Hybrid Algorithm of Retinal Blood Vessel Detection, Health Estimation, Optic Disc Segmentation and Glaucoma Detection

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***Abstract*— Human Eye is one of the most important sensor organs of human being, thus diseases and aliments of human Eye have a most important on a patient's life and thus advanced detection and prevention techniques are required, Diabetes is a contributing factor in causing eye aliments and catalyzing them. Two of the major eye diseases that possess saver threat to vision are Glaucoma and Micro-aneurysm. Glaucoma causes damage to the eyes optic nerve and worsens with time. Glaucoma has no early symptoms as pain, if continues untreated can cause per moment loss of vision micro-aneurysm is a swelling that occurs in the wall of capillary blood vessels. These small swelling may reports and allow blood leak in near by tissue. People suffering from diabetes may get micro aneurysm in the retina and can progress into vision loss. As Glaucoma and Micro aneurysm are not can able, but preventable diseases there early detection is the key for good prognosis on this work. We have propose on advanced algorithm using combination of image processing and artificial intelligence for early detection of Glaucoma and Micro Aneurysm. The steps accomplished are retinal blood vessel detection, Optic Disc segmentation optic disc and Optic cup detection CPR (cup disc ratio) computation and use of artificial neural network for training prediction.**

Keywords*— *Optic disc, Optic cup, Retinal image analysis, Glaucoma detection, Micro Aneurysm detection, Image analysis.

I. INTRODUCTION

The human eye is an important organ that reacts to light and has many purposes. The eye has a number of components which include, but are not limited to, the cornea, iris, pupil, lens, retina, optic nerve, choroid and vitreous. The eye does not have the shape of a perfect sphere; Rather, it is a unit merged into two parts. The smaller, transparent and curved frontal unit, called the cornea, is linked to the larger white unit called Sclerus. The eye is composed of three layers: (1) Extreme layer: the outermost layer, known as the fibrous tunic, is composed of the cornea and the scleral. 2) Intermediate layer - The central layer, known as the vascular tunic, consists of the choroid, the Ciliray body and the iris. 3) Inner layer - The deepest is the retina, which gets its circulation from the vessels of the choroid as well as retinal vessels, which can be seen in an ophthalmologist. The retina is an internal part of the eye. In the center of the retina, there is the optical disc, circular to oval. From the center of the optic nerve radiates the major blood vessels of the retina. The network of blood vessels is an important anatomical structure in the human retina, which makes it possible to recognize different types of diseases. However, manual detection of blood vessels is not simple because the vessels in the image of the retina are complex and have low contrast. For an ophthalmologist of the retinal anatomy, an ophthalmoscope is used. The image of retinal fundus is widely used in the diagnosis and treatment of various diseases such as diabetic retinopathy and glaucoma. There are different types of ocular diseases, such as cataract, iris, cyclite, corneal molecule, glaucoma and diabetic retinopathy. Here we see the three types of disease description Diabetes: Diabetes is a long-term condition that causes high levels of blood sugar. Diabetes is a serious complex condition.

