SYNOPSIS OF THE Ph.D. THESIS ENTITLED

Design of an Enhanced Non Invasive Prediction Mechanism for Diabetic Retinopathy using Machine Learning Algorithms

PROPOSED FOR Ph.D. DEGREE IN COMPUTER SCIENCE



SUBMITTED BY

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PURPOSE OF THE STUDY

As a research group, we wanted to do our undergraduate thesis on a research that will assist a huge amount of people in their healthy lives. The number of people with diabetic retinopathy is growing higher day by day. If proper consideration is not given, number will grow from 126.6 million to 191.0 million by 2030 and the number with vision-threatening diabetic retinopathy (VTDR) will increase from 37.3 million to 56.3 million, if any proper action is not taken. Despite growing evidence documenting the effectiveness of routine DR screening and early treatment, it is frequently leads to poor visual functioning and represents the leading cause of blindness. Most of the time it has been neglected in health care and in many low income countries because of inadequate medical service. While researching about these factors we get motivated to work with this topic. As there is insufficient ways to detect about diabetic retinopathy, we will build a system which will give prediction about diabetic retinopathy. Thus, I decided to use Machine Learning Algorithms for the prediction of this disease.

BACKGROUND AND MOTIVATION

Eyesight is one of the most important senses that keep us in touch with the environment. Although each part of the eye is important to perceive a good image, the most crucial layer for vision is the retina. Ophthalmic disease is common. As per World Health Organisation (WHO), currently 39 million people in the world are found to be blind and 246 million people have some degree of visual impairment. In many instances, the loss or impairment of sight is unnecessary since the disease is preventable or curable. There are several ways to identify the causes for diseases in population. In the case of eye disease, much research has been conducted into the association among diet, nutritional status and exposure to ultraviolet light. According to WHO report which came in 2013, about 347 million people worldwide have diabetes and around 80% of them from low-and middle-income countries has the possibility of deaths. The disease has been projected as 7th leading cause of death in the year 2030. Worldwide, The occurrence of diabetes is speculated to rise from 2.8% in 2000 to 4.4% of the world population by 2030. In India, the incidence of diabetes is increasing at a higher rate. Regular physical activity, healthy diet and maintaining a normal body weight can prevent the onset of diabetes. Eye diseases are mostly developed among patients with diabetes. Diabetes has been proven to lead to severe late complications. One of its major complications is called Diabetic Retinopathy (DR) which affects vision. DR is a ubiquitous eye disease that is associated with the long existence of diabetes. Retinopathy can occur with all the types of diabetes and can lead to blindness if left untreated. It is a silent disease and could be recognized by the people only when the retinal changes are progressed to a level, at which the treatment gets complicated and becomes nearly impossible. It is a non-communicable disease and treatment is vital to prevent the condition from complications.

The duration of diabetes has a key role in the occurrence of Diabetic retinopathy lesions and is considerably undetected in first five years but in15 years of the disease, could be greater than 95% . Timely diagnosis and treatment can prevent severe damage to retina which requires regular DR screening programs. This process involves acquiring the retinal images and detecting the abnormalities present in the retina. The risk of blindness can be reduced to 95% by regular screening of diabetic patients. The word “screening” means the mass examination of asymptomatic diabetics, and not the non-diabetic persons. Screening is employed to detect, treat and prevent the harmful changes on the sight. An early detection of DR facilitates laser treatment to be carried out to prevent vision loss. Nowadays, the manual detection and assessment of DR is expensive and requires skilled specialists. The need for screening methods of DR increases as the number of diabetes affected people is increasing worldwide.

RESEARCH GAP

Based on the literature review from the research papers, the following problems have been identified:

* There is no clear distinction between exudates and optic disc.
* There is no clarity in the detection of hard and soft exudates.
* No clarity in the investigation of severity level by measuring the distance between the pathologies and macula.

OBJECTIVES OF THE STUDY

Diabetic retinopathy is a severe eye disease that evolves from non- proliferative to proliferative nature owing to the chronicity of diabetes. Earlier detection of diabetic retinopathy aids ophthalmologists to provide an appropriate treatment and thereby protect the patients from vision loss or blindness. The capturing of retinal images used by ophthalmologists to diagnose diabetic retinopathy through mydriasis (dilation of the eye) induces inconvenience to the patient. The medication used for dilation irritates and affects the retina of the patient’s eye. Therefore, it is essential to implement an autonomous system to diagnose diabetic retinopathy disease using image processing algorithms for non-dilated retinal images. The objectives of this research would be:

1. Detection of exudates and differentiating it with optic disk using segmentation techniques for pre-processing.
2. To investigate the severity level of the diabetic retinopathy disease with respect to exudates detection near the macular region.
3. To investigate the severity level of diabetic retinopathy disease by classifier algorithms while detecting micro-aneurysms and haemorrhages using segmentation techniques.
4. To perform the comparison of classifier algorithms based on classifier parameters such as accuracy, severity and specificity.

