DETECTION OF DRUSEN IN AMD USING OPTICAL COHERENCE TOMOGRAPHY (OCT) IMAGES

A PROJECT REPORT SUBMITTED

IN PARTIAL FULFILMENT FOR THE AWARD OF

THE DEGREE OF

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS & INSTRUMENTATION ENGINEERING

Submitted by

D.ROSHAN	**16071A1046**
T.JANARDHAN	**17075A1006**
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DEPARTMENT OF ELECTRONICS & INSTRUMENTATION ENGINEERING

VALLURUPALLI NAGESWARA RAO VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY

AICTE Approved; UGC Autonomous; JNTUH Affiliated; UGC "College with Potential for Excellence"; NAAC "A++" Grade

ISO 9001:2015 Certified; QS I.GAUGE "Diamond" Rated; NIRF 2019: 109th Rank Engineering (151–200 Band Overall)

NBA Accredited: CE, CSE, ECE, EEE, EIE, IT, ME; JNTUH-Recognised Research Centres: CE, CSE, ECE, EEE, ME

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Under the Guidance of
Mrs. Jyothirmai Joshi
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CERTIFICATE

This is to certify that the project titled **"DETECTION OF DRUSEN IN AMD USING OPTICAL COHERENCE TOMOGRAPHY (OCT) IMAGES"** is being submitted, by **D.ROSHAN (16071A1046), T.JANARDHAN (17075A1006), B.VENKAT REDDY (17075A1008)** in partial fulfilment of the requirement for the award of degree of **Bachelor of Technology in Electronics and Instrumentation Engineering**, to the Department of Electronics and Instrumentation Engineering at the **Vallurupalli Nageswara Rao Vignana Jyothi Institute of Engineering and Technology** is a record of *bona fide* work carried out by them under my guidance and supervision. The results embodied in this thesis have not been submitted to any other University or Institute for the award of any degree.

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We express our special gratitude to our Project Guide, **Mrs. Jyothirmai joshi,** Assistant Professor, Department of Electronics & Instrumentation Engineering, VNRVJIET, for her guidance and help provided in successful completion of our project titled **"DETECTION OF DRUSEN IN AMD USING OPTICAL COHERENCE TOMOGRAPHY (OCT) IMAGES"**. We thank her for the earnest cooperation he/she extended to us in executing the current project work.

We express our sincere thanks to **Dr. R. Manjula Sri,** Professor & Head of the Department of Electronics & Instrumentation Engineering, VNRVJIET, and to other faculty members in the Department for guiding us through our education at the Institute and for encouraging us all through. We particularly thank our mentors, **Mrs. Vandhana,** Assistant Professor**, Mr. K.Vidyasagar,** Professor, **Dr.B.Rajashekar Reddy,** Assistant professor for helping us through our journey at VNRVJIET. We also extend our gratitude to the Project Coordinator, **Mr. V. Nageswar** Associate Professor with the Department of EIE, for his valuable guidance and for streamlining the review process for our project work. Our thanks are also due to the other members of the Review Panel and all other faculty members.

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D.ROSHAN

T.JANARDHAN

B.VENKAT REDDY

DECLARATION

We hereby declare that the project work titled **"DETECTION OF DRUSEN IN AMD USING OPTICAL COHERENCE TOMOGRAPHY (OCT) IMAGES"** submitted, towards partial fulfilment of requirements for the degree of Bachelor of Technology in Electronics and Instrumentation Engineering, to the Department of Electronics & Instrumentation Engineering at the Vallurupalli Nageswara Rao Vignana Jyothi Institute of Engineering and Technology, Hyderabad, is an authentic work and had not been submitted to any other University or Institute for any award of degree or diploma.

D.ROSHAN	**T.JANARDHAN**	**B.VENKAT REDDY**
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ABSTRACT

Among 5 important sense organs present in our body, Eye is one of the most essential organ,as it plays a vital role in human life. Its main function is to get respond to the external stimulus and convey them to the nervous system to take necessary action. Human eye is the sensitive organ towards light. The light rays enter into the human eye through cornea, pupil, and lens and focused on to the retina a light sensitive tissue which is mainly responsible for vision.

The progress of age-related macular degeneration (AMD) can be evaluated through the quantification of drusen. Drusen are usually located by thresholding the distance between their limiting boundaries. Moreover, the proposed method can identify individually drusen present in clusters. The individualized drusen information allows the exploration of new range of metrics that go beyond the total drusen area or volume, such as drusen size, which is used to categorize the stages of AMD. Additionally, by using automatic segmentations to compute the features.

LITERATURE SURVEY

Young Jae Kim and Kwang Gi Kim

Existing drusen measurement is difficult to use in clinic because it requires a lot of time and effort for visual inspection. In order to resolve this problem, we propose an automatic drusen detection method to help clinical diagnosis of age-related macular degeneration .First, we changed the fundus image to a green channel and extracted the ROI of the macular area based on the optic disk. Next, we detected the candidate group using the difference image of the median filter within the ROI. We also segmented vessels and removed them from the image. Finally, we detected the drusen through Renyi's entropy threshold algorithm. We performed comparisons and statistical analysis between the manual detection results and automatic detection results for 30 cases in order to verify validity. As a result, the average sensitivity was 93.37 % (80.95%~100%) and the average DSC was 0.73(0.3~0.98).In addition, the value of the ICC was 0.984 (CI: 0.967~0.993,p<0.01), showing the high reliability of the proposed automatic method. We expect that the automatic drusen detection helps clinicians to improve the diagnostic performance in the detection of drusen on fundus image.

M.Esmaeili, A.M.Dehnavi, and H.Rabbani

Spectral-Domain Optical Coherence Tomography (SD-OCT) is a widely used interferometric diagnostic technique in ophthalmology that provides novel in vivo information of depth-resolved inner and outer retinal structures. This imaging modality can assist clinicians in monitoring the progression of Age-related Macular Degeneration(AMD) by providing high-resolution visualization of drusen. Quantitative tools for assessing drusen volume that are indicative of AMD progression may lead to appropriate metrics for selecting treatment protocols. To address this need, a fully automated algorithm was developed to segment drusen area and volume from SD-OCT images. The proposed algorithm consists of three parts pre processing, which includes creating binary mask and removing possible highly reflective posterior hyaloid that is used in accurate detection of inner segment/outer segment (IS/OS) junction layer and Bruch's membrane (BM) retinal layers; (2) coarse segmentation, in which 3D curvelet transform and graph theory are employed to get the possible candidate drusenoid regions fine segmentation, in which

morphological operators are used to remove falsely extracted elongated structures and get there fined segmentation results. The proposed method was evaluated in 20 publically available volumetric scans acquired by using Bioptigen spectral-domain ophthalmic imaging system. The average true positive and false positive volume fractions (TPVF and FPVF) for the segmentation of drusenoid regions were found to be 89.15%±3.76and0.17%±.18%, respectively.

B. Remeseiro, N. Barreira, D. Calvo, M. Ortega and M. G. Penedo

The proposed methodology consists of five stages. The first stage involves the acquisition of the retinal image. The second stage entails the extraction of the green channel of the colour image. In the third stage, the search area is restricted to the inside of the ETDRS (Early Treatment Diabetic Retinophaty Study) protocol grille. The fourth stage tries to localize the areas of the image which are suspected of being drusen using the template matching technique. Finally, the suspect areas are segmented using the region growing technique and filtered to rule out false lesions. In the following sections, all these stages will be explained in detail.

Acquisition of the Retinal Image The acquisition of the image is the first step towards the drusen detection. All of the images used in this work have been acquired with the FF 450plus Fundus Camera, a 2 Mpx camera. They are colour fundus images, in PPM format and their resolution is 1280×1024 pixels.

Extraction of the Green Channel The green channel of the colour image contains the most of the image information since its contrast is greater than the contrast of the other RGB channels. This is due to the optical characteristics of the eye and the nature of the cameras. the blue channel of the image contains little information while the red channel is too saturated. For this reason, the green channel of the image is extracted and it will be used in next stages. Other works also use the green channel according to the same reasoning [4,6,7].

Localization of the Search Area The ETDRS is a standard protocol that studies the diabetic retinopathy. The ETDRS protocol grille was initially created to divide the central retina in different areas to the treatment of diabetic people. Nowadays, ophthalmologists use it in other pathologies such as AMD. The drusen outside the grille correspond to a very peripheral area of the vision. In this area, there is neither vision in detail nor colour vision, so the presence of

drusen outside the grille has a negligible impact on the visual field. In addition, all of the images are focused on the macula so the peripheral drusen may appear blurred and deformed, distorting, consequently, their analysis. Therefore, the proposed system will detect the drusen inside the grille, so that this area has been called search area. The grille (see Fig. 3) consists of three concentric circumferences focused on the macula. The search area is limited to the area occupied by the grille in order to focus the system on the area of interest. As a result, the drusen are searched in a circumference of 7.2 mm diameter and centered on the macula. The idea proposed by Marin˜o et al. [9] was used to center the circumference on the macula.

Detection of the Suspect Areas

The detection of the suspect areas is one of the key stages in the proposed methodology. The goal is to identify the regions of the image that might be drusen. It is intended to achieve the fullest possible detection, which means high sensitivity. The technique used is the template matching [10]. Its adaptation to the suspect area problem entails the creation of a template that represents a drusen and the search for parts of the retinography that resemble the template. The similarity measurement used is the normalized cross correlation [10], so the output image will have pixels with values between -1 and 1. A threshold δ is selected to determine which are the suspect areas. Drusen have a circular shape with fuzzy edges and a whitish colour. Their intensity is variable, but always higher than the surrounding retinal tissue. Regarding the size, we only consider those drusen with a maximum diameter of 125µm. Due to the drusen characteristics, two different templates were tested : circular templates and gaussian templates. As drusen have different sizes, a multiscale approach was used. The experimental results obtained with four test images proved that the most suitable configuration includes two gaussiant emplates with radius 3 and 4 and square window sizes 9 and 15, respectively. The threshold was set to $\delta = 0.35$. Figure 4 shows the results which were obtained in a retinal image after applying this stage, using the above-mentioned parameters.

Characterization of the Suspect Areas

In the previous stage, all the suspect areas, this is, the candidate areas to contain drusen, were identified. The goal was to get a high sensitivity despite of the number of false positives. In this stage, the areas previously detected are analyzed to determine if they are drusen. This way, the number of false positives is reduced. This stage has two important steps: the segmentation of the

suspect areas, to achieve a good fit of the candidate regions, and the region filtering, to reduce the number of false positives. The goal of the segmentation process is to distinguish the different regions the suspect areas contain. In order to achieve a good fit of the candidate areas, the technique used is region growing [11]. This technique involves three steps: the selection of the center of mass or seed associated with each region, the definition of a criterion to include a pixel in a region and, finally, the creation of a stopping criterion to finish the segmentation. In our case,the seed for each suspect area is the point of maximum correlation for each region:

$\forall Ri, Si = pj/corr(pj) = \max\{corr(pk), \forall pk \in Ri\}, i = 1...N$. where Ri is the ith region of the N suspect areas of this stage, Si is the seed of the Ri region and pj is the jth pixel of the Ri which correlation value is the maximum of this region. Moreover, a pixel is added to a region if it exceeds a threshold ϑ and is neighbor of another pixel that belongs to that region. Since lighting is not constant throughout the retina this threshold is computed for each suspect area using the next equation:

$\vartheta(x,y) = Ibg(x,y) - \alpha(Ibg(x,y) - I(x,y))$. where I is the input image, Ibg is the input image after applying a median filter and α is a weighting variable, with values between 0 and 1. In this work $\alpha = 0.6$. The process finishes when no more pixels can be added to any existing region or if the region exceeds the maximum size $\zeta = 150$ pixels. After the segmentation process, we have a vector which contains all the candidate areas. This vector is processed to analyze the candidate areas and do the region filtering process. In this case, four properties were studied to reduce the number of false positives: size, circularity, intensity and correlation mean. The first two do not work because the segmented structures are very tiny. Also, the third one does not work due to the high variability in the tonality of the images. This way, the correlation mean is analyzed in order to rule out false lesions from the suspect areas. The idea is to create a correlation mean filter to eliminate the candidates which pixels do not show continuity with respect to their correlation value.

