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Fundamentals of Image processing & its applications

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Digital Image Processing

Why ? Two objective

1) To improve the quality of pictorial information for better human interpretation
2) Processing of image data for storage , transmission and representation for automatic machine interpretation

What is DIP ?

An image may be defined as a two-dimensional function f (x ,y) , where x and y are spatial coordinates and the amplitude of *f* at any pair of coordinates (x, y) is called the intensity or gray level of the image at that point.

When x ,y and the amplitude values of f are all finite , discrete quantities image is called a digital image and the processing of digital images by means of computer is called DIP. Image has to be converted into a discrete form using the process of sampling and quantization, known collectively as digitization.

Digital image is composed of a finite number of elements each has a particular location and value. These elements are referred as pixels

Digital Image Processing

Digital image representation

Matrix is used. image is written as f(x,y) first dimension is rows and second dimension is column

Image file formats

Simplest way of storing image data is by using a 2D array of pixel intensities . This is referred as bitmap

Raster file format

GIF (graphics interchange format) : lossless compression (LZW)

JPEG (joint photographics expert group)

PNG (portable network graphics)

DICOM : digital imaging and communication : use in medical imaging

Three related fields

Computer Graphics : synthesis images from 3D model of the objects i.e. input is 3D model and output is 2D image

DIP : input is image and output is also image

Computer vision : input is 2D image and output is 3D

Machine vision: to interpret the image and to extract its physical , geometric and topological properties. Automated visual inspection

Computer vision : scene understanding

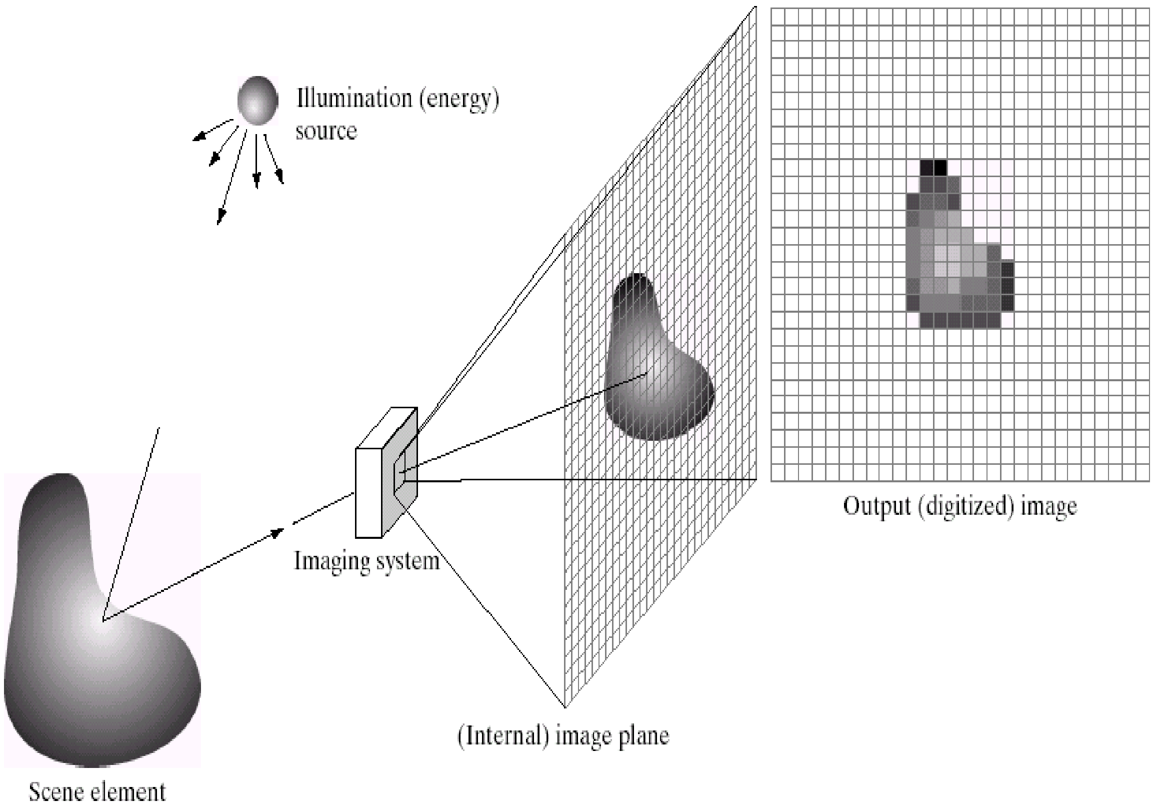
Steps of DIP

Image acquisition
Image enhancement
Image Segmentation
Feature extraction and object description
Pattern recognition

Image acquisition using sensor arrays

Same arrangement found in digital camera. Sensor for these cameras is a CCD (charged couple device) array . The response of sensor is proportional to light energy projected onto the surface of the sensor.

Here motion is not required



a b c d e

FIGURE 2.15 An example of the digital image acquisition process. (a) Energy ("illumination") source. (b) An element of a scene. (c) Imaging system. (d) Projection of the scene onto the image plane. (e) Digitized image.

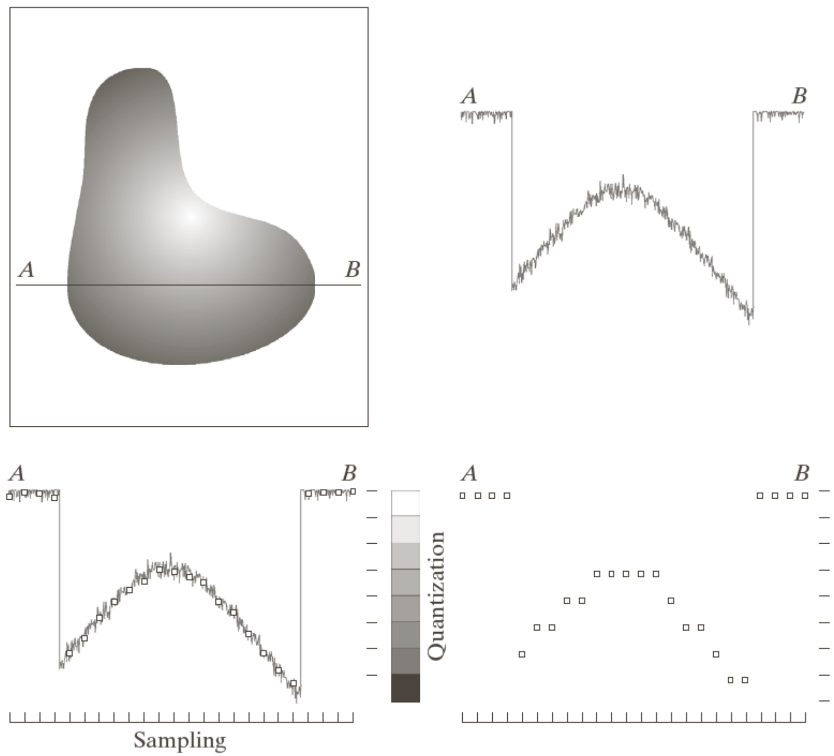
Digital Image Processing

Analog image processing is an area that deals with the processing of analog signal (continuous signal varying with time) using analog circuits. The imagining system that use film for recording images are also known as analog imagining systems. e.g. medical imagining.

The analog signal is often sampled, quantized and converted into digital form using a digitizer. We have to sample the function in both coordinates and in amplitude

Sampling :digitizing the coordinate values is called sampling

Quantization : converting the sampled analog value into a discrete value integer



a b
c d

FIGURE 2.16 Generating a digital image. (a) Continuous image. (b) A scan line from A to B in the continuous image, used to illustrate the concepts of sampling and quantization. (c) Sampling and quantization. (d) Digital scan line.

Three types of processes

Low level : Also known as image enhancement or preprocessing

Image Enhancement

- Bring out detail that is obscured
- Highlight certain features of interest of an image
- It perform primitive operations such as
- Noise removal , Contrast enhancement and image sharpening
- Inputs and outputs are images
- Subjective area of image processing

Image restoration

Image restoration refers to removal or minimization of known degradations in an image.

Improve appearance of an image

It is objective

This include deblurring of images degraded by the limitations of a sensor or its environment,

Techniques are based on mathematical or probabilistic models of image degradation. Enhancement on the other hand is based on human subjective preferences regarding what constitutes a good enhancement result

Mid-Level processing

It involves tasks such as

segmentation i.e. partitioning an image into regions or objects. Output of segmentation is raw pixels.

Description : describes in a form suitable for computer processing. Boundary : when focus is on shape or regional rep

Classification or recognition of individual objects

Input is images but outputs are attributes like edges , contours and identity of individual objects

Higher Level processing

Involves making sense of an ensemble of recognized objects

It is also known as image analysis

DIP scope is limited to

Image enhancement

Extract attributes

Recognition of individual objects

e.g. **automated analysis of text**

- **Acquiring an image of the area containing text**
- **Preprocessing**
- **Extracting (segmenting) the individual characters**
- **Describing the characters in a from suitable for computer processing**
- **Recognizing those individual characters**

Image Enhancement

To process an image so that the result is more suitable than the original image for a specific application

Image enhancement approaches fall into two broad categories

1) Spatial domain : image plane itself i.e. pixels are directly modified.

2) Frequency domain : modifying the Fourier transform of an image

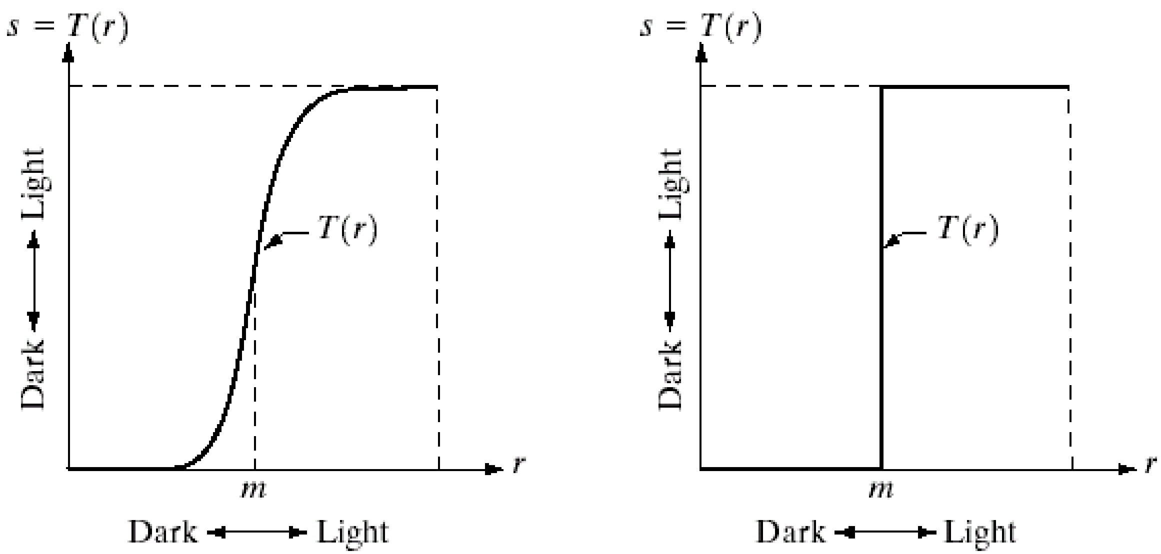
Two types of spatial domain enhancement

1. Intensity transformation
2. Spatial filtering

Spatial domain enhancement methods will be denoted by the expression

$$g(x, y) = T[f(x, y)]$$

Where $f(x, y)$ is the input image, $g(x, y)$ is the processed image and T is an operator on f



a b

FIGURE 3.2 Gray-level transformation functions for contrast enhancement.

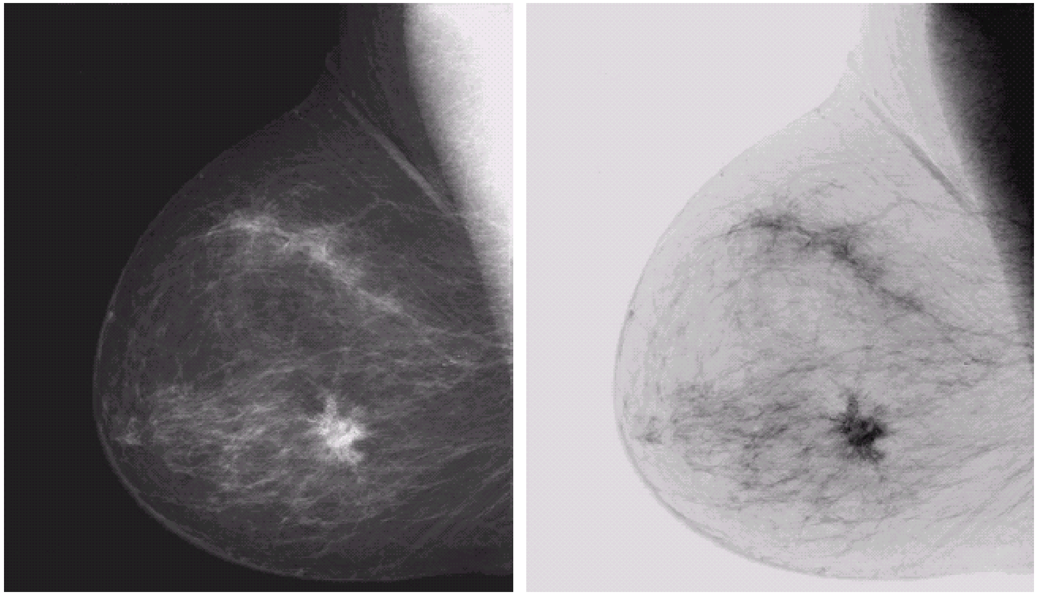
Some basic Gray Level transformations

Image Negatives

The negative of an Input image with gray levels in the range [0,L-1]

s= L-1-r

This type of processing is useful for enhancing white or gray detail embedded in dark regions of an image, especially when the black areas are dominant in size



a b

FIGURE 3.4 (a) Original digital mammogram. (b) Negative image obtained using the negative transformation in Eq. (3.2-1). (Courtesy of G.E. Medical Systems.)

It is easier to analyze the breast tissue in negative image

Log Transformations

$s=c*\log(1+r)$

Where c is a constant and $r>=0$

Maps narrow range of low gray-level values in input image into a wider range of output levels.

It expands the value of dark pixels in an image while compressing the higher level values.

