LAB MANUAL

Subject Code : **Digital Image Processing Lab**
Subject Name : **6CS4-21**
Branch : Computer Science Engineering
Year : III Year/ VI Semester

Arya Group of Colleges

Department of Computer Science & Engineering

(Rajasthan Technical University, KOTA)

INDEX

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

III Year-VI Semester: B. Tech. Computer Science and Engineering

6CS4-21: Digital Image Processing Lab

Credit: 1.5 **Max. Marks: 75 (IA:45, ETE:30)**

0L+0T+3P **End Term Exam: 2 Hours**

SN	List of Experiments
1	Point-to-point transformation. This laboratory experiment provides for thresholding an image and the evaluation of its histogram. Histogram equalization. This experiment illustrates the relationship among the intensities (gray levels) of an image and its Histogram.
2	Geometric transformations. This experiment shows image rotation, scaling, and translation. Two-dimensional Fourier transform
3	Linear filtering using convolution. Highly selective filters
4	Ideal filters in the frequency domain. Non Linear filtering using convolutional masks. Edge detection. This experiment enables students to understand the concept of edge detectors and their operation in noisy images
5	Morphological operations: This experiment is intended so students can appreciate the effect of morphological operations using a small structuring element on simple binary images. The operations that can be performed are erosion, dilation, opening, closing, Open-close, close-open.

DO'S AND DON'TS

DO'S

1. Student should get the record of previous experiment checked before starting the new experiment.
2. Read the manual carefully before starting the experiment.
3. Checked the program by the instructor.
4. Get your results checked by the teacher.
5. Computers must be handled carefully.
6. Maintain strict discipline.
7. Keep your mobile phone switched off or in vibration mode.
8. Students should get the experiment allotted for next turn, before leaving the lab.

DON'TS

1. Do not touch or attempt to touch the mains power supply Wire with bare hands.
2. Do not overcrowd the tables.
3. Do not tamper with equipments.
4. Do not leave the without permission from the teacher.

INSTRUCTIONS TO THE STUDENTS

GENERAL INSTRUCTIONS

- Maintain separate observation results for each laboratory.
- Observations or readings should be taken only in the observation copy.
- Get the readings counter signed by the faculty after the completion of the experiment.
- Maintain Index column in the observation copy and get the signature of the faculty before leaving the lab.

BEFORE ENTERING THE LAB

- The previous experiment should have been written in the practical file, without which the students will not be allowed to enter the lab.
- The students should have written the experiment in the observation copy that they are supposed to perform in the lab.
- The experiment written in the observation copy should have aim, apparatus required, circuit diagram/algorithm, blank observation table (if any), formula (if any), programme (if any), model graph (if any) and space for result.

WHEN WORKING IN THE LAB

- Necessary equipments/apparatus should be taken only from the lab assistant by
- Making an issuing slip, which would contain name of the experiment, names of batch members and apparatus or components required.
- Never switch on the power supply before getting the permission from the faculty.

BEFORE LEAVING THE LAB

- The equipments/components should be returned back to the lab assistant in good condition after the completion of the experiment.
- The students should get the signature from the faculty in the observation copy.
- They should also check whether their file is checked and counter signed in the index.

PROGRAM EDUCATION OBJECTIVES AND OUTCOMES

Subject Name/Code: Digital Image Processing Lab /6CS4-21
Class: B. Tech. III Yr VI Sem. Computer Science Engineering

L	T	P
0	0	2 External

Marks: 30 **Internal Marks: 45** **Total Marks: 75**

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(1) Program Description: To offer high quality education in the field of Electrical Engineering and to prepare students abreast of latest global industrial and research requirements and fulfill responsibility towards community.

(2) Program Objective:

I. **Preparation**: To prepare undergraduate students with appropriate blend of theoretical foundations, experimentation & technical implementation to comprehend and pinpoint problems in the field of electrical Engineering to excel in postgraduate programs or to succeed in industry / technical profession.

II. **Core competence**: To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve electrical engineering problems and also to pursue higher studies. Student will be able to employ his knowledge along with necessary techniques & tools for modern engineering applications.

III. **Breadth**: To train students with good scientific and electrical engineering breadth so as to comprehend, analyze, design, and create novel products and solutions for the real life problems in the present electrical system.

IV. **Professionalism:** To inculcate in students professional and ethical attitude, Communication Skills, teamwork Skills, computer programming skill and an ability to relate electrical engineering issues to broader social context.

V. **Learning Environment**: To provide student with an academic environment aware of excellence, leadership, and the life-long learning needed for a successful professional career through independent studies, thesis, internships etc.

(3) Course Outcomes & it's mapping with PO

List of Program Outcomes	
PO-1	**Engineering Knowledge**: Apply knowledge of mathematics and science, with fundamentals of Computer Science & Engineering to be able to solve complex engineering problems related to CSE.
PO-2	**Problem Analysis**: Identify, Formulate, review research literature and analyze complex engineering problems related to CSE and reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
PO-3	**Design/Development of solutions**: Design solutions for complex engineering problems related to CSE and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety and the cultural societal and environmental considerations.
PO-4	**Conduct Investigations of Complex problems**: Use research–based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO-5	**Modern Tool Usage**: Create, Select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to computer science related complex engineering activities with an understanding of the limitations.
PO-6	**The Engineer and Society**: Apply Reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the CSE professional engineering practice.
PO-7	**Environment and Sustainability:** Understand the impact of the CSE professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development.
PO-8	**Ethics**: Apply Ethical Principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO-9	**Individual and Team Work**: Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary Settings.
PO-10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large such as able to comprehend and with write effective reports and design documentation, make effective presentations and give and receive clear instructions.
PO-11	**Project Management and Finance**: Demonstrate knowledge and understanding of the engineering management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi disciplinary environments.
PO-12	**Life-Long Learning**: Recognize the need for and have the preparation and ability to engage in independent and life-long learning the broadest context of technological change.

List of Program Specific Outcomes (PSO)	
PSO-1	**Knowledge Enhancement in Computing:** The ability to interpret the foundation and strategy of hardware and software of computer systems. Graduates can solve

	the problems in the areas related to algorithms, multimedia, data analytics, cloud computing, human computer interface, robotics, artificial intelligence and networking for efficient design of computer systems.
PSO-2	**Software Design and Development**: The ability to understand the software development lifecycle and methodologies of software systems. Graduate will learn competent skills and knowledge of software design process. Graduate will be acquaintance to practical proficiency with a broad area of programming concepts.

MAPPING OF PROGRAM OBJECTIVE WITH PROGRAM OUTCOMES ANS PSO

PSO		**PROGRAM OUTCOME**										
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
I	2	1	3	2	1	-	-	-	-	-	-	3
II	1	1	2	2	-	-	-	-	-	-	-	2

Note: Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

(5) Course Objectives :

The study of subject **Digital Image Processing lab 8CS7A** in undergraduate program in Computer Science Engineering Branch will achieve the following major objective-

1. This Lab helps the student to understand the Fundamentals of Digital image and its processing.
2. Perform the image enhancement technique for the improvement of pictorial information for human perception i.e. enhancing the quality of the image so that the image will have a better look
3. Apply the concepts of image segmentation and compression using which a graduate will be able to remove the redundancy pixels and transmit the image using less bandwidth.
4. Describe object detection and recognition technique learning which a graduate will be able to understand the fundamentals of digital signal processing with particular emphasis on problems in biomedical research and clinical medicine.

(7) Course Objective to Program Outcomes Mapping:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO's	
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	-	-	-	-	-	-	-	-	-	-	1	1	-
CO-2	1	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-3	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-4	-	-	-	-	-	1	-	-	-	-	-	-	-	-

Note: Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

8) Experiments Covered Beyond the Syllabus/Additional Contents:

Along with the above stated experiments allotted in the lab we covered following experiments in this lab which are important for the digital image processing studies:

Sr. No.	Beyond Syllabus topic	Source
1	Image histogram and histogram equalization	Getting Started with MATLAB,The MathWorks, Inc.
2	Image filtering in spatial and frequency domain.	Getting Started with MATLAB,The MathWorks, Inc.
3.	Morphological operations in analyzing image structures	Getting Started with MATLAB,The MathWorks, Inc.

(9)Text Books /Reference Books:

S.N.	Author Name	Book Title	Publisher	Text/ Reference
1	Rafael C. Gonzalez	Digital Image Processing	Pearson	Text
2	Anil K Jain	Fundamentals of Digital Image Processing	Prentice Hall	Reference

(10) Instructional Methods:

1. Direct Instructions:

I. Black board presentation

II. Multimedia presentation

2. Interactive Instruction:

I. Experiment Table Instruction.

II. Quiz/Viva Voice

3. Indirect Instructions:

I. Problem Solving

II. Lab Assignment

4. Independent Instructions:

I. Lab Records

II. Performing experiments

(11) Learning Materials:

1. Lab Manuals
2. Multimedia material
3. Related Software.

(12) Assessment of Outcomes:

1. Session tests/ internal assessment (one in each semester).
2. End term exam/External assessment (Conducted by RTU, Kota)

(13) Outcomes will be achieved through following:

1. Class room/Lab teaching.
2. Experiment performance.
3. Video lectures

Lab Plan

Turn ⇨ / No./EXP. No.⇩	No. of Experiments									
	1	2	3	4	5	6	7	8	9	10
1	Experiment no 1									
2	Experiment no 2									
3	Experiment no 3									
4	Experiment no 4									
5	Experiment no 5									

6	**Experiment no 6**
7	**Experiment no 7**
8	**Experiment no 8**
9	**Experiment no 9**
10	**Experiment no 10**

Experiment – 1

Object: To provides the thresholding an image and the evaluation of its histogram using histogram equalization and illustrates the relationship among the intensities (gray levels) of an image and its histogram.

Software: MATLAB

Theory :

Histogram is a graphical representation of the intensity distribution of an image. In simple terms, it represents the number of pixels for each intensity value considered.

Histogram Equalization is a computer image processing technique used to improve contrast in images. It accomplishes this by effectively spreading out the most frequent intensity values, i.e. stretching out the intensity range of the image. This method usually increases the global contrast of images when its usable data is represented by close contrast values. This allows for areas of lower local contrast to gain a higher contrast.

