BLEEDING DETECTION IN RETINAL IMAGES USING IMAGE PROCESSING

A THESIS SUBMITTED TO THE GRADUTE SCHOOL OF APPLIED SCIENCES OF NEAR EAST UNIVERSITY

By
MEHMET KARA

In Partial Fulfillment of the Reguirements for the Degree of Master of Science in Electrical and Electronic Engineering

NICOSIA, 2019

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**Approval of Director of Graduate School of
Applied Sciences**

Prof. Dr. Nadire Cavus

We certify this thesis is satisfactory for the award of the degree of Masters of Science in Electrical and Electronic Engineering

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ACKNOWLEDGEMENTS

To my parents…

ABSTRACT

One of the most important reasons for prolonging human life in recent years is the use of computer science and image processing techniques for the diagnosis and early detection of diseases. Imaging techniques, such as X-ray and tomography, can be used to diagnose many diseases earlier and more rapidly with their use in medicine.

Eye is one of the important organs for human life to be able to spend in peace. Diabetes is an important problem in human health. One of the important organs affected by diabetes is eye. This disease is called diabetic retinopathy. Early diagnosis, treatment and visual disturbance is of great importance for the event. Due to diabetic retinopathy, the structure of the eye vessels deteriorates and causes bleeding in the eye. The retinal blood vessels must be separated from the retina image so that the blood vessels in the retina are diagnosed early for diabetic retinopathy. Therefore, image processing plays an important role in the treatment of some diseases such as diabetic retinopathy.

In this thesis, different algorithms for automatic detection of bleeding of the retina were investigated. Bleeding to be detected in the retinal images taken with the fundus camera plays an important role in determining the ability to see diabetes mellitus and later stages of the disease.

 In this study, image processing technology is being developed. In this study, different algorithms in different studies were combined in this study and more and more advanced algorithms were used to determine the best method and the best result, ie the best algorithm. As a result of the studies carried out in the green channel developed algorithms were the best method.

Keywords: Diabetic retinopathy; edge detection; image processing; object recognition; retinal image.

ÖZET

Son yıllarda insan ömrünün uzamasının en önemli nedenlerinden biri, hastalıkların teşhisi ve erken tespiti için bilgisayar bilimi ve görüntü işleme tekniklerinin kullanılmasıdır. Röntgen ve tomografi gibi görüntüleme teknikleri, tıpta kullanımıyla daha önce ve daha hızlı bir şekilde birçok hastalığı teşhis etmek için kullanılabilir.

Göz insan hayatının refah içerisinde geçirebilmesi için önemli organlardan birisidir. Diyabet hastalığı insan sağlığında önemli bir sorun olarak baş göstermektedir. Diyabet hastalığının etkilediği önemli organlardan birisi de gözdür. Bu hastalığa Diyabetik retinopatiye denilir. Erken teşhis, tedavi ve görme olayının bozulmaması için büyük önem taşımaktadır. Diyabetik retinopatiye bağlı olarak göz damarlarının yapısı bozulmakta ve gözde kanamaya neden olmaktadır. Retinadaki kan damarlarının diyabetik retinopati hastalığı nedeniyle erken teşhis edilmesi için retina kan damarlarının, retina görüntüsünden ayrılması gerekir. Bu nedenle görüntü işleme diyabetik retinopati gibi bazı hastalıkların tedavisinde önemli rol oynamaktadır.

Bu tez çalışmasında retinanın kanamasının otomatik tespiti için farklı algoritmalar araştırıldı. Fundus kamerasıyla çekilen retina görüntülerinde tespit edilecek kanamalar, diabetes mellitus ve hastalığın ilerleyen aşamalarında görebilme yeteneğinin belirlenmesinde önemli rol oynamaktadır.

Bu çalışmada görüntü işleme teknolojisi geliştirilmekte. Bu çalışmada, farklı çalışmalarda yapılmış farklı algoritmalar bu çalışmada birleştirildi ve en iyi yöntemi ve en iyi sonucu, yani en iyi algoritmayı belirlemek için gittikçe daha ileri algoritmalar kullanıldı. Yapılan çalışmalar sonucunda yeşil kanalda geliştirilen algoritmalarda en iyi yöntem başarılı olmuştur.

Anahtar Kelimeler: Diyabetik retinopati; görüntü işleme; kenar algılama; nesne tanıma; retinal görüntü.

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LIST OF ABBREVIATIONS

CCD   Charge Coupled Device

DR   Diabetic Retinopathy

FC   Fundus Camera

MF   Median Filter

PR   Proliferative Retinopathy

RGB   Red, Green, Blue

TV   Television

CHAPTER 1

INTRODUCTION

This section presents a general introduction to the eye veins and bleeding in retinal images. He talks about types of eye and diabetic retinopathy. This section also explains the purpose of the thesis. In addition, the contributions of this study and the overview and structure of the teas are discussed (Geetharamani and Balasubramsan, 2016).

It is reported that diabetes affects a large part of human beings nowadays. Studies show that this disease is increasing gradually over the years. Besides the diabetes mellitus, studies on all three people are thought to be secretive diabetic. People with diabetes are known to suffer various organs in our bodies due to the disease's condition (Geetharamani and Balasubramsan, 2016). One of the most important of these organs is the eye. It does not end up counting human beings for life. In people with diabetes, the cervical layer (retina) is affected by 40%. In research, diabetic retinopathy due to diabetes is observed. According to the results of the studies, it is seen that diabetes leads to a serious public health problem.

The diabetic's body can not use and store sugar properly. According to blood sugar levels, it causes damage to the nerve layer located behind the eye and performing the sight. This is called diabetic retinopathy.

Diabetic retinopathy, caused by the deterioration of the structure of the veins in the retinal layer, is the most common eye disease and is the cause of significant visual impairment in young people. As the disease progresses to higher levels, it causes abnormal vascular growth and bleeding on the retina surface (Merlin and Shan, 2015).

Abnormal blood vessels that simply bleed can develop, which can lead to bleeding in the eye, resulting in blurring. This occurs in the most advanced and fourth stage of the disease, the "proliferative retinopathy" part.

From the blood vessel walls that are deformed due to diabetes, the liquid part of the blood can leak to the center of the center where the central visualization takes place. The leaked fluid causes swelling in the macula and blurring of vision. This condition is called macular edema. Although the risk of macular edema emerging increases as the disease progresses, it can also be seen in any stage of the disease.

Eye is one of our most important sensory organs. It is necessary to have the capacity to see the life of the living in prosperity. Eye; Cornea, Iris, Sclera, Retina and Optic Disc. It is also linked to nerve cells from hundreds of brains. The following sections discuss these in more detail.

As diabetes progresses gradually, the body first affects the eye, which is among the sensory organs. In this case, the initial diagnosis of diabetes mellitus is of great importance in terms of treatment. In this study, it was tried to determine whether a bleeding was present on the images after retinal images of the eye were taken with the fundus camera considered.

It is not possible to overlook the image processing technology used in this study for the early detection of the stages of the diabetic retinopathic disease if it is thought to be the stages of this disease.

1.1 Thesis Additive

This thesis is a contribution to the early detection of diabetes in the world by using image processing techniques in rapidly developing software and image (or signal) processing technology.

Diabetic retinopathy is part of a series of investigations aimed at detecting and diagnosing a disease, aiming at reducing its presence and identifying it at an early stage to treat it before it develops, leading to its development. It can also help ophthalmologists and opticians monitor their condition early on.

1.2 Thesis Aim

The purpose of this study is to develop an image processing algorithm to detect undesired bleedings in retinal images. The proposed system in the thesis is to allow ophthalmologists and specialists to easily diagnose diabetic retinopathy and to start treatment as soon as possible.

1.3 Thesis Limitations

In this thesis, image processing aims to detect bleeds (originating from diabetes) that may occur in the eye veins. However, the image contains many different structures other than hemorrhages and it can sometimes be a little difficult to separate hemorrhages. In addition, another limitation of this study may be that it is difficult to reach the database in order to test and optimize the performance of the system so that the data are at a sufficient level. Because for some hospitals and research centers the data are specific. As a result, a database for testing purposes is obtained and used.

1.4 Overview of the Thesis

In this thesis; The first part gives a brief introduction, the purpose of the thesis and the thesis summary. The second part is eye anatomy and diabetes anatomy. The third part is information about image processing, historical development and general techniques that may be in image processing. In the fourth chapter, the methods used in the study. In the fifth section, the results obtained from the designed system and the discussion of the analysis results are presented.

CHAPTER 2

ANATOMY OF EYE AND DIABETES DISEASE

2.1 Eye

The eye is a spherical body that allows you to see, in a pile of balls, a large ball size.

The eye consists of the combination of three layers that are suitable for passing light and breaking. The outermost first layer is called Sclera or "eyeball". This layer bumps forward and continues as a transparent cornea layer. This hard layer, which is white and fibrous, is a thick layer that protects the eye against external impacts (Antal and Hajdu, 2012). The vein layer, which is a multi-grain bond texture, turns the eyeball into a complete dark room with the dyed cell cover on both sides. At the front, there is a cuffy region with cuff body muscles; the projection of the small pyramids filled with blood to keep the tangy ligament tense, which is the multi-core of the ciliated region, is called the "ciliated extension" (Antal and Hajdu, 2012).

As an extension of the lash portion, the vascular layer in the anterior portion changes colour and forms an aperture (pupil) diaphragm (iris). The iris, which varies from human to human, includes muscle fibers that enlarge or shrink the pupil: Muscle fibers that are placed vertically stretch to stretch the pupil, while hoop muscles that are placed in a circle provide contraction of the eye baby. Thus, the iris works as a "diaphragm" that adjusts the amount of light entering the eye into the eye, according to changing conditions (Citirik and Teke, 2016).

The third, very thin layer of the eye, is a sensitive layer. The middle hole in the back of this is the whitish little bubble (the optic nerve disk), the place where the optic nerve enters, and is called the "blind spot". Beyond the blind spot, there is a yellow spot; this is the vision area where the external images are best shaped. The optic nerve, which enters the posterior pole of the eye, spreads in the form of many nerve fibers toward the damartocyte and ends up with three neurons arranged in three layers (Citirik and Teke, 2016). The cylinder axis of the neurons in the first layer (multipolar neurons) runs in the optic nerve; the frontal extensions

connect to the bipolar neurons of the second layer; The neurons of the second layer also adjoin the cylinder axes of the third layer's visual neurons. This layer contains neurons in the form of cones and rods that enter the red part of a tributary layer. The free ends of the cones and rods are directed to the side of the vein layer: the light rays coming into the vein layer break and affect the nerve endings of the mesh cells. In Figure 2.1, the names of the eye anatomy and eye structure are given.
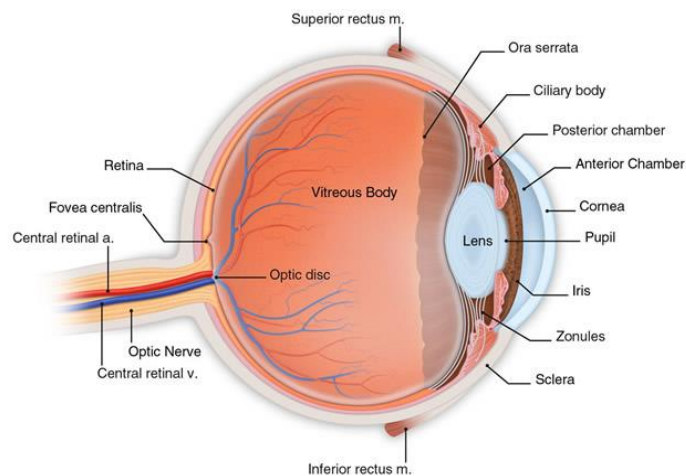
Figure 2.1: Anatomy of the eye

2.1.2 Eye structure

Cornea;

The outer transparent layer of our eye is called the cornea. The cornea, which has a non-vascular structure, is responsible for the focus of the incoming light on retinas. It protects its integrity by feeding on the oxygen found in the tears and the eye liquor. Therefore, when wearing lenses for long periods, corneal thinning may occur due to oxygen depletion. At the same time, dust particles on the lens that are not visible to the eye can cause the cornea to be scratched.

