Detection of Blood Vessels and Diseases in Retinal Images

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Abstract— The significant health issues among the senior and old individuals are eye ailments. One of the most important internal components in eye is called retina. Retina located in the back of the eye is not only a vital part of human sight, but also contains valuable information that can be used in biometric security applications, or for the diagnosis of certain diseases. The monitoring of the effects of Glaucoma and Diabetic retinopathy can be assisted by quantitative analysis of the vascular architecture of the retina. In this paper we detect the blood vessels and diseases such as Glaucoma and Diabetic Retinopathy. We used RGB image for obtaining the traces of blood vessels. We proposed a method to detect blood vessels consists of three phases, Pre-processing, Vesselness Filter and Vessel detection. Also we proposed an algorithm for detection of diseases in retinal images consists of four main steps, Pre-processing, Segmentation, Feature Extraction and Classifier. The performance of algorithms is compared and analyzed on database.

Index Terms- Retinal Images, Segmentation, Feature Extraction, Classifier

I. INTRODUCTION

A. THE HUMAN EYE-RICH SOURCE OF INFORMATION

The eye is an important organ that provides the magic of sight. It allows us to observe, react and adapt to surrounding environments by interpreting shapes, colors and dimensions of objects seen. This is accomplished when the lens of the eye focuses light onto the photoreceptive cells of the retina. The photons of light trigger a response by producing neural impulses which are processed by different parts of the brain. The anatomy of the eye seen in Fig. 1can divided into three different layers external, intermediate and internal. The external layer consists of the sclera and cornea. The intermediate layer is split into two parts: iris and cilliary body. The internal layer is the retina. Fig. 1 shows the structure of Human Eye. Parts of human eye explain below.

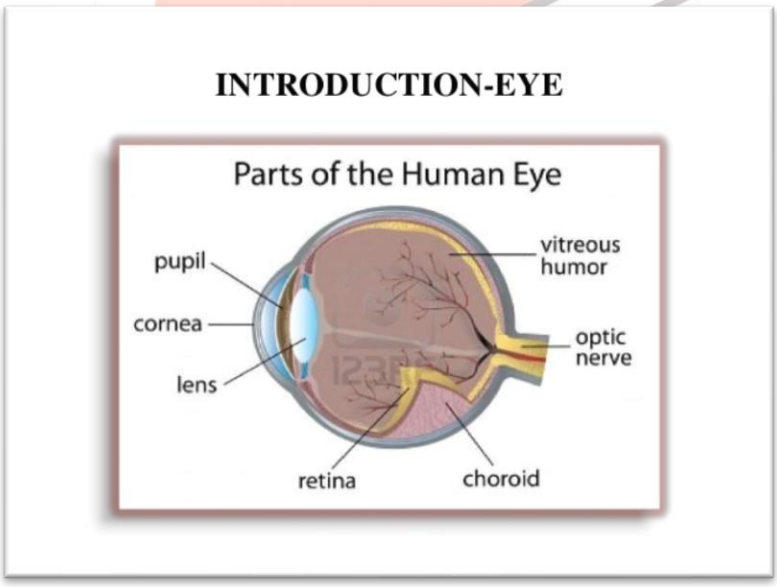


Fig.1 Human Eye

The cornea is a tough transparent tissue that covers the anterial surface of the eye. Sclera is an opaque membrane that encloses the part of optic globs. It lies directly below the sclera which contains the network of blood vessels. These blood vessels are the major source of nutrients to the eye. Retina is an inner most layer of eye. This is responsible for visualization of external scenario. It is a thin layer of tissue in the back of the eye that senses light and sends images to your brain. In the center of retina there is the optic disk, a circular to oval shape. From the center of optical nerve radiates the major blood vessels of the retina. The blood vessels network is an important anatomical structure in human retina, which is use to recognize different types of disease. However, manual detection of blood vessels is not simple because the vessels in retina image are complex and have low contrast. For retinal anatomy ophthalmologist uses an ophthalmoscope. The retinal fundus image is widely used in the diagnosis

and treatment of various types' diseases such as diabetic retinopathy and glaucoma. There are different types of eye diseases, such as Cataract, Iridocyclitis, Corneal Haze, Glaucoma and Diabetic retinopathy.

