Development Of Ocular Fundus Assessment For Early Detection Of Diabetic Retinopathy

[1]Mr. Rajasekaran T , [2]Ms. Sharmeli J ,[3]Ms. Shunmathi Sivam B ,[4]Ms. Selva Shobika T

[1]Assistant Professor, [2, 3, 4]IV year B.E CSE students
Valliammai Engineering College, Kattankulathur, Kanchipuram

***Abstract*— Automated retinal image analysis is becoming an imperative screening tool for early revealing of certain risks and diseases like Diabetic Retinopathy. Diabetic Retinopathy (DR) is the prominent cause of blindness in the world. Early detection of diabetic retinopathy can provide operative treatment. Early treatment can be conducted from detection of microaneurysms. Microaneurysms are the earliest clinical sign of diabetic retinopathy and they appear as small red spots on retinal fundus images.Microaneurysms are reddish in colour with a diameter less than 125 µm. The existing trained eye care specialists are not able to screen the growing number of diabetic patients. So there is a need to develop a technique that is capable to detect microaneurysms as a part of diagnosis system, so that medical professionals are able to diagnose the stage of the disease with ease. Automated microaneurysm detection can decrease the workload of ophthalmologists and cost in DR screening system. Early automated microaneurysms detection can help in reducing the incidence of blindness. In this project, we review and analyse the techniques, algorithms and methodologies used for the detection of microaneurysms from diabetic retinopathy retinal fundus images.**

***Keywords*: DR (Diabetic Retinopathy), fundus image, Microaneurysms, Blood vessel segmentation, Conditional Random Fields, Structured Output SVM.**

Introduction

Due to modern living style, a list of people is getting affected with Diabetes. Diabetes is a systematic and chronic end organ disease that occurs when the pancreas does not secrete enough insulin or the body is unable to process it properly. A side effect of diabetes is DR in which different parts of the retina get affected.

DR is a medical condition where the retina is damaged because fluid leaks from blood vessels into the retina. DR can be divided into three stages of non-proliferative retinopathy: mild, moderate, severe and one stage of proliferative retinopathy. Different retinal features are blood vessels, optic disk, macula and fovea.

Due to DR different parts of the retina get damaged and lead to vision loss. A retinal scan is performed by casting an unperceived beam of low energy infrared light into a person's eye as they look through the scanners eye piece. This beam of light traces a standardized path on the retina. Also the characteristics are changed due to different pathological conditions. Due to changes in retinal features, new features such as micro aneurysms, exudates, and haemorrhages appear in the retina.

I. ARCHITECTURAL DESIGN

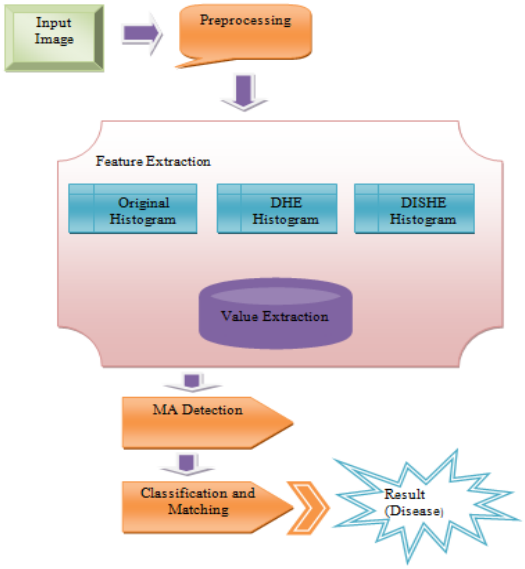

Figure 2.1 Architectural Diagram

Architectural design of the system is depicted in the above diagram Figure 1.1. Platform on which system will be running is JAVA. The existed system is Cross-section based model that can be used before any candidate extractor and do not change the characteristics of the original images. Double filtering grading of these images to determine the severity of Diabetic retinopathy (DR) is rather slow and resource demanding. Crossings of thin blood vessels may result in small circular spots that are locally similar can be detect by Vessel segments it may be disconnected from the vascular tree diagnosis. Image from which the structures that are smaller than the structuring vascular tree element are missing.