A color histogram of an image represents the number of pixels in each type of color component. Histogram equalization cannot be applied separately to the Red, Green and Blue components of the image as it leads to dramatic changes in the image's color balance. However, if the image is first converted to another color space, like HSL/HSV color space, then the algorithm can be applied to the luminance or value channel without resulting in changes to the hue and saturation of the image.

Adaptive Histogram Equalization

Adaptive Histogram Equalization 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.

Contrastive Limited Adaptive Equalization

Contrast Limited AHE (CLAHE) differs from adaptive histogram equalization in its contrast limiting. In the case of CLAHE, the contrast limiting procedure is applied to each neighborhood from which a transformation function is derived. CLAHE was developed to

prevent the over amplification of noise that adaptive histogram equalization can give rise to.

Program:

```
clc;
clear all;
close all;
imgetfile;
u=imread(ans);
o=rgb2gray(u);
imshow(o);
figure;
imhist(o);
i=histeq(o);
figure;
imshow(i);
figure;
imhist(i);
```

Result: In this experiment provides for thresholding an image and the evaluation of its histogram using Histogram equalization. This experiment illustrates the relationship among the intensities (gray levels) of an image and its histogram.

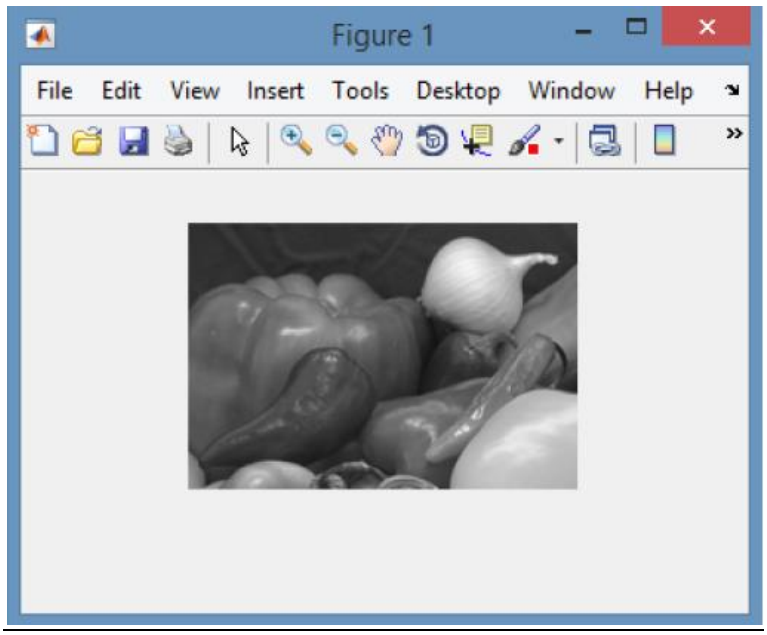


Fig 1.1: Gray Scale Image

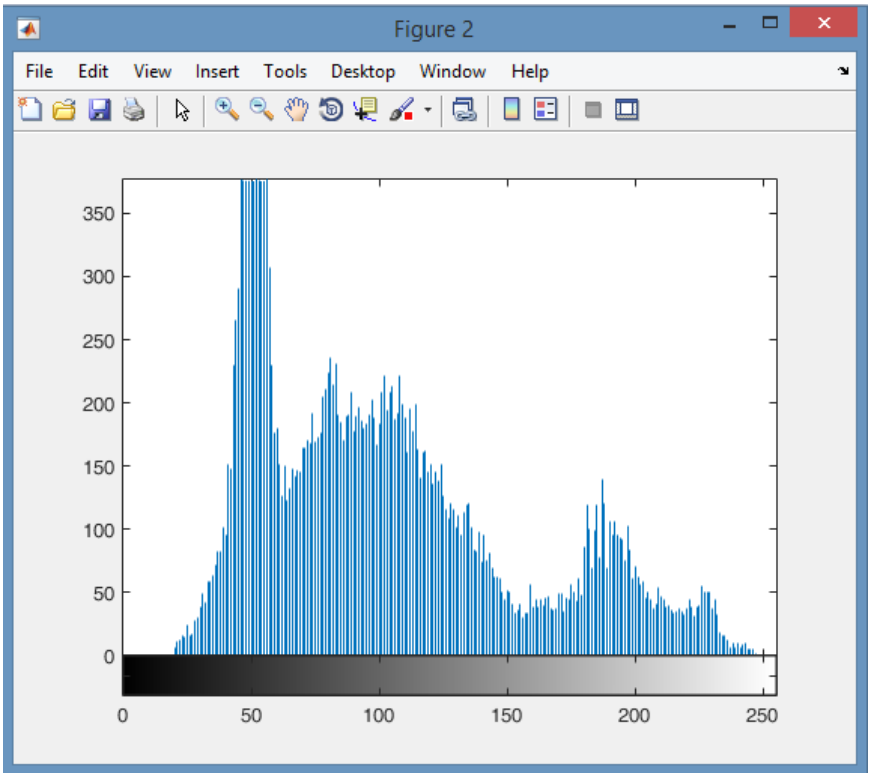


Fig 1.2: Histogram of Original Image

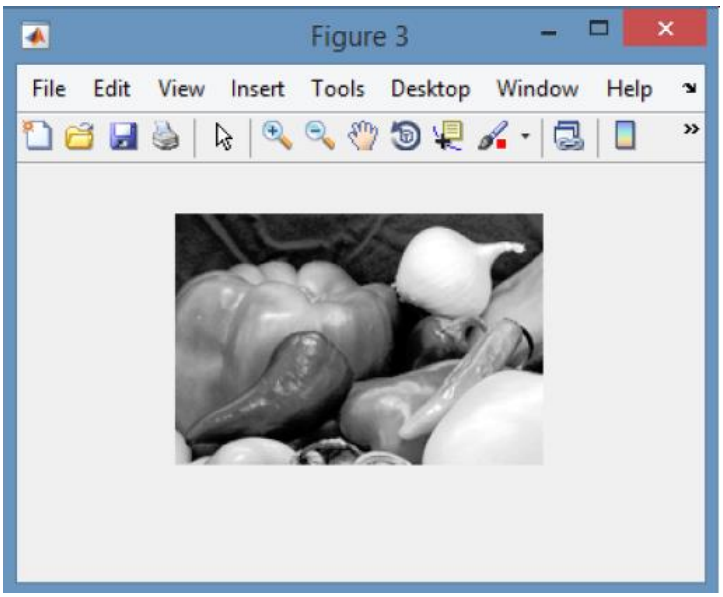


Fig 1.3: Image after Applying Histogram Equalization

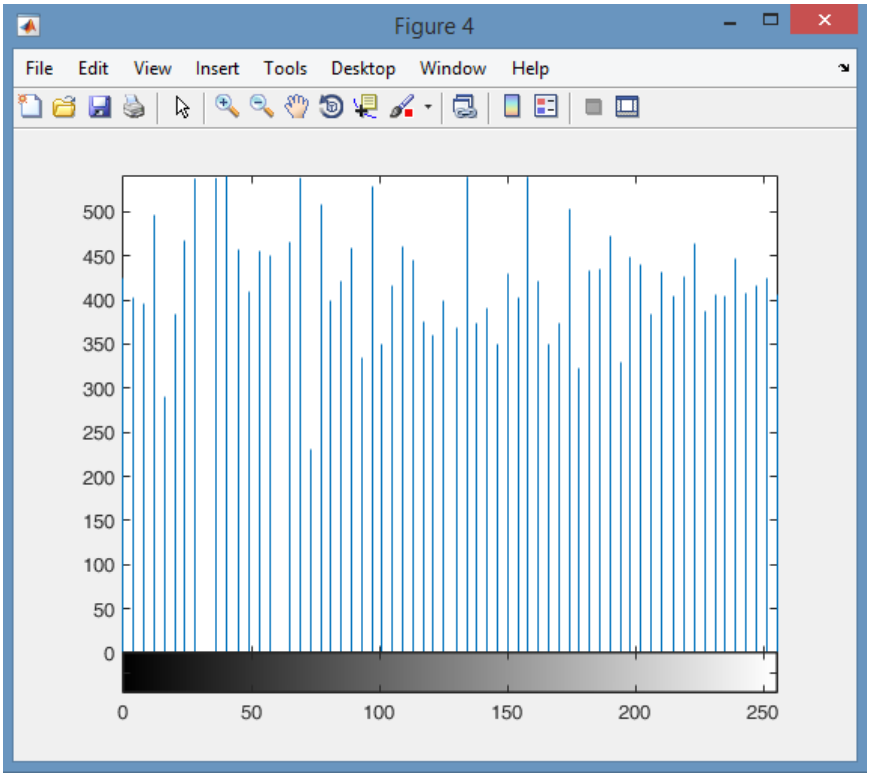


Fig 1.4: Histogram equalization

Viva Question

1.	What is histogram equalization in digital image processing?
2.	Why histogram equalization is needed?
3.	What happens if histogram equalization is applied twice?
4.	Why histogram is used in image processing?
5.	What is histogram equalization in Matlab?
6.	What is entropy image processing?
7.	Why is a histogram useful?
8.	What is the advantage of histogram?
9.	What is contrast in image processing?
10.	How do you make a histogram graph?

Experiment – 2

Object: To shows image rotation, scaling, and translation using Geometric transformations.

Software: MATLAB

Theory:

Perform generic geometric transformations using the imwarp workflow. Geometric transformations map pixel coordinates in the output image to coordinates in the input image. The mapping process then interpolates the value of output pixels from the input image. Use these functions to perform general 2-D, 3-D, and N-D geometric transformations. To perform a 2-D or 3-D geometric transformation, first create a geometric transformation object that stores information about the transformation. Then, pass the image to be transformed and the geometric transformation object to the imwarp function.