SCOPE OF THE STUDY

The research would be carried over a period of 4 years with data sets from Ophthalmologists, and web data bases like Kaggle, Messidor or any other suitable source to be decided later.

The proposed body of research is an effortless technique that enables ophthalmologists to detect the exudates as a DR symptom in a very short period of inspection. Moreover, this method is inexpensive and does not require trained experts. The quality of the images provided and used in the hospital is very low, making it very difficult for ophthalmologists to perform manual visual grading. The method of illumination equalization improves the image quality.

The proposed method intends to help ophthalmologists performing the diabetic retinopathy screening process, to detect symptoms more easily using low contrast images. The pre-processing steps will be applied to the non-dilated retinal fundus images which will improve the quality of the image for further image processing.

The feature extraction methods extract the features and feed them as input to the classifiers. The usage of classifiers classifies whether the test image is normal or abnormal. These classifiers in addition, assist in classifying the abnormality to whether it is moderate or severe. Further study will include a comparison of the classification approaches of the images. The severity level of the diabetic retinopathy disease involves detecting the location of exudates with respect to the macula. Application of different segmentation techniques detects the presence and location of the different stages of diabetic retinopathy such as micro-aneurysms, haemorrhages and exudates. Although the classifiers and the feature extraction methods are very familiar, the novelty of this proposed method is the segmentation of exudates using connected component labelling based on the neighbourhood approach. Moreover, the performance analysis of all the classifiers encompasses the different combination of segmentation and feature extraction methods. The segmentation of the exudates will be useful for ophthalmologists to diagnose diabetic retinopathy with a high degree of accuracy and to treat to the patients in an individual manner. In summary, the proposed thesis is a preliminary diagnostic tool or decision support system to assist the ophthalmologists and it does not affect the vision of the patients.

The high accuracy of the proposed system demonstrates the extent to which the use of image processing can replace the tedious and strenuous work of image interpretation at various hospitals.

PROPOSED RESEARCH METHODOLOGY

I will employ machine learning algorithms in medical image processing for segmentation and classification for a simple advantage that the time for applying a these to solve a medical image processing problem is negligibly small.

Segmentation process partitions an image into distinct regions containing each pixel with similar attributes. To perform image analysis and interpretation, the regions should strongly relate to depicted objects or features of interest. The segmentation algorithms will detect location of bright and red lesions and could be selected from:

* Fuzzy C means
* Fuzzy K Means
* JSEG
* Mean Shift Algorithm
* Connected Component Labeling
* Recursive Fuzzy C Means

Classification will be executed on the basis of spectral or spectrally defined features, such as density, texture, etc. in the feature space. It can be said that classification divides the feature space into several classes based on a decision rule. Classification techniques, such as supervised or unsupervised learning will then be selected on the basis of training data sets. The following are classifier algorithms which could be used for measuring degree of severity of the diabetic retinopathy disease.

* Support Vector Machine (SVM) classifier
* Probabilistic Neural Network (PNN) classifier
* Cascade Neural Network (CNN) classifier
* Expectation Maximization (EM) classifier
* K Nearest Neighbour (KNN) classifier
* Guassian Mixture Model (GMM) classifier
* Partial Least Squares (PLS) classifier

Transforming the input data into a set of features is called Feature Extraction. For that, Common numerical programming environments, such as MATLAB, Scilab and R-language could be used for simpler feature extraction techniques. Common feature extraction techniques include Gray Level Co-occurrence Matrix (GLCM), Speeded Up Robust Features (SURF), Scale -Invariant Feature Transform (SIFT), Local Binary Patterns (LBP), Local Tetra Pattern (LTrP) and Principal Component Analysis (PCA).

REFERENCES

[1] Reema, M & Pradeepa, R 2007, “Diabetic retinopathy: An Indian perspective, Indian Journal of Medical Research”, vol. 125, no. 3, pp. 297–310.

[2] T. Shanthi ∗, R.S. Sabeenian 2019, “Modified Alexnet architecture for classification of diabetic retinopathy images ”, Computers and Electrical Engineering 76 (2019) 56–64

[3] Kemal Adem, 2018, “Exudate detection for diabetic retinopathy with circular Hough transformation and convolutional neural networks” Expert Systems With Applications 114 (2018) 289–295.

[4] Peter H Scanlon, 2019, “Diabetic retinopathy”, open access article under the CC BY-NC-ND license.

