ORDER DEMAND FORECASTING THROUGH CUSTOMER BEHAVIOR AND SEASONAL PATTERN

PROJECT REPORT

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BONAFIDE CERTIFICATE

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

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A successful man is one who can lay a firm foundation with the bricks others have thrown at him. —*David Brinkley*

Such a successful personality is our beloved Founder Chairman, **Thiru.MJF.Ln. LEO MUTHU.** At first, we express our sincere gratitude to our beloved chairman through prayers, who in the form of a guiding star has spread his wings of external support with immortal blessings.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF ABBREVIATIONS

ACRONYM	ABBREVIATION
IP	Image Processing
MATLAB	Matrix Laboratory
OCT	Optical Coherence Tomography
HRT	Heidelberg Retinal Tomography
SLP	Scanning Laser Polarimetry
HWT	Haar Wavelet Transform
MST	Minimum Spanning Tree
SVM	Support Vector Machine
PNN	Probabilistic Neural Network

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION TO SUPPLY CHAIN MANAGEMENT

Supply chain management is the coordination and management of all activities involved in the creation and delivery of products and services, from the procurement of raw materials to the delivery of finished goods to customers. It is a crucial aspect of modern business operations, as it enables companies to optimize their resources, reduce costs, and improve customer satisfaction.

A typical supply chain includes various stages, such as procurement, production, logistics, warehousing, and distribution. Effective supply chain management requires companies to have a clear understanding of each stage of the process and to optimize them for maximum efficiency and effectiveness.

The key components of supply chain management include planning, sourcing, making, delivering, and returning. Planning involves forecasting demand and creating a strategy for meeting that demand. Sourcing involves selecting suppliers and negotiating contracts. Making involves manufacturing the product or providing the service. Delivering involves logistics and transportation of the product to the customer. Returning involves managing returns and recycling or disposing of products.

Supply chain management is also impacted by various external factors, such as global market trends, regulations, and consumer preferences. As a result, companies must be flexible and adaptable in their supply chain management practices to remain competitive in today's fast-paced business environment.

Overall, effective supply chain management is critical for companies to remain competitive and meet the needs of their customers. It requires a coordinated effort across all stages of the supply chain, as well as a commitment to continuous improvement and innovation.

1.1.1 CHALLENGES IN SCM

The following are the different kind of challenges that is faced by the supply chain network which can disrupt its efficiency and effectiveness.

- Lack of visibility

- Inventory management
- Supplier Management
- Transportation and Logistics
- Demand visibility
- Risk management
- Data management

The above-mentioned challenges can eventually lead to a great impact on an organization's performance and that will be resulting in a consequence that an organization can suffer such as increased inventory cost, decreased customer satisfaction, and decreased efficiency such as resulting in delays, forecast error and other inefficiencies, reduced revenue because of out of stock in the inventory which cannot be able to meet the consumer demand and increased risk due to natural disasters the product could not be delivered on time to the consumer.

1.1.2 WHAT IS DEMAND FORECASTING

Demand forecasting is the process of predicting future demand for a product or service. It involves analyzing historical sales data, identifying trends and patterns, and using statistical models to estimate future demand levels. The goal of demand forecasting is to help businesses make informed decisions about production, inventory, and pricing, among other factors, based on anticipated demand. Accurate demand forecasting can help businesses reduce waste and excess inventory, optimize resource allocation, and increase profitability. Demand forecasting is used in a variety of industries, including retail, manufacturing, and services, and can be done using qualitative techniques, such as expert opinions and market research, or quantitative techniques, such as time-series analysis and regression analysis.

1.1.3 APPLICATIONS OF DEMAND FORECASTING

Demand forecasting is an essential tool for businesses to predict future consumer demand and optimize their operations accordingly. By analyzing historical data and identifying trends, businesses can estimate the level of demand for their products or services and plan their production, inventory, and marketing strategies accordingly.

This information can be used to make informed decisions about pricing, promotions, and resource allocation, which can ultimately lead to increased profitability and customer satisfaction. Additionally, demand forecasting can help businesses identify potential bottlenecks in their supply chain and make adjustments to prevent stockouts or overstocking. Overall, demand forecasting is a crucial aspect of business planning and can provide valuable insights to help businesses stay competitive and meet the needs of their customers.

1.1.4 CUSTOMER BEHAVIOUR AND SEASONAL PATTERN

Customer behavior refers to the actions and decisions made by customers when purchasing products or services. It includes factors such as preferences, needs, habits, and purchasing patterns. Customer behavior is a crucial aspect of demand forecasting, as it helps businesses understand how customers interact with their products or services, and how this interaction may change over time.

Seasonality pattern, on the other hand, refers to the cyclic variations in demand for a product or service that occur at regular intervals throughout the year. Seasonality patterns are common in industries such as retail, hospitality, and tourism, where demand fluctuates based on the time of year, holidays, and other seasonal events. Seasonality patterns are important to consider in demand forecasting, as they can significantly impact sales and inventory management.

In demand forecasting, understanding customer behavior and seasonality patterns is critical to developing accurate and effective forecasts. Businesses can use data on customer behavior and historical sales patterns to identify trends and patterns, which can be used to predict future demand. For example, by analyzing customer behavior and seasonality patterns, a retailer may be able to anticipate increased demand for summer clothing in the months leading up to summer, and adjust their inventory and marketing strategies accordingly.

Overall, customer behavior and seasonality patterns are two important factors that should be considered in any demand forecasting process, as they can have a significant impact on the accuracy and effectiveness of the forecast.

1.2 OVERVIEW OF THE PROJECT

Demand forecasting is the process of predicting the future demand for a product or service. It is a critical element of any business strategy as it helps companies to optimize their production, inventory, pricing, and marketing decisions. Accurate demand forecasting enables businesses to avoid stockouts, minimize waste, improve customer satisfaction, and increase profitability.

Demand forecasting can be done using qualitative or quantitative methods. Qualitative methods involve collecting data through surveys, expert opinion, and market research to gain insight into consumer behavior and preferences. Quantitative methods use statistical models to analyze historical data on sales, pricing, promotions, and other relevant factors to forecast future demand.

There are several techniques and tools used for demand forecasting, including regression analysis, time series analysis, neural networks, and artificial intelligence. The choice of method depends on the complexity of the market, the type and availability of data, and the level of accuracy required.

Overall, demand forecasting is a crucial process that helps businesses make informed decisions and stay competitive in their respective markets.

1.3 ARCHITECTURE OF DEMAND FORECASTING

The general architecture diagram basically shows how the model was trained under the given dataset to predict the future demand for the products so that the manufacturing firm or any other supply chain partners can be able to place the order only the customer demands this will further give many other benefits like optimizing the inventory to avoid extra storage of the inventory items so that the unwanted spaces can be utilized by the some other products which are currently demanded by the customers. The following will describe the detailed information about each and every step in the architecture diagram.

- **Input Dataset:** The input dataset consists of fields like product code, warehouse name, product category, date of demand for the product, and order demand which says the count of orders for the specific product on that date.
- **Data Preprocessing:** This step is done to prepare the raw data into further analysis which involves cleaning of data, transforming and formatting of raw

data into more usable and understandable form. Data preprocessing is specifically done to ensure that the raw data is accurate, consistent and relavent to the analysis.

- **Analyzing the data based on multiple factors:** The factors will include analysis based on the warehouse which shows detailed information about the demand for the product at the specific warehouse on each or monthly basis if we need detailed information about the demand of the product, analysis based on product category which basically separseparatesproducts into a category which comes under that based on that the analysis will be performed, analysis on the monthly and yearly basis for the given dataset.
- **LSTM Model:** LSTM (Long Short-Term Memory) is a type of recurrent neural network (RNN) that is commonly used in deep learning for time-series data analysis and prediction. It is particularly useful when dealing with sequences of data that have long-term dependencies, such as speech recognition or natural language processing.
- **Visualization of data:** After optimizing the model for better performance the next step is to visualize the data for the product demand on a monthly basis or yearly basis this will give a clear picture of the demand graph for each and every product.

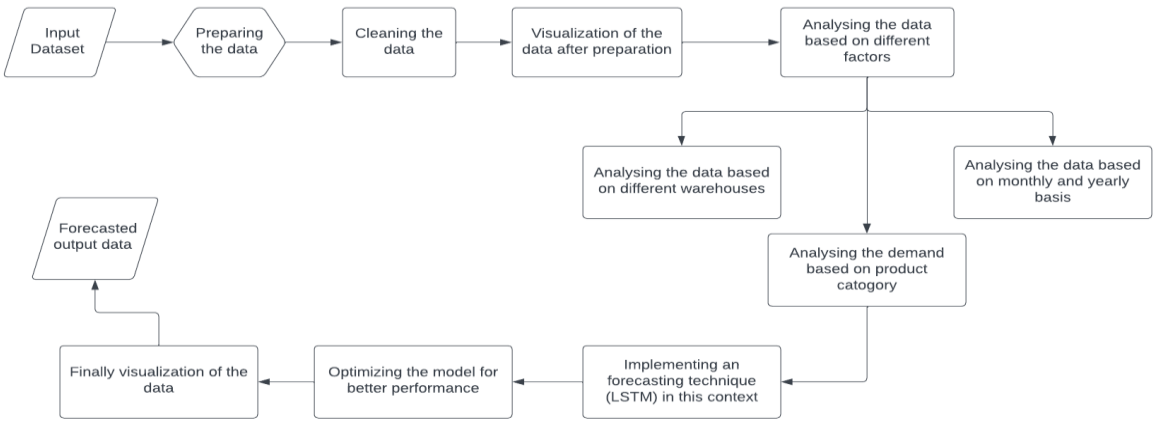


Fig 1.7 Architecture Of Demand Forecasting

1.4 SCOPE OF THE PROJECT

The scope of demand forecasting refers to the range of applications and areas where demand forecasting is useful and relevant. Demand forecasting is an important tool for businesses and organizations to plan their operations and make informed decisions about production, inventory, marketing, and resource allocation. The scope of the demand forecasting includes the following areas:

- **Production Planning:** Demand forecasting helps businesses to estimate the future demand for their products and plan their production accordingly.
- **Inventory Management:** Demand forecasting helps businesses to determine the optimal level of inventory to maintain based on expected future demand.
- **Sales And Marketing:** Demand forecasting helps businesses to plan their sales and marketing strategies, such as pricing, promotions, and advertising, based on expected future demand.
- **Resource Allocation:** Demand forecasting helps businesses to allocate their resources, such as labor and capital, in a more efficient and effective manner based on expected future demand.
- **Financial Planning:** Demand forecasting helps businesses to forecast their future revenue and cash flows, which is important for financial planning and budgeting.
- **Supply Chain Management:** Demand forecasting helps businesses to manage their supply chain, including procurement, transportation, and logistics, based on expected future demand.