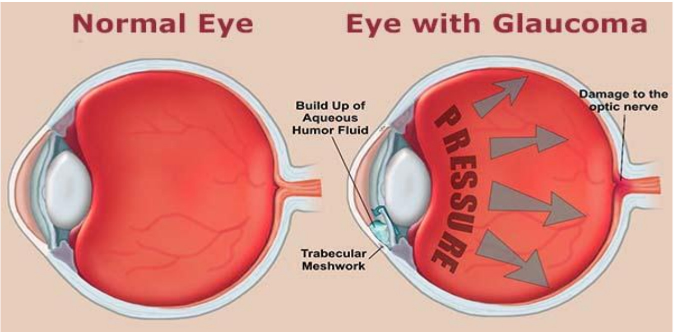

Fig1.:Eye with and without Glaucoma

That can affect the whole body. When someone has diabetes, his body can not maintain healthy levels of glucose in the blood. Glucose is a form of sugar that is the main source of energy for our body. Glaucoma: Glaucoma is a group of eye diseases that in most cases produce increased pressure in the eye, if left untreated, the patient may lose vision and even become blind. This high pressure is caused by a fluid backup in the eye. Hemorrhage: An eye disorder in which bleeding occurs in the light-sensitive tissue on the fundus of the eye. Retinal haemorrhage may be caused by arterial hypertension, occlusion of the retinal vein (blockage of a retinal vein) or diabetes (which causes the formation of small, easily damaged blood vessels). Checking for changes in images of the retina in a special period can help the doctor diagnose the disease. Applications of retinal images diagnose the progression of certain cardiovascular diseases, diagnosing the region without blood vessels (Macula). The analysis of the retinal image is a complicated task, notably due to the variability of the images in terms of color, morphology of the retina The anatomical pathological structure and the existence of particular characteristics in different patients, which can lead to Misinterpretation. A. Motivation The detection of retinal blood vessels for the diagnosis of the disease has provided more information about blood vessels and retinal disease. Compared to the other more traditional technology, detection of retinal blood vessels for disease diagnosis has strong resistance to counterfeiting, small imaging devices, low cost, easy collection of Images with a universal use of contactless and livens. Moreover, because the blood vessels are located inside the living body, the disease identification system is less affected by the external environment of the skin (skin disease, moisture, dirt, etc.). Therefore, retinal blood vessels for disease identification are considered one of the most promising solutions for the diagnosis of the disease in the future.

II. LITERATURE REVIEW

The main contribution of the document is to derive an optimal method for segmentation of the optical disk and the optical cut and the detection of the cup and disk limit to calculate the ratio of the cup to the disk. The cut-to-disk ratio is an important parameter for the detection of glaucoma. The method used in this article uses the ratio of cup to disk as a parameter for the detection of glaucoma and the results are validated by a medical ophthalmologist. In addition, the document is organized as follows. Section II describes the important parameters related to the image of the fundus of the eye and the changes that occur as a result of glaucoma. Section III describes the steps of pretreatment of the processing of the background image. The following section describes the segmentation of the optical cup and the optical disk. Section V describes the detection of limits. In section VI, the evaluation of the vertical ratio of the cup to the disk is carried out. Finally, Section VII presents the conclusion and future work that may be possible in this area .[1] In this paper, selections of optical discs and optical segments based on super-pixel classification for glaucoma screening have been presented. This article is presented and evaluated for the detection of glaucoma in patients using multimodalities, including a simple linear iterative grouping algorithm (SLIC), K-Means clustering and Gabor filter of the color-colored camera image to obtain A precise delimitation of the boundaries. Using structural characteristics such as CDR (Cut to Disc Ratio), the value of the ratio exceeds 0.6 should be recommended for further analysis of a patient to the ophthalmologist. This will help patients around the world by protecting a further deterioration of vision through timely medical intervention. We can increase the number of patients and analyze the performance.[2] In this study document, the various image processing techniques used for the detection and diagnosis of glaucoma were compiled. The main objective here is to highlight the extensive research conducted in this area and to highlight the seriousness of this disease.
Later, the techniques mentioned in this study document can be verified for their effectiveness by applying them and testing them on a large sample of data. Various factors such as the area of the neuroretinal rim, the ratio of cup to disc, etc., have been found to indicate the severity of glaucoma. It is therefore necessary to have an effective image processing technique to calculate the various factors which are the indicators of the severity of glaucoma.[3]In this article, a method for the diagnosis of glaucoma, based on the segmentation of ONH images of the retina, is proposed. Our frame is able to precisely extract the cut and the rim of the optical disc to extract high level geometric features. The values obtained are then used as input for a machine learning classifier, responsible for the detection of glaucoma, due to a new retinal image. Our approach has been designed for the detection of glaucoma under real conditions. Experiments on various data sets were carried out to evaluate our scheme with different cameras and resolutions, and color and black and white images. The proposed method has achieved high accuracy rates that surpass the state-of-the-art methodologies in real-world conditions when small training packages are available. The experiments also validated the use of geometric features for the detection of glaucoma and in addition to the methods based on appearance. As a future work, a diagnostic study will be carried out to ensure the validity of our conclusion on a larger scale and the potential of our framework for the detection and diagnosis of glaucoma in real life[4]

III. METHODOLOGY

Image processing- In Image Processing we find four result ratinal blood vessel, optic disc segmentation, optic disc & optic cup detecetion, CDR (cup to disc ratio).
The RGB image obtained from the fundus camera after pre-processing is separated in to its component images. Red, Green and Blue channels. On separating the RGB image in to its components, the green channel is found to exhibit a better contrast level. So only the green channel is selected for further processing. The contrast of the green channel is further increased by adding the image to the top-hat filtered image, and then subtracting the bottom hat filtered image from the same. This contrast enhanced image of the green channel is shown in Figure. This image is then converted in to a gray scale image and its histogram is computed. Later on, histogram equalization is performed on this image. Now bit plane slicing is done on the image to decompose it into its bit planes. The lower order bit planes are preserved for further processing and the higher order ones are discarded. Bit plane 0 is now opened by a suitable disc shaped structuring element to obtain a clear dark region corresponding to the macula. This image is then complemented to take advantage of a white region corresponding to the macular region. Again an opening operation is performed with a disk shaped structuring element to obtain an image. A suitably processed bit plane 1 can be used to compensate for errors, if any, in the previous operation.

