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Detection of Diabetic Retinopathy by Using Skin Locus Model

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Abstract: - **Medical image analysis is a very popular research area in these days in which digital images are analyzed for the diagnosis and screening of different medical problems. Diabetic retinopathy is one of the serious eye diseases that can cause blindness and vision loss. Diabetes mellitus, a metabolic disorder, has become one of the rapidly increasing health threats both in India and worldwide. Diabetic Retinopathy (DR) is an eye disease caused by the increase of insulin in the blood and may cause blindness. An automated system for the early detection of DR can save a patient vision and can also help the ophthalmologist in the screening of DR which contains different types of lesion, i.e., micro aneurysms, hemorrhages, exudates. Diabetic retinopathy is a vision threatening complication as a result of diabetes mellitus which is the main cause of visual impairment and blindness in diabetic patients. In many cases, the patient is not conscious of the disease until it is too late for effective treatment. The prevalence of retinopathy varies with the age of diabetes and the duration of disease. Early diagnosis by regular screening and treatment is beneficial in preventing visual impairment and blindness. This project presents a method for detection and classification of exudates in colored retinal images. It eliminates the replication exudates region by removing the optic disc region. Several image processing techniques including Image Enhancement, Segmentation, Classification, and registration has been developed for the early detection of DR on the basis of features such as blood vessels, exudes, hemorrhages and micro aneurysms. This project presents a review of latest work on the use of image processing techniques for DR feature detection. Image Processing techniques are evaluated on the basis of their results. Exudates are found using their high gray level variation, and the classification of exudates is done with exudates features and SVM classifier.**

Keywords: Automatic detection ,image processing, screening, etc.,

I. INTRODUCTION

Diabetic retinopathy, also known as diabetic eye disease, is a medical condition in which damage occurs to the retina due to diabetes and is a leading cause of blindness. It affects up to 80 percent of people who have had diabetes for 20 years or more. At least 90% of new cases could be reduced if there were proper treatment and monitoring of the eyes. The longer a person has diabetes, the higher his or her chances of developing diabetic retinopathy. Each year in the United States, diabetic retinopathy accounts for 12% of all new cases of blindness. It is also the leading cause of blindness for people aged 20 to 64 years. Retinopathy is any damage to the retina of the eyes, which may cause vision impairment. Retinopathy often refers to retinal vascular disease, or damage to the retina caused by abnormal blood flow. Age-related macular degeneration is technically included under the umbrella term retinopathy but is often discussed as a separate entity. Retinopathy, or retinal vascular disease, can be broadly categorized into proliferative and non-proliferative types. Frequently, retinopathy is an ocular manifestation of systemic disease as seen in diabetes or hypertension. Diabetes is the most common cause of retinopathy in the U.S. as of 2008. Diabetic retinopathy is the leading cause of blindness in working-aged people. It accounts for about 5% of blindness worldwide and is designated a priority eye disease by the World Health Organization. In clinical research the retinal disease which causes poor vision is Diabetic retinopathy (DR). It is an eye disease that is associated with long standing diabetes. Diabetic retinopathy is a leading cause of vision loss for approximately 50% of patients with diabetic retinopathy. Automatic exudates detection would be useful in order to detect and treat diabetic retinopathy in an early stage. DR patients require frequent, at least six monthly screening and automating the process will go a long way in relieving the burden on the specialist and reducing the most common cause of preventable blindness. An approach to detect exudates by the combined region growing and edge detection is proposed. A method of SVM and kNN classifier has been proposed to classify the input image as normal or diseased one based on the

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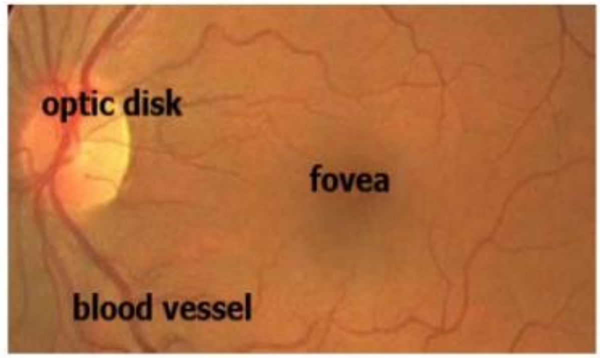
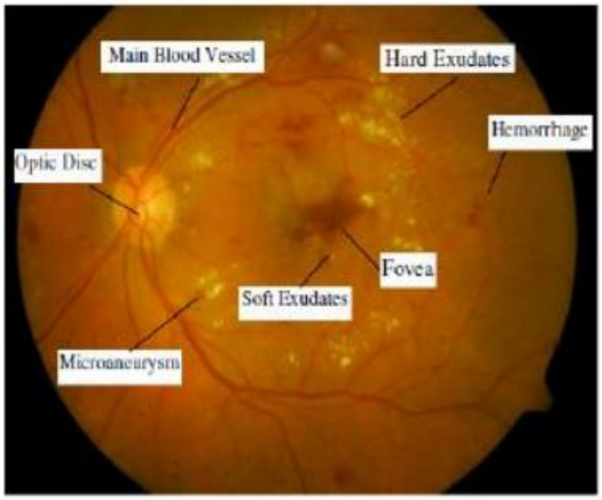
color and texture features of hard exudates. Candidates are detected using a combination of coarse and fine segmentation. The coarse segmentation is based on a local variation operation to outline the boundaries of all candidates which have clear borders. The fine segmentation is based on an adaptive thresholding and a new split-and-merge technique to segment all bright candidates locally. Segmentation of exudates is by thresholding and classification is by Fuzzy C-Means (FCM) clustering techniques with classification accuracy of 85%. Diabetic retinopathy diagnosed by machine learning techniques with three models Probabilistic Neural Network(PNN), Bayesian Classification and Support Vector Machine with input features as blood vessels, hemorrhages and exudates. It is inferred that SVM outperforms good accuracy results. Detection of hard exudates is proposed with top down image segmentation and local thresholding with the combination of edge detection and region growing. The neural network classifier types Multilayer Perceptron, Radial Basis Function and Support Vector Machine has been analyzed for the detection of hard exudates. Based on the marker-controlled watershed segmentation techniques exudates has been extracted. The algorithm of mixture model with dynamic thresholding is used for the analysis of retinal images. The diabetic retinopathy has been diagnosed based on the detection of exudates. by morphological operations. Features like blood vessel, microaneurysms, exudates, fovea regularity employing with curvelet transform is implemented and classifies the DR into three categories with the help of SVM classifier. A new exudates segmentation based on mathematical morphology, normalization, denoising and detecting reflections and artifacts. Contextual features are used to train the random forest algorithm which classifies the exudates. However automation of diabetic retinopathy grading analysis with modern tools of image processing techniques gives way for the radiologists in early treatment to avoid vision loss. In this paper, we focus on the detection of exudates, one of the symptoms for the presence of DR. As the exudates and optic disc appear as white/yellow structures in retinal images, it is necessary to remove the replication of the exudates region i.e optic disc. The optic disc is detected by Region of Interest (RoI) and removed by K-means Clustering techni ques. The exudates are identified with the gray level variation and the detected exudates are classified using the exudates and statistical features trained using SVM classifier and grading of DR done as No exudates, low, medium and severe based on the area of exudates region.