Iris;

In the middle there is a space called the pupil. The task of the iris is to adjust the amount of light entering the eye by breaking and loosening (enlarging and enlarging the eye baby). Eye disease shrinks in extreme light conditions. Grows in dim light or darkness. The darker the

iris is, the better it does. The reason why people with open eyes are uncomfortable with light is that the eye is a good sight.

Sclera;

It is the hard part of the eye known as white. It covers the delicate structures inside and all the muscles in the eye are held by the sclera. It is completely opaque. It prevents light from coming out of the cornea. The eye provides protection of the curved shape. The outermost layer of the front section has a softer and more vascular structure; this division is called episcler. There are no vessels in the sclera. Episclera contains many veins and these veins feed the sclera. Sclera's duties: Protect the eyes that are not covered by the cornea. Visible veins and nerves enter from the back of the sclera. All the muscles of the eye hold onto the sclera.

Retina;

The retina is the network layer of the eye cells that covers the back wall of the eye's eye like a wallpaper. Diseases that occur in the retina directly threaten our sense of sight. The retina is an important structure in the eye that perceives the optical energy with the photoreceptor property that it has in the innermost layer of the eye and transfers it to the brain by converting it into electrical signals. The surface area of the retinas is 1200 millimeters. The area covered by the retina is on the inner side of the eye, and the heads continue until the optic nerve is in the back. Vessels from the retina are vascularized from both sides. The outer third of the retina is chorio-papillary muscle located on the retina-facing outer surface of the choroidal region; and two thirds are fed from the retinal artery. Since the retinal vessels are transparent, the ophthalmoscope examines the red blood vessels in the blood.

Optic Disc;

In fact, it is not a real fiber, but a specialized cerebral extension with the process of perception and transmission to the brain. The cone and rod cells in the retina layer are the first cells to perceive. Cone cells in these colors, black and white cells are perceived. These cells turn the light energy from the eye into neural bioelectric stimuli. The donkey and cone cells establish links called retina cells called "bipolar cells" called synapses. The nerve cell-

bioelectrical hand induced by the light stimuli perceived through these connections is transmitted to the bipolar cells.

2.1.3 Diabetes and eye effect

It is reported that diabetes affects a large part of human beings nowadays. Studies show that this disease is increasing gradually over the years. Besides the diabetes mellitus, studies on all three people are thought to be secretive diabetic. People with diabetes are known to suffer various organs in our body due to the disease's condition. One of the most important of these organs is the eye. It does not end up counting human beings for life. In people with diabetes, the cervical layer (retina) in the eye and the yellow spot (macula) are affected by 40%. In research, diabetic retinopathy due to diabetes is observed. According to the results of the studies, it is observed that diabetes leads to a serious public health problem.

2.2 Diabetic Retinopathy

The diabetic's body can not use and store sugar properly. According to blood sugar levels, it causes damage to the nerve layer located behind the eye and performing the sight. This is called diabetic retinopathy (Alaimahal and Vasuki, 2013).

Diabetic retinopathy, caused by the deterioration of the structure of the veins in the retinal layer, is the most common diabetic eye disease and is a cause of significant visual impairment in adult humans. As the disease progresses to higher levels, it causes abnormal vascular growth and bleeding on the retina surface. Figure 2.2 shows an example of a bleeding retinal image.

Figure 2.2: Eye image with bleeding

2.2.1 Diabetic retinopathy can cause the following effects

Abnormal blood vessels that simply bleed can develop, which can lead to bleeding in the eye, resulting in blurring. This occurs in the most advanced and fourth stage of the disease, the "proliferative retinopathy" part.

From the blood vessel walls that are deformed due to diabetes, the liquid part of the blood can leak to the center of the center where the central visualization takes place. The leaked fluid causes swelling in the macula and blurring of vision. This condition is called macular edema. Although the risk of macular edema emerging increases as the disease progresses, it can also be seen in any stage of the disease.

As a result, diabetes affects diabetic retinopathy and results in severe loss of vision.

CHAPTER 3

IMAGE PROCESSING

3.1 Introduction

Enhanced image technology and method used to perform some technical operations on the image to obtain useful information is called image processing. An image is used as input. In the output section, the image or feature (numerical data, graphics, etc.) associated with this image is data. Image processing is a type of signal processing. Today, image processing is among the fastest growing technologies. It also forms basic research areas in the fields of engineering and computer science (Krause et al., 2016).

There are two types of methods for analog and image processing. Analog image processing can be used for copying, such as printed photos. Image experts use specific methods when using these visual techniques. Digital image processing performs technical changes to digital images using a computer. When using Digital Techniques, there are three general steps that all data types must pass through. These; Pre-processing, development and imaging, information output.

Image processing generally involves the following steps:

- • Imaging with image processing techniques,

- • It analyzes the picture and changes it if necessary,

- • As a result, to obtain an image data or report data based on image analysis.

3.2 Digital Image

It consists of digital image pixels. This pixel is a small dot. The pixel word is derived from the English word "picturecell". Each pixel has a color value defined by a 2-base number. Basically, a one-bit picture consists of a series of 1s and 0s (open / closed) pixels and the resulting colors are only black and white. In color digital images, 24 bits are used for each pixel, so 3 segments of 8 bits (8 bits) are created the main color to create true images; red,

green and blue colors. The image size is determined by the numbers of pixels in the transverse and longitudinal direction. The pixel value present in the image is the result of multiplying the pixels with each other.

3.2.1 Pixel

Numerical structure is the building blocks. These points on the computer are called pixels, and each image consists of thousands, millions of pixels. Each photo or image displayed on your computer contains pixels in various colors. If we enlarge a numerical image sufficiently, these dots, which our eyes can not readily pick up at the beginning, will become visible. Then these images are digitized by the number of pixels that can not be detected easily by our eyes (Krause et al., 2016).

The computer screen also consists of pixels. If you get close enough, you have a chance to see them. You can easily take a magnifying glass to your hand. A drop of water would never function as a magnifying glass. What you will see are; red, green and blue dots. The colors in the images reflected on the screen are obtained by blending these three main colors.

3.2.2 RGB (Red Green Blue) color area

We can get the real life colors with the combination of green, red and blue. As can be seen from the figure below, these three colors are white when 100% is mixed and black when the ratio is 0%. Even when you look at your old analog TV, you can easily see these three colors at each point. Figure 3.1 shows the mixture of the three main colors.


Figure 3.1: Three main color components

3.2.3 True color concept in RGB color space

Today's monitors and LCD panels can produce true color at the highest color footprint. Although the true color is expressed in 32 bits, each dot is not about 4.3 billion; It can get 16.7 million different colors. That's the explanation:

Suppose you have a color code (true color) below 32 bits in length. The bit values on the color intensity are shown in figure 3.2.
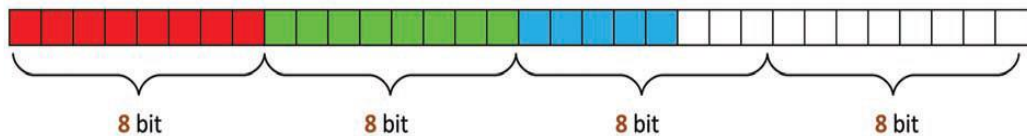
Figure 3.2: Color bits in images

As the figure shows, it first created 8 bits of red, the next 8 bits of green, and the last 8 bits of blue form the color. The last 8 bits are called alpha channel, which holds the transparency information of the pixels.

In the first 8 bits allocated to red, red can take $2^8 = 256$ different color tones.

The second 8-bit green assigned to the green can take $2^8 = 256$ different color tones.

The second 8 bit blue allocated to the blue can take $2^8 = 256$ different color tones.

Since the last 8 bits are not related to color; a total of 256 x 256 x 256 = 16.777.216 there may be various colors obtained.

The actual color representing the value is 8 bits in the first 3 parts of the representation, despite the 32 bit space. There are different impressions. RGB (125,33,0), RGB (0,0,0), RGB (255,10,98) etc ... as well as hexadecimal as follows.

3.2.4 RGB color space 256 color concept:

It is not certain how many bits of color will cover the 256 color (8 bit) concept. Use the red, green, and blue 8 bits as the optimal value to select a color closest to the true color from the color palette. For example, sometimes the red 2, the green 3, the blue 3 bits indicate the most vivid color; sometimes the most vivid color is obtained when it is expressed in red 3 green 2 blue 3 bits.

Assume that the system is set to 256 colors, but we open a 16-bit image file. In this case, a color close to the color can be produced using different combinations of existing colors, and this color is displayed instead of the color to be produced. It's called dithering. Of course, the quality of a picture obtained with this method is much lower than the original picture.

As the depth of color increases; since the size required to express each point in the image increases, the total size of the view increases proportionally. For example, a photo with 16-bit color depth occupies twice as much space as the other photo with 8-bit color depth at the same resolution.

As a result, the more the color depth, the closer the color is to each dot. In turn, the size becomes larger. Nowadays, 24bit color depth which occupies 32bit space has become standard for digital panels.

3.3 Image Processing Purpose;

The general purposes of image processing techniques are divided into 5 categories. These;

     1.) Visualization; Observing obscure objects on the image

     2.) Image sharpening and restoration; Improving noisy images on an image

     3.) Image acquisition; Interesting and high-resolution image search

     4.) Pattern recognition; Identify specific points in an image

     5.) Image recognition; Be able to distinguish desired objects in an image.

3.4 Image Processing Methods;

Image processing can be examined in three main sections. These; optical, analog and digital image processing methods (Sinthanayothin et al., 2003).

Optical processing uses the arrangement of optics to carry out an operation. An important step in optical processing is to find and process photos in the dark room. For years, photographers have manipulated, increased, and abstracted images from one to the other in order to achieve the most attractive and optimal printing. This classical image processing method has reached the advanced and advanced position of today's image processing as a result of trial-and-error methods (Sinthanayothin et al., 2003).

Analog processing of images; depends on the electrical change of the images. Accordingly, the image must first be of electrical form. This application is, for example, a television image. In the television image, the television signal is a voltage level that is amplitude-varying to produce brightness in the image process (Sinthanayothin et al., 2003). We can change this signal electronically to change the last image. The light and contrast settings on the television are used to adjust the amplitude and the reference of the video signal, resulting in a change in the darkening and darkening of the image (Sinthanayothin et al., 2003).