The proposed system is Micro aneurysms (MA's) detectors tackle the following way: first, the green channel of the fundus image is extracted and preprocessed. A local maximum region (LMR), of a grayscale (intensity) image is a connected component of pixels with a given constant intensity value. Pixels of the image are processed sequentially, and compared to their N-neighbors. The proposed method has been process the template matching, wavelet transformation, statistical approaches, baseline corrections, thresholding. Our method can easily distinguish the vessel bifurcations and crossings from Micro aneurysms (MAs).

II. COMPONENT AND TECHNOLOGY STUDY

3.1 Retina

The vertebrate retina is a light-sensitive layer of tissue, lining the inner surface of the eye. The optics of the eye create an image of the visual world on the retina (through the cornea and lens), which serves much the same function as the film in a camera. Light striking the retina initiates a cascade of chemical and electrical events that ultimately trigger nerve impulses. These are sent to various visual centres of the brain through the fibres of the optic nerve. In vertebrate, the retina and the optic nerve originate as outgrowths of the developing brain, so the retina is considered part of the CNS and is actually brain tissue. It is the only part of the CNS that can be visualized non-invasively.

Sensitive to light are the photoreceptor cells. These are mainly of two types: the rods and cones. Rods function mainly in dim light and provide black-and-white vision, while cones support daytime vision and the perception of colour. A third, much rarer type of photoreceptor, the photosensitive ganglion cell, is important for reflexive responses to bright daylight. Neural signals from the rods and cones undergo processing by other neurons of the retina. The output takes the form of action potentials in retinal ganglion cells whose axons form the optic nerve. Several important features of visual perception can be traced to the retinal encoding and processing of light.

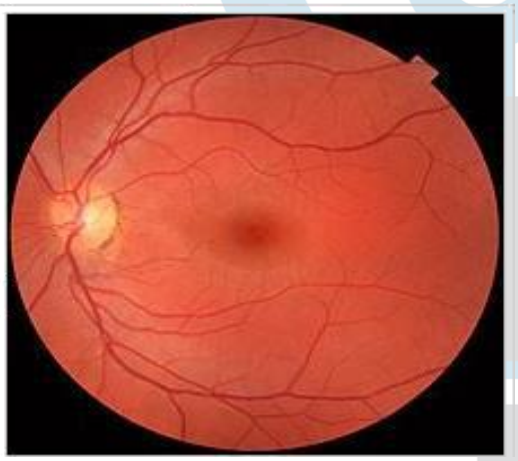

Figure 3.1 Human Eye (Grey Scale Image)

3.2 Retinal blood supply

There are two circulations, both supplied by the ophthalmic artery. The uveal circulation consists of arteries entering the globe outside the optic nerve, these supply the uvea and outer and middle layers of the retina. The retinal circulation, on the other hand, supplies the inner layer of the retina and passes with the optic nerve as a branch of the ophthalmic artery called the central artery of the retina. The central arteriole and venula bifurcate several times and arteriolar and venular branches run mostly in parallel with some crossovers. The vascular topographical geometry in the retina is known to conform to structural principles that are related to certain physical properties. The unique structure of the blood vessels in the retina has been used for biometric identification. Changes in the retinal microcirculation are seen with aging, exposure to air pollution and may indicate cardiovascular diseases such as hypertension and atherosclerosis. The identification of vascular bifurcations is one of the basic steps in this analysis. Results of such analyses of the retinal microcirculation can be evaluated against the ground truth data of vascular bifurcations of retinal fundus images that are obtained from the DRIVE data set.

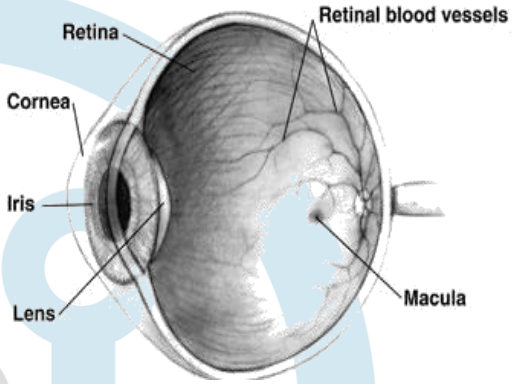

Figure 3.2 Retinal Fundus Image

3.3 Retinal Diseases and Treatments

There are many inherited and acquired diseases or disorders that may affect the retina. They are diagnosed and treated with certain treatments. Some of the retinal diseases are

1. Retinal detachment (RD)
2. Diabetic retinopathy (DR)
3. Age-related macular degeneration(AMD)
4. Central retinal vein occlusion (CRVO)
5. Central retinal artery occlusion (CRAO)
6. Retinopathy of prematurity (ROP)

A number of different instruments are available for the diagnosis of diseases and disorders affecting the retina. Ophthalmoscopy and fundus photography are used to examine the retina. Recently, adaptive optics has been used to image individual rods and cones in the living human retina.