2. Artificial intelligence- According to the father of Artificial Intelligence John McCarthy, it is “The science and engineering of making intelligent machines, especially intelligent computer programs”. Artificial Intelligence is a way of making a computer, a computer-controlled robot, or a software think intelligently, in the similar manner the intelligent humans think. AI is accomplished by studying how human brain thinks, and how humans learn, decide, and work while trying to solve a problem, and then using the outcomes of this study as a basis of developing intelligent software and systems.

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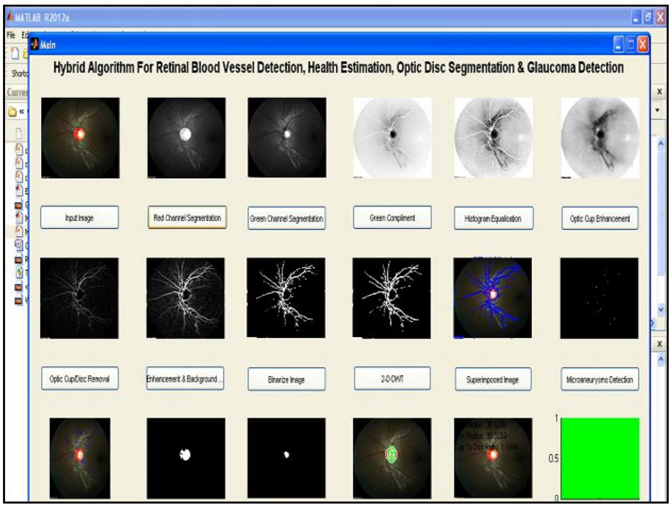


Fig 2: Hybrid algorithm for retinal booled vessel detection

The Levenberg-Marquardt Method The Levenberg-Marquardt algorithm adaptively varies the parameter updates between the gradient descent update and the Gauss-Newton update, h J TWJ + λI i hlm = J TW(y − ˆy) , (12) where small values of the algorithmic parameter λ result in a Gauss-Newton update and large values of λ result in a gradient descent update. The parameter λ is initialized to be large so that first updates are small steps in the steepest-descent direction. If any iteration happens to result in a worse approximation (χ 2 (p + hlm) > χ2 (p)), then λ is increased. Otherwise, as the solution improves, λ is decreased, the Levenberg-Marquardt method approaches the Gauss-Newton method, and the solution typically accelerates to the local minimum In Marquardt's update relationship h J TWJ + λ diag(J TWJ) i hlm = J TW(y − ˆy) , (13) the values of λ are normalized to the values of J TWJ. The Levenberg-Marquardt algorithm implemented in the Matlab function lm.m In this section, the use of lm.m is illustrated in three curve-fitting examples in which experimental measurements are numerically simulated. Noisy experimental measurements y are simulated by adding random measurement noise to the curve-fit function evaluated with a set of "true" parameter values ˆy(t; ptrue). The random measurement noise is normally distributed with a mean of zero and a standard deviation of 0.50. yi = ˆy(ti ; ptrue) + N (0, 0.50). (26) The convergence of the parameters from an erroneous initial guess pinitial to values closer to ptrue is then examined. Each numerical example below has four parameters (n = 4) and one-hundred measurements (m = 100). Each numerical example has a different curve-fit function ˆy(t; p), a different "true" parameter vector ptrue, and a different vector of initial parameters pinitial. For several values of p2 and p4, the log of the reduced χ 2 error criterion is calculated and is plotted as a surface over the p2 − p4 plane. The "bowl-shaped" nature of the objective function is clearly evident in each example. The objective function may not appear quadratic in the parameters and the objective function may have multiple minima. The presence of measurement noise does not affect the smoothness of the objective function. The gradient descent method endeavors to move parameter values in a down-hill direction to minimize χ 2 (p). This often requires small step sizes but is required when the objective function is not quadratic. The Gauss-Newton method approximates the bowl shape as a quadratic and endeavors to move parameter values to the minimum in a small number of steps. This method works well when the parameters are close to their optimal values. The Levenberg-Marquardt method retains the best features of both the gradient-descent method and the Gauss-Newton method. The evolution of the parameter values, the evolution of χ 2 ν , and the evolution of λ from iteration to iteration is plotted for each example. The simulated experimental data, the curve fit, and the 99-percent confidence interval of the fit are plotted, the standard error of the fit, and a histogram of the fit errors are also plotted. The initial parameter values pinitial, the true parameter values ptrue, the fit parameter values pfit, the standard error of the fit parameters σp, and the correlation matrix of the fit parameters are tabulated. The true parameter values lie within the confidence interval pfit − 2.58σp < ptrue < pfit + 2.58σp with a confidence level of 99 percent.