Digital image processing is an image processing method that has been developed with the spread of digital computers (Dimililer et al., 2018). When given the exact data, this method has a very high efficiency compared to other methods. An image under numerical sovereignty is represented by different points of the described brightness. Each dot (pixel) has a numerical settling and numerical brightness in the image (Dimililer et al., 2018). With the manipulation of these brightness values in the image, the computer can handle very complicated operations quite easily. Further, the flexibility in programming the computer accelerates the characterization of operations. These features are absent in optical and exemplary positive image processing (Sinthanayothin et al., 2003).

Emerging computer technology and image processing have also been developed to meet the requirements of digital image processing and handling of hardware and software and special peripherals. In this regard, digital image processing is constantly subjected to methodological developments (Dimililer et al., 2018).

3.5 Image Processing History

In primitive living creatures that lived about seven hundred million years ago, imaging began with the evolution of eye-like organs. These primitive organs created a simplified model of the field of view by tracing the light reflected from the three-dimensional objects in the field of view onto the two-dimensional primitive eye's surface (Parkin, 2018). Although every living organism with an eye organ perceives the environment in a similar way, the framework of visualization with the development of the language in humans has differentiated and has enabled the emergence of the concept of oral history. Oral history is also the first image compression technique that comes out as antithesis. The first imaging with a high retention value started with cave paintings (Parkin, 2018). Throughout history,

painting techniques continue to evolve day by day, but the only element that has remained unchanged in countless technics, from cave walls to medieval painters' canvases, modern wall paintings to advanced digital animations, has been interpreted by human eyes and brains (Zhigang and Queiroz, 2003). Human interpretation with the invention of the photographic machine; light, focus and angle settings. The father of the camera is a box called camera obscura, with a pinhole on one of its surfaces. The filtered light from this hole creates an inverted image on the opposite surface of the box. Although it is not exactly known for the first time by whom it was designed, In the 4th century, the writings of the Chinese philosopher Mo Di were mentioned as the collecting plate or the locked treasure chamber from the relevant design. Aristotle also depicts the sun's eclipse through the leaves during the same period. It is the speculation that it was made by who, although it is estimated to be the first time between the 10th and 13th centuries, that the dark box studied by various philosophers. The camera is designed with a chemical coating on the surface of the dark box that reacts to the light. Joseph Nicéphore was made by Niépce in 1825 as the first photographer to take photographs that would last as long as the sun. The first experimental color photograph was taken by James Clerk Maxwell in 1861. The idea of digitally sensing light was proposed in a space research conference in 1961, and was produced in 1968 with a logical light detection panel that was proposed (Zhigang and Queiroz, 2003). The first digital camera was designed by Kodak in 1975 by an engineer named Steven Sasson. A Charge Coupled Device (CCD) sensor, manufactured in 1973, was used for space research in this camera, which weighs 3.6 kg and can take colorless pictures at a resolution of 0.01 megapixels at 23 seconds. A moving image, or video in other words, is obtained by basically taking a series of photos, called frames, which are shot quickly. The first motion picture recording was done at the end of the 1880s. In order for a moving view to be perceived as uninterrupted by people, there are video systems that contain as few as 20 frames per second, but practically fewer frames. The debate over which one of the first successful video cameras is due to the uncertainty in the number of frames. The same uncertainty has also affected the history of the digitization of video cameras. It is also known that even in the late 1990s digital cameras are not enough for cinematography. The latest technology being developed today is three-dimensional imaging. Two images, which are basically captured by two separate cameras placed on the right and left eye, are mirrored by separate filters on the right

and left eye, creating an eye illusion. Three-dimensional films with experimental shootings in the 1950s; equipment and installation costs, loss of color depth in red / green / blue glasses, etc. it has not been popular for some reason (Zhigang and Queiroz, 2003). With the progress of the technology, costs have been reduced and systems without color loss have emerged. Nowadays polarized, digital curtains and so on. as well as three-dimensional display systems that use technologies, as well as three-dimensional displays that can be viewed from a narrow angle of view without glasses.

3.6 Image Processing Applications

Visual information obtained by visual technology is the most important type of information that is processed and obtained. It was interpreted by the human brain. If we think about the human brain, according to the research done, one third of the brain is devoted to processing visual information.

As a computer-controlled technology, digital image processing automates the processing, such visual information to be influenced and interpreted plays an important role in the enormous range of rules and fields that we have in our daily lives. Science and technology, television, photography, robotics, remote sensing, medical diagnostics and industrial auditing.

• Computer photography (eg Photoshop)

• Spatial (Space) image processing (eg Hubble space telescope views, interplanetary probe views)

• Biological /Medical image processing (eg Interpretation of X-ray images (X-ray), blood cell microscopic images)

• Automatic character recognition (zip code, license plate recognition)

• Fingerprint / face / iris recognition

• Remote sensing: antenna and satellite view comments

• Discovery

• Industrial applications (eg product inspection / sorting)

3.7 General Methods of Image Processing

3.7.1 Media filter

A median filter is a nonlinear digital filtering technique that is used for noises from one side to the other, generally from an image. Noise reduction is a preliminary step that is developed to optimize the results of subsequent operations (eg edge detection on an image). Median filtering is often used in digital image and signal processing technologies because, under certain conditions, it generates and enhances edge points while producing noise. Figure 3.2 shows the input and output image of the median filtered image.


(a) Original Image   (b) Median Filtered Image

Figure 3.3: Speak median filtered image

3.7.2 Binarization methods (Threshold)

Thresholding is the process of separating objects from the background and is the simplest segmentation method. The easiest way to separate objects we need from unwanted backgrounds is to compare the pixel values in the image with a T threshold value that is relatively determined from the histogram. Accordingly, for any (i, j) pixel in the image, If f (i, j)> T is a point of a pixel object (i, j) and f (i, j) ≤ T, then the pixel (i, j) is a point in the background. Figure 3.4 shows the input and output images of an image with a threshold applied.
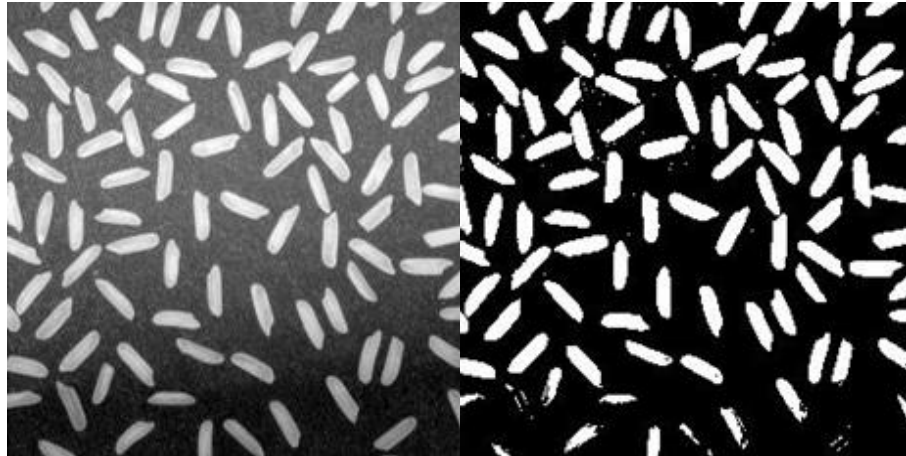
(a) Original Image   (b) Threshold Image

Figure 3.4: Threshold applied image

Thresholding methods; Global Binarization Methods and Locally Adaptive Binarization Methods. The holistic threshold method calculates based on a single threshold value for all views. A pixel darker than the threshold value is labeled black. Contrarily, the background is labeled (background, white).

On the other hand, the local adaptive thresholding methods calculate a threshold value for each pixel based on the information adjacent to the applied pixel. Some different methods calculate a threshold value throughout the entire view. This (x, y) pixel is labeled as background if it has a gray level higher than the calculated threshold at an (x, y) pixel (x, y) in the input image. Otherwise it is labeled as print. Some local adaptive thresholding methods available in the literature are:

1) Bernsen's method, although adaptive thresholding methods are successful in some complex images, they often do not accept the edge property and cause a fake shadow. this algorithm calculates a separate threshold for each pixel; therefore, it has a clearer adaptation than the global thresholding methods (Qiang et al., 2008).

2) Chow and Kaneko's method, Binary renders a grayscale image using a threshold operation. Local thresholds are calculated on a grid by the Otsu method and added to the full-size image (Yanowitz and Bruckstein, 1988).

3)   Eikvil et al.'s method, Pixels within a small window S are threshed by the clustering of pixels in a larger concentric window L (Trier and Jain, 1995).

4)   Mardia and Hainsworth's method, this method first makes an initial binarization, using, (for example, Otsu's method) Then several steps are iterated until convergence is reached (Trier and Jain, 1995).

5)   Niblack's method, it is the local thresholding technique for images where the background is not uniform, especially for text recognition. Instead of calculating a single global threshold for the entire image, several thresholds are calculated using special formulas that take into account the mean and standard deviation of the local thresholds for each pixel (Qiang et al., 2008).

6)   Taxt et al.'s method, the image is divided into non-overlapping windows 32x32 pixels. The histogram in each window is an approximate value. With a mixture of two Gaussian distributions. The parameters of the mixture are estimated using an expectation-maximization (EM) algorithm (Trier and Jain, 1995).

7)   Yanowitz and Brucksteiri's method, by showing possible object edges, we presented an image segmentation method based on the threshold surface determined by interpolation of the image gray levels at high gradient points. Because this method is completely bound to the image edge, objects are lost when fake objects or object edges are too weak when noise is large (Qiang et al., 2008).

8)   White and Rohrer's Dynamic Threshold Algorithm, is used as an average threshold value (Trier and Jain, 1995).

9)   Parker's method, this method first detects the edges, and then the objects between the edges are filled. (Trier and Jain, 1995).

10)   White and Rohrer's Integrated Function Algorithm, applies a gradient like processor called image on the image (Trier and Jain, 1995).

11)   Trier and Taxt's method, the following 3 methods were used;

✓   Input image corrects with 5 x 5 average filter.
✓   The use of search vectors has been abandoned.

✓   Yanowitz and Bruckstein's Postprocessing step method; used to remove the wrong print objects (Trier and Jain, 1995).

Some global adaptive thresholding methods available in the literature are:

1)   Kapur, the algorithm uses the entropy of the image. Each class accepts the pinging image as two event classes characterized by a pdf. The method then maximizes the sum of the entropy of the two pdfs to converge to a single threshold (Rosin and Ioannidis, 2003).

2)   Kittler, The method proposed by the Kittler is characterized by the nature of a non-parametric and uncontrolled threshold selection and has the following desired advantages: The procedure is very simple; only the zero and first order cumulative moments of the gray level histogram are used. A simple extension to multi-threshold problems is possible with the criterion on which the method is based (Shafarenko et al., 1998).

3)   Abutaleb, the gray level of each pixel and the gray level of the neighborhood are examined. AS. Abutaleb first tried this approach because the frequency of occurrence of each gray level pair and the local average gray level, called thousand, were calculated. Produces two peaks with a valley corresponding to the foreground and background, respectively, for any generalized gray-level image that has no blur in the image (Abutaleb, 1989).

