A SELF REGULATING TOOL TO CHARACTERIZE AN ABNORMAL RETINA FROM A NORMAL RETINA USING NEURAL NETWORK

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ABSTRACT

Diabetes Mellitus is the most complicated proliferative health issue all through the world. The International Federation Committee of diabetes had made an analysis with reference to the diabetic sufferer count and had concluded that more than 199 million people deteriorate from diabetic complications globally and it is expected to surge to 366 million by 2030. Diabetes Mellitus is the leading cause for Retinopathy. It is the dominant proliferative eye problem and it is one among the extensive reason for the loss of eyesight. Eyesight problems can be abstained potentially by detecting the signs of retinopathy at an earlier stage. Microaneurosyms and Exudates are the emerging signs of Diabetic Retinopathy. Presently the lesions are observed and detected manually and this detection is not so useful for the mass eye screening programs. A huge group of research community are involved in the process of designing an automatic tool to individualize a deficient retina from the normal retina which provides a complete solution for all the retinal problems and to also solve the issues in terms of time and cost and to satisfy the needs of ophthalmologist. In this paper the necessary region are segmented and are given as the input to the neural network which uses the construction neural network algorithm with back propagation technique in order to classify the retinopathy level. This automatic tool will individualize the patients on the basis of their retinopathy level and it will be useful for the doctors to describe and analyze the inmate conditions more accurately. The prospect of blindness can be probably diminished by detecting the retinopathy at an earlier stage.

Keywords: diabetic retinopathy, microaneursym, exudates, fundus image, constructive neural network.

1. INTRODUCTION

Diabetic Retinal disease attribute to several eye problems. The major source for retinal disease is the diabetes Mellitus. Beyond proper screening and treatment retinal disease may result in relentless vision damage or blindness. Diabetic retinopathy is one of the most universal diabetic retinal diseases and is one among the prominent factor which causes blindness in people who suffer from diabetes. It arises as a result of changes in retinal blood vessels and due to clotting of blood. The retina is the significant part of our eye which is responsible for our vision and it is light delicate tissue present at the posterior part of the eye. A firm retina is needed for a better vision. For few people with retinopathy their blood vessels may swell or blood clot may occur. For others persons with diabetes peculiar new blood vessels may emerge on the exterior part of the retina. Initially as a result of retinopathy no changes may appear in our vision. But later Diabetic retinopathy can become worse. At the beginning the person may detect spots hovering over their eyesight or might see a gradual blur. Ultimately diabetic retinopathy might cause blurring of vision or even blindness. In peculiar, epidemiological survey carried out in automated countries dispose the diabetic retinopathy as fourth major cause for blindness. According to world health organization, India spends 210 billion dollars every year for detecting diabetic retinopathy. Diabetic retinopathy acerbity is discovered by the count and types of symptoms. Hence there is a need to detect Diabetic retinopathy earlier to probably diminish the prospect of blindness.

As a consequence, an automatic tool based on construction neural network algorithm with back propagation technique is designed to extract the features at low cost and time and to use for mass eye screening programs. This algorithm will constructs the network during the training itself when the system efficiency and the error function is not attained. This Automatic process will replace physicians because it can be used by operators with eventually little training. Ophthalmologists used fundus images to study Diabetic Retinopathy. Countenance such as Retinal vessels, Optical disk and Lesions such as Microaneurosyms, Exudates are extracted. Various methods have been proffered in order to get accurate blood vessels, optic disk and lesions from the fundus images. Ramon Pires [10] proposed a referral method which labels the color retinal fundus images by using a metaclassifier. An ensemble framework system [2] based on preprocessing and candidate extractor was used to detect microaneurosyms but this method did not concentrate on exudates. Mindert *et al.*, [7] proffered a computer aided system combination based on generic method and to investigate the performance.

An automatic tool [6] is used to detect microaneurosym from the color fundus images. Gwénolé Quellec *et al.*, [4] intended a way to identify Microaneurysms by using wavelet transform in which the template of lesions are matched to the sub bands and based on the modality microaneurysms were analyzed. Standard STARE database is used for performance evaluation of the algorithm.

D.Usman akram *et al.*, [12] used gabor filter based vessel segmentation algorithm. In this Gabor wavelet was used to intensify and the sharpening filter to acuminate the secular pattern. This method excerpts the vessels from the acuminated retinal image by applying edge detection algorithm. But this method is computationally intensive because of the use of Gabor

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filters. Osareh *et al*., [1] proffered a method based on fuzzy c-means algorithm.