Functions

imwarp	Apply geometric transformation to image
affineOutputView	Create output view for warping images
fitgeotrans	Fit geometric transformation to control point pairs
findbounds	Find output bounds for spatial transformation
fliptform	Flip input and output roles of spatial transformation structure
makeresampler	Create resampling structure
maketform	Create spatial transformation structure (TFORM)
tformarray	Apply spatial transformation to N-D array
tformfwd	Apply forward spatial transformation
tforminv	Apply inverse spatial transformation

Program:

```
clc;
clear all;
close all;
 imgetfile;
u=imread(ans);
im_cr = imcrop(u,[75 68 130 112]);
imshow(u);
figure;
imshow(im_cr);
im_rt=imrotate(u,90);
figure;
imshow(u);
figure;
 imshow(im_rt);
im_ts= imtranslate(u,[15, 25],'FillValues',255);
figure, pi=imshow(u);
pi.Parent.Visible='on';
figure, op=imshow(im_ts);
 op.Parent.Visible='on';
```

Result: We have done the operation on digital image and shown image rotation, scaling, and translation using Geometric transformations.

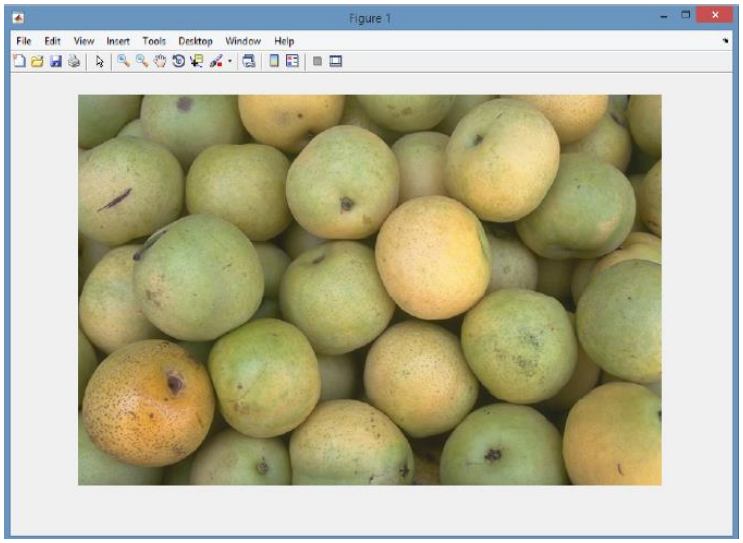


Fig 2.1: Original Image

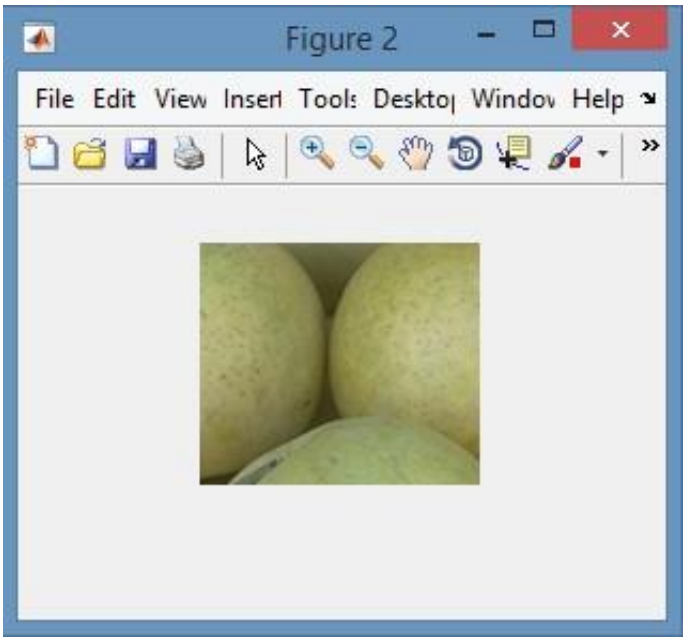


Fig 2.2: Image Crop

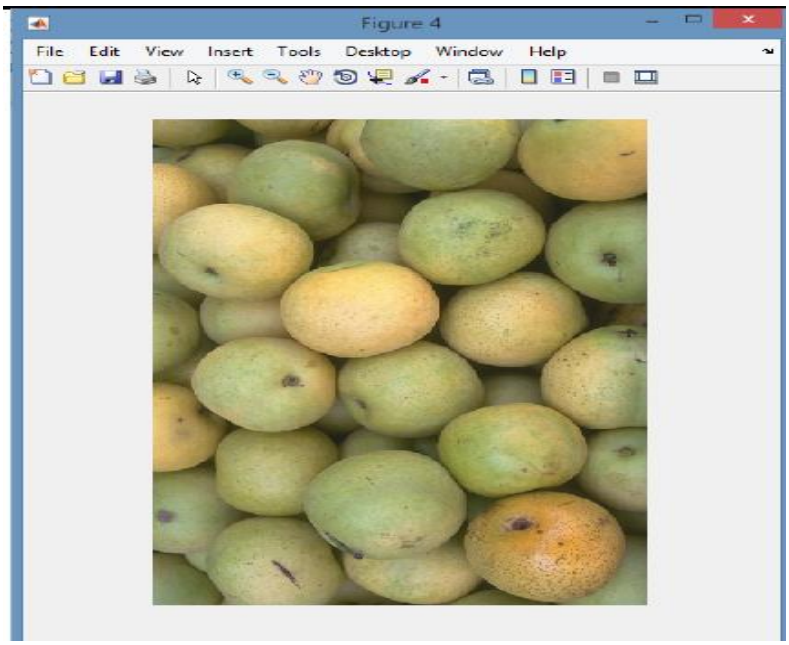


Fig 2.3: Original Image Rotate 90^0

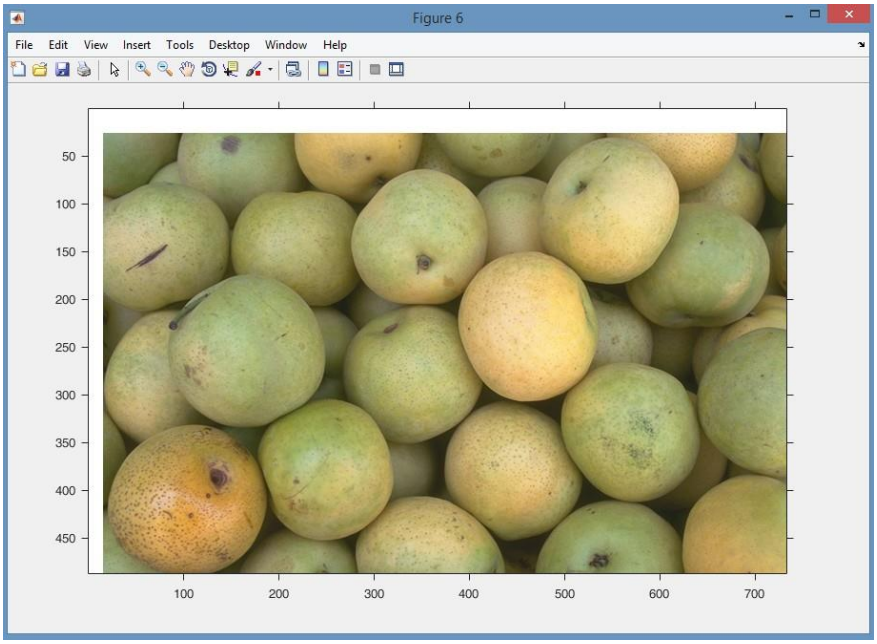


Fig 2.4: Image Scaling

Viva Question

1.	What is meant by geometric transformation?
2.	What is spatial transformation?
3.	What are the types of geometric transformation?
4.	What is geometric transformation in image processing?
5.	What are the basic transformations?
6.	What are the rules of translations?
7.	What is the mean of transformation?
8.	What is a coordinate rule?
9.	What is Transformation computer graphics?
10.	What do you mean by 3d transformation?

Experiment – 3

Object: To perform the Two-dimensional Fourier transform operation in an image.

Software: MATLAB

Theory:

The Fourier Transform is an important image processing tool which is used to decompose an image into its sine and cosine components. The output of the transformation represents the image in the Fourier or frequency domain, while the input image is the spatial domain equivalent. In the Fourier domain image, each point represents a particular frequency contained in the spatial domain image.

The Fourier Transform is used in a wide range of applications, such as image analysis, image filtering, image reconstruction and image compression.

Program:

```
clc;  clear all; close all;
imgetfile;
u=imread(ans);
oip=rgb2gray(u);
imshow(oip);
uiop=fft2(oip);
figure;
imshow(uiop);
uyiop=ifft2(uiop);
figure;
imshow(uint8(uyiop));
```

Result: Performed the Two-dimensional Fourier transform operation in an image.