4)   Yang Xiao, further simplified this approach by defining a GLSC histogram, built in consideration of the similarity with some adaptive thresholds as a measure of similarity in neighborhood pixels (Xiao et al., 2008).

5)   Entropic, the principle of entropy is to use uncertainty as a measure of knowledge in a source. We think that the noise and the edge of the entropic thresholds can provide more information than the object and background. Thus, in relation to the GLSC histogram as an information source, the different m elements within it should not be considered equally in the calculation of entropy as in Kapur's method (Xiao et al., 2008).

6)   Water flow model, background subtraction, water flow model, average and standard derivation of pixel values, and local image contrast can be handled in different ways. Some disadvantages of local thresholding techniques are region-dependent, individual image characteristics and time-consuming (Oh et al., 2005).

7)   Yanni, used another way to define the threshold by starting the midpoint between the two accepted peaks. The histogram is the smallest non-zero gray level and the smallest. This category fails in complex or corrupted images (Wagdy et al., 2015).

3.7.3 Edge detection

The edge in an image falls against a significant change in the physical appearance of a scene, such as lighting or surface reflections, which manifests itself as brightness, color and texture. In edge detection methods, you will only be interested in changes in image brightness; areas where a scene has sudden changes in gray levels are called "edges" (Dharampol and Mutneja, 2015).

Edge detection is performed in the following steps:

• Edge pixels are detected. The discontinuities in gray values are determined by edge operators. For a difference between the gray values, a threshold is used to determine whether the pixel belongs to an edge.

• Edge pixels are associated with edges.

• Edges are grouped. Straight lines, multiple lines, and parallel lines are specified separately.

3.7.4 Edge detection purposes

There is a linear relationship between the properties of the objects and their edges. For this reason, many results to be extracted from the images can be removed from the edge information taking into account the physical property. Edge detection is therefore one of the important issues in the analysis of the image.

• Edge detection can be used to recognize an object in an image. The basic step in object recognition is to divide a view into different regions that are opposed to different objects.

• Edge detection is a low-rate image coding application that only encodes the edges of the image.

• One of the important applications of edge detection is the process of accurately measuring the size of certain objects in the image.

3.7.5 Sobel detector

Sobel edge method first It is based on partial derivatives. It uses a mask. That is, the pixel gradient corresponding to the middle of the mask is calculated considering the neighborhood. With the Sobel detector, we can see the input and output image of a scanned image in figure 3.5.

(a) Original Image   (b) Sobel Image

Figure 3.5: The edges are perceived with the sobel method

3.7.6 Prewitt detector

Prewitt detector Sobel detector is a little simpler to calculate calculation according to the detector, but tends to produce slightly noiser results. This method also uses a mask. We can see the input and output image of a scanned image with the prewitt detector at figure 3.6.

(a) Original Image   (b) Prewitt Image

Figure 3.6: The edges are perceived with the prewitt method

3.7.7 Roberts detector

The Roberts detector is the oldest and simplest detectors in image processing. This detector can only detect horizontal or vertical edges. Because it is fast and simple, it is used in real time applications. We can see the input and output image of a scanned image with the Roberts detector at figure 3.7.

(a) Original Image   (b) Roberts Image

Figure 3.7: The edges are perceived with the roberts method

3.7.8 Canny detector

The Canny detection filter is the strongest edge detection filter. This method;

Image; it is softened with a certain standard deviation using a Gaussian filter to reduce noise. The Local Gradient and edge direction are calculated separately for each pixel in each spot. An edge point can be defined asa point with maximum gradient power. The specified edge points cause the tilt magnitude image to appear on the output. The algorithm then follows the peaks in these peaks along the peak, and in fact all peaks that are not peak peaks are zeroed until a thin line is given. This process is known as "non-maximum 23 uppression". As a result, the algorithm performs edge merge by including weak pixellies. With the Canny detector we can see the input and output image of a scanned image in figure 3.8.

(a) Original Image   (b) Canny Image

Figure 3.8: The edges are perceived with the canny method

CHAPTER 4

DESIGN OF BLEEDING DETECTION OF EYE VESSELS

4.1 Methodology

This section describes the basic steps of detecting the bleeding of the eye vessels.
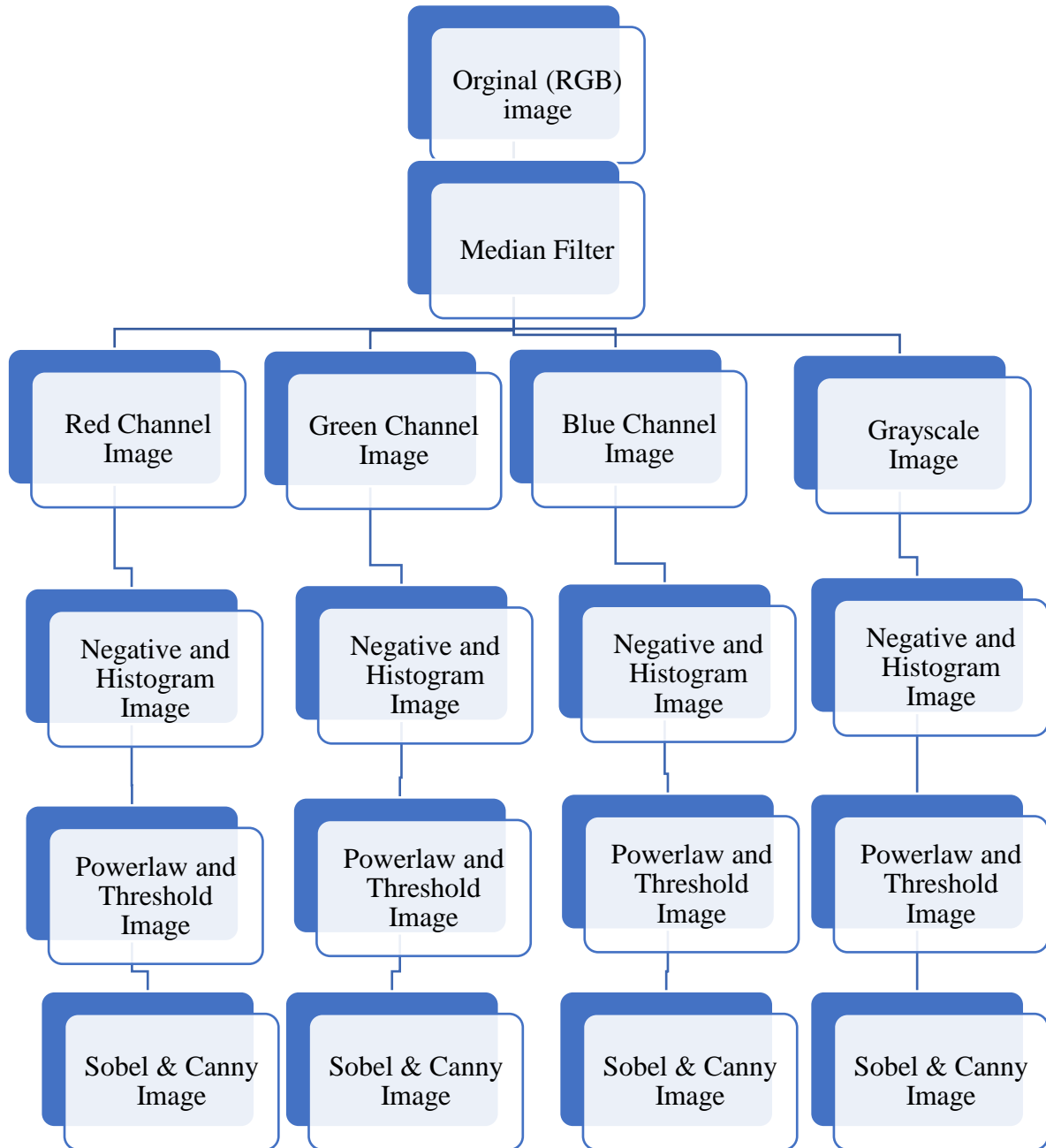
4.1.1 Proposed system

In this thesis, bleeding detection system of eye vessels is designed. The system uses different techniques in the image processing process to detect hemorrhages originating from the diabetic eye. System; It was applied using Matlab programming language and simulated with a hundred pictures (Matlab R2013a).

The bleeding detection system of the eye vessels is based on the different results of various image processing techniques. The retinal image database is created by shooting with a fundus camera can be used for experts and researchers working in image processing field.dijital First, the retina image taken in the system in color form is divided into RGB color channels. Also the picture is converted to black and white picture. Illuminated and median filters are applied to separate images separately to remove pollution and unnecessary detail. Each of these pictures is taken separately negative, and the lighting rates of the Powerlaw filter are repeated at four different values. The histogram values of all images are determined separately. Thresholding is applied according to these values. A threshold value is a special value thattransforms a view into a binaryview because of the thresholding method. The bleeding point is then observed by eliminating the unnecessary and small details in the binary image-converted images for clarification of the bleeds. As a result, by using edge detection methods, points where possible bleeding may be drawn on the image are drawn and the result is officially taken into account.

4.1.2 Flowchart

The system flow diagram is shown below.

Figure 4.1: Flow diagram of the designed system

4.1.3 Proposed system procedure

In this system, many methods and techniques have been used. If we need to look at these in turn; database creation, RGB channel separation and grayscale image conversion, image filtering, image negatives, Powerlaw filter lighting, thresholding using segmentation and edge detection.

4.1.4 Database

In this study, fundus camera images were used to observe blood vessels and undesired bleeds in retinal images. For the researchers, the data set that was previously created on the internet was used (these data set names: Diaretdb0_v_1_1, Diaretdb1_v_1_1, Drions-DB). The images from the data sets were randomly selected from among them for study. The images are in .jpg formatted in this study..It has been processed with its original dimensions without any processing of image dimensions. 50 of the images used in the original dimensions have retinal hemorrhage, and 50% have a total of 100 images without hemming. This number will suffice if the designed system is an image analysis system. Some retinal images are given in figure 4.2.
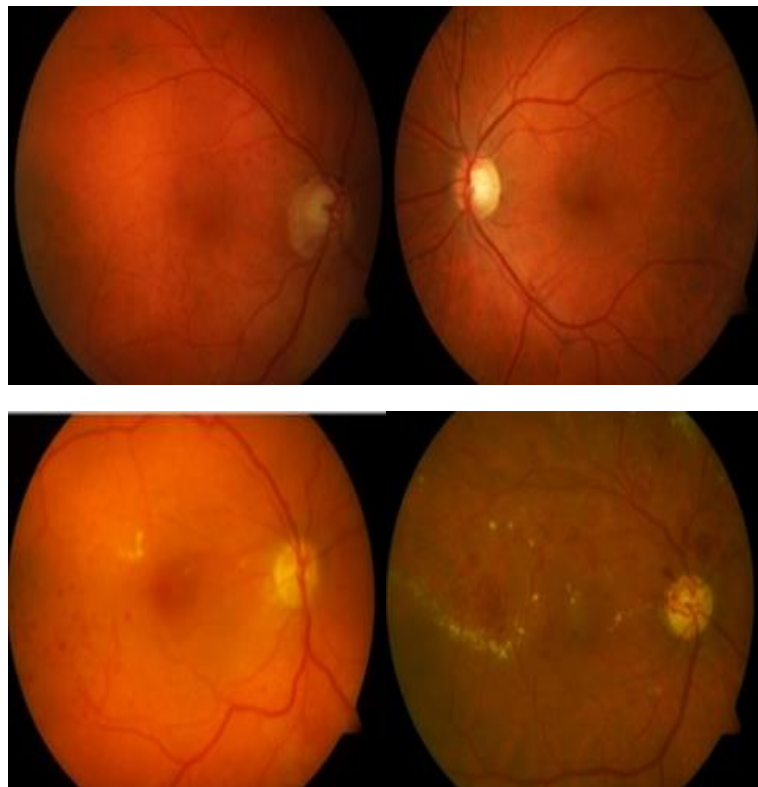
Figure 4.2: Some retinal images used in the system

4.2 Image Filtering

Image processing is being used more and more every day and the usage area is widening. One of the most popular areas of image processing in our era was the ridiculous cleaning of the scenery (Thanh et al., 2016).

