Analysis of Eye Retina for Diabetic Detection using PCA & SVM Methods

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Abstract - *Medical imaging plays a very important role now a days and many millions of imaging analysis are carried out every week worldwide. It is a process of creating visual representation based on the functioning of human organs or tissues to identify abnormalities or study diseases. Diseases based on few set of conditions in human eyes and various parameters may have change in our human body which affects to blood pressure, blood glucose, diabetes, heart diseases, blood clot in brain etc. Many researchers acknowledged that diabetes is one of the most common disease. Based on the eye vision like having trouble in reading or seeing faraway objects, blindness or any changes may happen in eye retina that affects diabetes in human body. Diabetic retinopathy is one of the most common disease found to detect diabetic patients. In this paper, we apply computational techniques like machine learning methods - SVM & PCA methods for early prediction of diabetics and compare our results by finding few performance metrics for obtaining the better accuracy results.*

Keywords: Machine learning, support vector machine (SVM), principle component analysis (PCA), Root Mean Square Error (RMSE), Peak Signal Noise Ratio (PSNR), Relative Dimensionless Global Error (ERGAS), Entropy (E), Accuracy.

1. INTRODUCTION

Medical Imaging is the method of creating visual representation of some organs or tissues for diagnosis and treatment purposes to improve the health of human body. As in the field of medical imaging, there are many types of imaging like – Magnetic Resonance Imaging (MRI), X-ray, Ultrasound Imaging, Computed Tomography (CT), Retinal Imaging, and many are relevant to medical imaging-based procedures. Using medical imaging, the use of effective diagnosis depends on correct assessing and predicting many diseases to improve the health of human. The three important parameters like effective, safe and high quality images are important for medical imaging decision making and reduce complicated procedures. Without any side-effects many diagnosis and surgical interventions can be avoided using high quality imaging.

Retinal imaging uses high-resolution imaging systems that captures images of human eye. Doctors evaluate the health of human eye retina which helps to detect eye health conditions such as vision problems, diabetes, cancer, diabetic retinopathy, hypertension, glaucoma, heat diseases, liver diseases etc. Some eye disorders in human cause few or no symptoms in early stages. Diabetic retinopathy using retinal imaging helps in detecting diabetes in human which can cause changes in the blood vessels of eye retina like leakage or swelling in middle-aged people [2]. In later stages of the disease, blood vessels in the retina start to bleed into the vitreous (gel-like fluid in the center of the eye) [1].

2. LITERATURE SURVEY

Diabetic Retina affects approximately to many people by screening of the eye structure of normal and diabetic patiend using optoalmoscope screening tool. [2]. Diabetic retinopathy includes normal features like fundus images, blot hemorrhages [3] exudates detection and identification of disease in eye. The classification methods like Neural Networks, Fuzzy C-means clustering, Bayesian classification are been tested. The sensitivity and specificity calculated were 95% and 75%. In the detection and classification of diabetic retinopathy using retinal images, , they propose a new method of blood vessel extraction which is an improvement over the previously developed matched filter, a new method of hemorrhages detection and classify the retinal cases using an advanced nonparametric method with higher classification accuracy [4] . The results obtained from our method of feature extraction and classification scheme revealed that normal cases were classified with 90% accuracy while moderate and severe NPDR cases were 87.5% accurate, which are better in terms of sensitivity, specificity and positive prediction accuracy considering three cases during classification (normal, moderate and severe). Few techniques like convolutional neural networks model is also used for detection of diabetic retinopathy. The features are extracted and recognised from healthy patients and diabetic patients samples of 15 and tested the accuracy of 91.66% [5]. In this paper, we considered the methods like SVM and PCA and compare our accuracy results.

3. METHODOLOGY

We analyse the eye retina images using image processing techniques and perform computational methods like machine algorithms – SVM and PCA techniques for prediction of diabetic. The block diagram is shown in below Fig- 3.1:

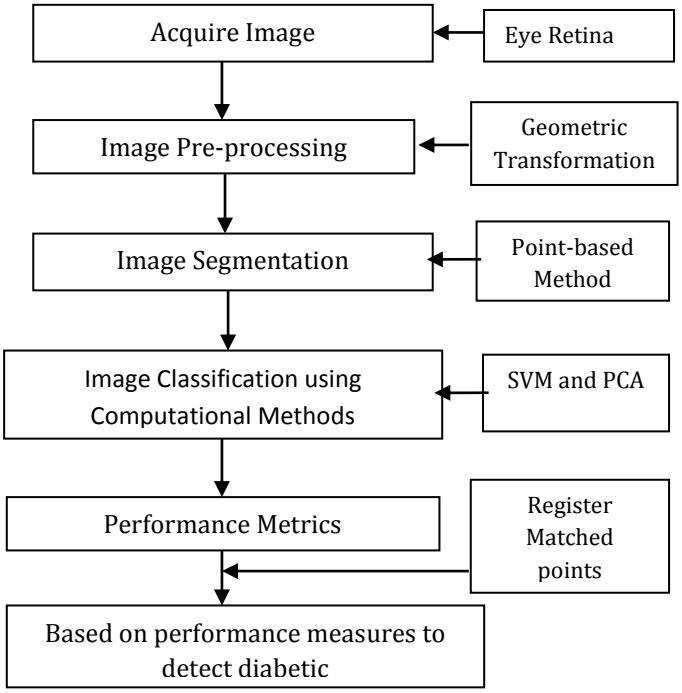

Fig- 3.1: Block Diagram

The analysis steps are as follows:

3.1 Acquire Image:

In this step, eye retina images that are captured using high-resolution sensors for diagnosis are taken as input [6]. We input two eye retina images which are taken at different timings, Image-1 and Image-2 For further analysis of input images, we use image processing techniques for further pre-processing steps.

3.2 Image Pre-processing:

Image pre-processing is a significant task in handling images acquired/captured from different sensors, different viewpoints or different timings. This process gives an improvement of the information or data in input images for further calculations or results by applying various methods to demonstrate the accurate effectiveness based on application, objective and goals. In image pre-processing step, we apply geometric transformations like rotation, translation or scaling to the input Image-2 which removes noise or any distortion in an image and improves the quality of image [7].

3.3 Image Segmentation:

There are many techniques that are used for image segmentation. Few techniques in image segmentation are threshold method, edge-based method, point-based method, region-based method, clustering method, all the methods have their own importance based on need and outcome [8]. In this step, we apply point-based method and register the input image and pre-processed image for further processing [9].

3.4 Image Classification using Computational Methods:

Image Classification is a complex process that affects many factors. It is used in many applications like medical images, underwater images, satellite images, etc. Correct classification has vital importance especially in medical applications. Image classification using computational methods includes machine learning & artificial techniques [10]. Machine learning techniques like SVM and PCA are implemented to extract the features for improvement in better accurate results in detection of diabetics.

3.5 Performance Metrics:

3.5.1 Root Mean Square Error (RMSE):

RMSE is commonly used to compare the difference between the two images by directly computing the variation in pixel values. The combined image is close to the input image when RMSE value is zero. RMSE is a good indicator of the spectral quality of another image. The RMSE is calculated using the formula:

$$\text{RMSE} = \sqrt{1/\text{MN}} \sum_{i=1}^{M} \sum_{j=1}^{N} (I1(i,j) - I2(i,j))^2$$

3.5.2 Peak Signal Noise Ratio (PSNR):

It is widely used metric it is computed by the number of gray levels in the image divided by the corresponding pixels in the input images. When the value is high, the images are similar. A higher value indicates superior results. The PSNR is calculated using the formula:

$$\text{PSNR} = 20\log10\left[\frac{L^2}{1/\text{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}(I1(i,j) - I2(i,j)^2)}\right]$$

3.5.3 Entropy (E):

Entropy is used to measure the information content of a input image. The high entropy value indicates the image as rich information content. The entropy formula is shown below:

$$\text{Entropy} = -\text{sum}(p. * \log2(p))$$

3.5.4 Relative Dimensionless Global Error (ERGAS):

It is used to compute the quality of fused image in terms of normalized average error of each band of processed image. Increase in the value of ERGAS indicates distortion in the fused image, lower value of ERGAS indicates that the image is similar to the input image. The formula for ERGAS is given below:

$$\text{ERGAS} = 100\frac{dh}{dl}\left[1/N\sum_{i=1}^{n}\left[\frac{\text{RMSE}^2}{\text{Mean}^2}\right]\right]^{1}/_{2}$$