IV RESULT

We have tested over proposed system on a dataset of fudus images, collected from Mahatma Gandhi University of Medical Sciences and Technology, Jaipur ten nos of Glaucoma effects and ten nos of healthy image have been used for artificial neural network and training randomly two Glaucoma effected and two healthy images have been selected from the image dataset to check the accuracy and validity of our proposed. the test image taken are.

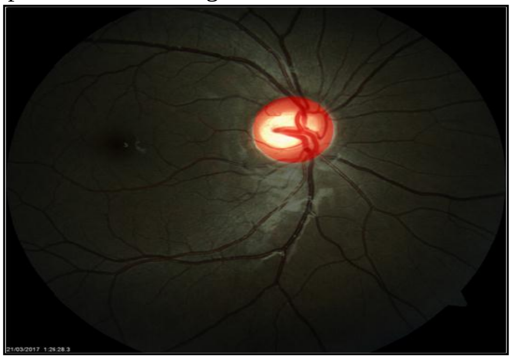


Fig 3: Healthy eye of Kunal yadav

Fig 4: Healthy eye of Mridul Agarwal

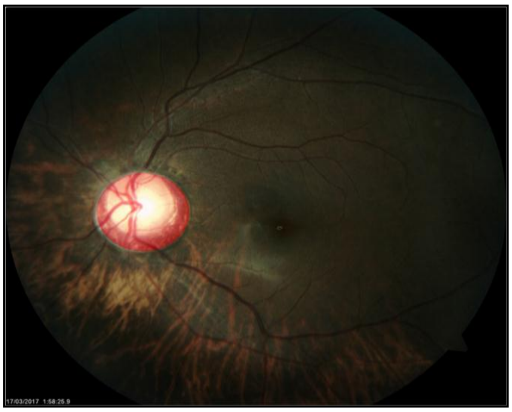


Fig 5: Glaucoma image of Naresh Dulani

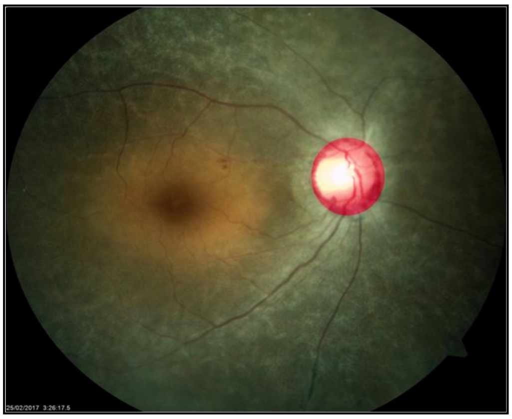


Fig 6: Result of Tara

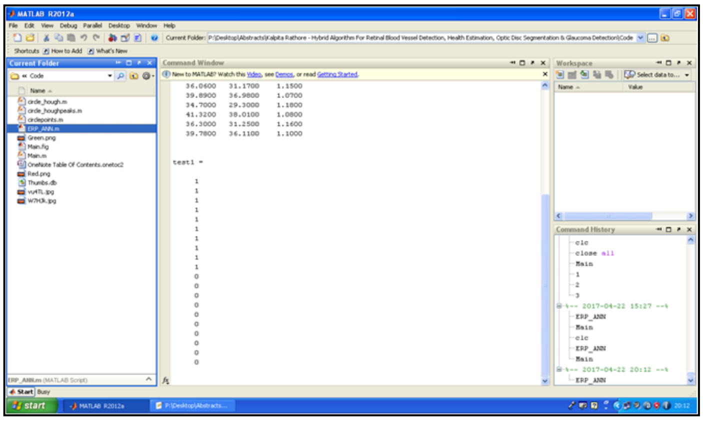
S.No.	Patient name	Micro-Aneurysms area	ANN Glaucoma Prediction	ANN Glaucoma Prediction Round off
1	Kunal Yadav	1059	0.0113	0
2	Mridul Agarwal	946.6250	5.1965e-04	0
3	Naresh Dulani	1.3115e+03	1.0479	1
4	Tara Devi	2.4094e+03	0.9943	1

