MACHINE LEARNING BASED DETECTION AND CLASSIFICATION OF DIABETIC RETINOPATHY IN RETINAL IMAGE

Submitted in partial fulfillment of the
requirements for the award of
Bachelor of Engineering degree in Computer Science and Engineering

By

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **BALIBOINA PRAVEEN KUMAR (Reg.No - 39110117) and BADE BHANU PRAKASH (Reg.No – 39110110)** who carried out the Project Phase-2 entitled **"MACHINE LEARNING BASED DETECTION AND CLASSIFICATION OF DIABETIC RETINOPATHY IN RETINAL IMAGE"** under my supervision from November 2022 to June 2023

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DECLARATION

I, **BALIBOINA PRAVEEN KUMAR (Reg.No - 39110117),** hereby declare that the Project Phase-1 Report entitled **"MACHINE LEARNING BASED DETECTION AND CLASSIFICATION OF DIABETIC RETINOPATHY IN RETINAL IMAGE"** done by me under the guidance of **Mr. B. SATHIYAPRASAD, M. E., (Ph. D.)** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in **Computer Science and Engineering**.

DATE: 19.4.2023

PLACE: Chennai **SIGNATURE OF THE CANDIDATE**

ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to **Board of Management** of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

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I would like to express my sincere and deep sense of gratitude to my Project Guide **Mr. B. SATHIYAPRASAD, M. E., (Ph. D.**) for his valuable guidance, suggestions and constant encouragement paved way for the successful completion of my phase-1 project work.

I wish to express my thanks toall Teaching and Non-teaching staff members of the **Department of Computer Science and Engineering** who were helpful in many ways for the completion of the project.

ABSTRACT

We focus on the detection of retinal blood vessels which play a vital role in reducing proliferative diabetic retinopathy and preventing the loss of visual capability. The proposed algorithm which takes advantage of powerful pre-processing techniques such as contrast enhancement and thresholding offers an automated segmentation procedure for retinal blood vessels. To evaluate the performance of the new algorithm, experiments are conducted on 40 images collected from the DRIVE database.

One of the well-known and commonest diseases that need a computer-aided medical diagnosis is diabetic retinopathy (DR), which leads in most cases to partial or even complete loss of visual capability. The accurate diagnosis of this disease depends upon some features which have to be analyzed in order to quantify the severity level of the disease. Retinal blood vessels are considered one of the most important features for the detection of DR. As diabetic retinopathy is a progressive disease, regular screening of the human retina is essential for reducing the proliferative diabetic retinopathy and for preventing the subsequent loss of visual capability. The screening should be done every 6 months, which includes obtaining and analyzing a sequence of fundus images and observing the early changes in blood vessel patterns as well as the presence of microaneurysms.

The results show that the proposed algorithm performs better than the other known algorithms in terms of accuracy. Furthermore, the proposed algorithm being simple and easy to implement is best suited for fast-processing applications. Due to the rapid development in computing technology and techniques, algorithms that support automated medical diagnosis have been gaining importance. Retinal vasculature has received attention from specialists in different pathologies, where the detection and analysis of retinal vasculature may lead to early diagnosis and prevention of several diseases, such as hypertension, diabetes, arteriosclerosis, cardiovascular disease, and stroke.

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CHAPTER 1

INTRODUCTION

Diabetic retinopathy (DR) is the result of damage caused by diabetes to the small blood vessels located in the retina. Blood vessels damaged from diabetic retinopathy can cause vision loss. Diabetic retinopathy is a leading cause of adult blindness, and screening can reduce the incidence. Screening just increases the chances that a condition will be avoided, found early, or are able to be cured.

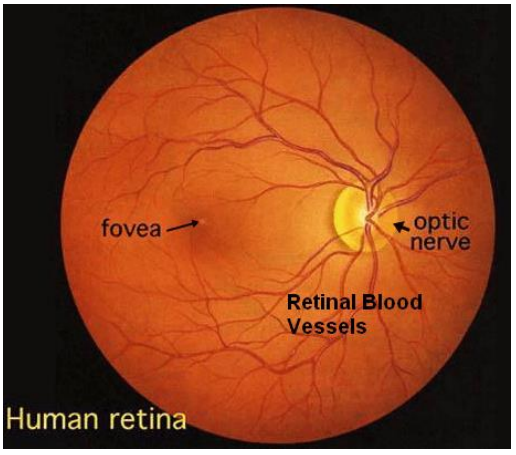
It is widely recommended that all persons with diabetes mellitus should be regularly screened for diabetic retinopathy.

