International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8, Issue-1, May 2019

An Automatic Classification of Glaucoma Disease using Knowledge Discovery Approach

M. Nageswara Rao, M. Venu Gopala Rao , Ch.K Priya

Abstract: ***Glaucoma is one of the dangerous disease which consequences in the loss of vision of the individual. The main cause of this type of disease is the hypertension or any communicable disease which deals with high disorders in disturbing the optic nerves in the retina of the individual. This paper deals with the efficient learning approach for the automatic classification of the glaucoma disease which deals with the less error rate probabilities and having high recognition rate. This paper deals with the segmentation and filtration using discrete wavelet transform and feature extraction and optimization on the basis of which the classification will be done using linear discriminant analysis. The feature extraction is done using independent component analysis and the feature optimization is done using particle swarm optimization. The whole simulation is done in MATLAB environment.***

Index Terms: Automatic classification, discriminant analysis, recognition rate, error rate probabilities

I. INTRODUCTION

Glaucoma is a very serious disorder which deals with individual retina. The analysis of the retinal illnesses is significant to avoid loss of vision of the human being. Though, at large screening, these assessments are not accurate, mostly in case of the developing nations because of the non-trained specialists and also due to lack of the imaging equipment. Therefore, a programmed and automatic recognition classificationis needed which routinely recognizes the features of these dangerous disorders which can be the advantage for identification of diseases. Glaucoma deals with the primary cause for loss of sight and the recognition of glaucoma is important in avoiding optical loss. The loss of vision can be affected by either hyper tension or due to communicable infections. Glaucoma is a problem generally occurs in the eye which leads to unclear or compactability of vision in glaucoma patients. Discovery of Glaucoma symptoms is very crucial as it can happen deprived of any chief recognized symptoms. This type of disease is sensed through retinal inspections; immediate behavior or actions are essential which contains laser operation and controlling of blood pressure to avoid the loss of individual's vision. Glaucoma infections can be acknowledged by sensing the optic cup and optic disc from the patient's retinal sample image and examining the border area among optic cup and optic disc in the image retina. Optic disc deals with brightest or advanced concentration of the pixel area particularly in the outline of ring in the retinal images. Optic cup is known as the inner bright area in the form of circle shape. To detect the range among the optic disc and optic curve is very significant which is essential to recognize the glaucoma infection. By examining the inflammation or reduction of Neuro rim in patient's retina, the glaucoma illness is identified. The strictness of glaucoma disease is measured reliant on disc ratio to cup arena which deals with the Neuro retinal border surface zones in retinal appearance. Cup Disc Ratio is a significant structural pointer for assessing the happening of the infection and figure 1 shows the image sample which is the retinal image having Glaucoma illness. The blood vessels initiated from the midpoint of the disc are brutally affected by this disease.

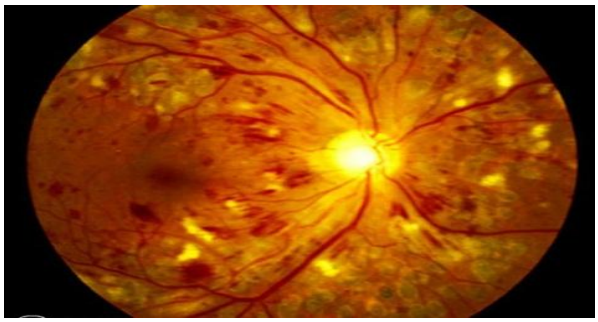


Figure 1: Glaucoma Image

There are many efficient researches are done by the highly qualified researchers which presented their work in the efficient manner.S. Atheesan S. Yashothara et al. [3] has presented an involuntary scheme to classify glaucoma from fundus sample of the images. They have extracted the cup and disc by average and extreme grey level pixels using histogram. Then they have used contours which are helpful to draw fitting circle to find cup and disc radius. Fauzia Khan, Shoaib A. Khan, Ubaid Ullah Yasin, Ihtisham ul Haq, Usman Qamar et al. [4] proposed image processing procedure for detection of glaucoma sample.They have proved that the practice is executed on total 50 retinal images and they were able to achieve accuracy of 94% in total execution time of 1.42 seconds. Gayathri Devi T.M., Sudha S, Suraj P et al. [5] proposed an efficient system which is used by discrete wavelet transform helpful in extracting diverse wavelet structures attained from three different filters named as symlets, daubechies and bi-orthogonal wavelet filters.