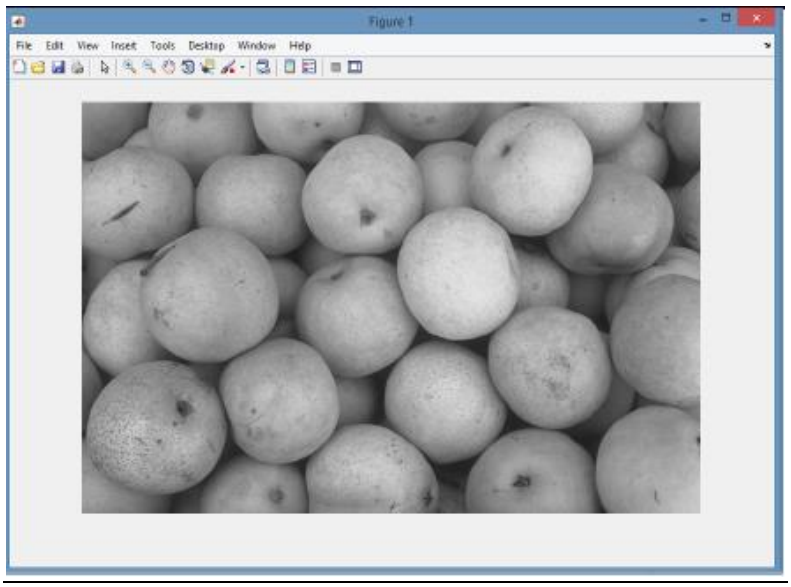


Fig 3.1: Gray Scale Image

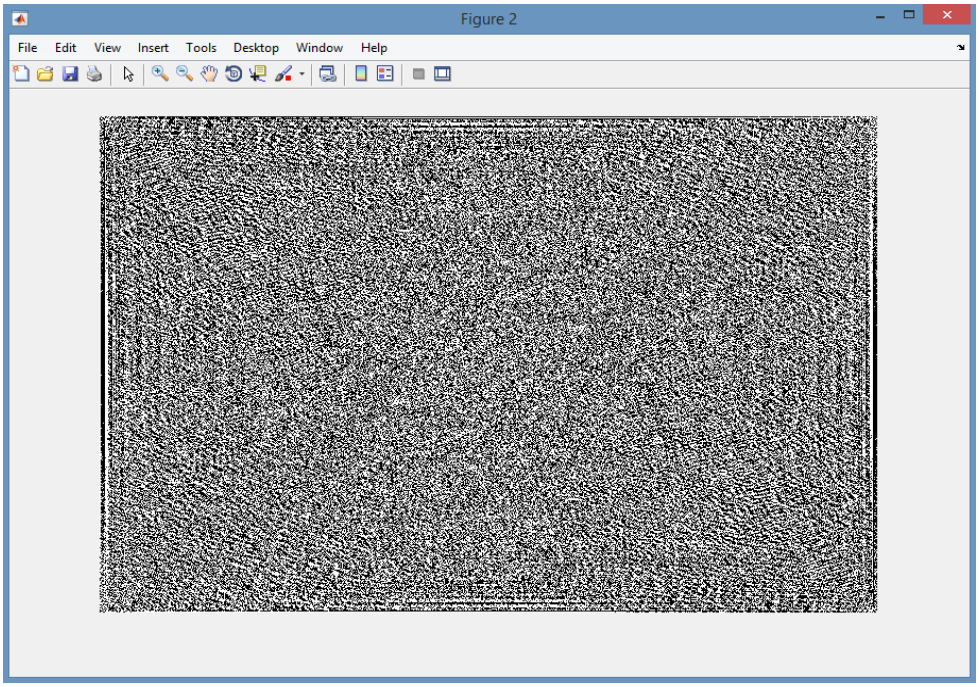


Fig 3.2: Encrypted Image after Applying Fourier Transform

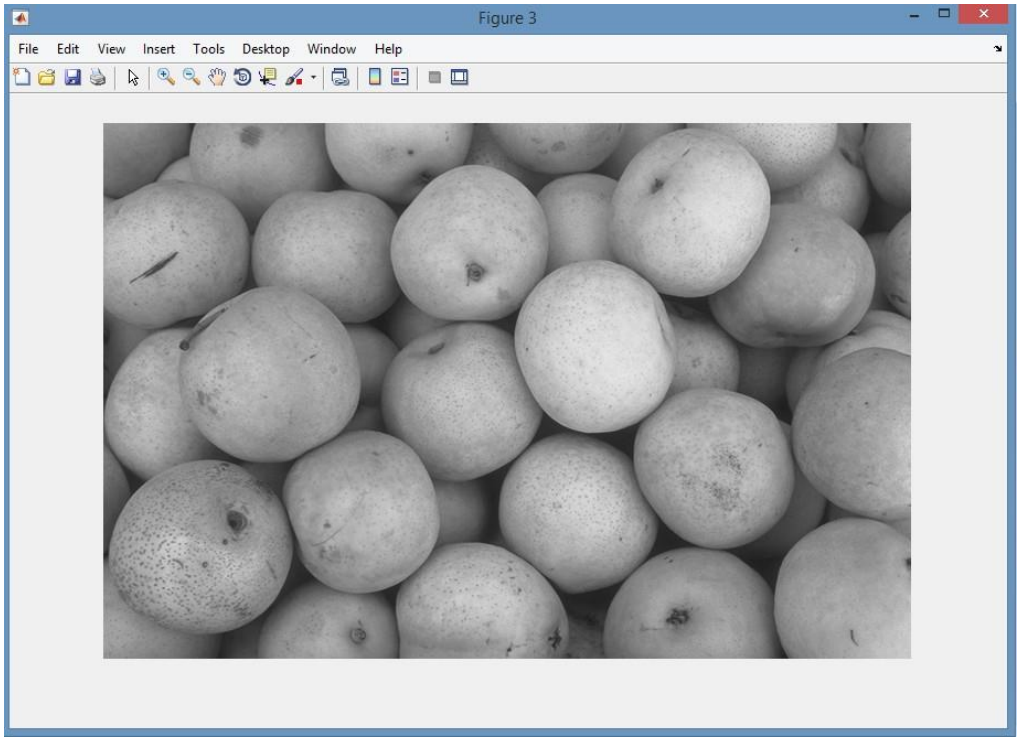


Fig 3.3: Decrypted image After Applying Inverse of Fourier Transform

Viva Question

1.	What is the Fourier transform of an image?
2.	What is 2d Fourier transform?
3.	What is spatial frequency in image processing?
4.	Why FFT is used in image processing?
5.	What is the difference between DFT and FFT?
6.	What is the convolution theorem in image processing?
7.	What is Fourier Transform and its applications?
8.	What is an image signal?
9.	What is FFT size?
10.	What are the steps involved in digital image processing?

Experiment – 4

Object: To perform the Linear filtering using convolution in an image.

Software: MATLAB

Theory:

Linear filtering of an image is accomplished through an operation called *convolution*. Convolution is a neighborhood operation in which each output pixel is the weighted sum of neighboring input pixels. The matrix of weights is called the convolution kernel, also known as the filter. A convolution kernel is a correlation kernel that has been rotated 180 degrees.

For example, suppose the image is

A = [17 24 1 8 15
23 5 7 14 16
4 6 13 20 22
10 12 19 21 3
11 18 25 2 9]

and the convolution kernel is

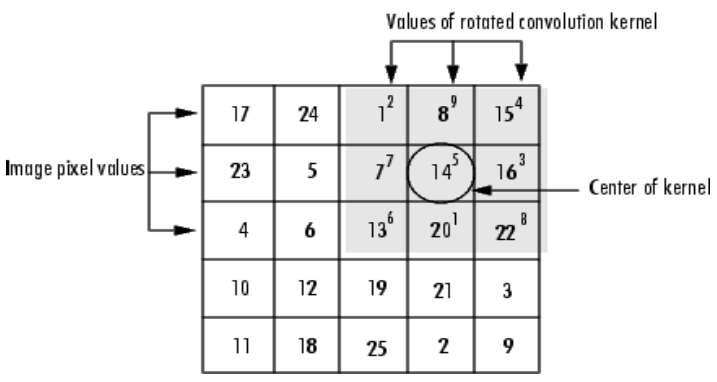
h = [8 1 6
3 5 7
4 9 2]

The following figure shows how to compute the (2,4) output pixel using these steps:

1. Rotate the convolution kernel 180 degrees about its center element.
2. Slide the center element of the convolution kernel so that it lies on top of the (2,4) element of A.
3. Multiply each weight in the rotated convolution kernel by the pixel of A underneath.
4. Sum the individual products from step 3.

Hence the (2,4) output pixel is

$$1 \cdot 2 + 8 \cdot 9 + 15 \cdot 4 + 7 \cdot 7 + 14 \cdot 5 + 16 \cdot 3 + 13 \cdot 6 + 20 \cdot 1 + 22 \cdot 8 = 575$$



Program:

```
clc;
clear
all;
close
all;
imgetfile;
u=imread(ans);
imshow(u);
Hm = fspecial('motion',20,45);
MotionBlur =
imfilter(u,Hm,'replicate'); figure;
imshow(MotionBlur);
Hb =
fspecial('disk',10);
blurred = imfilter(u,Hb,'replicate');
figure;
imshow(blurred);
```

Result : We perform the Linear filtering using convolution in an image.

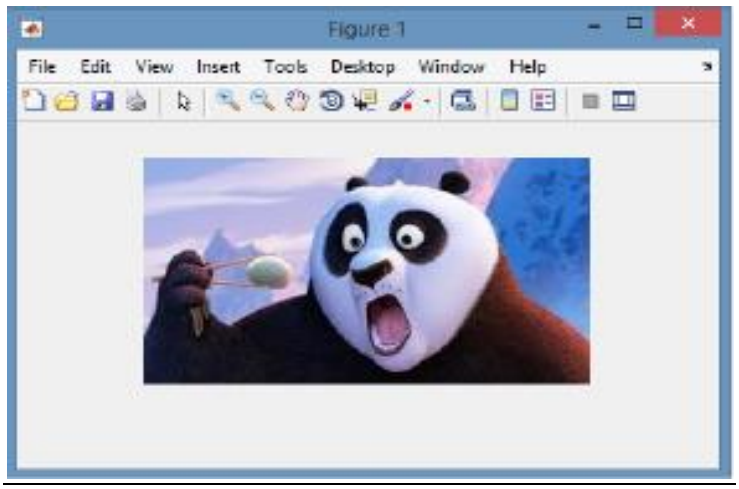


Figure 1
File Edit View Insert Tools Desktop Window Help

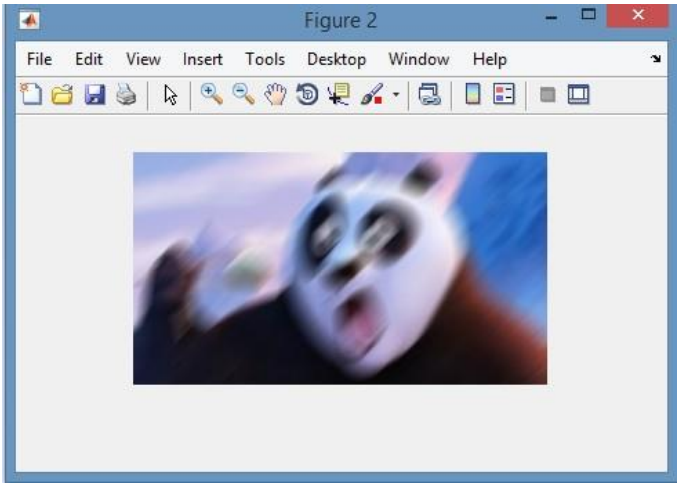


Figure 2
File Edit View Insert Tools Desktop Window Help

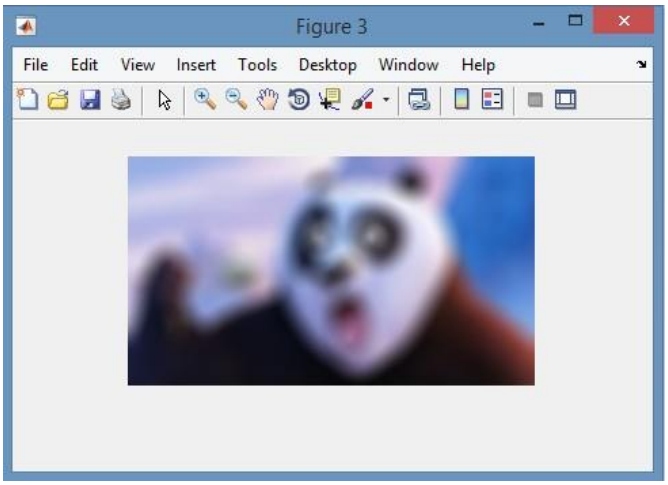


Figure 3
File Edit View Insert Tools Desktop Window Help

Viva Question

1.	What is linear filtering in image processing?
2.	What is a convolution filter?
3.	What is linear image?
4.	Why filters are used in image processing?
5.	What makes a filter linear?
6.	Are convolution filters linear?
7.	What is convolution of an image?
8.	What is the purpose of convolution?
9.	What is nonlinear filter in image processing?
10.	What is the intensity of an image?