The electroretinogram is used to measure non-invasively the retina's electrical activity, which is affected by certain diseases. A relatively new technology, now becoming widely available, is OCT. This non-invasive technique allows one to obtain a 3D volumetric or high resolution cross-sectional tomogram of the retinal fine structure with histologic-quality. Treatment depends upon the nature of the disease. Transplantation of retinas has been attempted, but without much success.

3.4 WEKA

Waikato Environment for Knowledge Analysis (**Weka**) is a suite of machine learning software written in Java, developed at the University of Waikato, New Zealand. It is free software licensed under the GNU General Public License. Weka contains a collection of visualization tools and algorithms for data analysis and predictive modeling, together with graphical user interfaces for easy access to these functions. The original non-Java version of Weka was a Tcl/Tk front-end to (mostly third-party) modeling algorithms implemented in other programming languages, plus data preprocessing utilities in C, and a Makefile-based system for running machine learning experiments. This original version was primarily designed as a tool for analyzing data from agricultural domains, but the more recent fully Java-based version (Weka 3), for which development started in 1997, is now used in many different application areas, in particular for educational purposes and research. Following are the advantages of weka tools

1. Free availability under the GNU General Public License.
2. Portability, since it is fully implemented in the Java programming language and thus runs on almost any modern computing platform.
3. A comprehensive collection of data preprocessing and modeling techniques.
4. Ease of use due to its graphical user interfaces

3.5 JAVA Swing

Swing is a GUI widget toolkit for Java. It is part of Oracle's Java Foundation Classes (JFC) – an API for providing a graphical user interface (GUI) for Java programs. Swing was developed to provide a more sophisticated set of GUI components than the earlier Abstract Window Toolkit (AWT). Swing provides a look and feel that emulates the look and feel of several platforms, and also supports a pluggable look and feel that allows applications to have a look and feel unrelated to the underlying platform. It has more powerful and flexible components than AWT.

In addition to familiar components such as buttons, check boxes and labels, Swing provides several advanced components such as tabbed panel, scroll panes, trees, tables, and lists. Unlike AWT components, Swing components are not implemented by platform-specific code. Instead, they are written entirely in Java and therefore are platform-independent. The term "lightweight" is used to describe such an element.

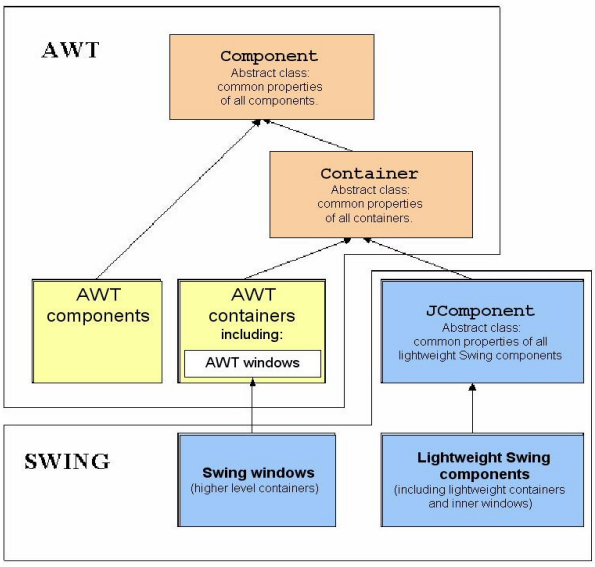

Figure 3.5 Architecture

3.6 NetBeans

NetBeans is an integrated development environment (IDE) for Java. NetBeans allows applications to be developed from a set of modular software components called modules. NetBeans runs on Microsoft Windows, macOS, Linux and Solaris. In addition to Java development, it has extensions for other languages like PHP, C, C++ and HTML5, Javadoc and JavaScript. Applications based on NetBeans, including the NetBeans IDE, can be extended by third party developers. The NetBeans IDE Bundle for Web & Java provides complete tools for all the latest Java EE 6 standards, including the new Java EE 6 Web Profile, Enterprise Java Beans (EJBs), servlets, Java Persistence API, web services, and annotations. NetBeans also supports the JSF 2.0 (Facelets), Java Server Pages (JSP), Hibernate, Spring, and Struts frameworks, and the Java EE 5 and J2EE 1.4 platforms. It includes Glassfish and Apache Tomcat.

