iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** VIII **Month of publication:** August 2019

DOI: http://doi.org/10.22214/ijraset.2019.8017

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue VIII, Aug 2019- Available at www.ijraset.com

Diabetic Retinopathy Detection using Hybrid Classifier

Pranali Ramesh Adivarekar[1], Sonali Ajankar[2]
[1, 2]*MCA Department, VJTI, Mumbai, India*

Abstract: ***Diabetic Retinopathy is one of the leading causes for blindness in today's working age population. Patients suffering from Diabetes Mellitus are prone to Diabetic Retinopathy. Diabetic Retinopathy is a condition which affects the retina of the patient. In this condition due to high levels of sugar in blood, the tiny blood vessels going to the retina are blocked. As a result the retina is cut off from blood flow which nourishes it due to which retina tries to grow new blood vessels. Since these blood vessels are not properly formed they start leaking which eventually leads to blindness. Diabetic Retinopathy is not curable but it can be controlled by proper treatment and medical attention. Currently the detection of Diabetic Retinopathy is done by dilating the retina and capturing retinal images using fundus photography. These fundus images are then examined by a trained ophthalmologist. This process is lengthy, time consuming and sometimes prone to human error. Automated detection of Diabetic Retinopathy will help the patients suffering from it to control the damage done to the retina and possibly avoid blindness.***
Keywords: Diabetic Retinopathy, PCA, Hybrid classifier, Dimensionality Reduction

I. INTRODUCTION

For controlling Diabetic Retinopathy, early diagnosis is a critical roadblock that is faced. The current system for detection involves human intervention. An ophthalmologist has to manually grade the fundus that is the retina images to identify whether a patient is suffering from Diabetic Retinopathy or not. As this system is manual, it is prone to human error. It is time consuming and labour intensive task. Due to which early detection cannot be achieved. The proposed paper tries to give a solution to solve the problem. This task of classifying can be done using Machine Learning. In this, the model is trained to identify fundus images suffering from Diabetic Retinopathy which can be used to classify fundus images as Normal or Diabetic Retinopathy. As a result, the time and effort required to carry out the manual grading of fundus images is reduced. Since machine learning techniques are used, human error is minimized. The classifier focused in the proposed paper is Hybrid Classifier. In problem statements like this, extracting the features from an image plays a very crucial role since wrong extracted features may result in incorrect classification. To overcome this Neural Networks are used since they automatically extract the features from the image. As a result, human error and bias in extracting the feature is reduced. But one disadvantage of using Neural Network is that the classifiers implemented by the Neural Network have to be used. This restricts the option to train the model using different classifiers which are more suitable to the particular problem. Here hybrid classifier comes into play, we eliminate the issues faced by both traditional classifier and neural network and combine their feature to create a better and accurate classifier. In hybrid classifier, Neural Network is used to extract the features and these features are then passed to traditional classifier.

II. RELATED WORK

In the paper Diagnosis of Diabetic Retinopathy using Machine Learning[1] , the classifiers used were SVM and KNN. Out of which SVM has a better accuracy of 86.67%. The image preprocessing techniques done were resizing image, RGB to HSI color space conversion, Histogram Equalization, Contrast Enhancement and Hybrid Median Filter. Features were extracted using GLCM.

Asha and Karpagavalli have explored Naïve bayes, Multilayer perceptron and Extreme learning machine[2]. ELM had a better accuracy of 90%. The image preprocessing techniques done were Optic Disc Removal, RGB to HSI color space conversion, Local Contrast Enhancement, Histogram Equalization and FCM Segmentation. The features extracted were Mean and Standard Deviation of LUV value inside and outside the segmented region, LUV value of region centroid, Region size and compactness.