When images are obtained, there is a significant reduction in the quality of the image during operations such as image digitization, signal amplification and transmission, or timing error in analog-to-digital conversion due to errors in analog components (sensor and amplifier etc.) (Chan et al., 2005; Yang et al., 2015, Ananthi and Balasubramaniam, 2016), and Goossens et al., 2009 (Lin et al., 2010; Zhang and Li, 2014).

Other reasons for adding noise to the display can be listed as follows; camera sensor irregularities and errors, hardware memory errors, and problems with unusual transmission errors (Jin et al., 2016).

For example, television images are distorted due to atmospheric noise and lack of image reception. Another reason is that when scanning artwork and digitizing it, noise is added to the image because of the operations that are done to prevent the original surfaces from being damaged. In the DNA microchip images, image noise is added due to lack of source and detector in microchip technology (Morillas et al., 2009). Due to reasons like these, unwanted or unreal information is added to the images. This unwanted information is called noise in images. It is impossible to obtain a noiseless image with today's cameras, and the cameras add a certain amount of noisy images (Cho et al., 2012).

The most fundamental problem is the elimination of noises in the image processing or the minimum noise reduction (Jiang et al., 2014, Azimirad and Haddadnia, 2015). The most important factor when lifting the noise is to protect the original image information such as edges, textures of the image (Nguyen and Chun, 2017).

Salt-pepper is present in noisy images due to transmission and memory errors during the image acquisition phase (Gonzalez and Woods, 2008). Although noise intensity is low in images with salt-pepper noise, there is a significant decrease in image quality and changes (Sulaiman et al., 2015). Salt-pepper noise makes the pixel value negative or positive minimum or maximum in gray scale images. If a gray scale image is contaminated with salt-pepper image, some pixel values are 0 or 255 (Erkan and Kilicman, 2016).

Many methods have been developed to reduce salt-pepper noise. Many of the process developed have only adopted processing on noisy pixels. The most common method of removing salt-pepper noise is Median Filter (MF). MF is windowing at the given parameter size. Then, the pixel in the window is in small to large order, and the pixel value in the middle of all pixels is the new pixel value. The median filter produces very good results when is pollution level low. But, when the noise intensity increases, no noise pixels will remain in the window, so it is insufficient to remove the noises. If the image size is large, this removes the edges and other details in the image. This causes blurring in the image.

We will apply a filter to make corrections in our visuals. Commonly used filter types are linear filters such as median filter as well as recommended filters in our system. This filter. has easy-to- use features. It is preferred to reduce noises in the image and in the signal, while preserving the edges of the image. Median Filter works with linear algorithm filter processing logic. Pixel window surrounding the examined pixel is computed and the output of the pixel being processed is calculated (Eng and Malek, 2001). As a result, the median filter passes over each element of the picture and replaces all pixels with the median value of neighboring pixels. It uses the middle pixel value by creating a square matrix around the pixel to be replaced (eg 5x5 can be a 3x3 square matrix).

How does this affect border objects? There are various approaches and methods with different features. Can be used in cases of necessity:

> • Then avoid cutting the border of the signal or image or handling the border without breaking or restricting.

> • Inputs are being received from different data locations in the signal. For example, images can be selected from remote horizontal or vertical boundaries.

> • Windows will shrink around the borders, so that each window is full.

For the median filter, see the following example:

3-by-3 unified blog:

6, 3, 4, 5, 2, 5, 4, 5, 9

After the order step, the result values:

2, 3, 4, 4, 5, 5, 5, 6, 9

Median result value:

5

The system illustrates an example of the operation logic of a median filter to reduce noise in the image by arranging a core point or window according to the desired state along the entire matrix of the image and finding an output for each pixel processed using the window's media. (Church et al., 2008). With the median filter, we see the image of the de-noiseed picture in figure 4.3.

(a) Original Image   (b) Median Filtered Image

Figure 4.3: Median filtered image

4.3 Threshold

Segmentation is performed by separating into regions (or contours) corresponding to small objects of a scene. We usually try to divide the segments into segments by specifying common points for the whole image. Or, similarly, we define contours by defining different properties between regions (edges).

The simplest features that the pixels can give us are tired. For this reason, these points are the easiest and natural way to separate them from the chapters. Through the separation of open and dark regions.

Thresholding generates binary images at gray levels, translating global pixels to a zero value below a specified threshold value, and to global pixels at that threshold. (It does not matter what you want to do with pixels as long as you are stable and linear).

If G (x, y) is a method with a threshold f (x, y) at some global threshold T,

$$g(x,y) = \begin{cases} 1 & \text{if } f(x,y) \geq T \\ 0 & \text{otherwise} \end{cases}$$

One of the threshold values most commonly used image or signal segmentation methods. Useful for separating foregrounds from backgrounds. A gray screen level can be transformed into a zero and one image by specifying a threshold value (T) at a sufficient level. The binary image contains information about the position-shape of the objects in the image. (Jain, 1986).

The biggest advantage of getting a binary image at the beginning is that it reduces complexity by maximizing the classification timing and accelerates the algorithm. The most common way to translate a gray level image into a binary image is to select the threshold value (T). Subsequently, all values below this threshold will be classified as black (0) and white as top level (1). The problem of segmentation is to become the most appropriate value choice for the threshold value.

The most common threshold method is described below:

- Otsu thresholds
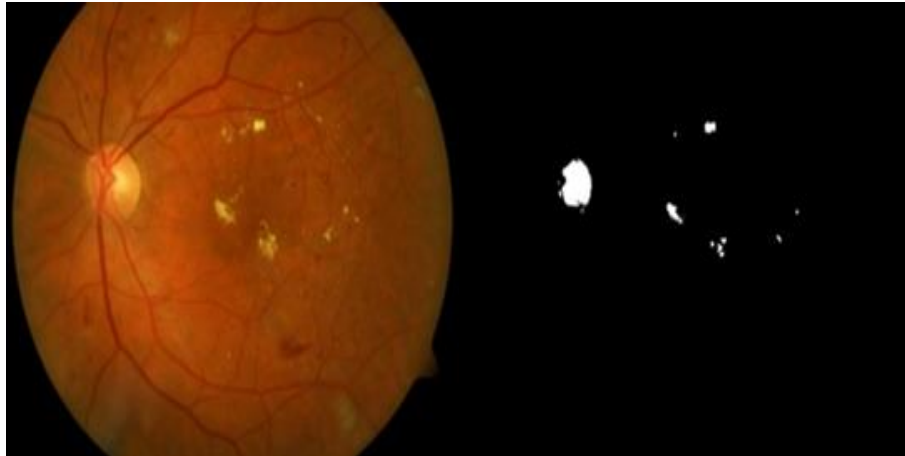
(a) Original Image   (b) Threshold Image

Figure 4.4: Threshold applied image

Otsu thresholding;

Otsu threshold method performs the segmentation process by selecting the threshold value automatically. Another way to achieve similar results is to adjust the threshold so that the whole cluster is as tight as possible, thus minimizing overlapping. Obviously, we can not change the distributions, but we can set the points to split them (the threshold). Since the threshold can be adjusted by certain methods, we can reduce the spread of someone by increasing the distribution of any one. (Qu and Hang, 2010).

The base method is a global thresholding method because the threshold value is only associated with the black-and-white values of the view. The Otsu method was developed by Scholar Otsu in 1979 effective (Gonzalez and Woods, 2007).

The Otsu threshold method requires that a histogram graph of a gray-level image be extracted before the first step in the pro-processing phase. However, due to the one-dimensional gray level information, a clearer segmentation result can not be achieved. Otsu's method is one of the better threshold selection methods for layouts and shapes.. However, this method can not work well with uneven illumination (Uzelaltinbulat and Ugur, 2017).

When considered, a given set of pixels are accepted at L gray levels [1, 2, ..., L]. The number of pixels at level I, ni and the total number of pixels are denoted by N = n1 + n2 + + nL. To

simplify the concept, the gray level generated histogram is simplified and considered as probability distribution. (Otsu, 1979):

$$pi = ni/N, \quad pi > 0 \sum_{i=1}^{L}, Pi = 1 \tag{4.1}$$

We create two classes of Co and C1 (background and objects, or vice versa) with a threshold at any k level; CO representing the pixels that represent the pixels with [1, k] and [k + 1, ..., L]. In the latter case, the probability of class formation and class average levels

$$\omega_0 = \Pr(Co) = \sum_{i=1}^{k} pi = \omega(k) \tag{4.2}$$

$$\omega_1 = \Pr(C1) = \sum_{i=K+1}^{L} pi = 1 - \omega(k) \tag{4.3}$$

and

$$\mu_0 = \sum_{i=1}^{k} i \Pr(i|C_0) = \frac{\mu(k)}{\omega(k)} \tag{4.4}$$

$$\mu_1 = \sum_{i=k+1}^{L} i \Pr(i|C_1) = \mu_T - \mu(k)/1 - \omega(k \tag{4.5}$$

where

$$\omega(k) \sum_{i=1}^{k} Pi \tag{4.6}$$

and

$$\mu(k) = \sum_{i=1}^{k} i p_i \tag{4.7}$$

This is the time that the histogram reaches to the nth level and the time from the first grade.