Overall, the scope of demand forecasting is quite broad and includes a range of applications across different industries and sectors.

1.5 OBJECTIVE

The objective of demand forecasting is to estimate the future demand for a product or service. The primary goal is to provide decision-makers with the information they need to make informed decisions about production, inventory, marketing, and resource allocation. The specific objectives of demand forecasting include:

- ✓ **To estimate the future demand for a product or service:** Demand forecasting aims to provide accurate estimates of the future demand for a product or service so that businesses can plan their operations accordingly.
- ✓ **To improve production planning:** By forecasting demand, businesses can plan their production schedules to ensure that they have enough inventory to meet customer demand.
- ✓ **To optimize inventory management:** Demand forecasting helps businesses to determine the optimal level of inventory to maintain based on expected future demand, which can help to reduce costs and minimize the risk of stockouts.
- ✓ **To support sales and marketing decisions:** Demand forecasting provides valuable information that can help businesses to plan their sales and marketing strategies, such as pricing, promotions, and advertising.
- ✓ **To facilitate resource allocation:** By forecasting demand, businesses can allocate their resources, such as labor and capital, in a more efficient and effective manner based on expected future demand.
- ✓ **To support financial planning and budgeting:** Demand forecasting helps businesses to forecast their future revenue and cash flows, which is important for financial planning and budgeting.

Overall, the objective of demand forecasting is to provide decision-makers with the information they need to make informed decisions about the future of their business.

CHAPTER 2

LITERATURE SURVEY

2.1 Solar Radiation Forecasting Based on the Hybrid CNN-CatBoost Model.

In 2023, Hyojeoung Kim, Sujin Park, Hee-Jun Park, Heung-Gu Son, and Sahn Kim presented Solar Radiation Forecasting using the Hybrid CNN-CatBoost Model. This paper compared the CatBoost machine learning and CNN deep learning model and presented it as a single model CNN-CatBoost hybrid model prediction method that gives better performance. They also noticed that the accuracy changed when adding wind speed and precipitation to the hybrid model. Hyojeoung Kim [2023] proposed a solution for predicting solar radiation which will resolve the issues in solar energy due to climate change.

2.2 Customer Order Behavior Classification Via Convolutional Neural Network in the Semi-Conductor Industry.

In 2022, Marc Ratusny, Maximilian Schiffer, and Hans Ehm presented Customer Order Behavior Classification via Convolutional Neural Network in the Semi-Conductor Industry. This paper discusses the development of a framework where they utilize data enrichment via synthetical training samples, Integrating synthetically generated data into the training phase allowed them to strengthen the inclusion of rare pattern variants that were identified during the initial analysis. Actual customer data is used to benchmark the performance of the framework and it shows that the baseline CNN approach outperforms all available state-of-the-art benchmark models.

2.3 Profit Prediction Using ARIMA, SARIMA, and LSTM Models in Time Series Forecasting: A Comparison.

In 2022, Uppala Meena Sirisha, Manjula C. Belavagi, and Girija Attigeri presented Profit Prediction Using ARIMA, SARIMA, and LSTM Models in Time Series Forecasting: A Comparison. In this paper they studied the statistical methods-Autoregressive Integrated Moving Average (ARIMA) and Seasonal ARIMA (SARIMA) models, as well as the deep learning method, Long Short-Term Memory (LSTM) Neural Network model. The models were fitted and used to predict profit on test data, resulting in accuracies of approximately 93.84% (ARIMA), 94.378%

(SARIMA), and 97.01% (LSTM). Forecasts for the next 5 years were made, and the results show that the LSTM method outperforms both statistical models in creating the best model.

2.4 Retail Demand Forecasting using CNN- LSTM Model

In 2022, Nithin Soundar S J presented Retail Demand Forecasting Using CNN-LSMT Model. In this paper, they proposed a solution using a CNN-LSTM model to forecast retail demand. Equipped with the Swish Activation Function it works better than the traditional ReLU (Rectified Linear Unit). Data from 10 stores each consisting of 50 items are taken as input. The experiment results suggest using CNN- LSTM Model as it has considerably lower RMSE (Root Mean-Squared Error).

CHAPTER 3

SYSTEM ANALYSIS

3.1 PROBLEM DEFINITION

The goal of demand forecasting is to predict the amount of a product or service that customers will buy during a specific period, usually ranging from weeks to months or years in advance. This prediction is essential for businesses to make informed decisions about production planning, inventory management, pricing, and marketing strategies. To address this problem, businesses need to collect and analyze historical sales data, as well as external data sources such as market research, industry reports, and social media trends. They must also use statistical and machine learning techniques to identify patterns and trends in the data, and build models that can forecast future demand with reasonable accuracy. The success of demand forecasting depends on the quality of the data, the accuracy of the models, and the ability of businesses to adapt to changes in market conditions. Effective demand forecasting can help businesses optimize their operations, reduce costs, improve customer satisfaction, and gain a competitive advantage in the marketplace.

3.2 EXISTING SYSTEM

The existing system proposed uses the CNN-LSTM model with an activation function as relu to predict the future demand which is placed by the customers which takes the past sales history of the product and outputs the demand raised by the customers in the future if the changes happened dynamically it will fail to predict the output in those scenarios.

3.2.1 DISADVANTAGES OF EXIXTING SYSTEM

- ❖ Inaccurate forecasted data
- ❖ Eventually leads to great loss for the firm or organization.
- ❖ Only work for passed input data.
- ❖ This technique will fail if the demand changes dynamically.

3.3 PROPOSED SYSTEM

Detection of glaucoma using retinal fundus images using Haar transform and classifiers. Here the image is preprocessed to remove the noise and also to equalize the

irregular illumination associated with retinal images. The abnormal features of the enhanced image are selected and extracted using Haar Wavelet transform [HWT]. The extracted image is further segmented by Minimum Spanning Tree method [MST]. Using this segmented image the classifiers such as SVM and PNN are used to classify the normal and abnormal retinal images. Experiments have been carried out to verify the ability and accuracy among these two classifiers to achieve good classification rate.

3.3.1 ADVANTAGES OF PROPOSED SYSTEM

- Glaucoma can be detected at early stage.
- Haar transform provide better efficiency/results for feature extraction.In terms of computation time, it produced Best performance.
- Haar Wavelet Transformations deals with Simplicity in working.
- When compared to other segmentation methods, Minimum spanning tree provides very low execution time.
- More than one classifiers have been used in order to achieve better classification rate.

CHAPTER 4

SYSTEM REQUIREMENTS

4.1 SOFTWARE REQUIREMENTS

Simulator :MATlab R2013a

Operating System :Windows 7

4.2 HARDWARE REQUIREMENTS

Processor : Intel(R)core(TM)i5-2410M CPU@2.30GHz Processor

Speed :2.30 GHz

Operating System : 64-bit operating system

RAM :4 GB RAM

CHAPTER 5

SOFTWARE DESCRIPTION

5.1 MATLAB

MATLAB is a **fourth-generation programming language** and numerical analysis environment and also a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. It is used by engineers and scientists in many fields such as image and signal processing, communications, control systems for industry, **smart grid** design, robotics as well as computational finance. This is the easiest and most productive software for engineers and scientists. Whether you're analyzing data, developing algorithms, or creating models, MATLAB provides an environment that invites exploration and discovery. It combines a high-level language with a desktop environment tuned for iterative engineering and scientific workflows.

Typical uses include:

- Math and computation
- Algorithm development
- Modeling, simulation, and prototyping
- Data analysis, exploration, and visualization
- Scientific and engineering graphics
- Application development, including graphical user interface building

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time

it would take to write a program in a scalar non interactive language such as C or Fortran.

The name MATLAB stands for *matrix laboratory*. MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects. Today, MATLAB uses software developed by the LAPACK and ARPACK projects, which together represent the state-of-the-art in software for matrix computation. MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. Industry, MATLAB is the tool of choice for high-productivity research, development, and analysis.

Key Features

- High-level language for scientific and engineering computing
- Desktop environment tuned for iterative exploration, design, and problem-solving
- Graphics for visualizing data and tools for creating custom plots
- Apps for curve fitting, data classification, signal analysis, control system tuning, and many other tasks
- Add-on toolboxes for a wide range of engineering and scientific applications
- Tools for building applications with custom user interfaces
- Interfaces to C/C++, Java®, .NET, Python, SQL, Hadoop, and Microsoft® Excel®
- Royalty-free deployment options for sharing MATLAB programs with end users

Toolboxes

MATLAB features a family of application-specific solutions called *toolboxes*. Very important to most users of MATLAB, toolboxes allow you to *learn* and *apply* specialized technology. Toolboxes are comprehensive collections of MATLAB functions (M-files) that extend the MATLAB environment to solve

particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation, and many others.