Experiment – 5

Object: Image Edge Detection Using Sobel Filtering and Canny Filtering.

Software: MATLAB

Theory:

Edge detection is an image processing technique for finding the boundaries of objects within images. It works by detecting discontinuities in brightness. Edge detection is used for image segmentation and data extraction in areas such as image processing, computer vision, and machine vision. Common edge detection algorithms include Sobel, Canny, Prewitt, Roberts, and fuzzy logic methods.

Edge detection method, specified as one of the following.

Method	Description
'Sobel'	Finds edges at those points where the gradient of the image I is maximum, using the Sobel approximation to the derivative.
'Prewitt'	Finds edges at those points where the gradient of I is maximum, using the Prewitt approximation to the derivative.
'Roberts'	Finds edges at those points where the gradient of I is maximum, using the Roberts approximation to the derivative.
'log'	Finds edges by looking for zero-crossings after filtering I with a Laplacian of Gaussian (LoG) filter.
'zerocross'	Finds edges by looking for zero-crossings after filtering I with a filter that you specify, h

'Canny'	Finds edges by looking for local maxima of the gradient of I. The edge function calculates the gradient using the derivative of a Gaussian filter. This method uses two thresholds to detect strong and weak edges, including weak edges in the output if they are connected to strong edges. By using two thresholds, the Canny method is less likely than the other methods to be fooled by noise, and more likely to detect true weak edges.
'approxcanny'	Finds edges using an approximate version of the Canny edge detection algorithm that provides faster execution time at the expense of less precise detection. Floating point images are expected to be normalized in the range [0 1].

Program:

```
clc;clear all;close all;

po=imgetfile;
I = imread(po);%select coin
 imshow(I)
BW1 = edge(I,'sobel');
BW2 = edge(I,'canny');
figure;
 imshowpair(BW1,BW2,'montage');
 title('Sobel Filter Canny Filter');
```

Result: we have perform the Image Edge Detection Using Sobel Filtering and Canny Filtering

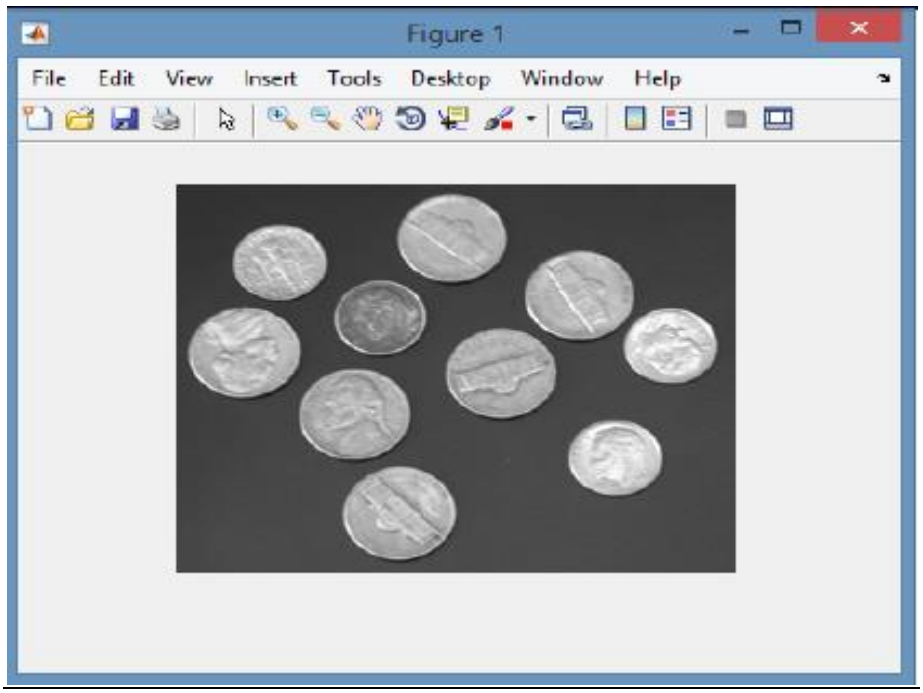


Figure 1
File Edit View Insert Tools Desktop Window Help

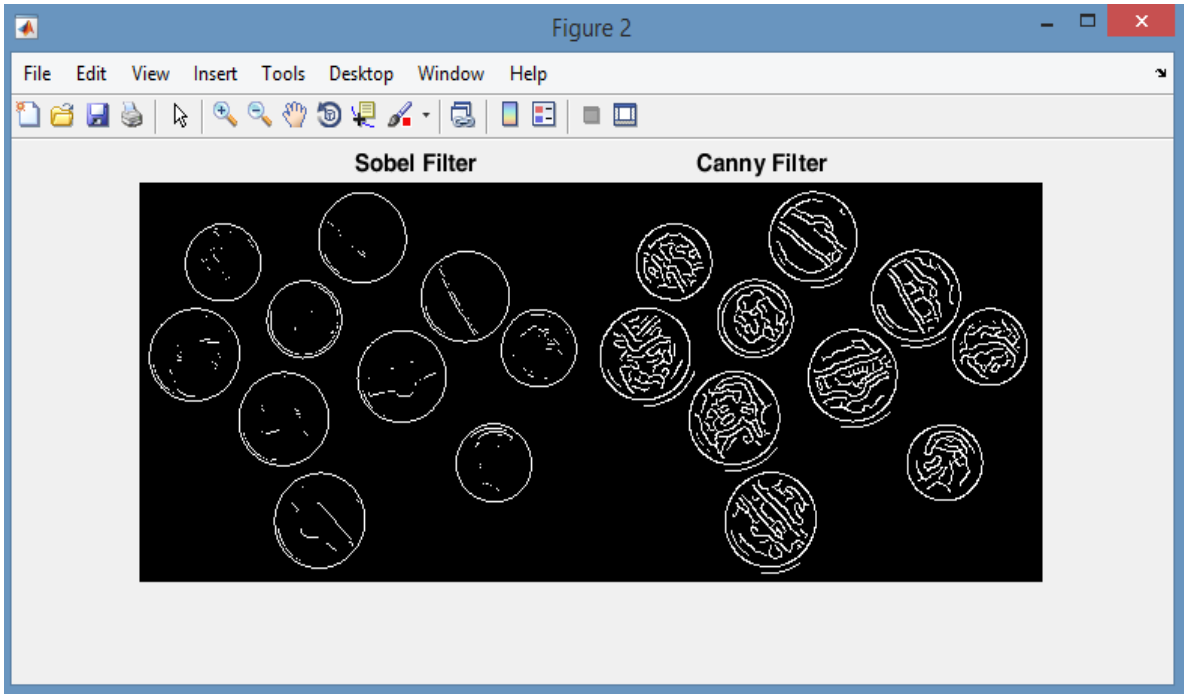


Figure 2
File Edit View Insert Tools Desktop Window Help
Sobel Filter
Canny Filter

Viva Question

1.	What does a Sobel filter do?
2.	What is canny edge detection in image processing?
3.	How does Sobel edge detection work?
4.	How do you implement Canny edge detection?
5.	How is edge detection done?
6.	What does Sobel mean?
7.	Why is Sobel edge detected?
8.	What does Laplacian filter do?
9.	What is an edge in an image?
10.	What is an edge filter?

Experiment – 6

Object: To perform the following operations in an image.

(a) erosion,

(b) dilation.

Software: MATLAB

Theory:

Morphology is a broad set of image processing operations that process images based on shapes. Morphological operations apply a structuring element to an input image, creating an output image of the same size. In a morphological operation, the value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbors.

The most basic morphological operations are dilation and erosion. Dilation adds pixels to the boundaries of objects in an image, while erosion removes pixels on object boundaries. The number of pixels added or removed from the objects in an image depends on the size and shape of the structuring element used to process the image. In the morphological dilation and erosion operations, the state of any given pixel in the output image is determined by applying a rule to the corresponding pixel and its neighbors in the input image. The rule used to process the pixels defines the operation as a dilation or an erosion. This table lists the rules for both dilation and erosion.

Dilation and erosion are often used in combination to implement image processing operations. For example, the definition of a morphological opening of an image is an erosion followed by a dilation, using the same structuring element for both operations. We can combine dilation and erosion to remove small objects from an image and smooth the border of large objects.