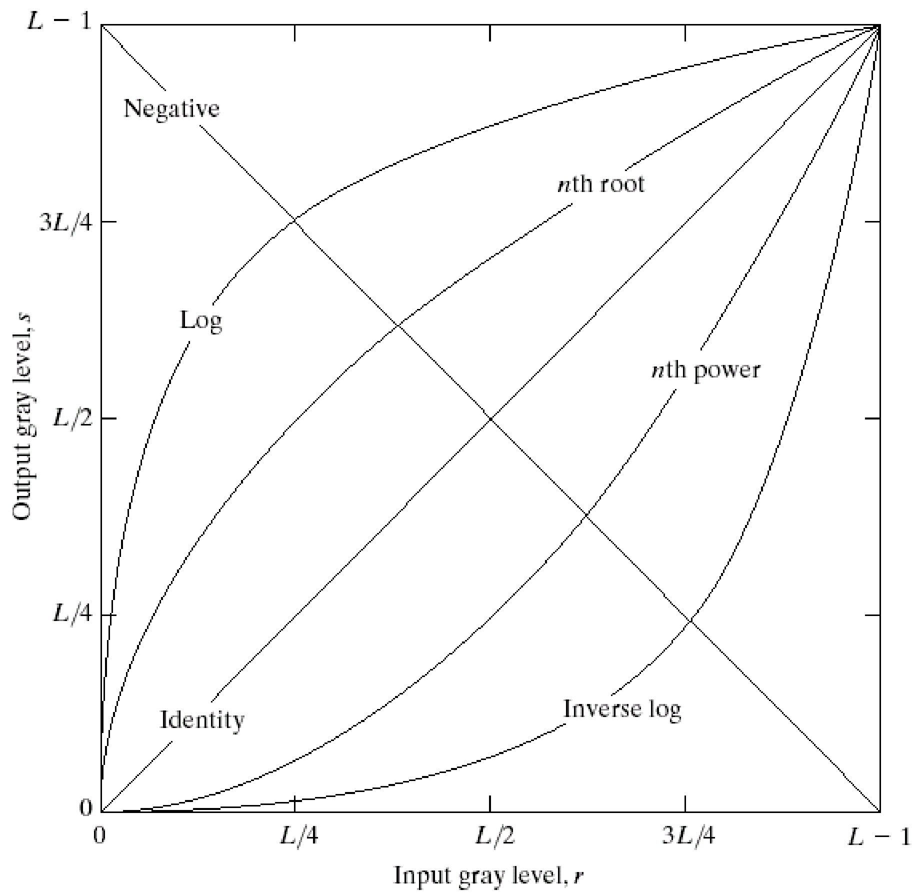
The opposite is true of the inverse log transformation

It compress the dynamic range of images with large variations in pixel values

Power-Law Transformations

$s=c(r)^{gamma}$

FIGURE 3.3 Some basic gray-level transformation functions used for image enhancement.



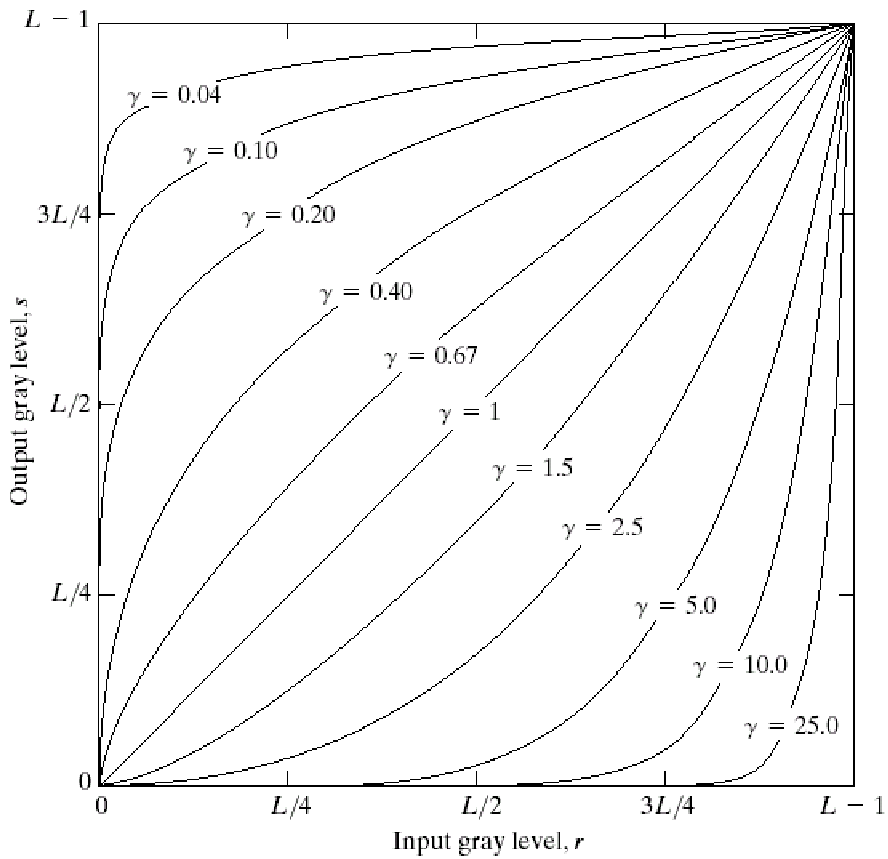


FIGURE 3.6 Plots of the equation $s = cr^{\gamma}$ for various values of γ ($c = 1$ in all cases).

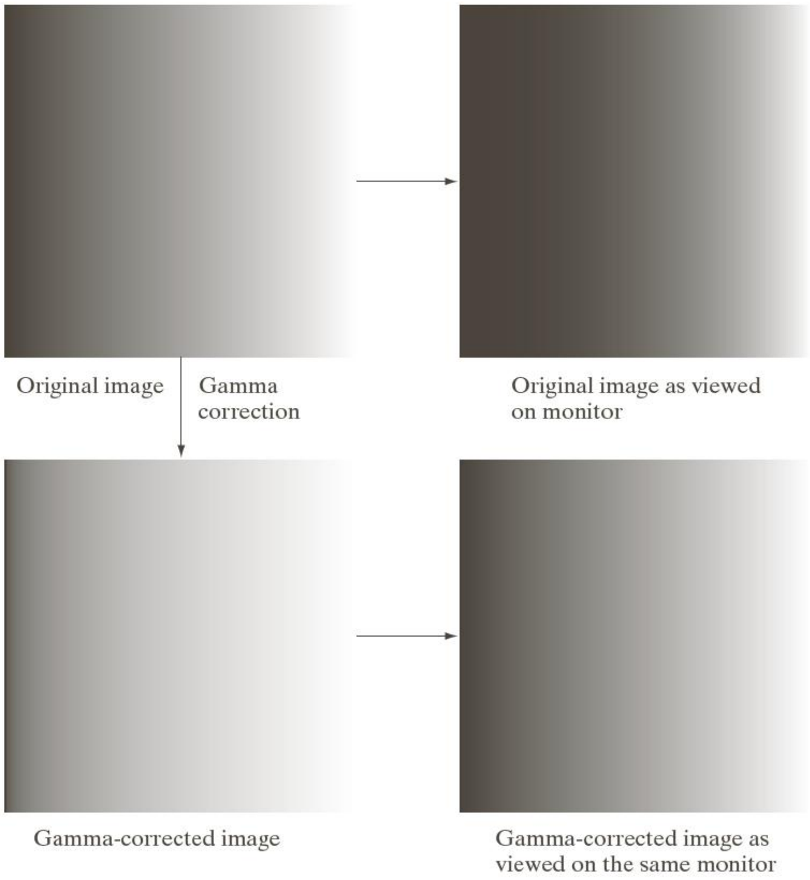
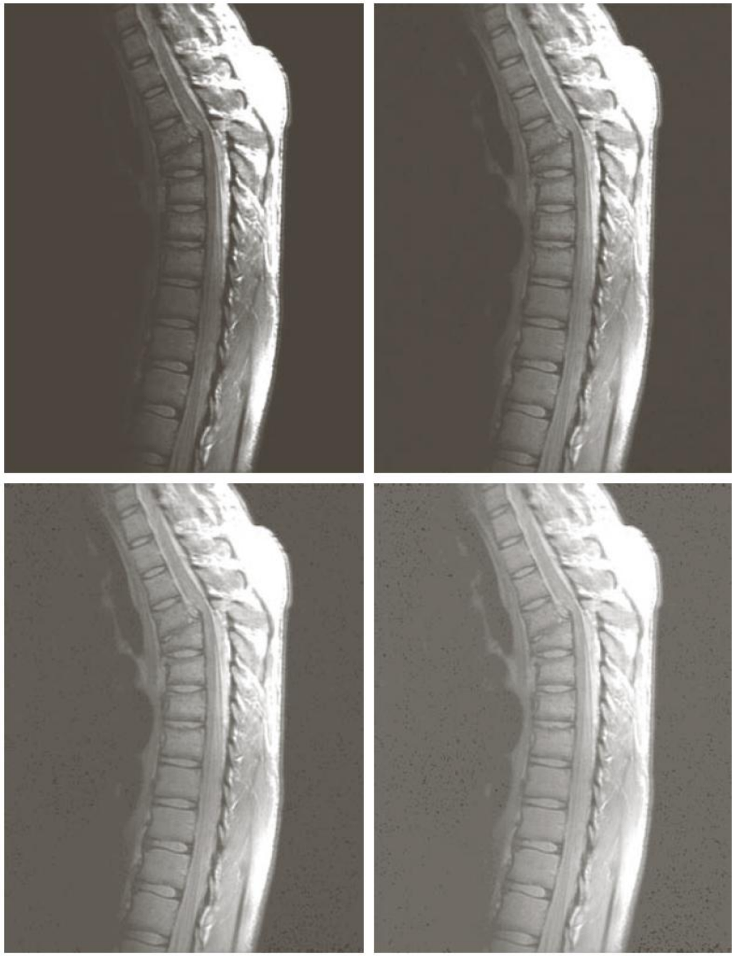


FIGURE 3.7 (a) Intensity ramp image. (b) Image as viewed on a simulated monitor with a gamma of 2.5. (c) Gamma-corrected image. (d) Corrected image as viewed on the same monitor. Compare (d) and (a).

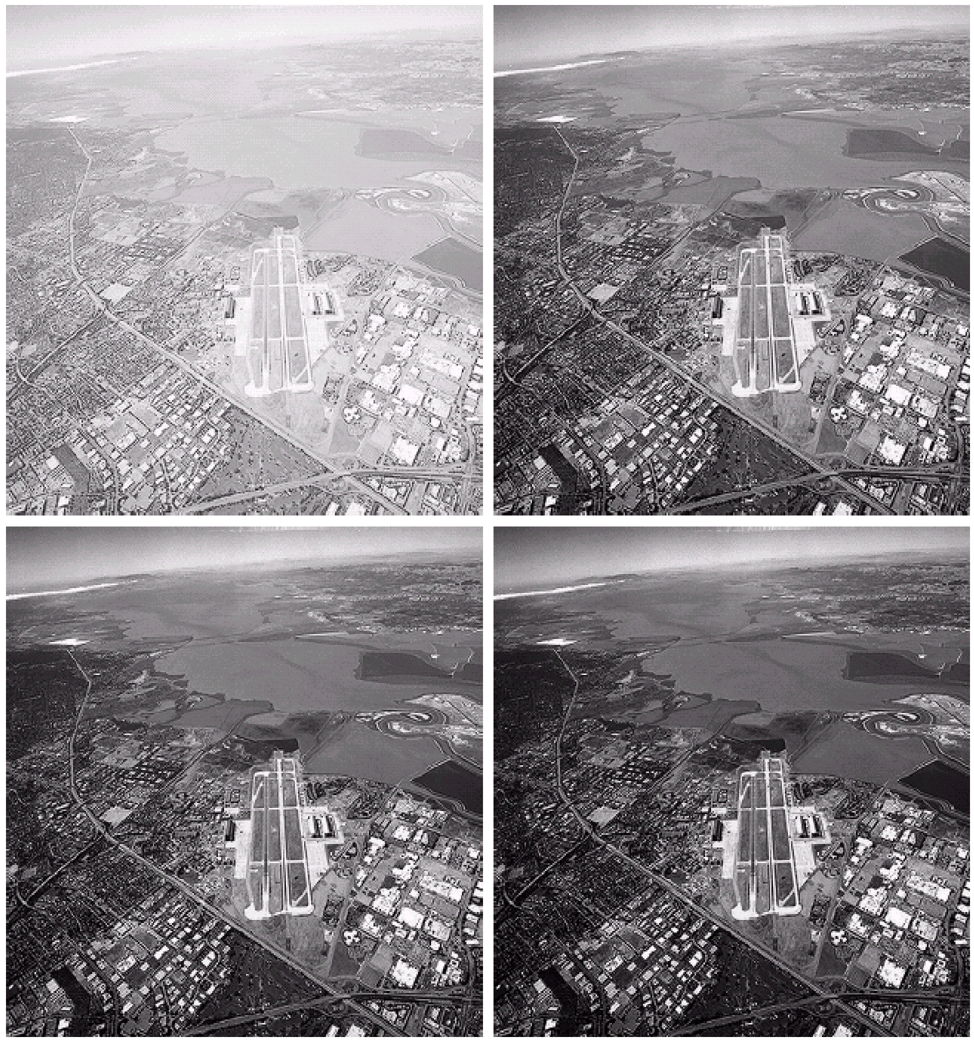
Contrast manipulation. As gamma decreasing more detail become visible. Better result for gamma =0.4. further reduce in gamma reduce contrast



a b
c d

FIGURE 3.8 (a) Magnetic resonance image (MRI) of a fractured human spine. (b)–(d) Results of applying the transformation in Eq. (3.2-3) with $c = 1$ and $\gamma = 0.6, 0.4,$ and 0.3, respectively. (Original image courtesy of Dr. David R. Pickens, Department of Radiology and Radiological Sciences, Vanderbilt University Medical Center.)

Image has washed-out appearance. So compression of intensity levels is desirable. Suitable results ware obtained with gamma=3 and 4. increase contrast



a b
c d

FIGURE 3.9 (a) Aerial image. (b)–(d) Results of applying the transformation in Eq. (3.2-3) with $c = 1$ and $\gamma = 3.0, 4.0$, and 5.0, respectively. (Original image for this example courtesy of NASA.)

