An Effective Diabetic Retinopathy Technique Using SVM Classification

Neha Kumari
M.Tech Scholar
Department of Computer Science
Bansal Institute of Engineering & Technology, Lucknow,India

Madan Kushwaha
Assistant Professor
Department of Computer Science
Bansal Institute of Engineering & Technology, Lucknow,India

Abstract- **Diabetic Retinopathy is one of the prevalent chronic disease of the modern world affecting millions of people globally. In developing countries access to ophthalmologists is restricted and thus an early detection scheme using computer vision methods can be effective. In this research work, an automated diabetic retinopathy technique based on image processing methods have been suggested. It extracts GLCM and LBP texture features from the fundus images. SVM classifier is used to classify these images based on which training database is constructed. The testing phase performs the same operation on test database and performance parameters have been evaluated. The proposed methods has shown an accuracy of 95.45% and a sensitivity of 92.85%**

Keywords – Fundus Image, Diabetic Retinopathy, Classification, feature extraction.

I. INTRODUCTION

One of the main undesirable conditions associated with diabetes is diabetic retinopathy, which causes visual impairment in long-term treatment deficiencies. Diabetic retinopathy (DR) is a serious eye disease caused by diabetes and is the most common cause of blindness in developed countries. One in three diabetic individuals show signs of DR, and unfortunately this is a very severe threat to their eyesight. Diabetic retinopathy is a latent condition that can be detected only when the retinal changes are advanced to a degree that makes treatment difficult or even impossible. The rising number of cases of diabetic retinopathy worldwide needs efforts to improve tools to help diagnose diabetic retinopathy. Naturally, early diagnosis and treatment is crucial to prevent patients from being affected by this condition or at least slow the progression. Diabetic retinopathy is automatically detected which saves a great deal of time and energy. Therefore, mass screening of diabetic patients is extremely important. However, manual grading may not always give accurate results because it requires good experience and expertise. Therefore, a lot of effort has been put into installing reliable computerized scanning systems based on color fundus images. Likewise, many studies have been conducted on detecting computer-aided DR using image processing and machine learning.

There are two forms of diabetic retinopathy: nonproliferative diabetic retinopathy (NPDR), which can be subdivided into mild, mild and extreme diabetic retinopathy[1]. Currently, NPDR is 80 per cent of all cases, the most severe diabetic retinopathy. The MAs are the first and most significant symbol of DR. Due to blood capillary dilations, MAs will be produced. The red marks or spots on the retina are visible. When MAs burst [2], haemorrhages occur. A haemorrhage is a little micro-blood patch in the back of the eye that arises from the artery or vein[3]. A leak of fluid from MAs has been caused by yellow colored lesions, namely Hard Exudates (HEs). The occlusions of the nervous fiber layer are the result of an additional white colored loss called soft exudate spot (SEs) or cotton wool of yellow color.

Diabetes is becoming increasingly common in almost all the countries around the world due to unhealthy lifestyle. In a country like India, which lacks sufficient healthcare facilities, this poses a serious risks on the life of people as it is achronic disease leading to a number of problems , one of them being vision loss. The screening for DR will theoretically reduce the risk of blindness by 50 percent in diabetic patients. Automated analysis of grading and classification of anomalies in the fundus picture can be performed in the developed country's mass screening program. An automatic detection system will provide ophthalmologists with a second opinion and avoid or stop further disease development in some patients.

This paper therefore suggests a new digital processing-based computer aided diagnosis of retinal pictures to help people diagnose diabetic retinopathy in advance. The main purpose is to automatically categorize every retinal picture as non-proliferating diabetic retinopathy. In order to extract features that can be used by support vector machine to assess the retinopathy degree of each retinal image, the initial stage of image processing isolates blood vessels, microaneurysms, and hard exudates.

II. LITERATURE REVIEW

Many studies have been done on Image processing and machine learning based detection of computer-aided DR detection. Seoud et al. [4] presented an automatic grading system for retinopathy. In their study, they identified 35 features to combine size and probability information for classification by detecting a red lesion to create a lesion probability map. This features random forest and have achieved classification accuracy of 74.11%

Savarkar et.al proposed the method of detecting MAs by analyzing density values along the discrete sections of different directions centered in the candidate pixel. In this method, the image was first determined by its peaks and then the feature set was determined and classified [5].