The authors in [3] explored Ensemble having Alternating Decision Tree, AdaBoost, Naïve Bayes, Random Forest, SVM as classifier. Features extracted are Euclidean distance of macula center and the optic disc center, Optic disc diameter, Number of MA and exudates found at different confidence level. Before extracting the features image preprocessing techniques done were Hidden Markov Random Fields, Amplitude- Modulation Frequency-Modulation, Lesion- specific component detection and Anatomical component detection.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue VIII, Aug 2019- Available at www.ijraset.com

In the paper, Diagnosis of Diabetic Retinopathy using Machine Learning Techniques [4], image preprocessing techniques done were Gray scale conversion, Adaptive Histogram Equalization, Discrete Wavelet Transformation, Matched Filter Response and FCM Segmentation. The features extracted were Radius, Diameter, Area, Arc length, Centre Angle, Half area of Exudates detected using Green Channel Extraction, Thresholding and Dilation. The classifiers used were SVM, PNN and Bayesian Classifier. SVM had accuracy of 95.38%.

III. PROPOSED WORK

Accuracy can sometimes be deceiving. For instance, consider that in a dataset of 100 images, if 95 images are Normal fundus images and 5 are of patients suffering from Diabetic Retinopathy. If a classifier identifies all of them as Normal images then the accuracy is 95% but the recall for Diabetic Retinopathy is 0%. In problem statements like this along with accuracy, recall plays a very important role. We don't want a patient suffering from diabetic retinopathy to be misclassified. The focus of this paper is to improve F1-Score. The proposed work compares different Hybrid classifiers with and without Dimensionality reduction. Figures below show block diagram of the proposed work.

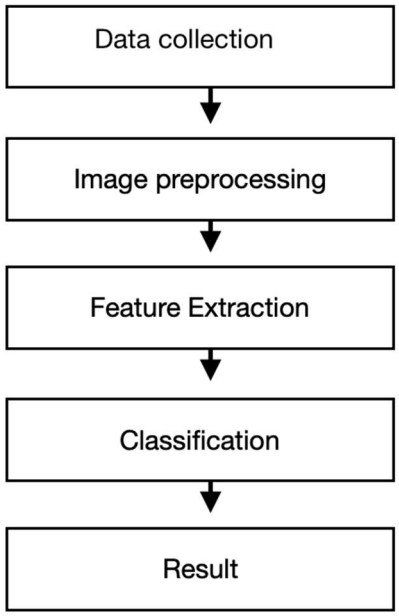

Fig1. Block diagram of proposed system.

A. Data Collection and Preprocessing

Images required to train the model are downloaded from Messidor Database. The dataset downloaded had images along with an excel to classify which image was Normal retina image and which one was Diabetic Retinopathy image. The first task was to segregate these images into different folders. The images were of .tiff format, to train these images they had to be converted to .jpg format. After converting these images into .jpg format, all images were converted into same size.

B. Classifiers Used

Hybrid Classifier is used to combine and utilize the features of two or more classifiers. In this paper, we classify and compare Hybrid Classifier using CNN-SVM, CNN-Random Forest and CNN-Decision Tree. We also compare the effect of dimensionality reduction on each of these Hybrid Classifiers. In the proposed paper, CNN is used to extract features from the images. Features are extracted from the last bottleneck layer of CNN. The bottleneck layer extracts 2048 features from every image. Since these features are extracted by CNN automatically, there's no human bias or error in extracting these features. The features are of type integer. These features are then passed to SVM, Random Forest and Decision Tree for classification. Along with it PCA, dimensionality reduction technique is used.

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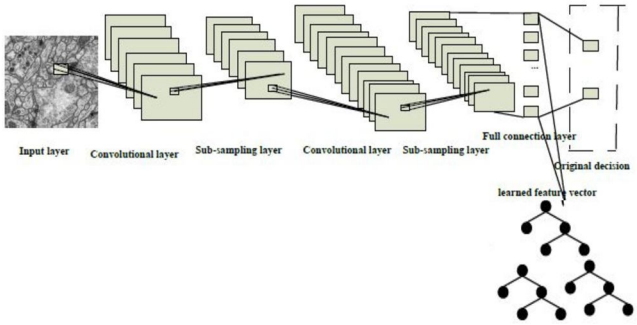

Fig 2. Block diagram of Hybrid Classifier

The classifiers used in Hybrid Classifiers are CNN, SVM, Decision Tree and Random Forest.