B. DISEASE DESCRIPTION

i) Glaucoma:

Glaucoma is a group of eye diseases which result in damage to the optic nerve and vision loss. Detection of the OD is useful in the diagnosis of glaucoma, optic neuropathies, optic neuritis, anterior ischemic optic neuropathy or papilledema and optic disc druses. It can also be used as a marker to help locate fovea/ macula as well as decide if the image is of the left or right eye. There are two types of glaucoma which we describe below.

a) **Primary glaucoma** - this means that the cause is unknown.

b) **Secondary glaucoma** - the condition has a known cause, such as a tumour, diabetes, an advanced cataract, or inflammation.

ii) Diabetic Retinopathy

Diabetic retinopathy, also known as diabetic eye disease, is a medical condition in which damage occurs to the retina due to diabetes and is a leading cause of blindness. Diabetes occurs when the pancreas fails to secrete enough insulin, slowly affecting the retina of the human eye, leading to diabetic retinopathy**.** It affects up to 80 percent of people who have had diabetes for 20 years or more. At least 90% of new cases could be reduced if there were proper treatment and monitoring of the eyes. The longer a person has diabetes, the higher his or her chances of developing diabetic retinopathy. Types of diabetic retinopathy DR can be broadly classified as non-proliferative DR (NPDR) and proliferative DR (PDR).Depending on the presence of specific DR features, the stages can be identified.

Following list describes three subclasses of NPDR as well as PDR: Stages of Diabetic Retinopathy.

a) **Mild Non-Proliferative Retinopathy:** At this earliest stage, micro aneurysms occur. They are small areas of balloon-like swelling in the retinas tiny blood vessels.

b) **Moderate Non-Proliferative Retinopathy:** As the disease progresses, some blood vessels that nourish the retina are blocked.

c) **Severe Non-Proliferative Retinopathy:** Many more blood vessels are blocked, depriving several areas of the retina with their blood supply. These areas of the retina send signals to the body to grow new blood vessels for nourishment.

d) **Proliferative Retinopathy:** At this advanced stage, the signals sent by the retina for nourishment trigger the growth of new blood vessels. This condition is called proliferative retinopathy. These new blood vessels are abnormal and fragile. They grow along the retina and along the surface of the clear vitreous gel that fills the inside of the eye. By themselves these blood vessels do not cause symptoms or vision loss. However, they have thin fragile walls. If they leak blood severe vision loss and even blindness can result.

II. LITERATURE REVIEW

[1] Archna Sharma and Hempriya have proposed a method for Detection of Blood Vessels and Diseases in Human Retinal Images. In this the detection of blood vessels is important task in diagnosis the diseases of eye. The present study is aimed at developing an automated system for the extraction of normal and abnormal features in retinal images. The blood vessel network is an important anatomical structure in human retina. Several diseases such as Diabetic retinopathy, glaucoma, hemorrhages, and the performance of automatic detection methods may be improved if regions containing vessels can be excluded from the analysis.

[2] Megha Lotankar, Kevin Noronha, Jayasudha Koti have proposed a method for Detection of Optic Disc and Cup from color Retinal Images for Automated Diagnosis of Glaucoma. In this paper the Detection of Optic Disc and Cup is important task in diagnosis the Glaucoma. Automated glaucoma detection system based on the four features vertical CDR, CDAR, H-V.CDR and RDAR is presented in this paper. This paper uses OD segmentation for accurate segmentation results. Finally by using SVM, NB and KNN classifier the fundus retinal images into Glaucoma class and Normal class.

[3] A.ELBALAOUI, M. FAKIR and K. TAIFI, A. MERBOUHA, has proposed a method on" Automatic Detection of Blood Vessel in Retinal Imag**es",** In this paper experimentations are performed on all three publicly available retinal image databases, namely, DRIVE, STARE and CHASE. In this they use a segmentation algorithm for detection purpose, before segmentation they apply image enhancements on retinal images for improve the quality of image. Algorithm for detection of blood vessels has the advantage that it is applicable to all types of retinal images, healthy as well as abnormal.

[4] Minal Wankhade and Dr. A. A. Gurjar have proposed "Analysis Of Disease using Retinal Blood Vessels Detection". In this paper they found the disease such as diabetes, glaucoma and hemorrhage on the basis of their segmentation. In this paper they used a proposed methodology such as Image acquisition, Image segmentation and feature extraction.

III. AN OVERVIEW

Blood vessels detection is an important but difficult task during surgeries. An unexpected location of a blood vessel or anatomical variations may results in an accidental injury to the blood vessel. This problem would extend the operation time or cause a serious complication. Following steps are used for blood vessel detection.