The automatic retinal features analysis program was proposed by Maher et al. [6]. Better preprocessing methods were used to minimize noise in order to enhance contrast and medium strength. During the database pictures the hard exudates were identified and separated. The use of polynomial contrast enhancement also suggested dark lesion detection methods. For regression-based data classification, the SVM-based supervised learning method was applied.

Shruthi et al. [7] have developed an automated method to recognize early signs of DR. Top-hat and bottom-hat operations and K-mean cluster techniques were used to detect and extract retinal features. Statistical parameters were determined to distinguish safe and negative photos of retinal using KNN-classifier.

Welikala et al.[8] identified an automated method of detecting new vessels in retinal DR images. The use of a regular line operator and a novel changed line operator was used for two vessel segmentation approaches. The operators were also analyzed and characteristics calculated for two different sets of functions from each binary vessel diagram. SVM was used to classify each collection individually and to make a final decision using the combination of the individual classification.

Kaur et al.[9] has established an automated DR vessel segment approach for both normal and abnormal features from DR retinal fundus images, which was designed to suit the vessels extracted and the non-ships based on their thresholding approach.

In another study, anatomical structures such as blood vessels, exudates and Mas were segmented by Selavathi D et.al [10]. Based on the segmented features, the gray level co-occurrence features were used to classify DR images. The classifier utilized was the SVM classifier.

The Automated MA detection systems for non-diluted RGB Fundus images have been developed by Kumar et al.[11]. In order to minimize the occurrence of blindness, early DR signs were observed. The proposed approach followed simple measures such as pre-processing, texture extraction and last assessment of the intensity of DR.

According to Akter et.al[12], retinopathy is a condition linked to diabetic disease and a significant cause of diabetic patients losing their vision. The key symptom of diabetic retinopathy are exudates. They introduced a morphological approach to diagnose diabetic retinopathy using color fundus images. Fundus images were used and satisfactory results were obtained, which were contrasted with the essential truths of the ophthalmologist.

Carrera.et.al[13] suggested computer-assisted diagnostic to help people diagnose retinal diabetic retinopathy in advance by digitally manipulating retinal photos. The main goal is to identify non-proliferating diabetic retinopathy in any retinal picture automatically. In order to obtain the features that can be used by the supporting vector machine to assess the retinopathy level of each retinal image, an initial image processing stage isolates blood vessels, microaneurysms and hard exudates. Maximum sensitivity of 95% and predictive capacity of 94% was obtained on testing with a database of 400 images.

III. PROPOSED METHODOLOGY

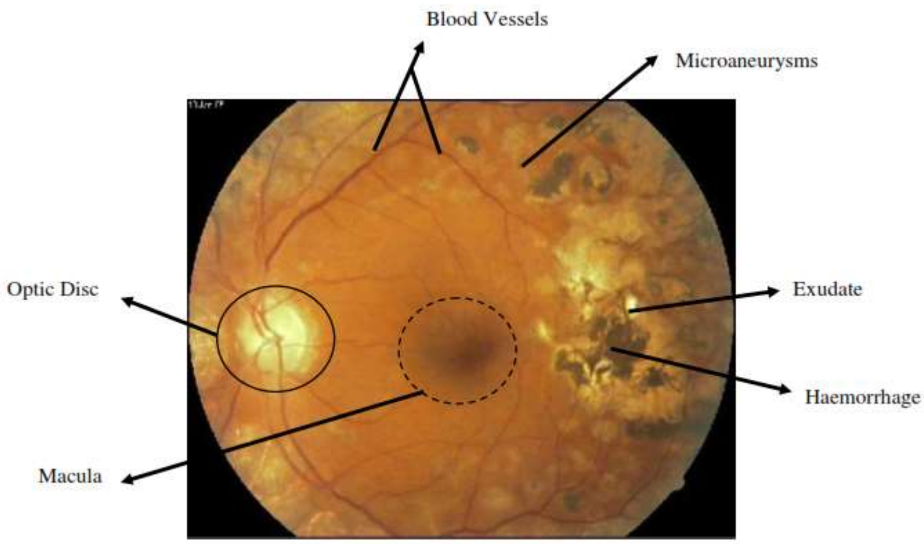

Figure 1: Fundus image

Figure 1 above indicates a fundus image with various normal and abnormal characteristics. The automated computer-based system must learn to produce automatic diagnosis by means of controlled and automated training in artificial intelligence principles and by diagnosis to define the general method.

