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Survey of Neovascularization on Optic Disk Region

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ABSTRACT: Diabetes is the most leading disease increases day by day. Due to diabetic condition a patient suffer from many other physical problems, out of those Diabetic retinopathy is one disease which causes the alternation in the blood vessel of the retinal optic disk of patient eye. These uncommon retinal blood vessels increase prominently and may cause the permanent vision loss. So it is significance to recognition the retinal uncommon blood vessels at its initial stage. The detection unexpected retinal blood vessels in the optic disk are very complex process. In the proposed paper we conduct survey on different techniques for image analysis used in ophthalmology for disease detection. A simple neovascularization detection model is designed in the proposed paper, various image enhancement models are adopted to increase the quality of medical image further segmentation and feature extraction method increase the overall working ability of the system. A decision based classification algorithm is used for disease detection.

KEYWORDS: Retinal Fundus Images, Segmentation, Feature Extraction, Classification.

I. INTRODUCTION

Retina is one of the most significant internal components of eye. Severe disease is occurred if any damage in the retina, this retinal damage leads to the special disease. These diseases are very harmful if it not detected at its early stage. To diagnose the retinal disease an optic imaging techniques used in medical sector. The resultant image from optic imaging is termed as fundus image. A special ophthalmoscope medical device is used to capture the fundus images, these images are analyzed by the skilled doctor. Usually fundus image consist of Red, Green and Blue pixel value of retinal image, based on the image obtained from optic imaging doctor can identify the disease [01]. Blood vessels present the retina supply the efficient level of blood and oxygen to the retina, if supplies are not smooth then it indicates several severe diseases such as hypertension, diabetes and stroke [02].

According to the survey 80% of the patient suffering from diabetes, it leads to diabetic retinopathy (DR). The early detection of diabetic retinopathy is very important, in fact if it not identified or treated at it initial stage than patient may be blind completely. The retinal disease classified into two parts i.e. Non – Proliferative diabetic retinopathy (NPDR) and Proliferative diabetic retinopathy (PDR). In NPDR microaneurysms, blot hemorrhages and dots are present in the retina. In PDR new abnormal blood vessels are grown in the inner surface of the retina. The formations of new blood vessel are classified into two parts, first one is neovasculature of the optic disk and second one is neovascularisation elsewhere in the retina. The advanced stage of diabetic retinopathy leads to the PDR, the growth of the blood vessels prevent the light to pass through the retina. This prevention of light to retina causes a bad vision [01].

The application of image processing in medical sector improve the quality of acquired medical image, a series of image preprocessing techniques are applied to enhance the color image. This preprocessing technique enhances the visual quality of the image, remove the noise present in medical data set and help the physician to identify the disease.

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(a) (b)

Figure 1: (a) Retinal Fundus Image of Normal Eye; (b) Rentinal Fundus Image of PDR

The above Figure 1 gives the internal retinal structure of the normal eye and retinal fundus image of eye affected by the PDR and their resultant vision image is shown Figure 2. The person suffer from diabetic will defiantly affected by the PDR, hence it is necessary to detect the neovascularisation at its initial stage for better results.

(a) (b)

Figure 2: (a) Normal Vision; (b) Vision with Diabetic Retinopathy

The proposed paper list the survey on various image processing techniques used to detect the neovascularisation on optic disk region, a list of algorithm used in different model is summarized in below survey section. Based on the survey result a new model is designed for better detection of neovascularisation.

II. LITERATURE SURVEY

Various researches are done on retinal disease identification where Gopal Datt Joshi et.al [03] proposed automatic segmentation methods for color retinal images to detect the Glaucoma disease. Optic disk examination is one of the standard methods used in glaucoma detection. Based on the segmented optic disk and cup regions, paper explains the efficient automatic OD techniques. In referred paper a novel optic method is used for integration of retinal image information present around the optic disk region. For a bend blood vessels a novel cup segmentation method is used, along with that region of support concept is used for detecting the bended vessels. The performance of the referred model is analyzed by using 138 retinal images, out of 138 images 33 are normal image and 105 are affected glaucomatous images. The result is estimated in the form of mean to standard deviation ratio.

Bhausahed Shinde et.al [04] proposed different image filtering methods to remove the noise present in medical images. In the paper the experimental work is conducted on MRI, Cancer, Brain and X –ray images. The paper explain the different filtering techniques such as max and min filter, midpoint filter, Alpha – trimmed filter and adaptive median filtering. The performance of each filtering technique is calculated for different medical images. Finally paper concluded that accuracy of the MRI, Cancer and X-ray images depends on the noise present in the image and filtering technique applied during examinations.

SujithKumar S B et.al [05] proposed automatic microneurysms detection of retinal fundus images. In diabetic retinopathy microneurysms indicate the initial stage of the retinal disease. Microneurysms are the small red dots present at the retinal fundus image, physician identify the severity of the disease based on the number of microneurysms present at the fudus images. In the referred automatic detection of diabetic retinopathy (ADDR) is designed with colored retinal images. The referred model is divided into parts i.e. Pre processing, feature extraction and classification. In pre processing method input colored retinal images converted into gray scale, contrast

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enhancement is done to improve the quality of medical image and binaries the enhanced image. Feature extraction is used to collect the detail information of the retinal image. Finally patient severity condition is justified by using a classification method. The performance of the referred paper is represented in the form of sensitivity and specificity and the respective value is given as 94.44 % and 87.5 %.