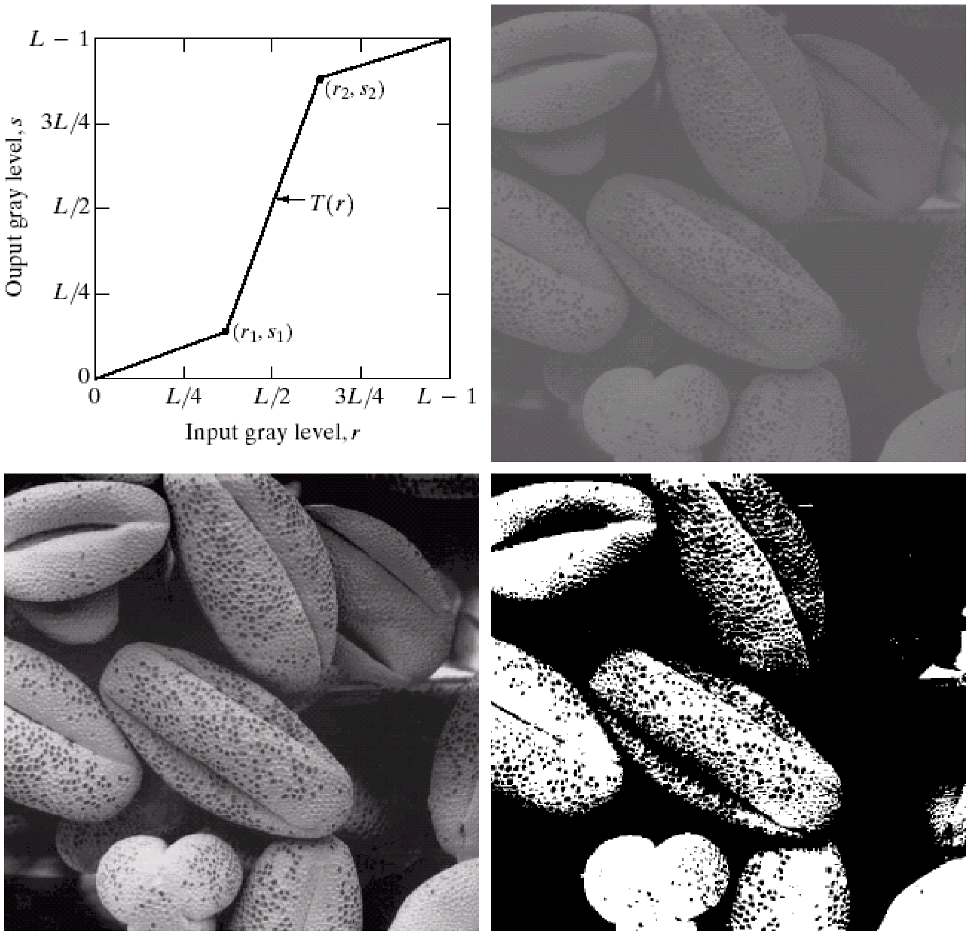
Piecewise-Linear transformation

Contrast Stretching

Poor illumination, lack of dynamic range in the imaging sensor or wrong setting of a lens aperture

Contrast stretching is the process that expands the range of intensity levels in an image so that it spans the full intensity range of the recording medium or display device. Increase dynamic range of the grey levels

The locations (r1,s1) and (r2,s2) control the shape of the transformation



a b
c d

FIGURE 3.10 Contrast stretching. (a) Form of transformation function. (b) A low-contrast image. (c) Result of contrast stretching. (d) Result of thresholding. (Original image courtesy of Dr. Roger Heady, Research School of Biological Sciences, Australian National University, Canberra, Australia.)

If r1=s1 and r2=s2 no change in grey level

r1=r2 , s1=0 and s2=L-1 then transformation becomes a thresholding function that creates binary image

In general r1<=r2 and s1<=s2 so the transformation function is single valued and monotonically increasing

If (r1,s1)=(rmin,0) and (r2,s2) = (rmax,L-1) then input image is stretched to the full range

Histogram

Find out the number of pixels having grey level r_k where rk is in the range form 0 to L-1

Histogram is discrete function denoted as

$h(r_k)=n_k$

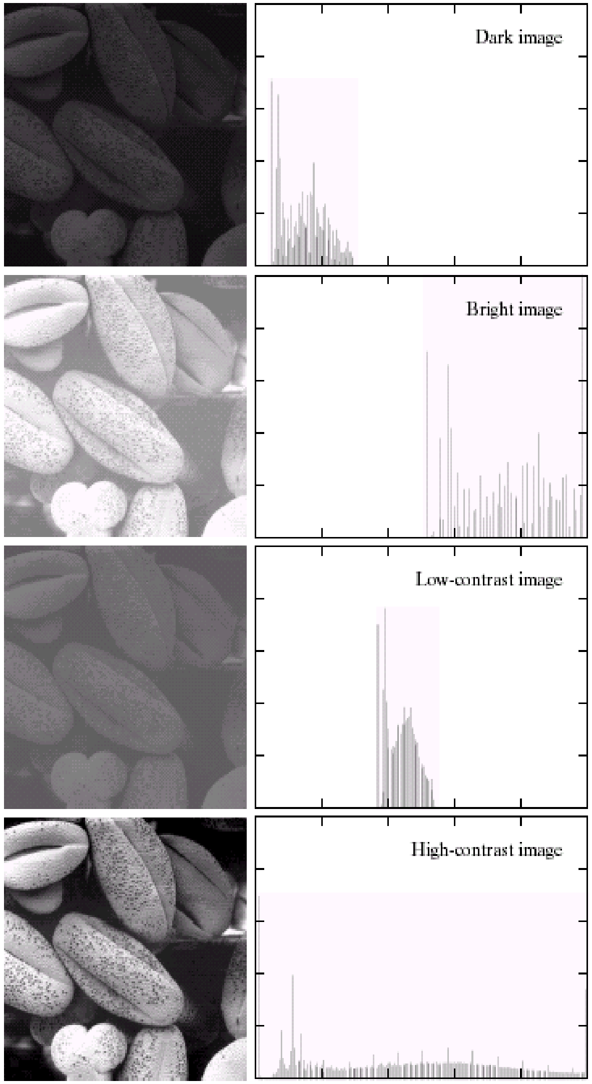
Normalized histogram is given as

$p(r_k) = n_k/n$ where n is total number of pixels in image. n=MXN

P(rk) is an estimate of the probability of occurrence of intensity rk in an image

Histogram of the image tells us whether it is dark ,light ,low contrast or high contrast. We can enhance image by applying appropriate transformation function.

Histogram provide image statistics which is useful for image compression and segmentation


Dark image
Bright image
Low-contrast image
High-contrast image

Histogram processing

An image whose pixels tend to occupy the entire range of possible intensity levels and in addition tend to be distributed uniformly.

Such image shows a great deal of gray level detail and has high dynamic range.
Is it possible to develop a transformation function that can automatically achive this effect based only on information available in the histogram of the input image?

Yes and this is called Histogram equalization

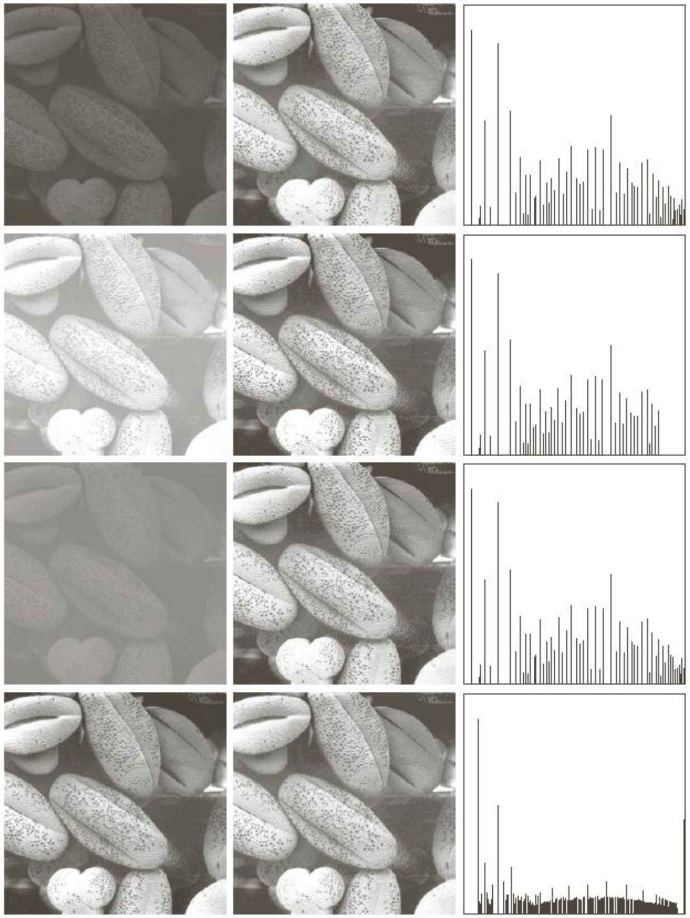


FIGURE 3.20 Left column: images from Fig. 3.16. Center column: corresponding histogram-equalized images. Right column: histograms of the images in the center column.

```
1. calculate histogram
loop over i ROWS of input image
loop over j COLS of input image
k = input_image[i][j]
hist[k] = hist[k] + 1
end loop over j
end loop over i
2. calculate the sum of hist
loop over i gray levels
sum = sum + hist[i]
sum_of_hist[i] = sum
end loop over i
3. transform input image to output image
n = (ROWS x COLS)
L = number of gray levels in output image
loop over i ROWS
loop over j COLS
k = input_image[i][j]
out_image[i][j] = (L/n) x sum_of_hist[k]
end loop over j
end loop over i
```

Basics of spatial filtering

we have discussed enhancement techniques in which enhancement at any point in image depends only on gray level at that point. These techniques are known as point processing.

Another approach in which to use a function of the values of f in predefined neighborhood of (x,y) to determine the value of g at (x,y)

In this approach filter or mask (also known as kernel, window or template) is used

Size of mask determine size of neighborhood and mask coefficient determine the nature of process.

Enhancement techniques based on this approaches are known as mask processing or filtering

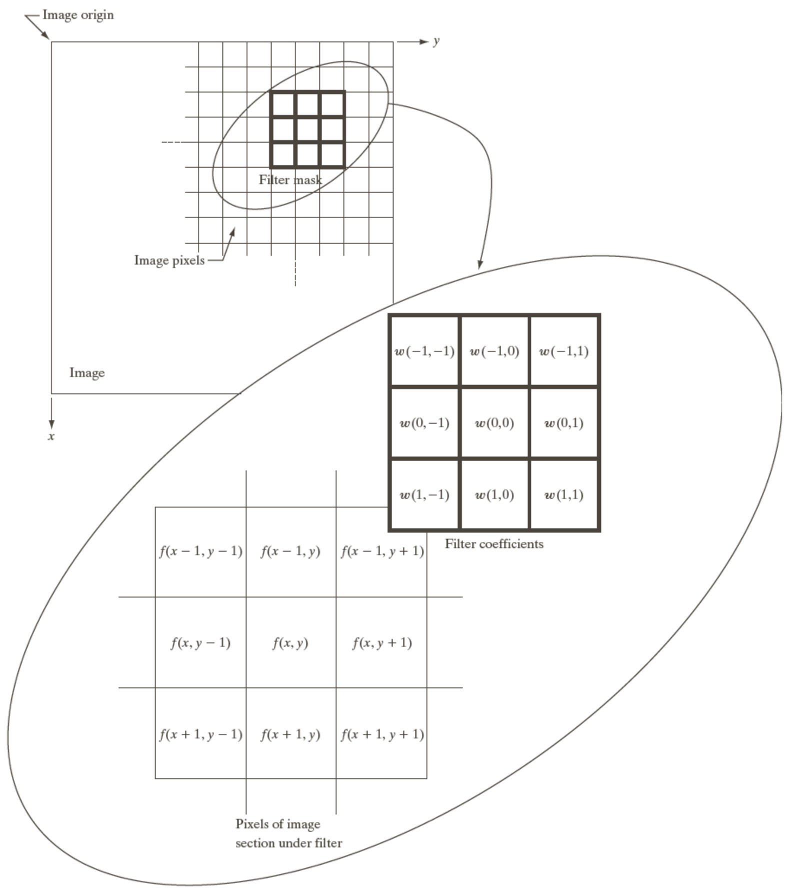


FIGURE 3.28 The mechanics of linear spatial filtering using a 3×3 filter mask. The form chosen to denote the coordinates of the filter mask coefficients simplifies writing expressions for linear filtering.

Smoothing Spatial Filtering

The response of linear spatial filtering is given by a sum of products of the filter coefficients and the corresponding image pixels in the area spanned by the filter mask

Linear Filtering of an image f of size M X N with a filter mask of size mXn is given by

$$g(x,y) = \sum\sum w(s,t) f(x+s, y+t)$$

$a=(m-1)/2$ and $b=(n-1)/2$

1/16 X

1	2	1
2	4	2
1	2	1

Low Pass Filter : remove noise.

Blur High frequency

do averaging 1/9 X

1	1	1
1	1	1
1	1	1

Smoothing filters are used in preprocessing steps such as removal of small details from an image prior to large object extraction and bridging of small gaps in lines or curves.

They reduced sharp transitions in gray levels. Random noise consists of sharp transitions in gray levels. So smoothing filters are used for noise reduction

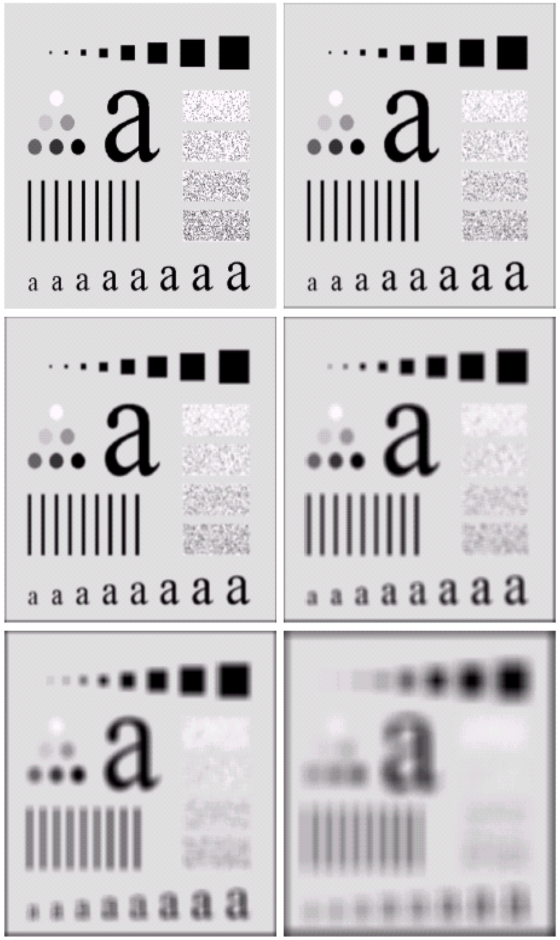
Disadvantage

Edges are blur

A spatial averaging filter in which all coefficients are equal is some times called a box filter.

Another kind of filter known as weighted avarege.

-to reduce blurring effect.

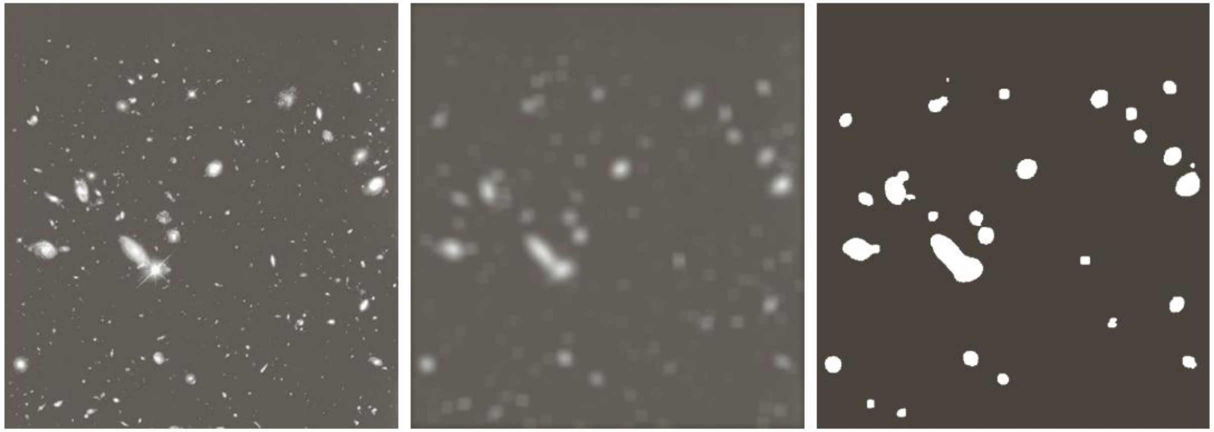


Averaging filter with masks of sizes n=3 ,5,9,15 and 35 respectively

Small detailed is removed using different size mask

When mask size is larger than smaller object is removed

Intensity of smaller objects blend with the background and larger objects become bloblike and easy to detect.



a b c

FIGURE 3.34 (a) Image of size 528 × 485 pixels from the Hubble Space Telescope. (b) Image filtered with a 15 × 15 averaging mask. (c) Result of thresholding (b). (Original image courtesy of NASA.)

