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LBP Feature Extraction for Early Detectionof Diabetic Eye Diseases

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Abstract: Diabetic Eye Diseases, such as diabetic retinopathy, pose a significant threat to the vision of individuals with diabetes. Early detection of these diseases is crucial for effective treatment and prevention of severe vision loss. In this study, we propose a novel approach for the early detection of Diabetic Eye Diseases using Local Binary Patterns (LBP) feature extraction. The LBP method captures local texture patterns in retinal images, allowing for the identification of characteristic features associated with the diseases. To evaluate the effectiveness of our approach, we utilized a dataset consisting of retinal images from diabetic patients with varying stages of the diseases. The dataset was pre-processed using standard techniques, and LBP features were extracted from the segmented retinal regions. A classification algorithm such as SVM, Random Forest, Adaboost was employed to differentiate between normal and diseased retinal images based on the extracted LBP features. Our experimental results demonstrated the efficacy of the proposed LBP feature extraction method, achieving a high accuracy of 79% using Adaboost in MESSIDOR and 85% using SVM in DIARETDB0 dataset in early detection of Diabetic Eye Diseases.
Keywords: Diabetic Retinopathy Detection (DR), Local Binary Pattern (LBP), Support Vector Machine (SVM), Random Forest, Adaboost.

I. INTRODUCTION

Diabetic Eye Diseases, including diabetic retinopathy, are significant complications of Diabetes Mellitus and can lead to severe vision loss and blindness if not detected and treated early. With the increasing prevalence of diabetes worldwide, the need for accurate and efficient methods for early detection of these diseases has become crucial. Early diagnosis allows for timely intervention and preventive measures, reducing the risk of irreversible damage to the eyes and improving patient outcomes. The problem lies in the challenges associated with early detection of Diabetic Eye Diseases. Traditional diagnostic approaches based on clinical examinations and subjective assessments are time-consuming, require skilled experts, and may lack consistency. Therefore, there is a pressing need for automated and objective methods that can assist healthcare professionals in early detection. The objective of this research is to develop an effective and reliable approach for the early detection of Diabetic Eye Diseases using Local Binary Patterns (LBP) feature extraction. LBP is a widely used texture analysis technique that captures local patterns in images. By extracting meaningful features from retinal images, we aim to identify characteristic patterns associated with Diabetic Eye Diseases, enabling early detection and facilitating timely intervention.

II. LITERATURE REVIEW

Diabetic retinopathy detection is a well-known research area in which researchers focus and contribute their ideas that put forward in the improvement of various assessment techniques.

In [1], the author describes a cutting-edge automated glaucoma detection system that makes use of local binary patterns (LBP) and bit-plane slicing. The system distinguishes between normal and glaucoma-related images with an exceptional accuracy of 99.30% thanks to the use of support vector machines (SVMs) and decision-level fusion.

The Multi-Scaling Discriminative Robust Local Binary Pattern (MS-DRLBP) was used in [2] to extract features. In comparison to multi-classification of retinal illnesses, the deep learning CNN classifier integrated with Radial Basis Function (RBF) exceeds it with classification performance metrics of 96.49% for sensitivity, 100% for specificity, and 97.22% for accuracy. [3] has done work that is comparable to this. They employed CNN as a classifier and Local Binary Patterns (LBP) to extract textural information. When applied to the ResNet Dataset, DenseNet Dataset, and DetNet Dataset, respectively, it provided accuracy values of 96.35%, 84.05%, and 93.99%.

Nine texture descriptors were examined in the study in [4] using the DIARETTDB0 dataset based on their recognition rate, extraction time, recognition time, and feature vector dimension. Gradient-based Local Binary Patterns (GLBP) descriptor has the maximum accuracy of 84.62%. More so than features based on form and colour, a Generalised Rotational Invariant LBP [5] feature extraction technique improves the sensitivity of MA identification. The results show that the acquired method is more effective than the traditional LBP method at discriminating between MAs and non-MAs.

