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Micro-aneurysm Detection in Diabetic Patients using Principle Component Analysis(PCA) with Support Vector Machine(SVM), Random Forest(RF) and Neural Network(NN)

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Abstract: Machine Learning provides seemingly immense opportunities to computer aided classification and diagnosis that could reduce inevitable fallibilities diagnostic variations in Healthcare. Detection of Micro-aneurysm's in Retina helps to ensure whether the person has diabetic retinopathy or not and to determine the severity of the disease and diagnose it. This project proposes an analysis to use optimistic algorithms through the study conducted using various algorithms. The Agenda is to provide a better understanding of the machine learning algorithms.

IndexTerms – Machine Learning, Micro-aneurysm, Smart Diagnosis, PCA, SVM, RF, NN

INTRODUCTION

Machine learning (ML) is a field of study that focuses on understanding and developing methods that 'learn,' or ways that use data to improve efficiency on a set of tasks. It's thought to be a part of artificial intelligence. Machine learning algorithms build a model based on training data and use it to generate predictions or judgments without needing to be explicitly programmed. The application of machine learning algorithms to detect various ailments allows clinicians to quickly identify the disease's fundamental cause and deliver a more accurate diagnosis. The primary goal is to determine which algorithm is better at recognizing micro-aneurysms in fundus pictures. We were able to perform analysis on three machine learning techniques that were classified using Principle Component Analysis (PCA) before being analysed using machine learning methods.

MOTIVATION OF THE PROJECT

Implementation of machine learning methods in the field of medics can be more costly such that all the mid-sized hospitals could not be able to afford it. So implementing it cost efficiently would make these techniques helpful to all doctors who would like to make use of these techniques. We can implement these machine learning techniques in consumer grade hardware which will meet the basic requirements necessary to run these machine learning software's.

PROBLEM STATEMENT

Vision Impairment in diabetic patients has become a common issue. Retinal micro aneurysms are the most typical lesions of diabetic retinopathy, but also present in other pathologies that affect micro vessels. Micro aneurysms are a small widening of capillary walls.When left unnoticed it could lead to permanent vision loss. If we are able to identify it in early stages then we could prevent vision loss in diabetic patients.

LITETRATURE SURVEY

1. Automated Microaneurysms Detectionin Retinal Images Using Radon Transform and Supervised Learning: Application to Mass Screening of Diabetic Retinopathy

Authors: Meysam Tavakoli, Alireza Mehdizadeh, Afshin Aghayan, Reza Pourreza Shahri, Tim ellis, and Jamshind Dehmeshki.

Findings: Detecting red lesions in colour retinal imaging is an important step in preventing vision loss and blindness caused by diabetic retinopathy (DR). The most common lesions seen as a result of DR are microaneurysms (MAs), which are usually the first to emerge. As a result, their detection is required for DR mass screening. However, due to the low picture contrast and wide range of imaging settings, finding these lesions is a difficult process. Recently, computer-aided diagnosis systems have emerged as potential tools for detecting these lesions for diagnostic reasons. We focus on building unsupervised and supervised algorithms to intelligently deal with the MAs detection challenge in this research. The retinal images are preprocessed in the first stage to remove background. Finally, using a mix of RT and a supervised support vector machine classifier, the MAs are recognised and numbered.

2.*Localizing Microaneurysms in Fundus Images Through Singular Spectrum Analysis*

Authors*:* Su Wang, Hongyng Lilian Tang, Luftfiah Ismail Al turk, Yin Hu, Saied Sanei

Findings: When building an automated analysis system for diabetic retinopathy (DR) diagnosis, reliable recognition of microaneurysms (MAs) is a must. In this paper, we offer an integrated approach for high-accuracy automated MA detection. A dark object filtering procedure is used to discover candidate objects first. Singular spectrum analysis is used to process their cross-section profiles in many directions. The correlation coefficient between each processed profile and a standard MA profile is calculated and utilised as a scaling factor to change the candidate profile's form. This is to widen the gap between true MAs and other non-MA applicants in their profiles. After that, a K-nearest neighbour classifier is used to extract a collection of statistical features from those profiles. Experiments show that with this method, MAs may be easily distinguished from the retinal background, as well as the most prevalent interfering objects and artefacts. The findings show that the technique is resilient when tested on big datasets with clinically acceptable sensitivity and specificity. When utilised in an automated DR screening tool or for large-scale eye epidemiology investigations, the approach provided in the evaluated system has a lot of potential.

