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An Enhanced Wavelet Based Neural Network Algorithm for Diabetic Retinopathy Image

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Abstract: This Diabetic retinopathy contributes to serious health problem in many parts of the world. With the motivation of the needs of the medical community system for early screening of diabetics and other diseases, a computer aided diagnosis system is proposed. This work is aimed to develop an automated system to analyze the retinal images for important features of diabetic retinopathy using image processing techniques and an image classifier based on artificial neural network which classify the images according to the disease conditions. Retinal haemorrhage is a disorder of the eye in which bleeding occurs into the retina. A retinal hemorrhage can be caused by hypertension, retinal vein occlusion (a blockage of a retinal vein), or diabetes mellitus (which causes small fragile blood vessels to form, which are easily damaged). Exudates is a fluid with a high content of protein and cellular debris which has escaped from blood vessels and has been deposited in tissues or on tissue surfaces, usually as a result of inflammation. Different findings such as exudates and hemorrhage in the retina over time can be used for the early detection of diabetic retinopathy. For the detection the scope of digital image processing and artificial neural networking is utilized and the working environment used in our project is matlab.

Keywords: Artificial Neural Network Algorithm, Diabetic Retinopathy, Image Processing.

I. INTRODUCTION

Diabetic retinopathy is one of the common complications of diabetes. Unfortunately, in many cases the patient is not aware of any symptoms until it is too late for effective treatment. The screening of diabetic patients for the development of diabetic retinopathy potentially reduces the risk of blindness in these patients by 50%. It has been estimated that 30,000 individuals per million total populations need to be examined to implement such a program. This is beyond the scope of currently existing ophthalmology departments and would produce a heavy clinical burden if left to diabetic physicians. Photographing the fundus of such patients with later assessment of the photographs has been tried with some success, but still requires the relatively expensive time of the specialist ophthalmologist to provide a classification of the retinopathy. This may delay referral of the patient for further examination. A wholly automated approach involving fundus image analysis by computer could improve the efficiency of the assessment of the image by providing an immediate classification of the fundus of the patient at the time of acquisition of the image.

Diabetic retinopathy is the most common diabetic eye disease and a leading cause of blindness in American adults. It is caused by changes in the blood vessels of the retina. In some people with diabetic retinopathy, blood vessels may swell and leak fluid. In other people, abnormal new blood vessels grow on the surface of the retina. The retina is the light-sensitive tissue at the back of the eye. A healthy retina is necessary for good vision. If you have diabetic retinopathy, at first you may not notice changes to your vision. But over time, diabetic retinopathy can get worse and cause vision loss. Diabetic retinopathy usually affects both eyes.

Our project work is aimed to develop an automated system to analyze the retinal images for important features of diabetic retinopathy using image processing techniques and an image classifier based on artificial neural network which classifies the images according to the disease conditions. In this work it is presented a novel approach to automatically detect the presence of Diabetic Retinopathy in color digital retinal images. The proposed approach utilizes the morphological operations for the segmentation and fuzzy logic for the identification of features of diabetic retinopathy in digital fundus images. This approach utilizes the features like hard exudates, soft exudates and the red lesions such as Micro aneurysm, hemorrhages of diabetic retinopathy to detect the presence of it in retinal images.

The digital retinal images are segmented using the morphological operations to identify the regions showing signs of diabetic retinopathy. The XYZ, YIQ, LUV,HSVand Lab color space of the identified regions are determined and a fuzzy set is formed from the values. Then fuzzy rules are derived from the fuzzy set based on fuzzy logic. These fuzzy rules are used to detect the presence of diabetic retinopathy in digital fundus images. We have used the publicly available dataset DIARETDB0 (Standard Diabetic Retinopathy dataset) for the evaluation of the proposed algorithm.

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II. LITERATURE REVIEW

Ketki S. Argade et al Diabetic Retinopathy is a disease of retina which affects patients with diabetes mellitus and it is a main reason for blindness. It is a disease in which the retinal blood vessels swell. es focus on the feature relevance and classification techniques to accurately categorize the disease associated with the retina based on the features extracted from retinal images through image processing techniques [1].