The proposed method consists of two major phases: the training phase and the testing phase. In the training phase, the fundus images are trained according to the machine learning model to compile a database of features. In the testing phase, the test images are taken and processed to obtain test features which are then compared with the existing feature database and the decision is made accordingly. Figure 2 shows the block diagram of the complete setup.

I. Training Phase:

In the training phase, the fundus images of retina is acquired and preprocessed to convert into acceptable form. The image is first resized because the images obtained from the repository are high resolution. Gaussian filtering is applied on the images to get rid of any noise. The stronger contrast channel of green is used than all other channels. The context situations for identification are best contrasted. Green channel for automatic detection algorithms is therefore considered a normal basis. In order to avoid or minimize uniform illumination when collecting fundus images, the noise reduction is included in the preprocessing phase and the image can be automatically detected. The adaptive histogram equalisation technique is used to enhance the images. Optical disk consists of a series of light spots that can not be used to classify the highest thus the exudates the circular border is eliminated. The optical disk and exudate shows high values in contrast with the other characteristics. The fundus image blood vessel network is to be eliminated as one of the essential safety features of the retina. Morphological operators are used to remove the exudates, namely the opening function, dilation and erosion. The resulting image only contains the abnormal features like Microaneurysms, Exudates, Hemorrhages and neovascularization.

GrayLevel Co-Occurrence Matrix(GLCM) is used as statistical features which are extracted from the segmented images. LBP features have been extracted as well which are used to encode local texture information of the fundus images. The feature database consists of three features homogeneity, energy and average of LBP.

II. Testing Phase

In the testing phase similar steps are performed to obtain features of the test image as has been described in the training phase. The only difference is that the features are not stored in the database. Post feature extraction step the features of current test image are compared with those stores in the database for classification. Support Vector Machine has been used as the classification algorithm.