In this thesis study, Otsu threshold method was used., value was used because of the simplicity and differences in graylevels densities requiring different threshold images. For this reason, values are automatically selected for different images using the herbaceous threshold (Uzelaltinbulat and Ugur, 2017). With otsu threshold method, we see the thresholded image on a non-bleeding retinal image at figure 4.5.
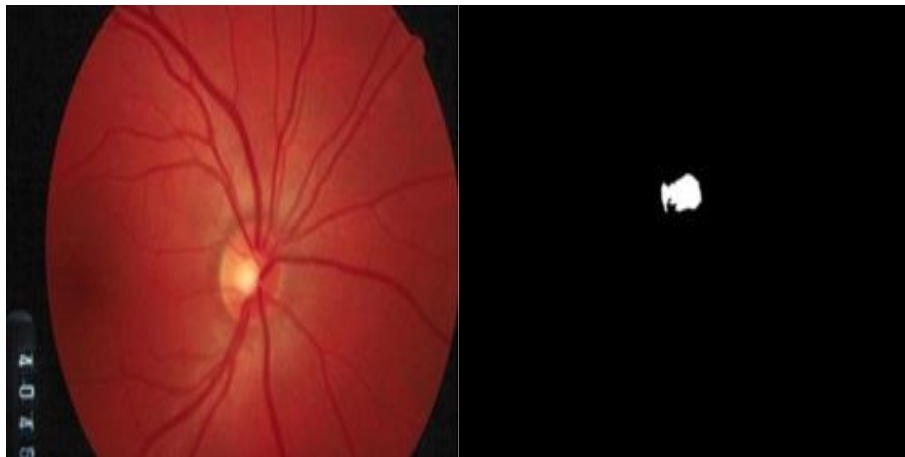
(a) Original Image   (b) Otsu Threshold Image

Figure 4.5: Otsu threshold applied image

4.4 Edge Detection

The edge of an image is a major change in the physical appearance of an image, such as light or surface reflections, indicating brightness, color, and texture. Edge detection technique, you will single be interested in changes in image luminosity; areas where a scene has sudden changes in gray levels are called "edges".

Edge detection is performed in the following steps:

• Edge pixels are detected. The black-and-white discontinuity is determined by the edge detectors. The threshold is usually used to make a graycolored border check.

Edge pixels are associated with edges within the image.

• Edges are grouped in general. Plain, multiple and parallel lines are specified separately.

4.4.1 Edge detection purposes

The physical properties of the objects in the image, the edge lines, there is a linear relationship to the edge creation. For this reason, many physical features of the view can be extracted from the edge information. Edge detection is the most important aspect of the image processor.

• Edge detection can be used to detect an object in an image. The basic step in object recognition is to divide a view into different regions that are opposed to different objects.

Edge detection is a low-rate image coding application that only encodes the edges of the image.

• The most common use in edge detection applications is to measure the size information of certain objects in the image.

Sobel detector;

Sobel edge method first It is based on partial derivatives. It uses a mask. That is, the pixel gradient corresponding to the middle of the mask is calculated considering the neighbourhood. An image showing the screening points on a bleeding retinal image with the Sobel detector is shown in figure 4.6.

Figure 4.6: Images with perceived edges

Canny detector;

The Canny detection filter is the strongest edge detection filter. This method;

Image; It is softened with a certain standard deviation using a Gaussian filter to reduce noise. Local Gradient and edge directions are calculated at en every point. Any edge can be defined as a point with maximum slope angle and power. The specified edge points cause the tilt

magnitude image to appear on the output. The algorithm then follows the peaks in the peaks, and the peaks in the peaks, and the peaks in the peaks. This course is known as "non-maximum supression". As a result, the algorithm performs edge merging with lower pixels. An image showing the screening points on a bleeding retinal image with the Canny detector is shown in figure 4.7.

Figure 4.7: The picture is scanned with the canny method

CHAPTER 5

RESULTS AND DISCUSSIONS

The testing phase of the system developed in this section is discussed and the usage numbers of the images used in the system are specified. The methods in the system used here are briefly mentioned. In addition, the performance of the designed system and the most successful methods are mentioned.

5.1 System Performance

The developed system will begin to detect diabetic retinopathy-induced hemorrhages in retinal images. The system has been advanced by using 4 different methods that we mentioned in the blog diagram. By separating our original images into color channels and dividing them into black and white images, we continued our path by taking the histogram of our pictures. In our work, more than one method has been tried to determine the most successful methods. Some of them are color, 4 different types of pictures are included in our program, the histogram is taken separately in the program, the negative steps are taken in these pictures. We have developed our program by adding a powerlaw filter (with different gamma values) to our processing techniques. Threshold method, we set thresholds and thresholded the whole of our images. Later, we used Sobel and Canny methods of edge detection. In order to observe the performance of the system, 50 non-hemostatic retinal images were used.

In the table below, we observe the success rate of bleeding and hemorrhage in the retinal images we use in our system.

Table 5.1: Success rate of our work

	Total Images	Number of partitioned images	Success rate
No Bleeding	50	50/50	100%
Bleeding	50	48/50	96%
Total	100	98/100	98%

In the table below, we see 4 methods with the most success rate among the many methods used.

Table 5.2: Most successful methods

No	Success Rate Method Used Name	Gamma	Success Rate (100%)	Number of Successful Pictures	Number of Medium Success Pictures	Number of Find Incorrect Images
1	Green Channel Power Law Filtered Image	3	80	65	15	20
2	Green Channel Power Law Filtered Image	6	76	66	10	24
3	Negative-Subtracted Green Channel Threshold Image	-	73	31	42	27
4	Green Channel Threshold Image	-	70	30	40	30

The four most successful methods for displaying 48 output images for each image are shown in our table above. As can be seen from the table above, the original images are separated by the green channel and have achieved the highest success in image processing techniques performed in this area.

As a result of the interviews conducted with the specialist physician, powerlaw gamma value was 3 according to the results of the interviews and the highest success was achieved. In some pictures, the medium-successful number of pictures tag was used because it detected other than the bleeding point. These conditions are also included in the success rate. Because the bleeds have also identified points.

5.2 Results of Discussions

When compared with other studies, this thesis used different ways to detect bleeds in retinal images and continued by increasing the number of methods to choose the most successful path. A variety of image processing techniques have been used in this thesis for this reason.

First, the images were developed using various pre-processing filters and using correction techniques. The images were converted from the color image to the original 3 main colors and the grayscale image. The images with separate histograms of the images were transferred to the next step. At this stage, the PowerLaw (Gamma 3 and 6) filter is used to illuminate and darken the image. Then, the threshold method is used for thresholding.

The final step has become more evident by the edge detection methods, which are the main part of the system, and the edges of the points where bleeding and other objects are pointed. In this method, the sobel and canny methods are used.

There were many difficulties in implementing and developing this design. One of them is to record the data properly by giving at least 48 image outputs in one image, since more than one method is used to select the most accurate method and each output of these methods emits an output image. In addition, when the system was thresholded, he lost some hemorrhage points and eye baby spot on the retina layer. Selecting the appropriate threshold value is another difficulty.

5.3 Comparison of Results

Very similar studies were performed to process the retina images. Some of these studies have tried to determine bleeding points by using different methods. In addition to these studies, a similar study was conducted to examine the structure of blood vessels in the eye only for the detection of different diseases. One of them is the study of blood vessels. In this study, sequential thresholding method was used and the veins were determined to be effective. In addition, the studies on the graphical processor unit in parallel calculations for the rapid operation of the algorithm took place in these studies. Fuzzy based methods have been used in different studies as 89%. In a different study, only the green channel was studied and, in this method, a new approach was taken for taking blood vessels in combination using Morphological, Gaussian High Pass Filter and Wiener filter.

In this study, the original image for the detection of bleeding in the retina layer due to diabetic retinopathy was tried with 4 different methods and the most successful and effective methods were obtained by obtaining different image data from the subsequent processing techniques. In this study, different methods were tried by different methods. As a result, it was seen that the original images achieved a higher success in the work to be done by separating the green color.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

One of the most important reasons for prolonging human life in recent years is the use of computer science and image processing techniques for the detection and early detection of diseases. Imaging techniques such as X-ray and tomography, and image processing technology can be used to diagnose many diseases earlier and faster, using medicine.

Diabetes in humans is the biggest problem in humans. Many patients sometimes lose body limbs and organs. Diabetes also affects the eye. This is called diabetic retinopathy. Early diagnosis, treatment is of great importance to prevent loss of vision and vision. Due to diabetic retinopathy, the structure of the eye vessels deteriorates and causes bleeding in the eye. Therefore, it plays an important role in the treatment of some diseases such as diabetic retinopathy.

The retinal blood vessels and blood vessels must be separated from the retina image so that the blood vessels in the retina are diagnosed early due to diabetic retinopathy.

In this study, Matlab program was used. All codes are written in this program. Matlab program is actively used in many areas.

Before the study, different methods were used in the studies. Our main goal in this study is to test different methods to get the most successful results. This is also achieved in studies on the green channel. Negative studies were taken in this area. As the next stage, the histograms taken were transferred to the next stage. The output image of each stage is recorded. The histogram value is different from the pictures taken with the negative powerlaw filter is made (We have used two different values for this filter as the gamma values 3 and 6). The pictures that were clarified by this filter were threshed by the grassy threshold method and the desired desired image values were obtained as black-white logic by getting rid of the unwanted sections. Then, the edge detection method was used to determine the edges of the points in the image and the success of the project was tried.

The results were evaluated in terms of the success of the results obtained in consultation with a specialist ophthalmologist.

These methods, which are used together with the development of computer systems, will develop further. Thus, clearer and faster results will be obtained.

6.2 Recommendations

For future studies, a number of techniques have been suggested and recommended for strengthening and detecting bleeding in retinal images.

In addition to this work, artificial neural networks and similar artificial intelligence programs and data from image processing program can be processed with these programs to obtain better results. Electronic and computer technology, which is rapidly developing today and, in the future, will be an important factor in early diagnosis and treatment in medical treatments. Human life will be better in this way.

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APPENDICES

APPENDIX 1

SOURCE CODE

```
close all

clear

clc

%% Image Read

[FileName,PathName]     =     uigetfile({'*.jpg';'*.png';'*.gif';'*.bmp'},'Select     IMAGE
MESSAGE.');

    A = imread( strcat(PathName,FileName) );

% A = imread('image_001.jpg'); % Read image

B=rgb2gray(A);

IMAD=imadjust(B);

MED=medfilt2(B);

AVARe=fspecial('average',3);

FILT=imfilter(MED,AVARe,'replicate');

MEDg=medfilt2(FILT);

ORDh=ordfilt2(MEDg,15,true(5));

%% RGB Channel


red = A(:,:,1);     % Red channel

green = A(:,:,2);   % Green channel

blue = A(:,:,3);    % Blue channel

JA=imcomplement(B);
```

```
JR=imcomplement(red);

JG=imcomplement(green);

JB=imcomplement(blue);
```

%% Histogram equalization

```
% imhist(B)

C = histeq(ORDh);
```

% figure(7), imhist(C),title('histogram synchronized grafic');

```
red_histeq = histeq(red);

green_histeq = histeq(green);

blue_histeq = histeq(blue);

JAH=imcomplement(C);

JRH=imcomplement(red_histeq);

JGH=imcomplement(green_histeq);

JBH=imcomplement(blue_histeq);
```