Program:

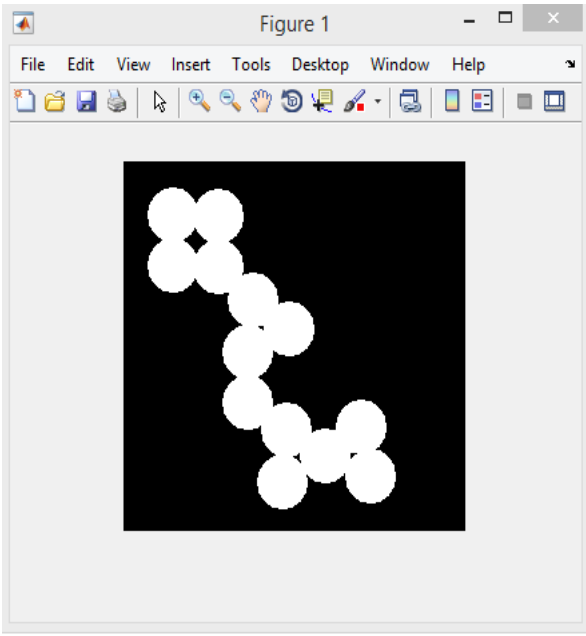
(a) erosion

```
clc;  clear all; close all;
po=imgetfile;
I = imread(po);
originalBW = I;
se = strel('disk',11);
erodedBW = imerode(originalBW,se);
imshow(originalBW),
figure, imshow(erodedBW)
```

(b) dilation

```
clc;  clear all; close all;
po=imgetfile;
I = imread(po);
se = strel('ball',5,5);
I2 = imdilate(I,se);
imshow(I), title('Original')
figure, imshow(I2),
title('Dilated')
```

Result: We have perform the erosion and dilation operations in an image.



Original Image

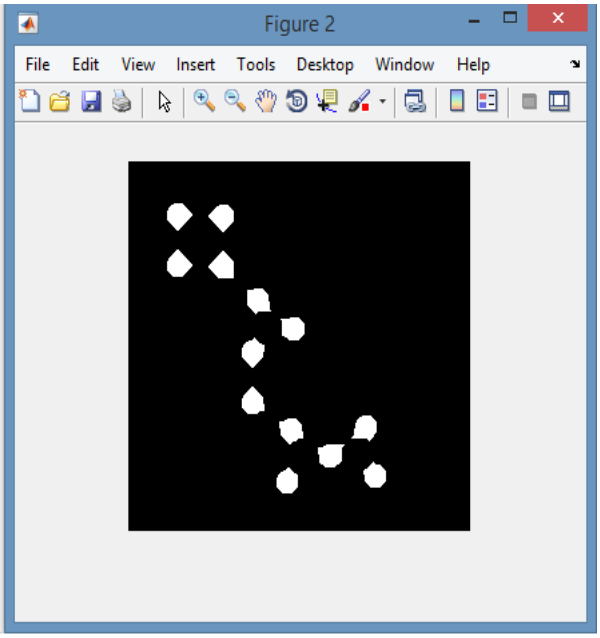
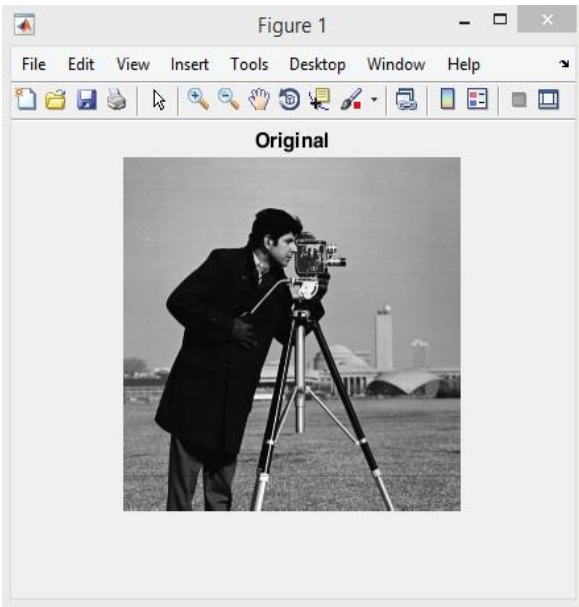
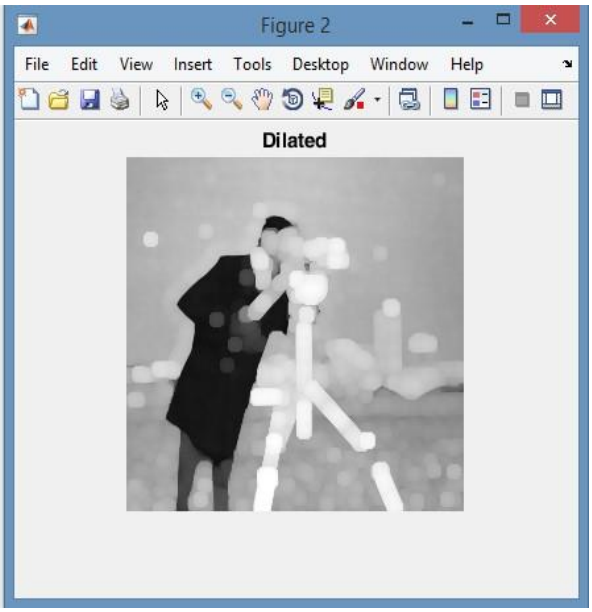


Image After erosion operation





Viva Question

1.	What is erosion in image processing?
2.	What are morphological operators?
3.	What is binary dilation?
4.	How segmentation is done in image processing?
5.	What is erosion and dilation?
6.	How do you do dilation?
7.	What are the types of morphology?
8.	What is resolution of an image?
9.	What is the highest resolution photo?
10.	How many pixels is considered high resolution?

Experiment – 7

Object: To perform the following operations in an image.

(a) opening,

(b) closing.

Software: MATLAB

Theory:

Morphological image processing is a collection of non-linear operations related to the shape or morphology of features in an image. According to Wikipedia, morphological operations rely only on the relative ordering of pixel values, not on their numerical values, and therefore are especially suited to the processing of binary images. Morphological operations can also be applied to greyscale images such that their light transfer functions are unknown and therefore their absolute pixel values are of no or minor interest.

Morphological techniques probe an image with a small shape or template called a structuring element. The structuring element is positioned at all possible locations in the image and it is compared with the corresponding neighborhood of pixels. Some operations test whether the element "fits" within the neighborhood, while others test whether it "hits" or intersects the neighborhood:

Program:

(a) Opening

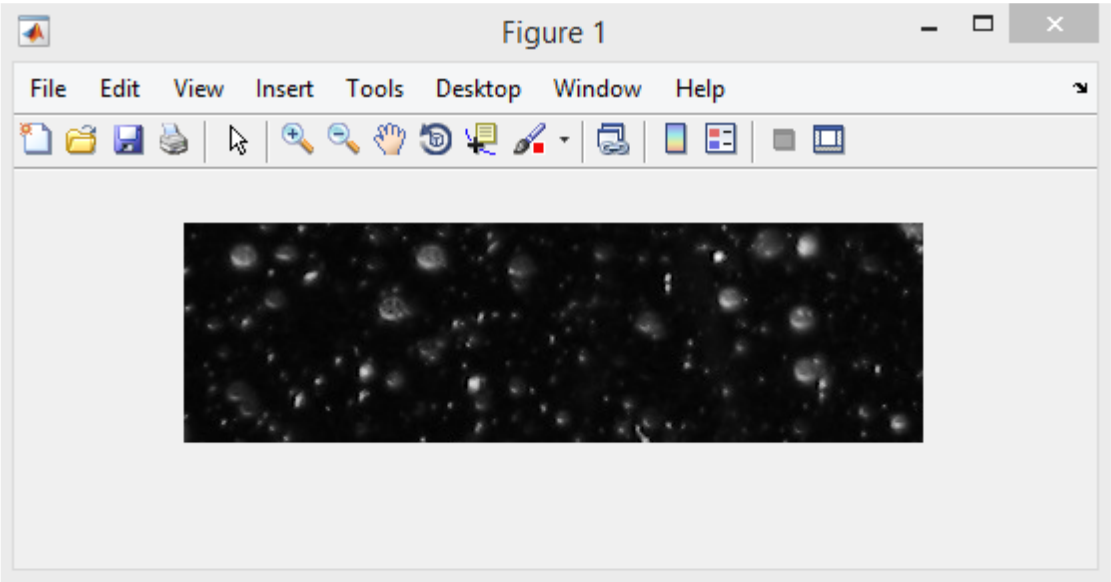
```
clc;  clear all; close all;
po=imgetfile;
I = imread(po);

figure, imshow(I);

se = strel('disk',5);
afterOpening = imopen(I,se);
figure, imshow(afterOpening,[]);
```

(b) Closing

```
clc;clear all;close all;
```

```
po=imgetfile;
I = imread(po);
originalBW = I;
imshow(originalBW);
se = strel('disk',10);
closeBW = imclose(originalBW,se);
 figure, imshow(closeBW);
```

Result: We have perform the opening and closing operations in an image.



Original Image

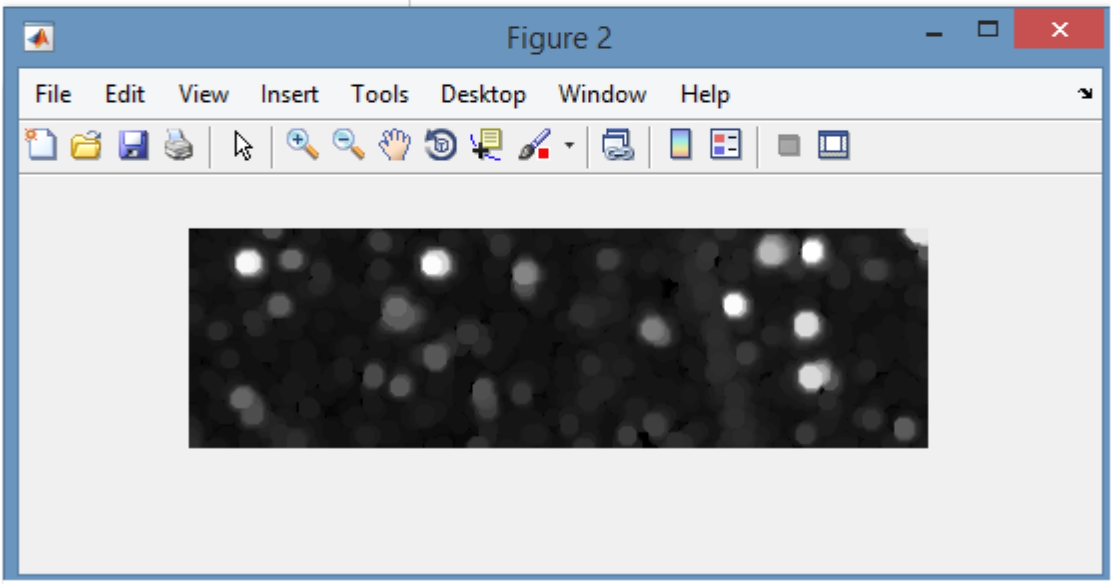


Image After Open operatrion

Viva Question

1.	What are morphological operators?
2.	What is opening and closing in image processing?
3.	What is an opening image?
4.	What are the types of morphology?
5.	What is morphological reconstruction?
6.	What is the meaning of morphological structure?
7.	What is another word for morphology?
8.	What is meant by digital image?
9.	What do you mean by image processing?
10.	Why is image processing important?

