**ABSTRACT**

Automatic retinal blood vessel segmentation algorithms provides useful information for the diagnosis and monitoring of eye diseases such as diabetic retinopathy, hypertension, glaucoma etc. Many of the methods in a variety of edge detection algorithms do not always lead to acceptable results in extracting various features in an image. Automatic retinal blood vessel segmentation algorithms provides useful information for the diagnosis and monitoring of eye diseases such as diabetic retinopathy, hypertension, glaucoma etc.

Many of the methods in a variety of edge detection algorithms do not always lead to acceptable results in extracting various features in an image. The concepts of matched filtering is used to detect piecewise linear segments of blood vessels in these images. Generally we construct different templates that are used to search for vessel segments along all possible directions. All these templates are combined to get a accurate segmented vessel structure. The concepts of matched filtering is used to detect piecewise linear segments of blood vessels in these images. Generally we construct different templates that are used to search for vessel segments along all possible directions. All these templates are combined to get a accurate segmented vessel structure

Vision is the most fundamental of human senses. The eye is a very complex and truly amazing organ. It is approximately one inch wide and deep, and 0.9 inches tall. Human eyes allow humans to appreciate all the beauty of the world they live in, to read and gain knowledge, and to communicate their thoughts and desires to each other through visual expression and visual arts. The human eye is wrapped in three layers of tissue: the external layer, formed by the sclera and cornea; the intermediate layer, divided into two parts: anterior (iris and culinary body) and posterior (choroid); and the internal layer, or the sensory part of the eye, the retina.

Cornea: the clear front window of the eye. The cornea transmits and focuses light into the eye Iris: the colored part of the eye. The iris helps regulate the amount of light that enters the eye. Lens: the transparent structure inside the eye that focuses light rays onto the retina.

Macula: a small area in the retina that contains special light-sensitive cells. The macula allows us to see fine details clearly. Optic Nerve: The nerve that connects the eye to the brain. The optic nerve carries the impulses formed by the retina to the brain, which interprets them as images. Pupil:the dark center in the middle of the iris. The pupil determines how much light is let into the eye. It changes sizes to accommodate for the amount of light that is available. Retina:the nerve layer that lines the back of the eye. The retina senses light and creates impulses that are sent through the optic nerve to the brain.

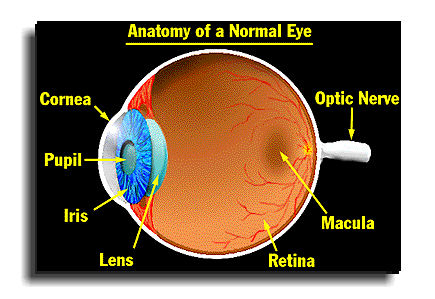


Fig \* human eye

Fundus photography involves capturing a photograph of the back of the eye i.e. [fundus](https://en.wikipedia.org/wiki/Fundus_(eye)). Specialized fundus cameras that consist of an intricate microscope attached to a flash enabled camera are used in fundus photography. The main structures that can be visualized on a fundus photo are the central and peripheral [retina](https://en.wikipedia.org/wiki/Retina), [optic disc](https://en.wikipedia.org/wiki/Optic_disc) and [macula](https://en.wikipedia.org/wiki/Macula_of_retina).



Fig fundus camera

Retina is the tissue lining the interior surface of the eye which contains the light-sensitive cells (photoreceptors). Photoreceptors convert light into neural signals that are carried to the brain through the optic nerves. In order to record the condition of the retina, an image of the retina (fundus image) can be obtained. A fundus camera system (retinal microscope) is usually used for capturing retinal images. Retinal image contains essential diagnostic information which assists in determining whether the retina is healthy or unhealthy. Retinal images have been widely used for diagnosing vascular and non-vascular pathology in medical society. Retinal images provide information on the changes in retinal vascular structure, which are common in diseases such as diabetes, occlusion, glaucoma, hypertension, cardiovascular disease and stroke.

These diseases usually change reflectivity, tortuosity, and patterns of blood vessels .For example, hypertension changes the branching angle or tortuosity of vessels and diabetic retinopathy can lead to neovascularization i.e., development of new blood vessels. If left untreated, these medical conditions can cause sight degradation or even blindness. The early exposure of these changes is important for taking preventive measure and hence, the major vision loss can be prevented



Fig \* fundus image

Automatic segmentation of retinal blood vessels from retinal images would be a powerful tool for medical diagnostics. For this purpose, the segmentation method used should be as accurate and reliable as possible. The main aim of segmentation is to differentiate an object of interest and the background from an image.

SCOPE OF THE PROJECT:

The aim of this project is Automatic Segmentation of retinal blood vessels from retinal images using Matched Filter would be a powerful tool for medical diagnostics. Thus, automated segmentation is valuable as it decreases the time and effort required.

The algorithms for retinal blood vessel segmentation concentrate on automatic detection related to diabetic retinopathy, which is found to be major cause of blindness in recent years.

Organization of this report:

Chapter 1: structure of the human eye, introduction about the fundus images are covered. And the scope of this project also discussed

Chapter 2: a brief discussion about the literature survey.