M. Usman Akram et.al [06] has proposed a automatic detection of neovascularisation in retinal fundus images. The model is designed with multivariate m- mediods based classifier. Proliferative diabetic retinopathy is the condition where new blood vessel is formed. In that condition it is very difficult for the physician to identify the normal and abnormal blood vessels. The referred paper proposed a technique to detect abnormal blood vessels. A multilayered thresholding and Hough transform technique is used to extract vascular pattern from the retinal fundus images. Experiment is conducted on four different medical data sets i.e. DRIVE, STARE, DIARETDB and MESSIDOR. Multivariate m- mediods based classifier increase the system accuracy to 97.53%, 97.75% and 98.24 for respective database.

Jack Lee et.al [07] has proposed fractal and texture based neovascularization disease detection model. The model includes high order spectrum analysis, statistical texture analysis. Along with that system accuracy in identification of the new blood vessels is improved by using fractal dimension methods. In referred paper the practical experiment is conducted on MESSIDOR and DIAREDB0 database. MESSIDOR data base include 1200 colored retinal fundus images in TIFF format where as DIARETDB0 database contain 130 color retinal fundus images. Out of 130 fundus image 20 are healthy retinal images where as 110 retinal fundus images are diabetic retinopathy images. A pre processing technique increase the quality of input NVD images, further HOS (high order spectrum analysis), SA (statistical texture analysis) and FD (fractal dimension) method is used to extraction features from the input image. Logistic regression classifier method is used for disease prediction.

Ana Salazar Gonazalez et.al [08] has proposed novel based blood vessel and OD segmentation method in the fundus retinal images. Blood vessel and OD are two important part considered in modern ophthalmology. A graph cut technique is used to extract the retinal vascular tree. Location of OD estimated based on blood vessel information. There are two alternative techniques are used in optic disk segmentation. The Markov random field (MRF) and Compensation factors are two methods, where blood vessel from the OD is removed by MRF method. The performance of referred model is tested by using three datasets, DIARETDB1, DRIVE and STARE.

Dharmanna Lamani et.al [09] has proposed fractal dimension based automated neovascular glaucoma detection model. Fractal structure of retinal fundus image is extracted by using box – counting method. A set of preprocessing technique include color conversion of fundus image, filtering to remove the noise present at the medical image. Based on the fractal dimension method healthy retinal vessel are recognized within the range of 0.988 to 1.61, whereas abnormal blood vessels are identified above 1.61 to 1.99.

Anupriyaa Mukherjee et.al [15] proposed model to detect and diagnose the diabetic retinopathy. In the referred model a set of retinal fundus images used as input, the designed system made the classification that given is normal or affected by the DR. In pre – processing method input retinal RGB image is converted into HSI color plane, noise present in the retinal image is minimized by using median filter. The quality of the retinal image is enhanced by using adaptive histogram equalization. A thresholding technique is used for OD segmentation, which divide the retinal image into foreground and background form. In the referred model blood vessels extracted by using morphological operation, further exudates edges are detected by using dilation operation. The over model is designed in MATLAB tool, at lastly author conclude that used algorithm gives better accuracy with less computing time.

Table 1: Survey on Different Image Analysis Algorithm used in Retinal disease diagnosis

Title	Year	Algorithm	Advantage	Performance
Automated Early Detection of Diabetic Retinopathy Using Image Analysis Techniques [10]	2010	Fuzzy C- mean Clustering, Retinal grading Algorithm and Neural Network	Optimal vessel extraction	Helps in prediction of the severity of disease
A Segment based Technique for detecting Exudates from Retinal Fundus image [11]	2012	PCA and Support Vector Machine	Produce effective and identical result	Improve the sensitivity up to 97.1% and specificity 98.3%
Detection of Hard Exudates in	2012	Contextual clustering and	Recurrent neural	CC segmentation and

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Color Fundus Images of the Human Retina [12]		Echo State Neural Network	network classify the lesion with good result	Classifier increase the sensitivity of the system
Automated Detection of Diabetic Retinopathy in Fundus Images [13]	2015	Color space transformation and morphological filtering	Positive economical benefits	Automated early detection of DR
Automated Detection System for Diabetic Retinopathy Using Two Field Fundus Photography [14]	2016	Contrast Limited Adaptive Histogram Equalization and thresholding	Improve the diagnosis accuracy	Sensitivity 80% and Specificity 50%

Pavitra G et.al [16] has proposed automatic Neovascular Glaocoma diagnose system using image analysis methods. Neovascular glaucoma is one of the major disease present in diabetic patients, so it important to identify the disease at it early stage to reduce vision loss progression. In the referred paper author designed a model with image feature fractal method to diagnosis Neovascular Glaocoma. Healthy and neovascular retina is easily identified by unique parameter i.e. fractal dimension. For the disease classification a support vector machine learning algorithm is implemented. In Result section a healthy retina is ranged within 1.20 to 1.70 where as affected neovascular glaucoma exceeds the upper limit.

