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Early Detection of Diabetic Retinopathy Using Deep Neural Network and Image Processing

[1]N. M. Ramalingeswara Rao

[1]*AssistantProfessor, Dept of ECE, Godavari Institute of Engineering and Technology(A), Rajahmundry*

Abstract- *Diabetic retinopathy (DR) is a common complication of diabetes that affects the eyes and can lead to vision loss or blindness. Early detection and treatment of DR are crucial to prevent permanent damage to the eyes. Deep neural networks (DNNs) have shown promising results in various medical image analysis tasks, including the detection of DR. In this study, we propose a deep neural network-based approach for the detection of diabetic retinopathy using retinal fundus images. We use a pre-trained convolutional neural network (CNN) as the base model and fine-tune it on a large dataset of retinal images with DR annotations. Our proposed model achieves high accuracy in DR detection, We also perform a comprehensive analysis of the model's performance, including the sensitivity, specificity, precision, and recall. Additionally, we investigate the importance of different layers in the CNN architecture and show that certain layers are more important than others for DR detection. In conclusion, our study demonstrates the effectiveness of deep neural networks in the detection of diabetic retinopathy using retinal fundus images. The proposed method has the potential to improve the accuracy and efficiency of DR diagnosis, leading to earlier detection and better management of this serious complication of diabetes.*

Keywords: DNN, CNN, Sensitivity, Specificity, Precision.

1. INTRODUCTION

Diabetic retinopathy is a complication of diabetes that affects the blood vessels in the retina, the light-sensitive tissue at the back of the eye. The condition occurs when high blood sugar levels cause damage to the blood vessels, which can lead to leaking, swelling, and the growth of abnormal blood vessels in the retina. There are two types of diabetic retinopathy: non-proliferative diabetic retinopathy (NPDR) and proliferative diabetic retinopathy (PDR). NPDR is the early stage of the disease and is characterized by microaneurysms, hemorrhages, and exudates in the retina. PDR is a more advanced stage and is characterized by the growth of abnormal blood vessels, which can leak and cause scarring that can lead to vision loss or blindness. Diabetic retinopathy often has no symptoms in its early stages, which is why regular eye exams are crucial for early detection and treatment. Symptoms may include blurred vision, floaters, and difficulty seeing at night. Treatment for diabetic retinopathy may include laser therapy, injections of medication into the eye, and surgery in advanced cases. The best way to prevent diabetic retinopathy is to manage

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blood sugar levels through a healthy diet, exercise, and medication as prescribed by a healthcare provider.

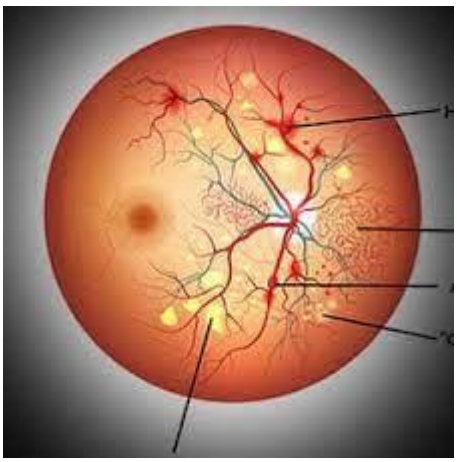

Fig: Retinopathy eye

Deep neural networks (DNNs) are a powerful tool for detecting diabetic retinopathy. DNNs are a type of artificial intelligence that can automatically learn and identify patterns in data. In the case of diabetic retinopathy, DNNs can analyze images of the retina and detect signs of the disease, such as microaneurysms, hemorrhages, and exudates. The use of DNNs in diabetic retinopathy detection has shown promising results. Studies have shown that DNNs can achieve high levels of accuracy in detecting diabetic retinopathy, even outperforming human experts in some cases. The ability of DNNs to analyze large amounts of data quickly and accurately makes them an attractive tool for screening and diagnosing diabetic retinopathy. In addition to detection, DNNs can also be used for predicting the progression of the disease and monitoring treatment effectiveness. By analyzing changes in retinal images over time, DNNs can provide valuable insights into the course of the disease and help healthcare providers make informed decisions about patient care. Overall, the use of DNNs in diabetic retinopathy detection has the potential to improve early detection and treatment of the disease, ultimately leading to better patient outcomes and reduced healthcare costs.