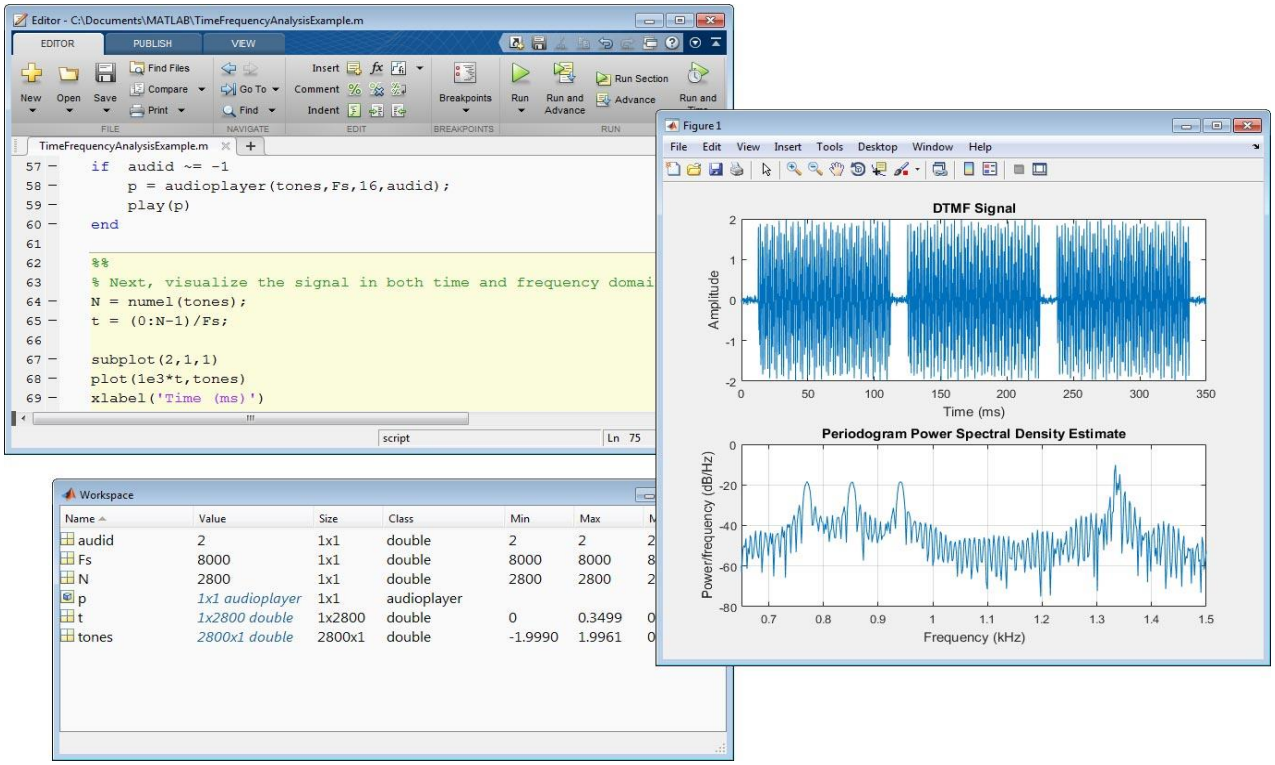


Fig 5.1 Desktop Environment Of MATLAB

The MATLAB system consists of five main parts:

Development Environment

This is the set of tools and facilities that help you use MATLAB functions and files. Many of these tools are graphical user interfaces. The desktop environment of MATLAB has shown in fig 5.1. It includes the MATLAB desktop and Command Window, a command history, and browsers for viewing help, the workspace, files, and the search path.

The MATLAB Mathematical Function Library

This is a vast collection of computational algorithms ranging from elementary functions like sum, sine, cosine, and complex arithmetic, to more sophisticated functions like matrix inverse, matrix eigenvalues, Bessel functions, and fast Fourier transforms.

The MATLAB language

This is a high-level matrix/array language with control flow statements, functions, data structures, input/output, and object-oriented programming features. It allows both “programming in the small” to rapidly create quick and dirty throw-away programs, and “programming in the large” to create complete large and complex application programs.

Handle Graphics®

This is the MATLAB graphics system. It includes high-level commands for two-dimensional and three-dimensional data visualization, image processing, animation, and presentation graphics. It also includes low-level commands that allow you to fully customize the appearance of graphics as well as to build complete graphical user interfaces on your MATLAB applications.

The MATLAB Application Program Interface (API)

This is a library that allows you to write C and Fortran programs that interact with MATLAB. It include facilities for calling routines from MATLAB (dynamic linking), calling MATLAB as a computational engine, and for reading and writing MAT-files.

CHAPTER 6

SYSTEM DESIGN

6.1 ARCHITECTURE

A system architecture or systems architecture is the conceptual design that defines the **structure** and/or **behavior** of a **system**. An architecture description is a formal description of a system, organized in a way that supports reasoning about the structural properties of the system. It defines the building blocks of the system and provides a plan for execution of the system.

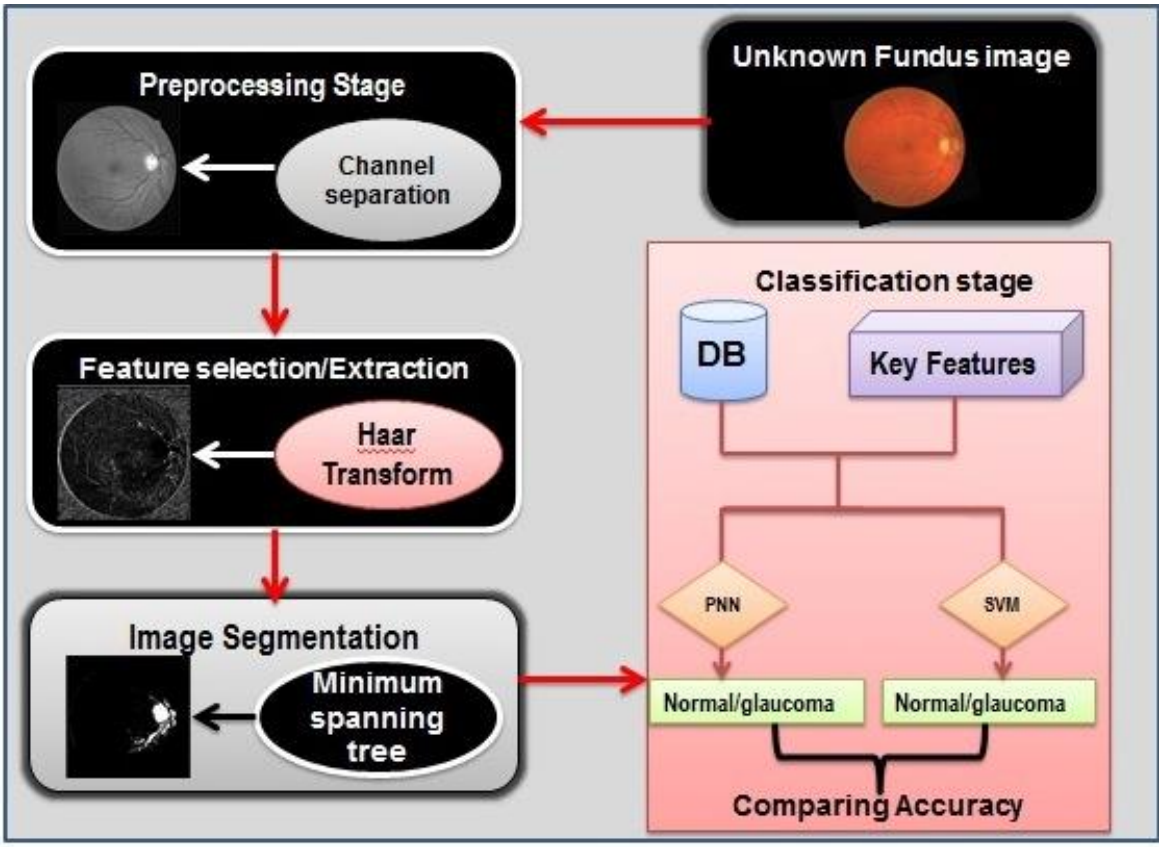


Fig 6.1 System Architecture

The architecture in fig 6.1 depicts that unknown fundus image is taken as the input for image analysis. The unknown retinal image undergoes several stages in order to detect glaucoma. It consists of two phases. In the first phase, the retinal images has been preprocessed and abnormal features has been extracted using haar transform. In the second phase, the extracted features are segmented for accurate results and further proceed for classification. Finally two classifiers have been used to predict the accuracy of classifiers in order to increase the classification rate.

6.2 MODULES

- Image Preprocessing
- Feature Selection/Extraction
- Image Segmentation
- Image Classification
- Comparing Accuracy

6.2.1 IMAGE PREPROCESSING

The image preprocessing technique is the process of adjusting the digital images so that the results are more suitable for display (or) further image analysis. Several filter operations which intensify or reduce certain image details enable an easier or faster evaluation.

Here the unknown retinal fundus image is taken as the input for preprocessing Stage. It undergoes several levels to convert as an enhanced image suitable for further process. Here the preprocessing levels are

- Gray scale conversion
- Noise reduction
- Histogram equalization
- Resizing
- Rescaling
- Tophat filtering

The retinal image is a RGB image so in order to extract the green channel from the retina, the fundus image has been converted to gray scale image. Here noise has been removed by using the inbuilt median filters in matlab. The tophat filtering has been made in order to remove the negative region .The result of tophat filtering is shown in black and white image. All images has been rescaled and resized to 500*500. Histogram equalization is also applied to remove the irregular illumination of image.

Gray scale conversion

Gray scale image is one of the simplest image enhancement techniques. The process of conversion of colour image (RGB) into a gray image is called gray scale conversion. The conversion of colour image to gray scale image has shown in fig 6.2 and 6.3 respectively. It can be performed using the following function,

y=f(x) Where x: original input data; y: converted output data

A gray scale or grey scale 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.

Fig 6.2 Normal Image

Fig 6.3 Gray Scale Image

In order to extract the green channel image and noise reduction process from the RGB image, it has been converted to gray scale image. Colour digital images are made of pixels, and pixels are made of combinations of primary colours. In RGB colour model red color has more wavelength of all the three colors, and green is the color that has not only less wavelength then red color but also green is the color that gives more soothing effect to the eyes. It means that we have to decrease the contribution of red color, and increase the contribution of the green color, and put blue color contribution in between these two colours. Hence images in green bands shows fundus structures more reliably, so the green band was extracted.

Noise reduction

Noise reduction is the process of removing noise from a image. Images taken with both digital cameras and conventional film cameras will pick up noise from a variety of sources. Further use of these images will often require that the noise be removed. In order to get an enhanced image, noise can be added manually and removed. In salt and pepper, pixels in the image are very different in color or intensity from their surrounding pixels. The noise added image is shown in fig 6.4 and it has been removed using median filters is shown in fig 6.5. Generally this type of noise will only affect a small number of image pixels. In Gaussian noise, each pixel in the image will be changed from its original value by a small amount.