Deepthi K Prasad et al. This paper proposes the use of morphological operations and segmentation techniques for the detection of blood vessels, exudates and microaneurysms. The retinal fundus image is partitioned into four sub images. Various features are extracted from the retinal fundus image. Haar wavelet transformations are applied on the features extracted. Principal component analysis technique is then applied for better feature selection. Back propagation neural network and one rule classifier techniques are used for the classifying the images as diabetic or non-diabetic. Experiments are performed on a publically available diabetic retinopathy data set DIARETDB1. A total of forty one features are extracted from these partitioned images. The proposed work uses Haar wavelet transform followed by principal component analysis as an effective method for feature selection. Haar wavelet transformation is reported to be one the basic, novel and faster method for dimensionality reduction thereby making it a suitable method for feature selection compared to other methods. Observed results on the DIARETDB1 database have proved to be competent enough with an accuracy of 93.8% for back propagation neural networks and 97.75% for one rule classiffer thereby making it more efficient than the existing methods [2].

Bhagyashri S. Mankar et al. The method proposed in this paper for detection of Diabetic Retinopathy disease level emphasizes on determination of two important types of Diabetic Retinopathy; Hemorrhages and Exudates. These types can be extracted using fundus images of patients and processing these fundus images through an appropriate image processing technique. This technique helps in determining levels of DR in its early stage and thus preventing vision loss. A set of features that describes one case (i.e., a row of predictor values) is called a vector. So the goal of SVM modelling is to find the optimal hyper-plane that separates clusters of vector in such a way that cases with one category of the target variable are on one side of the plane and cases with the other category are on the other size of the plane. The vectors near the hyper-plane are the support vectors. In this paper, SVM classifier is trained with the features of known images, i.e. images whose DR level is already known. This process is known as learning of SVM classifier. The test fundus image is then applied as an input to SVM classifier which provides at the output the level of DR [3].

K. R. Ananthapadmanaban et al. Diabetic retinopathy the most common diabetic eye disease, is caused by complications that occurs when blood vessels in the retina weakens or distracted. It results in loss of vision if early detection is not done. Several data mining technique serves different purposes depending on the modeling objective. The outcome of the various data mining classification techniques was compared using rapid miner tool. We have used Naive bayes and Support Vector Machine to predict the early detection of eye disease diabetic retinopathy and found that Naive bayes method to be 83.37% accurate. Naives Bayes is more efficient than SVM. Thus this work presents a successful Diabetic Retinopathy Diagnosing method which helps to predict the disease in early stage that can eventually reduce the manual work.We started with a preprocessing operation to improve image quality by eliminating defects caused by lighting and acquisition processes. [4].

Neelam D. Panse et al. Eye diseases are one of the factors, which include vision loss due to glaucoma and diabetic retinopathy. Glaucoma damages the optic nerve of the eye. DR cause changes in eye damage the blood vessel. This work specifically places focus on the feature relevance and classification techniques to accurately categorize the disease associated with the retina based on the features extracted from retinal images through image processing techniques. SVM classifier is trained through supervised learning for the features extracted to classify the retinal images. The Overall classification rate of the proposed system will give the better efficiency and accuracy of identifying the disease with respect to existing systems [5].

III.PROPOSED WORK

The existing algorithm for the detection of diabetic retinopathy has some false detection because some pixels with similar color to the exudates belong to optic disc and edge of blood vessels. Also the existing methods have had varying success identifying and localizing components of the retina, since they typically cannot operate on images with a less amount of contrast.

In order to eliminate the problems of the existing system for the early detection of diabetic retinopathy such as false detection, we are proposing a new approach. In our method for detecting the diabetic retinopathy the scope of the digital image processing and artificial neural networking is utilized. Here we can process a retinal image having less amount of contrast since the possibilities of digital image processing is used. That means a less contrast image can be pre-processed by digital image processing for making the input image a better one. Also the chance of false detection can be minimized with the help of implementing the artificial neural networks. Here we are using supervised two layer back propagation network in which the possibility of occurrence of error can be minimized. In this work we developed

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an automated tool for the early detection of diabetic retinopathy. For this the fundus photographs of retina were taken with a fundus camera during mass screening. These photographs were then scanned by a flat bed scanner and saved as image files. The image files were then analyzed using the algorithms.