Computer-based analysis for automated segmentation of blood vessels in retinal images will help ophthalmologists screen larger populations for vessel abnormalities.

A wide variety of approaches have been proposed for retina blood vessels segmentation. Many image processing methods proposed for retinal vessels extraction.

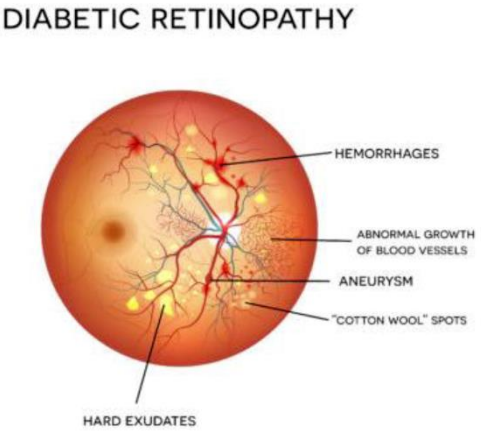
This literature is based on an optimized Gabor filter with local entropy thresholding. Gabor filters have been widely applied to image processing and computer vision application problems such as face recognition and texture segmentation [8]. Optimized Gabor filter methods often produce false positive detections and fail to detect vessels of different widths.

Retinal image



Also, the detection process much more complicated when the retinal image abnormal condition. This paper has proposed a much robust more and fast method of retinal blood vessels extraction using an optimized Gabor filter with local entropy thresholding.

Retinal image classification



Disease

- Retinal tear.
- Retinal detachment.
- Diabetic retinopathy.
- Epiretinal membrane.
- Macular hole.
- Macular degeneration.
- Retinitis pigmentosa.

Retinal image types

- Optical Coherence Tomography.
- OCT Angiography.
- Retinal Fundus Photography.
- Autofluorescence Imaging.
- Scanning Laser Ophthalmoscopy.

Methods used for retinal image

- Optical Coherence Tomography.
- OCT Angiography.
- Retinal Fundus Photography.
- Autofluorescence Imaging.
- Scanning Laser Ophthalmoscopy

CHAPTER 2

LITERATURE SURVEY

2.1 INFERENCES FROM LITREATURE SURVEY

Preliminary results of the application of morphological operations to ophthalmic image data seem to show the morphological tools may appear very useful in the ophthalmology analysis as enabling, shape- and size-based feature extractions, detection of gaps, pattern matchings, etc. The basic morphological operations dilations and erosion may be sophistically combined to create a complex transformation for a specific task in ophthalmology. Preliminary results of the application of morphological operations to ophthalmic image data seem to show the morphological tools may appear very useful in the ophthalmology analysis as enabling, shape- and size-based feature extractions, detection of gaps, pattern matchings etc. The basic morphological operations dilations and erosion may be sophistically combined to create a complex transformation for a specific task in ophthalmology. General, reliable procedures for morphological operations however do not exist – they will remain goal-driven tasks, for which domain-specific knowledge should be always explored in advance. Preliminary results of the application of morphological operations to ophthalmic image data seem to show the morphological tools may appear very useful in the ophthalmology analysis

2,2 OPEN PROBLEMS IN EXISTING SYSTEM

Reguant, R.; Brunak, S.; Saha, S. Understanding inherent image features in CNN-based assessment of diabetic retinopathy. Sci. Rep. 2021, 11, 9704

Diabetic retinopathy (DR) is a leading cause of blindness and affects millions of people throughout the world. Early detection and timely checkups are key to reduce the risk of blindness. Automated grading of DR is a cost-effective way to ensure early detection and timely checkups. Deep learning or more specifically convolutional neural network (CNN)—based methods produce state-of-the-art performance in DR detection. Whilst CNN-based methods have been proposed, no comparisons have been done between the extracted image features and their clinical relevance. Here we first adopt a CNN visualization strategy to discover the inherent

image features involved in CNN's decision-making process.