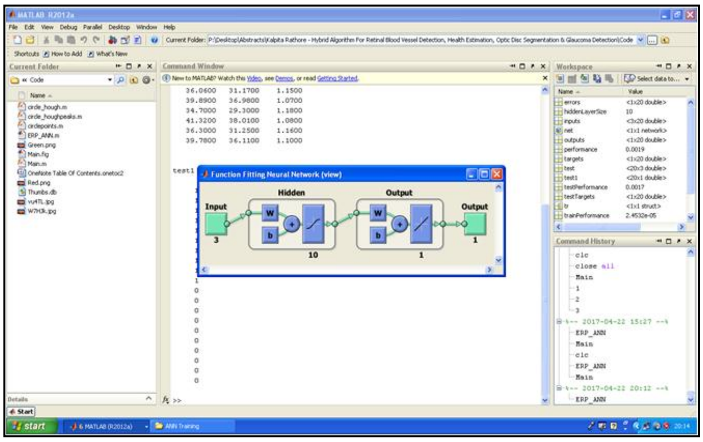
Table 1: Micro-aneurysms and glaucoma Detection Statistics

S. No.	Patient name	ANN Prediction	Clinical Glaucoma	Error
1	Kunal Yadav	0	0	0
2	Mridul Agarwal	0	0	0
3	Naresh Dulani	1	1	0
4	Tara Devi	1	1	0

Table 1: Comparison of our proposed system to clinical Diagnostic

ANN Training:





V CONCLUSION

Glaucoma and Micro-Aneurysm are vision threatening diseased and Diabetic patients fall in high risk category for acquiring these diseases. As these diseases have. Very fewer no symptoms until later storage and are notorious to cause permanent blindness early detection and prevention of these disease is a vital factor in patient relief. Traditionally detection of these aliments is done by retinal imagery also known as fundus imaging is observed by trained and experienced ophthalmologist to determine the presence of these aliments.

S. No	Parameter	Base Paper	Our Proposed Method
1	Disease Detected	Glaucoma	Glaucoma, Micro-aneurysm
2	Glaucoma Detection Method	Cup to Disk Ratio(CDR) Thresholding	Artificial Neural Network Trained With Cup Radius, Disk radius & CDR
3	Micro-aneurysm detection method	NA	2D DWT with Binary Image Area Computation
4	Glaucoma detection accuracy	90%	99%
5	Interface	Generally Command Based	GUI based UI with intermediate results

Table : Comparative Table of Our Proposed Method with Base Paper

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With the advancement of computer sciences, Image processing offers a new approach to the same detection process by completely automating the entire process of Fundus Image acquisition, Disease detection and classification. We have used artificial neural networks in conjunction of the results obtained from Image processing to detect and classify the disease accurately rather than manual thresholding of CDR. As observed in the results, our method provides improved accuracy And manual CDR thersholding along with micro aneurysm detection. As below all table's result we found the value of average of errors are 0, because of given data by Mahatma Gandhi Medical College Jaipur, is matched with our data which was found by our operation in this paper.

VI FUTURE SCOPE

The proposed system has been able to detect the presence of Glaucoma and micro aneurysm through image processing and artificial intelligence thus greatly reducing the blood ophthalmologists and technicians but a lot of evolution is under way in medical fraternity computer sciences. The proposed system is a promising technology and more dimensions can be added in future use. One of prime improvement can be addition of cataract protection and staging technique along with Glaucoma detection. Also the machine intelligence systems can be trained from vied data sets, from various ethincities, geographical locations, occupational groups and thus to identity and detect disease more accurately conveyancing the effects of these factors. Also the machine intelligence systems can take medical history of diabetes high blood pressure etc, to augment the accurate detection and early prediction of eye diseases.

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