Median filter

Non linear filter or order statistics

Sort the values of pixels in question and its neighbors

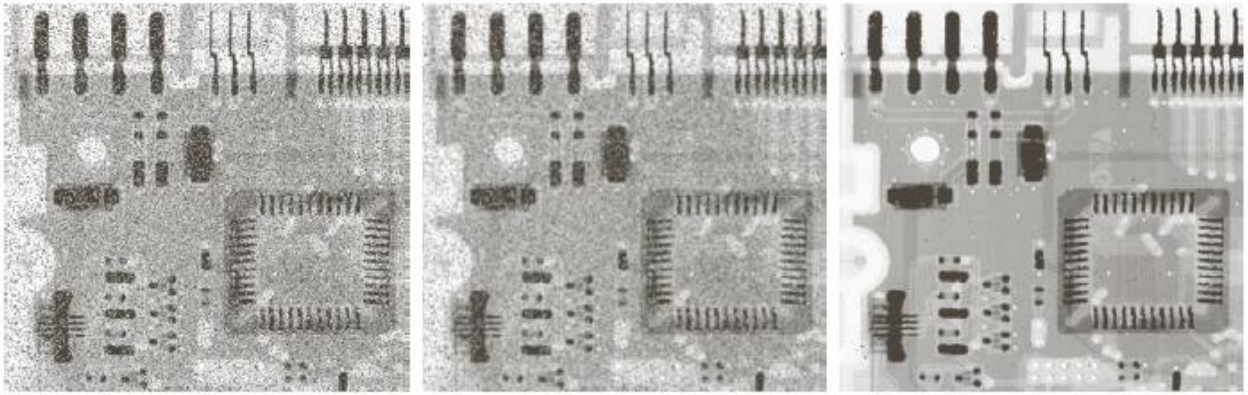
Replace the value of centre pixel with median

Median of a set of values is such that half values in the set are less than or equal to median and half are greater than or equal to median

Determine their median .eg. In 3X3 neighborhood the median is the 5th largest value

They provide good result in case of random noise. Salt and peper noise they give good result with less blurring

Forces points with distinct gray levels to be more like their neighbors



a b c

FIGURE 3.35 (a) X-ray image of circuit board corrupted by salt-and-pepper noise. (b) Noise reduction with a 3×3 averaging mask. (c) Noise reduction with a 3×3 median filter. (Original image courtesy of Mr. Joseph E. Pascente, Lixi, Inc.)

Sharpening spatial filter : is to highlight fine detail in an image or to enhance detail that has been blurred

Also known as High pass filter

Sharpening filters are based on first and second order derivatives

Doing differentiation. i.e differences

First order derivative of a one-dimensional function f(x) is

$df/dx=f(x+1)-f(x)$

Second order derivative in x-direction

$d^2f/dx^2 = f(x+1,y) + f(x-1,y) - 2f(x,y)$

$d^2f/dy^2 = f(x,y+1) + f(x,y-1) - 2f(x,y)$

First order derivative

1) Must be zero in flat segments
2) Must be nonzero at the onset of a gray level step or ramp
3) Must be nonzero along ramps

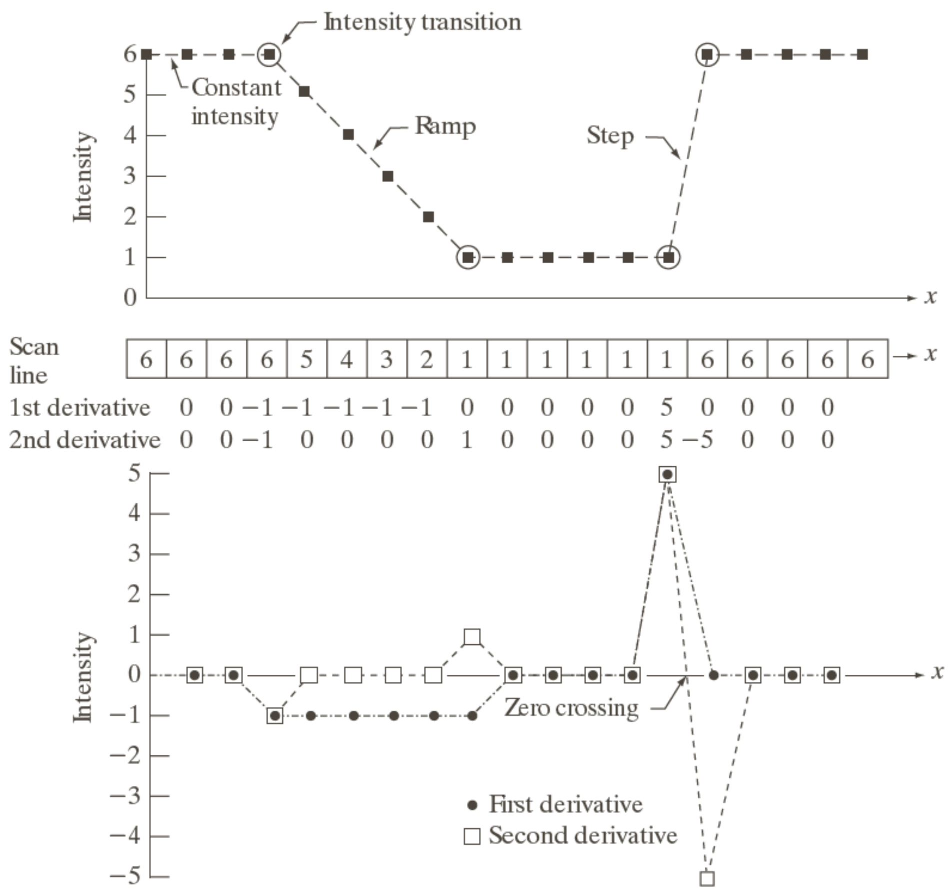
Second order derivative

1) Must be zero in flat areas
2) Must be nonzero at the onset and end of a gray level step or ramp
3) Must be zero along ramps of constant slope.

Observations

A second-order derivative is much more aggressive than a first-order derivative in enhancing sharp changes. Second order derivative is useful to enhance fine detail (including noise) much more than a first order derivative

First order derivatives produce thicker edges and have stronger response to a gray-level step



a
b
c

FIGURE 3.36 Illustration of the first and second derivatives of a 1-D digital function representing a section of a horizontal intensity profile from an image. In (a) and (c) data points are joined by dashed lines as a visualization aid.

1) First order derivatives generally produce thick edges in image
2) Second order derivatives have a stronger response to fine detail such as thin lines and isolated points
3) Second order derivatives produce a double response at step changes in gray level

Second order derivatives are better for image enhancement because they enhance fine detail in image

First order derivatives are use for edge extraction

Second order derivative OR

Laplacian opreator is defined as (isotropic)

$\Delta^2 f = d^2f/dx^2 + d^2f/dy^2$ derivatives of any order is linear operations

$\Delta^2 f = [f(x+1,y) + f(x-1,y) + f(x,y+1) + f(x,y-1)]-4f(x,y)$

Filter mask used to implement Laplacian

Produce noisier result

0	1	0
1	-4	1
0	1	0

1	1	1
1	-8	1
1	1	1

It is used to highlights gray level discontinuities and deemphasizes regions with slowly varying gray levels

Background features can be recovered while still preserving the sharpening effect of the laplican operator by adding original and laplacian images

G(x,y)=f(x,y)+c[Δ2f(x,y)]

C= -1 if laplacian filter with mask with negative value in centre

Otherwise C=1

0	1	0
1	−4	1
0	1	0

1	1	1
1	−8	1
1	1	1

0	−1	0
−1	4	−1
0	−1	0

−1	−1	−1
−1	8	−1
−1	−1	−1

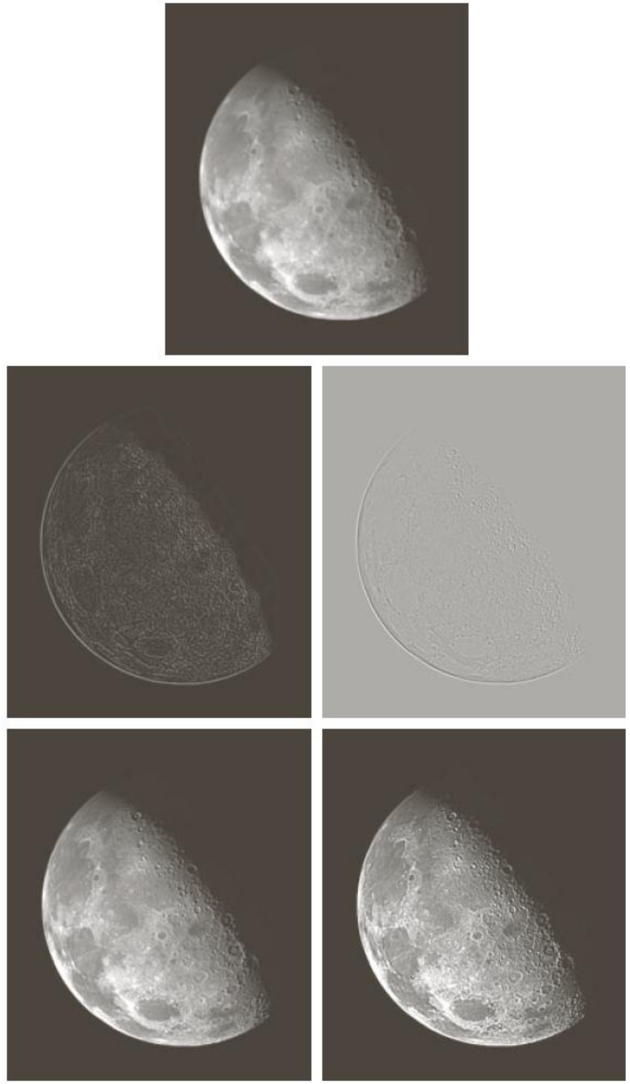


FIGURE 3.38 (a) Blurred image of the North Pole of the moon. (b) Laplacian without scaling. (c) Laplacian with scaling. (d) Image sharpened using the mask in Fig. 3.37(a). (e) Result of using the mask in Fig. 3.37(b). (Original image courtesy of NASA.)

First order derivatives

Also known as Gradinet used to enhance prominent edges. It has stonger response in area of gray level transitions (gray level ramps and steps)

It always point the direction of maximum rate of change of f at cordinates (x,y)

Magnitude give rate of increase of f(x,y) per unit distance in the direction of Δf

$\Delta f=[Gx,Gy]^T=[df/dx\ df/dy]^T$

$mag(\Delta f) =[Gx^2 +Gy^2]^{1/2}$

z1	z2	z3
z4	z5	z6
z7	z8	z9

For 3X3 mask gradient at z5 is given as

$\Delta f = |(z7+2z8+z9)-(z1+2z2+z3)| +|(z3+2z6+Z9)-(z1+2z4+z7)|$

Sobel operator

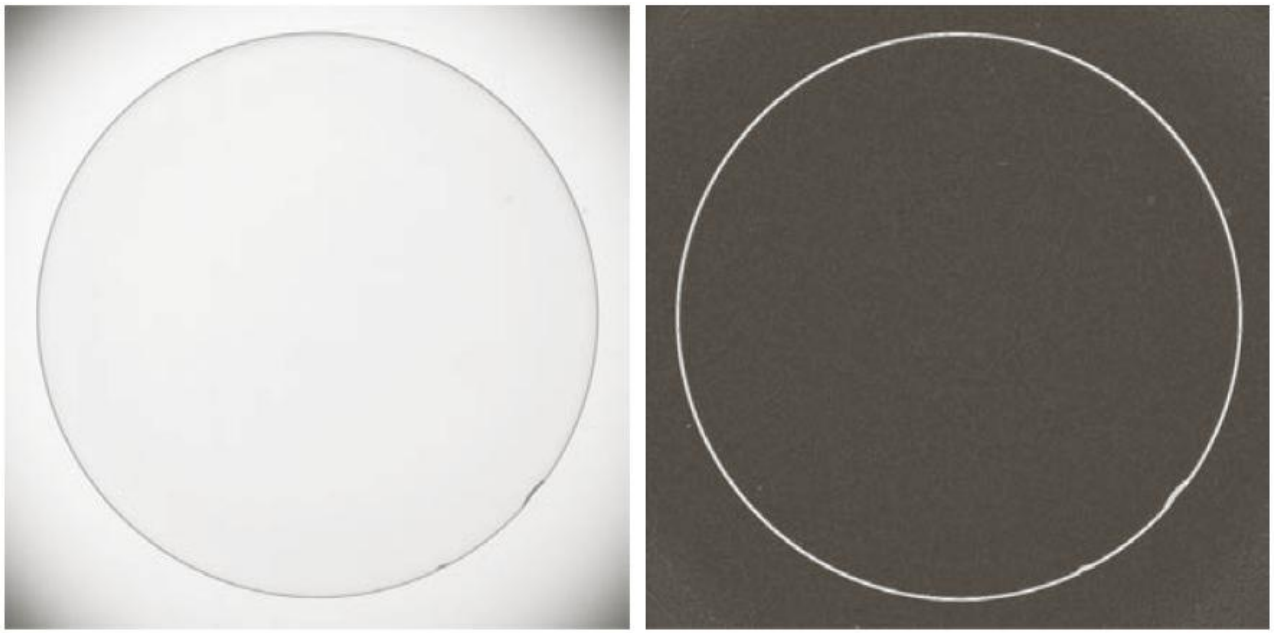
X direction and y direction gradient can be found using following mask

Wight of value 2 is to achieve some smoothing by giving more importance to the center point

Sum of all coefficients in masks sum to zero indicating that they would give zero response of 0 in an area of constant gray level

-1	0	1
-2	0	2
-1	0	1

-1	-2	-1
0	0	0
1	2	1



a b

FIGURE 3.42
(a) Optical image of contact lens (note defects on the boundary at 4 and 5 o'clock).
(b) Sobel gradient.
(Original image courtesy of Pete Sites, Perceptics Corporation.)