The first step is pre-processing of retinal image to improve the retinal images. To enhance the blood vessels we used vesselness filter in second step. In final stepHessian multiscale enhancement filter is designed from the adaptive thresholding of the output of the vesselness filter for vessels detection.

The proposed method for diseases detection consists of following main steps i.e. Pre-processing, Segmentation, Feature Extraction, Classifier.

A. Pre-processing

The main objective of pre-processing technique is to attenuate image variation by normalizing the original retinal image [3]. Pre-processing steps are as follows:

1) Image Resize: In this step we can change the image size. Resizing an image will not affect screen display.
2) RGB to HSV processing: HSV is a color model that is often used in place of RGB color model. By using HSV color model, a color is specified then white or black is added to easily make color adjustment.
3) Filtering: To reduce the distortion or noise in the image.
4) CLAHE: We use CLAHE because it can increase the contrast between contours.

B. Segmentation:

The goal of segmentation is to simplify an image into something that is more meaningful and easy to analyze. Retinal vessel segmentation is an essential step of the diagnosis of various eye diseases [3]. Segmentation is used in compression to compress different areas, segments of an image, at different compression quality. In this stage, blood vessels are segmented properly using Super pixel segmentation. Super pixel segmentation is used to reduce the input entities for the subsequent algorithm.

C. Feature Extraction:

Once the image is divided by using segmentation then we extract features in image. Feature Extraction plays a very important role in the area of image processing. The main goal of Feature Extraction is to obtain more relevant information in a lower space. We use HOG technique to extract features. HOG calculates gradient magnitude and gradient angle for each pixel in a block.

D. Classifier:

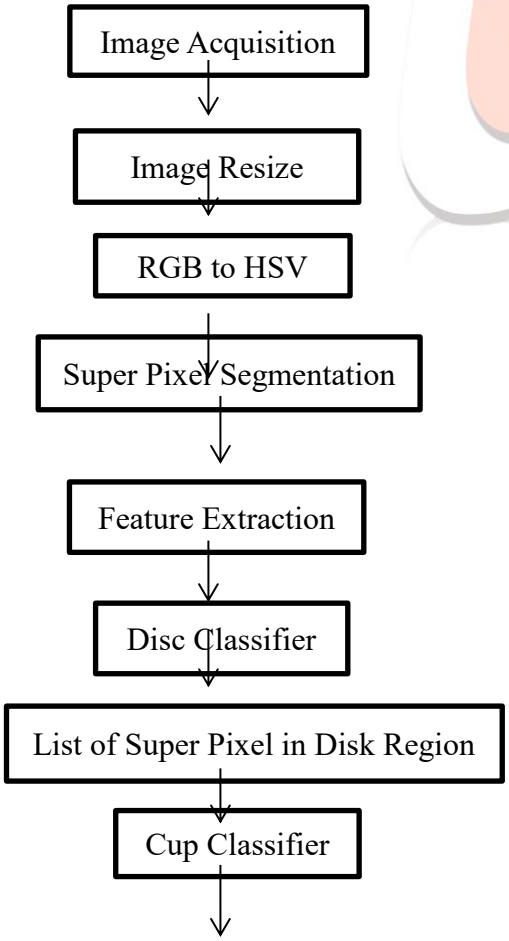
In our methodology, we use Random Forest classifier. Random Forest is a flexible, ease to use machine learning algorithm that produces, even without hyper parameter tuning, a great result most of the time. This classifier is used for both classification and regression tasks. Another great quality of Random Forest algorithm is that it is very easy to measure the relative importance of each feature on the prediction.