To remove noise from the image many type of filters have been used. Here mean filters have been used to remove noise. A mean filter is a non-linear filter and if properly designed, is very good at preserving image detail. Median filters and others RCRS (rank-condition rank-selection) filters are good at removing salt and pepper noise from an image. To run a median filter

- Consider each pixel in the image.

- Sort the neighboring pixels into order based upon their intensities.
- Replace the original value of the pixel with the median value from the list.

Fig 6.4 Noise Added Image

Fig 6.5 Noise Removed Image

Histogram equalisation

Histogram conversion is the conversion of the histogram of the original image to another histogram. Histogram conversion can be said to be a type of gray scale conversion. There are two typical histogram conversion techniques,

- histogram equalization
- histogram normalisation

In first step, an accumulated histogram should be made. Second, the accumulated histogram should be divided into a number of equal regions. Third the corresponding gray scale in each region should be assigned to a converted gray scale. The effect of histogram equalization is that parts of the image with more frequency variation will be more enhanced, while parts of an image with less frequency will be neglected.

Image editors have provisions to create an image histogram of the image being edited. The histogram of normal image is shown in fig 6.6. The histogram plots the number of pixels in the image (vertical axis) with a particular brightness value (horizontal axis). Algorithms in the digital editor allow the user to visually adjust the brightness value of each pixel and to dynamically display the results as adjustments are made. The histogram after equalization is shown in fig 6.7. Improvements in picture brightness and contrast can thus be obtained.

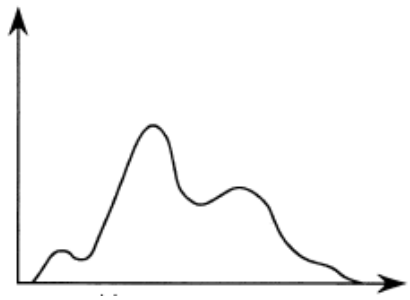


Fig 6.6 Histogram

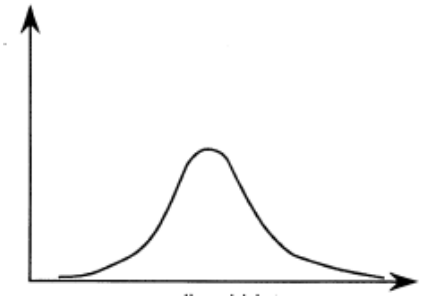


Fig 6.7 Histogram Equalisation

Resizing/Rescaling

Images taken for analysis may be different in size; analysis of such images tends to be difficult and may leads to error in results. In order to avoid this resizing and rescaling have been done in pre-processing stage. Scaling refers to the resizing of a digital image. Image resizing is necessary when you need to increase or decrease the total number of pixels, whereas remapping can occur when you are correcting for lens distortion or rotating an image.

Top hat filtering

In digital image processing, top-hat filtering is an operation that extracts small elements and details from given images. Here the negative regions of the retinal image has been removed using tophat filtering technique. Tophat filtering enhances the bright object in a dark background. For example: galaxy, it consists of small bright particles in dark background as shown in fig 6.8. These bright particles can be removed separately from the dark background of galaxy by using top hat filtering method. This has been clearly shown in fig 6.9. There exist two types of top-hat filtering,

- White top-hat filtering - The difference between the input image and its opening by some structuring element.
- Black top-hat filtering - The difference between the closing and the input image.

Fig 6.8 Normal Image

Fig 6.9 Tophat Filtered Image

6.2.2 FEATURE SELECTION/EXTRACTION

A feature is nothing but the significant representative of an image which can be used for further segmentation and classification .Feature selection is the first step to get the feature extracted images. This method is very much helpful to the repeated feature and the selected feature which has no data. It will not choose without data, will not useful for future processing.

The selected feature has been extracted to simplifying the amount of resources requires to describe a large set of data accurately. Feature Extraction is a general term which depicts to extract only valuable information from given raw data. The main objective is represent raw image in its reduced form and also to reduce the original data set by measuring certain properties to make decision process easier for classification

The proposed method called “Haar Wavelet Transform” is used for feature extraction. Nowadays the wavelet theorems make up very popular methods of image processing. Due to its low computing requirements, The Haar transform has been mainly used for image processing and pattern recognition. It has efficient application due to their wavelet like structure.

To improve the accuracy, the efficient algorithm called “haar wavelet transform” is used for feature extraction. This method is applicable for different kinds of image extraction features.

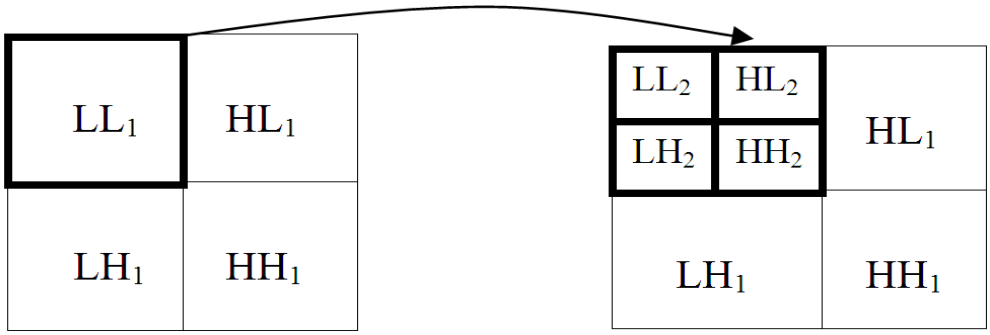


Fig 6.10 Haar Transformation

Haar Wavelet transform is used to calculate the feature vectors of textured images. Here it converts texture of retinal image to comparable mathematical characterization. The image is decomposed to approximate components and detail components by 2-D wavelet function. The decomposition process by 2-D wavelet transform from the high scale to the low scale indicates approximate components.the decomposition of HWT is shown in fig 6.10, as *HH*, *HL*, *LH* (corresponding to , and) indicates detail components.

The general form of decomposition haar transform is shown in fig 6.11 as follows,

A H

V D

Fig 6.11 General Form Of Haar Transform

A- (Approximation area) includes information about the global properties of analysed image. Removal of spectral coefficients from this area leads to the biggest distortion in original image.

H- (Horizontal area) includes information about the vertical lines hidden in image. Removal of spectral coefficients from this area excludes horizontal details from original image.

V- (Vertical area) contains information about the horizontal lines hidden in Image. Removal of spectral coefficients from this area eliminates vertical details from original image.

D- (Diagonal area) embraces information about the diagonal details hidden in image. Removal of spectral coefficients from this area leads to minimum distortions in original image.

Finally haar transform is composed of four coefficients such as A,H,V,D as shown above .Thus the H,V,D coefficients are compared with the approximation coefficients value. Here the approximately assigned value is 0.003.so the feature that are more different from the approximate features are get extracted for further process.

6.2.3 IMAGE SEGMENTATION

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. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics.

The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image (see edge detection). Each of the pixels in a region is similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic(s). When applied to a stack of images, typical in medical imaging, the resulting contours after image segmentation can be used to create 3D reconstructions with the help of interpolation algorithms like marching cubes.

The several approaches of image segmentation are

- Edge-based segmentation
- Region growing
- Region split and merge
- Watershed segmentation
- Segmentation by motion

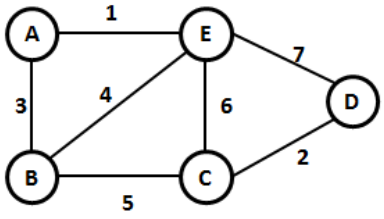
Image segmentation is an important and challenging problem in image analysis in the field of machine vision for a unsupervised object based segmentation. Minimum spanning tree method is used as a proposed work for image segmentation.

MST is a undirected graph which contains all edges and vertex of the graph. It is also called shortest spanning tree which is the important concept of graph theory. Here MST algorithm is used for medical image segmentation. MST is a sub graph that compasses over all the vertices of a given diagram with no cycle and has least entirely of weight over all the induced edges. In MST based clustering ,the weight of every edge is considered as the Euclidean separation between the end focus framing the edge .Accordingly any edges that in faces two sub trees in the MST must be the briefest. In such grouping, routines, conflicting edges which are surprisingly more are expelled from MST.

Basically MST has two types spanning tree algorithm. they are

- Prim's algorithm
- Kruskal's algorithm

Here kruskal's algorithm based minimum spanning tree is used for segmentation. First all small clusters are generated. In this method, which edges have minimum weight are connected and finally make a large cluster. After making this cluster edge inconsistency is applied to remove largest edge.



Edges	ae	cd	ab	be	bc	ec	ed
Weight	1	2	3	4	5	6	7

Fig 6.12 Weighted Graph

By applying Kruskal's algorithm,

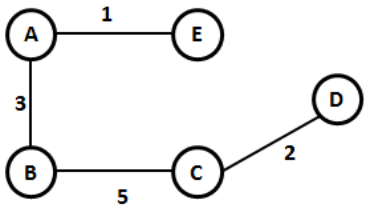


Fig 6.13 After Applying Kruskal's Algorithm

6.2.4 IMAGE CLASSIFICATION

Classification refers to the analysis of the properties of an image depending upon the analysis. It is one of the most often used methods of information extraction they classifies the extracted features to identify the normal and abnormal images. These are done using classifiers. Usually multiple features are used for a set of pixels i.e., many images of a particular object are needed. Most of the information extraction techniques rely on analysis of the spectral reflectance properties of such imagery and employ special algorithms designed to perform various types of 'spectral analysis'. The process of multispectral classification can be performed using either of the two methods:

- Supervised classification
- Unsupervised classification

Experiments have been carried out to find the better classifiers. Here the classifiers used are,

- SVM
- PNN

PNN (probabilistic neural network) is a kind of supervised neural network that is widely used for pattern recognition.

SVM (support vector machines) are supervised learning models with associated learning algorithms that analyze data used for classification and regression analysis.

6.2.5 COMPARING THE ACCURACY

In order to predict the better classifier and to increase the classification rate two classifiers called SVM and PNN classifiers have been used to detect the normal and abnormal retinal image.

CHAPTER 7
CONCLUSION

A method called “haar wavelet transform” has been proposed for feature extraction in analyzing the fundus image. It is capable for extracting the abnormal features vertically, horizontally, diagonally of the given image accurately. It is used to reduce the overall time complexity. This effectively minimizes the undesirable results and gives a good matching pattern, that will behaving zero or a minimum set of no relevant images. Hence this work was successfully identifies the affected features of the retinal image by using this proposed system.