Revised Manuscript Received on 30 May 2019.

***** Correspondence Author

M.Nageswara Rao, Research scholar, KL University, Asst. Professor, Department of Electronics and Communication Engineering, Sri Mittapalli College of Engineering, India.

Dr. M. Venu Gopala Rao, .Professor, Department of Electronics and Communication Engineering, KL University, India.

Ch.K Priya, Asst. professor, Department of Electronics and Communication Engineering, Narasaraopet engineering college, India.

II. DATABASE COLLECTION

In this paper the dataset considered is the drive dataset. The image samples included in this database can be used freely and are in open source for research studies and informative determinations. In this research we have taken total 80 images of both categories. The usage of the image samples of this database is for the research scholars for the testing of their research implementations in an effectual manner.

III. FEATURE EXTRACTION AND FEATURE OPTIMIZATION

The feature extraction is used to extract the characteristics of the image samples and optimization is done for extracting the relevant features from the images for the automatic classification of the **glaucoma diseases.**

1. Independent Component Analysis (ICA)

The ICA model is used to extract the features based on independent sources. The sources are generated through a linear basis transformation, where additive noise can be present. Suppose we have N statistically independent signals, S_i (t), i = 1,…., N where S_i (t) deals with the realization of probability distribution at time series t. Also there is an observation that for N samples, there are N observation signal samples x_i(t), i = 1,...,N which deals with the combinations of the sources. The essential feature of the mingling procedure is that the sensing should be separated spatially such that the different combination of the sources will be analyzed efficiently. With this spatial separation assumption in mind, we can model the mixing process with matrix multiplication as follows:

$$X(t) = P \times s(t)$$

Where P is called mixing matrix and x(t), s(t) deals with the vectors demonstrating the detected indications and source indications correspondingly. The justification for the explanation of this indication handling method as unsighted is that we are having no data or information on the mixing medium and also at the source themselves.

The aim is to improve the original indications, S_i (t) from the observed vector data X_i (t). The estimations have to performed for the causes by first obtaining the mixing of the matrix which is denoted as WT,

Where $WT = P^{-1}$ which allows an approximation, s (t), of the autonomous foundations to be attained:

$$S(t) = WT \times x(t)$$

The independent sources are diverted using matrix P which is the estimation of the weight matrix. If the approximation of the un-mixing conditions is precise, then the good independent approximation of the data can be obtained which will be the resultant features of the sampled data.

2. Particle Swarm Optimization

PSO is based on the swarm intelligence. In this type of optimization each particle is measured as a conceivable explanation to the optimization difficulty in the space which is having N- dimension. Every component has its own location in the N dimensional free space and also the random velocity assigned to it.

The locus of the swarm particle is characterized by $L_i = L_1, L_2, \ldots\ldots, L_n$. The speed of a particle is specified as $S_i = S_1, S_2 \ldots S_n$. Each particle in the swarm deals with the best location that is practiced by the component so far. A universally best solution keeps the best universe allocation found so far. This data gives contribution to the flying speed of each unit using equation:

$$S_i = S_i + \varphi_1 * rand\ (pbesti - L_i) + \varphi 2 * rand * rand * (gbest - L_i) \quad \ldots\ldots\ldots\ldots (1)$$

Where φ_1 and φ_2 are constants

Describing the higher boundary for the rapidity section upsurges the presentation of the method which gives the update position of the particle.

In [2], the shape of an inactive impact recovers the performance, as it regulates the rapidity over interval and recovers the exploration accuracy of the elements. So the (1) can be rephrased as:

$$S_i = I * S_i + \varphi_1 * rand * (pbest_i - S_i) + \varphi_2 * rand * (gbest_i - L_i) \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where I stand for inertia influence and rand is the random number ranges 0 to 1 in uniformly distributed manner. Then (1) was modified as:

$$S_i = T * (S_i + \varphi_1 * rand * (pbest - L_i) + \varphi_2 * rand * (gbest - L_i) \ldots\ldots\ldots\ldots (3)$$