3. Automated microaneurysms detection in fundus images using image segmentation

Authors: Syna Sreng**;** Noppadol Maneerat**;** Kazuhiko Hamamoto

Findings: Diabetic retinopathy is one of the complicated diseases which occurs in diabetic patients when the affects damage the retina. The eyes vision can lead to be lost in case of late treatment. Microaneurysms are the earliest detectable abnormalities of diabetic retinopathy, so the automated detection of the lesions is essential and useful task. This paper proposed a simple method to detect microaneurysms based on its characteristics in fundus images using some techniques in image segmentation. First, we preprocessed to reduce image noise and improve the contrast. Then we segmented them using Canny edges detection and maximum entropy thresholding. The characteristics of microaneurysms which appear as small red dots and circular shape are the specific points to discriminate them from the other lesions as well as the anatomical structures of the fundus image by applying area and eccentricity methods. Finally, the morphological operation was applied to mark out these symptoms. The results were analysis by ophthalmologist in order to define system accuracy and preciseness. According to results of comparison, we found that the accuracy is 90 % and the average processing time is 9.53 seconds per image.

4. Automated microaneurysms (MAs) detection in digital colour fundus images using matched filter

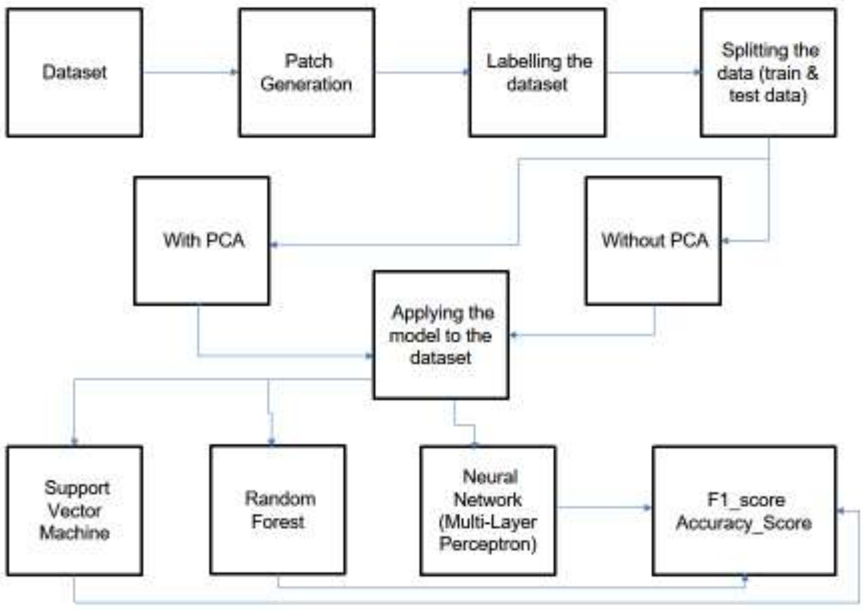
Authors: Hanung Adi Nugroho; Dhimas Arief Dharmawan; Indriana Hidayah; Latifah Listyalina