Diabetes mellitus is a vital cause of visual morbidity that affects an estimated 11.8 million diagnosed and 4.9 million undiagnosed persons in the US [1, 2]. Among them 40.3% have some degree of diabetic retinopathy and 8.2% have vision threatening retinopathy. The rates of retinopathy and vision frightening retinopathy are higher in persons with type 1 diabetes, occurring in 82.3% and 32.2% of affected persons, respectively. Persons with diabetic retinopathy (DR) are 29 times more to become blind than those without diabetes and it is estimated that diabetic retinopathy is responsible for 5% of all the world's blindness cases The medical cost of DR has been estimated to be US$500 million per year in the US alone. Diabetic retinopathy is a microvascular complication of diabetes and the common cause of damage to the retina of the eye of the diabetic patient. The prevalence of retinopathy varies with the age of diabetes and the duration of disease. For the detection of diabetic retinopathy color fundus photographs of the retina is required. If the symptoms are identified in earlier stage,then proper treatment can be provided. The effective treatment of diabetic retinopathy can inhibit the progression of the diseases. Many patients are not aware of this disease. It is point out that at least 90% of the new cases of diabetic retinopathy could be reduced by giving proper treatment and regular monitoring of the eye.Diabetic retinopathy can be diagnosed by the defects of the retina. The defects may include microaneurysms, haemorrhages and exudates. Microaneurysms are the primary abnormality occurring in the eye because of diabetes. These are recognized by tiny, dark red spots or haemorrhages that may occur as alone or in clusters and light sensitive to retina. Haemorrhages are round in shape,which are found in deep layer of the retina. Exudates are two types: hard exudates and soft exudates. Hard exudates are the fat and protein leaking out from the blood vessel, which prevents light from reaching the retina and causes visual impairment. There are some spots termed as soft exudates are seems in the severe stages of diabetic retinopathy called cotton wool spots.



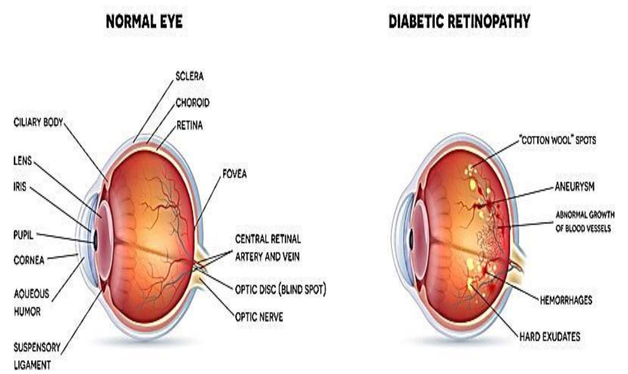
SIGNS AND SYMPTOMS:

Diabetic retinopathy often has no early warning signs. Even macular edema, which can cause rapid vision loss, may not have any warning signs for some time. In general, however, a person with macular edema is likely to have blurred vision, making it hard to do things like read or drive. In some cases, the vision will get better or worse during the day. In the first stage which is called non-proliferative diabetic retinopathy (NPDR) there are no symptoms, the signs are not visible to the eye and patients will have 20/20 vision. The only way to detect NPDR is by fundus photography, in which microaneurysms (microscopic blood-filled bulges in the artery walls) can be seen. If there is reduced vision, fluorescein angiography can be done to see the back of the eye. Narrowing or blocked retinal blood vessels can be seen clearly and this is called retinal ischemia (lack of blood flow).