Then, we critically analyze those features with respect to commonly known pathologies namely microaneurysms, hemorrhages and exudates, and other ocular components. We also critically analyze different CNNs by considering what image features they pick up during learning to predict and justify their clinical relevance. The experiments are executed on publicly available fundus datasets (EyePACS and DIARETDB1) achieving an accuracy of 89 ~ 95% with AUC, sensitivity, and specificity of respectively 95 ~ 98%, 74 ~ 86%, and 93 ~ 97%, for disease level grading of DR. Whilst different CNNs produce consistent classification results, the rate of picked-up image features a disagreement between models could be as high as 70%.

Liu, X. *et al.* A comparison of deep learning performance against health-care professionals in detecting diseases from medical imaging: A systematic review and meta-analysis. *Lancet Digit. Heal.* 1, e271–e297 (2021).

Deep learning offers considerable promise for medical diagnostics. We aimed to evaluate the diagnostic accuracy of deep learning algorithms versus healthcare professionals in classifying diseases using medical imaging. In this systematic review and meta-analysis, we searched Ovid-MEDLINE, Embase, Science Citation Index, and Conference Proceedings Citation Index for studies published from Jan 1, 2012, to June 6, 2019. Studies comparing the diagnostic performance of deep learning models and healthcare professionals based on medical imaging, for any disease, were included.

We excluded studies that used medical waveform data graphics material or investigated the accuracy of image segmentation rather than disease classification. We extracted binary diagnostic accuracy data and constructed contingency tables to derive the outcomes of interest: sensitivity and specificity. Studies undertaking an out-of-sample external validation were included in a meta-analysis, using a unified hierarchical model. This study is registered with PROSPERO, CRD42018091176.

Our search identified 31 587 studies, of which 82 (describing 147 patient cohorts) were included. 69 studies provided enough data to construct contingency tables, enabling calculation of test accuracy, with sensitivity ranging from 9·7% to 100·0% (mean 79·1%, SD 0·2) and specificity ranging from 38·9% to 100·0% (mean 88·3%, SD 0·1). An out-of-sample external validation was done in 25 studies, of which 14 made the comparison between deep learning models and healthcare

professionals in the same sample.

Comparison of the performance between healthcare professionals in these 14 studies, when restricting the analysis to the contingency table for each study reporting the highest accuracy, found a pooled sensitivity of 87·0% (95% CI 83·0-90·2) for deep learning models and 86·4% (79·9-91·0) for health-care professionals, and a pooled specificity of 92·5% (95% CI 85·1-96·4) for deep learning models and 90·5% (80·6-95·7) for health-care professionals.

Our review found the diagnostic performance of deep learning models to be equivalent to that of healthcare professionals. However, a major finding of the review is that few studies presented externally validated results or compared the performance of deep learning models and healthcare professionals using the same sample. Additionally, poor reporting is prevalent in deep learning studies, which limits the reliable interpretation of the reported diagnostic accuracy. New reporting standards that address specific challenges of deep learning could improve future studies, enabling greater confidence in the results of future evaluations of this promising technology.

Ramakrishnan Sundaram, Ravichandran KS, Premaladha Jayaraman and Venkatraman , Extraction of Blood Vessels in Fundus Images of Retina through Hybrid Segmentation Approach, 2019

A hybrid segmentation algorithm is proposed is this paper to extract the blood vessels from the fundus image of retina. Fundus camera captures the posterior surface of the eye and the captured images are used to diagnose diseases, like Diabetic Retinopathy, Retinoblastoma, Retinal haemorrhage, etc. Segmentation or extraction of blood vessels is highly required, since the analysis of vessels is crucial for diagnosis, treatment planning, and execution of clinical outcomes in the field of ophthalmology. It is derived from the literature review that no unique segmentation algorithm is suitable for images of different eye-related diseases and the degradation of the vessels differ from patient to patient.