Where T can be expressed as:

$$2/(|\ 2 - \varphi - \sqrt{(\varphi \hat{}\ 2 - 4\varphi)}) \quad \ldots\ldots\ldots (4)$$

IV. METHODOLOGY FLOW DIAGRAM

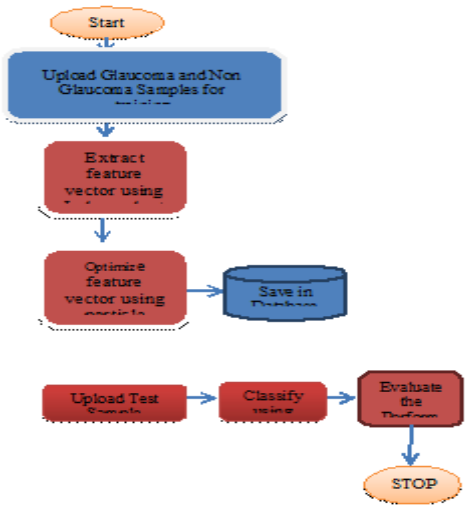


Figure2:Proposed Flow Diagram

The figure 2 shows the proposed flow diagram in which the developed system is divided into two phases. The very first is the training phase in which the learning process is evaluated.

The training phase consists of the feature extraction approach which deals with the extraction of characteristic vector which is further fed to the optimization criteria which is done using particle swarm optimization. The optimization will reduce the feature vector and selected the relevant instances of the characteristics. The second phase deals with the testing of the developed system in which the random sample is uploaded and the automatic classification will be done using LDA as a classifier.

V. PROPOSED ALGORITHM

Step 1: Initialize and Enter training vector as an input, $SX = \{SX_1, SX_2, SX_3, SX_4, \ldots\ldots\ldots SX_N\}$

Where SX = Sequence of the training data

Step 2: Renovate it into discrete wavelets and produce achieve the filtration in terms of approximations and detail coefficients for the normalization.

Step 3: Implement feature extraction process in N-dimensional feature space having weights with independent vectors $C(k) = C_1, C_2, C_3 \ldots\ldots, Cn$ to generate independent components $I(i) = I, I_2, I_3 \ldots\ldots\ldots, I_n$ and is given by

$C(J) = SX_{K(j)} \times I_{K(j)}$

C = output data vector form
SX = input data vector form
I=Independent vector for j=1, ……, n and Q=1,…..,m

Step 4: Make I as population swarm to be optimize and perform optimization for instance selection

Step 5: Generate Testing sequence

$T = \{T_1, T_2, T_3, T_4, \ldots\ldots\ldots\ldots T_N\}$

Step 6: Extract independent characteristic vector for testing sample.

Step 7: Load Training sample and perform classification using Linear Discriminant Analysis

Step 8: STOP

VI. SIMULATION AND RESULTS

The developed system is evaluated using MATLAB 2016 environment. We have chosen MATLAB because it's a powerful tool having lot of help in terms of toolboxes and machine learning. This section deals with the result and discussions based on simulations which are given below

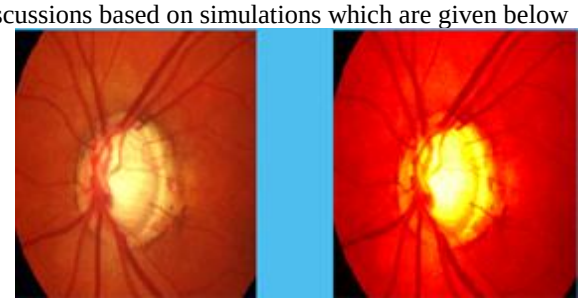


Figure 3: Original and pre-processed image

The figure 3 shows the original image uploading and its pre-processed image using normalization of the uploaded sample for the training sample. It is done for extracting the glaucoma regions more accurately and precisely. The figure 4 shows the low pass approximation using discrete wavelet transform in which the filtrations are done to remove the high frequency components in the image which are responsible for obtaining distortion in the execution and also the detail coefficients are attained using discrete wavelet transform which provides detail information of the signal values on which the processing of the images is done for the training process. In the same manner the execution will be done for the Non Glaucoma category and save the optimize feature vector in the database.