[5] Shilpa Joshi, P.T. Karule, 2019, “A review on exudates detection methods for diabetic retinopathy”, Biomedicine & Pharmacotherapy 97 (2018) 1454–1460

[6] *Charumathi Sabanayagam, et al., 2018, “*Incidence and progression of diabetic retinopathy:a systematic review”, <http://dx.doi.org/10.1016/S2213-8587(18)30128-1>

[7] N. Salamat et al,2018, “Diabetic retinopathy techniques in retinal images: A review”, Artificial Intelligence In Medicine, https://doi.org/10.1016/j.artmed.2018.10.009

[8] Ramon Pires, Sandra Avila, Jacques Wainer, Eduardo Valle, Michael D. Abramoff, Anderson Rocha, A Data-driven Approach to Referable Diabetic Retinopathy Detection, *<![CDATA[Artificial Intelligence In Medicine]]>* (2019), <https://doi.org/10.1016/j.artmed.2019.03.009>

[9] Jordi de la Torre, Aida Valls, Domenec Puig, A Deep Learning In- terpretable ClassiÞer for Diabetic Retinopathy Disease Grading, *Neurocomputing* (2019), doi:https://doi.org/10.1016/j.neucom.2018.07.102

[10] W. Zhang, J. Zhong, S. Yang et al., Automated identification and grading system of diabetic retinopathy using deep neural networks, Knowledge-Based Systems (2019),

<https://doi.org/10.1016/j.knosys.2019.03.016>

[11] *V. Bolón-Canedo,2015 ”* Dealing with inter-expert variability in retinopathyof prematurity: A machine learning approach” jo ur nal ho me p ag e: www.i n t l .elsevierhealt h.com/journals/cmpb

[12] Nielsen K.B., Lautrup M.L., Andersen J.K.H., Savarimuthu T.R. & Grauslund J., Deep Learning-based Algorithms in Screening of Diabetic Retinopathy: A Systematic Review of Diagnostic Performance., *Ophthalmology Retina* (2018), doi: <https://doi.org/10.1016/j.oret.2018.10.014>.

[13] Ankita Gupta, Rita Chhikara,2018, “Diabetic Retinopathy: Present and Past”, Procedia Computer Science 132 (2018) 1432–1440

[14] Peng Cao, Fulong Ren, ChaoWan, JinzhuYang, Osmar Zaiane, Efficient multi-kernel multi-instance learning using weakly supervised and imbalanced data for diabetic retinopathy diagnosis, *<![CDATA[Computerized Medical Imaging and Graphics]]>* (2018), <https://doi.org/10.1016/j.compmedimag.2018.08.008>

[15] Jonathan Krause, 2018, “Grader Variability and the Importance of Reference Standards for Evaluating Machine Learning Models for Diabetic Retinopathy”, American Academy of Ophthalmology, <https://doi.org/10.1016/j.ophtha.2018.01.034>

[16] Emran Saleh, 2017, “Learning ensemble classifiers for diabetic retinopathy assessment”, Artificial Intelligence in Medicine

[17] Micael Pedrosa, Jorge Miguel Silva, Jo˜ao Figueira Silva, S´ergio Matos, Carlos Costa, SCREEN-DR: Collaborative platform for diabetic retinopathy, *<![CDATA[International Journal of Medical Informatics]]>* (2018),

<https://doi.org/10.1016/j.ijmedinf.2018.10.005>

[18] Rory Sayres et al.,2018, “Using a Deep Learning Algorithm and Integrated Gradients Explanation to Assist Grading for Diabetic Retinopathy”, American Academy of Ophthalmology, <https://doi.org/10.1016/j.ophtha.2018.11.016>

# [19] [Parham Khojasteh](https://www.sciencedirect.com/science/article/pii/S0010482518303330" \l "!) et al.,2019, “Exudate detection in fundus images using deeply-learnable features ”, [Computers in Biology and Medicine](https://www.sciencedirect.com/science/journal/00104825)[Volume 104](https://www.sciencedirect.com/science/journal/00104825/104/supp/C), January 2019, Pages 62-69, <https://doi.org/10.1016/j.compbiomed.2018.10.031>

# [20] [M. UsmanAkram](https://www.sciencedirect.com/science/article/pii/S0169260714000224" \l "!) et al.,2014, “Automated detection of exudates and macula for grading of diabetic macular edema ”, [Computer Methods and Programs in Biomedicine](https://www.sciencedirect.com/science/journal/01692607), [Volume 114, Issue 2](https://www.sciencedirect.com/science/journal/01692607/114/2), April 2014, Pages 141-152, <https://doi.org/10.1016/j.cmpb.2014.01.010>

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