Macular edema in which blood vessels leak their contents into the macular region can occur at any stage of NPDR. The symptoms of macular edema are blurred vision and darkened or distorted images that are not the same in both eyes. Ten percent (10%) of diabetic patients will have vision loss related to macular edema. Optical Coherence Tomography can show the areas of retinal thickening (due to fluid accumulation) of macular edema. In the second stage, abnormal new blood vessels (neovascularisation) form at the back of the eye as part of proliferative diabetic retinopathy (PDR); these can burst and bleed (vitreous hemorrhage) and blur the vision, because these new blood vessels are fragile. The first time this bleeding occurs, it may not be very severe. In most cases, it will leave just a few specks of blood, or spots floating in a person's visual field, though the spots often go away after few hours.

These spots are often followed within a few days or weeks by a much greater leakage of blood, which blurs the vision. In extreme cases, a person may only be able to tell light from dark in that eye. It may take the blood anywhere from a few days to months or even years to clear from the inside of the eye, and in some cases the blood will not clear. These types of large hemorrhages tend to happen more than once, often during sleep.

On funduscopic exam, a doctor will see cotton wool spots, flame hemorrhages (similar lesions are also caused by the alpha-toxin of Clostridium novyi), and dot-blot hemorrhages.



II. LITERATURE SURVEY

Automated Early Detection of Diabetic Retinopathy Using Image Analysis Techniques[1] Neera Singh, Ramesh Chandra Tripathi-2010 proposed that Diabetic retinopathy (DR) is a common retinal complication associated with diabetes. It is a major cause of blindness in middle as well as older age groups. Various aspects and stages of retinopathy are analyzed by examining the colored retinal images. Microaneurysms are small saccular pouches caused by local distension of capillary walls and appear as small red dots. Their walls are thin and rupture easily to cause hemorrhages. Hard exudates are yellow lipid deposits which appear as bright yellow lesions. The bright circular region from where the blood vessels emanate is called the optic disk. Image analysis tools can be used for automated detection of these various features and stages of Diabetes Retinopathy and can be referred to the specialist accordingly for intervention, thus making it a very effective tool for effective screening of Diabetic Retinopathy patients. DR patients require frequent, at least six monthly screening of vast number of patients and automating the process will go a long way in relieving the burden on the specialist and reducing the most common cause of preventable blindness. Diabetic Retinopathy Detection using Image Processing: A Survey[2]Muhammad Waseem Khan 2013 proposed that Diabetic retinopathy

(DR) is a diabetes related eye disease which occurs when blood vessels in the retina become swelled and leaks fluid which ultimately leads to vision loss. Several image\ processing techniques including Image Enhancement, Segmentation, Image Fusion, Morphology, Classification, and registration has been developed for the early detection of DR on the basis of features such as blood vessels, exudes, hemorrhages, and microaneurysms. This paper presents a review of latest work on the use of image processing techniques for DR feature detection. Image Processing Technique for Hard Exudates Detection for diagnosis of Diabetic Retinopathy[3]Prof. Neha N.Gaikwad#1, Prof. Pravinkumar R. Badadapure*2-2015 proposed that Diabetic Retinopathy(DR) is a diabetic eye diseases which is referred as combination of various eye problems. These Problems are faced as a complication of diabetes by people, who are suffering from it. Prolongation of DR may result in permanent blindness. To avoid this, Detection of DR in an automated way at early stage is recommended. Hard Exudates are one of the primary abnormalities that can be seen in DR. In this paper, we have given various Image Processing Techniques that can be used for automated detection of Hard Exudates. We have evaluated the outcomes by using ground truth of the test images and the use of image databases in the particular digital algorithm for detection of Hard Exudates.Case for Automated Detection of Diabetic Retinopathy [4]Nathan Silberman, Kristy Ahlrich, Rob Fergus and Lakshminarayanan Subramanian proposed that Diabetic retinopathy, an eye disorder caused by diabetes, is the primary cause of blindness in America and over 99% of cases in India. This paper describes our early experiences working with Aravind Eye Hospitals to develop an automated system to detect diabetic retinopathy from retinal images. The automated diabetic retinopathy problem is a hard computer vision problem whose goal is to detect features of retinopathy, such as hemorrhages and exudates, in retinal color fundus images. We describe our initial efforts towards building such a system using a range of computer vision techniques and discuss the potential impact on early detection of diabetic retinopathy.Diagnosis of Diabetic Retinopathy [5]Anupriyaa Mukherjee, Diksha Rathore, Supriya Shree, Asst Prof. Shaik Jameel proposed that Diabetic retinopathy is a disease, caused by alternation in the retinal blood vessels. It is a strong sign of early blindness and if it is not treated may tend to complete blindness and the vision lost once cannot be restored once again. In this paper different image processing techniques are used to differentiate between the normal and the diseased image. The attempt is made to see where the problem actually lies so that proper diagnosis of patient can be done. Pre processing of an image, optic disk detection, Blood vessels extraction, Exudates detection are some of the methods that are applied here. Other algorithms are designed to obtain the desired result. A large number of populations are affected by this disease around the world.Detection of Diabetic Retinopathy with Feature Extraction using Image Processing[6]Meera Walvekar, Geeta Salunke-2015 proposed that Diabetes has become a new global challenge. If not diagnosed and treated in time, diabetes can encourage other illnesses in the body of patients. One such illness is related to the retina of human eyes that affects the retina and retinal structure in certain ways. The screening for detection of such abnormalities in the retina is called Diabetic Retinopathy (DR). Latest technological advances in the image processing helps auto detection of diabetic retinopathy based on the analysis of feature extractions. In this paper, we will look at the extraction and outcome of important features, using image processing, and the severity of Diabetic Retinopathy. The datasets used for this study are DRIVE and STARE. Automatic detection of retinal exudates in fundus images of diabetic retinopathy patients[7] Mahsa Partovi , Seyed Hossein Rasta, Alireza Javadzadeh- 2016 proposed that Diabetic retinopathy (DR) is the most frequent microvascular complication of diabetes and can lead to several retinal abnormalities including microaneurysms, exudates, dot and blot hemorrhages, and cotton wool spots. Automated early detection of these abnormalities could limit the severity of the disease and assist ophthalmologists in investigating and treating the disease more efficiently. Segmentation of retinal image features provides the basis for automated assessment. In this study, exudates lesion on retinopathy retinal images was segmented by different image processing techniques. The objective of this study is detection of the exudates regions on retinal images of retinopathy patients by different image processing techniques. Detection of Diabetic Retinopathy in FundusPhotographs[8] Pavle Prentaˇsi´c proposed that Diabetic retinopathy is one of the leading disabling chronic diseases, and one of the leading causes of preventable blindness in the world. Early diagnosis of diabetic retinopathy enables timely treatment and in order to achieve it a major effort will have to be invested into screening programs and especially into automated screening programs. This work examines recent literature on digital image processing in the field of early detection of diabetic retinopathy using fundus photographs. Algorithms were categorized into 5 groups (image preprocessing, localization and segmentation of the optic disk, segmentation of the retinal vasculature, localization of the macula and fovea, localization and segmentation of diabetic retinopathy pathologies). Diabetic retinopathy pathologies were further categorized into several groups. In this paper several different databases are presented and their characteristics discussed.