Implementation in C

```
 for(i=1; i<rows-1; i++){

   for(j=1; j<cols-1; j++){
sum = 0;
for(a=-1; a<2; a++){
for(b=-1; b<2; b++){
sum = sum +
img[i+a][j+b] *
quick_mask[a+1][b+1];
}
}
if(sum < 0) sum = 0;
if(sum > 255) sum =255;
out_img[i][j] = sum;
} /* ends loop over j */
} /* ends loop over i */
```

Image Enhancement in the frequency Domain

Fourier Transforms is tool to covert signal from spatial domain to frequency domain

Fourier series : When signal is periodic it can be represented as the sum of sines and /or cosines of different frequency multiplied by a different coefficients

Fourier Transform : when signal is not periodic but finite duration like images

Why?

Some information is not available in one domain

Frequency means intensity variation. So if we want remove slow intensity variation or faster variation , it is possible in frequency domain because it represent intensity variations

Discrete Fourier Transform (DFT)

Image is discrete so discrete Fourier transform of image f(x,y) of size MXN is given by

F(u,v)=1/MN

$$\sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f(x,y)e - j2\prod(ux/M + vy/N)$$

U=0,1,….M-1 and v=0,1,2,….N-1

Inverse Fourier Transform is given as

f(x,y) =

$$\sum_{u=0}^{M-1}\sum_{v=0}^{N-1} F(u,v)ej2\pi(ux/M + vy/N)$$

Magnitude of Fourier transform called Fourier spectrum or frequency spectrum

$F(u,v)=|F(u,v)|\ e^{jphy(u,v)}$

$|F(u,v)|=sqrt(R^2 + I^2)$ is called fourier spectrum

¢(u,v)=arctan(I/R) is phase angle

Power spectrum $P(u,v)= \{F(u,v)|^2$

Filtering in Frequncy domain

Filtered image=inverse(F(u,v)H(u,v))

Convolution Theorem :relation between spatial and frequency domain

$$f(x,y)\otimes h(x,y) \Leftrightarrow F(u,v)H(u,v)$$

Filtering in frequency domain

-frequency is directly related to rate of change

-Fourier transform shows patterns of intensity variations in image

-slowest varying frequency component (u=v=0) corresponds to the average gray level of an image

-as we move away from the origin of the transform, the low frequencies correspond to the slowly varying components of an image

-as we move away further higher frequencies begin to correspond to faster and faster gray level changes in the image

Filtering in Frequncy domain

Filtered image=inverse(F(u,v)H(u,v))

Convolution Theorem

$$f(x,y)\otimes h(x,y)\Leftrightarrow F(u,v)H(u,v)$$

The narrower the frequency

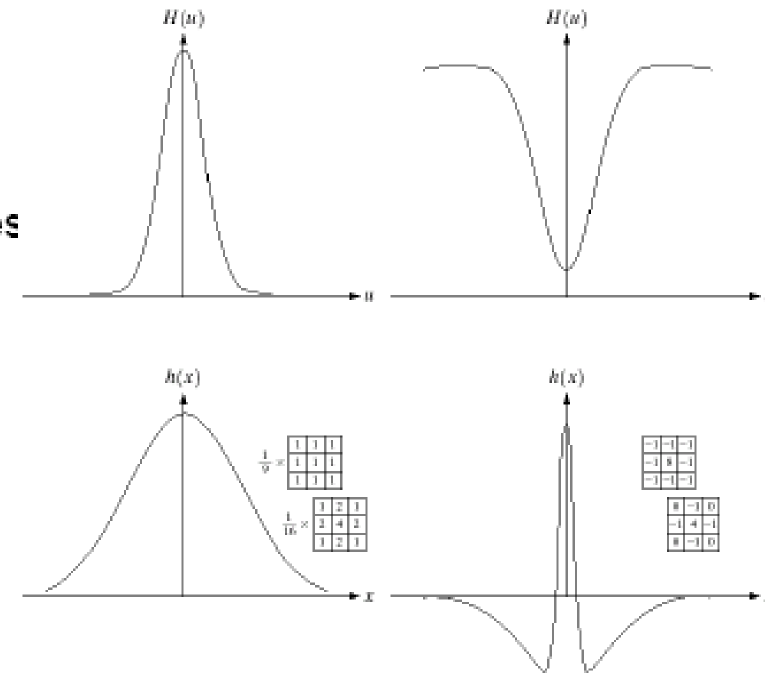
Domain filter, the more it will

Attenuate low frequencies, res

In increased blurring.

In spatial domain this means

A larger mask



a b
c d

FIGURE 4.9 (a) Gaussian frequency domain lowpass filter. (b) Gaussian frequency domain highpass filter. (c) Corresponding lowpass spatial filter. (d) Corresponding highpass spatial filter. The masks shown are used in Chapter 3 for lowpass and highpass filtering.

Filtering in frequency domain

-multiply the input image by $(-1)^{x+y}$ to centre the transform

$F[f(x,y)\,(-1)^{x+y}]=F(u-M/2,v-N/2)$

-compute $F(u,v)$

-multiply $F(u,v)$ by a filter function $H(u,v)$

-compute the inverse DFT of the previous result

-Obtain the real part of the above result

-Multiply the above result by (-1)x+y

Mathematical Morphology (1/2)

- The word morphology deals with the form and structure (usually of animals and plants in biology).
- Mathematical morphology is a tool for extracting image components that are useful in the representation and description of region shape like boundaries, skeletons and convex hull.
- Morphological processing include
  - Morphological filtering
  - Thinning
  - Pruning.

Dilation

- Consider set A and B defined in Z^2, the dilation of A by B, denoted by $A \oplus B$, is defined as

  $$A \oplus B \quad = \quad \{z \mid [(B'')_z \cap A\,] \subseteq A\}$$

  NOTE: Dilation of A by B is the set of all displacements, z, such that B″ and A overlap by at least one element.

- Set B is commonly referred to as the structuring element in dilation (and all other morphological operations).

  NOTE: The *anchor point* about which the structuring element is defined is very important.

Dilation – Example (1/2)

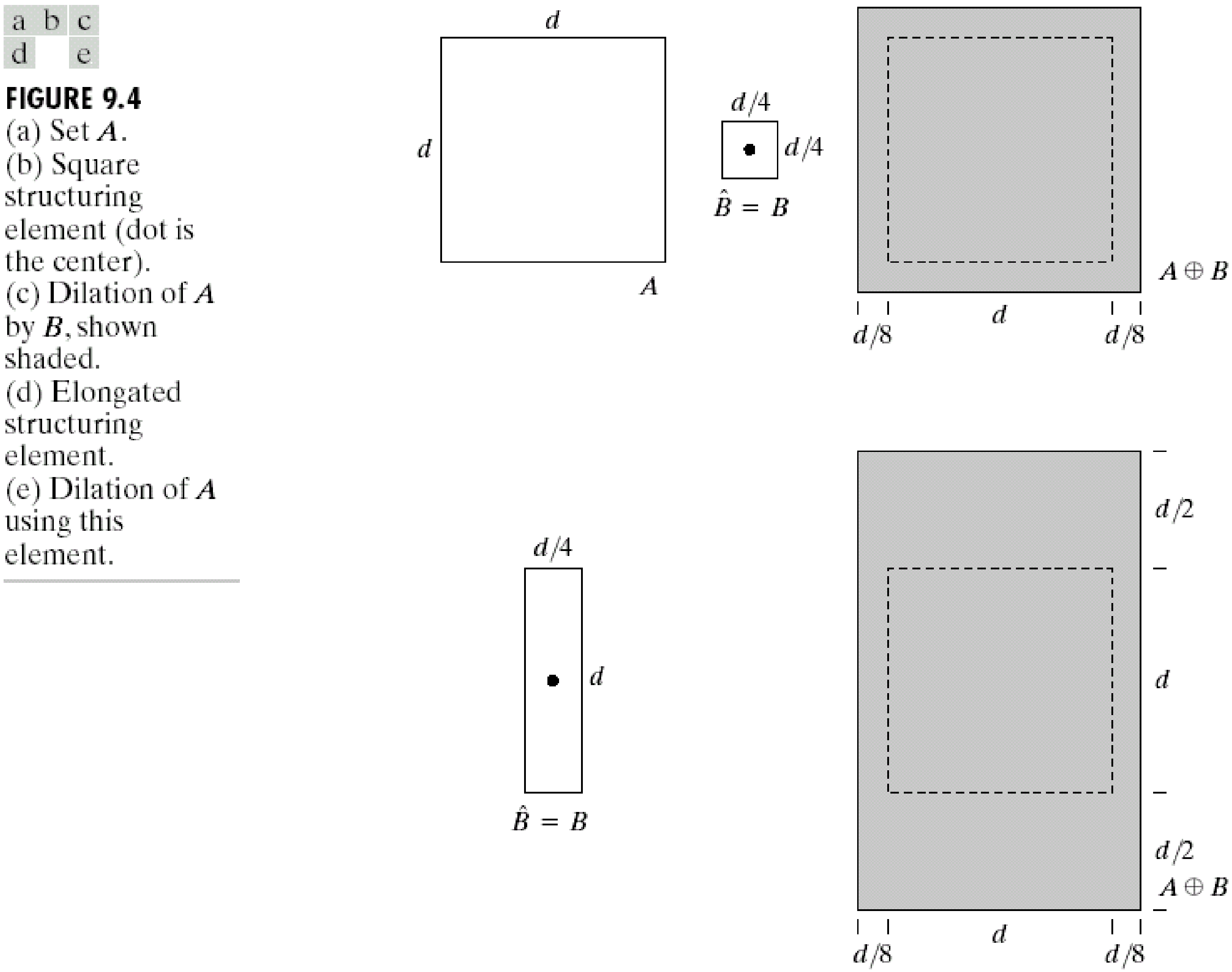
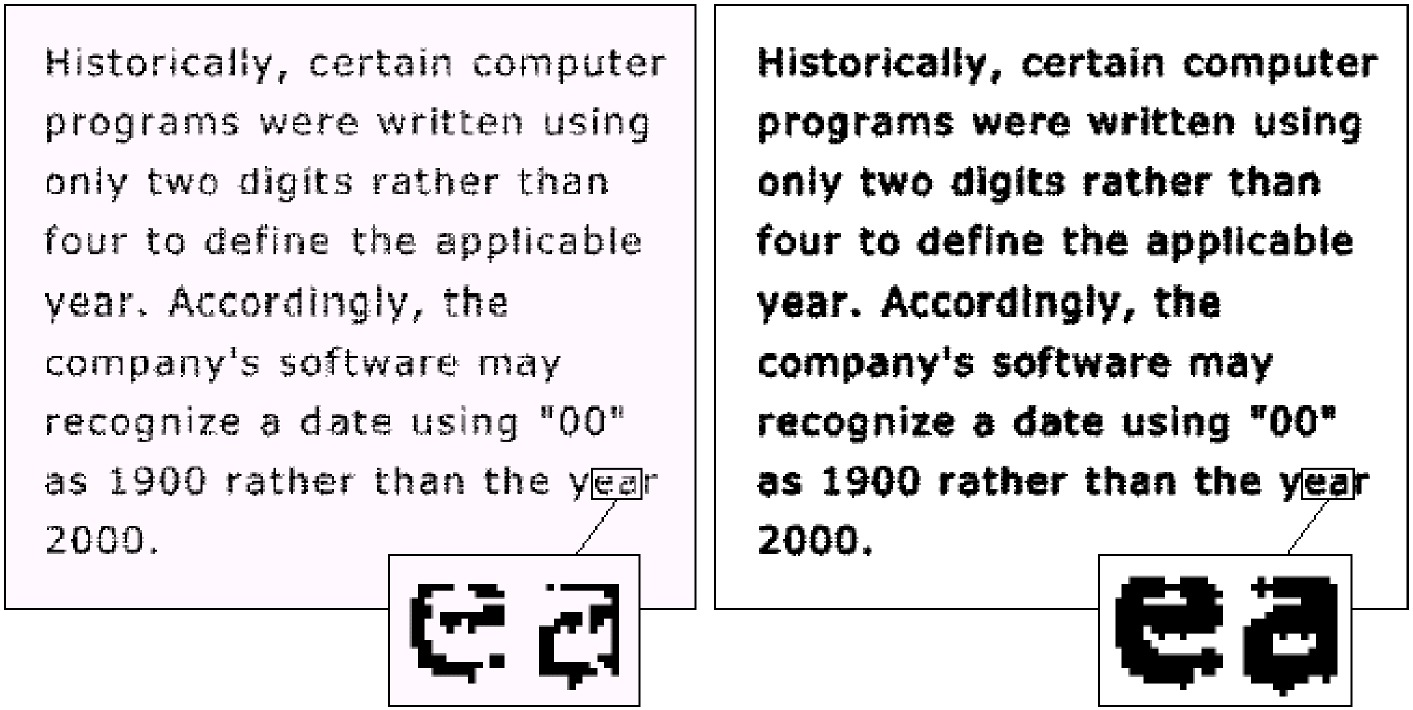


FIGURE 9.4
(a) Set A.
(b) Square structuring element (dot is the center).
(c) Dilation of A by B, shown shaded.
(d) Elongated structuring element.
(e) Dilation of A using this element.

Dilation – Example (2/2)



0	1	0
1	1	1
0	1	0

a c
b

FIGURE 9.5
(a) Sample text of poor resolution with broken characters (magnified view). (b) Structuring element. (c) Dilation of (a) by (b). Broken segments were joined.

Erosion

- Consider set A and B defined in Z^2, the erosion of A by B, denoted by A ϴ B, is defined as

  $$A \ominus B = \{z \mid (B)_z \subseteq A\}$$

  NOTE: Erosion of A by B is the set of all points z, such that B translated by z, is contained in A.

  NOTE: Dilation and Erosion are duals of each other with respect to set complementation and reflection i.e.

  $$(A \ominus B)^c = A^c \oplus B''$$

- Generally, dilation expands an image and erosion shrinks it.