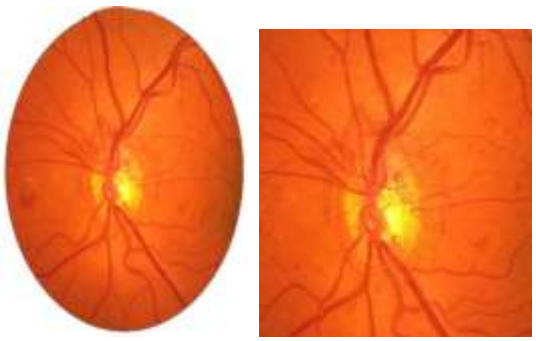
IV. METHODOLOGY

A. Input Images

For the image dataset digital fundus images are obtained using a special camera called ' fundus camera'. A fundus camera or retinal camera is a specialized low power microscope with an attached camera designed to photograph the interior surface of the eye, including the retina, optic disc, macula, and posterior pole (i.e. the fundus). Fundus cameras are used by optometrists, ophthalmologists, and trained medical professionals for monitoring progression of a disease, diagnosis of a disease (combined with retinal angiography), or in screening programs, where the photos can be analyzed later A fundus camera provides an upright, magnified view of the fundus. A typical camera views 30 to 50 degrees of retinal area, with a magnification of 2.5 xs.

B. Image Cropping

Cropping refers to the removal of the outer parts of an image to improve framing, accentuate subject matter or change aspect ratio. A digital image is made up of pixels. Cropping is the process of removing selected pixels from a digital image. The collected normal as well as diseased retinal images are cropped in order to make them into equal sizes. For cropping operation to perform we have to specify the upper left corner and the bottom right corner of the particular rectangular image. For example, suppose rect is [20 20 40 30], using the default spatial coordinate system. The upper-left corner of the specified rectangle is the center of the pixel (20,20) and the lower-right corner is the center of the pixel (40,30). After cropping the matrix representing the cropped image will have smaller dimension. But the values of the pixels in the cropped image will be same as that in the original image.



Original image cropped image

Figure 1: Image cropping

C. Feature Extraction

The images are analyzed to extract the features of normal retina, retinal hemorrhage and retinal exudates. The feature set should be selected such that the between class discrimination is maximized while the within class discrimination is minimized. Based on these criteria we have selected three features for the disease identification. Tey are:

- Pixel count
- Mean
- Standard deviation

D. Disease Identification

The classification of input images is done using an artificial neural network. The principle advantages of artificial neural network are that they are able to generalize, adapting to signal distortion and noise without loss of robustness. They are trained by example and do not require precise description of patterns to be classified or criteria for classification. Based on the pixel count of the cropped image, mean and standard deviation the given input retinal images are classified as normal, exudates and hemorrhage.

The network was trained to recognize features in the retinal image. In this work a 2-layer supervised back propagation network is used. Two layers are 1.input layer 2. Output layer. There are three neurons in the input layer. The criteria for selecting the number of neurons in the input layer are the number of extracted features. They are pixel count, mean and standard deviation. The hemorrhage images are already classified based on pixel count. Now we have to classify the

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remaining two; they are exudates and normal. This is the reason for selecting two layer networks. If we need more classification more layers can be included. These additional layers are called hidden layers. For the training process we have to fix a target. Here the target is a matrix of order 1x20 consisting of ten zeros and ten ones. The network is trained a number of times until the error is minimized and goal is achieved.

To calculate the weight changes in the hidden layer the error in the output layer is back-propagated to these layers according to the connecting weights. This process is repeated for each sample in the training set. One cycle through the training set is called an epoch. The number of epochs needed to train the network depends on various parameters especially on the error calculated in the output layer.

V. RESULT

The input retinal images are classified and disease conditions are identified as exudates and hemorrhages or whether it is normal image based on three extracted features, pixel count, mean and standard deviation. There are certain threshold values for these features in order to make the disease identification more accurate.

For identifying the hemorrhage the threshold value is taken as 5000(pixel count). For classifying normal images and exudates the mean and standard deviation are the extracted features. The values of pixel count, mean and standard deviation of twenty images are given below.