MATLAB:

MATLAB is a programming language developed by MathWorks. It started out as a matrix programming language where linear algebra programming was simple. It can be run both under interactive sessions and as a batch job. MATLAB (matrix laboratory) is a fourth generation high-level programming language and interactive environment for numerical computation, visualization and programming. MATLAB is developed by MathWorks. It allows matrix manipulations; plotting of functions and data; implementation of algorithms; creation of user interfaces; interfacing with programs written in other languages, including C, C++, Java, and FORTRAN; analyze data; develop algorithms; and create models and applications. It has numerous built in commands and math functions that help you in mathematical calculations, generating plots and performing numerical methods.

MATLAB'S POWER OF COMPUTATIONAL MATHEMATICS:

MATLAB is used in every facet of computational mathematics. Following are some commonly used mathematical calculations where it is used most commonly:

- Dealing with Matrices and Arrays
- Plotting and graphics
- Linear Algebra
- Algebraic Equations
- Non-linear Functions
- Statistics
- Data Analysis
- Calculus and Differential Equations
- Numerical Calculations
- Integration
- Transforms
- Curve Fitting

FEATURES OF MATLAB:

It is a high-level language for numerical computation, visualization and application development.

It also provides an interactive environment for iterative exploration, design and problem solving.

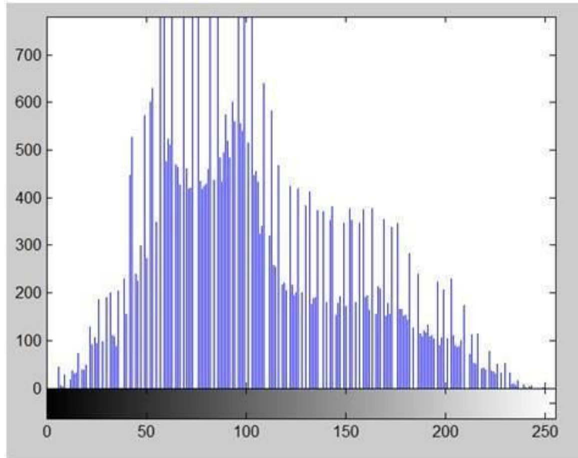
It provides vast library of mathematical functions for linear algebra, statistics, Fourier analysis, filtering, optimization, numerical integration and solving ordinary differential equations.

It provides built-in graphics for visualizing data and tools for creating custom plots.

MATLAB's programming interface gives development tools for improving
code quality,maintainability and maximizing performance.

It provides tools for building applications with custom graphical interfaces.

It provides functions for integrating MATLAB based algorithms with external applications and languages such as C, Java, .NET and Microsoft Excel.



USES OF MATLAB:

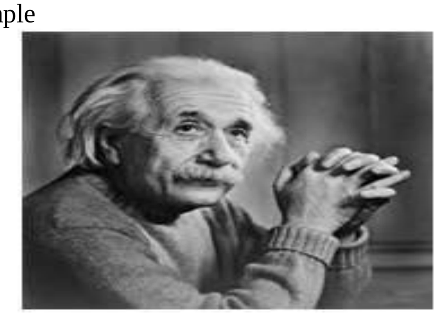
MATLAB is widely used as a computational tool in science and engineering encompassing the fields of physics, chemistry, math and all engineering streams.

It is used in a range of applications including:
signal processing and Communications
image and video Processing
control systems
test and measurement
computational finance
computational biology

HISTOGRAM OF IMAGE

Histogram of an image, like other histograms also shows frequency. But an image histogram, shows frequency of pixels intensity values. In an image histogram, the x axis shows the gray level intensities and the y axis shows the frequency of these intensities.