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CHAPTER 1
INTRODUCTION

Vision loss is an important factor taken into consideration, due to aging the pin point vision of eye may lost due to degeneration of tissue like macula of the retina.

Age-related macular degeneration (AMD) is a significant cause of visual loss in USA. In the United States, AMD affects more than 1.75 million people, and this figure is expected to grow to 3 million by 2020. With the increasing elderly population , the prevalence of AMD will continue to rise, resulting in visual impairment, a decline in quality of life, and increased risk of falls, injuries, depression and mortality.

1.1 About Human Eye

The eye is a complex structure composed by 8 main elements, as shown in Figure2.1.

• The cornea is a transparent layer at the front of the eye that covers the iris and the anterior chamber.

• The iris is a circular structure of the eye that controls the amount of light that reaches the retina.

• The crystalline lens is a biconvex structure in the eye that refracts the light that reaches the retina.

• The anterior and posterior chambers comprise the space located between the crystalline lens and the cornea. They are filled with aqueous humor, a fluid similar to plasma.

• The vitreous humor is located between the lens and the retina and consists of a gelatinous transparent mass.

• The optic disc is the entry and exit point of the eye for the blood vessels and nerves.

• The retina is a light-sensitive layer of tissue.

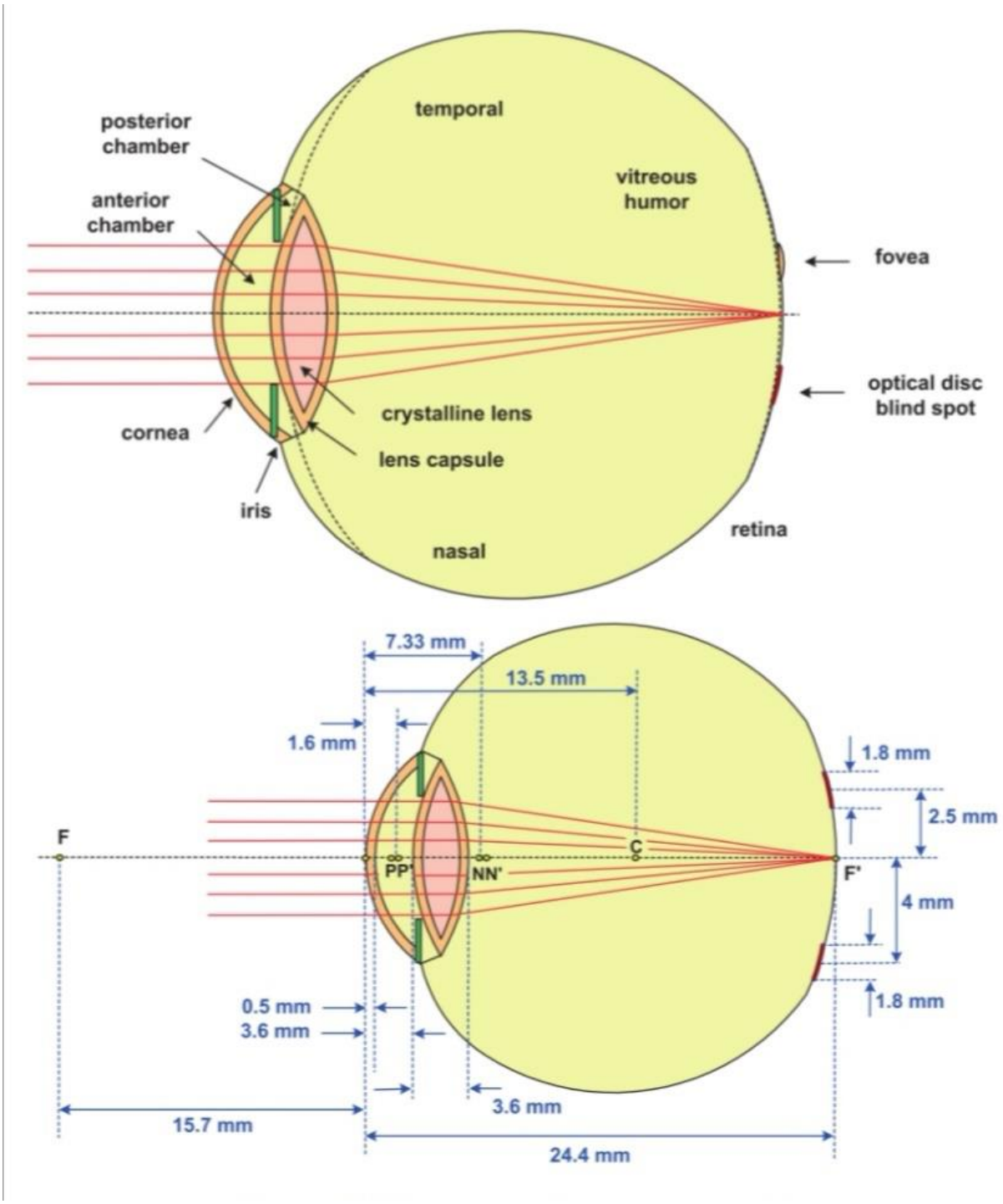

Figure 1.1 Diagrams of the eye structure

1.2 Objective

The main goal of Project is to Detect the Drusen in AMD by using Optical Coherence Tomography (OCT) images.

1.3 Outline

Age-related macular degeneration (AMD) is a disease characterised by the progressive loss of centre vision. It is currently the leading cause of blindness in the industrialized world affecting approximately 1 in 20 people in the age of 60 years.

Cholesterol build-up in arteries and veins on atherosclerosis occurs as a natural consequence of using likewise in AMD, cholesterol is also known to accumulate in the eye with deposits called Drusen.

One of the most common cause of blindness in old Americans, according to indications in a study in mice was supported by the National Institute of Health (NIH).

An estimated of 2 million of Americans have AMD the disorder causes damage to the macula, a region of the retina responsible for central high resolution vision.

Requirements for this project

Hardware:

We need a laptop with minimum specifications which should able to run the program, with python installed in it.

Storage of 100gb, 4gb of ram and intel i3 processor can be used.

Software:

The programming language used in this project is Python. As it requires less code and syntax is also easy to read.

1.4 Motivation

Macula is rich with light-sensing cells called photoreceptors and what people rely on for activities involving clear vision, such as reading, driving, and facial recognition. An eye care professional can detect AMD less before vision by looking for drusen, which are yellow deposits under the cholesterol-containing retina and other defris. Though small drusen are a common part of aging, AMD is usually indicated by layer drusen

1.5 Scope for the Work

Age-related macular degeneration (AMD) is the most common degenerative eye disease that is known as macula affecting the central portion of retina.

The AMD is encountered in patients aged 65 and over in developed countries.

AMD is the most degenerative condition affecting the macula part of the retina, which is mainly responsible for pin point vision and lets us do things like drive, facial recognition. Although identification of drusen lets patients take steps to prevent loss of vision.

CHAPTER 2

Project Overview

Here we discuss the causes and the areas where the drusen is affected in the retina and also the layers of the retina.

2.1 The Retina

The retina is a layer of photosensitive tissue that coats the inner side of the eye. It consists of a structure composed by several layers of neurons, which are connected by synapses. Photoreceptor cells are the only neurons that are sensitive to light, and they can be classified into three types: rods, cones and ganglion cells. The network of rods allows to observe low resolution perception in black and white. Cones, on the other hand, allow for high resolution color perception. Finally, ganglion cells are important for reflexive responses to bright light. A frontal view of the retinal fundus is shown in Figure 2.2.

Blood reaches the retina in two different ways, both supplied by the ophthalmic artery. The central artery and vein of the retina enter the eye through the optic disc, and bifurcate several times into arterioles and venules that distribute the blood to the inner layers of the retina. The middle and outer layers of the retina are supplied blood via the uveal circulation, in which a series of branches of the ophthalmic artery penetrate the globe without doing so through the optic disc. The vessel tree present in the inner layer in the retina provides most of the potential information that can be exploited by registration methods.

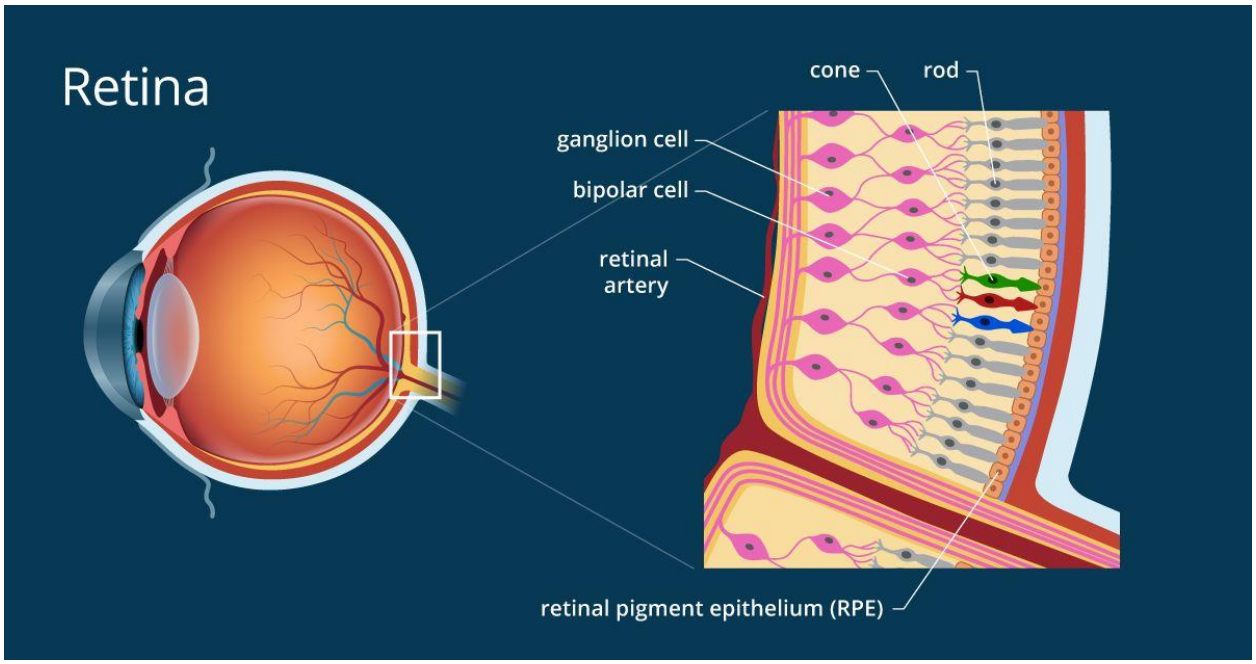

Figure 2.1 the Retina

2.2 Retina layers

In all vision the retina at the back of the eye is necessary. Every layer of cells in that tissue serves a particular purpose. As we brace for February's Age-Related Macular Degeneration Awareness Month, take a closer look at the retina layers and their function.