III. IMPLEMENTATION

The input image which is need to trained were collected from the DRIVE, STARE, HRF datasets. After opening our project in the NetBeans, the Input dialog box will appear (Fig 4(a)).In testing system, the input image is selected from the datasets and starts preprocess.

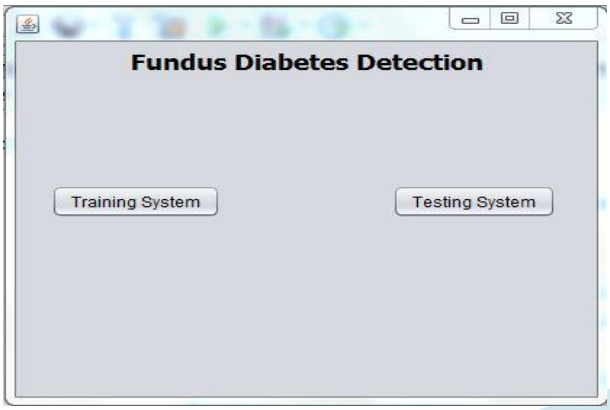

Figure 4(a) Input Window

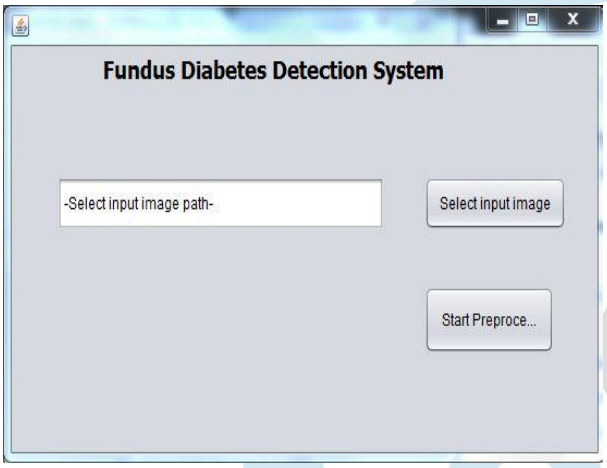

Figure 4(b) Testing System

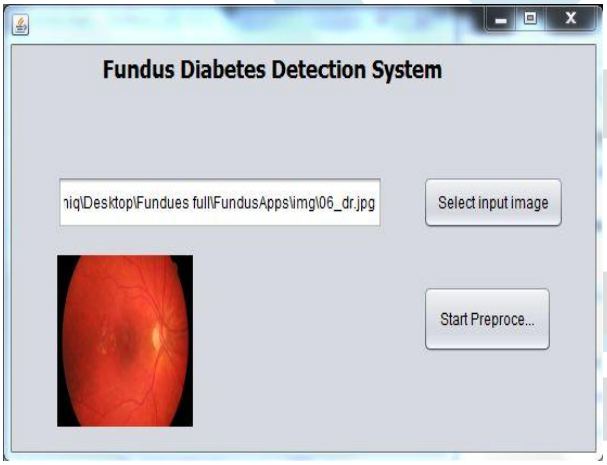

Figure 4(c) After selecting the input image

4.1 Image Preprocessing

Each Image preprocessing is required for the reduction of noise and contrast enhancement. It is performed in all methods of micro aneurysms detection.

4.1.1 Filtering

The filter is the optimal linear filter for maximizing the signal in the presence of additive stochastic noise. It uses morphological opening operation to estimate the background illumination. Morphological opening is erosion followed by dilation, using the same structuring element for both operations. The opening operation has the effect of removing objects that cannot completely contain the structuring element. For more information about morphological image processing, see Morphological Operations. Use the surf command to create a surface display of the background.