For example



The x axis of the histogram shows the range of pixel values. Since its an 8 bpp image, that means it has 256 levels of gray or shades of gray in it. Thats why the range of x axis starts from 0 and end at 255 with a gap of 50. Whereas on the y axis, is the count of these intensities.

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As you can see from the graph, that most of the bars that have high frequency lies in the first half portion which is the darker portion. That means that the image we have got is darker. And this can be proved from the image too.

Applications of Histograms

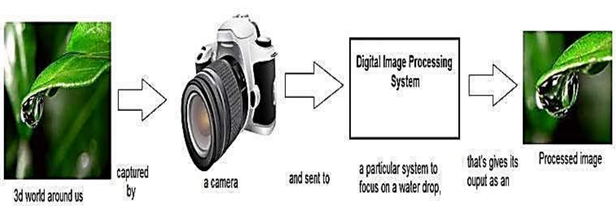
Histogram has many uses in image processing. The first use as it has also been discussed above is the analysis of the image. We can predict about an image by just looking at its histogram. Its like looking an x ray of a bone of a body.The second use of histogram is for brightness purposes. The histograms has wide application in image brightness. Not only in brightness, but histograms are also used in adjusting contrast of an image.Another important use of histogram is to equalize an image.And last but not the least, histogram has wide use in thresholding. This is mostly used in computer vision. Before we discuss, what is image transformation, we will discuss what a transformation is.

Transformation

Transformation is a function. A function that maps one set to another set after performing some operations.

Digital Image Processing system

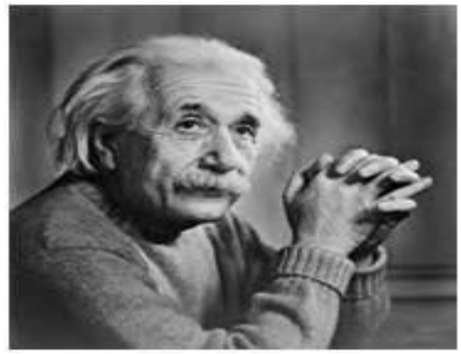
We have already seen in the introductory tutorials that in digital image processing, we will develop a system that whose input would be an image and output would be an image too. And the system would perform some processing on the input image and gives its output as an processed image. It is shown below.



Now function applied inside this digital system that process an image and convert it into output can be called as transformation function.

HISTOGRAM EQUALIZATION

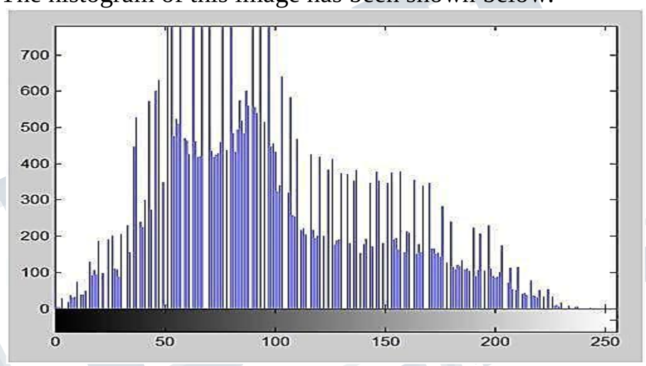
Histogram equalization is used to enhance contrast. It is not necessary that contrast will always be increase in this. There may be some cases were histogram equalization can be worse. In that cases the contrast is decreased. Lets start histogram equalization by taking this image below as a simple image.



Image

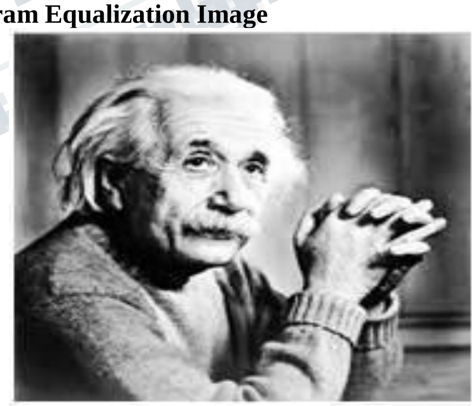
Histogram of this image

The histogram of this image has been shown below.

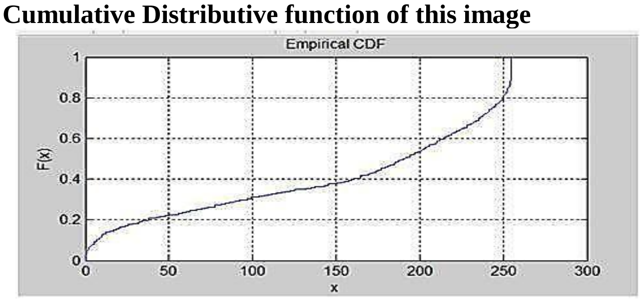


Now we will perform histogram equalization to it.