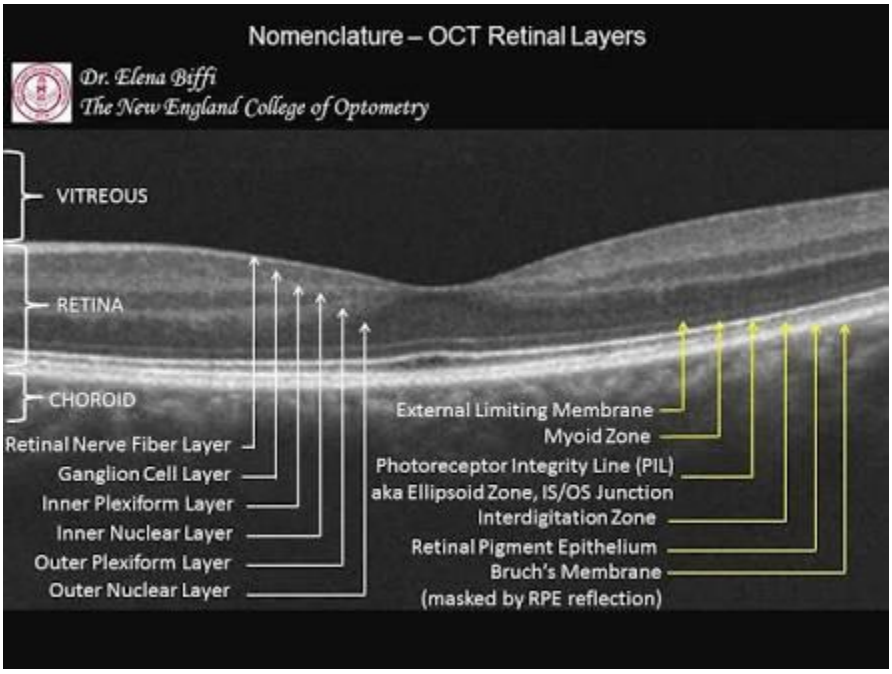

Figure 2.2 OCT Retinal Layers

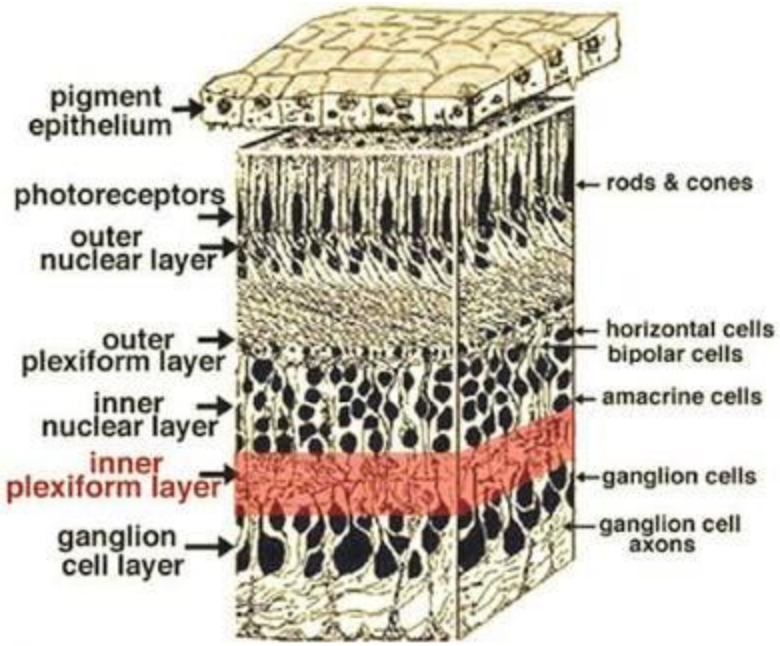

Figure 2.3 3-D block diagram of retina

Layers of the Retina

Retinal pigment epithelium-It is a single layer of cells that provide the photoreceptor cells with necessary nutrients and waste removal. Waste build-up can lead to AMD and Stargardt disease.

It is composed of a single layer of hexagonal cells, densely packed with granules of pigment.

Those cells are smooth and hexagonal in shape when viewed from the outer surface. When viewed in section, each cell consists of an outer non-pigmented part containing a large oval nucleus and an inner pigmented portion that extends between the rods as a series of straight thread-like processes, this being particularly the case when the eye is exposed to light.

The RPE has several functions, namely light absorption, epithelial transport, buffering of spatial ions, visual cycle, phagocytosis, secretion, and immune modulation.

Light absorption: The RPE is responsible for the absorption of dispersed light. For two main reasons, this role is very important, first, to improve the quality of the optical system, second, light is radiation, and it is concentrated on the macula cells by a lens, resulting in a high concentration of photo-oxidative energy. Melanosomes absorb the scattered light and thus reduce the photo-oxidative stress. The high retinal perfusion brings a high demand condition for oxygen.

Epithelial transport: As described above, RPE composes the outer blood-retinal barrier, the epithelium has tight junctions between the lateral surfaces and implies separation from systemic influences of the inner retina. This is vital for the immune privilege of eyes, a highly selective transport of substances for a tightly controlled environment (not only as a barrier but also with signalling process). RPE provides the photoreceptors with nutrients, controls homeostasis of ions and removes water and metabolites.

Spatial ion buffering: changes in the subretinal space are rapid and require RPE capacitative compensation several cells are involved in light transduction, and if they are not compensated for, they are no longer excitable and it would not be possible to properly transduce them. Standard transepithelial ion transport would be too sluggish to account for such changes quickly enough, there are many underlying mechanisms based on the operation of voltage-dependent ion channels contributing to the simple transepithelial ion transport.

Visual cycle: The visual cycle fulfills an important role of preserving visual function, and thus needs to be tailored to different visual needs, such as dark vision or lightness. For this reason practical factors come into play: retinal storage and reaction speed change. Vision at low light intensities essentially involves a lower vision cycle turn-over rate, while the turn-over rate is much higher during daytime. Suddenly, large amounts of retinal 11-cis are needed in the transition from darkness to light. This does not come directly from the visual process but from multiple retinal pools of retinal binding proteins that are interconnected by the transportation.

Photoreceptor outer segment (POS) membranes phagocytosis: POS is subjected to persistent photo-oxidative stress and is constantly being killed thereby. They are continually renewed by shedding their end, which is then phagocytosis and digested by RPE.

Secretion: The RPE is an epithelium that interacts closely with photoreceptors on one side but often needs to be able to communicate with cells on the epithelium 's blood side, such as endothelial cells or immune system cells. The RPE is able to secrete a wide range of factors and signaling molecules to interact with the surrounding tissues. It secretes ATP, fas-ligand (fas-L), fibroblasts (FGF-1, FGF-2, and FGF-5), insulin-like growth factor-β (TGF-β), ciliary neurotrophic factor (CNTF), platelet-derived growth factor (PDGF), vascular endothelial growth factor (VEGF), lens epithelial growth factor (LEDGF) and pigment epithelium-derived factor (PEDF).

Immune eye privilege: The inner eye reflects a protected immune area that is isolated from the blood stream's immune system. The RPE supports the immune right in two respects. First, it reflects a mechanical and strong barrier separating the inner space of the eye from the stream of blood. Second, the RPE is able to interact with the immune system to quiet the immune reaction in the healthy eye or, in the case of illness, to activate the immune response.

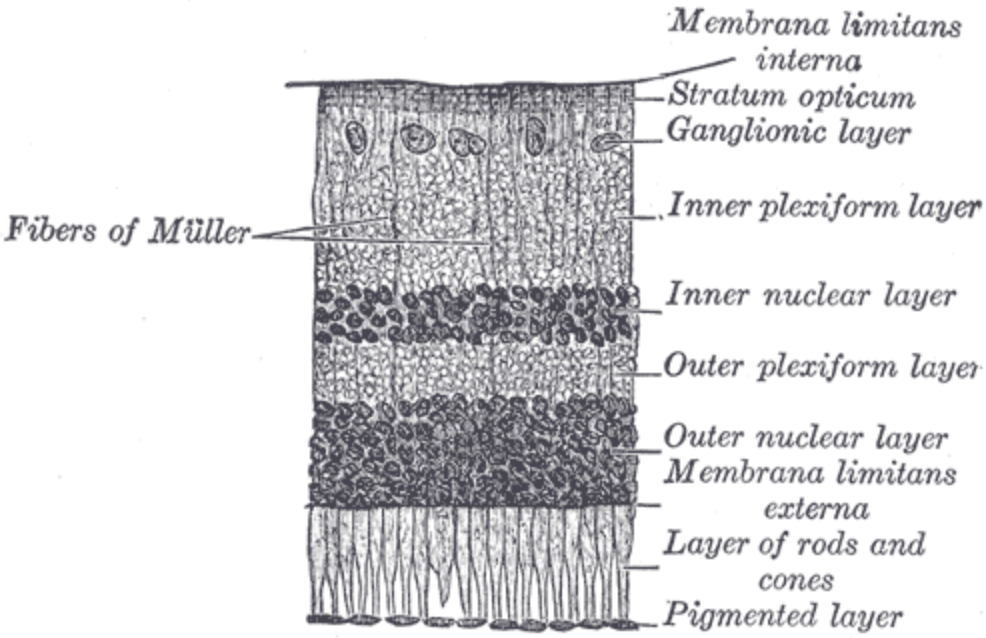

Figure 2.4 Retinal Pigment Epithelium

Bruch membrane – Separates choroid from overlying pigment epithelium, is 2-4 microns thick, has 5 distinct layers (basal lamina of overlying retinal pigment epithelium, collagen layer and basal lamina of choriocapillaris endothelial cells), thickens with age, has focal excrescences known as drusen.

The membrane of Bruch consists of five layers (within to without):

The epithelium base membrane of the retinal pigment

1. Within the collagen region

2. A central Elastic Fiber Band

3. Outside Collagen Region

4. The Choriocapillaris base membrane

The epithelium of the retinal pigment transports metabolic waste from the photoreceptors through Bruch 's membrane to the choroid.

Bruch 's membrane densifies with age, slowing metabolite transport. This may contribute to the formation of drusen in age-related macular degeneration.[3] A accumulation of deposits (Basal Linear Deposits or BLinD and Basal Lamellar Deposits BLamD) also occurs on and within the membrane, consisting mainly of phospholipids. In the central fundus the accumulation of lipids seems greater than in the periphery. This build-up seems to fragment the membrane more like a puff-pastry than a barrier, into a lamellar structure. Inflammatory and neovascular mediators can then invite choroidal vessels to expand into the fractured membrane and beyond it. The neovascular membrane damages the outer retina system and leads to a complete loss of central vision-macular degeneration associated with wet age. Pseudoxanthoma elasticum, myopia, and trauma may also cause defects in Bruch 's membrane that can contribute to neovascularization of choroids. Alport 's syndrome, a genetic condition that affects the alpha(IV) collagen chains, can also lead to defects in the Bruch membrane, such as retinopathy with dot and fleck.

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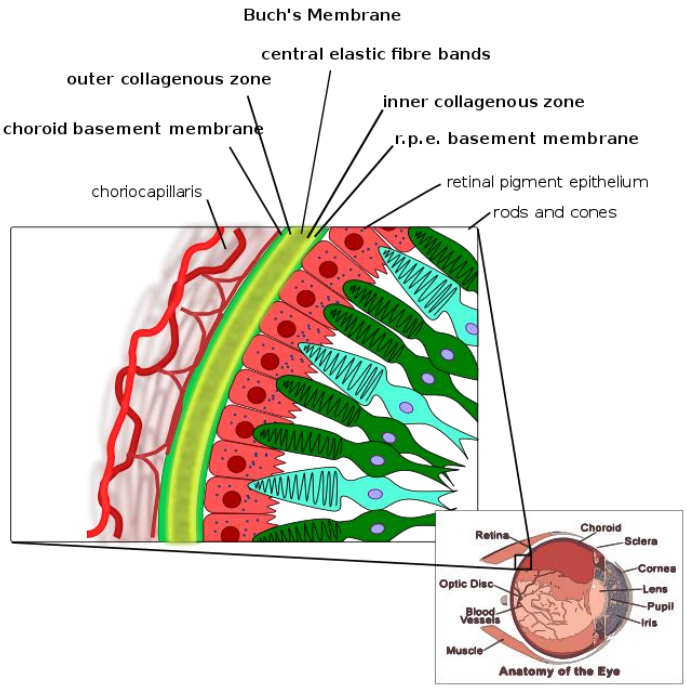


Figure 2.5 Bruch’s Membrane

2.3 Macula

The macula is a small but important area in the retina center. The macula is needed to see clearly details of objects in front of you, such as faces and written text.