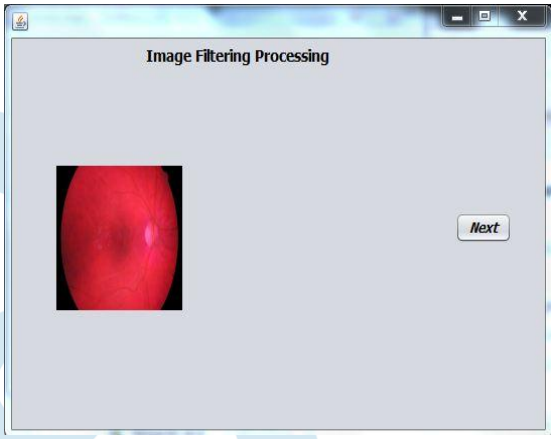

Figure 4.1.1 Filtering Process

4.2 Histogram Generation

A histogram is the probability distribution of pixel values in an image. (For RGB images, the histogram is usually broken into three histograms of the three component channels.)

Like any other distribution, histograms have simple mathematical rules. Two operations that affect the pixel values, and thus the Histograms, will be used extensively through these posts:

1. Adding a value to all the pixels adds that amount to the histogram; visually, this shifts the histogram

2. Multiplying all the pixel values by a certain amount scales where the histogram data appears; visually, this stretches the histogram Contrast limited Adaptive Histogram Equalization (CLAHE), Equal area dualistic sub-image histogram equalization (DSIHE), Dynamic Histogram equalization (DHE).

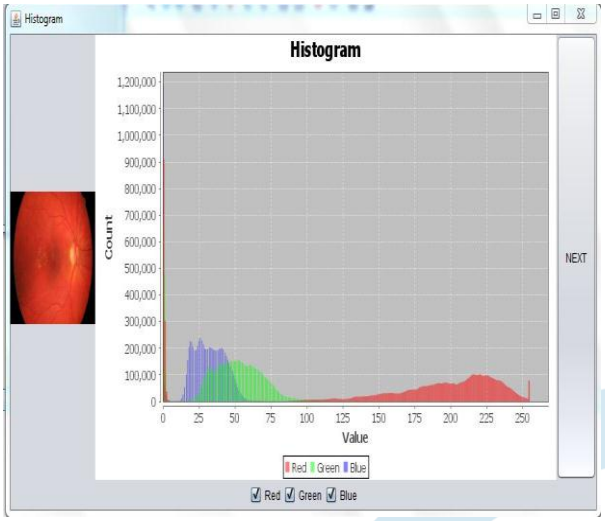

Figure 4.2 Histogram Generation

4.3 Feature Extraction

A feature is an interesting part of an image, such as a corner, blob, edge, or line. Feature extraction enables you to derive a set of feature vectors, also called descriptors, from a set of detected features. Computer Vision System Toolbox offers capabilities for feature detection and extraction. Feature extraction a type of dimensionality reduction that efficiently represents interesting parts of an image as a compact feature vector. This approach is useful when image sizes are large and a reduced feature representation is required to quickly complete tasks such as image matching and retrieval.

Feature detection, feature extraction, and matching are often combined to solve common computer vision problems such as object detection and recognition, content-based image retrieval, face detection and recognition, and texture classification.

4.4 SVM Classification

Support vector machines (SVMs) are a relatively new learning process influenced highly by advances in statistical learning theory and a sufficient increase in computer processing power in recent years. In the last ten years SVMs have led to a growing number of applications in image classification and handwriting recognition, to name just a few. Before the discovery of SVMs, machines were not very successful in learning and generalization tasks, with many problems being impossible to solve. SVMs are very effective in a wide range of bioinformatics problems and in particular, perform well in analyzing microarray expression data and detecting remote protein homologies.

Much like the human brain, SVMs learn by example. Each example consists of a m number of data points(x1,xm) followed by a label, which in the two class classification we will consider later, will be +1 or -1. -1 representing one state and 1 representing another.

4.5 Edge Detection

The method by which images are produced--the interaction between objects in real space, the illumination, and the camera--frequently leads to situations where the image exhibits significant shading across the field-of-view. In some cases the image might be bright in the center and decrease in brightness as one goes to the edge of the field-of-view. In other cases the image might be darker on the left side and lighter on the right side