The literature survey reveals that research is conducted on various image analysis techniques are used to meet efficient retinal disease diagnosis prediction. Application of image processing in medical filed reduces the human error in disease prediction. Usually disease prediction related with retina is very complex process. Below section briefly explain the intermediate blocks used for neovascular disease detection.

III. OVERALL SYSTEM BLOCK DIAGRAM

Based on the survey, over system block diagram is shown in Figure 3. A real time NVD image is considered as input for practical examination, the colored input image is pre processed to enhance the quality of the input image. This pre processing method includes color conversion, filtering techniques to remove the noise present in the digital medical images. After pre processing, the enhanced image is transferred to segmentation block to separate the optical disk and blood vessels.

The various image segmentation techniques are used in medical filed for blood vessel extraction like Kernel based fuzzy c-means algorithm. Further segmented retinal image transferred to the feature extraction block to collect the relevant retinal information of the input NVD image.

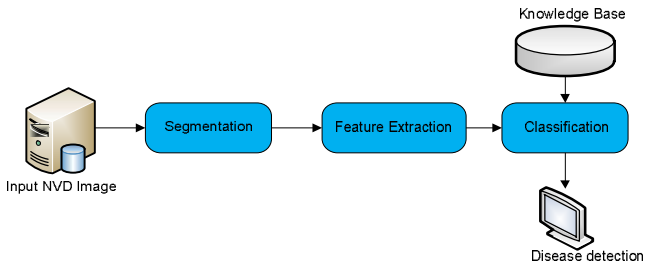

Figure 3: Overall System Architecture

Collected input features of NVD image is compared with the knowledge base using machine learning algorithms. Based on the comparison a classifier detects the affected NVD images. The overall model is simple and reduces the mathematical computation involved in neovascularization detection and helps the physician to identify abnormal blood vessels at its initial stage. The expected result of the above block diagram is shown in below section.

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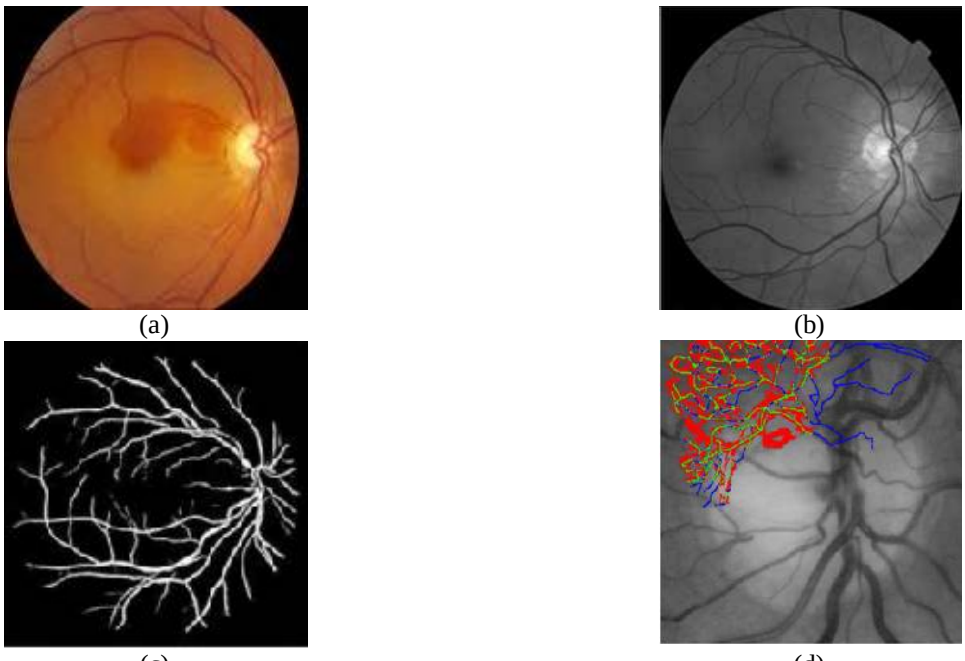
IV. EXPECTED RESULT

The real time colored retinal NVD input image is pre processed as to suit further image analysis techniques. Segmentation method extracts the blood vessel and separates the optic disk from the input retinal image. Feature extraction methods increase the system accuracy in identification of the abnormal blood vessels, the intermediate expected result of the above system is represented in Figure 4.

V. CONCLUSION

Application of image analysis techniques in medical sector, increase quality service and reduce the cost related with medical treatment. Disease detection related with retina is very complicated process and it is very difficult for the physician to recognize the disease at its early stage. Form the survey we conclude that used image analysis techniques reduces the human error related with neovascular disease detection and it helps the doctor to distinguish healthy blood vessel and abnormal blood vessel present in retinal optical disk. Segmentation, feature extraction method and decision based classifier increase the overall system performance.



(a) (b) (c) (d)

Figure 4: (a) Digital NVD Input Image; (b) Preprocessed Image; (c) Segemented Retinal Image; d) Deteced abnormal Blood vessels on Optis disk

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