Histogram Equalization Image



Cumulative Distributive function of this image



Histogram Equalization histogram

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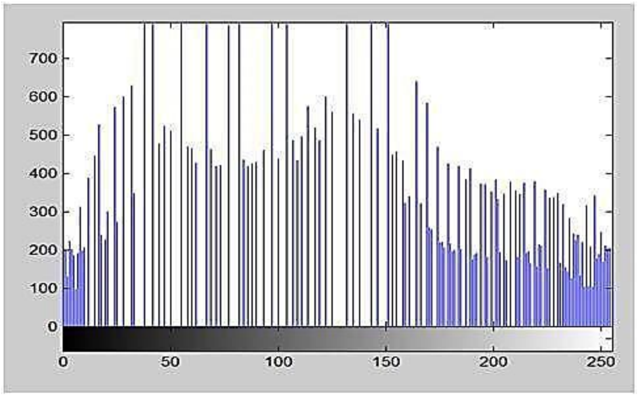
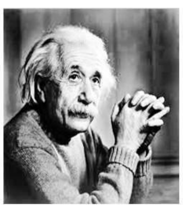
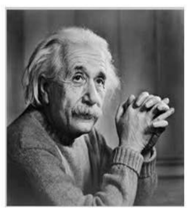


Comparing both the histograms and images

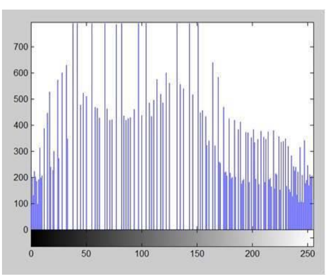
New Image



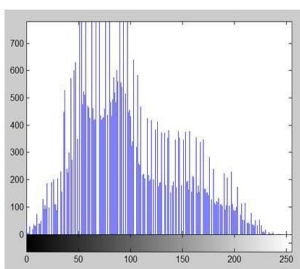
Old image



New Histogram



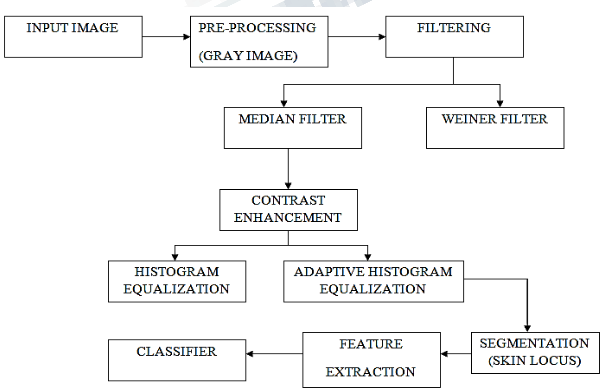
Old Histogram



Graphical User Interfaces

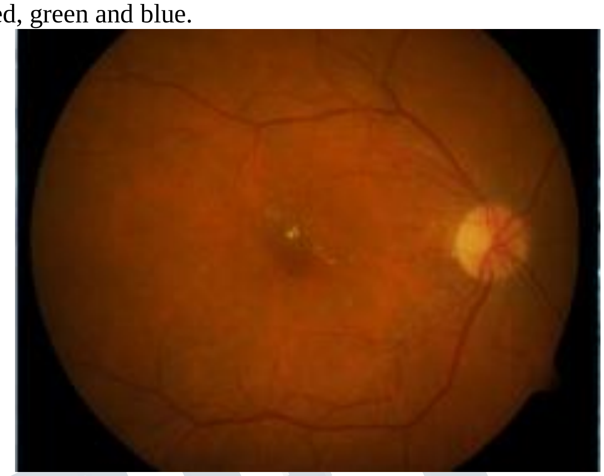
It is used to make graphical user interfaces objects like buttons, icons and other components.

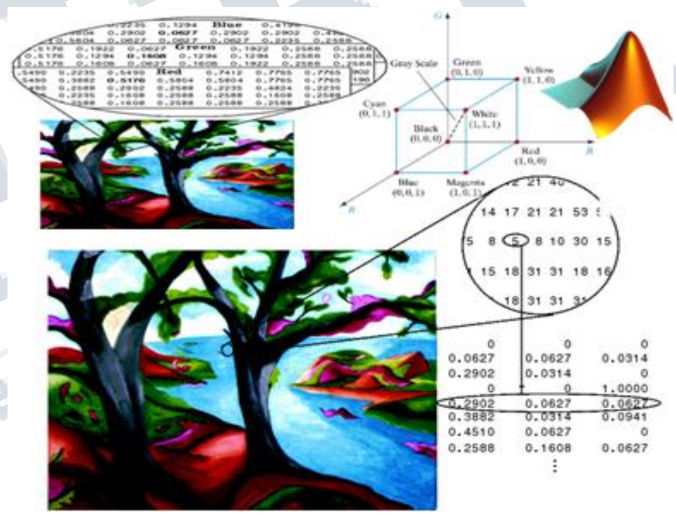
BLOCK DIAGRAM



INPUT IMAGE

The RGB color model is an additive color model in which red, green and blue light are added together in various ways to reproduce a broad array of colors. The name of the model comes from the initials of the three additive primary colors, red, green and blue.





GRAY IMAGE

In photography and computing, a grayscale or greyscale digital image is an image in which the value of each pixel is a single sample, that is, it carries only intensity information. Images of this sort, also known as black-and-white, are composed exclusively of shades of gray, varying from black at the weakest intensity to white at the strongest. In photography and computing, a grayscale or greyscale digital image is an image in which the value of each pixel is a single sample, that is, it carries only intensity information. Images of this sort, also known as black-and-white, are composed exclusively of shades of gray, varying from black at the weakest intensity to white at the strongest.