This segments the color retinal fundus images by performing some preprocessing methods such as Background normalization and Equalization. The fully segmented image is divided into sub-regions where these regions are analyzed for the presence of the exudates using some initial countenance such as shape, size and texture. T. Spencer *et al.,* [11] introduced a method to detect microaneurosyms which characterize each objects using region growing algorithm. F. Mendels *et al*., [5] proposed a method to detect optical disk using active contours. In this method the optical disk region is detected using thresholding method and the exact boundary of optical disk is drawn using active contour technique. But this method fails to detect optical disk in the presence of hard exudates. Digital imaging, Retinal photography and optometrist [8] are evaluated to detect retinopathy.

Adaptive contrast limited Histogram equalization [9] in which the contrast is limited based on the requirements. Edge is detected [3] based on computational approach. The hybrid constructive algorithm [13] is performed to classify the training dataset in order to attain the efficiency level and to minimize the error function.

In this paper, an automatic tool is proffered for Diabetic Retinopathy detection from Retinal fundus images. Originally the paper has been widely prorated into distinct modules like blood vessel segmentation, Optic disk detection, Microaneurosym segmentation and Exudates detection. The fundus retinal image is the interior part of the eye is acquired from the fundus camera and the image is pre-processed for intensity inversion, adaptive histogram equalization, Normalization, blood vessel and optic disk elimination and it percolates the segmentation Algorithm to validate and extract lesions. Then the extracted features outcome is fed into the neural network system which analyzes the outcomes and assorts the patients with the level of severity of retinopathy.

2. DEPICTION OF RETINOPATHY

Diabetic retinopathy can lead to blindness. Early detection of symptoms of retinopathy can prevent blindness. Primary symptoms of retinopathy are lesions such as microaneursyms and exudates. Presently 15% of metropolitan population in India and 6% of agrarian population, the people with diabetes are beyond the age group of 15. Diabetic Retinopathy is the prominent reason for blindness. It is of rising concern in both the refined as well as flourishing nations.

The WHO assess that the fatality rate due to diabetes Mellitus and heart stroke, charges India of about $220 billion dollars each year and is predicted to raise to $340 billion in the later twenty years. Anybody who has diabetes is at prospect of suffering from Retinopathy but not all. It is assessed that about 10% of patients who suffer from diabetes will have Retinopathy and they require pertinent treatment. Most of the Retinopathy complexities can be avoided with regular screening and analysis. The chemical reaction due to diabetes influences the retinal capillaries joining arteries and veins. This radical blemish is called diabetic retinal disease and arises mainly due to the composite of micro-vascular occlusion and leakage.

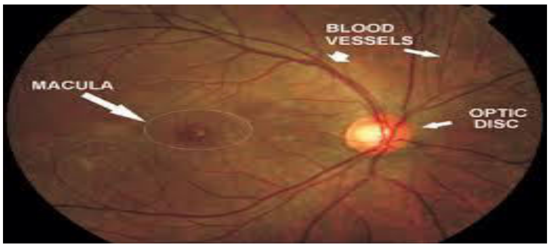

Figure-1. Cytology of eye.

Diabetic Retinopathy is prorated based on the presence of lesions that occurs due to leakage or blood clot, and their location in the central part of the retina. They are classified into three major forms namely background retinopathy, Non-proliferative and proliferative retinopathy. Retinopathy occurrence due to vascular effluent aside from the macula region is called background retinopathy and is seen with sacculations from the walls of the capillaries (microaneurysms), retinal haemorrhages, soft and hard exudates and oedema. This phase of the disease generally has no distinct cautioning signs and the people are uninformed that they endure from the retinal disease as far as it develops into more serious levels. Identification at this level is one of the desires of this work to help people to know about their conditions and to take medications to preclude eventual complications. Vascular leakage, blood clotting and lipid appear in the key part of the retina and this concludes in blurring of vision and is named as diabetic maculopathy. Oedema is the most popular reason for ease vision in people with non-proliferative Retinopathy. Less often, micro vascular blood clot or leakage might also arise at the macula leading to defective eyesight because of lacking blood flow to that area and due to this reason blood clot or leakage occurs and they are the scientific signs and are not commonly treatable.