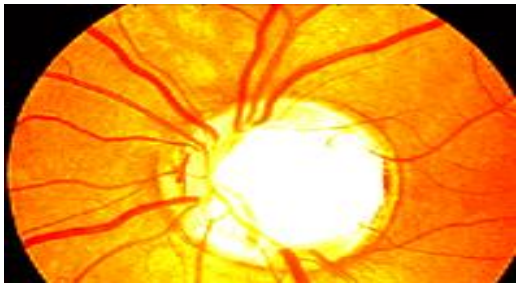


Figure 4: Low pass approximation (training sample)

The figure 5 shows the optimize feature vector graph which provide the global best values after performing instance selection using particle swarm optimization. The instance selection is performed after feature extraction which is done using independent component analysis.

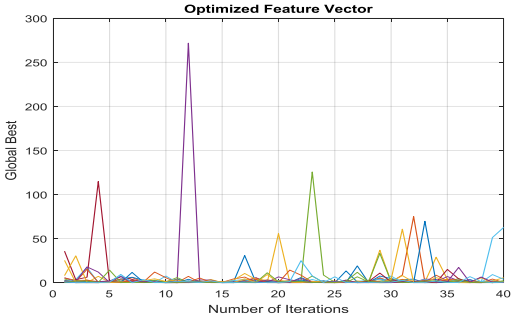
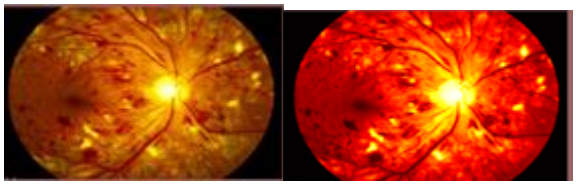
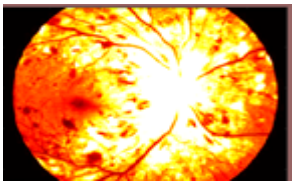


Figure 5: Optimize feature vector



(a) (b)



(c)

Figure 6: Test processing (a) Test Sample (b) Low pass approximations (c) Detail Coefficients

The figure 6 shows the test panel in which the testing sample is uploaded randomly and the processing is done on the test sample and shows the feature extraction and filtration using ICA and DWT.

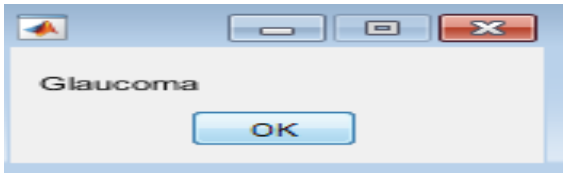


Figure 7: Disease recognition

The figure 7 shows the recognition of the glaucoma disease based on the test sample which is done by the classification approach i.e. linear discriminant analysis. The LDA predicts the test sample based on the training and evaluates the performance of the developed system.

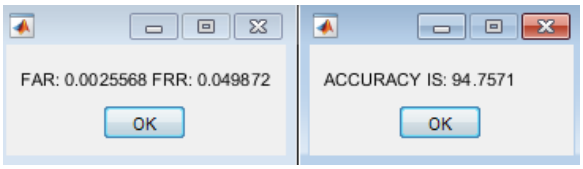


Figure 8: Error rates and recognition accuracy

The figure 8 shows the false acceptance rate and false rejection rate and also the accuracy rate and shows that the system is having less error rate probabilities and having high recognition rate. As the error probability decreases the recognition rate increases which shows that the system is robust and effectual for automatic classification.