3.5.5 Accuracy:

Accuracy, reliability also called as segmentation accuracy, it is used to determine the effectiveness of segmentation algorithms evaluation variables. The accuracy formula is given below:

$$\text{Accuracy} = (k / m * n) * 100$$

4. RESULTS

In this paper, we discuss our results based on our problem identification. We applied PCA and SVM methods as classification techniques to extract the features of input images eye retina for identification of early diabetic detection. The results are analysed based on parameter metrics and implemented using Matlab tool. The below figure 4.1 shows the analysis of eye retina using PCA method:

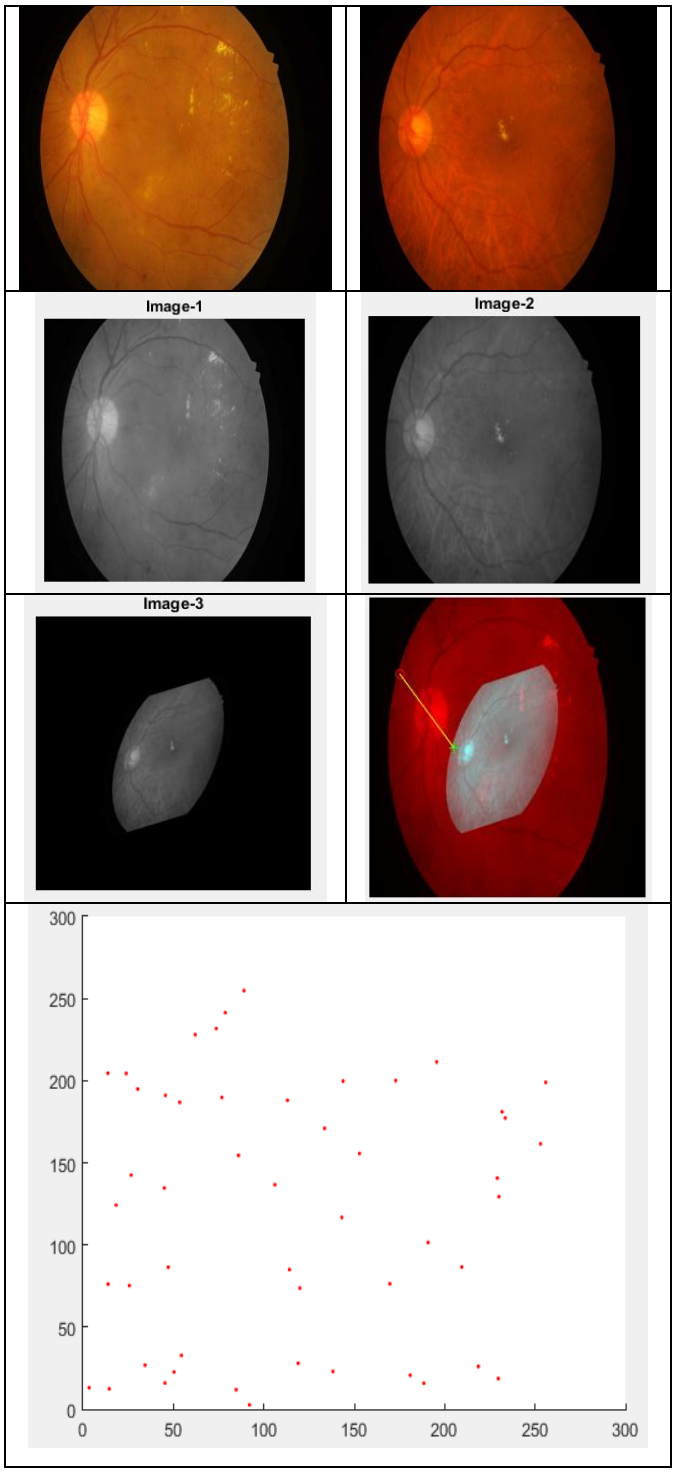

Fig 4.1: Analysis of eye retina using PCA method.