Beyond Syllabus

EXPERIMEMT No-1

OBJECTIVE: Color Image Segmentation algorithm development

SOFTWARE REQURIED: MATLAB 7.7

THEORY:-

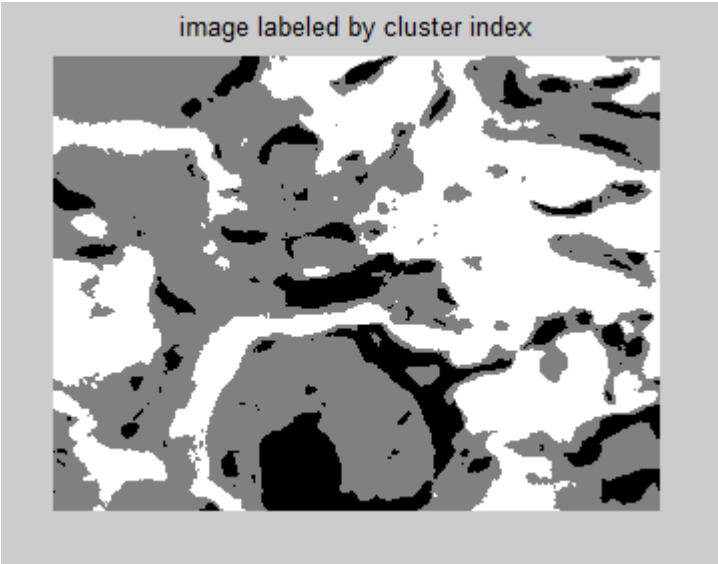
Image Segmentation:
Image segmentation is the division of an image into regions or categories, which correspond to different objects or parts of objects. Every pixel in an image is allocated to one of a number of these categories. A good segmentation is typically one in which:
pixels in the same category have similar grayscale of multivariate values and form a connected region, neighboring pixels which are in different categories have dissimilar values.
Segmentation is often the critical step in image analysis: the point at which we move from considering each pixel as a unit of observation to working with objects (or parts of objects) in the image, composed of many pixels. If segmentation is done well then all other stages in image analysis are made simpler.

A great variety of segmentation methods has been proposed in the past decades, and some categorization is necessary to present the methods properly here. A disjunct categorization does not seem to be possible though, because even two very different segmentation approaches may share properties that defy singular categorization. The categorization presented in this chapter is therefore rather a categorization regarding the emphasis of an approach than a strict division.
The following categories are used:
• Threshold based segmentation. Histogram thresholding and slicing techniques are used to segment the image. They may be applied directly to an image, but can also be combined with pre- and post-processing techniques.
• Edge based segmentation. With this technique, detected edges in an image are assumed to represent object boundaries, and used to identify these objects.
• Region based segmentation. Where an edge based technique may attempt to find the object boundaries and then locate the object itself by filling them in, a region based technique takes the opposite approach, by (e.g.) starting in the middle of an object and then “growing” outward until it meets the object boundaries.

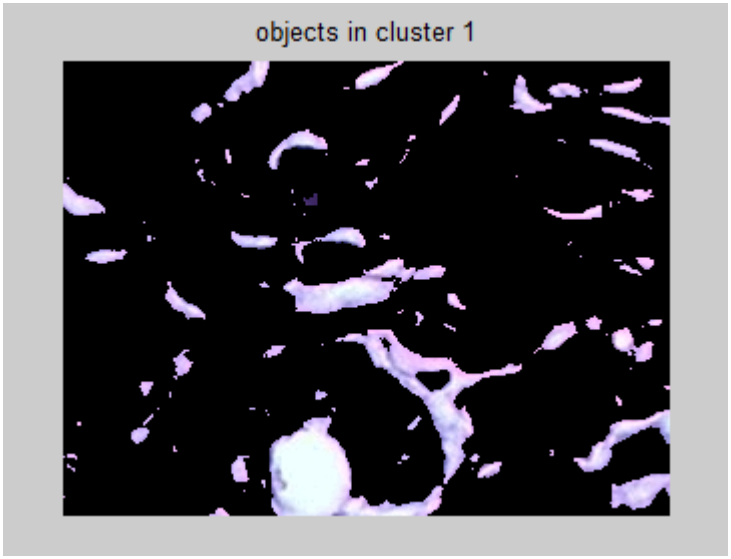
Matlab Code:

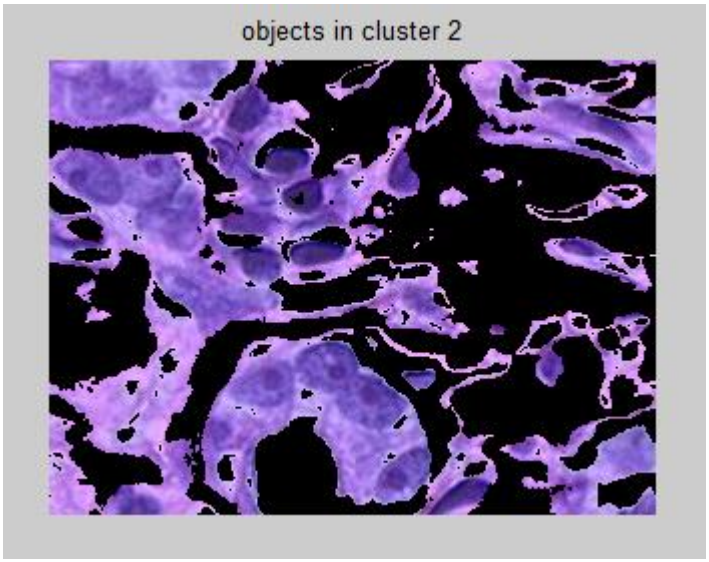
```
he = imread('hestain.png');
imshow(he), title('H&E image');
text(size(he,2),size(he,1)+15,...
    'Image courtesy of Alan Partin, Johns Hopkins University', ...
    'FontSize',7,'HorizontalAlignment','right');
 cform = makecform('srgb2lab');
lab_he = applycform(he,cform);
ab = double(lab_he(:,:,2:3));
```

```
nrows = size(ab,1);
ncols = size(ab,2);
ab = reshape(ab,nrows*ncols,2);
 nColors = 3;
% repeat the clustering 3 times to avoid local minima
[cluster_idx, cluster_center] = kmeans(ab,nColors,'distance','sqEuclidean', ...
                                 'Replicates',3);
pixel_labels = reshape(cluster_idx,nrows,ncols);
imshow(pixel_labels,[]), title('image labeled by cluster index');
segmented_images = cell(1,3);
rgb_label = repmat(pixel_labels,[1 1 3]);
 for k = 1:nColors
    color = he;
    color(rgb_label ~= k) = 0;
    segmented_images{k} = color;
end
 imshow(segmented_images{1}), title('objects in cluster 1');
imshow(segmented_images{2}), title('objects in cluster 2');
```



-


objects in cluster 1


objects in cluster 2

Viva Questions:

1. What do you understand by Digital Image Processing?
2. Explain image segmentation.
3. What is a pixel?
4. How many pixels are needed for a gray scale image and for a colored image?
5. How is segmentation technique useful?
6. What are the different segmentation techniques?
7. What is an object in an image?
8. Define cluster?
9. What are the benefits of segmenting an image?
10. Can we segment an image without recognizing an object?

Experiment No-2

OBJECTIVE: Image filtering in spatial and frequency domain.

SOFTWARE REQURIED : MATLAB 7.5

Theory:-

SPATIAL DOMAIN

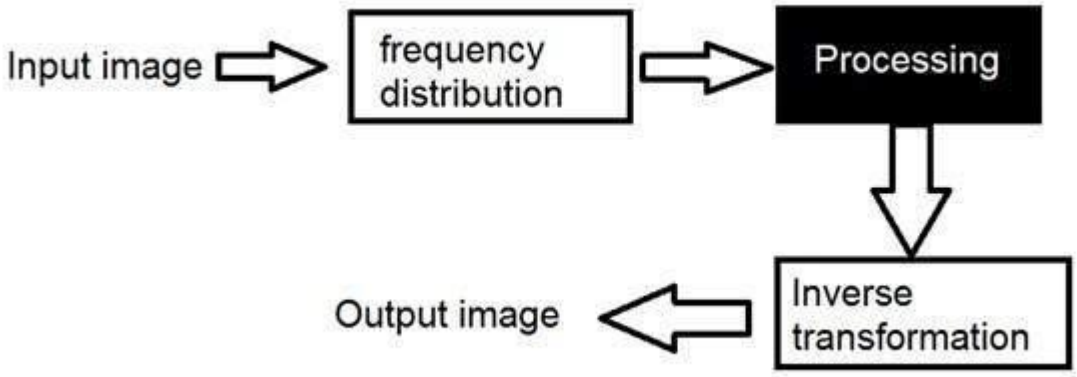
In simple spatial domain, we directly deal with the image matrix. Whereas in frequency domain, we deal an image like this.

- is manipulating or changing an image representing an object in space to enhance the image for a given application.
- Techniques are based on direct manipulation of pixels in an image
- Used for filtering basics, smoothing filters, sharpening filters, unsharp masking and laplacian

FREQUENCY DOMAIN

We first transform the image to its frequency distribution. Then our black box system perform what ever processing it has to performed , and the output of the black box in this case is not an image , but a transformation. After performing inverse transformation , it is converted into an image which is then viewed in spatial domain.

