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Comparative Study of Diabetic Retinopathy Detection Using Machine Learning Techniques

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Abstract: ***Untreated diabetic retinopathy, a condition brought on by unmanaged chronic diabetes, can result in total blindness. In order to avoid the serious side effects of diabetic retinopathy, early medical diagnosis of diabetic retinopathy and its medical treatment are imperative. Ophthalmologists must spend a lot of time manually diagnosing diabetic retinopathy, and patients must endure a lot of discomfort throughout this process. With the use of an automated technology, we can rapidly identify diabetic retinopathy and conveniently continue treatment to prevent further damage to the eye. Exudates, haemorrhages, and micro aneurysms are three features that this study suggests extracting using machine learning. These features are then classified using a hybrid classifier, which combines support vector machines, k nearest neighbours, random forests.***
Keywords: Diabetic Retinopathy, Machine Learning, SVM, KNN, Random Forest.

I. INTRODUCTION

Diabetes is a condition marked by complications, one of which is diabetic retinopathy, which affects the eyes. In severe cases, it might result in total blindness and vision loss. Eye floaters, fuzzy vision, darker areas of vision, and trouble seeing colours are some of the early signs of diabetic retinopathy. It is crucial to correctly diagnose diabetic retinopathy in its early stages if you want to avoid going completely blind. In this research, we extract the characteristics haemorrhage, micro aneurysms, and exudates for automated computer-aided detection of diabetic retinopathy utilising hybrid machine learning mode. In this proposed model, a blend of SVM and KNN is used as the classifier.

II. LITERATURE SURVEY

Deep learning is one of the methods that has gained popularity recently and has improved performance in many fields, particularly in the classification and analysis of medical images. In order to analyse medical images, convolutional neural networks are increasingly used as a deep learning technique. They are also very efficient. This research has studied and analysed the most recent state-of-the-art methodologies for classifying and detecting DR colour fundus images using deep learning algorithms [1]. The colour fundus retina datasets for DR have also been looked at. In the medical field, early disease detection increases the effectiveness of treatment. Diabetes is a condition that worsens from a lack of insulin and raises blood glucose levels. There are 425 million adult sufferers globally. Diabetes wreaks havoc on the kidneys, heart, nerves, and retina.

III. PROPOSED WORK

Employing image processing, an automated system can distinguish between diabetic retinopathy and normal retinal pictures. Exudates, haemorrhage, and micro aneurysms are among the characteristics. The proposed system was divided into two sections, the first of which performed classification and the second of which was based on feature extraction. Created a system to extract the size and number of microaneurysms from a dataset of coloured fundus images in order to improve the identification of diabetic retinopathy. Fundus images were pre-processed utilising the morphological method, histogram equalisation, and green channel extraction.

IV. METHODOLOGIES

The study of machine learning, a subfield of artificial intelligence (AI) and computer science, aims to simulate human learning processes using data and algorithms, gradually increasing the accuracy of the results.

We use four modules in our project: admin, doctor, patient, and lab. The admin can add doctors, labs, and hospitals after logging in to the admin module using a legitimate email address. Admin can also view the patient's details. A doctor can add patients and their information, as well as the medical information for those patients, on the doctor's home page after logging in to the doctor module using a valid email address and password. Doctors can also view their own profiles. In the patient module, patients must check in using their email address and password on the login page before they can read their profile and medical information in the home page. Lab will check the patient's medical information and by checking the retinal image it will predict the diabetic retinopathy.

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A. Machine Learning

Artificial intelligence (AI) in the form of machine learning (ML) enables computer programmes to forecast outcomes more accurately without having been expressly taught to do so. Machine learning algorithms forecast new output values using historical data as input.

B. K- Nearest Neighbour (KNN) Algorithm

1) *Step 1:* Choose the K- number of the neighbours.
2) *Step 2:* Determine the Euclidean distance between K neighbours.
3) *Step 3:* Take the K closest neighbours based on the estimated Euclidean distance.
4) *Step 4:* Determine how many data items fall into each category among these K neighbours.
5) *Step 5:* Assign the new data points to the category where the number of neighbours is highest.
6) *Step 6:* The completed model.

C. Support Vector Machine(SVM)

1) *Step1:* Import Pre-Defined Library.
2) *Step 2:* Pre-processing the Datasets.
3) *Step 3:* Use Support Vector Regression Model.