The tissues on the retina which is build up on the retinal vessels for their nourishment discharges a proliferative aspect appealing the surge of strange peculiar blood vessels through which the capillaries are closed. This type of Diabetic retinopathy which appears as a result of closing of capillaries and rise of strange vessels is known as proliferative retinopathy. It might cause bleeding inside the cavity of the retina and finally will lead to loss of eyesight. This work is designed to detect all forms of Retinopathy diseases. Proliferative retinopathy probably never occurs in the absence of background retinopathy or maculopathy. Background Retinopathy is the most popular variety of Retinopathy computing for almost 80% of complete patients. It might arise at any time subsequently on the assault of diabetes. An experienced specialist being a generic ophthalmologist might identify these differences by

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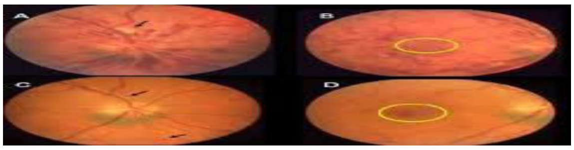

Figure-2. a) Normal retinal image; b) Background Retinopathy; c) Non - proliferative Retinopathy; d) Proliferative Retinopathy.

analyzing the patient's retinal fundus image. The specialist will view for blood clot, exudates or the field of swelling on the retina provoked due to the effluent of oedema and it will be of major distressed if these lesions occur at the key region of the retina is the point when eyesight might become damaged. A detailed computation of retinopathy acerbity lacks the capability to identify and archive the lesions of Retinopathy.

3. AUTOMATIC TOOL FOR RETINOPATHY DETECTION

An Automatic tool to characterize an abnormal eye from a normal eye is absolutely an automated system for Diabetic Retinopathy Detection. Input to the automatic system is the fundus image. It is the interior part of the eye captured from the fundus camera. It includes the optic disc, Retina, macula, Blood vessels and foveae region. As the image aspect is not gratifying due to indigent contradiction, irregular brightness etc. Pre-processing is necessary to obtain prominent outcomes.

The proffered process is composed of three major sections (i) pre-processing is done in order to improve contrast and to enhance the image quality in this intensity inversions are performed on the gray scale image. Background normalization is performed to normalize the image. Contrast enhancement to highlight the certain features of the image and Image binarization is performed to convert the image to binary image. (ii) Feature extraction process main goal is to segment lesions such as microaneurysms and Exudates by using circular metric method and thresholding algorithm and other features are eliminated as noise. (iii) Classification is done to identify the severity level of patients using artificial neural network.

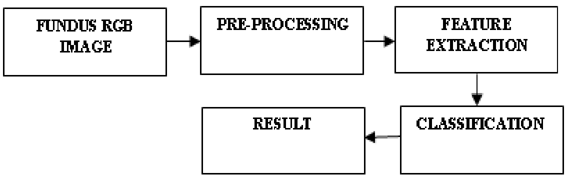

Figure-3. Vital structure level block diagram.

3.1. Pre-Processing

The objective of the process is to mitigate artifact and to enhance the contradiction and to appropriate the irregular brightness. In color fundus image the green channel shows better contrast. The red channel is almost saturated in the retinal images and the blue ones tend to exhibit low contrast. Thus green channel is preferred for processing. From the green channel image, the gray scale image is extracted. Then it is preprocessed to improve the image aspect. Intensity inversion is performed in such a way that the outer black region is changed to white and inner region is inverted to white. Contrast Limited Adaptive histogram equalization is performed to intensify the image. Then background normalization is performed to normalize the image and finally Image Binarization is performed to change the image to binary image.

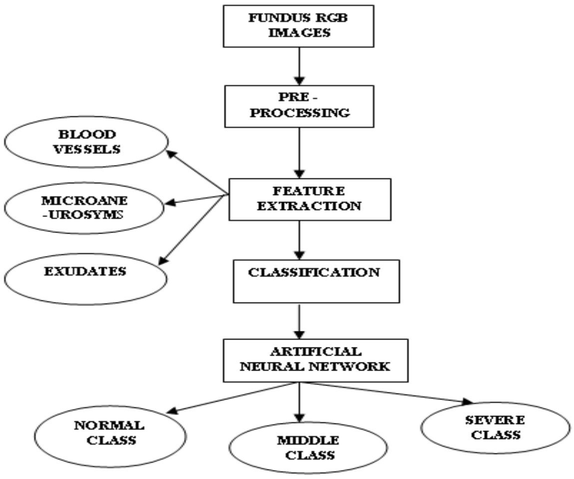

Figure-4. Block diagram of overall proposed system.