False Acceptance Rate = number of false acceptances ÷ Number of observations

False Rejection Rate = Total number of false rejections ÷ Number of observations

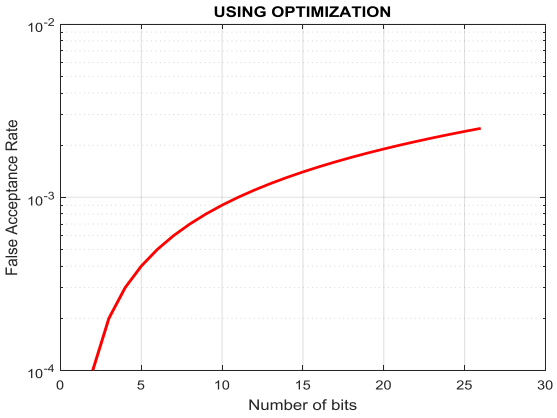


Figure 9: False acceptance rate

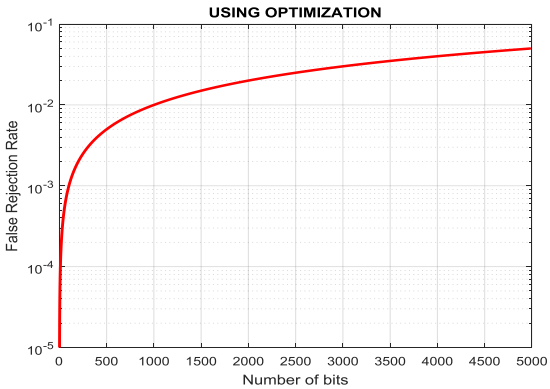


Figure 10: False rejection rate

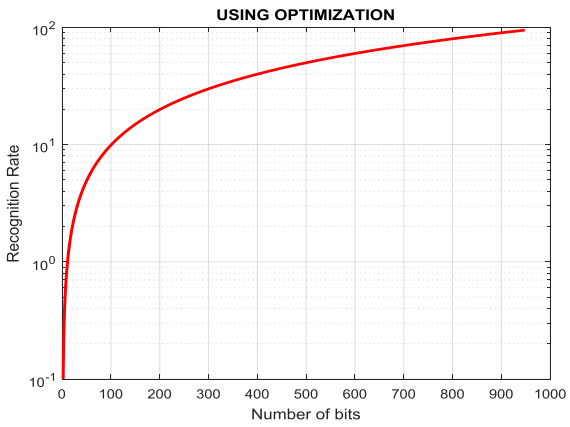


Figure 11: Detection accuracy

Table 1: Performance comparison classification approach [5]

Classifier	False Acceptance Rate	False Rejection Rate	Accuracy (%)
SVM	0.05	0.07	92
Random forest	0.07	0.06	91
Naive Bayes	0.04	0.08	92
SMO	0.08	0.06	91
LDA (Proposed)	0.0025	0.0498	94.751

Table 1 show the performance comparison with existing classification approaches and it is noticed that our proposed approach is performing well in achieving high recognitions and less error rate probabilities

VII. CONCLUSION AND FUTURE SCOPE

Automatic classification of the fundus images is a very crucial part or step to detect glaucoma diseases. In this paper an automatic classification and robust approach is presented based on segmentation and filtration which is done using wavelet transform, feature extraction and optimization and classification using LDA for glaucoma and non-glaucoma disease detection and based on the knowledge discovery process the performance evaluation is done in terms of high accuracy rate and less error rate probabilities. The system is achieving less false acceptance rate which is 0.0025 and less false rejection rates which are 0.0498 and the accuracy rate of 94.751 % which shows the robustness of the system for the automatic recognition.

REFERENCES

1. Sivaswamy, Jayanthi, S. R. Krishnadas, Gopal Datt Joshi, Madhulika Jain, and A. Ujjwaft Syed Tabish. "Drishti-gs: Retinal image dataset for optic nerve head (onh) segmentation." In Biomedical Imaging (ISBI), 2014 IEEE 11th International Symposium on, pp. 53-56. IEEE, 2014