- **Advantages of Random Forest:**

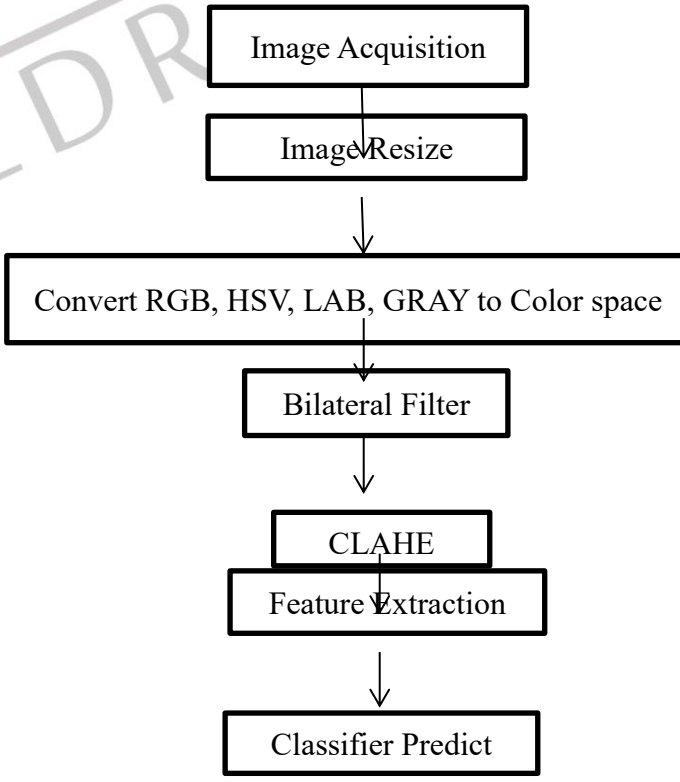
1. The over fitting problem never come when we use the RF algorithm in any classification problem.
2. The RF algorithm can be used for feature engineering.

IV. METHODOLOGIES USED IN DISEASE DETECTION

FLOW CHART OF GLAUCOMA



FLOW CHART OF DIABETIC RETINOPATHY



List of Super Pixel in Cup Region

V. RESULTS AND DISCUSSION

The important step in the detection of glaucoma and diabetic retinopathy is the blood vessel segmentation. The risk of cardio vascular diseases can be identified by measuring the blood vessels. The identification of the wrong blood vessels may lead to a wrong diagnosis result. A retinal image provides a good diagnostic approach of what is happening inside the human body. By analyzing the humans retinal image one can able to identify cardio vascular condition of the body.

Diabetic retinopathy (DR) and glaucoma are two most common retinal disorders that are major causes of blindness. In this project for detection of Glaucoma we take vertical ratio of cup region and vertical ratio of disk region. If the ratio is more than 0.5 then Glaucoma is detected otherwise it is a normal eye. Depending on the presence of specific DR features, the stages can be identified.

In this article, the proposed method is implemented in Ubuntu version 16.04. All codes are written in Open CV. We worked on DRISHTI & KAGGLE database to detect the blood vessels and diseases in retinal images like Glaucoma and Diabetic Retinopathy.