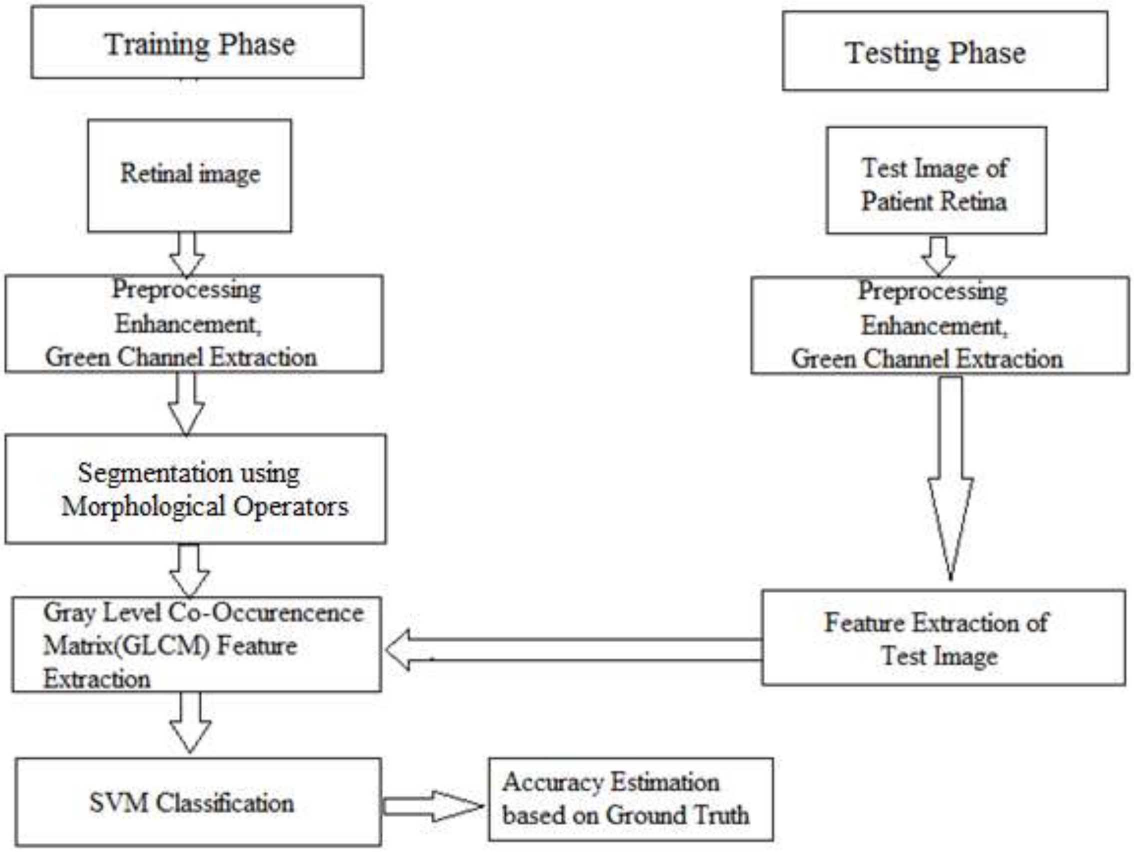

Figure 2: Block diagram of the Proposed method

IV. Results & Discussions

The proposed algorithm has been implemented using MATLAB 2014a and Kaggle database for DR. A total of 45 images are used for training and 22 for testing.

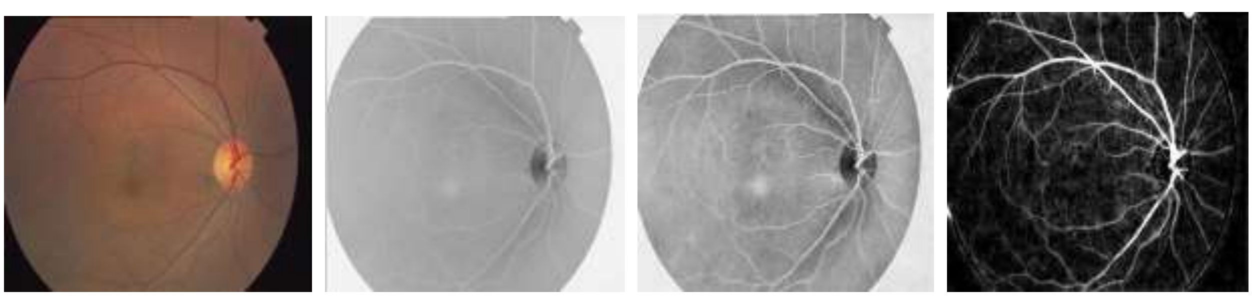

Figure 3: Processing Fundus Images a) Input Image b) Green channel c)Histogram Equalized d) Morphologcal Operated

Figure 3 shows the various image processing algorithms and their results on the fundus images. 3(a) shows the original fundus image 3(b) shows grayscale converted image 3(c) shows histogram equalized image and 3(d) shows result after applying morphological operations on the fundus image.

Classification accuracy is based on the four possible outcomes of sensitivity, specificity and precision-true positivity , false positive , true negative (TN) and false negative (FN). The sensitivity measures the correctly defined proportion of the actual positive DR level. Specificity tests the correctly recognized proportion of the negative point, on the other hand. The greater the vulnerability and symptoms, the stronger the diagnosis. Table I shows the performance of the proposed method in terms of various parameters. As can be seen, the method reaches a high accuracy of 95.45 % and sensitivity of 92.85%.

Table I: Performance evaluation

No. Of Training Images	45
No. of Testing Images	22
True Positive	13
True Negative	8
False negative	1
False Positive	0
Accuracy	95.45
Sensitivity	92.85
Specificity	100

V. CONCLUSION

Automated DR detection and prediction have been successfully developed for various related diseases. The proposed method uses image processing techniques to process fundus images and detect anomalies which can act as an early indicator of diabetic retinopathy. Early identification, diagnosis and examination of DR is becoming more important as it enables timely care and loss of vision. In this method GLCM and LBP features of the fundus images have been extractwd and classified using multi SVM based classifier. A high accuracy rate of 95.45% have been observed based on the testing results, which speaks for the effectiveness of the proposed method.

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