Christy Lyona , Joyce Menezes , Tushar Shinde , Mayura Gavhane, Classification of retinal images in stages of diabetic retinopathy using deep learning, 2020

Large numbers of retinal images are generated as diabetes patients all over the world and it is increasing every year. This increases the workload of ophthalmologists which may result in delayed diagnosis and treatment. In this paper,

automatic classification of normal eye and DR eye using convolutional neural network (CNN) is presented

B. Harini Priya dharsini ; M. Renuka Devi. Analysis of Retinal Blood Vessels Using Image Processing Techniques. 2014.

Assessment of blood vessels in human eye allows earlier detection of eye diseases such as glaucoma and diabetic retinopathy. Digital image processing techniques play a vital role in retinal blood vessel detection, Several image processing methods and filters are in practise to detect and extract the attributes of retinal blood vessels such as length, width, pattern and angles. Automated Digital image processing techniques and methods has to undergo more of improvisation to achieve precise accuracy to study the condition of Retinal Vessels especially in cases of Glaucoma and retinopathy, we have explained various Templates based matched filters, Thresholding Methods, Segmentation methods, and functional approaches to isolate the blood vessels.

Sonali S. Gaikwad, Ramesh R. Manza. Fundus Blood Vessels Extraction Using Digital Image Processing Techniques. -2017.

Diabetic retinopathy is major eye complications produced by the diabetes mellitus, which causes other problems such as stroke, cardiovascular disease, diabetic nephropathy and diabetic neuropathy. Diabetic retinopathy consequences in visual conflicts and can lead to permanent blindness. Therefore, a regular diabetic retinopathy screening is essential for early treatment, along with an effective risk factor management to overcome the diabetic complications and reduce morbidity and mortality influence.

Noha A.El-Hag, Ahmed Sedik, Walid El-Shafai, Ashraf A. M. Khalaf, Classification of Retinal Images Based on Convolutional Neural Network 2020

CONTENT: Automatic detection of maculopathy disease is a very important step to achieve high-accuracy results for the early discovery of diseases and help ophthalmologists to treat patients. Manual detection of diabetic maculpathy is time consuming and it needs much effort from ophthalmologists. Detection of exudates in eye images is used for diagnosis of the maculpathy disease. The proposed framework begins with fuzzy image enhancement of eye images for contrast enhancement in order to better represent objects of the images. After that, the

segmentation process is performed to determine the optic disc and blood vessels to remove them. The next step is working on an image with exudates only if existing. A gradient process is performed on the image. The histogram of gradients is evaluated. A cumulative histogram is further generated for discrimination between image with and without exudates. A threshold histogram curve is generated based on predefined images with and without exudates for classification of images in the testing phase. A Convolutional Neural Network (CNN) is used to classify the normal and abnormal cases. CNN appears a higher performance prior to the accuracy rather than the traditional techniques. The main objective of this paper is to build up an efficient Computer Assisted Diagnosis (CAD) system for the detection of anomalies from medical eye images to help ophthalmologists for identifying diabetic maculpathy, easily.

MadhuMithra, G. Sasikala, A.Tharamaraiselvi. Retinal Image Classification Using Neural Network Based A Cnn Methods, 2022

This article is to develop a system for distinguishing retinal diseases from fundus images. Accurate and programmed analysis of retinal images is believed to be an effective method for determining retinal disorders such as diabetic retinopathy, hypertension and atherosclerosis. In this task, a convoluted neural network is used to extract various retinal features such as the retina, optic nerve, and lesions, and to detect multiple retinal diseases in fundus photographs participating in a structured analysis (STARE) database of the retina. I applied the base model. He described an innovative solution that used convolutional neural networks (CNNs) to enable efficient disease detection and deep learning, with great success in the classification of various retinal diseases. Various neural and slice-by-slice visualization techniques were applied using CNNs trained on publicly available retinal disease image datasets. Neural networks have been observed to be able to capture the color and texture of disease-specific lesions at diagnosis. This is similar to human decision making. And this model for deploying the Django web framework. Experiment with various retinal features as input to a convolutional neural network for effective classification of retinal images.