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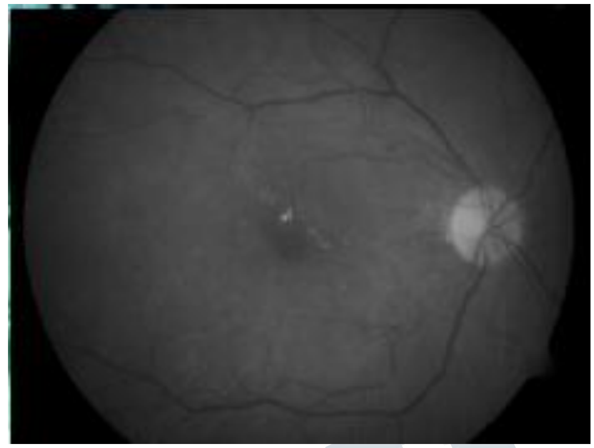
Grayscale images are distinct from one-bit bi-tonal black-and-white images, which in the context of computer imaging are images with only two colors, black and white (also called bilevel or binary images). Grayscale images have many shades of gray in between. Grayscale images are often the result of measuring the intensity of light at each pixel in a single band of the electromagnetic spectrum (e.g. infrared, visible light, ultraviolet, etc.), and in such cases they are monochromatic proper when only a given frequency is captured. But also they can be synthesized from a full color image; see the section about converting to grayscale.

MEDIAN FILTER

The median filter is a nonlinear digital filtering technique, often used to remove noise from an image or signal. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise, also having applications in signal processing. The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries. The pattern of neighbors is called the "window", which slides, entry by entry, over the entire signal. For 1D signals, the most obvious window is just the first few preceding and following entries, whereas for 2D (or higher-dimensional) signals such as images, more complex window patterns are possible (such as "box" or "cross" patterns). Note that if the window has an odd number of entries, then the median is simple to define: it is just the middle value after all the entries in the window are sorted numerically. For an even number of entries, there is more than one possible median.

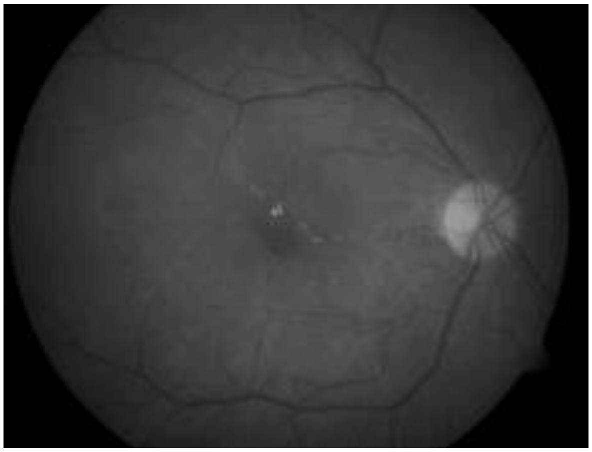


WEINER FILTER

In signal processing, the Wiener filter is a filter used to produce an estimate of a desireSd or target random process by linear time-invariant (LTI) filtering of an observed noisy process, assuming known stationary signal and noise spectra, and additive noise. The Wiener filter minimizes the mean square error between the estimated random process and the desired process. The goal of the Wiener filter is to compute a statistical estimate of an unknown signal using a related signal as an input and filtering that known signal to produce the estimate as an output. For example, the known signal might consist of an unknown signal of interest that has been corrupted by additive noise. The Wiener filter can be used to filter out the noise from the corrupted signal to provide an estimate of the underlying signal of interest. The Wiener filter is based on a statistical approach, and a more statistical account of the theory is given in the minimum mean square error (MMSE) estimator article.

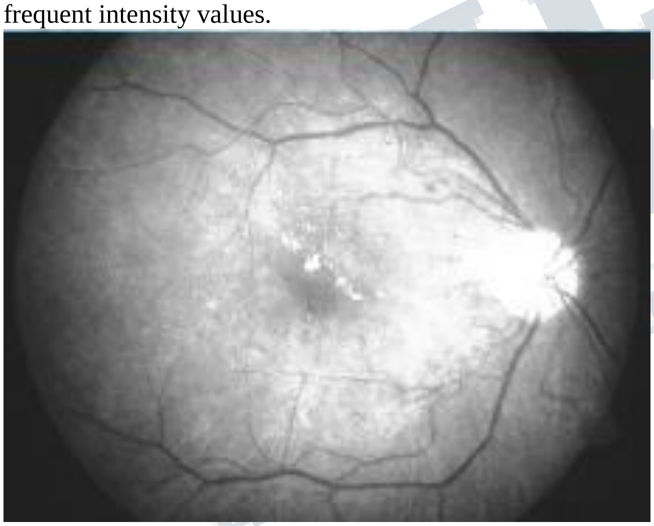
Typical deterministic filters are designed for a desired frequency response. However, the design of the Wiener filter takes a different approach. One is assumed to have knowledge of the spectral properties of the original signal and the noise, and one seeks the linear time-invariant filter whose output would come as close to the original signal as possible. Wiener filters are characterized by the following:

Assumption: signal and (additive) noise are stationary linear stochastic processes with known spectral characteristics or known autocorrelation and cross-correlation
Requirement: the filter must be physically realizable/causal (this requirement can be dropped, resulting in a non-causal solution)
Performance criterion: minimum mean-square error (MMSE).