EXPERIMENTAL RESULTS FOR BLOOD VESSELS DETECTION

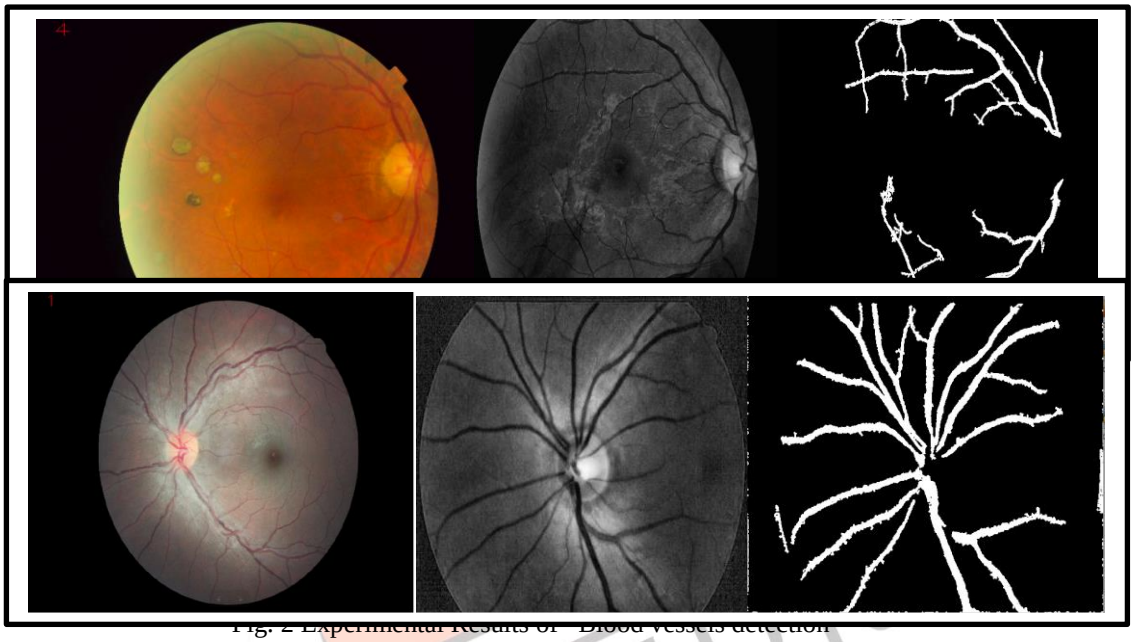


Fig. 2 Experimental Results of Blood vessels detection

EXPERIMENTAL RESULTS FOR GLAUCOMA

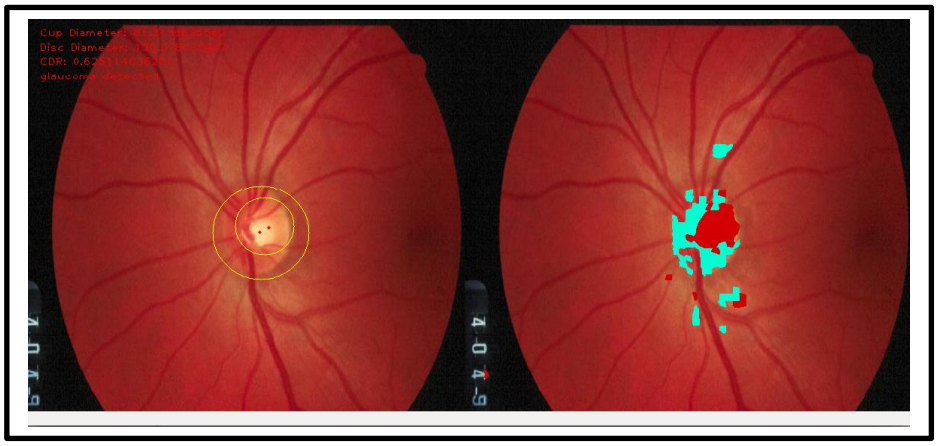
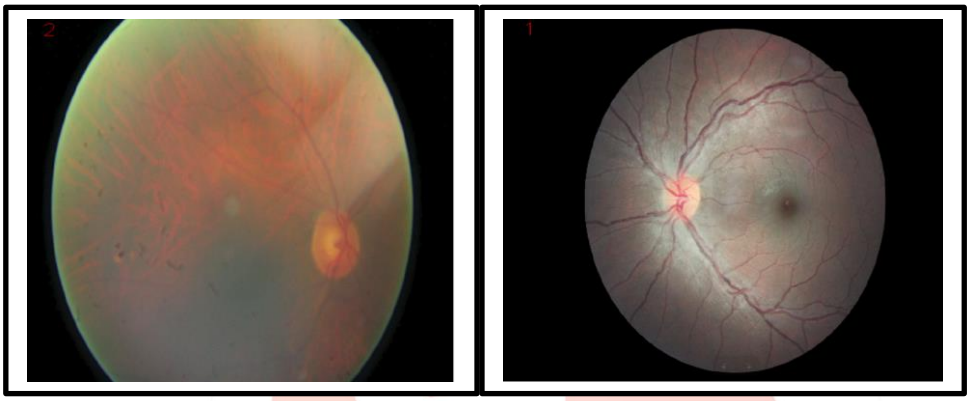
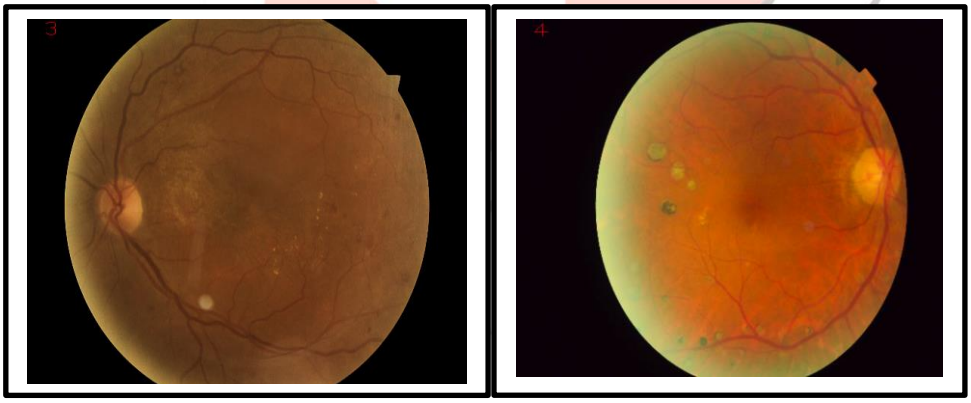


Fig. 3 Outputs for Glaucoma

EXPERIMENTAL RESULTS FOR DIABETIC RETINOPATHY



a) Mild NPDR b) Moderate NPDR



c) Sever NPDR d) Proliferative DR

fig. 4 Stages of Diabetic Retinopathy

VI. CONCLUSION

Retinal images are being used by ophthalmologists to aid in diagnoses and to look for change in severity of diseases. The appearance of blood vessel is an important indicator for many diagnoses, including diabetes, arteriosclerosis. Assessment of blood vessels in human eye allows earlier detection of eye diseases such as glaucoma and diabetic retinopathy.

