Assignment

History of Digital Image Processing (DIP)

The history of digital image processing can be traced back to its first application which was in the Newspaper Industry when pictures were to be transformed from London to Newyork via a submarine cable.

The Barttane cable for picture transmission was used in the Early 1900s to shorten the time used to transfer images across the Atlantic from one week to less than two(2) hours.

~~Although, during this time,~~ the early Bartlane systems were capable of coding images in five (5) distinct levels of gray. This capability was increased to 15 levels in 1929.

*Facial Recognition using MATLAB

Text Book: ① * Digital Image Processing by Rafael C. Gonzalez & Richard E. Woods

② DIP using MATLAB by Gonzalez, Woods & Edding

③ Computer Vision Algorithms and Application by Richard Szeliski

* ④ Image Processing: Principles and Application by Tinku Acharya & Ajoy K. Ray.

Assignment (Each chapter, make a minimum of 10 references. Make sure you put in your own words).

Chapter 1

1.0 Introduction

1.1 What is Digital Image Processing

1.2 Origin of Digital Image Processing

1.3 Examples of fields that use DIP

1.4 Application of DIP

1.5 Problems associated with DIP

1.6 Fundamental steps in DIP.

1.7 Components of an Image processing System

Chapter 2

put more than on reference in ~~H~~ the

Ref style: APA

2.0 Digital Image fundamentals

2.1 Human Visual Perception

- Structure of the Human eye
- Image formation in the eye

2.2 Image sensing and acquisition

2.3 Image sampling and quantization.

2.4 Basic relationship between pixels

2.5 Digital Image file format

Chapter 3

3.0 Image enhancement and restoration

3.1 Noise and Degradation in an image

3.2 Types of Noise in an image

3.3 Image Enhancement

- Spatial Domain
- Frequency Domain

3.4 Image Restoration

Discuss the following filters

① Contrast stretching

② Histogram Equalization

③ Image Subtraction

④ Image Averaging

⑤ Median filter
⑥ Gaussian filter
⑦ Homomorphic filter
⑧ Wiener filter.
⑨ Inverse filter

Sample Question
Illustrate with a diagram, the basic steps of DIP.

Fundamentals or Basic steps in DIP
① Image acquisition.
② Problem domain
③ Image enhancement
④ Image Restoration
⑤ Color Image processing
⑥ Wavelength / Multi-Resolution processing
⑦ Compression
⑧ Morphological processing
⑨ Segmentation
⑩ Representation & description (feature selection)

⑪ Recognition.

Components of Image processing system

① Image sensor

② specialize Image Processing hardware

③ Specialized Image processing sopftware

④ Networking used for Image transmission and communication within remote site

⑤ Hardcopy

⑥ Computer: i) General purpose
  ii) specialized

⑦ Main storage

⑧ Image Display [monitor]

Network used for Image Transmission and Communication with remote site via the Internet

Basic Relationship between pixels

4 - Neighbor (Conected component.)
$N_4(P)$ (only horizontal & vertical pixels)

8 - Neighbor (Connected component)
$N_D(P)$ (Diagonal pixels are included)

Example

$$\begin{bmatrix} 0 & 1 & \underset{\uparrow}{0} & 1 \\ 0 & 0 \leftarrow & \boxed{1} \rightarrow & 0 \\ 0 & 0 & \overset{\downarrow}{1} & 0 \\ 1 & 0 & 0 & 0 \end{bmatrix}$$

Image Type: Binary Image (between 0 & 1)

Image Type: Grayscale (between 0 & 255)

* For adjacency connection, a pixel can only be connected to its same value.

* Mixed adjacency, diagonal connectivity does

not apply Take the straight path

* check the foramula for computing the area of anmage

* The area of an image is computed based on the pattern.

Histogram Equalization (To increase the brightness or contrast

This is a spatial filter used for image enhancement.