HISTOGRAM EQUALIZATION

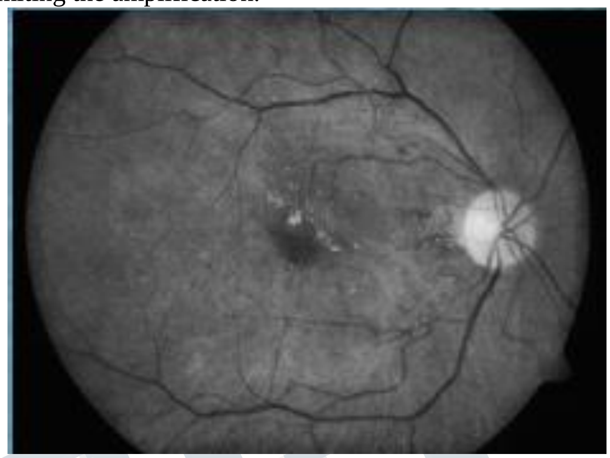
This method usually increases the global contrast of many images, especially when the usable data of the image is represented by close contrast values. Through this adjustment, the intensities can be better distributed on the histogram. This allows for areas of lower local contrast to gain a higher contrast. Histogram equalization accomplishes this by effectively spreading out the most frequent intensity values.



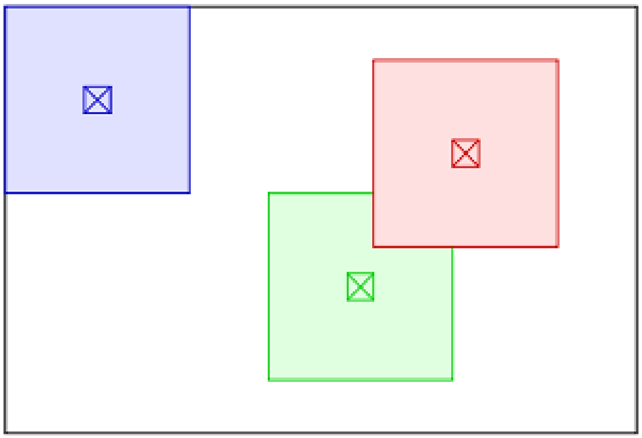
ADAPTIVE HISTOGRAM EQUALIZATION

Adaptive histogram equalization (AHE) is a computer image processing technique used to improve contrast in images. It differs from ordinary histogram equalization in the respect that the adaptive method computes several histograms, each corresponding to a distinct section of the image, and uses them to redistribute the lightness values of the image. It is therefore suitable for improving the local contrast and enhancing the definitions of edges in each region of an image.

However, AHE has a tendency to overamplify noise in relatively homogeneous regions of an image. A variant of adaptive histogram equalization called contrast limited adaptive histogram equalization (CLAHE) prevents this by limiting the amplification.



Ordinary histogram equalization uses the same transformation derived from the image histogram to transform all pixels. This works well when the distribution of pixel values is similar throughout the image. However, when the image contains regions that are significantly lighter or darker than most of the image, the contrast in those regions will not be sufficiently enhanced. Adaptive histogram equalization (AHE) improves on this by transforming each pixel with a transformation function derived from a neighbourhood region. It was first developed for use in aircraft cockpit displays. In its simplest form, each pixel is transformed based on the histogram of a square surrounding the pixel, as in the figure below. The derivation of the transformation functions from the histograms is exactly the same as for ordinary histogram equalization: The transformation function is proportional to the cumulative distribution function (CDF) of pixel values in the neighbourhood. Pixels near the image boundary have to be treated specially, because their neighbourhood would not lie completely within the image. This applies for example to the pixels to the left or above the blue pixel in the figure. This can be solved by extending the image by mirroring pixel lines and columns with respect to the image boundary. Simply copying the pixel lines on the border is not appropriate, as it would lead to a highly peaked neighbourhood histogram.

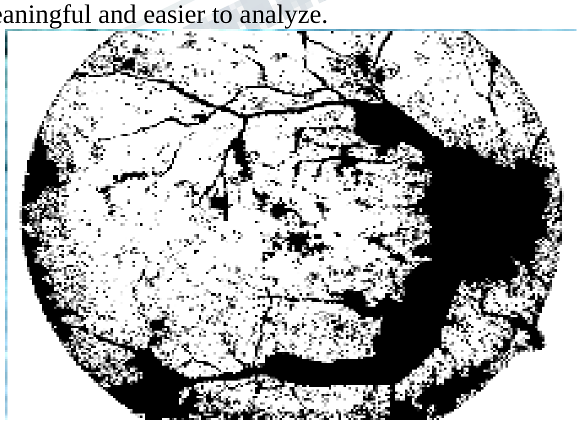


FEATURE EXTRACTION

In machine learning, pattern recognition and in image processing, feature extraction starts from an initial set of measured data and builds derived values (features) intended to be informative and non-redundant, facilitating the subsequent learning and generalization steps, and in some cases leading to better human interpretations. Feature extraction is related to dimensionality reduction. When the input data to an algorithm is too large to be processed and it is suspected to be redundant (e.g. the same measurement in both feet and meters, or the repetitiveness of images presented as pixels), then it can be transformed into a reduced set of features (also named a feature vector). Determining a subset of the initial features is called feature selection. The selected features are expected to contain the relevant information from the input data, so that the desired task can be performed by using this reduced representation instead of the complete initial data.

SKIN LOCUS SEGMENTATION

In computer vision, image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super-pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze.



III. RESULT

IV. CONCLUSION

In this project, the finding of optic disc is made by means of skin locus techniques, blood vessel segmentation and exudates detection by means of intensity computation, thresholding and features extraction. The exudates are classified as true or false exudates with the help of SVM classifier and were able to distinguish between four different types of grading level with an average accuracy of 94.17%. As an extension of our work, it is suggested to optimize the features selected and the foremost features with different classifier techniques can be compared and analyzed.

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