Chapter 3: it involves the methodologies proposed and the flowchart of the steps used to detect the blood vessels

Chapter 4: it contains the introduction

Literature survey:

Subhasis chaudhury,shankar chatterjee,Norman katz and Mark nelson "Detection of blood vessels in retinal images using two dimensional matched filters" year 1989.-

In this paper,the concept of matched filter detection of signals is used to detect piece wise linear segments of blood vessels in these images. 12 different templates are constructed that are used to search vessel segments along all possible directions. Template matching algorithm offers the advantage of ease of implementation on specialized high speed hardware as well as the possibility for parallel computations. Unlike edge detection algorithms, this method extracts blood vessels as a whole.Matched filter detection method is applicable only to stationary processes.Usually a prepossessing step is performed in which the local mean is subtracted from the image and then pixel intensities are divided by the square root of local variances to approximate image as a stationary process.

2.Jan odstrcilik, Radim kolar, Attila budai, joachim hornegger, Jiri Jan "Retinal vessel segmentation by improved matched filtering",year 2012-2013: evaluation on a new high resolution fundus image database.In this paper, the proposed method utilizes MF and minimum error thresholding technique to extract binary blood vessel tree. The 2D MF used locally exploits the correlation between local image areas and 2D masks developed according to the appearance of typical blood vessel segments of different widths(diameter) and orientations.DRIVE and STARE databases were included in the analysis in order to compare the proposed methods with state-of-the-art methods.Besides that new retinal database of high resolution fundus images of healthy subjects and subjects affected by DR and glaucoma are presented, corresponding gold standard images were created for each fundus image in the database by manual labelling of the blood vessel tree.

Anil Maharjan, School of Computing Computer Science, university of eastern finland, Joensuu “blood vessel segmentation from retinal images” June 2016

In this thesis, the literatures regarding different methods for retinal blood vessel segmentation were studied and the three state-of-the-art methods from three different categories (i.e. supervised, unsupervised, and match filtering methods) were selected based on their good performance results as published in the literature. Among the three state-of-the-art methods, the literature related to the supervised method and matched filtering based method are well documented, which made the implementation process easier. Whereas the unsupervised method is relatively poorly documented, so other similar kind of literature was taken into consideration for studying and implementing the algorithm.

**METHODOLOGIES:**

There are several techniques for blood vessel segmentation and diagnosis of diseases related to retina. Different authors have categorized those methods in different way.

In, the authors divided the retinal vessel segmentation into seven main categories;

1. pattern recognition techniques
2. matched filtering,
3. mathematical morphology,
4. multi-scale approaches,
5. vessel tracking,
6. model based approaches,
7. Parallel/hardware based approaches.

Pattern recognition deals with classification of retinal blood vessels and non-vessels together with background, based on key features. This approach has two methods;

1. supervised and
2. Unsupervised.

If a priori information is used to determine a pixel as a vessel or not, then that method is super-vised, otherwise it is unsupervised method. Matched filtering uses convolution of two dimensional kernels, which is designed to model a feature at some position and orientation, with the retinal image and detect vessels by maximizing the responses of kernels used [2, 4]. Mathematical morphology deals with the mathematical theory of representing shapes like features, boundaries, etc. using sets.

Mainly two morphological operators; erosion and dilution, are used for applying structuring element to the images. The idea behind multi-scale approach is to use the vessel’s width to determine blood vessels having varying width at different scales.

Many of the multi-scale algorithms are based on the vessel enhancement filters. Vessel tracking method segments a vessel between two points by identifying vessel center line rather than entire vessels at once. In this method, the tracing of the vessel, which seems like a line, is done by using local information and by following vessel edges. Parallel hardware based approach is mainly for fast and real time performance, and implementation is done in hardware chips. The implementation of this approach for real time image processing is done in VLSI chip by representing cellular neural network

Based on the classification method, pattern recognition can be either supervised or unsupervised. Supervised classification is the procedure in which user interaction is required: user defines the decision rules for each class/pixels or provides training data for each class/pixels to guide the classification. It uses supervised learning algorithm for creating a classifier, based on training data from different object classes. The input data are provided to the classifier, which assigns the appropriate label for each input. Whereas unsupervised method attempts to identify the patterns or clusters from the input dataset without predefined classification rules. It learns and organizes information on its own to find the proper solution

FUTURE WORK:

1. Presently the matched filter detection method is applicable only to stationary process. Usually the pre-processing step is performed in which the local mean is subtracted from the image and then the pixel intensities are divided by the square root of the local variances to approximate the image as a stationary process. This pre-processing step may be omitted as the qualitative improvement. Future work proposes to introduce vessel morphology to improve the vessel segmentation results for achieving improved performances.
2. Investigate the use of more robust segmentation techniques for the detection of both large and thin vessels in retinal images.
3. The future insight includes applying enhanced post-processing techniques to achieve the better results for the segmented image.
4. In the future work detection of combined together, to develop a software package, that accepts retinal color fundus image as input and provide a set of numerical indices as output that describes the current status of the vessel morphology vessel tortuosity, branching angle, branching coefficient, vessel width, and fractal dimensions
5. Histogram equalization is performed to improve the image quality and to improve the contrast. Instead of using normal histogram equalization, adaptive histogram equalization is used since it operates on small regions in the original image

FLOWCHART:

Extract all three

color channels

Final output

Apply xnor between above output and channel filtering image

Apply xor between R & B channel filtering image

Apply matched filtering on all three channel images

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