Example.

$$\begin{pmatrix} 3 & 2 & 4 & 5 \\ 7 & 7 & 8 & 2 \\ 3 & 1 & 2 & 3 \\ 5 & 4 & 6 & 7 \end{pmatrix}$$

Apply histogram equalization on the given image in a scale of 20:

Pixel intensity	1	2	3	4	5	6	7	8
No of pixel	1	3	3	2	2	1	3	1
Probability	$1/16$	$3/16$	$3/16$	$2/16$	$2/16$	$1/16$	$3/16$	$1/16$.
cumulative Probabiity (C.P)	$1/16$	$1/16+3/16$	$\frac{1}{16}+\frac{3}{16}+\frac{3}{16}$	$1/16+3/16+3/16+2/16$				
C.P x 20								
Floor rounding	1	5	8	11	13	15	18	20

$$\begin{bmatrix} 3 & 2 & 4 & 5 \\ 7 & 7 & 8 & 2 \\ 3 & 1 & 2 & 3 \\ 5 & 4 & 6 & 7 \end{bmatrix} \Rightarrow \begin{bmatrix} 8 & 5 & 11 & 13 \\ 18 & 18 & 20 & 5 \\ 8 & 1 & 5 & 8 \\ 13 & 11 & 15 & 18 \end{bmatrix}$$

~~18~~ ~~22~~

Median filter

Apply a median filter on the image given below. Use a 3x3 ~~kernel~~ mask or kernel

$$\begin{bmatrix} 18 & 22 & 33 & 25 \\ 34 & 128 & 24 & 172 \\ 22 & 19 & 32 & 31 \\ 17 & 33 & 32 & 20 \end{bmatrix}$$

Soln

First 3x3

~~18~~ ~~19~~ ~~22~~ ~~22~~ 24 ~~32~~ ~~34~~ ~~33~~
~~128~~

Median = 128 => 24

Second 3x3

~~19~~ ~~22~~ ~~24~~ ~~25~~ 31 ~~32~~ ~~33~~ ~~128~~ ~~172~~

24 => 31

Third 3x3

~~17~~ ~~19~~ ~~22~~ ~~24~~ 32 ~~32~~ $\overset{33}{}$ ~~34~~ ~~128~~

19 => 32

fourth 3x3

$\cancel{19}$ $\cancel{20}$ $\cancel{24}$ $\cancel{31}$ 32 $\cancel{32}$ $\cancel{33}$

$\cancel{128}$ $\cancel{112}$

32 => 32.

Color Space

This is a method by which we can create and visualize colors. As Humans, we ~~can~~ may define a color by its attributes of brightness, hue and colorfulness ~~but~~. A computer may define a color using the amount of red, green, and blue phosphor emission required to match color. for example, a printing press may achieve a color by the reflectance and absorbance of Cyan, Magenta, etc. There are different types which are:

① HSI (Hue Saturation and Intensity.)

② RGB

NB: Take note of the formula for converting from RGB to HSI

$$r = \frac{R}{R+G+B} ; \quad g = \frac{G}{R+G+B} ; \quad b = \frac{B}{R+G+B}$$

$$h = \cos^{-1}\left[\frac{0.5\,[r-g] + [r-b]}{[r-g]^{2} + [(r-b)(g-b)]^{1/2}}\right] \quad h \in [0, \pi] \text{ for } b \leq g$$

$$h = 2\pi - \cos^{-1}\left[\quad '' \quad\right] \quad \text{for } b > g$$

(saturation) $s = 1 - 3\min(r, g, b)$

(intensity) $i = \frac{1}{3}(R + G + B)$

Example

Given an Image:

$$\begin{bmatrix} (\overset{r}{100}, \overset{g}{100}, \overset{b}{100}) & (150, 0, 0) & (0, 150, 0) \\ (255, 0, 0) & (255, 255, 255) & (0, 0, 0) \\ (100, 150, 200) & (0, 0, 255) & (100, 200, 150) \end{bmatrix}$$

To compute HSI value of A_{31} (100, 150, 200)

where $R = 100$; $G = 150$; $B = 200$

$r = ?$, $g = ?$, $b = ?$

soln.

$$r = \frac{R}{R+G+B} = \frac{100}{100+150+200} = 0.2222$$

$$g = \frac{G}{R+G+B} = \frac{150}{100+150+200} = 0.3333.$$

$$b = \frac{B}{R+G+B} = \frac{200}{100+150+200} = 0.4444.$$

$b > g$ Therefore

$$h = 2\pi - \cos^{-1}\left(\frac{0.5(r-g)+(r-b)}{(r-g)^2+[(r-b)(g-b)]^{1/2}}\right)$$

$$\frac{0.5(0.2222-0.3333)+(0.2222-0.4444)}{(0.2222-0.3333)^2+\sqrt{(0.2222-0.4444)(0.3333-0.4444)}}$$