To extract image characteristics and analyse picture datasets, data mining techniques like Support vector machine (SVM), naive bayes, and Local Binary Pattern (LBP) [6] are utilised. It was discovered that SVM outperforms naive bayes in terms of accuracy and processing speed. Incorporating the best feature extraction and classification methods is a novel DR diagnosis model [7]. According to experimental findings, LBP integration increases precision and discriminative capability. With a considerable accuracy improvement of 30.1% over NN, 32.2% over KNN, and 17.1% over SVM and DBN, the suggested MGS-ROA-DBN model outperforms competing approaches.

Four training sessions are conducted on the model [8] employing refined transfer learning with the Darknet53 model. Deep features from the DarkNet-53 model are combined with handcrafted features including LBP, HOG, and SFTA. The outcomes show a remarkable 99.9% accuracy in reducing the effects of hostile attacks, especially when LBP is used. The DRIVE, STARE, and CHASEDB1datasets have been used to evaluate the suggested framework [9] for retinal vascular segmentation techniques. The average accuracy results for LBP on the DRIVE, STARE, and CHASEDB1 datasets are 92.9%, 93.6%, and 93.8%, respectively, according to experimental findings.

III. PROPOSED METHODOLOGY

With the use of a practical prediction strategy, we offer a method for the early diagnosis of diabetic eye diseases utilizing local binary patterns (LBP) feature extraction. We used the Support Vector Machines (SVM), AdaBoost, and Random Forest classification techniques. MESSIDOR and DIARETDB0, two publically accessible datasets, were used in the study to train and assess our model. The classification models were trained to distinguish between images of health and images of disease using the LBP characteristics that were extracted from retinal images. Metrics like accuracy, sensitivity, specificity, and area under the receiver operating characteristic curve (AUC-ROC) were used to assess the efficacy of the suggested methodology.

A. Data Description

The MESSIDOR and DIARETDB0 datasets, which are both openly accessible, were used in this study to test the effectiveness of the feature extraction technique we suggested. There are 1200 retinal fundus images in the MESSIDOR collection, which were taken from diabetic patients. Two folders, "train" and "test," each comprising 800 and 400 photos, are created from these images. For the existence of diabetic retinopathy in the photos, the dataset offers ground truth annotations.

The DIARETDB0 dataset, on the other hand, contains retinal photos taken from 89 patients at varying stages of diabetic retinopathy. There are 89 folders in all, each one relating to a different patient, and each one has various retinal scans of that patient. The dataset contains the data from 72 and 17 patients, respectively, and is divided into 'train' and 'test' sets.

B. Preprocessing

The quality of the retinal pictures was improved using a variety of ways. In order to make features more visible, the photos were first processed by isolating the green, blue, and red channels. The original photos were improved using edge zero-padding, median filtering, adaptive histogram equalisation (CLAHE), and lighting correction.

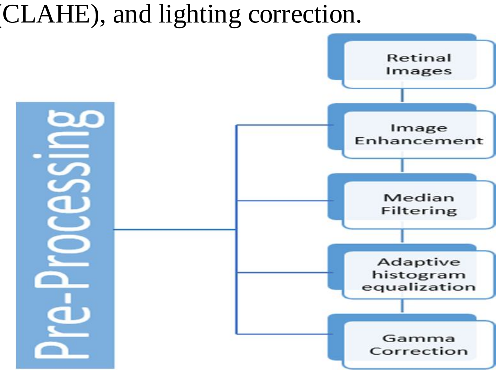
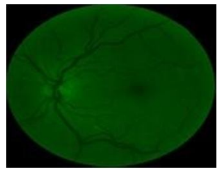
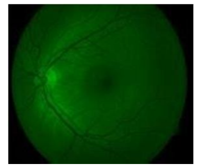
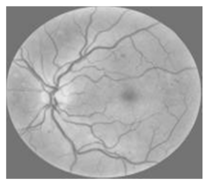
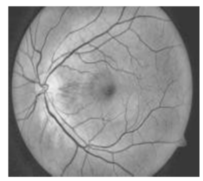


Fig. 1 Pre-prcessing steps

The pre-processing steps along with the images are listed in Table 1.