1) *CNN:* Convolutional Neural Network is one of the well known image classifiers. In CNN the image is passed through Convolutional Layer, Nonlinear Layer, Pooling Layer and Fully Connected Layer. Below is the diagram of CNN

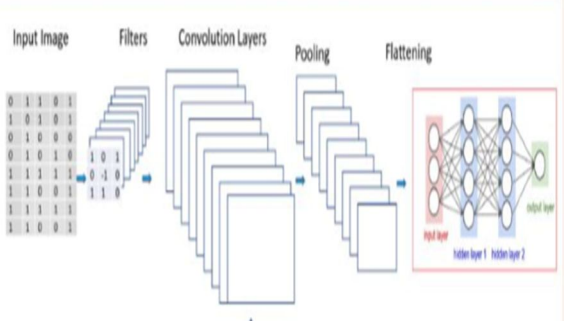

Fig 3. Block diagram of CNN

2) *SVM:* A Support Vector Machine (SVM) is a discriminative classifier. It is mainly defined by a separating hyperplane. In this, given labeled training data, the algorithm gives an optimal hyperplane which categorizes new examples. In two dimensional space this hyperplane is a line dividing a plane in two parts where in each class lay in either side.

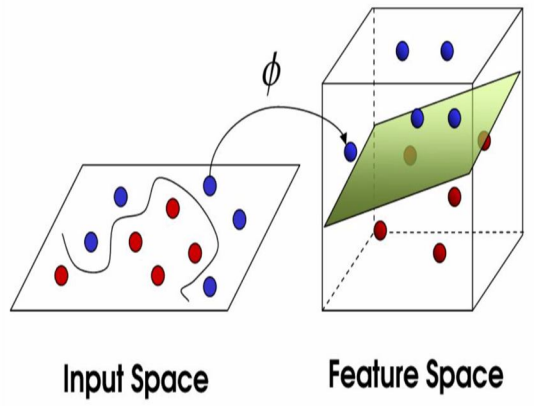

Fig 4. SVM

3) *Decision Tree:* Decision Tree algorithm is a part of the family of SUPERVISED learning algorithms. Decision tree algorithm can also be used for solving regression and classification problems. The general motive of using Decision Tree is to create a training model which can be used to predict class or value of target variables by learning decision rules inferred from training data.
4) *Random Forest:* Random Forest is an ensemble algorithm. Here, multiple decision tree are constructed with randomly selected features. Then it collects votes from different decision trees to decide final class. This works better as a single decision tree is prone to noise but collection of decision tree reduces the effect of noise therefore giving it better accuracy.

IV. RESULT

A. Results obtained by using CNN-SVM

Accuracy - 64%

TABLE 1: RESULT OF CNN-SVM

	Normal	Diabetic Retinopathy
Precision	61%	67%
Recall	63%	64%
F1 - Score	62%	66%

B. Results obtained by using CNN-Decision Tree

Accuracy - 60%

TABLE 2: RESULT OF CNN-DECISION TREE

	Normal	Diabetic Retinopathy
Precision	57%	63%
Recall	58%	62%
F1 - Score	58%	63%

C. Results obtained by using CNN-Random Forest

Accuracy - 63%

TABLE 3: RESULT OF CNN-RANDOM FOREST

	Normal	Diabetic Retinopathy
Precision	59%	68%
Recall	69%	59%
F1 - Score	64%	63%

D. Results obtained by using CNN-SVM along with PCA

Accuracy - 71%

TABLE 4: RESULT OF CNN-SVM ALONG WITH PCA

	Normal	Diabetic Retinopathy
Precision	66%	76%
Recall	77%	67%
F1 - Score	71%	72%

E. Results obtained by using CNN-Decision Tree along with PCA

Accuracy - 63%

TABLE 5: RESULT OF CNN-DECISION TREE ALONG WITH PCA

	Normal	Diabetic Retinopathy
Precision	63%	64%
Recall	53%	73%
F1 - Score	57%	69%

F. Results obtained by using CNN-Random Forest along with PCA

Accuracy - 65%

TABLE 6: RESULT OF CNN-RANDOM FOREST ALONG WITH PCA

	Normal	Diabetic Retinopathy
Precision	60%	73%
Recall	77%	54%
F1 - Score	67%	63%

G. Brief Comparison between the above classifiers

1) *Accuracy:* Below graph shows us that Hybrid classifier of CNN and SVM along with PCA performs better as compared to other hybrid classifier.