A number of eye problems can affect the macula, and may result in loss of vision if not treated. Problems relating to macula include:

• Branch occlusion of retinal vein

• Central occlusion of a retinal vein

• Serous central retinopathy

• Neovascular choroidal membranes;

• A retinitis with cytomegalovirus

• Retinopathy with Diabetes

-- Histoplasmia

• Macular degeneration, both in dry and wet forms

• Edema Macular

• Spinal cord

• Puffer macular

• Telangiectasia macula

• Retinal offshoot

• Pigmentosal retinitis

• Retinoblastoma with

• Premature Retinopathy

• Stargardt Disease

• Consumer condition

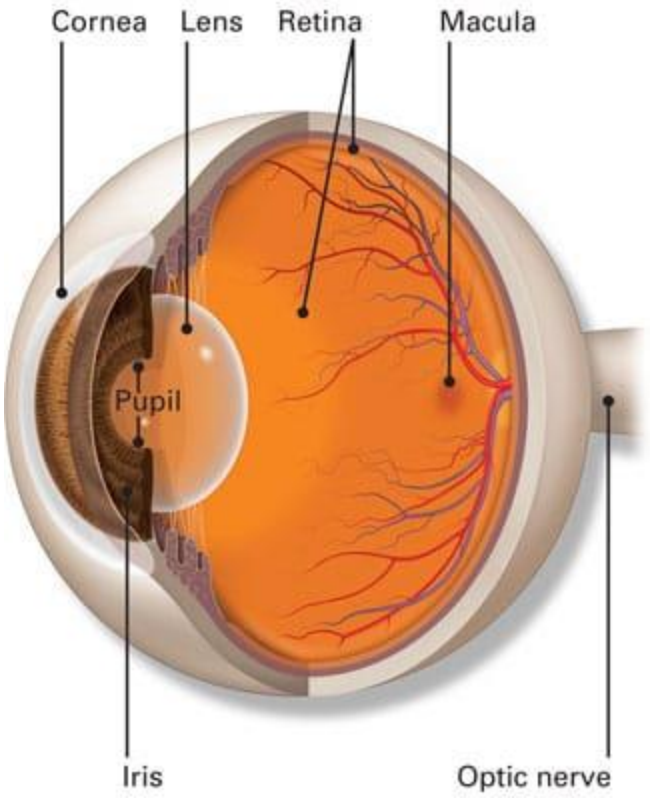


Figure 2.6 Macula

2.4 AMD (Age related Macular Degeneration)

Macular degeneration, or age-related macular degeneration (AMD), is a leading cause of vision loss which, according to the National Health Interview Survey, affects 5 percent of Americans 65 or older. It removes the sharp, central vision of a person that's required to clearly see objects and do stuff like reading and driving.

This occurs when wears down the tiny central part of the retina, called the macula. The retina is the nerve tissue that detects light at the back of your head.

It's also called age-related macular degeneration because the condition occurs when you grow older. It does not normally cause blindness but may cause serious vision problems.

2.4.1 DRY AND WET AMD (Age related Macular Degeneration)

For dry AMD the most common of the two, blurry vision is the most common early symptom. Because less cells in the macula will function, people can see information in front of them less clearly, like words in a book. This distorted vision also vanishes in clearer light. People in their field of vision may also see a small yet through blind spot. For dry AMD the vision changes begin to grow gradually. If only one eye is affected, the other might make up for it.

The typical early symptom for wet AMD is that straight lines tend to be crooked. This results in the collecting and raising of the macula fluid from the leaking blood vessels, distorting view. A small blind spot in wet AMD may also appear, resulting in the loss of one's central vision.

2.5 Drusen

Drusen, from the German word for node or geode (singular, "Druse"), are tiny yellow or white accumulations of extracellular material formed between the membrane of Bruch and the eye's retinal pigment epithelium. With advancing age, the presence of a few small ("hard") drusen is normal, and most over 40s have some hard drusen. However, a typical early sign of age-related macular degeneration is the appearance of larger and more frequent drusen in the macula.

Drusen can help to clog up this transportation system. The photoreceptor cells, the rods and cones, need loads of oxygen and start degenerating or dying when they don't obtain enough of it. The macula consists mainly of cone cells. Cone cells are responsible for our vision of colour, our central vision and our sharp vision of detail. As these cone cells die, colors become less vivid, detailed or sharp vision becomes blurry, and cloudy becomes our straight ahead or central vision.

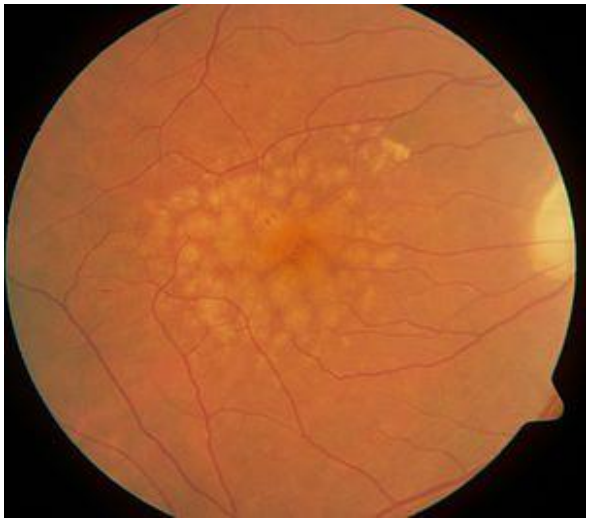


Figure2.7 drusen in eye

2.5.1 Hard Drusen and Soft Drusen

Strong drusen are small and round and have very straight boundaries. Such well-defined deposits are light yellow, and are considered less harmful. These become more common with age, and may or may not suggest age-related macular degeneration early in life.

Soft drusen is different. They are bigger and have less defined boundaries. The size and shape of these differ. There's more cause for concern when the eye doctor sees soft drusen during an eye exam. Such deposits are considered to be more dangerous, because they interfere with the removal of waste products from the macula and the delivery of rich oxygen to the macula. People who have soft drusen will always undergo more improvements in vision than those who are hard drusen. We can find that more light is needed to see bills, read or do hobbies. In the center of their vision can appear a smudge or a blurred spot.

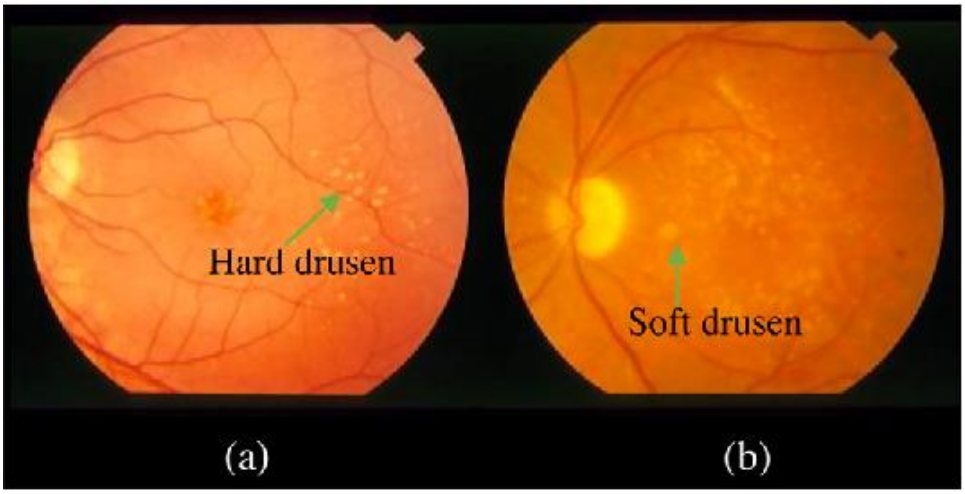


Figure2.8 hard and soft drusen

2.6 Optical Coherence Tomography (OCT)

Optical coherence tomography is an imaging technique that uses low-coherence light to capture two- and three-dimensional, micrometer-resolution images from inside the optical scattering media. It is used for nondestructive medical imaging and industrial research.

OCT research has grown into a standard of treatment for assessing and treating most retinal disorders. OCT uses luminous rays to measure retinal thickness. This procedure uses no radiation or X-rays, an OCT scan doesn't hurt and it's not painful.

You may be given an OCT scan for a number of reasons, including tracking your disease progression, testing or discounting suspected retina swelling or testing for OCT checks against other tests for evaluating the efficacy of the new drug regime.

Optical Coherence Tomography uses best-compared technology to ultrasound, except that it uses light rather than sound and therefore achieves better, finer resolution.

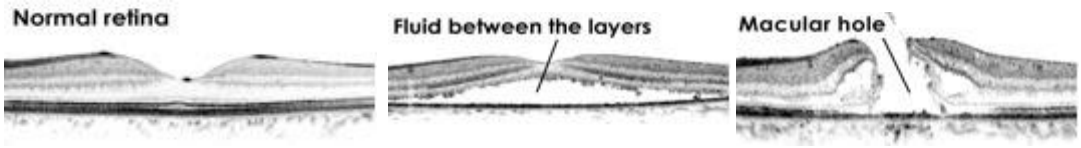


Figure 2.9 Optical Coherence Tomography

With OCT, the ophthalmologist is able to see the distinctive layers of each retina. That allows your ophthalmologist to map their thickness and measure it. For diagnosis these measures help. These also have guidelines for treatment of glaucoma and eye diseases. Such retinal diseases include age-related macular degeneration (AMD) and eye disease with diabetic effect.

Your ophthalmologist may or may not place dilatating eye drops in your eyes to brace you for an OCT test. These declines enlarge the pupil and make inspection of the retina easier.

You'll sit in front of the OCT computer and place your head on a backrest to keep it going. Then the machine scans the eye, without touching it. It takes between 5-10 minutes to search. If your eyes have been dilated, they can become responsive to light for many hours following the test.

2.7 Image Segmentation

In computer vision and digital image processing, image segmentation is the method of partitioning a digital image into multiple segments (pixel sets, also known as image objects). The purpose of segmentation is to simplify and/or modify the representation of an image into something more meaningful and easier to analyze.Generally, image segmentation is used to locate objects and boundaries (lines, curves, etc.) in photos. Most specifically, image segmentation is the mechanism by which each pixel in an image is assigned a label, such that pixels with the same label share similar characteristics.

The product of image segmentation is a set of segments that covers the entire image collectively, or a collection of contours derived from the image (see Edge detection). With respect to some characteristic or computed property, such as color, intensity or texture, each of the pixels in a region are identical. Adjacent regions are significantly different with respect to the same characteristic. The resulting contours after image segmentation can be used to create 3D

reconstructions using interpolation algorithms such as marching cubes when applied to a stack of images, typical in medical imaging.

2.8 Python with IDE

Python was invented in 1991 by Guido Van Rossum, and has quickly become one of the world's most popular programming languages.

Python has many advantages

- Developers can learn it quickly
- Typically involves less code
- Syntax is easier to read
- Utilized by every major technology company
- Huge source of additional open source libraries
- There are several ways to run python code.