D. Random Forest Algorithm

1) *Step 1:* Pick K data points at random from the training set.
2) *Step 2:* Construct the decision trees linked to the chosen data points (Subsets).
3) *Step 3:* Choose N for the decision tree size that you want to build.
4) *Step 4:* Repeat Step 1 and Step 2.
5) *Step 5:* Assign new data points to the category that receives the majority of votes by looking up each decision tree's predictions for the new data points.

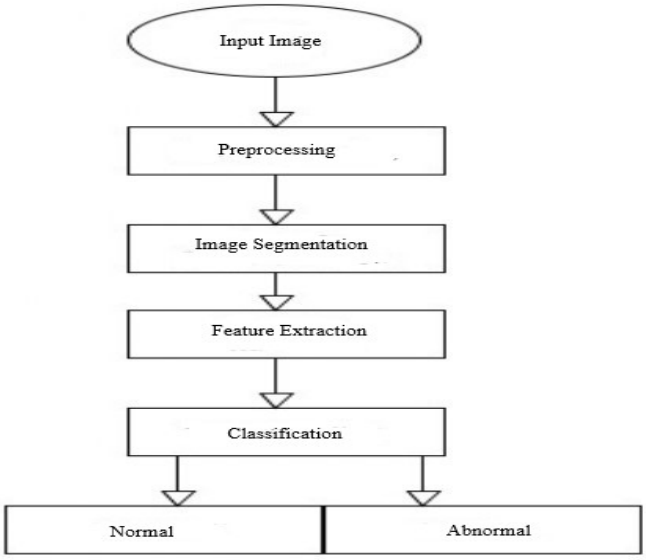


Fig 1. Flowchart of Diabetic Retinopathy Detection Model

E. Datasets

We are given access to a sizable collection of high-resolution retinal images that were captured under various imaging circumstances. For each subject, a left and right field is offered. Images are identified by a subject id and either the left or right eye (for example, 1 left.jpeg represents the patient number 1's left eye). We receive a substantial number of high-resolution retinal images. The images in the dataset were captured using a variety of camera models and types, which can change how the left and right sides seem to the eye.

Pre-processing is used on the dataset to get the input images ready for the proposed system's standard input. Pre-processing aims to improve microscopic image data by suppressing undesired distortions or enhancing certain image properties that are crucial for subsequent processing. Pre-processing operations include image resizing, noise removal, and destruction of undesired spots or holes that could convey the wrong idea. For accurate red blood cell identification and categorization, this is advantageous. The converted grayscale version of the obtained RGB image. A median filter is used to clean the border, locate all related components, and reduce noise.

F. System Architecture

First we input image dataset. Then it goes to preprocessing. In preprocessing step we resize the image. We should create a basic size for all photos fed into our ML algorithms because certain images acquired by cameras and submitted to our ML algorithm fluctuate in size. So we need to resize the images. Then we will remove noise in the image. And next step is image segmentation and Morphology. In this stage, we will segment the image to separate the background from the foreground objects and then add more noise removal to further enhance our segmentation. In the next we step we will extract feature like Exudates, haemorrhage, and micro aneurysms. Then we perform classification based on the extracted features. Finally we predict the output whether the retina image is normal or abnormal.