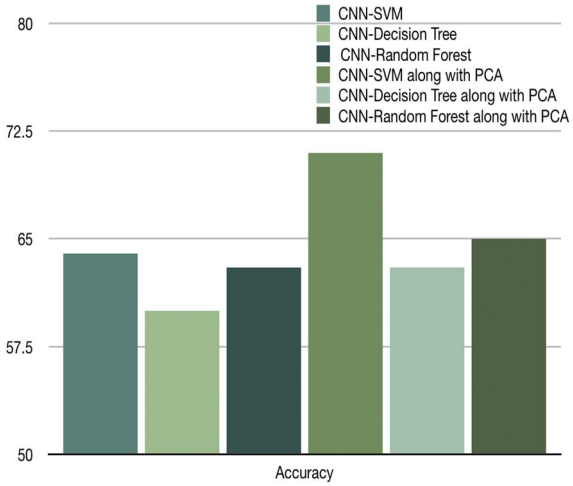

Fig 5. Accuracy Comparison

2) *F1- Score:* Below graph depicts the F1-score for Diabetic Retinopathy. Here also Hybrid Classifier CNN-SVM along with PCA performs better than others.

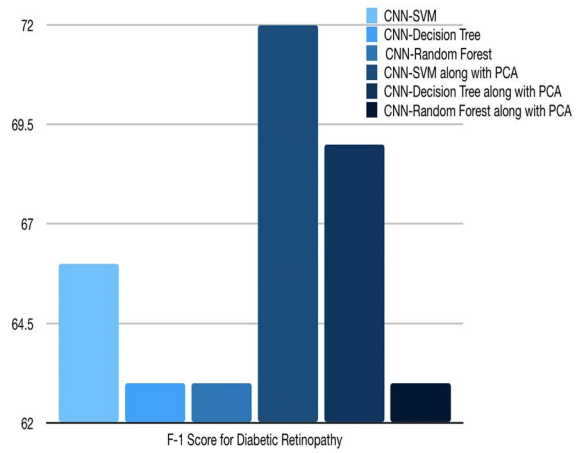

Fig 6. F1- Score Comparison

The results have proved that applying Dimensionality reduction before classifying features not only improves F1-Score but also the accuracy of the hybrid classifier. Below charts explain the same.

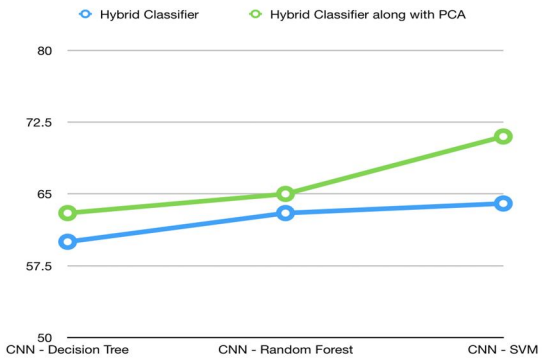

Fig 7. Comparison of Accuracy between Hybrid Classifier with and without Dimensionality Reduction Technique

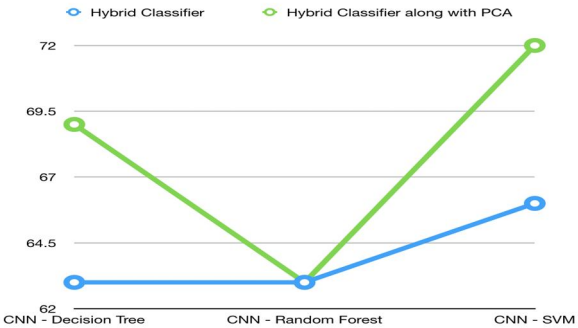

Fig 8. Comparison of F1-Score between Hybrid Classifier with and without Dimensionality Reduction Technique

V. CONCLUSION

Hybrid Classifier are used these days to overcome cons of classifiers and combine it's features. The proposed system proves that Hybrid classifiers along with Dimensionality Reduction performs better than its counterparts. The combination of CNN and SVM performs better than other combination of CNN.