	Count	Mean	S.D
1	3303	132.0331	18.95712
2	2103	134.3364	18.49879
3	3241	132.0684	18.93795
4	4622	124.2705	14.72925
5	88	147.8293	15.77134
6	2185	138.7952	21.63678
7	160	136.7052	13.34153
8	439	142.5952	16.73347
9	1524	140.6685	15.6601
10	224	145.0537	16.06511
11	161	211.9864	44.39471
12	857	227.764	33.95734
13	17	181.1162	26.4556
14	3986	155.2045	44.05587
15	260	158.6497	26.28624
16	235	168.8036	25.83781
17	1848	157.2298	30.28945
18	1816	160.5494	33.40156
19	273	167.7769	42.20101
20	342	163.8361	26.63932

Table 1: values stored in p matrix

Based on the above values of mean and standard deviation the normal and exudates are classified as follows.

Table 2: Classification table

Mean	Standard deviation	Output
<150	<25	Normal
>150	>25	Exudates

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Consider an exudates retinal image, then its corresponding cropped, binary, grey scale images will be appeared as shown below

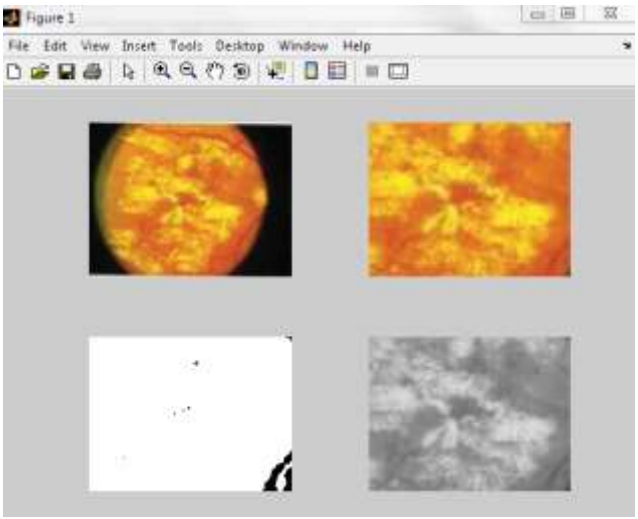

Figure 2: Output figure window

Suppose we fix the number of epochs as 1000 and goal as 0.01. The network will stop training when one of the following conditions is satisfied.

- When the maximum number of epochs is reached.
- When the performance is minimized to goal.
- Maximum amount of time is exceeded.

When the goal is achieved in 5 epochs, then the performance characteristics will be as shown below.

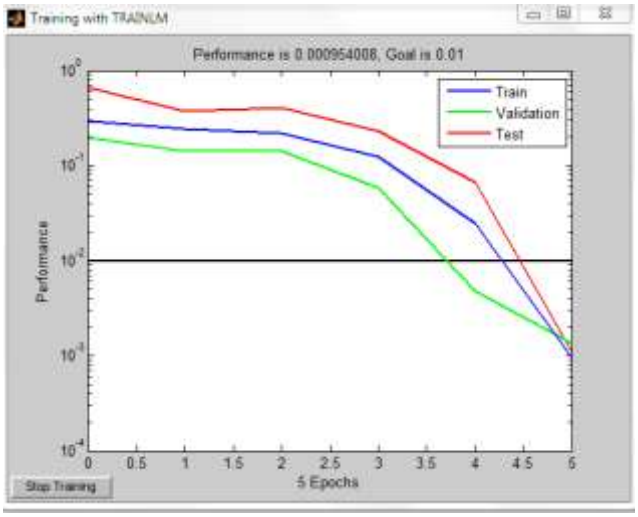

Figure 3: Performance characteristics

VI. CONCLUSION

The eye diseases mainly contribute to blindness and often cannot be remedied because the patients are diagnosed too late with the diseases. In this work we described image processing techniques, which can play a major role in the diagnosis of diabetic retinopathy. In this work the neural network classifier is developed as an automated diagnostic tool to aid the physician in the detection of these eye abnormalities. The accuracy achieved depends on various factors such as the parameters used and the feature set. A system for classification of diabetic retinopathy using digital image processing and artificial neural network has been developed. This project work describes a specific application, which can be extended to further applications in medicine. Presently we are testing the system on a large patient offline database and in future it can be implemented for routine clinical use. This method of classification of diabetic retinopathy condition using artificial neural networks almost coincides with expected retinopathy condition. These

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results will have significant usage in analyzing the diabetic retinopathy condition. This system provides early warning of diabetic retinopathy abnormalities for diabetic patients.

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