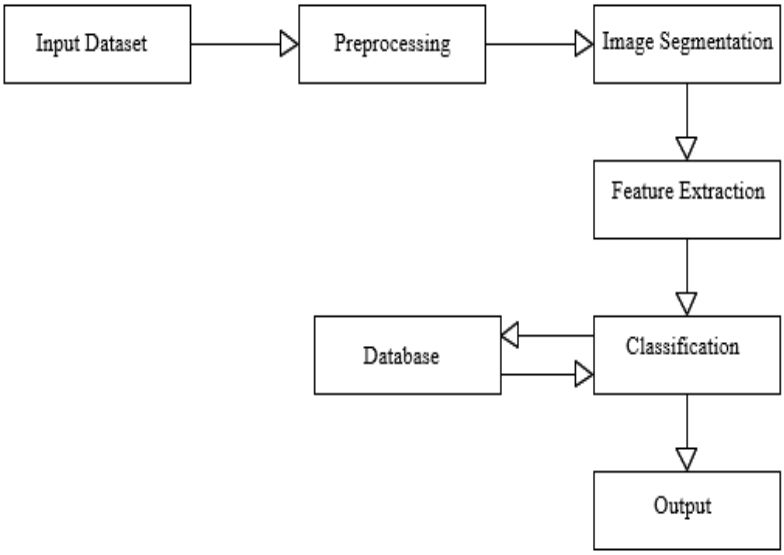


Fig 2. System Architecture

V. RESULT ANALYSIS

Below Fig 3 shows the accuracy comparison for the algorithm SVM and KNN. X axis represents the accuracy score and Y axis represents the algorithm. As we can see accuracy of the SVM algorithm is 0.8, accuracy of the KNN algorithm is 0.65.

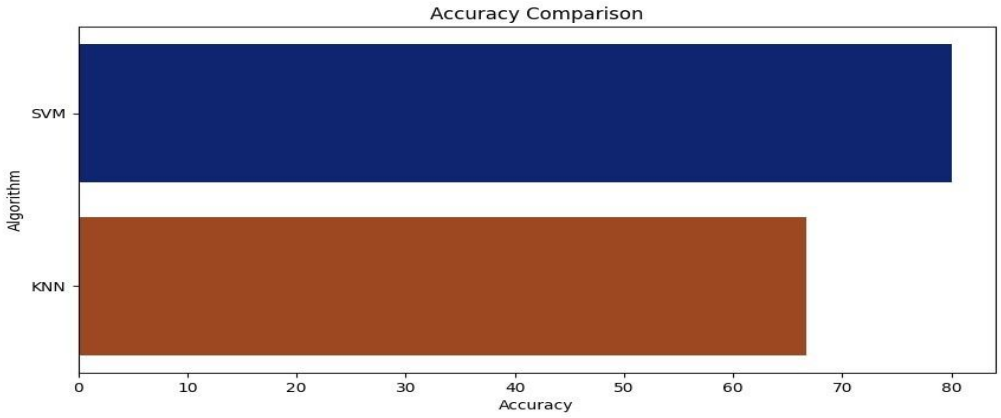


Fig 3. Accuracy Comparison Graph

Fig 4 shows precision score, recall score, f1-score, support, confusion matrix and accuracy score for the KNN classifier. KNN achieved the accuracy score as 0.65.

Below figure Fig 5 shows precision score, recall score, f1-score, support, confusion matrix and accuracy score for the SVM classifier. SVM achieved the accuracy score as 0.8.

By combining accuracy and recall, f1 score will elegantly summarises the prediction ability of the model.

Accuracy score means Forecasting accuracy is determined by the ratio of accurate predictions to all other predictions.

The ratio of accurately anticipated positive results to the total number of predicted positive observations is known as precision.

The proportion of accurately anticipated positive observations to all of the actual class's observations is known as recall.

```
Classification report :
              precision    recall  f1-score   support

         0.0       0.60      0.90      0.72        10
         1.0       0.80      0.40      0.53        10

    accuracy                           0.65        20
   macro avg       0.70      0.65      0.63        20
weighted avg       0.70      0.65      0.63        20

Confusion matrix :
 [[9 1]
 [6 4]]
Accuracy score : 0.65
```

Fig 4. KNN Accuracy Report

```
Classification report :
              precision    recall  f1-score   support

         0.0       0.80      0.80      0.80        10
         1.0       0.80      0.80      0.80        10

    accuracy                           0.80        20
   macro avg       0.80      0.80      0.80        20
weighted avg       0.80      0.80      0.80        20

Confusion matrix :
 [[8 2]
 [2 8]]
Accuracy score : 0.8
```