Table. 1 Pre-processing steps of MESSIDOR and DIARETDB0

IMAGES	MESSIDOR Dataset	DIARETDB0 Dataset
Green Channel Extraction		
Pre-processing		

C. Feature Extraction

The Local Binary Patterns (LBP) approach was used in our study to extract features. A selection of preprocessed retinal images was subjected to the LBP algorithm. LBP histograms were generated for each image using a 3-radius circular neighborhood and 8 sample points. To accommodate for changes in image intensity, these histograms were then normalized. A numpy array was used to store the resultant feature vectors for later examination. The LBP characteristics that were retrieved are a useful source of knowledge regarding the regional texture patterns visible in retinal images. The feature array's form, which represents the dimensionality of the extracted features, is (number of photos, number of LBP histogram bins).

D. Modelling

In the modelling phase, three different classifiers were employed to evaluate the performance of the extracted features for diabetic retinopathy (DR) detection. First, a Support Vector Machine (SVM) classifier was trained using the extracted LBP (Local Binary Patterns) features. The SVM model showed promising results with an accuracy of 76% using MESSIDOR dataset and 85% using DIARETDB0 dataset. Furthermore, a Random Forest classifier was utilized, employing 150 decision trees for classification. The Random Forest model achieved an accuracy of 76% using MESSIDOR dataset and 85% using DIARETDB0 dataset. Lastly, an AdaBoost classifierwas applied, which combined multiple weak classifiers to form a stronger ensemble model. The AdaBoost model yielded an accuracy of 79% using MESSIDOR dataset and 73% using DIARETDB0 dataset.

To assess the performance of the classifiers, several evaluation metrics were calculated. The classification reportsprovided detailed information on precision, recall, and F1-score for each class, including a breakdown of the evaluation measures for the positive and negative class. Additionally, Receiver Operating Characteristic (ROC) curves were plotted to visualize the trade-off between the true positive rate and false positive rate. The Area Underthe Curve (AUC) scores were calculated to quantify the overall performance of the models. The SVM, Random Forest, and AdaBoost classifiers demonstrated [insert AUC scores] AUC scores, indicating their effectiveness in differentiating between DR-positive and DR-negative cases. These findings suggest the potential utility of the LBP features combined with the selected classifiers for DR detection, providing a foundation for further researchand the development of more sophisticated models.