There are 3 main types of environments:

- Text Editors
- Full IDEs
- Notebook Environments

IDE stands for Environmentally Integrated Growth. It is a coding tool that makes it easier for you to write, check, and debug your code, as it usually offers code completion or code insight through highlighting, resource management, debugging tools, and although the IDE is a narrowly specified term, it is beginning to be redefined as other tools such as notebooks begin to acquire more and more features that historically belong to IDEs. You can also debug the code in the Jupyter Notebook for example.

CHAPTER 3

METHODOLOGY

This chapter provides an information about the proposed methodology of our project, includes mainly Pre-processing, Drusen detection.

3.1 Pre-Processing

Step-1 Input original image

Here we give an input image where we should find affected area as it is OCT image. Optical coherence tomography is a technique which is used to capture low coherence light. The images from OCT imaging system may be 2D or 3D images. OCT has high resolution, since it is focused on light, not sound or radio signals. An optical beam is directed to the tissue, and a small portion of this light is collected which reflects the features of the sub-surface.

Step-2 Conversion of RGB image to grayscale image

All captured input images are processed as they're all distorted by the shadow and noise of the lighting. This can cause data loss which can be used for diagnosis and treatment of diseases. Preprocessing can enhance the image characteristic for further processing. Preprocessing primarily includes the improvement of contrasts and the transformation of color space. The original pictures are in RGB color space.

A grayscale (or graylevel) image is just one where gray areas are the only colours. The cause for distinguishing such images from any other kind of color image is that it is for each pixel less knowledge is required. In reality, a 'gray' color is one in which the red, green and blue elements all have equal brightness in RGB space, and so it is only appropriate to determine a single brightness value for each pixel, as compared to the three intensities required to define each pixel in a complete color image. When the rates are spaced equally then the discrepancy is between Successive graylevels are considerably better than the human eye's graylevel resolving power.

Grayscale images are quite common, partly because most of today's equipment for screen and picture capture can only promote 8-bit images. Additionally, grayscale images are completely sufficient for many tasks and therefore there is no need to have more complicated and therefore more difficult color images to analyze.

Step-3 Filtering

Image noise in some of an image's pixel values can be described briefly as random variations. We know that filters are used to reduce the amount of noise present in an image, Median filtering is excellent in reducing noise of this kind. Using a small matrix, the filtering algorithm scans the entire image and recalculates the value of the center pixel by simply taking the mean of all the values within the matrice. A median filter is an image filter that operates on the image's spatial domain. Median filter is one of the smooth filters which removes speckle noise from the image and impulsive noise. The essential aspect of the median filter is that it retains the edges present in the picture as well. As the median filter is applied to an image, each pixel is replaced by its neighbors' mean value. Within the median estimate even the current pixel value is included.

3.2 Drusen detection

Step-4 Thresholding

Image thresholding is a easy but efficient way to partition an picture into both the foreground and background. This technique of image analysis is a form of image segmentation, which isolates objects by transforming grayscale images into binary images. Image thresholding is most efficient on high contrast images.

The Otsu thresholding is used for the automatic thresholding of images. The algorithm, in the simplest form, returns a single threshold of intensity that separates pixels into two classes, foreground and background. This threshold is calculated by minimizing variance in intra-class severity, or equivalently, by maximizing variance between classes. Otsu's approach is a one-dimensional, discrete variant of Fisher's Discriminant Analysis, is related to Jenks' approach of optimization, and is analogous to a globally optimal k-means performed on the strength

histogram. The original paper defined the extension to multi-level thresholding, and computationally efficient implementations have been proposed since.

Global Thresholding is a technique in OpenCV, which is the allocation of pixel values in relation to the defined threshold value. In thresholding, the threshold value is compared to each pixel. If the pixel value is less than the threshold, it is set to 0, then a maximum value is set. Thresholding is a very common technique of segmentation, used to distinguish an object considered to be a foreground from its context. A threshold is a value that has two regions on either side of it, i.e. below the threshold or above the threshold. In Computer Vision, this thresholding technique is applied to grayscale images. The image must therefore initially be converted to grayscale color space.

Adaptive thresholding is the process by which the threshold value for smaller regions is determined. This leads to different threshold values regarding changes in lighting for different regions. For this the algorithm calculates the threshold for a small image field. And we get different levels of the same image for different regions and this gives us better results for images with differing illumination.

Step-5 Clustering K-means

“Clustering is the process of dividing data sets into groups, consisting of similar data-points”.You don't know what you're looking for in Clustering, so you're trying to find some segments or clusters within your results. When using clustering algorithms in your dataset, unexpected items will unexpectedly pop up like structures, clusters, and groupings that you might never have considered otherwise. K-Means clustering algorithm is an unsupervised algorithm and is used to segment the region of interest from the context. It clusters or partitions the data provided into K-clusters or K-centroid-based sections. Several types of clustering techniques are available, amoung them K-means clustering is used mainly.

Types of clustering:

- Exclusive clustering
- Overlapping clustering
- Hierarchical clustering

Step-6 Segmentation

Segmentation of images is a method of partitioning a digital image into multiple segments (pixel sets, also known as image objects). The segmentation objective is to improve and/or make the representation of an image more meaningful and easier to analyze. The segmentation of images is usually used to identify points and boundaries in images (lines, curves, etc.) More specifically, image segmentation is the mechanism by which each pixel in an image is assigned a label so that pixels with the same label share similar characteristics.

Step-7 Drusen detection based on intensity

We can find drusen by variations between image achievement and original one. Nonetheless, to avoid affecting the detection of drusen due to noise in the original image, we made, subtracting image using noise removed image, the median filter was applied as a small mask that only affects noise except dressing. We experimented with masks of different sizes and concluded that eliminating the noisy without affecting drusen in a 5-in-5 mask would be sufficient. We can see the effects before and after adding a median filter of small mask size to reduce the noise. The test indicates that the drusen was not eliminated but the slight noise from the impulse was eliminated.

CHAPTER 4

PYTHON

Python is a high-level, object-oriented, interpreted programming language with complex semance. Combined with dynamic typing and dynamic linking, its high-level data structures make it very attractive for Rapid Application Creation as well as for use as a scripting or glue language for connecting existing components.

4.1 Python

Python 's simple, easy to read syntax emphasizes readability and thus reduces the cost of maintaining the software. Python supports modules and packages which promote modularity of the program and reuse of code. On all major platforms, the Python interpreter and the comprehensive standard library are available free of charge in source or binary form, and can be freely distributed.

Programmers also fall in love with Python because of the improved flexibility it provides. The modify-test-debug process is incredibly quick, since there is no compiling phase. Python debugging programs are simple: a bug or bad input will never trigger a segmentation fault. Instead it raises an exception when the interpreter discovers an error. If the program fails to catch the exception, the interpreter will print a stack trace. A source level debugger allows you to analyze local and global variables, evaluate arbitrary expressions, set breakpoints, step through the code one line at a time, etc. The debugger itself is written in Python, referring to the introspective strength of Python. And from the other hand, sometimes the easiest way to debug a program is to add a few print statements to the source: the quick process of edit-test-debug allows this simplistic approach quite efficient.

4.2 Installing Python on Windows

This segment provides specifics of installing Python's Anaconda distribution on Windows. I think Python's Anaconda distribution is the right approach for potential solutions that would like to use Python. Anaconda is free (even though it can take some time to download) and can be installed on school or work computers where you do not have any access to the administrator or the opportunity to install new programmes. Anaconda comes packed with preinstalled about 600 packages including NumPy, Matplotlib, and SymPy. All three products are very useful for solving problems, and will be covered in the following pages.

Follow the steps below to install the Anaconda distribution of Python on Windows.

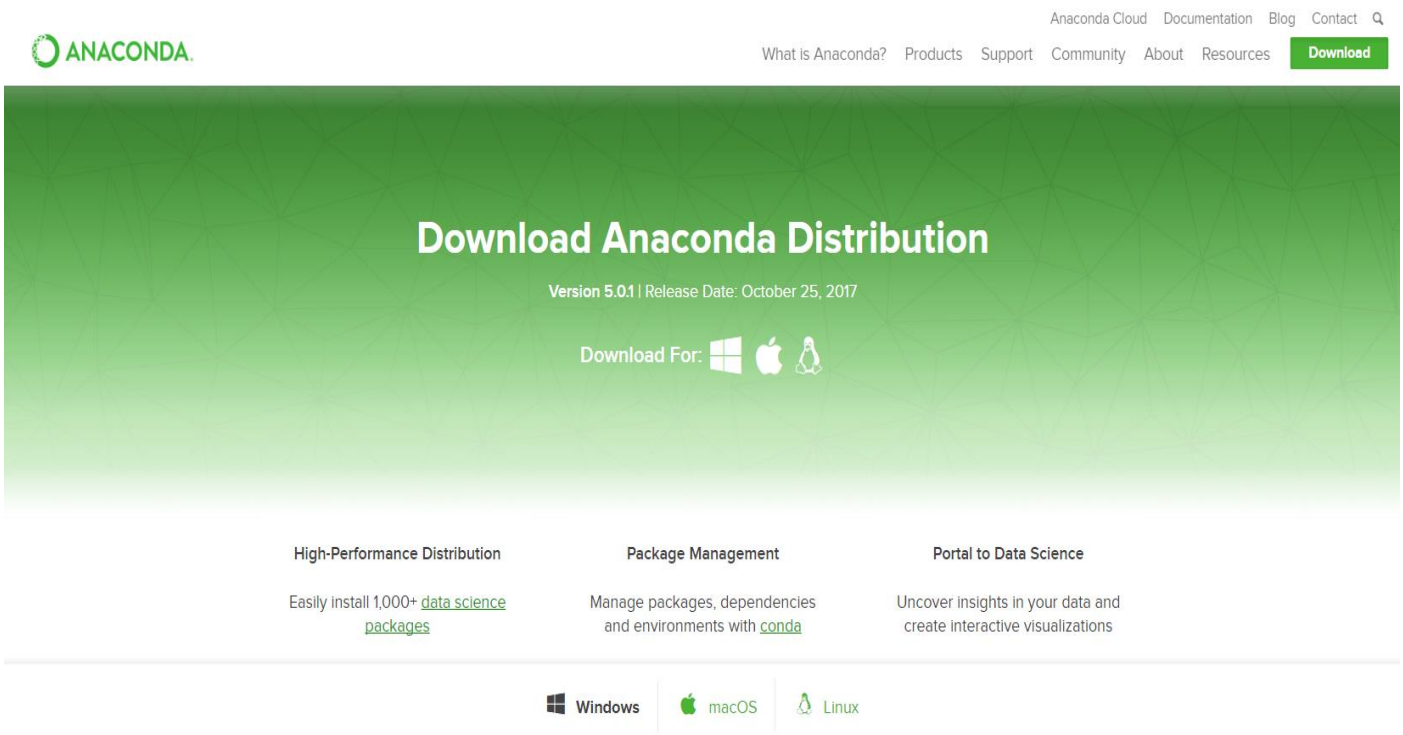
Steps:

1. Check out Anaconda.com/downloads
2. Tap on Windows
3. Download the .exe installer
4. Open and run the .exe installer
5. Open the Anaconda Prompt and execute some Python code

1. Visit the downloads page for anaconda

Go to the following link: Anaconda.com/downloads

The downloads page on anaconda will look something like this:

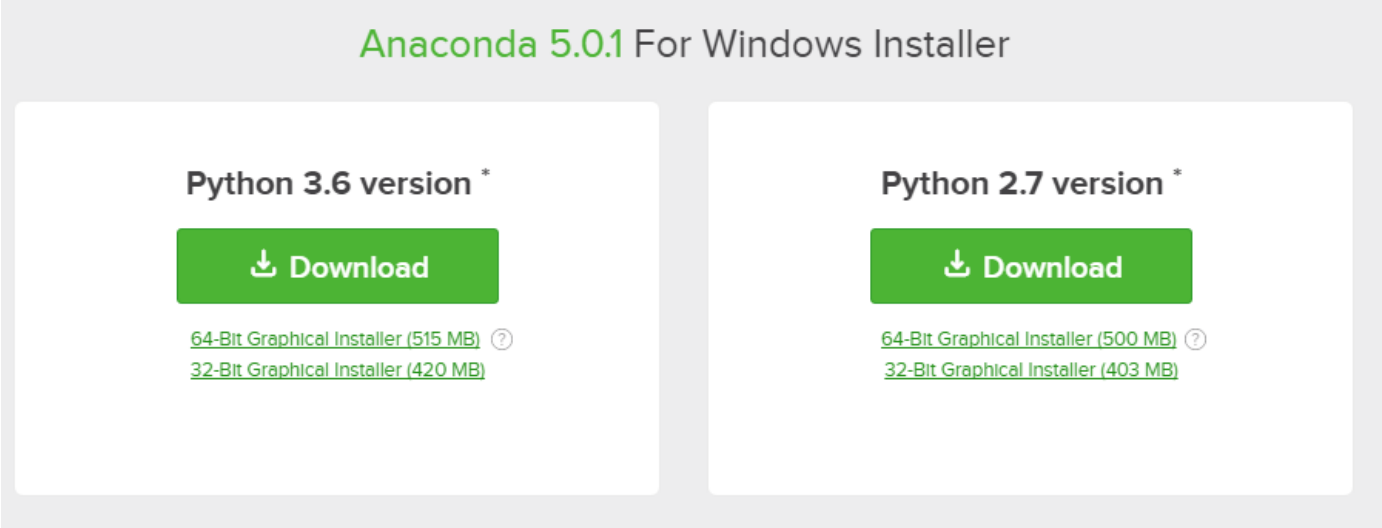


2. Select Windows

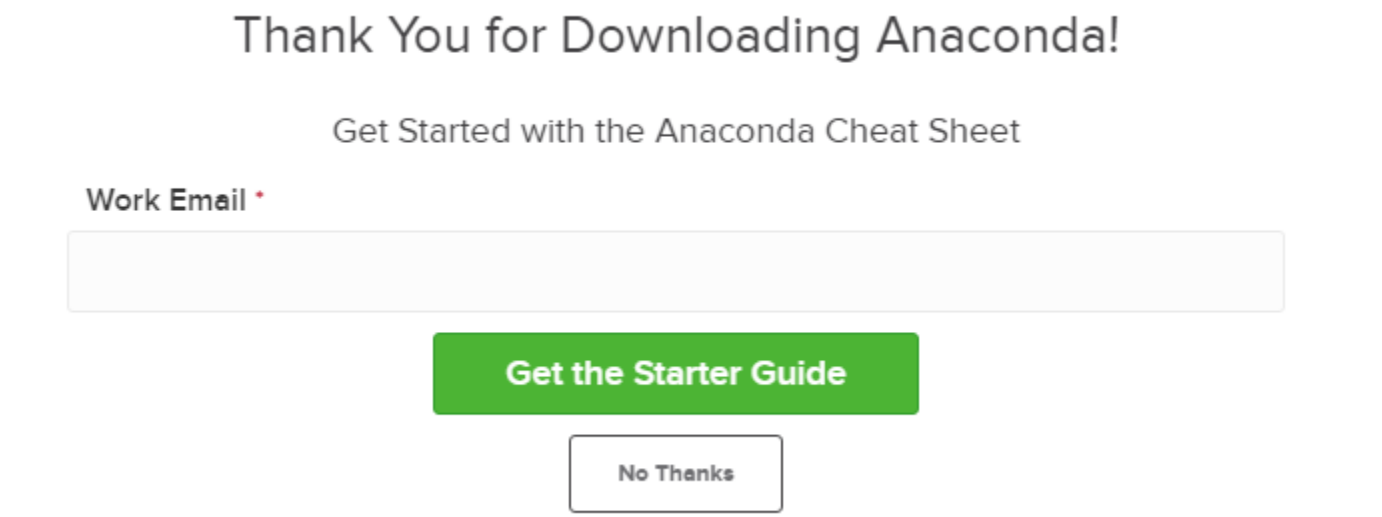
Tap on Windows where we can see three operating systems.

3. Download

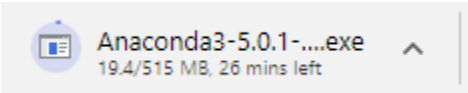
Download the most current version of Python 3. The most recent release at the time of writing was the Python 3.6 Version. Python 2.7 is patrimonial Python. For problem solvers, pick version Python 3.6. If you're unsure of running a 64-bit or 32-bit version of Windows on your computer, select 64-bit as Windows 64-bit is much more usual.



You may be said to enter your email. While we can still download Anaconda if you click (No Thank) and don't enter your Email address.

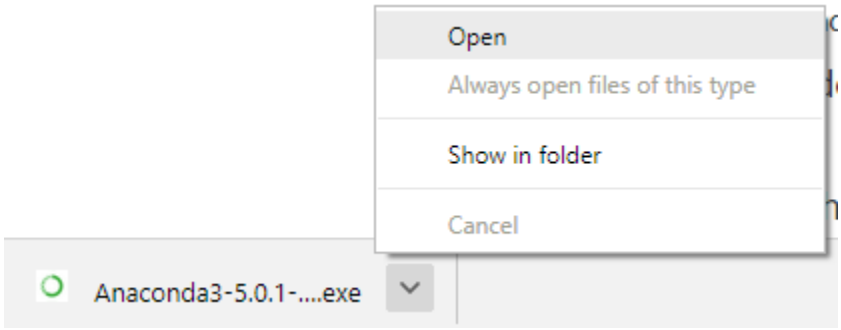


The download file is quite large (over 500 MB) so it may take a some time to for Anaconda to download.

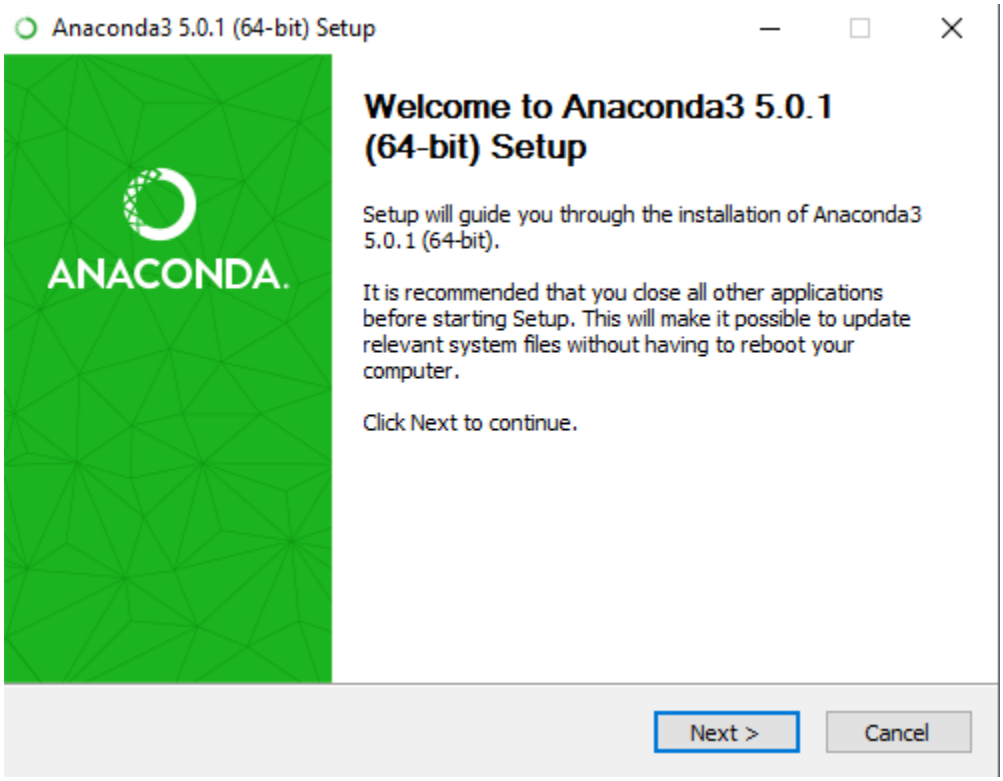


4. Open and run the installer

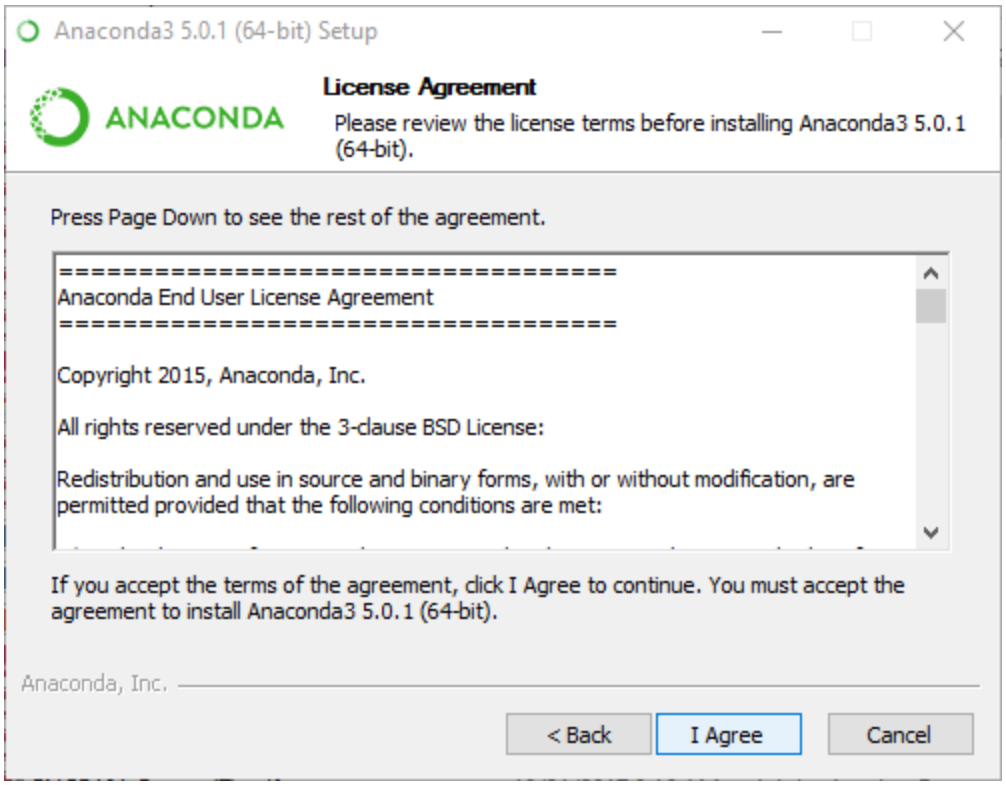
After completing the download, open and run the .exe installer