2. PROPOSED SYSTEM

Diabetic retinopathy (DR) is a serious eye condition that affects people with diabetes and can lead to vision loss or blindness if left untreated. Early detection and diagnosis of DR are crucial for preventing severe vision loss. A proposed system for DR detection using a combination of multi-structure morphological processes and segmentation techniques involves the following steps:

1. **Image acquisition**: The first step is to acquire high-resolution retinal images using a fundus camera or other imaging device.

2. **Preprocessing**: The retinal images are preprocessed to enhance the quality of the images and to remove any artifacts that may interfere with the detection of DR. This may include denoising, contrast enhancement, and illumination correction.

3. **Segmentation**: The preprocessed images are segmented to extract the regions of interest, including the optic disc and blood vessels. This can be done using thresholding, edge detection, or machine learning-based segmentation techniques.

4. **Morphological processing**: The extracted regions of interest are processed using a

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combination of morphological operations, such as dilation, erosion, opening, and closing. These operations are applied to enhance the shape and connectivity of the blood vessels and the optic disc**.**

5. Feature extraction: The processed images are then used to extract relevant features that can be used for the classification of DR. These features may include shape, texture, and intensity-based features.

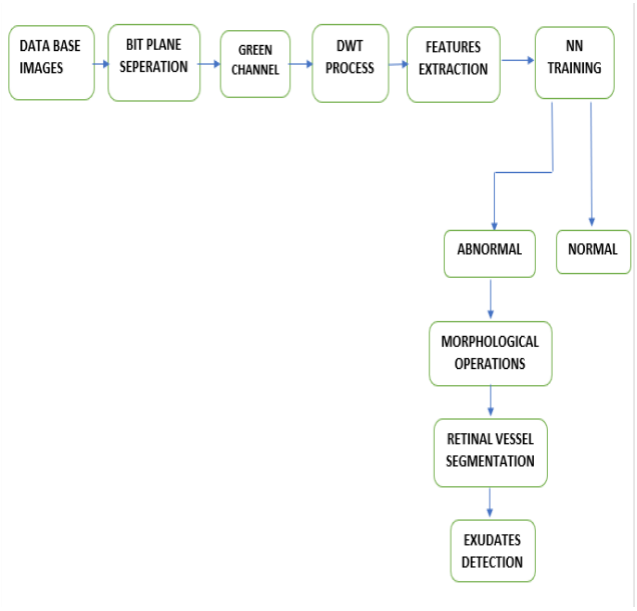
6. Classification: The extracted features are fed into a machine learning classifier, such as a support vector machine or a deep neural network, to classify the retinal images as either normal or having different stages of DR.

7. Validation: The system is validated using a separate dataset of retinal images to assess its performance in detecting DR accurately and reliably.

Overall, the proposed system combining multi-structure morphological processing and segmentation techniques for DR detection has the potential to improve the accuracy and efficiency of DR diagnosis, ultimately leading to better patient outcomes.

3. METHODOLOGY

Detecting diabetic retinopathy using deep neural networks typically involves the following methodology:



STEP 1: First we collected labeled data of different fundus/retinal images and form a database and we take input from that database.

STEP 2: Bit plane separation is a technique that can be used for diabetic retinopathy detection to enhance the contrast and highlight the features in retinal images. In this technique, the retinal image is decomposed into its individual bits, each representing a different level of brightness or darkness. The bits are then analyzed separately to identify the presence of diabetic retinopathy.