Fig 5. SVM Accuracy Report

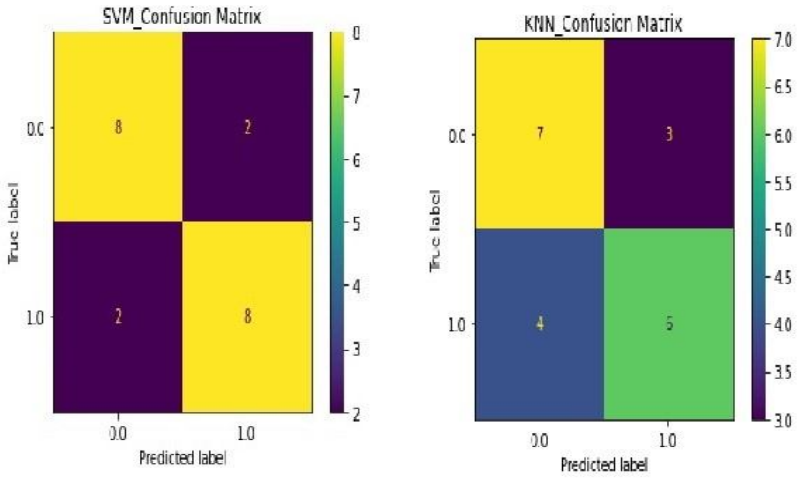


Fig 6. Confusion Matrix for SVM and KNN Classifiers

Fig 6 is a confusion matrix for SVM and KNN classifiers. It shows the true label and predicted label values. The expected outcomes for a classification task are summarised in a confusion matrix. With count values, the number of accurate and inaccurate predictions is tallied and separated by each class.

SVM algorithm takes CPU times : user 897 ms, sys : 576 ms, total : 1.47 s.

KNN algorithm takes CPU times : user 932 ms, sys : 56 ms, total : 988 ms.

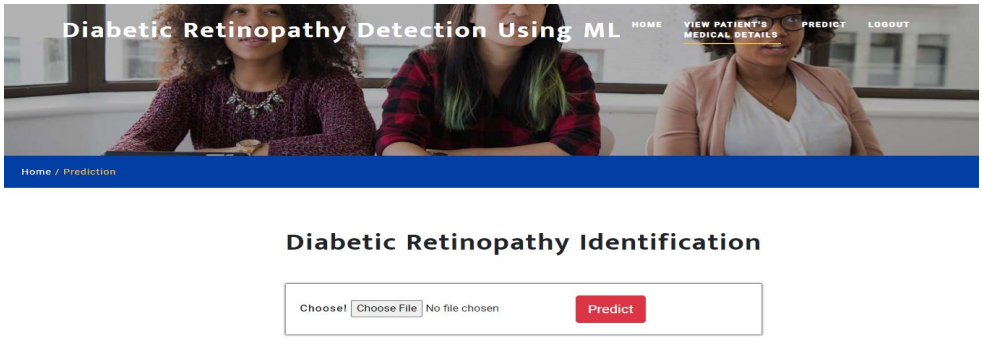


Fig 7. Prediction page to choose fundus image

In the figure Fig 6 shows the predict page of diabetic retinopathy detection. Here lab should choose the fundus image from the file.

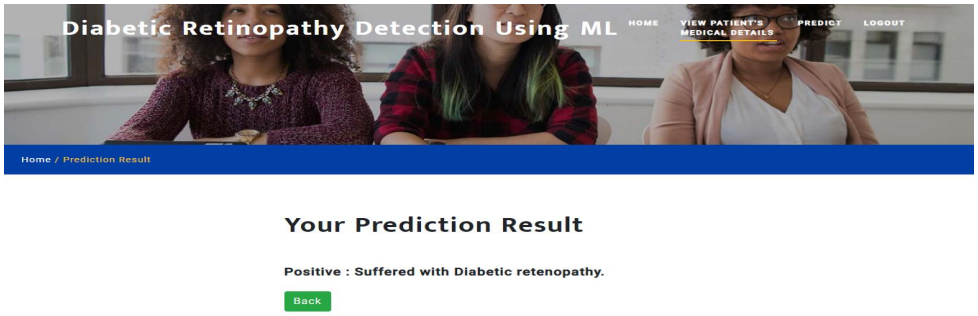


Fig 8. Diabetic Retinopathy Prediction Result

Fig 7 shows diabetic retinopathy prediction page. After selecting the fundus image it will processes the image and finally it will predict whether the patient is suffered with diabetic retinopathy or not.