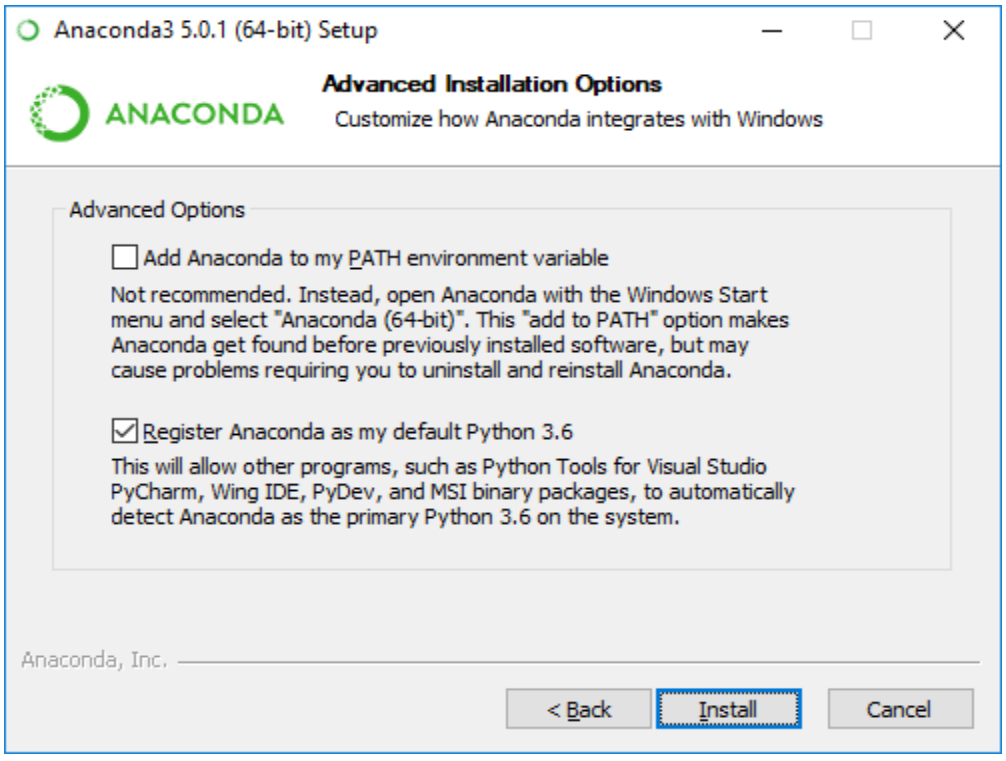
At the starting of the install, you should click **Next** to confirm the installation.



Then agree to the license.

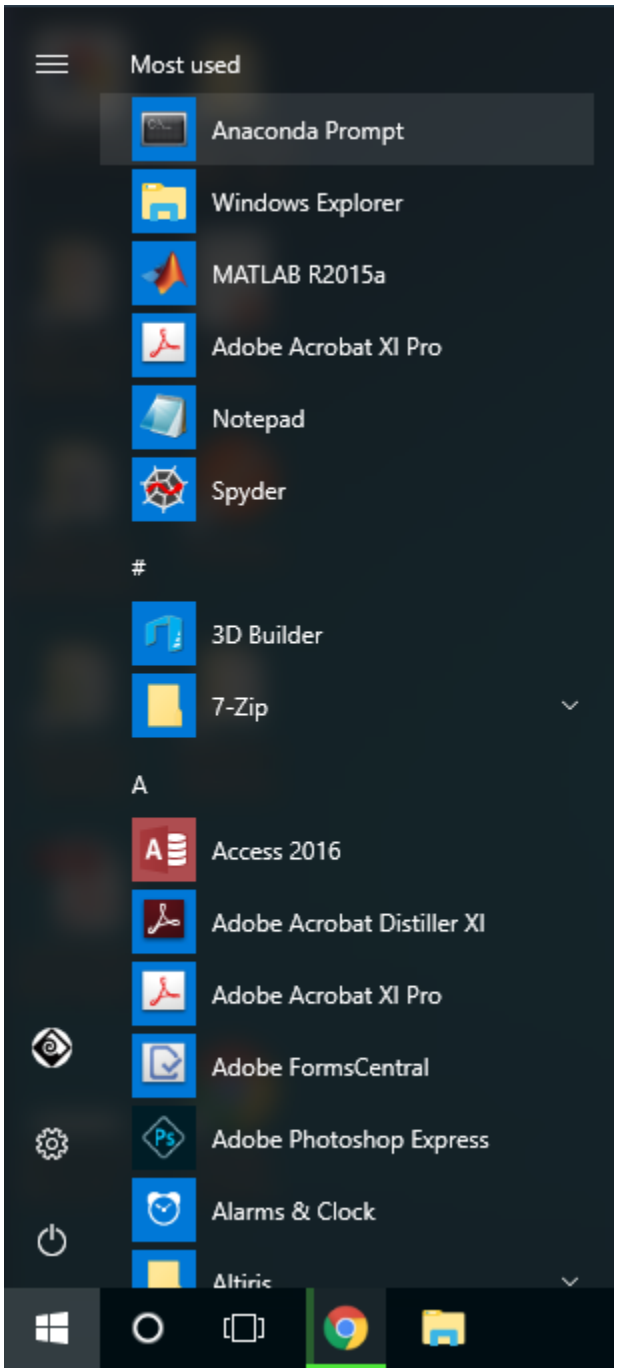


At the Advanced Installation Options screen, I recommend that you **do not check** "Add Anaconda to my PATH environment variable"



5. Open the Anaconda Prompt from the Windows start menu

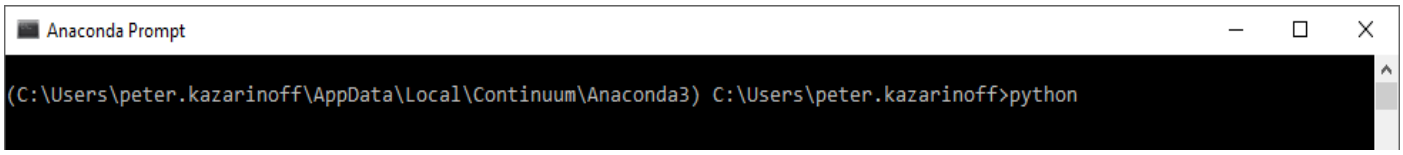
After the installation of Anaconda is complete, you can go to the Windows start menu and select the Anaconda Prompt.



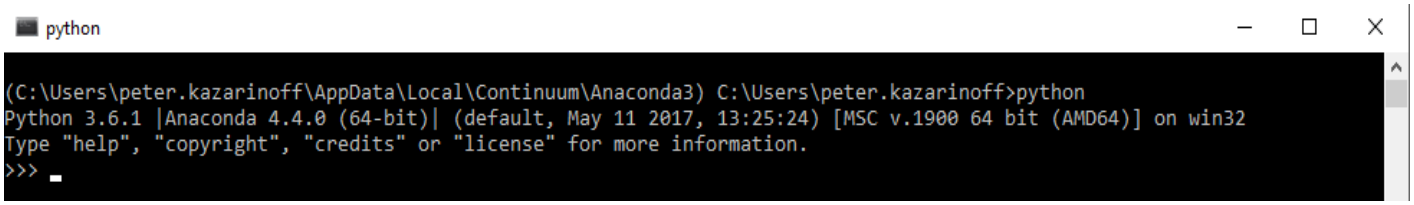
That opens the Prompt for Anaconda. Anaconda is the Python distribution, and Anaconda Prompt is a shell on the command line (a program where you type commands rather than using a mouse). The black screen and text that composes the Anaconda Prompt doesn't look like enough, but Python's use of potential solutions is very helpful.

At the Anaconda prompt, type python and hit [Enter]. The python command starts the Python interpreter, also called the Python REPL (for Read Evaluate Print Loop).

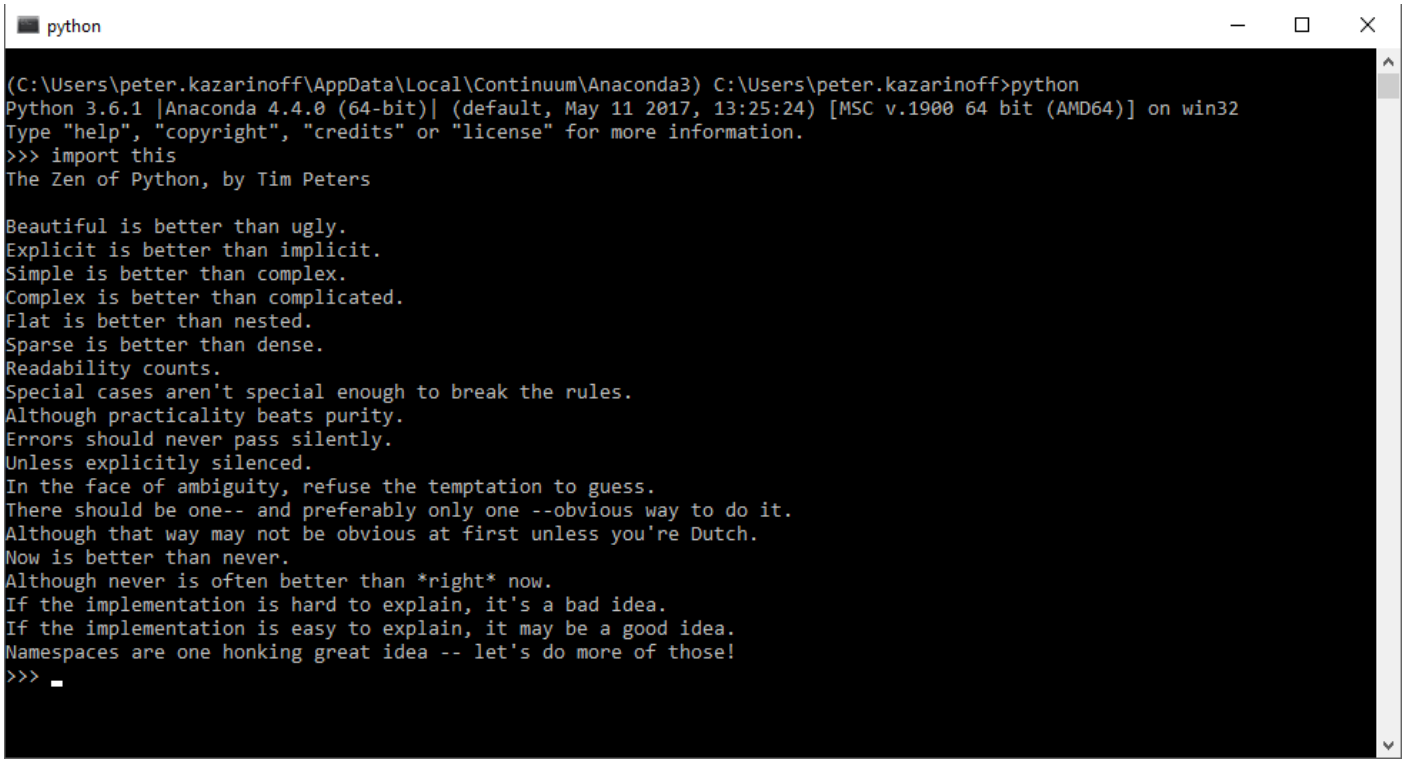
```
> python
```



See the Python version. You should see something like Python 3.6.1. With the interpreter running, you will see a set of greater-than symbols >>> before the cursor.



Now you can type Python commands. Try typing import this. You should see the ***Zen of Python*** by Tim Peters



Type exit) (at prompt > > > to close the Python Interpreter. Note double quotation marks at the end of command exit). To stop the Python interpreter and move back to the Anaconda Prompt, the () is needed.

You can either close the window with the mouse to close the Anaconda Prompt, or type exit, no parenthesis necessary.

If you're using the Python interpreter again, just click on the icon Start button to select the python and type the Anaconda Prompt.

4.3 IDE with packages and libraries

IDE stands for Environmentally Integrated Development. It is a coding tool that makes it very easy for you to write, check, and debug your code, as it usually offers code completion or code analysis through highlighting, resources development, debugging tools, and although the IDE is a narrowly specified term, it is beginning to be reinvented as other tools such as notebooks begin to acquire ever more functions that historically belong to IDEs. You can also debug your code in the Jupyter Notebook for example.