APPENDIX-1

SAMPLE CODINGS

```
%%%%%%%%%preprocessing %%%%%%%%%
clc;clear;
close all;
[Path,U_C]=imgetfile;
IMA=imread(Path);
IMA = imresize(IMA,[500 500]);
figure('name','Test Image','numbertitle','off');
imshow(IMA);impixelinfo;
Igreeno=(IMA(:,:,2));
Igreen=(IMA(:,:,2));
figure('name','Green Channel Image','numbertitle','off');
imshow(Igreen);
impixelinfo;
Igreen = histeq(Igreen);
figure('name','histogram equalization','numbertitle','off');imshow(Igreen);impixelinfo;
Igreen = imresize(Igreen,[500 500]);
figure('name','resizing','numbertitle','off');imshow(Igreen);impixelinfo;
Igreen = im2double(Igreen);
figure('name','rescaling','numbertitle','off');imshow(Igreen);impixelinfo;
In = 1-(Igreen);
Idark = abs(In-Igreen);
figure('name','Image with negative regions','numbertitle','off');imshow(In);impixelinfo;
SE = strel('line', 9,15);
Idark = imadjust(imtophat(Idark,SE));
figure('name','Image with dark regions','numbertitle','off');imshow(Idark);impixelinfo;
figure('name','Image with dark regions
imbw','numbertitle','off');imshow((im2bw(Idark)));impixelinfo;

%%%%%%%%%%Haar wavelet Transform%%%%%%%%%%%%
```

```
[ll lh hl hh] = dwt2(Igreen,'haar');