CHAPTER 3
REQUIREMENT ANALYSIS

3.1 FEASIBILITY STUDIES/RISK ANALYSIS OF THE PROJECT

3.2 SOFTWARE REQUIREMENTS SPECIFICATION DOCUMENT

MATLAB:

MATLAB® is a high-level technical computing language and interactive environment for algorithm development, data visualization, data analysis, and numerical computation. Using MATLAB, you can solve technical computing problems faster than with traditional programming languages, such as C, C++, and Fortran.

Matlab is a data analysis and visualization tool which has been designed with powerful support for matrices and matrix operations. As well as this, Matlab has excellent graphics capabilities, and its own powerful programming language. One of the reasons that Matlab has become such an important tool is through the use of sets of Matlab programs designed to support a particular task. These sets of programs are called toolboxes, and the particular toolbox of interest to us is the image processing toolbox. Rather than give a description of all of Matlab's capabilities, we shall restrict ourselves to just those aspects concerned with handling of images. We shall introduce functions, commands and techniques as required. A Matlab function is a keyword which accepts various parameters, and produces some sort of output: for example a matrix, a string, a graph. Examples of such functions are sin, imread, imclose. There are manyfunctions in Matlab, and as we shall see, it is very easy (and sometimes necessary) to write our own.

Matlab's standard data type is the matrix_all data are considered to be matrices of some sort. Images, of course, are matrices whose elements are the grey values (or possibly the RGB values) of its pixels. Single values are considered by Matlab to be matrices, while a string is merely a matrix of characters; being the string's length. In this chapter we will look at the more generic MATLAB commands and discuss images in further chapters.

When you start up MATLAB, you have a blank window called the Command Window_ in which you enter commands. Given the vast number of MATLAB’s functions, and the different parameters they can take, a command line style interface is in fact much more efficient than a complex sequence of pull-down menus.

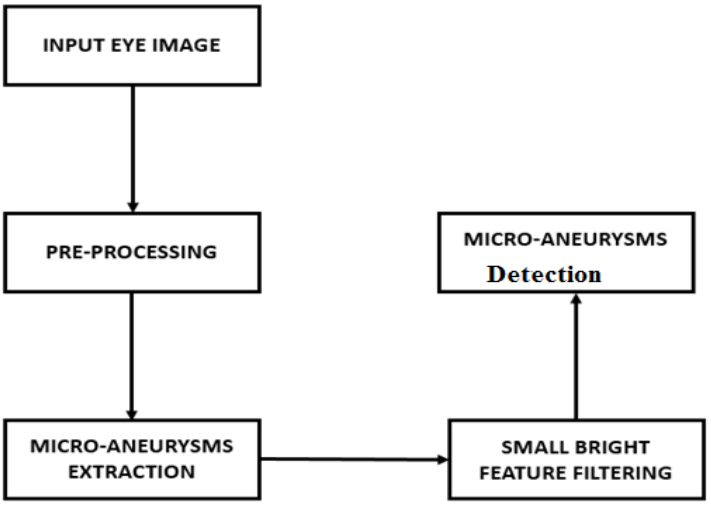
You can use MATLAB in a wide range of applications, including signal and image processing, communications, control design, test and measurement financial modelling and analysis. Add-on toolboxes (collections of special-purpose MATLAB functions) extend the MATLAB environment to solve particular classes of problems in these application areas.

MATLAB provides a number of features for documenting and sharing your work. You can integrate your MATLAB code with other languages and applications and distribute your MATLAB algorithms and applications.
When working with images in MATLAB, there are many things to keep in mind such as loading an image, using the right format, saving the data as different data types, how to display an image, conversion between different image formats.

