimal separating hyperplane (OSH) which the margin of separation is maximized. ROC classified as true positive rate and false positive rate. The main goal is to compare line length and segmentation of 2 databases. Manual segmentation effort of ophthalmologists is reduced. Performance estimated both terms of accuracy and AUC shows that our proposed method is slightly superior than existing method.

Ricky Gogoi, Kandarpakumar Sarma [8], has proposed neuro fuzzy system, artificial neural network, k-means clustering, ANFIS algorithms. Fuzzy system has two methods. These methods has followed some layers. First part of both methods works preprocessing. Then gray scale images are used to do clustering. To compare KMC and ANFIS, ANFIS is fast, more effective.

Gopal Datt Joshi, Jayanthi Sivaswamy[9] , in this paper, the main goal is to yield error reduction of CDR and CAR. We have used color fundus image (CFI). Cup segmentation can be broadly divided into two categories: monocular or stero. Two disparity maps first obtained using feature based and region based information. The proposed method choose demon's registration algorithm. It can improved with optimal assignment of weights to the individual evidence.

Jorge J.G.Leandro, Herbert F.Jelinek [10], has proposed 2-D gabor wavelet transform and supervised classification methods. STARE and DRIVE databases used. Supervised classification, bayes classification, Gaussian mixture model classifier (GMM), expectation maximization algorithm used. Accuracy values for GMM classifier increase with K. The main goal is to measure ROC curve. It has fast classification phase and good performance.

Adam Hoover, Michael Goldbaum [11], has proposed our method reduces false positives by as much as 15 times over basic thresholding of a MFR , at upto a 75% true positive rate. To segment blood vessels generally fall into three categories:1.window based 2.classifier based 3.tracking based. In this paper hough transform is used to locate the papilla in retinal image. The MFR image computed as probing techniques. our methods adapts to local maxima in MFR images. Compared to basic thresholding of an MFR, our method reduces false positive rate by factor of 15 times.

Rafeal Arnay, Jose Sigut [12],has proposed, this method has been tested with the RIM-ONE data set , yielding an average overlapping error of 24.3% of cup segmentation & an area under the curve(AUC) of 0.7957 using cup to disc ratio for glaucoma assessment. Optic disc contains two regions:1.central area, 2.peripheral area. Super pixel based classification used to segment the cup region. In this paper the result shows best average overlapping error of 24.3% in RIM-ONE data set, which is equivalent to best method for SIMES data set.

Muthukrishnan. R, M. Radha[13], has proposed segmentation areseperates an image into its component regions (or) objects. Edge detection is a fundamental tool for image segmentation. Segmentation algorithms for images based on discontinuity and similarity of image intensity values. Many edge detection techniques used for segmentation. Roberts, sobel,prewitt detection deviated from others. Marr-Hildreth, LOG, canny detection produce same edge map. Canny result is superior to the other results

Prof. Syed Akhter Hussain, Dr. Holambe A.N [14], has proposed image processing techniques such as, image registration, image enhancement, morphology, pattern matching, image classification, analysis & statistical measurements. The main idea of this paper is to illustrate a system which is based on image processing and classification techniques for automatic detection of glaucoma. In this paper we have studied several types of glaucoma:1.open-angle, 2.angle-closure,3.normal tension glaucoma, 4.congenital glaucoma. Five factors should be checked before making a glaucoma diagnosis:1.Tonometry, 2.Opthalmoscopy, 33.Perimetry, 4.Goniscopy, 5.Pachymetry

Sobia Naz,Sheela N Rao[15], has proposedglaucoma can characterised by elevated intraocular pressure(IOP).Automatic disc extraction is done using three techniques:1.edge detection, 2.optimal thresholding, 3.manual threshold analysis. Threshold level-set method is used for detection of cup.In this method green channel is used for processing, red channel is saturated and blue channel is noisy.

III. PROPOSED METHOD

In the proposed system, for the glaucoma detection many steps are needed. It includes the selection of input image, ROI detection and preprocessing, color based segmentation using k-mean clustering, ellipse fitting, cup area, disc area, cup to disc ratio by using k-mean clustering. The workflow model is given below:

Modules

The proposed system of this includes some modules. The modules are discussed below.

Image Acquisition

The first stage of any vision system is the image acquisition stage. The digitization and storage of an image is termed as the image acquisition. If the image has not been acquired satisfactorily, then the intended tasks may not be achievable. It is also the preparation process to obtain eye images. The RGB color images are collected and resized to the dimension of 256*256. All the images are saved in the JPG format. The prototype uses MATLAB image processing library.

Preprocessing and Region Of Interest (ROI)

Before the image processing, at first the damaged image should be cut off, this is termed as preprocessing and it can reduce the influence made by the background. Preprocessing images commonly involves removing low-frequency background noise, normalizing the intensity of the individual particles images, removing reflections under various illumination conditions, and masking portions of images. Image preprocessing is a technique of enhancing data images prior to computational processing. The procedure done before processing by correcting image from different errors is preprocessing. It can significantly increase the reliability of an optical inspection.