Findings: Diabetic retinopathy (DR), one of the most common causes of blindness, is a retinal abnormality caused by high glucose in diabetic patients that leads to micro vascular complications. DR has five levels of severity, i.e. no DR, mild non-proliferative diabetic retinopathy (NPDR), moderate NPDR, severe NPDR and proliferative diabetic retinopathy (PDR). Microaneurysms (MAs), the first sign of NPDR, can be used as a pre-indicator of DR. However, a manual assessment on digital colour fundus images conducted by ophthalmologists is time consuming. This paper introduces a new algorithm for the automated microaneurysms (MAs) detection in digital colour fundus images using matched filter. Generally, the algorithm consists of four phases, namely green band extraction, MAs and blood vessels isolation, MAs and blood vessels detection, and blood vessels removal. To validate the developed algorithm, the results are compared with their ground truths and annotations using ROI based validation. This algorithm obtains an average sensitivity, specificity, accuracy, and false positive number of 91.0603%, 99.9752%, 99.9752% and 256.44 pixels, respectively. This indicates that the proposed algorithm successfully detects microaneurysms and is able to be implemented in a system for DR mass screening purposes.

PROPOSED SYSTEM

- Cost Efficient
- Reliable
- Ease of Implementation
- Helps in better diagnosis
- More Appealing Accuracy

BLOCK DIAGRAM

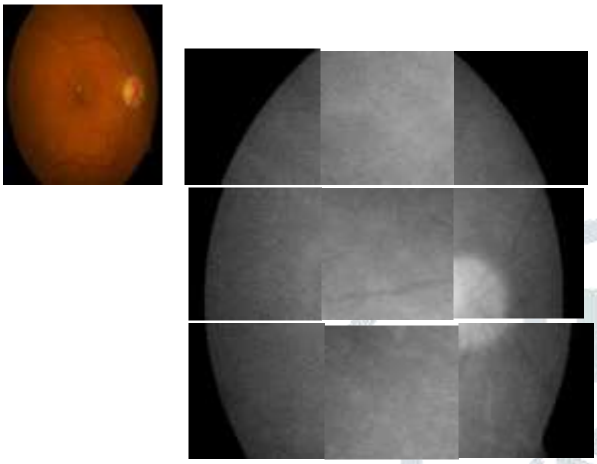


MODULES

* PATCH GENERATION

1. Patches of 300 x 300 will be generated from 50 ROC dataset's fundus images/ Patches of 300 x 300 will be generated from 89 DIARETDB1-1's fundus images (numpy array will be created that will contain all this patch-images -X)
2. Each patch will be converted to only red plane (in red planes the MA's will be clearly visible)
3. Yes/No Label will be assigned to each patch manually by checking whether that patch contains (numpy array will be created that will contain all this labels - y)
4. After that each of the machine learning will be applied without-PCA and with PCA

The below images represent the patches generated



* MANIPULATION OF DATA

1. Patches generated will be passed through PCA and without PCA before applying the machine learning methods.
2. First the X_train and X_test data will be normalized using StandardScaler() function in scikit-learn. (This is a prerequisite step for applying PCA to any dataset). **[FOR PCA]**
3. After that PCA() function of scikit-learn library will be applied to X_train and X_test to reduce the dimensionality of the dataset. **[FOR PCA]**
4. Neural network classifier with default parameters like max_iter = 200, activation_funciton = 'relu', hidden_layer_size = (10, 10, 10) etc.. will be created.
5. Support vector machine classifier with default parameters like kernel = rbf(radial basis function), degree=3, gamma = 'auto deprecated' etc.. will be created.
6. Random forest classifier with default parameters like number of trees=10, splitting criteria = Gini index, max_depth etc... will be created.
7. After that with the use of function train_test_split 10% of the original data is given to testing data and rest 90% to training data and it's accuracy, f_score etc.. will be calculated by using the classifier on testing data.

CONCLUSIONS

The trained model (RF, NN, SVM - with and without PCA) applied to testing data will predict the accuracy and will return f_score and auc score of particular algorithm. This aids in a better knowledge and analysis of which algorithm should be used to produce better and more dependable outcomes. This, in turn, will assist doctors in gaining a better understanding of their patients and offering the best possible diagnosis.

FUTURE SCOPE

With better hardware we can make this algorithm to get trained with large no. of datasets which simultaneously increases the accuracy of these algorithms.

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