%% PowerLaww Filter

```
I=im2double(green);

[m n] = size(I);

c = 2;
```

```matlab
g =[0.5 0.9 3 6];% Gamma Correction Array

for p = 1 : m

    for q = 1 : n

        I3(p, q) = c * I(p, q).^ g(1);

        I4(p, q) = c * I(p, q).^ g(2);

        I5(p, q) = c * I(p, q).^ g(3);

        I6(p, q) = c * I(p, q).^ g(4);

    end

end
%% Thershold

level = graythresh(ORDh);

bw = im2bw(ORDh,0.3000);

bw = bwareaopen(bw, 5);


level2 = graythresh(JGH);

bw2 = im2bw(JGH,0.4800);

bw2 = bwareaopen(bw2, 5);


level3 = graythresh(JG);

bw3 = im2bw(JG,0.6100);

bw3 = bwareaopen(bw3, 5);


level4 = graythresh(green);
```

```
bw4 = im2bw(green,0.3900);

bw4 = bwareaopen(bw4, 5);

%%

levelR = graythresh(JRH);

bwR = im2bw(JRH,0.4670);

bwR = bwareaopen(bwR, 5);


levelB = graythresh(JBH);

bwB = im2bw(JBH,0.3000);

bwB = bwareaopen(bwB, 5);


level5 = graythresh(I5);

bw5 = im2bw(I5,level5);

bw5 = bwareaopen(bw5, 5);


level6 = graythresh(I4);

bw6 = im2bw(I4,level6);

bw6 = bwareaopen(bw6, 5);


level7 = graythresh(I6);

bw7 = im2bw(I6,level7);

bw7 = bwareaopen(bw7, 5);

%% edge detection
```

51

```
sb = edge(bw,'Sobel');

cn = edge(bw,'Canny');


sb2 = edge(bw2,'Sobel');

cn2 = edge(bw2,'Canny');


sb3 = edge(bw3,'Sobel');

cn3 = edge(bw3,'Canny');


sb4 = edge(bw4,'Sobel');

cn4 = edge(bw4,'Canny');


sb5 = edge(bw5,'Sobel');

cn5 = edge(bw5,'Canny');


sb6 = edge(bw6,'Sobel');

cn6 = edge(bw6,'Canny');


sb7 = edge(bw7,'Sobel');

cn7 = edge(bw7,'Canny');


sb8 = edge(bwR,'Sobel');

cn8 = edge(bwR,'Canny');
```

```matlab
sb9 = edge(bwB,'Sobel');

cn9 = edge(bwB,'Canny');

%%  image output


figure(1), imshow(A), title('Original image')

figure(2), imshow(B), title('Grayscale image')

figure(3), imshow(red), title('Red channel')

figure(4), imshow(green), title('Green channel')

figure(5), imshow(blue), title('Blue channel')

figure(6), imshow(C),title('histogram synchronized image');

figure(7), imshow(red_histeq),title('red histogram synchronized image');

figure(8), imshow(green_histeq),title('green histogram synchronized image');

figure(9), imshow(blue_histeq),title('blue histogram synchronized image');

figure(10),              imshow(I3);title('Power-Law              transformation-
darkest');xlabel('Gamma='),xlabel(0.5);

figure(11),              imshow(I4);title('Power-Law              transformation-
dark');xlabel('Gamma='),xlabel(0.9);

figure(12), imshow(I5);title('Power-Law transformation-light');xlabel('Gamma='),xlabel(3);

figure(13),              imshow(I6);title('Power-Law              transformation-
lightest');xlabel('Gamma='),xlabel(6);


figure(14), imshow(JA), title('Negative image')

figure(15), imshow(JR), title('Negative RED image')
```

figure(16), imshow(JG), title('Negative GREEN image')

figure(17), imshow(JB), title('Negative BLUE image')

figure(18), imshow(JAH), title('Negative histeq image')

figure(19), imshow(JRH), title('Negative redhisteq image')

figure(20), imshow(JGH), title('Negative greenhisteq image')

figure(21), imshow(JBH), title('Negative bluehisteq image')

figure(22), imshow(bw),title('gray threshold image')

figure(23), imshow(bw2),title('Negtive grenhistq thres image')

figure(24), imshow(bw3),title('NEgative green threshold image')

figure(25), imshow(bw4),title('Green threshold image')

figure(26), imshow(bwR),title('negative red histeq threshold image')

figure(27), imshow(bwB),title('negative blue histeq threshold image')

figure(28), imshow(bw5),title('3 image')

figure(29), imshow(bw6),title('0.9 image')

figure(30), imshow(bw7),title('6 image')

figure(31), imshow(sb),title('Gray sobel threshold image')

figure(32), imshow(cn),title('Gray canny threshold image')

% figure(33), imshow(g4),title('gradient magnitude image')

figure(34), imshow(sb2),title('Negative green histeq Sobel ')

 figure(35), imshow(cn2),title('Negative green histeq Canny')

figure(36), imshow(sb3),title('Negativegreen Sobel')

 figure(37), imshow(cn3),title('Negative green Canny')

figure(38), imshow(sb4),title('Green Sobel')

figure(39), imshow(cn4),title('Green Canny')

figure(40), imshow(sb5),title('3 Sobel image')

figure(41), imshow(cn5),title('3 Canny image')

figure(42), imshow(sb6),title('0.9 Sobel image')

figure(43), imshow(cn6),title('0.9 Canny image')

figure(44), imshow(sb7),title('6 Sobel image')

figure(45), imshow(cn7),title('6 Canny image')

figure(46), imshow(sb8),title('negative red histeq Sobel')

figure(47), imshow(cn8),title('Negative Red Histeq Canny')

figure(48), imshow(sb9),title('negative blue histeq Sobel')

figure(49), imshow(cn9),title('Negative Blue Histeq Canny')

figure(50), imshow(bw),title('xxxxxxx')

%% Subplot image

subplot(6,6,1), imshow(A), title('Original image')

subplot(6,6,2), imshow(B), title('Grayscale image')

subplot(6,6,3), imshow(red), title('Red channel')

subplot(6,6,4), imshow(green), title('Green channel')

subplot(6,6,5), imshow(blue), title('Blue channel')

subplot(6,6,6), imshow(C),title('histogram synchronized image');

subplot(6,6,7), imshow(red_histeq),title('red histogram synchronized image');

subplot(6,6,8), imshow(green_histeq),title('green histogram synchronized image');

subplot(6,6,9), imshow(blue_histeq),title('red histogram synchronized image');

subplot(6,6,10), imshow(I3);title('Power-Law transformation-darkest');xlabel('Gamma='),xlabel(0.5);

subplot(6,6,11), imshow(I4);title('Power-Law transformation-dark');xlabel('Gamma='),xlabel(0.9);

subplot(6,6,12), imshow(I5);title('Power-Law transformation-light');xlabel('Gamma='),xlabel(3);

subplot(6,6,13), imshow(I6);title('Power-Law transformation-lightest');xlabel('Gamma='),xlabel(6);

subplot(6,6,14), imshow(JA), title('Negative image')

subplot(6,6,15), imshow(JR), title('Negative RED image')

subplot(6,6,16), imshow(JG), title('Negative GREEN image')

subplot(6,6,17), imshow(JB), title('Negative BLUE image')

subplot(6,6,18), imshow(JAH), title('Negative histeq image')

subplot(6,6,19), imshow(JRH), title('Negative redhisteq image')

subplot(6,6,20), imshow(JGH), title('Negative greenhisteq image')

subplot(6,6,21), imshow(JBH), title('Negative bluehisteq image')

subplot(6,6,22), imshow(bw), title('gray threshold image')

subplot(6,6,23), imshow(bw2), title('Negtive grenhistq thres image')

subplot(6,6,24), imshow(bw3), title('negative green threshold image')

subplot(6,6,25), imshow(bw4), title('green threshold image')

subplot(6,6,26), imshow(bwR), title('negative red histeq threshold image')

subplot(6,6,27), imshow(bwB), title('negative blue histeq threshold image')

subplot(6,6,28), imshow(bw5), title('3 image')

subplot(6,6,29), imshow(bw6), title('0.9 image')

subplot(6,6,30), imshow(bw7), title('6 image')

%% İmage save

imwrite(A,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(1) orginal T50.jpg')

imwrite(B,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(2)grayscale T50.jpg')

imwrite(red,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(3)   red_channel T50.jpg')

imwrite(green,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(4) green_channel T50.jpg')

imwrite(blue,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(5)   blue_channel T50.jpg')

imwrite(C,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(6)   histogram synchronized T50.jpg')

imwrite(red_histeq,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(7)   red histogram synchronized T50.jpg')

imwrite(green_histeq,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(8)   green histogram synchronized T50.jpg')