VI. FUTURE SCOPE

Future enhancement can be done on the proposed work. Same experiment can be observed with different neural networks and supervised classification algorithms consisting of but not limited to RNN. Using gradient boosted algorithms for classification could also be explored. Different dimensionality reduction techniques such as SVD can also be applied.

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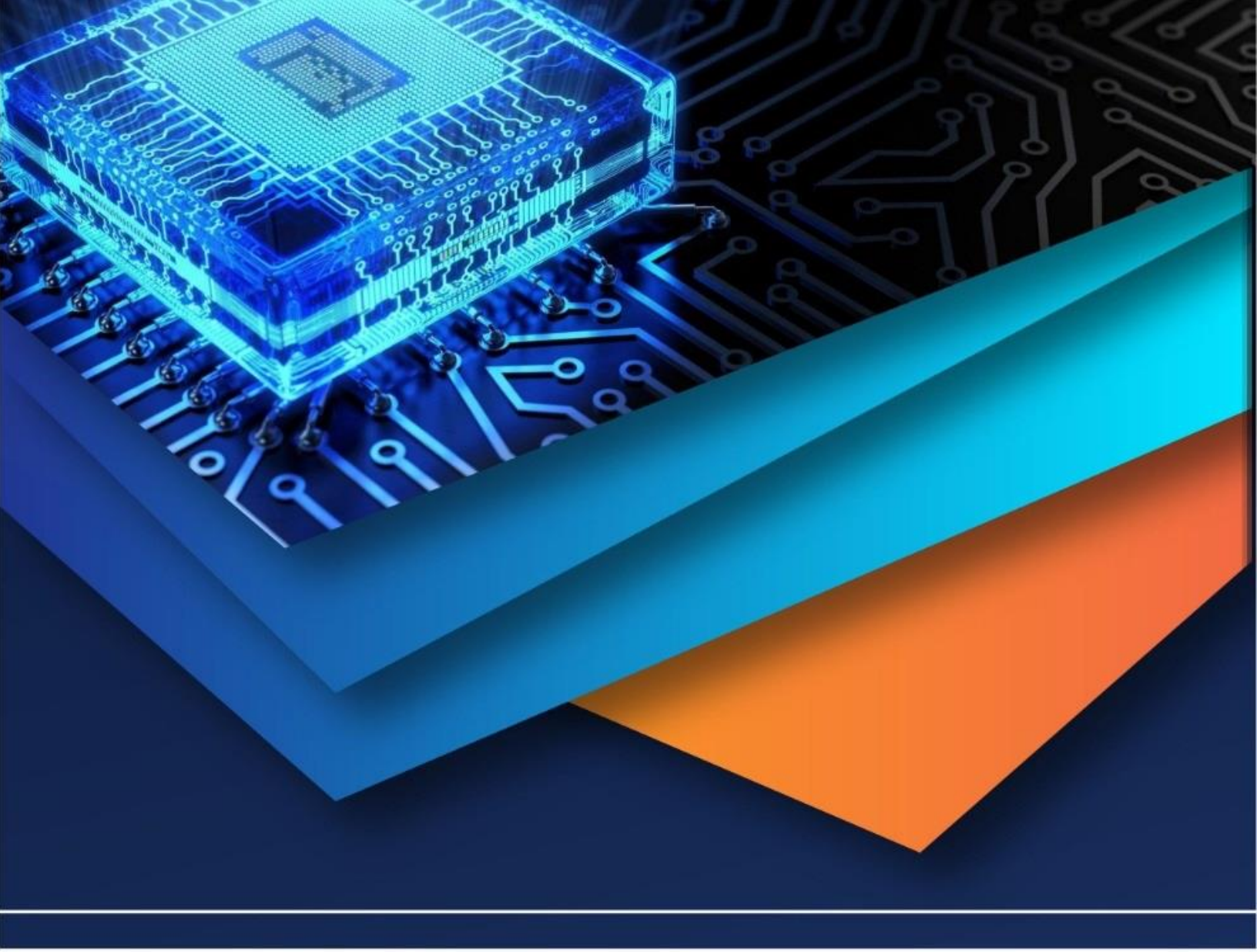

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