You can likely see this evolution very clearly in the results of the Stack Overflow Developer Survey following, which also involves these new tools, alongside the standard IDEs you should already know; they all fall together under "technology climate" portion.

They are particularly important for development because of the many functionality that IDEs just had to offer: they make the coding more relaxed and it is no different for data science. However, considering there weren't only conventional IDEs to consider, but also modern devices, such as notebooks, you may wonder which development platform to be used when starting with data science.

Top Integrated Development Environments are

- Spyder
- PyCharm
- Jupyter notebook
- Thonny
- Atom

CHAPTER 5

RESULTS AND CONCLUSIONS

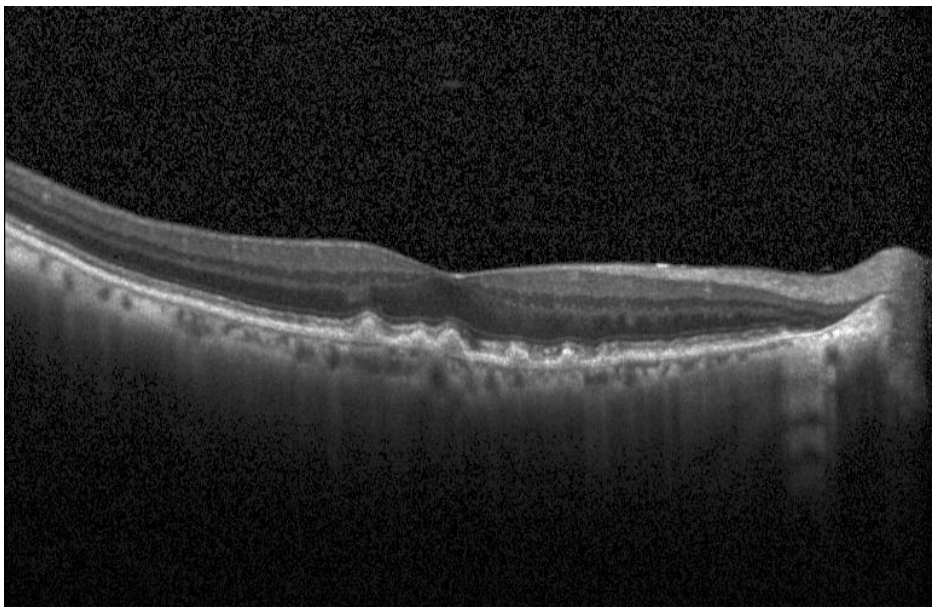


Figure 5.1 input image

Figure5.1 shows the input image of drusen eye, here we can give the access to select the input image to user in which he is interested to find the affected region.

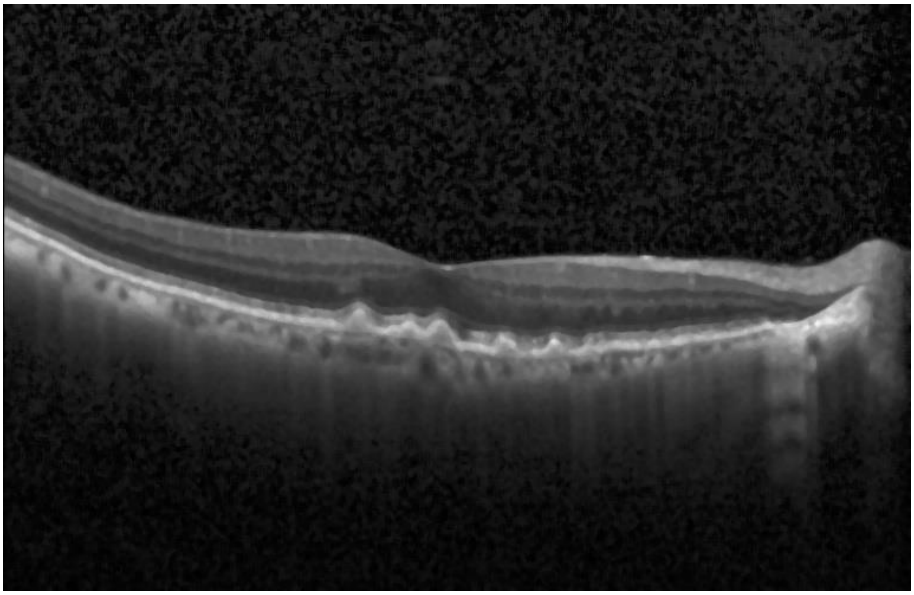


Figure 5.2 median filter image

In this image, Image noise in some of an image's pixel values can be described briefly.and also to reduce the amount of noise present in an image. Median filter is one of the smooth filters which removes speckle noise from the image and impulsive noise.

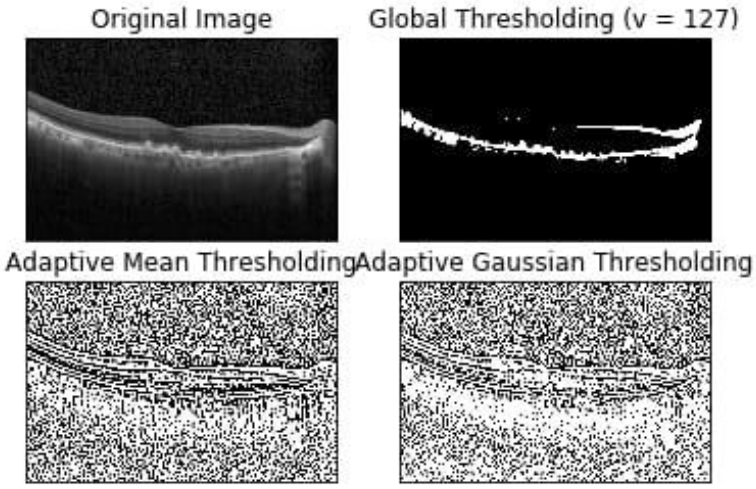


Figure 5.3 thresholding image

This technique of image analysis is a form of image segmentation, which isolates objects by transforming grayscale images into binary images. Image thresholding is most efficient on high contrast images. It can also be used for minimizing variance in intra-class severity, or equivalently, by maximizing variance between classes.

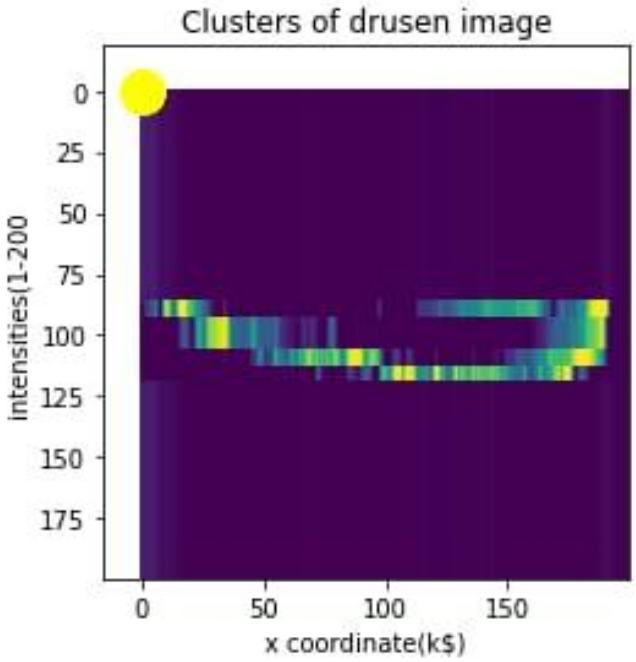


Figure 5.4 cluster intensity

Clustering is an unsupervised algorithm and is used to segment the region of interest from the context. It clusters or partitions the data provided into K-clusters or K-centroid-based sections.

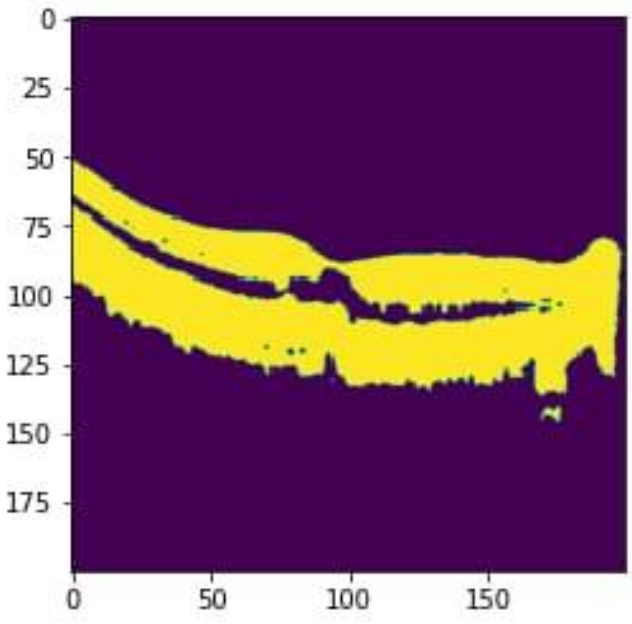


Figure5.5 drusen image

Finally, we can see the image of output image of affected region of the eye, by applying all the required filters and looking at that image we can determine the measure to be taken to control or operate the drusen.

Conclusion

This study demonstrates a novel method for automatically detecting the region of all drusen forms, which is detected by OCT without the need for segmentation of the internal RPE boundaries. The algorithm is based on a deep-resolved study of C-scans in two slabs placed above the Bruch membrane at different depths. The internal slab detects deposits of subretinal drusenoids while the outer slab detects soft drusen and cuticular drusen. Multi-modal approaches had previously identified the difficult form of subretinal drusenoid deposits but detection by OCT alone had not previously been demonstrated. The system exhibits good accuracy and repeatability in detection. Methods of detecting drusen that rely on irregular RPE segmentation confront two separate challenges. First, small drusen deposits require highly sensitive detection techniques, and second, segmentation errors at the RPE's inner boundary need to be avoided. Disadvantages of algorithms analyzing elevation maps from segmentation results can be summarized as: Graph search segmentation often fails on drusen with abrupt elevation, because the gradients between layers are not smoothly connected and the search for a neighboring pixel with the lowest connection cost is not very reliable. In addition, it is common for graph search segmentation algorithms to intentionally ignore minor changes in reflectance when defining cost functions, taking into account the effect of speckle noise. The segmentation fails because of the difference in reflection induced by the shadows of large vessels, media distortion or pupil vignetting. The threshold height used to discern whether there is a significant RPE line deviation from the "healthy" baseline (and therefore account for the presence of drusen) is arbitrary, not based on histological findings and limited by the OCT system's axial resolution. A disease that affects the older population such as AMD is often associated with reduced eye clarity such as cataract which leads to lower signal strength scans and lower layer contrast as a consequence. Any approach that attempts to calculate the drusen region must therefore demonstrate good performance in low quality scans. Although there is no method that reduces the high reliability of B-scan segmentation output on fine layer contrast, there are several validated and well-established methods that can be used on face images to accurately and reliably distinguish groups

of pixels with different reflection to detect areas with atrophy. For this reason our method appears more robust than those that rely on segmentation of the retinal layer.

The running time we recorded is primarily the cost of the semiautomatic segmentation phase of the Bruch 's membrane. Our approach also requires segmentation of this boundary but it should be remembered that even in the presence of drusen or other pathologies, Bruch 's membrane retains its form. For this reason, segmentation of the Bruch 's membrane is a fairly simple task and so our algorithm can perform its layer segmentation routine much faster and more accurately than those that depend on semi-automatic segmentation of the inner boundary of the pathologic RPE.

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