An image may be considered to contain sub-images sometimes referred to as region-of-interest, ROIs, or simply regions. This concept reflects the fact that images frequently contain collections of objects each of which can be the basis for a region. In a sophisticated image processing system it should be possible to apply specific image processing operations selected regions. Thus one part of an image (region) might be processed to improve color rendition. Sequence of image processing:

The digitized image is processed by a computer. To display a digital image, it is first converted into analog signal, which is scanned onto a display. An image defined in the "real world" is considered to be a function of two real variables, for examples, a(X,Y) with a as the amplitude (e.g.brightness) of the image at the real coordinate position (X,Y). Modern digital technology has made it possible to manipulate multi-dimensional signals with systems that range from simple digital circuits to advanced parallel computers.

The goal of each operation is to achieve some details or, it generalize by saying, extracting information from thesystem. The area of image analysis(also called understanding) is in between image processing and computer vision.

Optic Disc Segmentation

As fundus images consist of Red, Green, Blue channels. Red channel is used as it is having high difference between optic disc and non optic disc area as compare to remaining channels. Morphological operation including opening followed by closing is done to remove blood vessels. After morphological operations sharpening is performed to sharpen the edges of disc. Then RGB color is transformed into HSV. HSV color space defines the color as human eyes do. Value channel is taken as it has more contrast between the disc area and non-disc area, which is done equalization in order to adjust the intensity values.

Optic Cup Segmentation

More challenges faced while extracting optic cup as compare to optic disc as it interwine with blood vessels (or) surrounding area. Preprocessing steps done on ROI RGB image. Green channel is very appropriate for segmentation of optic cup as its pixel are having more brightness, contrast and visibility. Inverse transformation followed by morphological operation is done on green channel to enhance the cup region and for removal of blood vessel.. stretching is performed which is used for better visualization of cup as compare to disc. S channel is taken as cup is more prominent in it. Median filteration is done on saturation color space which is used for better evaluation (or)analysis of images. It works by all the pixels according to their brightness value in an ascending order and then middle value is selected as median.

Color based segmentation using K-mean clustering

K-mean clustering is an unsupervised iterative method to divide the data into k number of clusters. K means is fast and efficient method which results are more close to human observation. HSV image is transformed to LAB color space for improved segmentation.

Ellipse fitting

Optic disc and optic cup boundaries are detected by applying canny edge detection algorithm. After extracting edges these boundaries are smoothen by using linear ellipse fitting, which is based on least square fitting algorithm, finest fitting curve is obtained by minimizing distance. Linear least square ellipse fitting method is mainly based on ellipse, so that the influence of noise such as haemorrhages, eye blood vessels around the area of cup and disc can be minimized by forming the ellipse.

Cup to Disc Ratio(CDR)

Cup to disc ratio is commonly indicates glaucoma risk. CDR is obtained by using formula,

CDR=VCD/VDD

Where VCD represents vertical Cup Diameter and VDD is Vertical Disc Diameter. Standard threshold value for Glaucoma is greater than 0.5, while for normal it is less or equal to 0.5.

IV. RESULT AND DISCUSSION

The proposed methodology sample images are collected from armed forces institute of ophthalmology (AFIO). In this paper we have calculate CDR, correlation coefficient, area under curve between edge based segmentation and k-meanclustering.

CDR ERROR

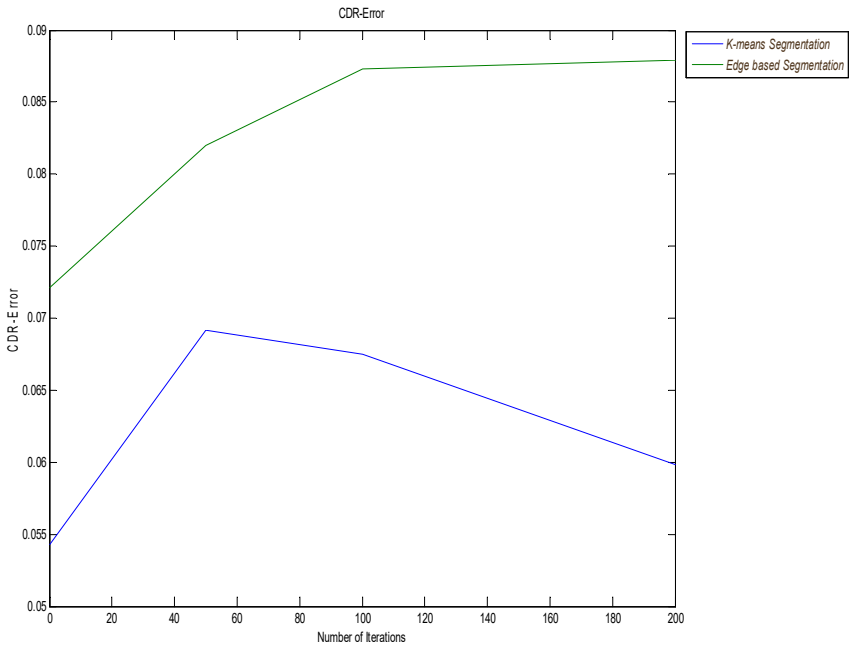

Fig 1 .CDR calculation of k-means and edge based segmentation

Table 1 .CDR calculation of edge based and k-mean clustering

No.of iterations	0	20	40	60	80	100	120	140	160	180	200
Edgebased segmentation	0.072	0.074	0.076	0.078	0.08	0.083	0.085	0.087	0.088	0.088	0.089
k-means clustering	0.054	0.058	0.062	0.069	0.068	0.067	0.066	0.064	0.062	0.061	0.06