STEP 3: In diabetic retinopathy detection, the green channel of retinal images has been found to be useful for enhancing the visibility of small blood vessels and lesions. This is because the green channel is less affected by the presence of macular pigment and has higher contrast in the green range of the spectrum**.**

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STEP 4: Discrete Wavelet Transform (DWT) is a signal processing technique that has been used in the detection of diabetic retinopathy. DWT is a mathematical method for decomposing a signal into a set of wavelets, which are small, well-localized oscillating functions. In the context of diabetic retinopathy detection, DWT can be used to analyze retinal images by decomposing them into multiple frequency sub-bands. This can be useful for identifying features in the images that may not be easily visible in the original image.

STEP 5: By using of dwt process, they extract the features like hemorrhages, Exudates, and spectral features of fundus images.

STEP 6: A deep neural network (DNN) classifier can also be used for diabetic retinopathy detection. A DNN is a type of neural network that has multiple hidden layers, allowing it to learn more complex representations of the input data. The steps involved in building a DNN classifier for diabetic retinopathy detection are similar to those of an NN classifier and include Data Preparation, Model Selection, Training, Validation, Testing, and Fine-tuning, Overall, a DNN classifier can achieve high accuracy in detecting diabetic retinopathy in retinal images with appropriate data preparation, model selection, and training techniques. However, building and training a DNN classifier requires more computational resources and longer training times than an NN classifier.

STEP 7: Based on the DNN classifier it can classify the fundus images as normal or abnormal. If the fundus is normal no DR is detected if it's abnormal it goes to further process.

STEP 8: Morphological operations can be used in diabetic retinopathy detection to enhance the retinal images and improve the accuracy of detection. Morphological operations are a set of image processing techniques that modify the shape, size, or orientation of the image objects. The morphological operations like dilation, erosion, opening and closing are used to enhance the fundus image.

STEP 9: The segmentation process can be used to identify specific features, such as blood vessels or lesions, that are indicative of diabetic retinopathy.

STEP 10: In the final step after the segmentation process, they extract all the features from the fundus images and then detect the exudates and lesions in the fundus images. Based on the detection it can classify whether the DR is detected or not.

4. RESULT

First, we load the database then take the input from the database images

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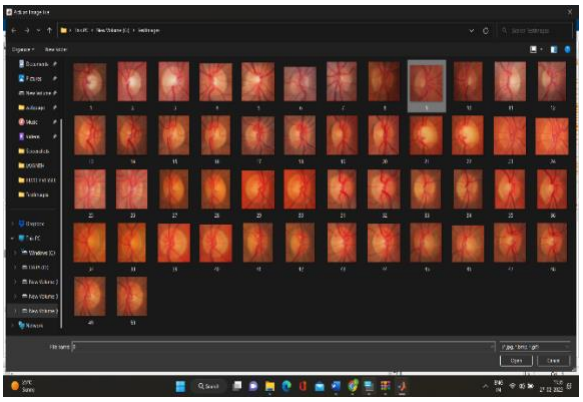
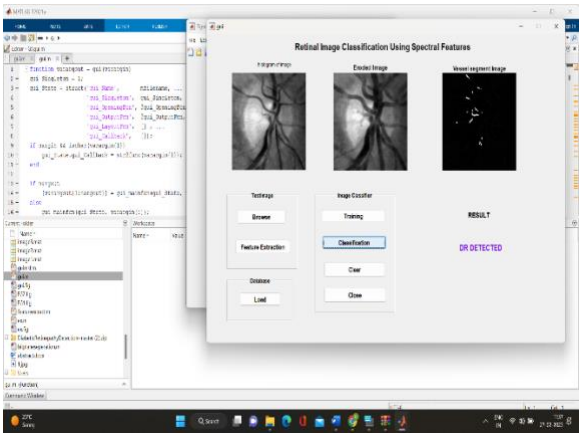


Then we extract the features and train and classify the model



Based on the model performance we have a performance matrix of the project

Our model gets nearly 96 percent of accuracy , specificity, sensitivity.

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