imwrite(blue_histeq,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(9)   blue histogram synchronized T50.jpg')
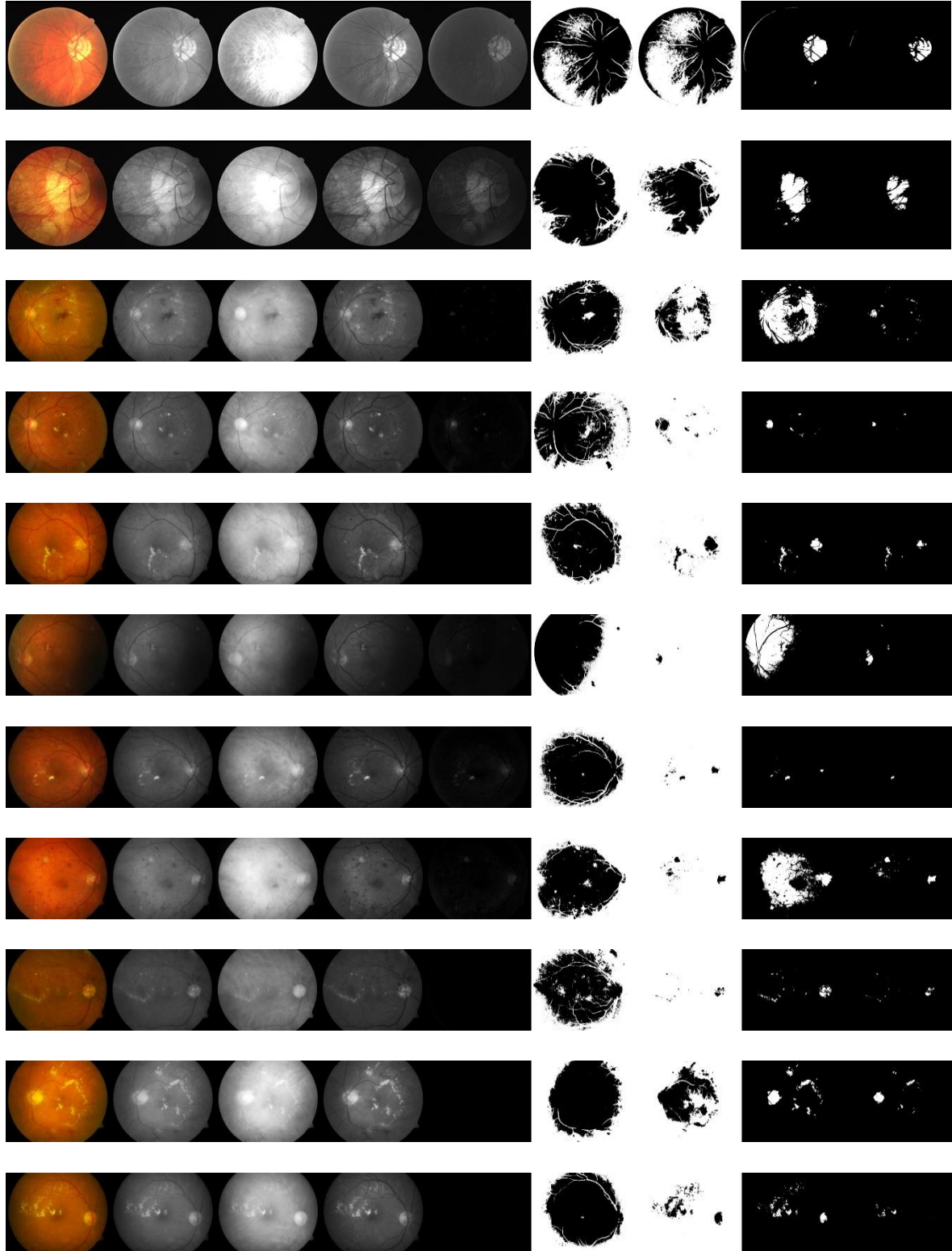
imwrite(I3,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(10)   powerlaw   0.5 T50.jpg')
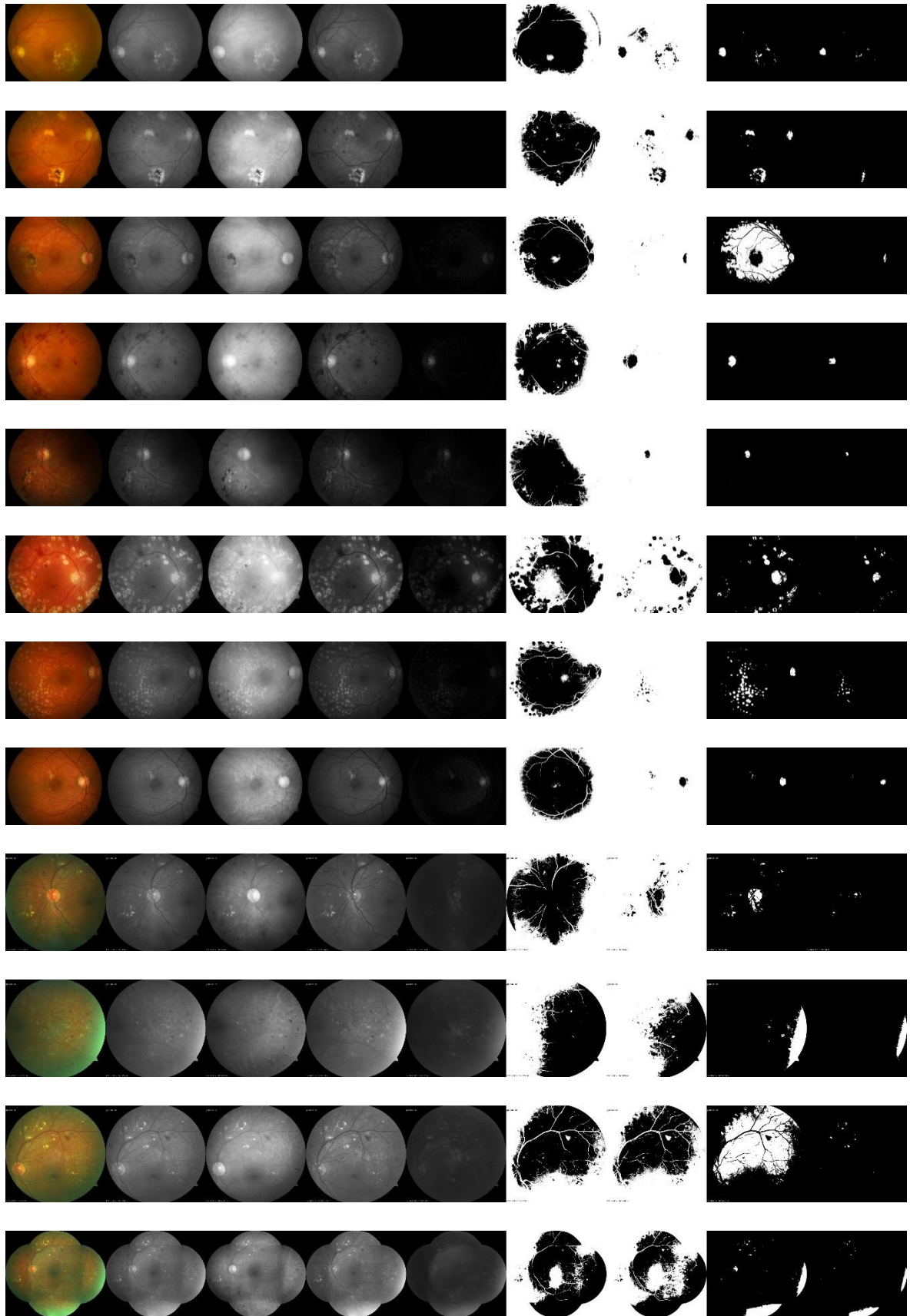
imwrite(I4,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(11)   powerlaw   0.9 T50.jpg')

imwrite(I5,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(12)   powerlaw   3 T50.jpg')

imwrite(I6,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(13)   powerlaw   6 T50.jpg')
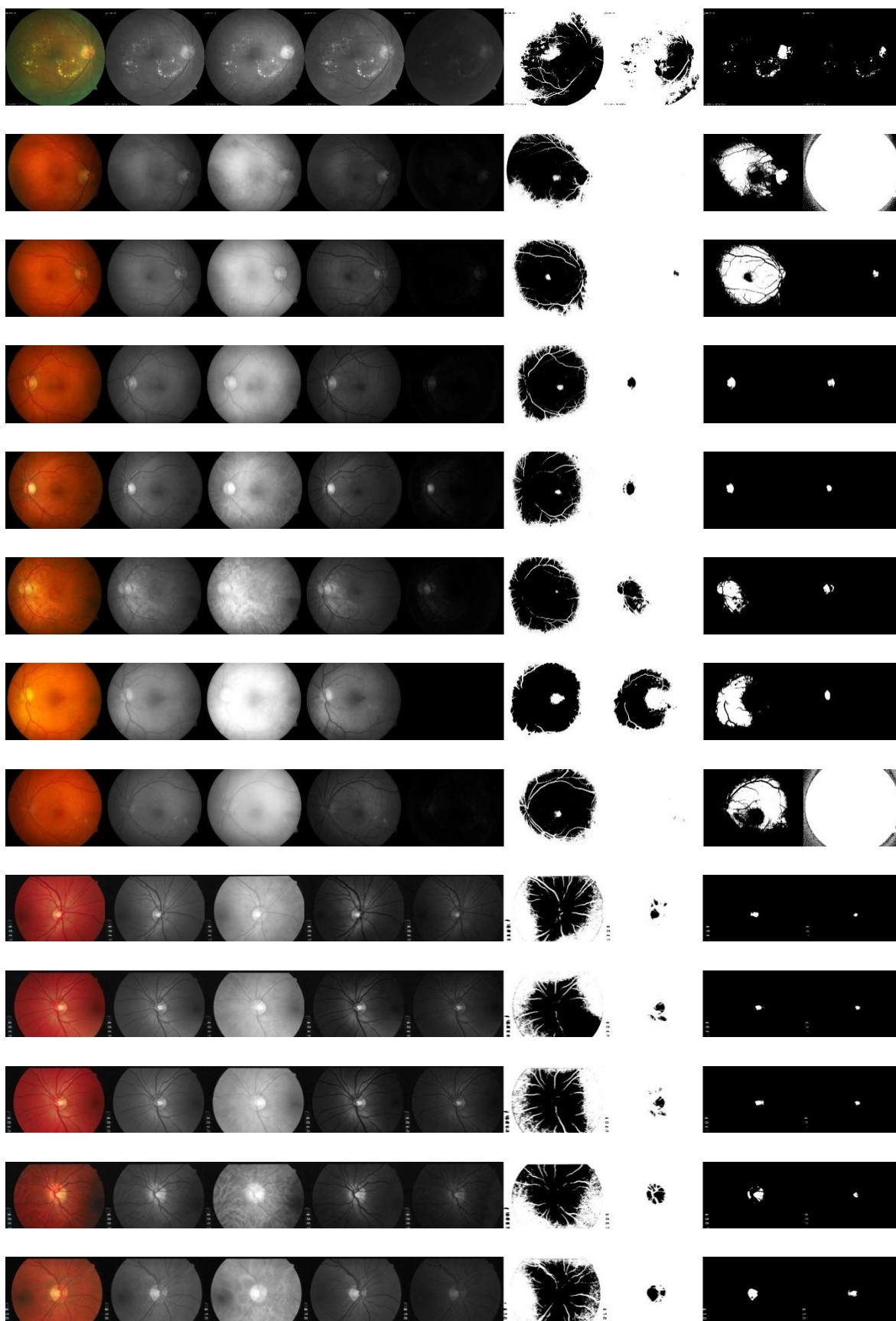
imwrite(JA,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(14) negative image T50.jpg')

imwrite(JR,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(15) negative red image T50.jpg')

imwrite(JG,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(16) negative green image T50.jpg')

imwrite(JB,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(17) negative blue imge T50.jpg')

imwrite(JAH,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(18) negative histeq image T50.jpg')

imwrite(JRH,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(19) negative red histeq image T50.jpg')

imwrite(JGH,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(20) negative green histeq image T50.jpg')

imwrite(JBH,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(21) negative blue histeq image T50.jpg')

imwrite(bw,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(22) gray threshold T50.jpg')

imwrite(bw2,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(23) negative green histeq threshold T50.jpg')

imwrite(bw3,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(24) negative green threshold T50.jpg')

imwrite(bw4,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(25) green threshold T50.jpg')

imwrite(bwR,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(26) negative red histeq threshold T50.jpg')

imwrite(bwB,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(27) negative blue histeq threshold T50.jpg')

imwrite(bw5,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(28) 3 threshold T50.jpg')

imwrite(bw6,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(29) 0.9 threshold T50.jpg')

imwrite(bw7,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(30) 6 threshold T50.jpg')

imwrite(sb,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(31) gray sobel threshold T50.jpg')

imwrite(cn,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(32) gray canny threshold T50.jpg')

imwrite(sb2,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(33) negative green histeq sobel T50.jpg')

imwrite(cn2,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(34) negative green histeq canny T50.jpg')

imwrite(sb3,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(35) negative green sobel T50.jpg')

imwrite(cn3,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(36) negative green canny T50.jpg')

imwrite(sb4,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(37) green sobel T50.jpg')

imwrite(cn4,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(38) green canny T50.jpg')

imwrite(sb5,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(39)   3   sobel T50.jpg')

imwrite(cn5,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(40)   3   canny T50.jpg')

imwrite(sb6,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(41)   0.9   sobel T50.jpg')

imwrite(cn6,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(42)   0.9   canny T50.jpg')

imwrite(sb7,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(43)   6   sobel T50.jpg')

imwrite(cn7,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(44)   6   canny T50.jpg')

imwrite(sb8,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(45)   negative   red histeq sobel T50.jpg')

imwrite(cn8,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(46)   negative   red histeq canny T50.jpg')

imwrite(sb9,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(47)   negative   blue histeq sobel T50.jpg')

imwrite(cn9,'C:\Users\mehmet\Dropbox\Workspace\work\Output\T50\(48)   negative   blue histeq canny T50.jpg')

APPENDIX 2

DATABASE

Mehmet Kara Thesis After Jury

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