Erosion – Example (1/2)

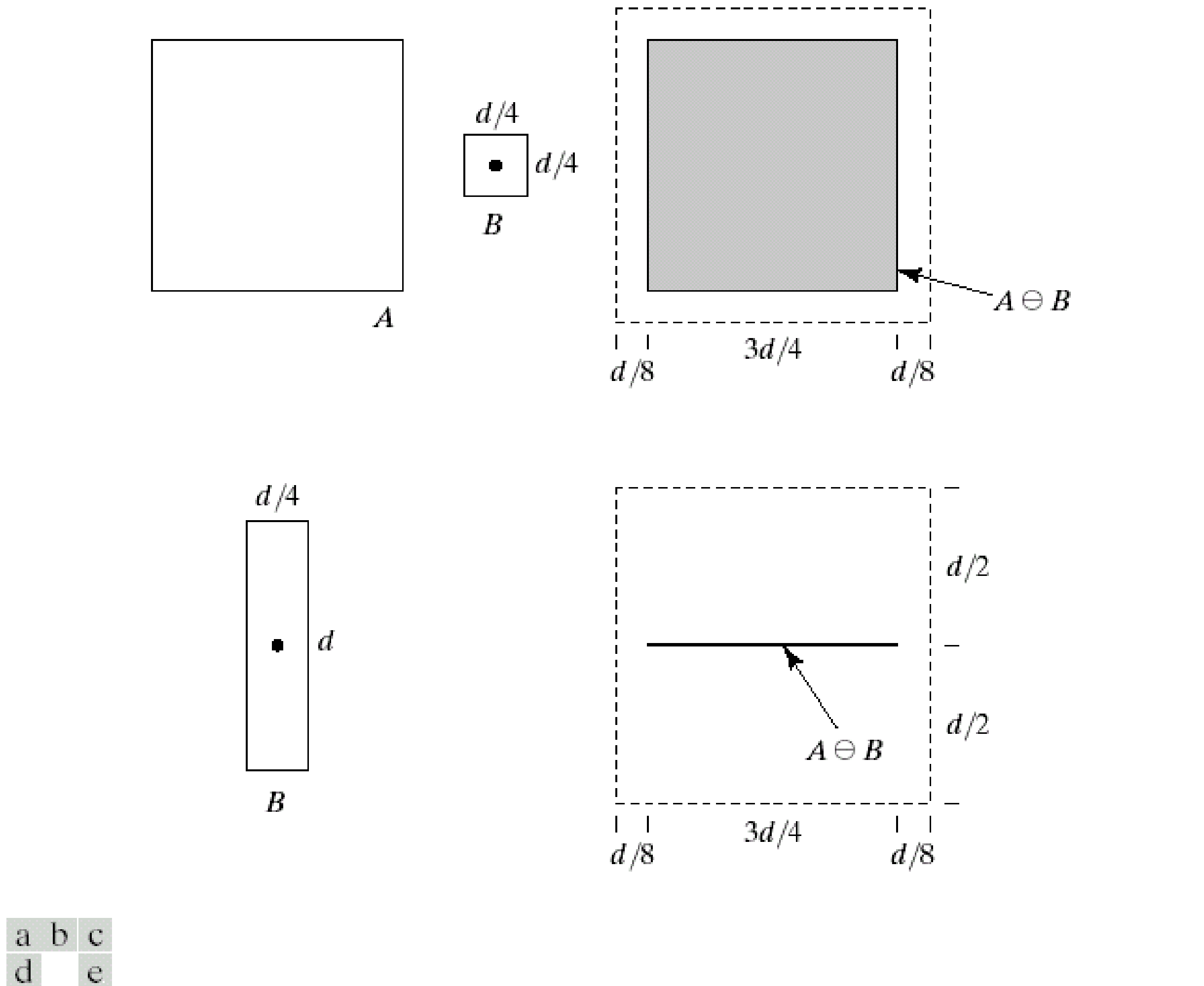
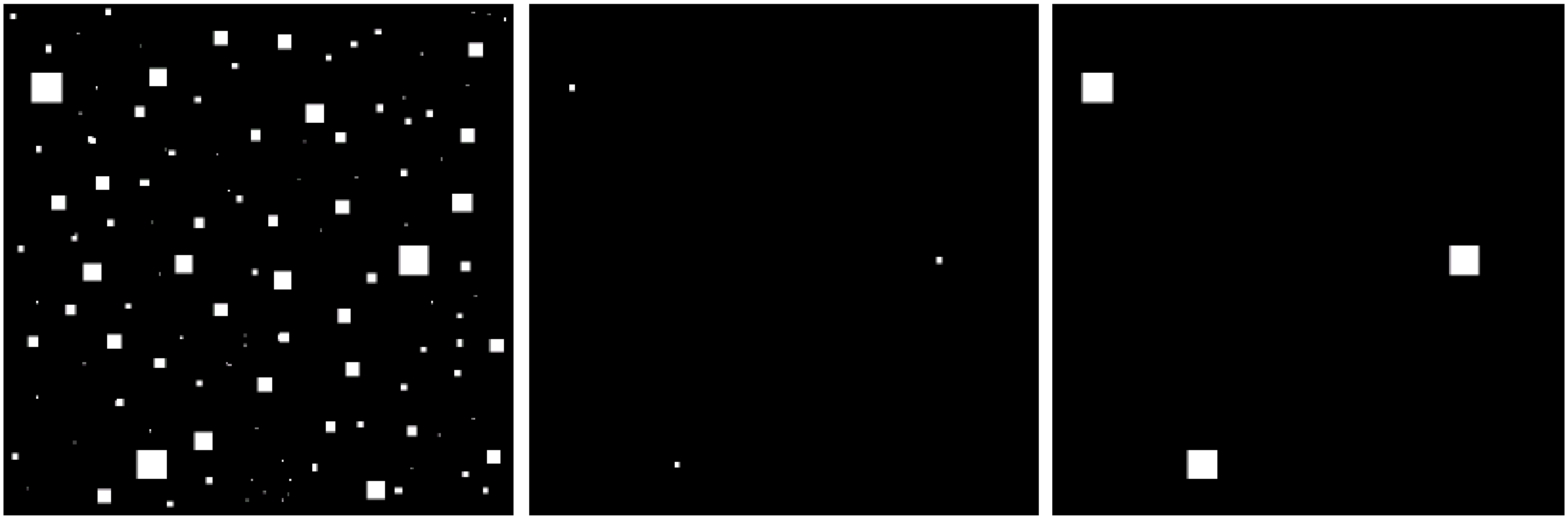


FIGURE 9.6 (a) Set A. (b) Square structuring element. (c) Erosion of A by B, shown shaded. (d) Elongated structuring element. (e) Erosion of A using this element.

Erosion – Example (2/2)



a b c

FIGURE 9.7 (a) Image of squares of size 1, 3, 5, 7, 9, and 15 pixels on the side. (b) Erosion of (a) with a square structuring element of 1's, 13 pixels on the side. (c) Dilation of (b) with the same structuring element.

Closing & Opening (1/3)

- Closing of set A by structuring element B, denoted by $A \bullet B$, is defined as

$$A \bullet B = (A \oplus B) \ominus B$$

- Thus closing of set A by B is the dilation of A by B, followed by a erosion of the result by B.
- Closing generally
  - Smoothes sections of the contours, but generally fuses narrow breaks and long thin gulfs.
  - Eliminates small holes
  - Fills gaps in the contour.

Closing & Opening (2/3)

- Opening of set A by structuring element B, denoted by $A \circ B$, is defined as

$$A \circ B = (A \ominus B) \oplus B$$

- Thus opening of set A by B is the erosion of A by B, followed by a dilation of the result by B.
- Opening generally
  - Smoothes the contour of an object
  - Breaks narrow isthmuses
  - Eliminates thin protrusions

Closing & Opening (3/3)

NOTE: Opening and closing are duals of each other w.r.t. set complementation and reflection

$$(A \bullet B)^c = (A^c \circ B'')$$

Opening & Closing – Example (2/3)

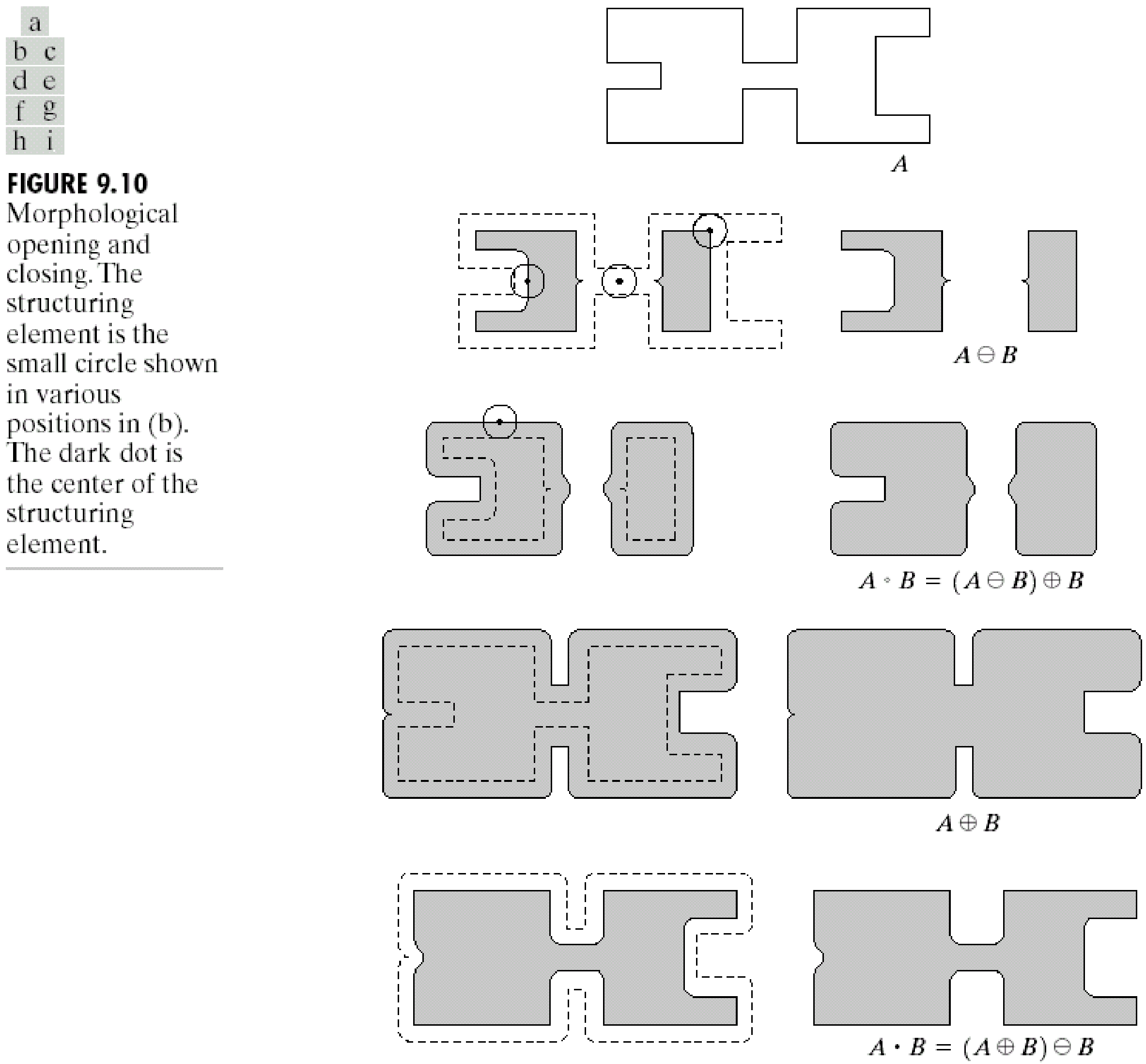
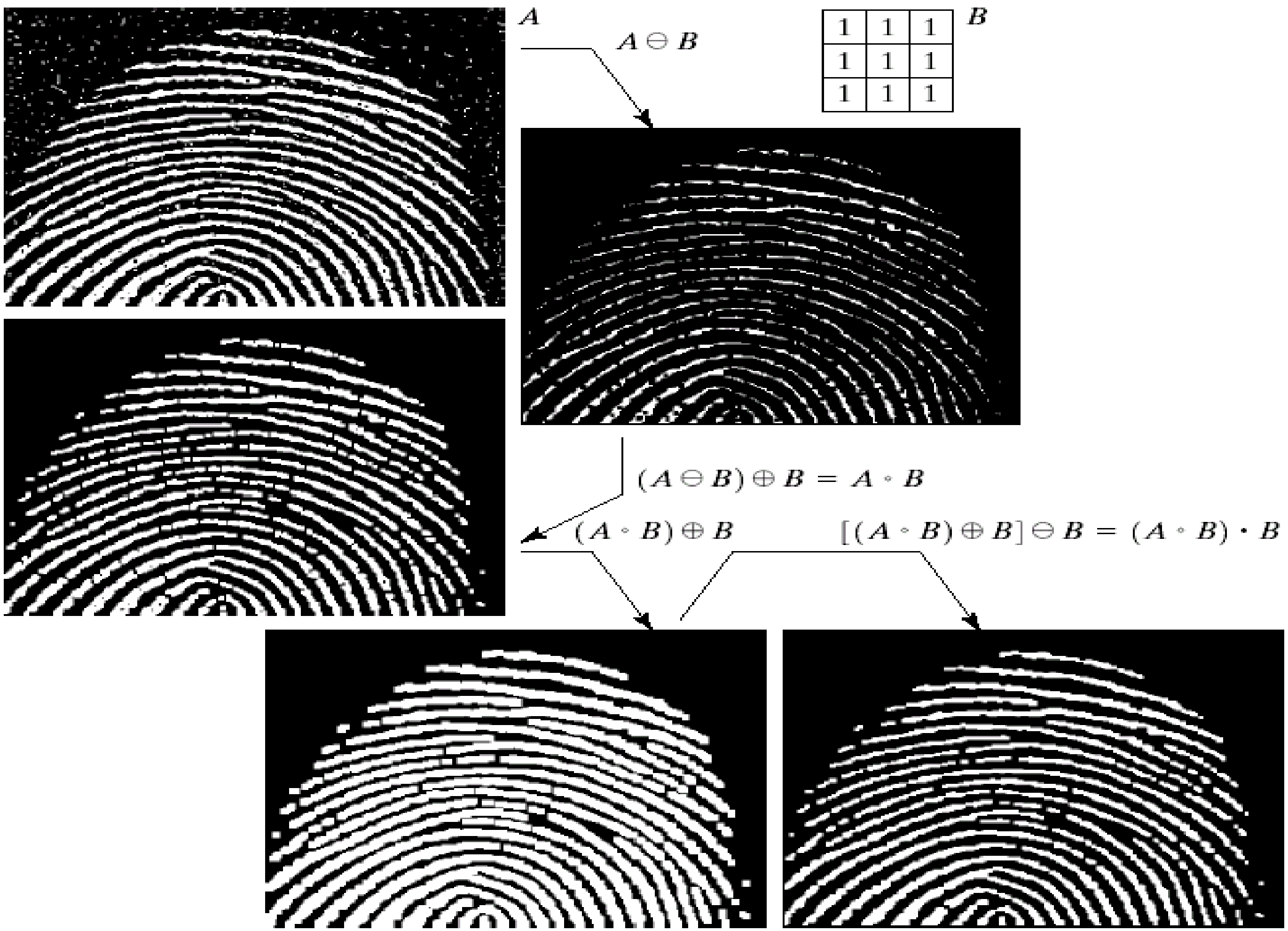


FIGURE 9.10 Morphological opening and closing. The structuring element is the small circle shown in various positions in (b). The dark dot is the center of the structuring element.

Opening & Closing – Example

(3/3)



a b
d c
e f

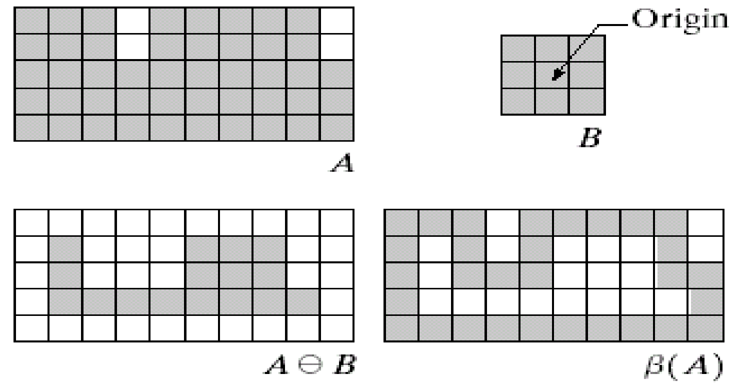
FIGURE 9.11
(a) Noisy image.
(c) Eroded image.
(d) Opening of A.
(d) Dilation of the opening.
(e) Closing of the opening. (Original image for this example courtesy of the National Institute of Standards and Technology.)