dwt_out = [ll lh ; hl hh];
figure;
imshow(ll,[]);
impixelinfo;
title('Approximation Coefficients Image');
figure;
imshow(lh,[]);
impixelinfo;
title('Details Coefficients Image1');
figure;
imshow(hl,[]);
impixelinfo;
title('Details Coefficients Image2');
figure;
imshow(hh,[]);
impixelinfo;
title('Details Coefficients Image');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

APPENDIX-2

SCREEN SHOT

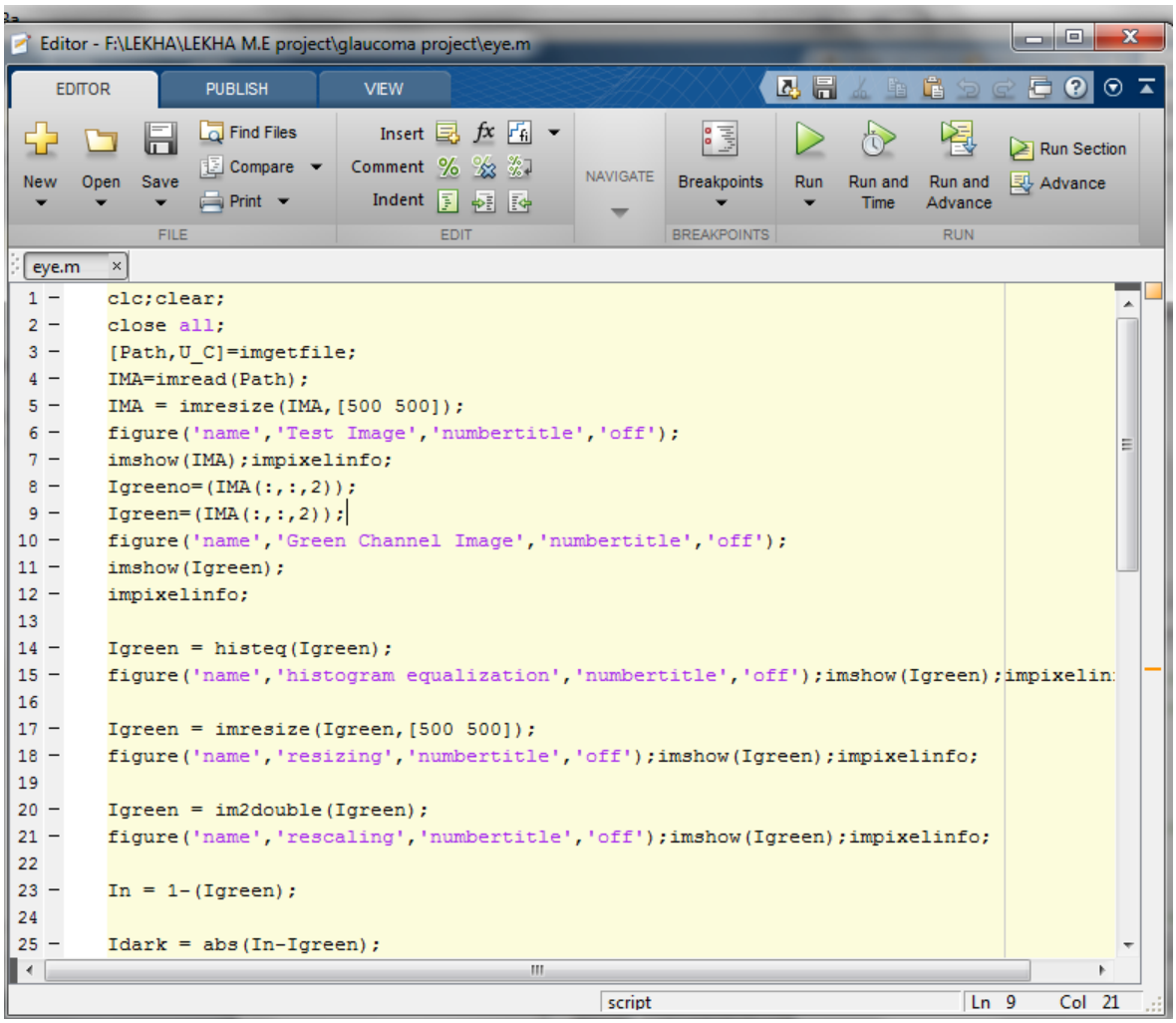


Fig 8.1 Workspace Of MATLAB

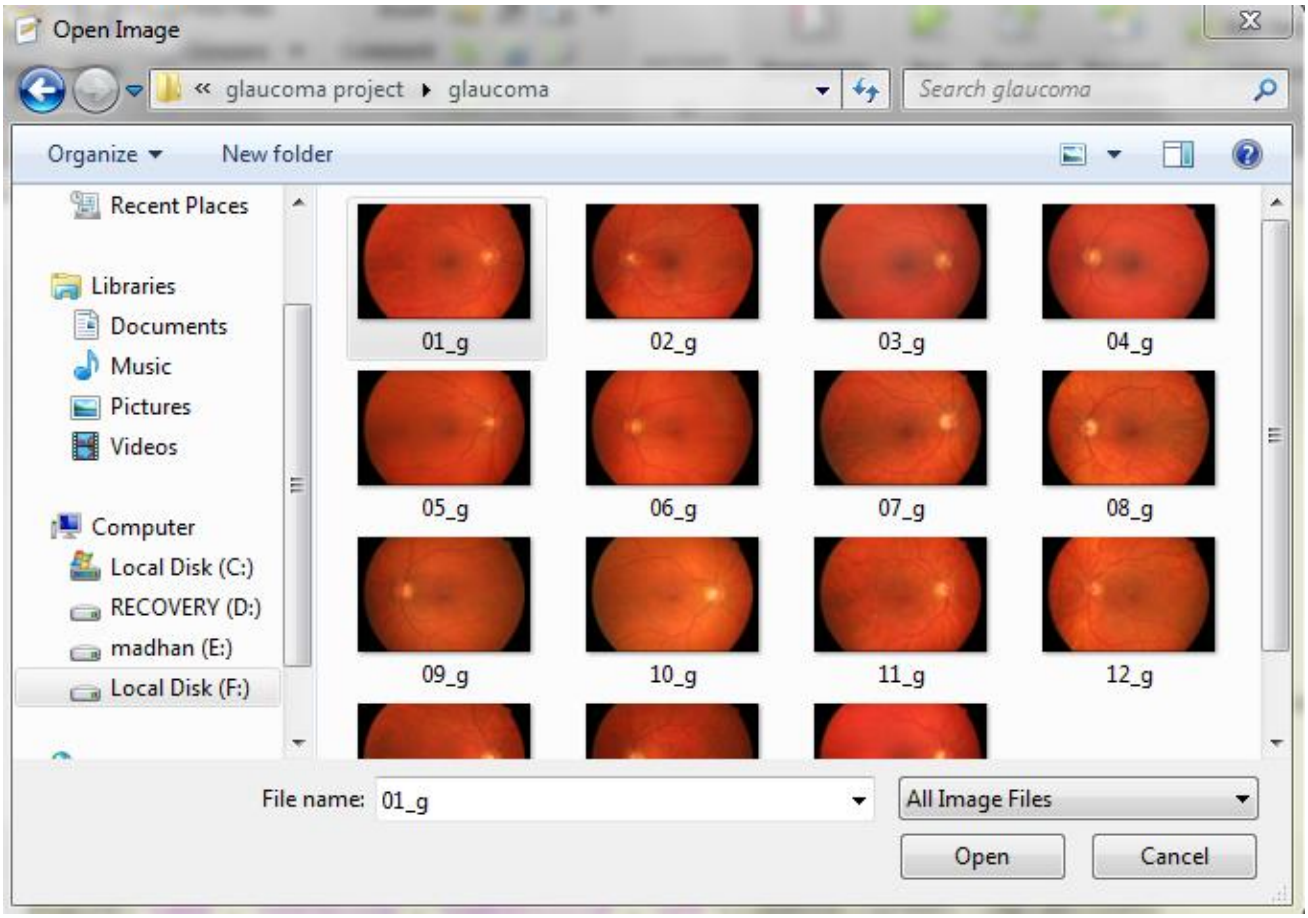


Fig 8.2 Input Image For Analysis

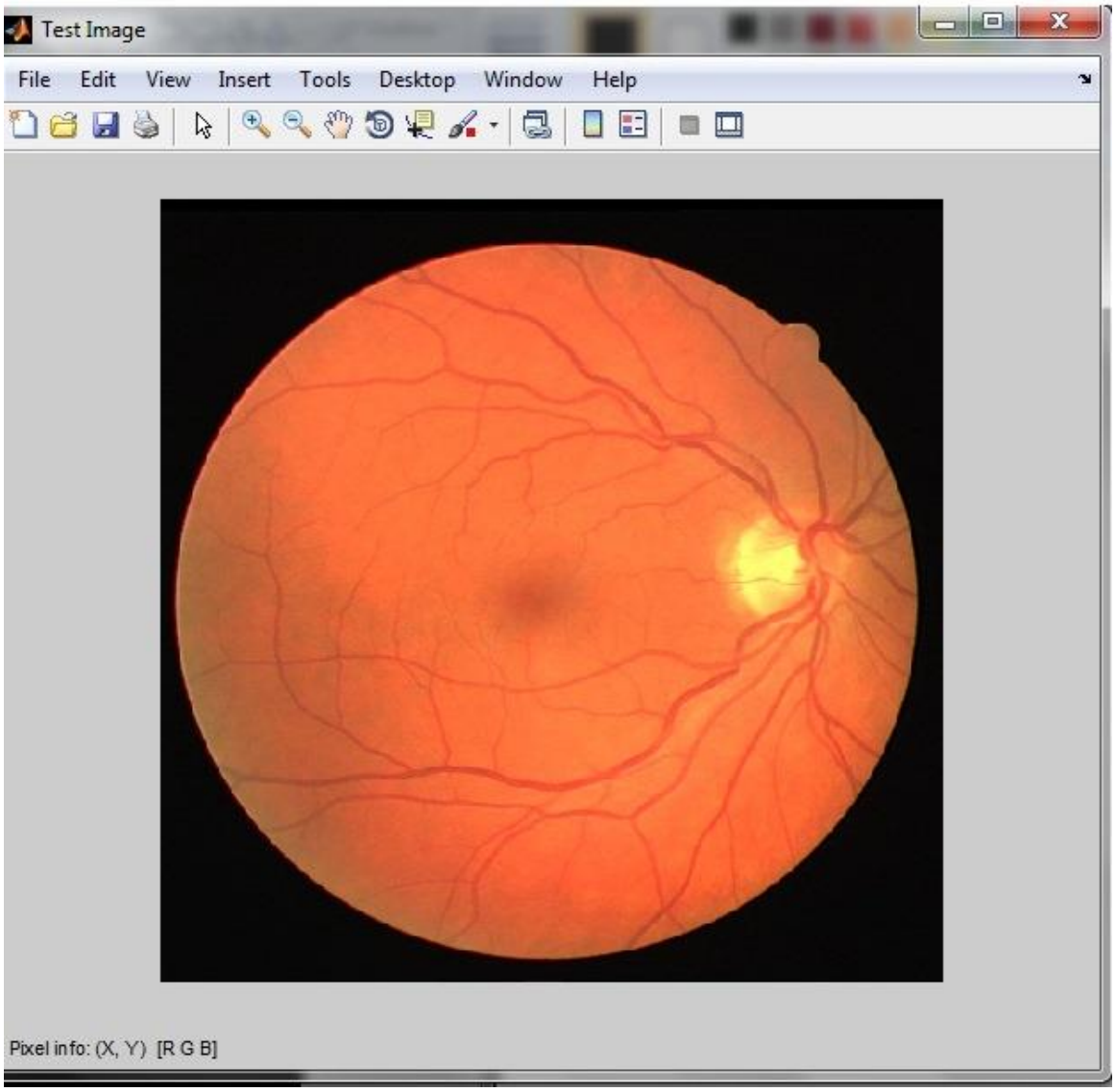