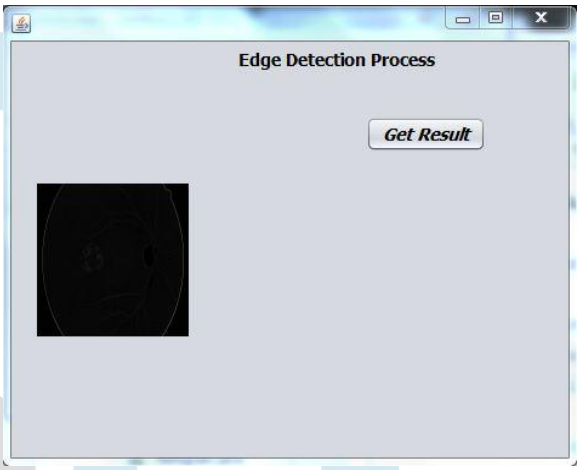

Figure 4.5 Histogram Generation

4.6 Result Analysis

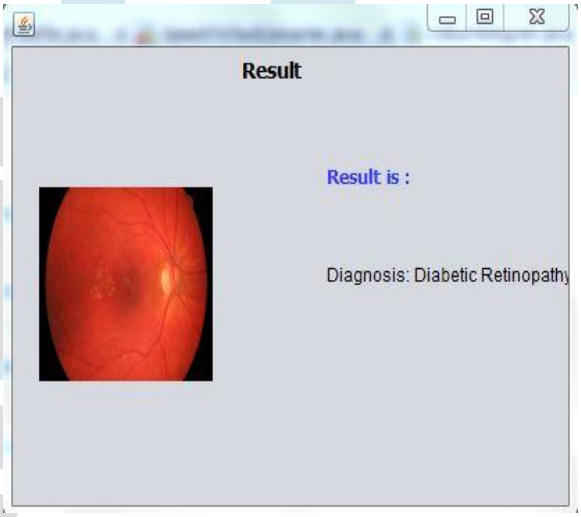

Figure 4.6 Histogram Generation

After the detection of the micro aneurysms particles the trained SVM which is a classifier analyses the images and gives out the type of disease present in the given input. Our SVM is trained to detect four types of disease and a normal eye. The diseases our SVM can detect are Cancer, Old-Age diseases, Diabetics and Glaucoma. We have experimented on large set of retinal fundus images and our system can detect the diseases exactly.

IV. WORKING AND RESULTS

The ocular fundus images are processed and create a histogram as an intermediate output.
Based on the values of RGB, the sample images undergo grayscale transformation. The pattern of that image will be matched with trained data obtained from the DRIVE, STARE, CHASE DB1 and HRF data sets. Parameters are learned automatically using a Structured Output Support Vector Machine. The classification and matching can be done by using Naive Bayes Classifiers.
By means of features extracted from the images and fully connected pair wise potentials, the result will be displayed.

V. CONCLUSION

We have provided a novel technique for the detection and extraction of true blood vessels and also implemented various techniques to efficiently calculate and locate the exact location of micro aneurysm particles. In this project we extracted the blood vessels from the retinal fundus image after going through various pre-processing steps and vessel segmentation process

VII . FUTURE SCOPE

This project is designed in such a way that it can detect the type of disease of any human retinal images. The SVM is trained to detect only four type of disease and a normal human eye, so in future it will be better if we train the SVM classifier to find more retinal diseases which reduces the work of the ophthalmologists. By improving this system we can be able to

REFERENCES

[1] R. Vega et al., "Retinal vessel extraction using lattice neural networks with dendritic processing," Computers in biology and medicine, vol. 58, pp. 20–30, 2015.
[2] A Discriminatively Trained Fully Connected
Conditional Random Field Model for Blood Vessel Segmentation in Fundus Images
Jos´e Ignacio Orlando*, Elena Prokofyeva, and Matthew B. Blaschko, 2017
[2] G. Azzopardi et al., "Trainable cosfire filters for vessel delineation with application to retinal images," Medical image analysis, vol. 19, no. 1, pp. 46–57, 2015.
[3] M. M. Fraz et al., "Delineation of blood vessels in pediatric retinal images using decision trees-based ensemble classification," International journal of computer assisted radiology and surgery, vol. 9, no. 5, pp. 795–811, 2014.
[4] T. Chakraborti et al., "A self-adaptive matched filter for retinal blood vessel detection," Machine Vision and Applications, vol. 26, no. 1, pp. 55–68, 2014.
[5] M. M. Fraz et al., "Application of morphological bit planes in retinal blood vessel extraction," Journal of digital imaging, vol. 26, no. 2, pp. 274–286, 2013.
[6] J. Odstr?cil´ik et al., "Retinal vessel segmentation by improved matched filtering: evaluation on a new high-resolution fundus image database," IET Image Processing, vol. 7, no. 4, pp. 373–383, 2013.