CHAPTER 4

DESCRIPTION OF PROPOSED SYSTEM

4,1 SELECTED METHODOLOGY OR PROCESS MODEL



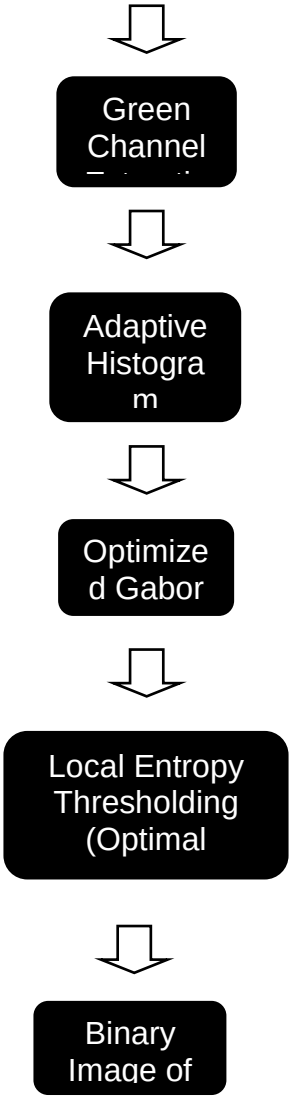
Four processing steps are proposed for MIs detection:

- A. Pre-processing step,
- B. Micro aneurysms extraction,
- C. Small bright features filtering and finally
- D. Micro aneurysms detection.

- Pre-processing is applied to eliminate the noises in the fundus image. Regarding the acquisition process, retinal images have often low contrast which causes them to hardly detect the blood vessels. This method is to improve the image dynamic range to prepare images for the next step, detection the blood vessels, and attain to higher accuracy and precision of segmentation.
- Concerning the our purpose, contrast enhancement, the green channel of colored retinal images are used, because compare to other channels it has the highest contrast.
- Combining advantages of brightness in the red channel decreases the contrast between the abnormalities and the retinal background; this helps to reduce some

responses from abnormalities that do not resemble any blood vessels that would otherwise decrease the performance of blood vessels segmentation methods. Contrast-limited adaptive histogram equalization is used for this analysis that enhancing the contrast of the green channel retinal image

4,2 ARCHITECTURE / OVERALL DESIGN OF PROPOSED SYSTEM



- In the clinical environment, the brightness and contrast of the back ground in fundus images will be the main obstacles for DR lesions detection.
- The approaches for MIs detection presented in the literature can be roughly divided into different types.
- Such as mathematical morphology base analyses on the characteristics of MIS i.e size, pixel range, shape, etc.
- The authors propose a method to detect MIs based on eigenvalue analysis using the Hessian matrix.

- Supervised learning method train the algorithm with 21 images to classify MIs candidates based on kernel density estimation.

- Support Vector Machines were applied to classify MIs candidates after extracting the features using different morphological operations.

OBJECTIVE:

- The basic morphological operations dilations and erosion may be sophistically combined to create a complex transformation for a specific task in ophthalmology. General, reliable procedures for morphological operations however do not exist – they will remain goal-driven tasks, for which domain-specific knowledge should be always explored in advance
- Preliminary results of the application of morphological operations to ophthalmic image
- data seem to show the morphological tools may appear very useful in the ophthalmology analysis as enabling, shape- and size-based feature extractions, detection of gaps, pattern matchings, etc. The basic morphological operations dilations and erosion may be sophistically combined to create a complex transformation for a specific task in ophthalmology.

4.3 DESCRIPTION OF SOFTWARE FOR IMPLEMENTATION AND TESTING PLAN OF THE PROPOSED MODEL/SYSTEM

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and the particular toolbox of interest to us is the image processing toolbox. Rather than give a description of all of Matlab's capabilities, we shall restrict ourselves to just those aspects concerned with handling of images. We shall introduce functions, commands and techniques as required. A Matlab function is a keyword which accepts various parameters, and produces some sort of output: for example a matrix, a string, a graph. Examples of such functions are sin, imread, imclose. There are manyfunctions in Matlab, and as we shall see, it is very easy (and sometimes necessary) to write our own.

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When working with images in MATLAB, there are many things to keep in mind such as loading an image, using the right format, saving the data as different data types, how to display an image, conversion between different image formats.

4.4 PROJECT MANAGEMENT PLAN

Month 1 : Choosing Domain

Month 2 &3: Survey papers collection

Month 4: Started to prepare the concepts.

Month 5 : Planed to prepare the Project and also Documentation.

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