Basic Morphological Algorithms

- Some of the practical uses of morphology are
  - Extracting image components that are useful in the representation and description of shape like extracting
    - Boundaries
    - Connected components
    - The convex hull
    - The skeleton of a region
  - Region based operations like
    - Filling
    - Thinning
    - Thickening
    - Pruning

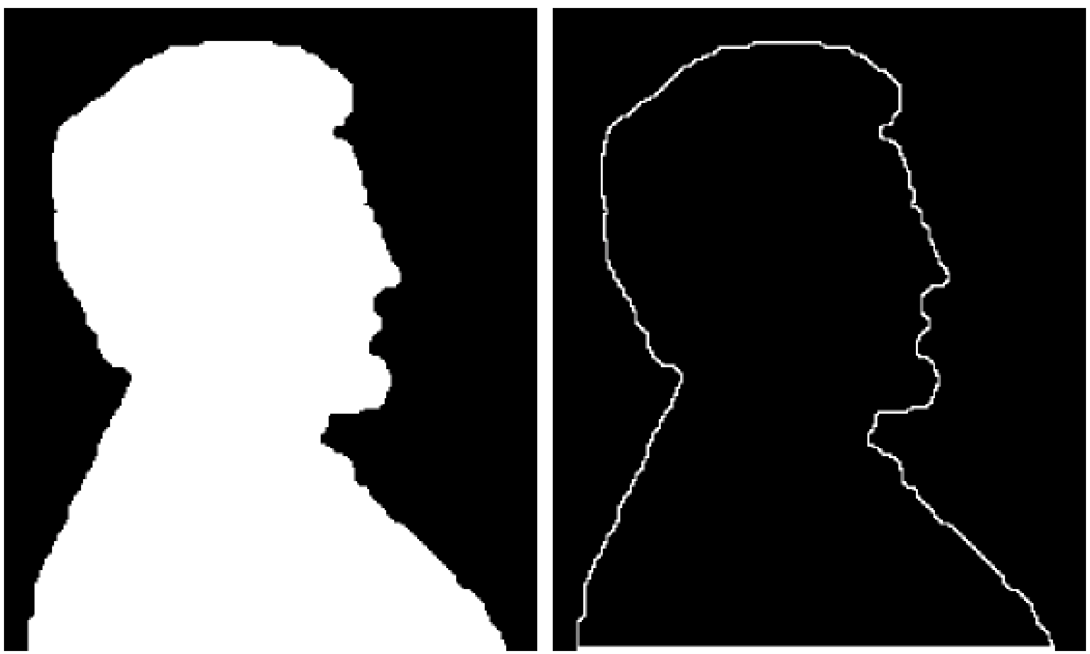
  NOTE: These are used frequently in conjunction with the other algorithms as pre or post processing steps

Boundary Extraction - Examples



a b
c d

FIGURE 9.13 (a) Set A. (b) Structuring element B. (c) A eroded by B. (d) Boundary, given by the set difference between A and its erosion.



a b

FIGURE 9.14 (a) A simple binary image, with 1's represented in white. (b) Result of using Eq. (9.5-1) with the structuring element in Fig. 9.13(b).

Image Segmentation Preview

Segmentation is to subdivide an image into its constituent regions or objects.

Segmentation should stop when the objects of interest in an application have been isolated.

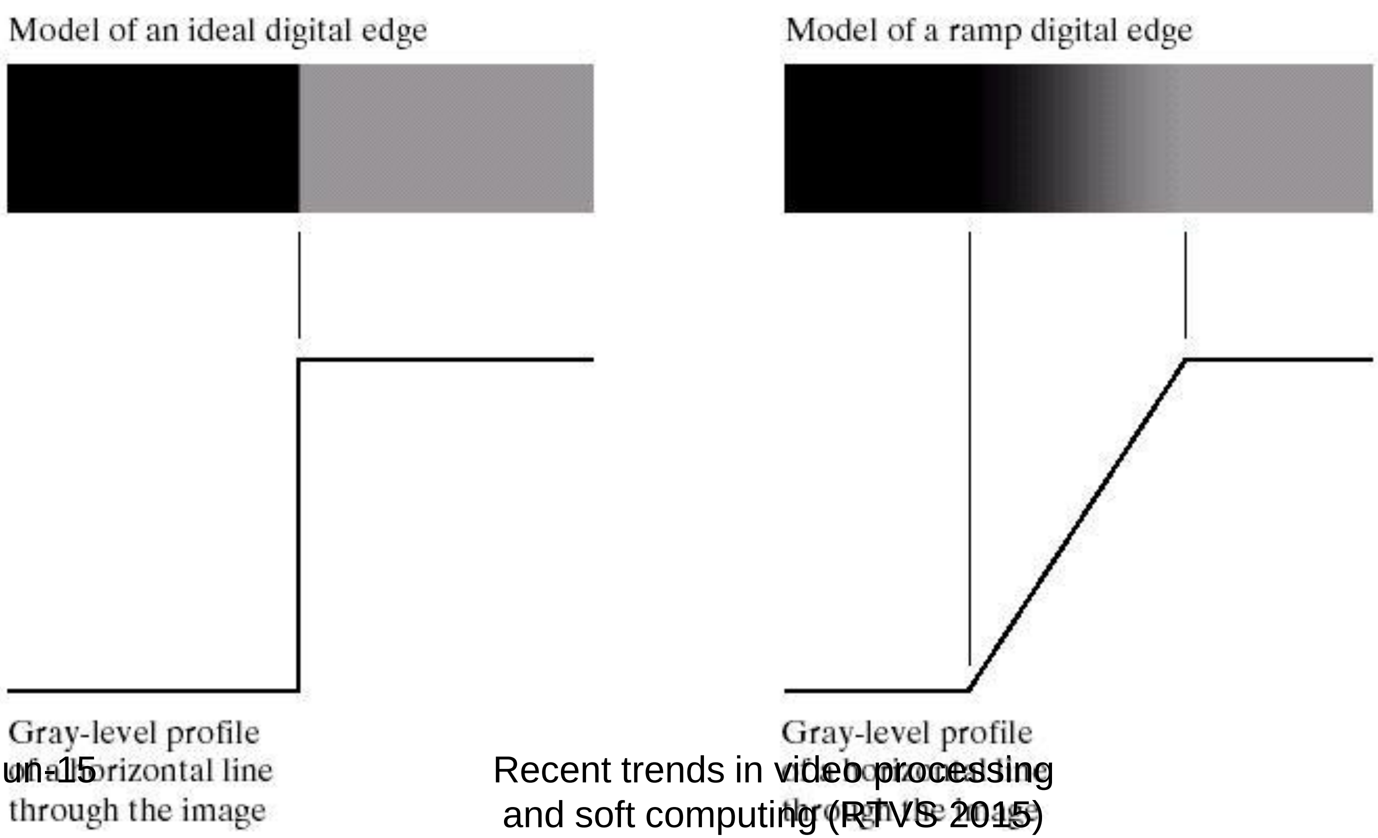
The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze

Principal approaches

Segmentation algorithms generally are based on one of the two basic properties of intensity values

- **discontinuity** : to partition an image based on abrupt changes in intensity (such as edges).

- **similarity** : to partition an image into regions that are similar according to a set of predefined criteria (thresholding, region growing and region splitting and merging are examples of this category).

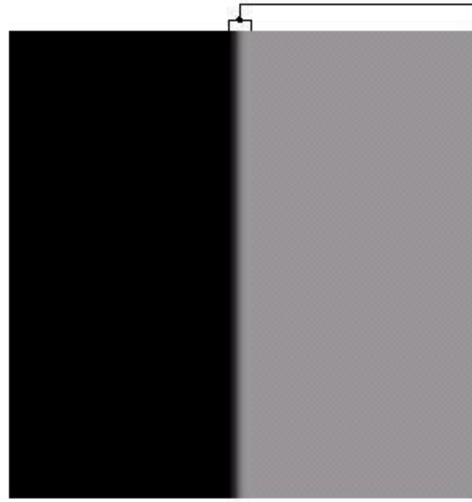


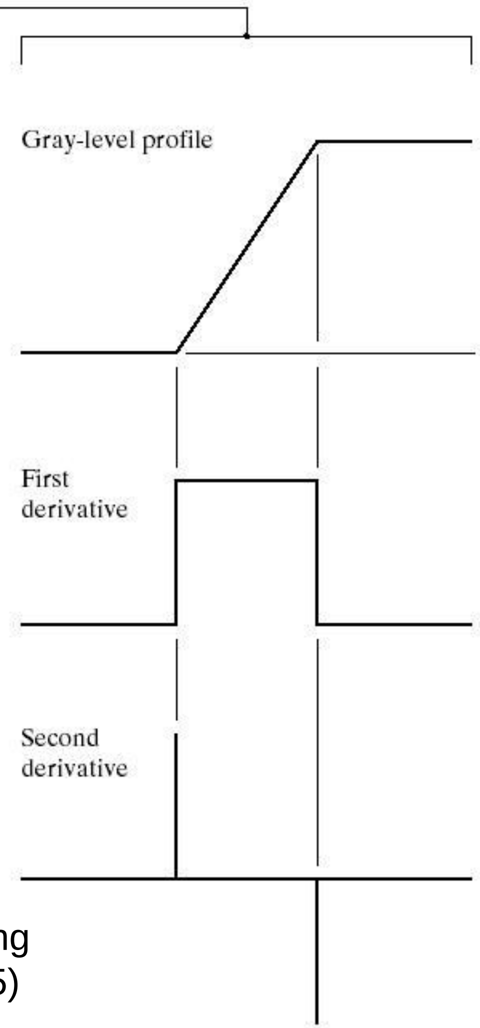
a b

FIGURE 10.5 (a) Model of an ideal digital edge. (b) Model of a ramp edge. The slope of the ramp is proportional to the degree of blurring in the edge.

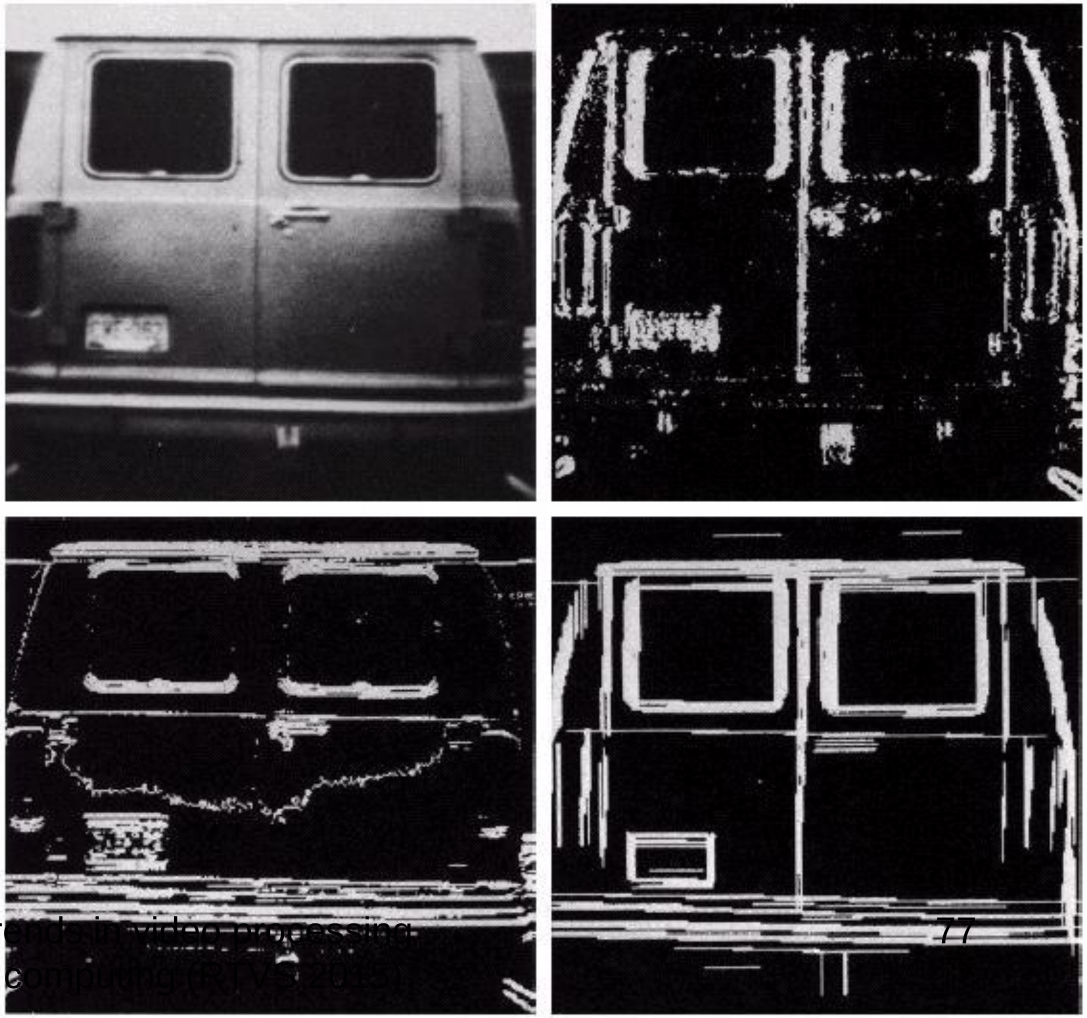
a b

FIGURE 10.6
(a) Two regions separated by a vertical edge.
(b) Detail near the edge, showing a gray-level profile, and the first and second derivatives of the profile.





the signs of the derivatives would be reversed for an edge that transitions from light to dark



a b
c d

FIGURE 10.16
(a) Input image.
(b) G_y component of the gradient.
(c) G_x component of the gradient.
(d) Result of edge linking. (Courtesy of Perceptics Corporation.)