2. Xu, Yanwu, Lixin Duan, Stephen Lin, Xiangyu Chen, Damon Wing Kee Wong, Tien Yin Wong, and Jiang Liu. "Optic cup segmentation for glaucoma detection using low-rank superpixel representation." In International Conference on Medical Image Computing and Computer-Assisted Intervention, pp. 788-795. Springer, Cham, 2014
3. Atheesan, S., and S. Yashothara. "Automatic glaucoma detection by using funduscopic images." In Wireless Communications, Signal Processing and Networking (WiSPNET), International Conference on, pp. 813-817. IEEE, 2016
4. Khan, Fauzia, Shoaib A. Khan, Ubaid Ullah Yasin, Ihtisham ul Haq, and Usman Qamar. "Detection of glaucoma using retinal fundus images." In Biomedical Engineering International Conference (BMEiCON), 2013 6th, pp. 1-5. IEEE, 2013
5. Devi, TM Gayathri, S. Sudha, and P. Suraj. "Glaucoma detection from retinal images." In Electronics and Communication Systems (ICECS), 2015 2nd International Conference on, pp. 423-428. IEEE, 2015.
6. Ayub, Javeria, Jamil Ahmad, Jan Muhammad, Lubna Aziz, Sara Ayub, Usman Akram, and Imran Basit. "Glaucoma detection through optic disc and cup segmentation using K-mean clustering." In Computing, Electronic and Electrical Engineering (ICE Cube), 2016 International Conference on, pp. 143-147. IEEE, 2016
7. Singh, Anushikha, Malay Kishore Dutta, M. ParthaSarathi, Vaclav Uher, and Radim Burget. "Image processing based automatic diagnosis of glaucoma using wavelet features of segmented optic disc from fundus image." Computer methods and programs in biomedicine 124 (2016): 108-120
8. Yarmohammadi, Adeleh, Linda M. Zangwill, Alberto Diniz-Filho, Min Hee Suh, Siamak Yousefi, Luke J. Saunders, Akram Belghith, Patricia Isabel C. Manalastas, Felipe A. Medeiros, and Robert N. Weinreb. "Relationship between optical coherence tomography angiography vessel density and severity of visual field loss in glaucoma." Ophthalmology 123, no. 12 (2016): 2498-2508
9. Hollo, Gabor, Hsu Shu-wei, and Farzaneh Naghizadeh. "Evaluation of a new software version of the RTVue optical coherence tomograph for image segmentation and detection of glaucoma in high myopia." Journal of glaucoma 25, no. 6 (2016): e615-e619.
10. Wang, Jieqiong, Ting Li, Bernhard A. Sabel, Zhiqiang Chen, Hongwei Wen, Jianhong Li, Xiaobin Xie et al. "Structural brain alterations in primary open angle glaucoma: a 3T MRI study." Scientific reports 6 (2016)
11. Oddone, Francesco, Ersilia Lucenteforte, Manuele Michelessi, Stanislao Rizzo, Simone Donati, Mariacristina Parravano, and Gianni Virgili. "Macular versus retinal nerve fiber layer parameters for diagnosing manifest glaucoma: a systematic review of diagnostic accuracy studies." Ophthalmology 123, no. 5 (2016): 939-949.
12. Singh, Anushikha, Malay Kishore Dutta, M. ParthaSarathi, Vaclav Uher, and Radim Burget. "Image processing based automatic diagnosis of glaucoma using wavelet features of segmented optic disc from fundus image." Computer methods and programs in biomedicine 124 (2016): 108-120

AUTHORS PROFILE

M.Nageswara Rao obtained his B.Tech degree from VITAM, Vishakapatnam, India during 2006. He obtained his M. Tech. from Narasaraopet Engineering College, Narasaraopet, and present Research schlor from KL Deamed to be University, Guntur. He possesses 10 years of teaching experience. Presently he is working as Asst.Professor in the department of ECE , Sri Mittapalli College of Engineering, Guntur Dt, A. P., India. His research interest includes signal, image processing.

Dr. M. Venu Gopala Rao, obtained his AMIETE degree from Institute of Electronics and Telecommunication Engineers, New Delhi, India during 1996. He obtained his M. Tech. from Regional Engineering College, Warangal, and Doctorate from Osmania University, Hyderabad. He possesses 17 years of teaching experience and 21 years of industrial experience. Presently he is working as Professor in the department of ECE and Associate Dean (Quality-Audits), K L University, Vaddeswaram, Guntur Dt, A. P., India.
He received a 'credit award' in Radio Servicing Theory from City and Guild's London Institute, London in 1978. He is a fellow of IETE and life member in IAE, ISTE, SSI, and ISOI. His research interest includes signal, image processing, GPS compressive sensing, Sparse and Dictionary learning. He has published more than 50 papers in various international and national journals, conferences and workshops.

Ch.Krishna Priya obtained her B.Tech degree from Sri Krishna Engineering College, Anna Univercity, India during 2007. She obtained her M. Tech. from LITAM Engineering College, Dhullipalla,India. She possesses 10 years of teaching experience. Presently he is working as Asst..Professor in the department of ECE , Narasaraopet Engineering College, Guntur Dt, A. P., India. Her research interest includes Communication & signal processing.