In this article we explore Segmentation methods for the purpose of detecting Glaucoma and Diabetic Retinopathy. This work determines the presence of glaucoma and diabetic retinopathy by applying techniques of digital image processing on fundus images taken by the use of medical image camera by medical personnel in the hospital. We tested our technique on database like DRISHTI and KAGGLE. This method gives clearer and more accurate output for ophthalmologists and retinal image diagnosis. The proposed method is applicable to all types of retinal images, healthy as well as abnormal. The results that we achieve on data base are higher than other methods.

VII. **ACKNOWLEDGEMENT**

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REFERENCES

1. Minal B. Wankhade and Dr. A. A. Gurjar, "Analysis Of Disease using Retinal Blood Vessels Detection", IJECS, Volume 05 Issue 12 Dec., 2016.

2. Shilpa Joshi, Dr. P. T. Karule, "Retinal Blood Vessel Segmentation", IJEIT, Vol1, Issue 3, March 2012.

3. Archna Sharma, Hempriya,"Detection of Blood Vessels and Diseases in Human Retinal Images", International Journal of Computer science and Communication Engineering IJCSCE Special issue on "Emerging Trends in Engineering & Management", IECTE 2013.

4. Seyed Mohesen Zabihi, Hamid Reza Pourreza, Touka Banaee, "Vessel Extration of Conjuctival Images Using LBPs and ANFIS", International Scholarly Research Network, ISRN Machine vision, vol. 2012, Article ID 424671,6pages.

5. Jaspreet Kaur, Dr. H. P. Sinha , "An Effective Blood Vessel Detection Algorithm for Retinal Images using Local Entropy Thresholding", (IJERT), ISSN:2278-0181, Vol. 1 Issue 4, June 2012.

6. Asha Gowda Karegowda, Asfiya Nasiha, M. A. Jayaram, A. S. Manjunath, "Exudates Detection in Retinal Images using Back propagation Neural Network", vol. 25- No. 3, july 2011.

7. A. Osareh, B. Shadgar, " Automatic Blood Vessel Segmentation In Color Images Of Retina", Iranian Journal of Science & Technology, Transsction B, Engineering, vol. 33, No. B2, pp 191-206, 2009.

8. Chaudhuri, S., Chatterjee, S., Katz, N., Nelson, M., and Goldbaum, M., Detection of blood vessels in retinal images using two-dimensional matched filters. IEEE Trans. Med. Imag. 8(3):263–269, 1989.

9. Deepa Patil, Bharti Patil, "An Ensemble based System for Detection of Retinal Microaneurysms and Diabetic Retinopathy", International Journal of Electronics Communication and Computer Engineering Volume 5, Issue (4) July, Technovision-2014, pp-214-218 ISSN 2249–071

10. Shradha Mirajkar and M. M. Pati, "Feature Extraction of Diabetic Retinopathy Images" ,International Journal of Computer Applications® (IJCA) (0975–8887) Proceedings on Emerging Trends in Electronics and Telecommunication Engineering (NCET 2013).

11. R.Radha and Bijee Lakshman,".setinal image analysis using morphological process and clustering technique". Signal & Image Processing : An International Journal (SIPIJ) Vol.4, No.6, December 2013.

12. Ketki S. Argade, Kshitija A. Deshmukh, Madhura M. Narkhede, Nayan N. Sonawane, Sandeep Jore, "Automatic Detection of Diabetic Retinopathy using Image Processing and Data Mining Techniques", 2015 International Conference on Green Computing and Internet of Things(ICGCIoT).

13. Amol Prataprao Bhatkar, Dr. G.U.Kharat, "Detection of Diabetic Retinopathy in Retinal Images using MLP classifier", 2015 IEEE International Symposium on Nano electronic and Information System, DOI 10.1109/iNIS.2015.30.