The below figure 4.2 shows the analysis of eye retina using SVM method:

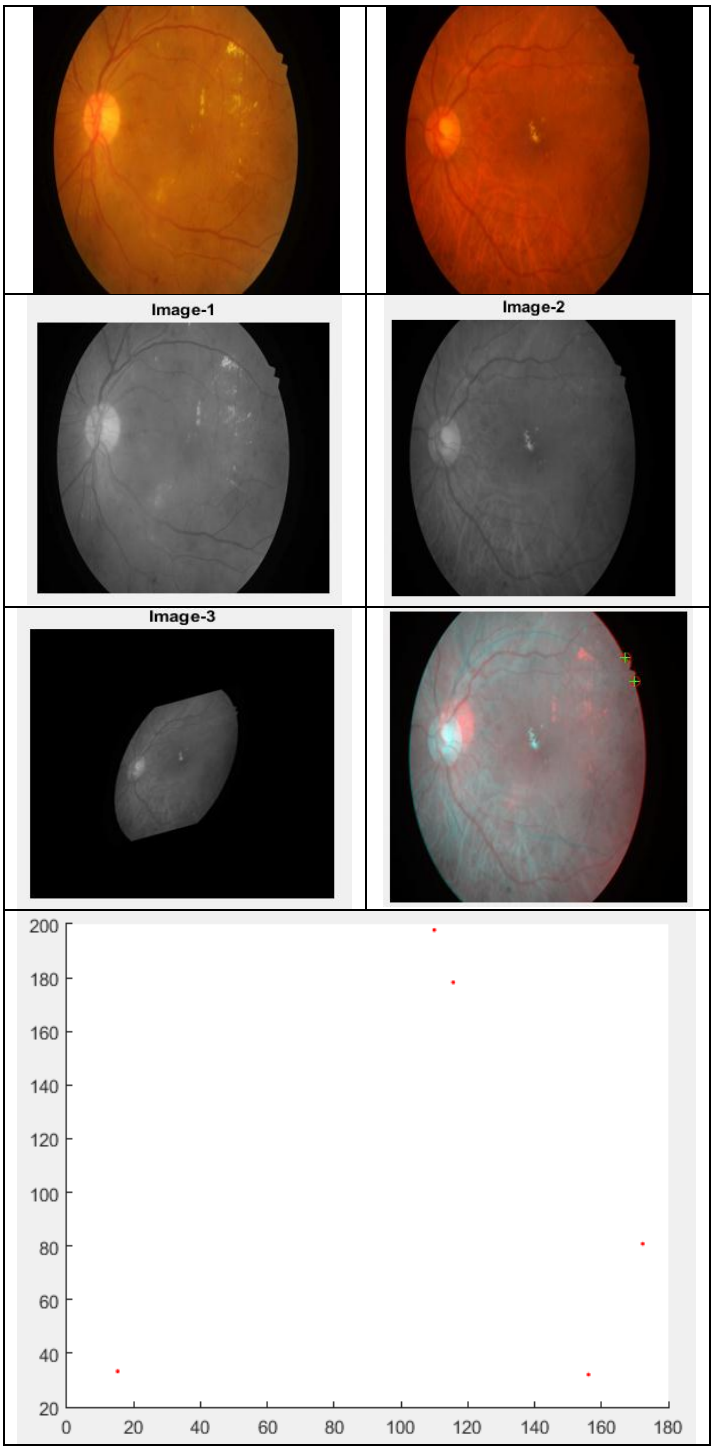

Fig 4.2: Analysis of eye retina using PCA method.

The below table 4.1 shows the performance metrics using PCA &SVM methods:

	RMSE	PSNR	E	ERGAS	Accuracy
PCA	0.000005	101.0283	1.9	0.000041	89%
SVM	0.000001	103.6489	1.2	0.000001	95%

Table 4.1: Performance metrics using PCA &SVM methods

From the table 4.1, based on the performance metrics we compare the results with both the methods PCA & SVM. We achieved better accuracy results by using SVM method since we achieve good accuracy, perform faster and early prediction of diabetics compared to PCA method.

5. CONCLUSION

There are many difficulties we faced while working. First of all, there's a lot more to do before an algorithm like this can be used widely. For example, as a classifier algorithm KNN and NNET was remarkable in percentage but we had to work more on binary classification. Secondly, if we could manage more of our training data we could train our algorithm more to achieve more accuracy. Furthermore, we also faced some problems while choosing algorithms. It was quite difficult for us to choose some specific machine learning algorithms like SVM, PCA techniques that would give accurate classification of the disease. In addition we used simple techniques for feature selection and scaling and possibly we could arrive at better results by introducing more complex techniques for selecting and generating features. We looked at small subspaces for model parameters. We have tried to construct an ensemble to predict if a patient has diabetic retinopathy using features from retinal photos. After training and testing the model the accuracy we get is sort of similar. We would like to extend our work using many machine learning algorithms like SHIFT, Deep Convolution Neural Network (DCNN) and many algorithm for more accurate results.

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