Fig 8.3 Test Image

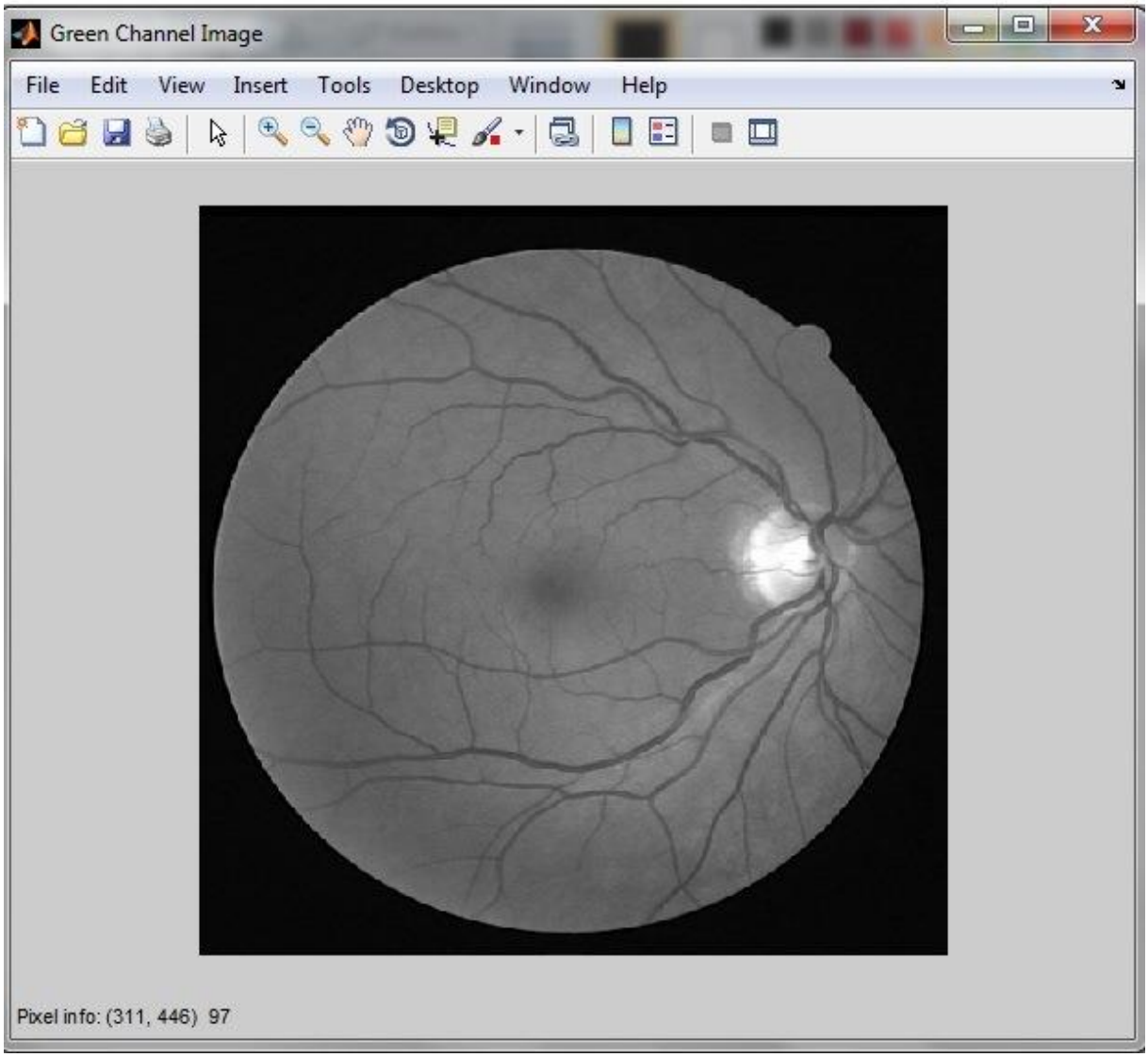


Fig 8.4 Green Channel Image

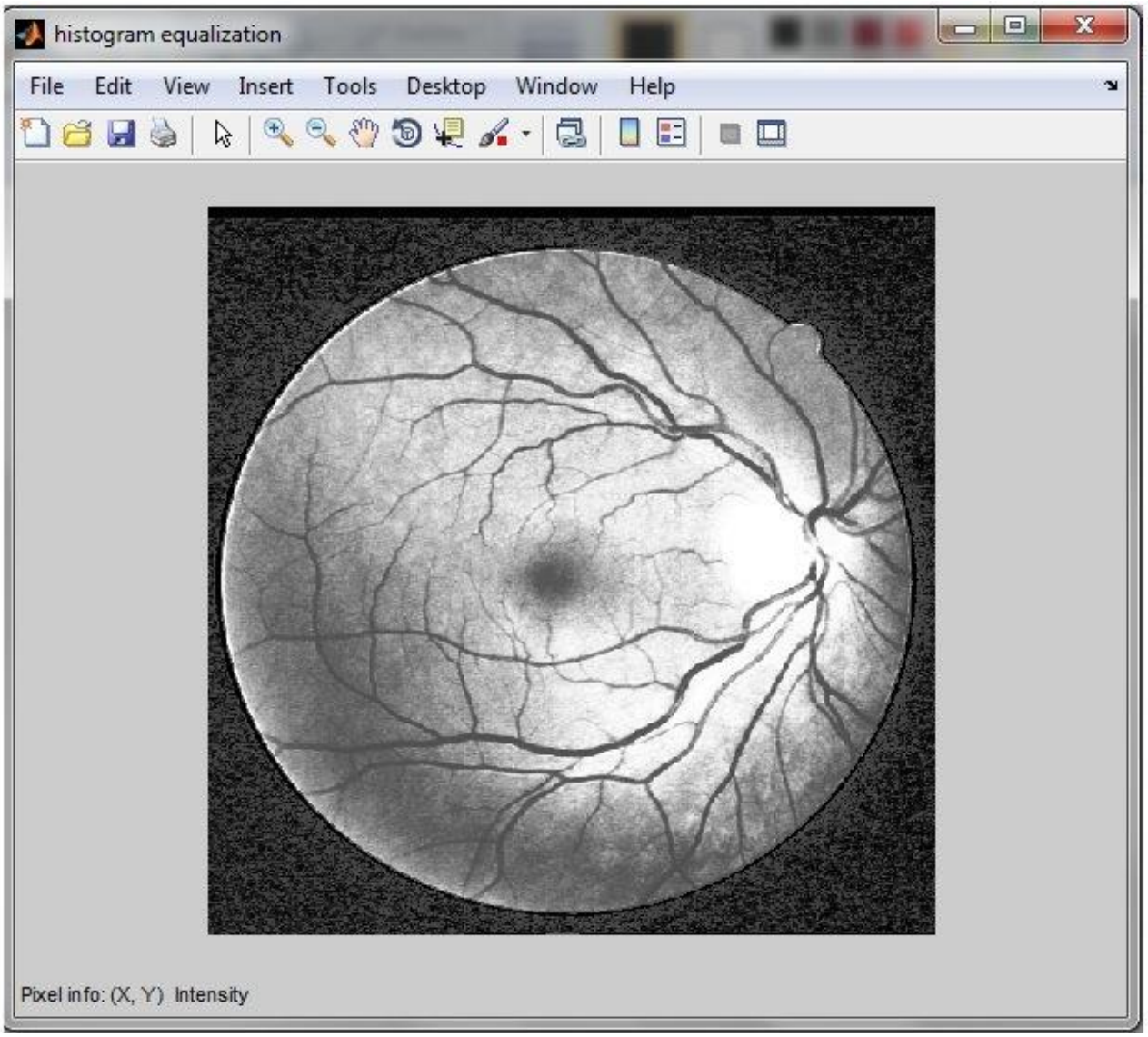


Fig 8.5 Histogram Equalisation

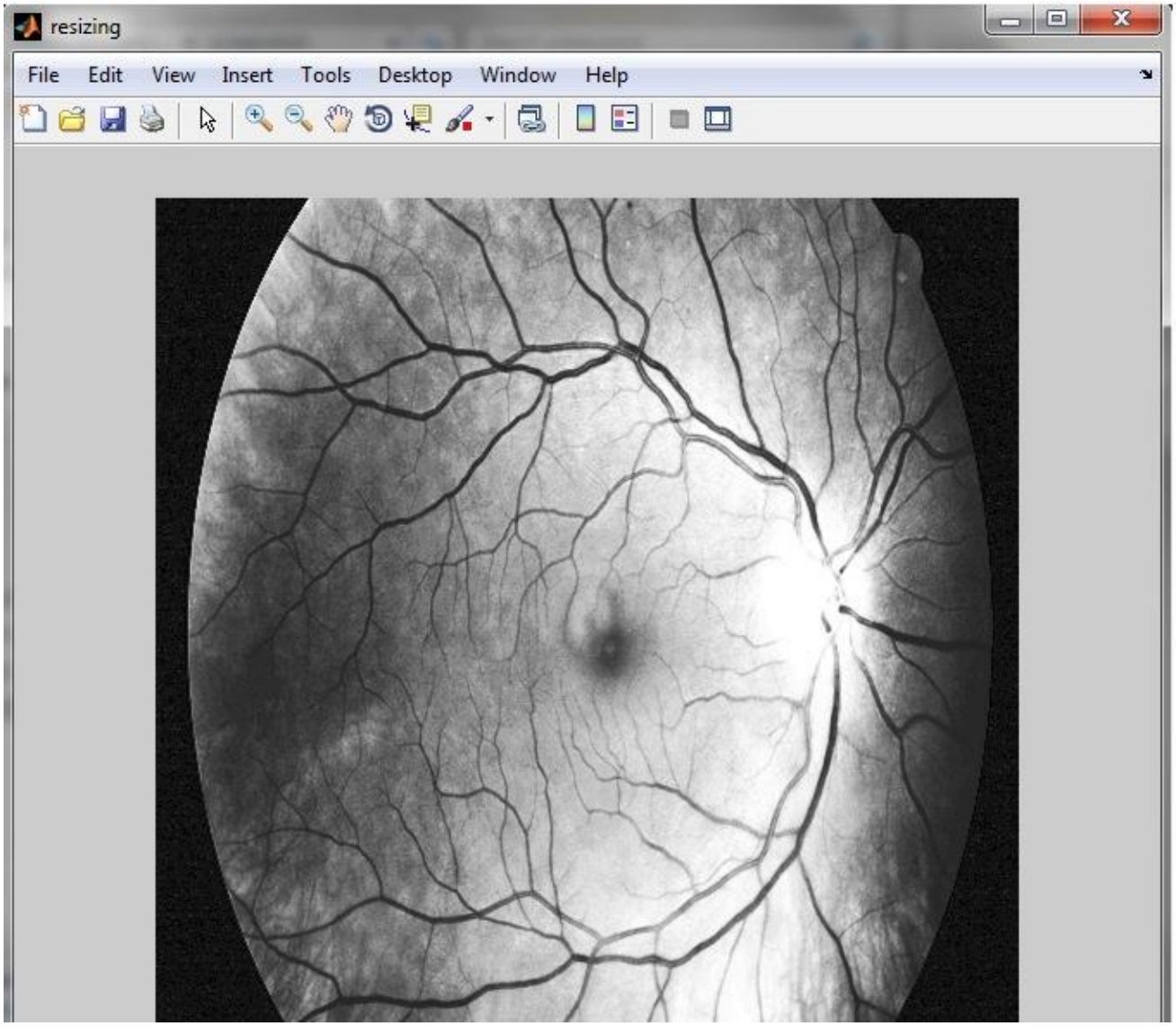


Fig 8.6 Resizing

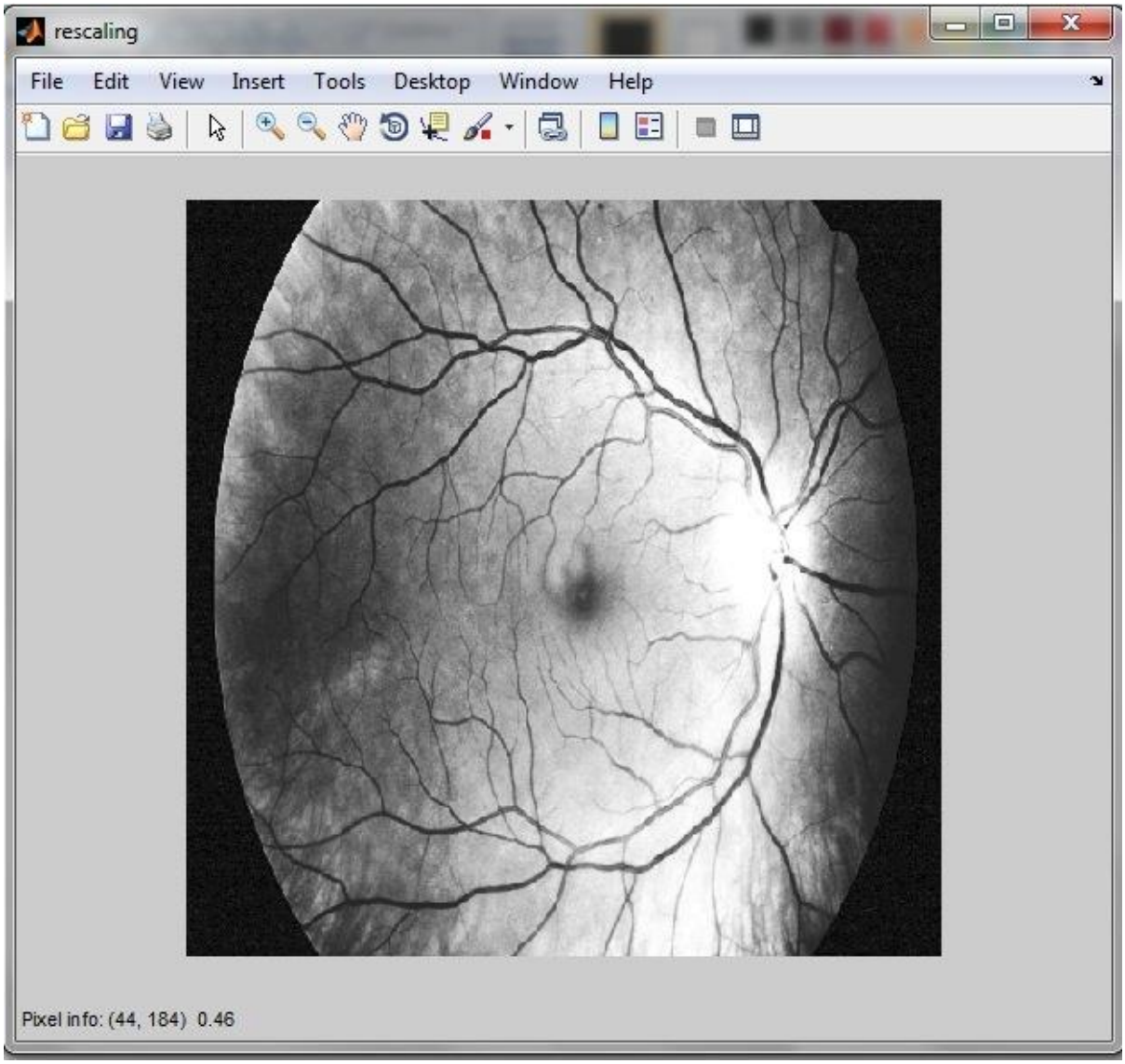


Fig 8.7 Rescaling

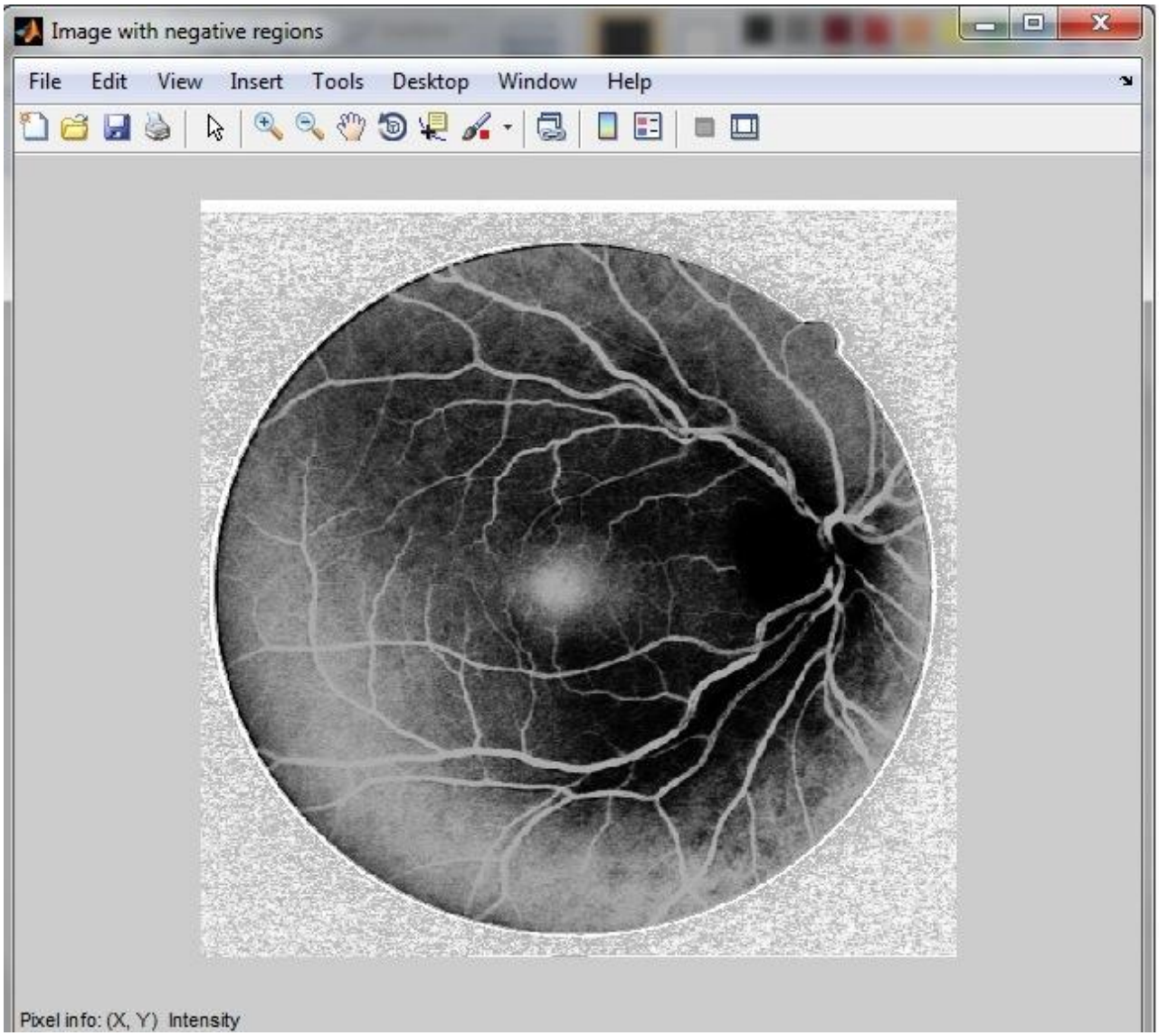


Fig 8.8 Image With Negative Region

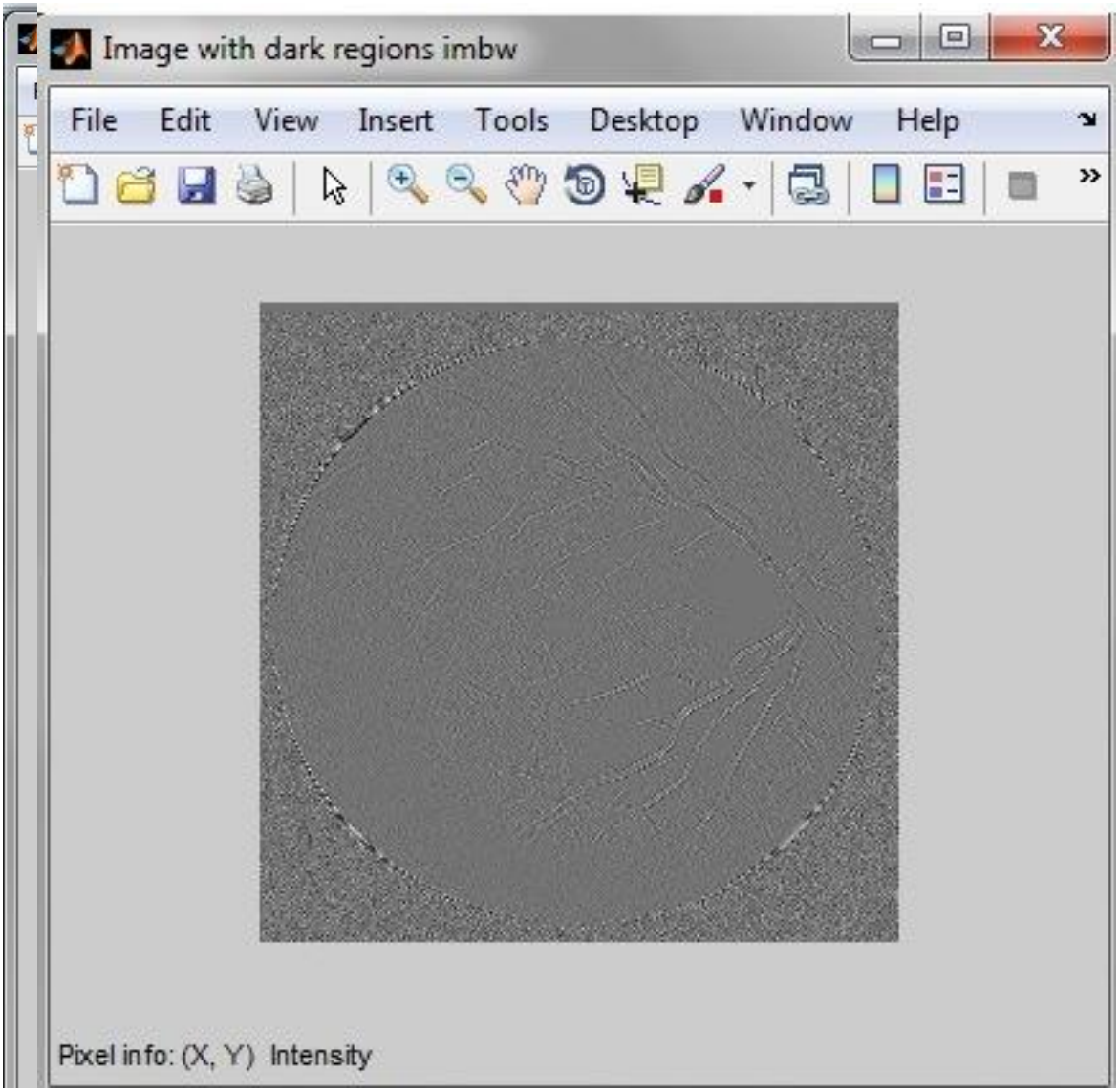


Fig 8.9 Image With Dark Region

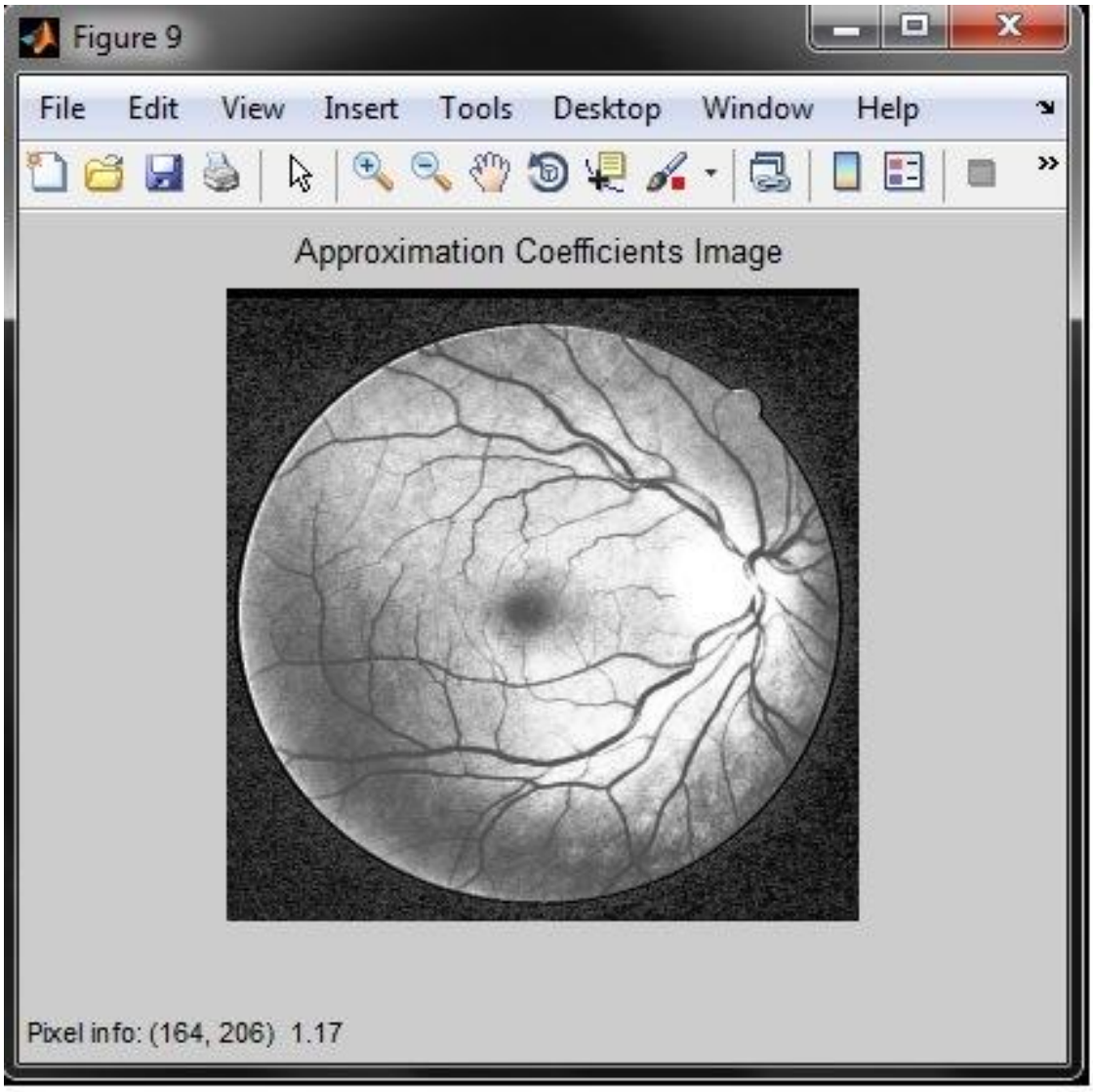


Fig 8.10 Image With Dark Region Imbw

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