Thresholding image with dark background and a light object

image with dark background and two light objects

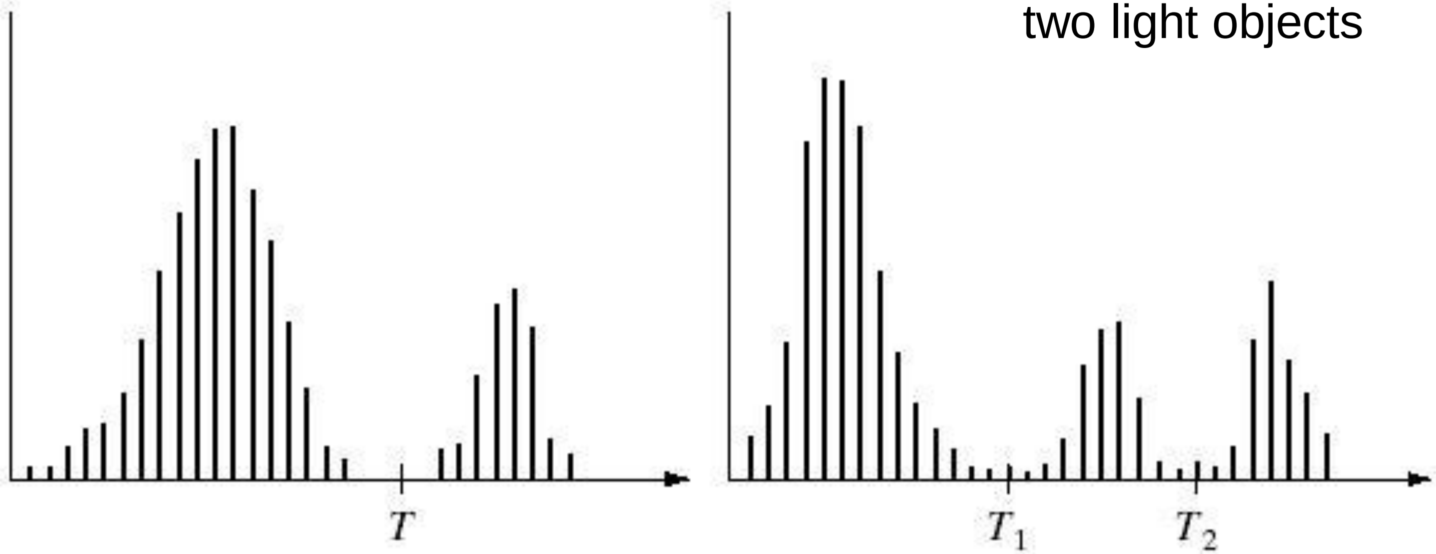


FIGURE 10.26 (a) Gray-level histograms that can be partitioned by (a) a single threshold, and (b) multiple thresholds.

Representation and description

-After image has been segmented into regions, methods required to represent and describe them

Representing regions involved two choices

1) external characteristics (Boundary)

2) Internal characteristics (pixels)

-two task are involved

1) Representation

2) Description

Representation and description

Region may be represented by its boundary and the boundary described by features such as length, the orientation of the straight line joining its extreme points etc

External representation is chosen when the primary focus is on shape characteristics

Internal representation is chosen when the primary focus is on regional properties such as color and texture

Some times both of representations are used

Features selected as descriptors should be insensitive to variations in size, translation and rotation

Representation :

After segmentation raw data in form of pixels along boundary or pixels contained in region

Chain code

Represent boundary by a connected sequence of straight line segments of specified length and direction

Fourier descriptors

-Statistical Moments

-mean , variance and higher order moments

Object Recognition

Descriptor is also known as feature

Classification

Bayes classifer: The classifier that minimizes the total average loss is called the Bayes classifier. Probabilistic approach

SVM

Neural Network

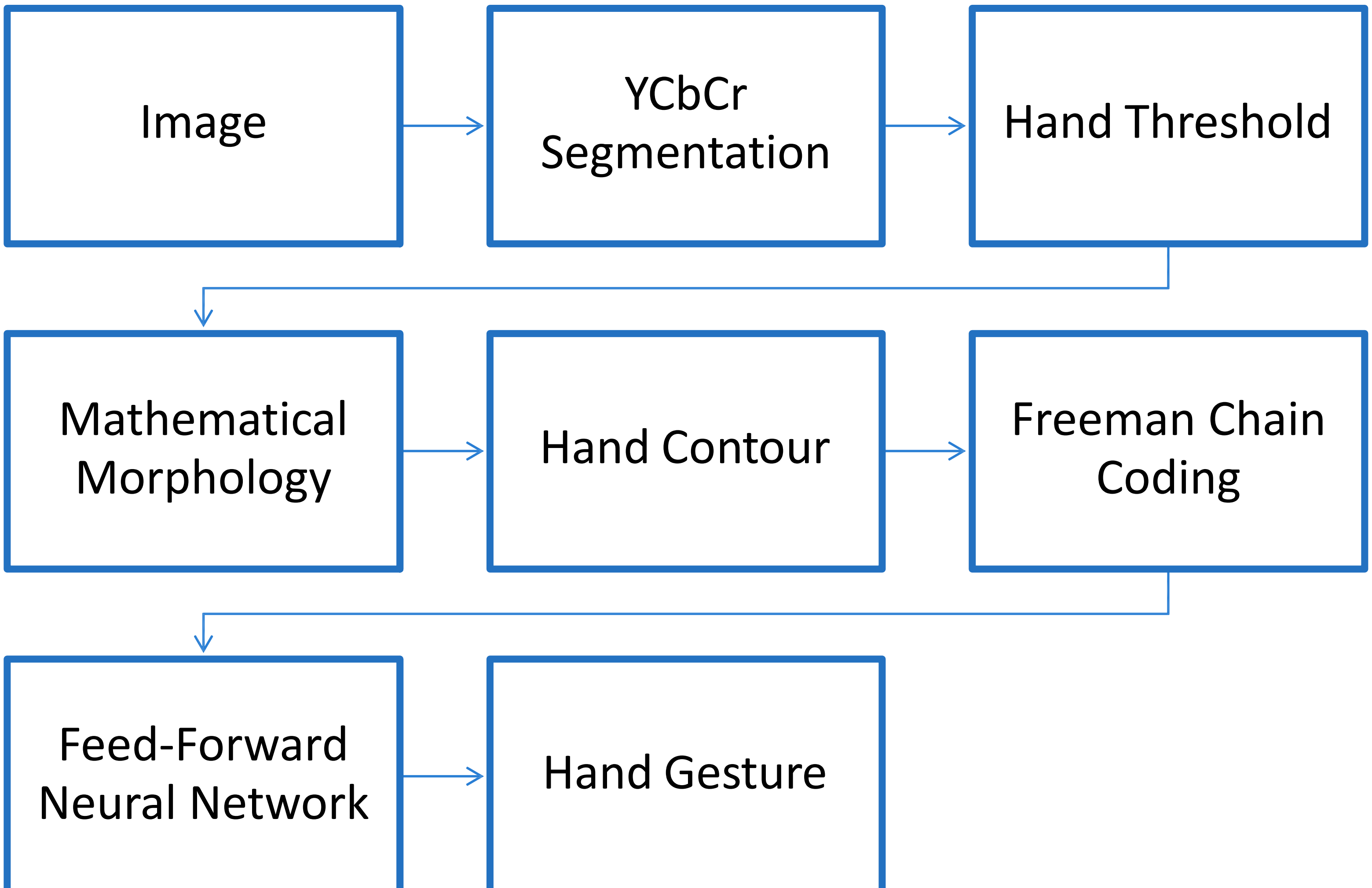
HAND GESTURE Recognition

Block Diagram

Literature Review

Conclusion from Literature Review

Proposed System



IMPLEMENTATION

1. Reading an Image
2. Conversion of Image from RGB to YCbCr
3. Skin Detection based on Cb and Cr values (77<=Cb<=127 & 133<=Cr<=173) [11]
4. Threshold Image
5. Find Maximum component and remove other components
6. Edge Detection using Canny Edge Detection
7. Find Contour Points
8. Apply Freeman Chain Coding
9. Find Chain Code Histogram

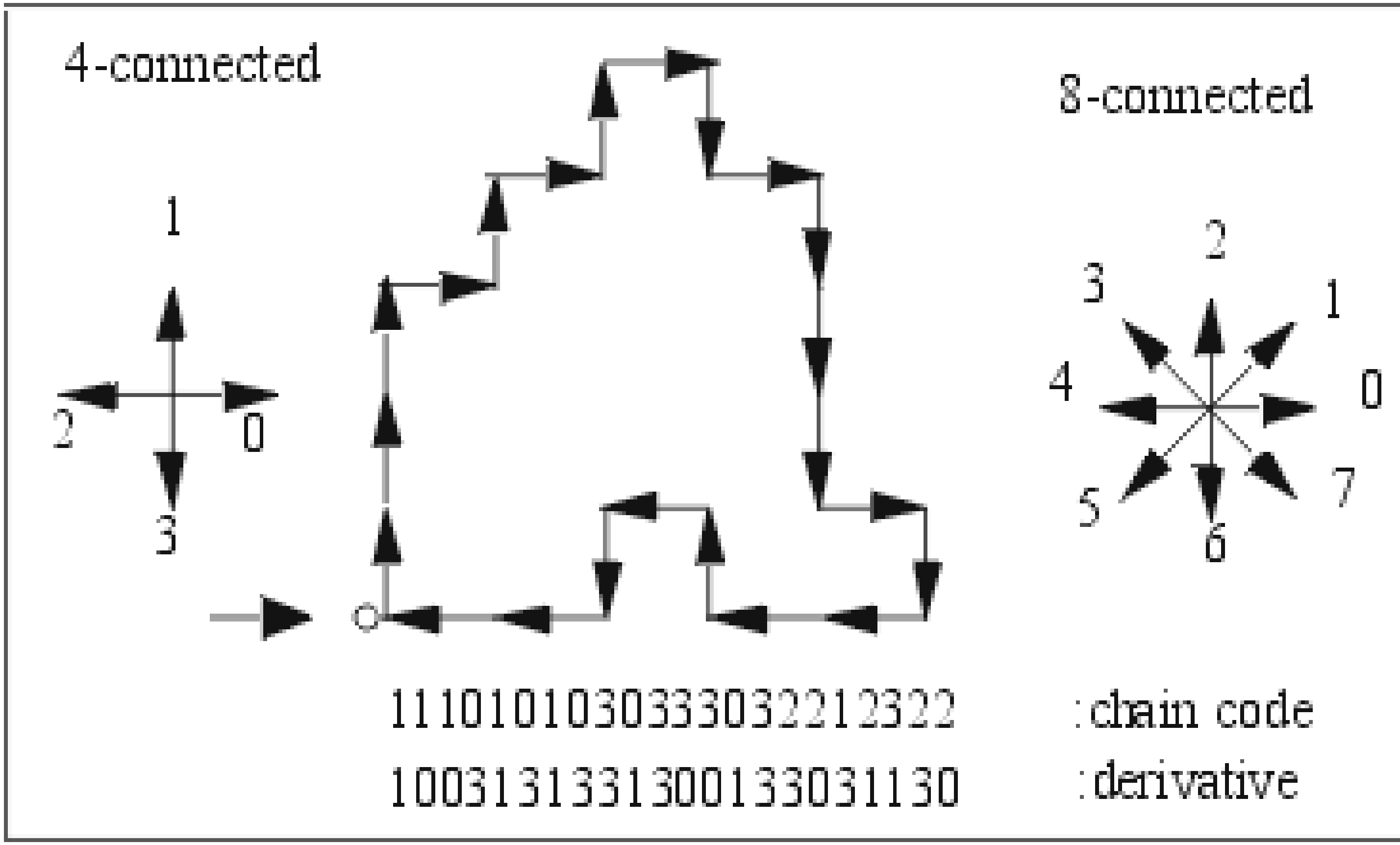
FREEMAN CHAIN CODING [12]

Implementation

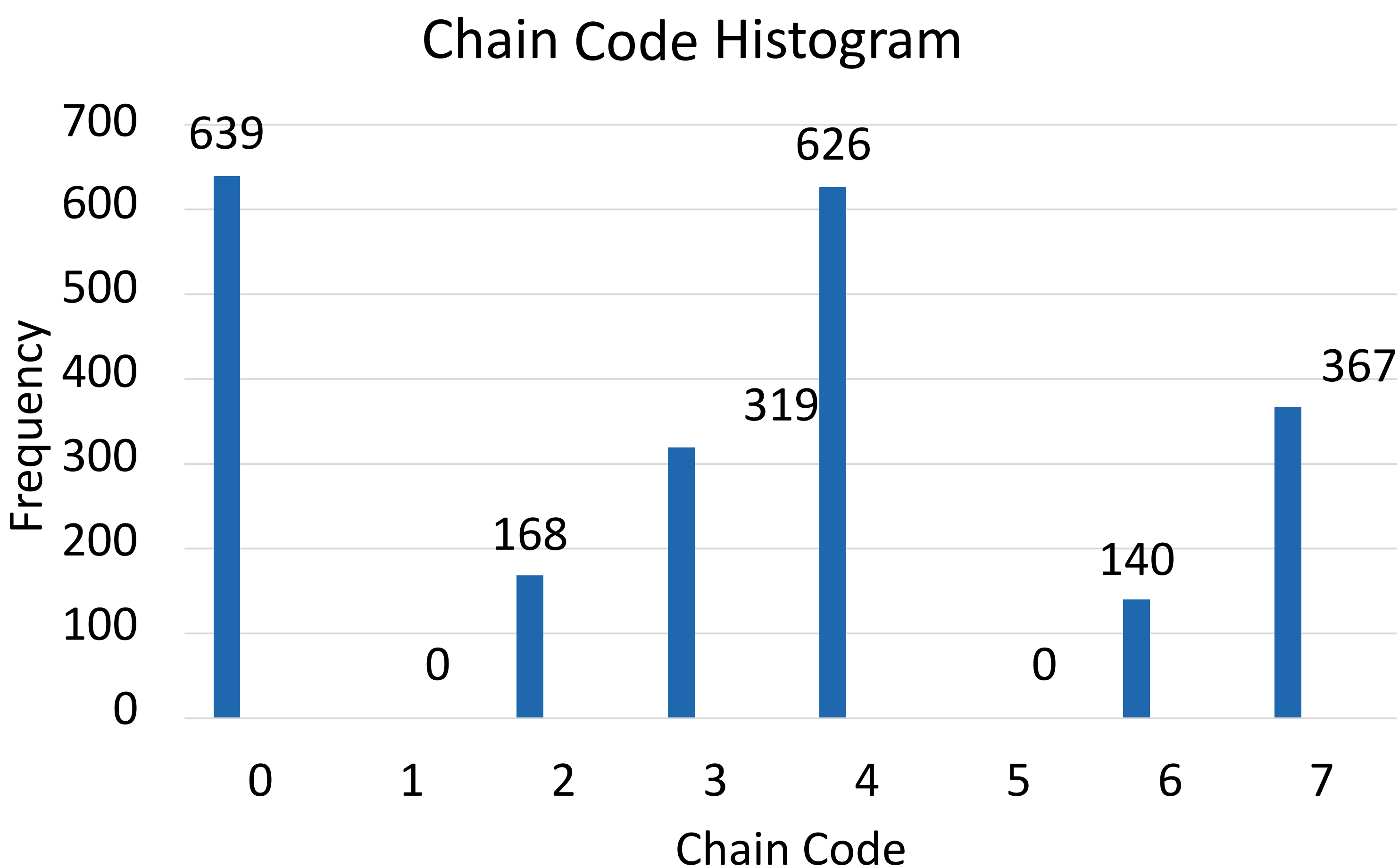
Screenshots

Future Work

References



CHAIN CODE HISTOGRAM



THANK YOU