It can be pictorially viewed as



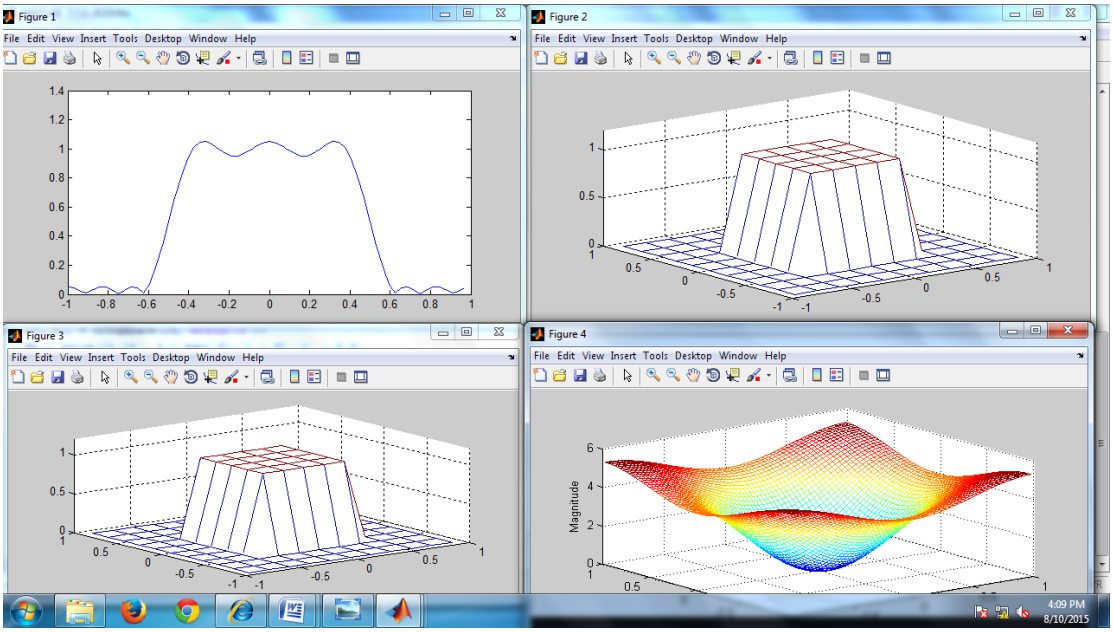
- Techniques are based on modifying the spectral transform of an image
- Transform the image to its frequency representation
- Perform image processing
- Compute inverse transform back to the spatial domain
- High frequencies correspond to pixel values that change rapidly across the image (e.g. text, texture, leaves, etc.)
- Strong low frequency components correspond to large scale features in the image (e.g. a single, homogenous object that dominates the image)

Program

```
b = remez(10,[0 0.4 0.6 1],[1 1 0 0])
h = ftrans2(b);
[H,w] = freqz(b,1,64,'whole');
colormap(jet(64))
plot(w/pi-1,fftshift(abs(H)))
figure, freqz2(h,[32 32])
Hd = zeros(11,11); Hd(4:8,4:8) = 1;
[f1,f2] = freqspace(11,'meshgrid');
mesh(f1,f2,Hd), axis([-1 1 -1 1 0 1.2]), colormap(jet(64))
h = fsamp2(Hd);
figure, freqz2(h,[32 32]), axis([-1 1 -1 1 0 1.2])
Hd = zeros(11,11); Hd(4:8,4:8) = 1;
[f1,f2] = freqspace(11,'meshgrid');
mesh(f1,f2,Hd), axis([-1 1 -1 1 0 1.2]), colormap(jet(64))
h = fwind1(Hd,hamming(11));
figure, freqz2(h,[32 32]), axis([-1 1 -1 1 0 1.2])
[f1,f2] = freqspace(25,'meshgrid');
Hd = zeros(25,25); d = sqrt(f1.^2 + f2.^2) < 0.5;
Hd(d) = 1;
mesh(f1,f2,Hd)
h =[0.1667    0.6667    0.1667
```

```
    0.6667   -3.3333    0.6667
    0.1667    0.6667    0.1667];
freqz2(h)
[H,f1,f2] = freqz2(h);
```

Result:



VIA-QUESTION

1 Explain Image Histogram?

2 Define Application of Image Histogram?

3 What is setting the point technique?

4 Define histogram Equalization?

5 What is the back projection?

6 What is histogram matching?

7 What process include by the histogram process?

8 Define Histogram remapping method?

9 Define use of subhistogram?

10 Define multipeak histogram equalization (MPHE)?

11 Write the direct program for reading the image from direct drive?

12 Explain PDF function?

13 Define syntax of the PDF function?

14 Explain CDF function?

15 Define the syntax of CDF function?

Experiment No-10

OBJECTIVE: Morphological operations in analyzing image structures.

SOFTWARE REQURIED : MATLAB 7.5

.

Theory:- ***The morphological transformations*** extract or modify the structure of the particles in an image. Such transformations can be used to prepare the particles for the quantitative analysis, for the analysis of the geometrical properties or for extracting the simplest modeling shapes and other operations. The morphological operations can also be used for expanding or reducing the particle dimensions, gap "filling" or closing inclusions, the averaging of the particle edges and others. The morphological transformations are separated in two main categories:

- ***binary morphological*** functions, which are applied for binary images
- ***gray-level morphological*** functions, which are applied for gray-level images

A binary image is an image which was segmented into an object region (which contains particles – typically the object pixels are coded by ones) and a background region (typically the background pixels are coded by zeros). The most simple segmentation process is by binary thresholding the gray-level images.

The basic morphological transformations include two types of processing: ***erosion*** and ***dilation***. The other types of transformations are obtained by combining these two operations.

Erosion

The ***erosion*** eliminates the isolated pixels from the background and erodes the boundaries of the object region, depending on the shape of the structuring element. For a given pixel *P0* we will consider the structuring element centered in *P0* and we will denote with *Pi* the neighboring pixels that will be taken into consideration (the ones corresponding to the coefficients of the structuring element having the value 1).

Dilation

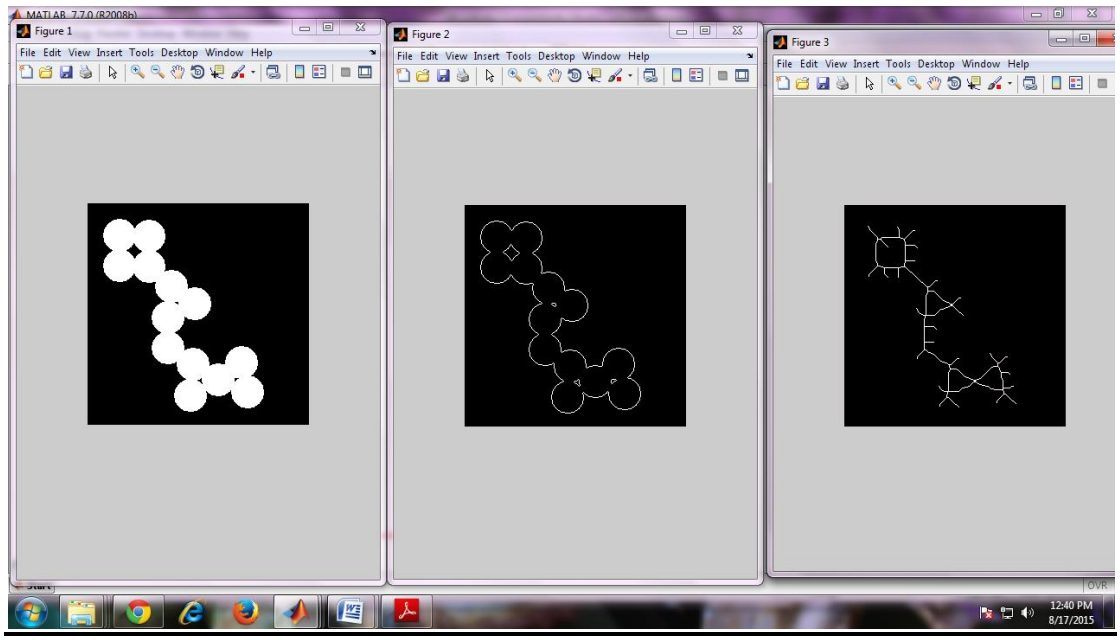
The dilation process has the inverse effect of the erosion process, because the particle dilation is equivalent to the background erosion. This process eliminates the small and isolated gaps from the particles and enlarges the contour of the particles depending on the shape of the structuring

element. For a given pixel *P0* we will consider the structuring element centered in *P0* and we will denote with *Pi* the neighboring pixels.

Program Code

```
BW = imread('circles.png');
imshow(BW);

BW2 = bwmorph(BW,'remove');
figure
imshow(BW2)

BW3 = bwmorph(BW,'skel',Inf);
figure
imshow(BW3)

BW1 = Array(imread('circles.png'));
figure
imshow(BW1)

BW2 = bwmorph(BW1,'remove');
figure
imshow(BW2)

BW3 = bwmorph(BW1,'skel',Inf);
figure
imshow(BW3)
```

Result:


MATLAB 7.7.0 (R2008b)
Figure 1
File Edit View Insert Tools Desktop Window Help
Figure 2
File Edit View Insert Tools Desktop Window Help
Figure 3
File Edit View Insert Tools Desktop Window Help
12:40 PM
8/17/2015

VIA-QUESTION

1 Define Morphological Operation?

2 How many transformations are available in morphological operation?

3 Define structuring element?

4 Explain basic morphological transformations of binary images?

5 Define Erosion Process?

6 Define Dilation process?

7 Explain the opening function in morphological?

8 Explain the Closing function in morphological?

9 Explain the hit miss function in morphological?

10 Explain Structuring function with image?

11 Provide Syntax of Morphological Operation?

12 Provide the expression for Morphological Operation?

13 Define Skel Operation?

14 Explain remove operation?

15 Explain Perimeter Determination?