VI. CONCLUSIONS

Hemorrhages, exudates, and microaneurysms are identified using the suggested procedure. Exudates are more accurately calculated and extracted when channel extraction, masking, smoothing, and bitwise green AND are used for exudate identification. Opening is one type of morphological procedure used to detect haemorrhages and micro aneurysms. Here, erosion and dilation operations are carried out. We can determine the condition of the image by counting the number of microaneurysms, haemorrhages, and exudates that happened in the image during the detection of diabetic retinopathy. Following that, features are computed and fed into the SVM, KNN, and Random Forest classifiers. The results of three classifiers' voting determine the final prediction. Therefore, the disease grade is directly inferred from the retrieved feature as either normal or abnormal. Thus, early detection and diagnosis of diabetic retinopathy prevent blindness in patients and lessen the severity of the disease's symptoms.

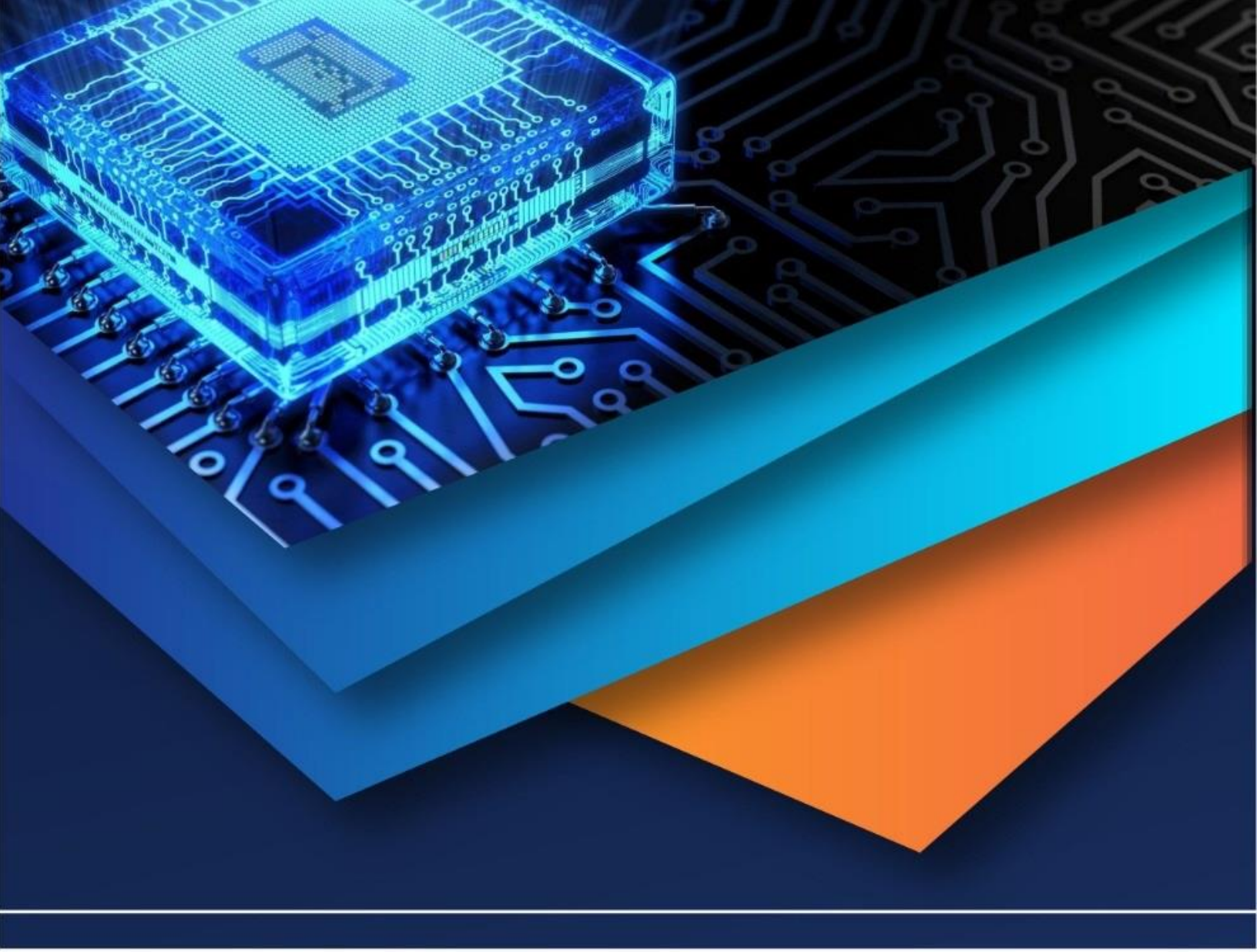
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