3.2. Feature extraction

The aim of Feature Extraction is to segment the blood vessels, Optic disk, Microaneurysms and finally exudates from the fundus image. Lesions occur as confined patterns and are detached from the blood vessels. The symptoms can be abstracted based on size, color, shapes and intensity level.

Optic disk is detected by using intensity detection method. Since optic disk region has high intensity pixel value it is detected by this method and is removed by creating circular mask and the optic disk region is removed. Blood vessels are broad in area and are associated component. These vessels are larger in size hence detected by using thresholding algorithm. The region having pixel value greater than the threshold value is eradicated as noise.

Microaneurysms are the modest accessions developing on the subsidiary of insignificant vessels are the utmost expected and generally the early lesions which develop as an issue of Retinopathy. Microaneurysms occur as petite red dots in the fundus image this is clearly visible on the angiogram. Consistently angiograms are clearly seen on only angiography and there is no analogous yellow abrasion which epitomizes arisen. Acuminated dilations of capillary vessels are not admitted as microaneurysms. Petite Red dot are commonly classified as hemorrhages and not microanuerysms. These microaneurosyms are exactly circular in shape. Hence they are detected by using circular metric method. If the calculated metric is 1 then the objects are exactly circular in shape.

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In non-proliferative retinopathy, impaired blood vessels discharge fatty protein containing flecks. These intra Retinal protein particles are commonly known as exudates and they are the clinical signs of Diabetic Retinopathy and they are also used for indicating the presence of simultaneous edema. If these edema or exudates accumulates on the key region of the retina such as macular region, then it provides an extensive root for vision loss in the non-proliferative Diabetic Retinopathy. Exudates are correlated with chunks of secular pattern damages with occlusions and leakage on their area and are generally illustrated as arbitrary patterns of white chunks differing in intensity and shapes. Exudates are irregular in shape and are identified by using fuzzy c- means algorithm.

4. DESIGN OF CONSTRUCTIVE NEURAL NETWORK WITH BACK PROPOGATION

The ANN used for this screening is a feed-forward back propagation network and uses supervised learning to train the neural network. Superintended training is by feeding the neural network with the input information and then comparing it with the results. The weights of the input and the output data would regulate bestowing to its training precedent as it endure learning before testing the certainty. The input layer is composed of nodes to obtain the data. While the consecutive layers measures the data by applying the function used for activation. The hidden layer is composed of 10 neurons and the qualified neural network might produce binary output which is used for representing distinct stages.

One of the major issues with the conventional backpropagation algorithm is the identification of the neurons in the hidden unit. To resolve these issues hybrid construction algorithm for the feed forward backpropogation network was designed, which has the capability of constructing the network during the training itself when the accuracy is not attained. Hence this algorithm provides the required neuron in the hidden unit to attain the minimum error function and the efficiency for the specific problem. In this the network training is done within the short estimated period. The algorithm will automatically generate the stopping condition when the efficiency level reaches 100%. But in many conventional cases the efficiency and accuracy is not attained.

Initially the neural network is created with the hidden unit h = 1 and then all the initial weight of the network are randomly arranged. The network is trained by using hybrid constructive algorithm to minimize the error function and to improve the efficiency. If the desired error function and the efficiency are attained then the validation process will be stopped. If not satisfied then additional hidden unit is included during the training process and the process is repeated till the efficiency is attained.