CORRELATION COEFFICIENT

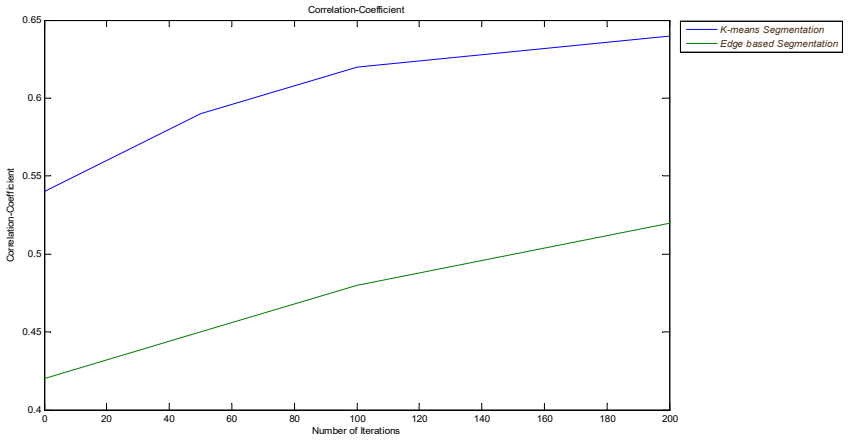

Fig.2 Correlation coefficient of k-means and edge based segmentation

Table 2 Correlation coefficient of edge based and k-mean clustering

No.of iterations	0	20	40	60	80	100	120	140	160	180	200
Edgebased segmentation	0.42	0.43	0.44	0.45	0.46	0.47	0.48	0.50	0.50	0.51	0.52
k-means clustering	0.54	0.55	0.56	0.58	0.6	0.62	0.62	0.63	0.63	0.64	0.64

AREA UNDER CURVE

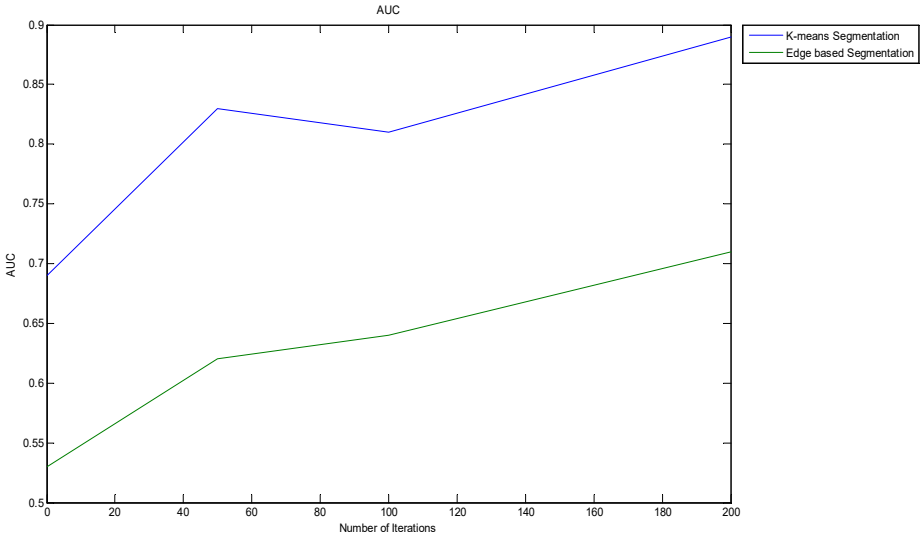

Fig 3. Area under curve of k-means and edge based segmentation

Table 3. Area under curve of edge based and k-mean clustering

No.of iterations	0	20	40	60	80	100	120	140	160	180	200
Edgebased segmentation	0.53	0.55	0.57	0.60	0.62	0.62	0.63	0.65	0.65	0.65	0.68
k-means clustering	0.69	0.71	0.76	0.82	0.80	0.78	0.80	0.82	0.85	0.86	0.88

V. CONCLUSIONS

This project represents k-mean clustering based optic disc and cup segmentations for glaucoma detection. In this project we have measured cup to disc ratio, Area under curve, correlation coefficient. The CDR is a crucial feature to detect glaucoma risk on fundus images. The optic disc and cup are firstly segmented then CDR, correlation coefficient, Area under curve are calculated. To compare correlation coefficient, Area under curve the CDR has better result. K-means clustering gives more reliable and accurate results as compared to previous method.

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