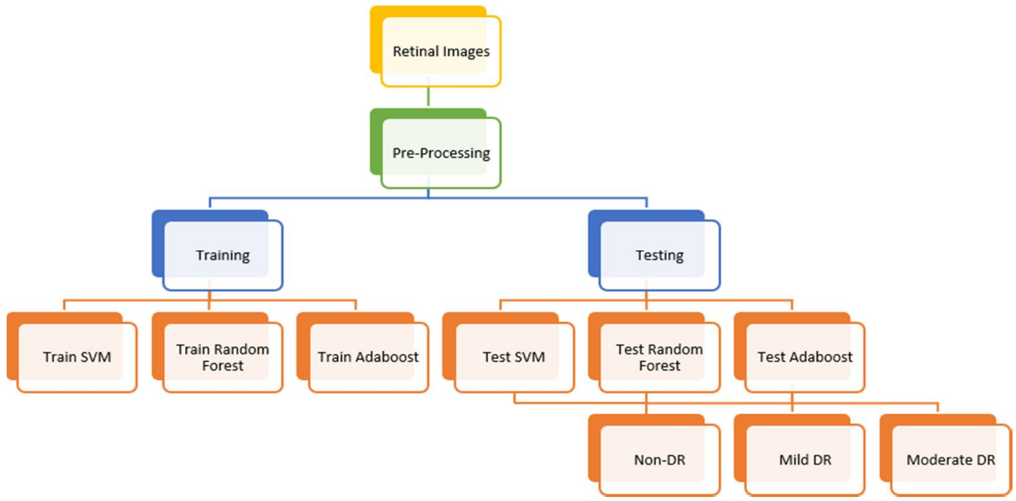


Fig. 2 Overall workflow of the proposed system

E. Results

On the MESSIDOR and DIARETDB0 datasets, the suggested system is evaluated. Table 2 includes the accuracy, precision, recall, and f1-score. As it is clear from the results, the Adaboost classifier achieved the maximum accuracy on the MESSIDOR dataset. However, when tested on DIARETDB0, Support Vector Machine (SVM) and Random Forest achieve the same results.

Table. 2 Comparison of precision, recall, accuracy and f1 score for MESSIDOR and DIARETDB0

Classification Algorithms	MESSIDOR Dataset				DIARETDB0 Dataset			
	Precision	Recall	curacy	F1 Score	Precision	Recall	curacy	F1 Score
SVM	59%	32%	76%	29%	92%	50%	85%	46%
Random Forest	59%	32%	76%	29%	92%	50%	85%	46%
Adaboost	93%	33%	79%	29%	41%	43%	73%	42%

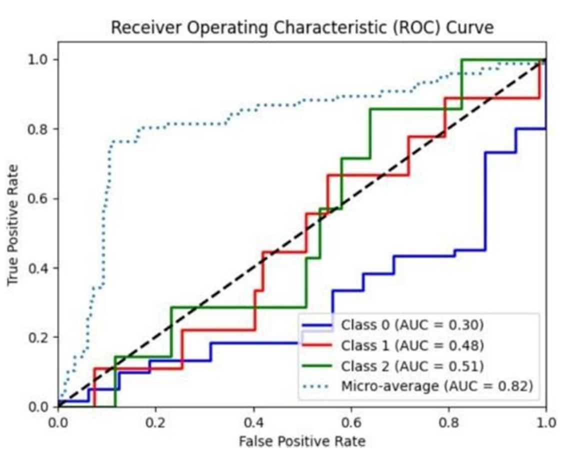


Fig. 3 ROC curve of MESSIDOR using Adaboost

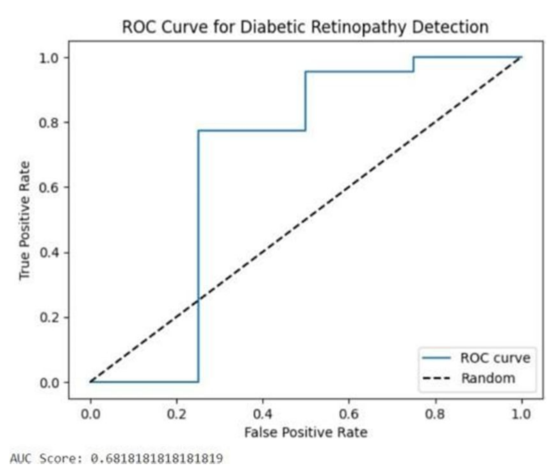


Fig. 4 ROC curve of DIARETDB0 using Random Forest

IV. CONCLUSION

The early diagnosis of diabetic eye diseases has showed remarkable promise when using Local Binary Pattern (LBP) feature extraction. LBP can help to identify between healthy and unhealthy retinas by examining the texture patterns in retinal images. Numerous studies have shown how well LBP works in identifying particular abnormalities like Microaneurysms (MAs) and other retinal disorders.

It is crucial to remember that the effectiveness of LBP can change based on the dataset size, the calibre of the images, and the particular LBP variant being employed. Researchers have looked into several LBP variations and found that extended LBP (E-LBP) is a particularly useful descriptor.

To improve LBP feature extraction methods and combine them with other imaging modalities for greater accuracy, more study and development is required. The robustness and generalizability of LBP-based therapies should also be evaluated across a range of populations and therapeutic contexts.

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