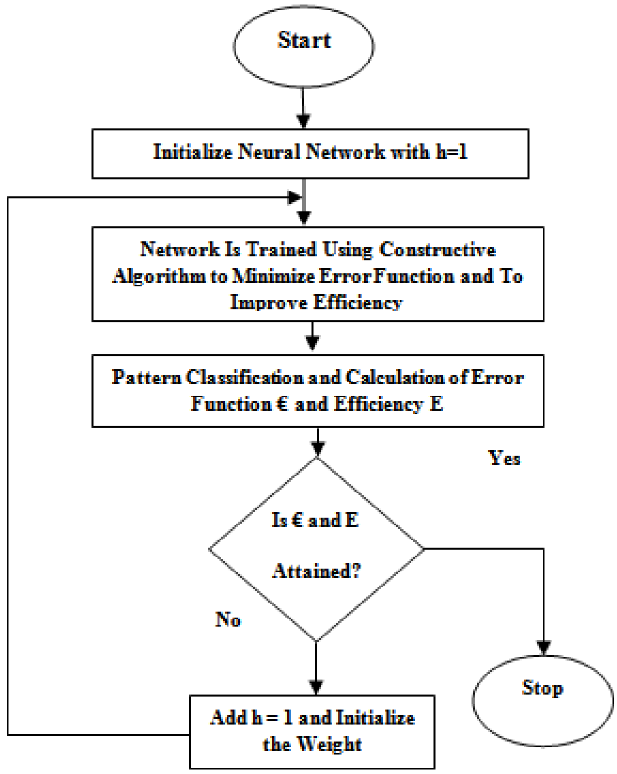

Figure-5. Flow chart of proposed algorithm.

The information attained from the Figures is separated into two distinct portions. The 80% of the information is used for learning and the rest 20% for testing. All the values are quantized between the ranges 0's and 1's in order to attain a rigid flow and to equalize the weight of each neuron of the neural network.

5. RESULTS AND DISCUSSIONS

Clear analysis of the interposed results are achieved by proffered algorithm and to make this process automatic Hybrid constructive neural network algorithm is used and the GUI is designed in an analogous way which is obvious to be inferred and which is usable by operators with little training. The consequences of the study are presented in a clear and efficient way. The fundus retinal images when given to the neural network it will be classified automatically into three definite classes. They are Background Retinopathy, Middle class, severe class. This automatic tool characterizes an abnormal retinal from a normal retina very effectively and the desired accuracy is attained. Exploited analysis of 47 images out of 50 images was perfectly identified and remaining 3 images were inappropriate.

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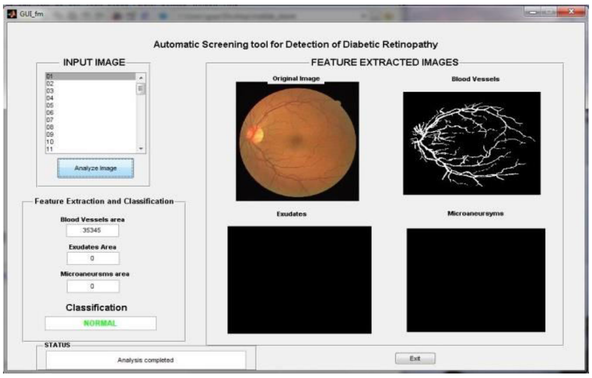

Figure-6. Implemented output.

5.1. Analysis of performance

The performance analysis is based on two important parameters such as Sensitivity and specificity. They are used to measure the performance and efficiency. The efficiency is based on the following specifications referred as True positive, True negative, False positive and finally False negative. True Positive rate condition arises when a proliferative image is accurately diagnosed as Proliferative. False Negative rate situation appears when a proliferative image is inappropriately identified as Non-Proliferative. True Negative rate occurs when a Non-Proliferative image is perfectly diagnosed as Non-Proliferative and finally False Positive rate is characterized as when the Non-Proliferative image is falsely identified as Proliferative image. Sensitivity is defined as the rate of certain microaneurosyms values being observed and specificity is defined as the rate of Non-Proliferative values that are accurately classified as Mild class values. Magnificently Sensitivity and Specificity can attain 100% but due to noise and vestige in the image it is arduous to attain 100% results.

$$\text{Sensitivity} = \frac{\text{TP}}{\text{TP+FN}}$$

$$\text{Specificity} = \frac{\text{TN}}{\text{TN+FP}}$$

TP – True Positive TN - True Negative
FN – False Negative FP- False Positive

6. CONCLUSIONS

In this paper, an automatic tool to individualize a deficient retina from a normal retina has been designed successfully. Originally the symptoms of retinopathy were detected such as microaneursyms and exudates. These outcomes were evaluated and were fed into the constructive algorithm with backward propagation neural network algorithm. Then the Neural network divides the images into three definite classes such as normal class, Middle class and severe class. The outcome of the tool is based on system sensitivity and is of about 94.5%. The Proffered method is able to archive specific results for 47 images out of the total 50 images given in the input database. The inappropriate identification of the 3 images is mainly due to irregular illumination and noise. This is further improved in the future by improving the preprocessing steps for the intensity inversion, background normalization and enhancement of the fundus images. The graphical user interface is designed for the accurate analysis of the fundus images. The proffered system is effective for automatic screening process which can be used for mass screening programs and this tool provides the complete solution for all retinal problems to resolve the complicated eye problems.

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