-0.0

Morphological Image Processing

Types of Morphological Operation

~~Gyration~~ Dilation

Erosion

Closing

opening

~~Gyration~~ Diration

Dilation

The ~~Gyration~~ of a binary Image A and a structuring element (mask or filter) B is given as:

$$A \oplus B = \{ z \mid (\hat{B})_z \cap A \neq \phi \}$$

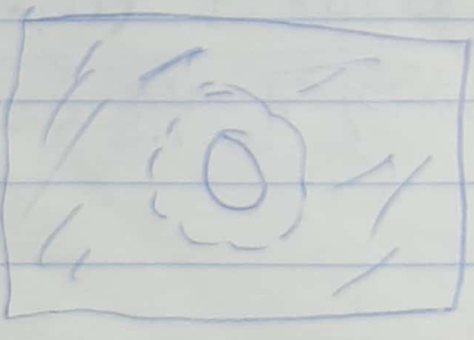
Where,

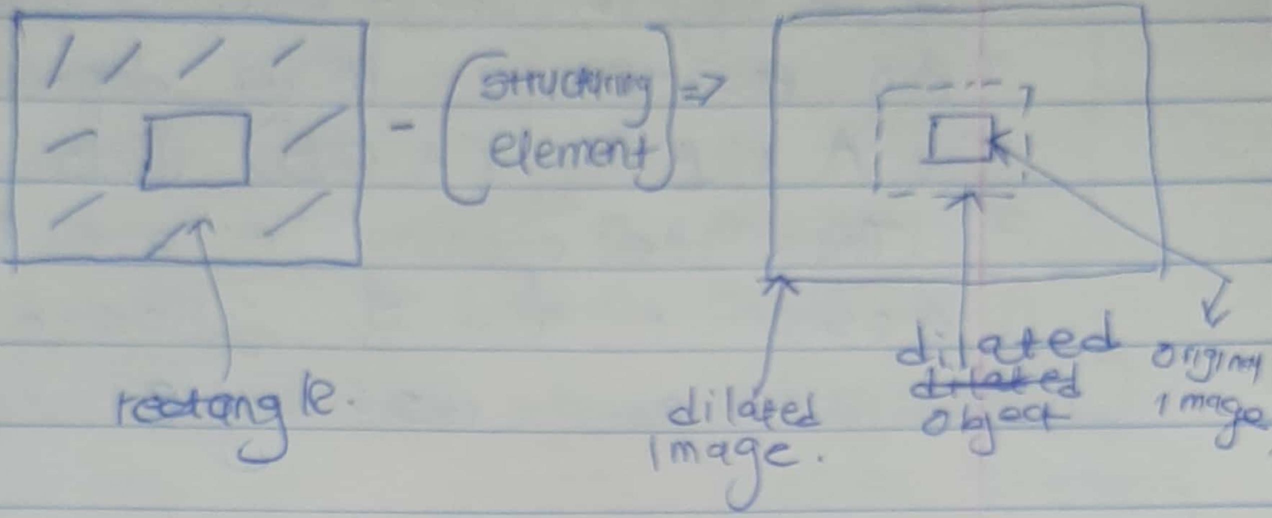
A = Image

B = Structuring element

z = displacement

$\hat{B}$ = reflection of B





Erosion

The Erosion of a Binary Image A and a structuring element B is defined as:

$$A \ominus B = \{Z \mid (B)_Z \subseteq A\}$$

NB Erosion shrinks an Image

The eqn Indicates that the erosion Of A and B is a subset of Z such that B translated by Z is contained in A.

Opening

Opening generally smooths the contour

of an object, break narrow strips and thin postrusion. It is defined by:

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

Thus, the opening A and B is the erosion A and B, followed by the dilation of the result by B

Closing

This tends to smooth section of contours but as opposed to opening, it generally fuses narrow breaks, eliminates small hoses and fills gaps in the contour.

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

Thus the closing A and B is the delation of A and B followed by the erosion of the result by B.

Example

Given Image
$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & \boxed{0 \quad 0 \quad 1} \end{bmatrix}$$

and structuring element $[1\ 1\ 1]$
compute the dilation, erosion, opening and closing

Solution

i) For erosion, multiply and take the minimum value as the new value

$[1\ 1\ 1] \times [1\ 0\ 0]$

$= [1\ 0\ 0].$

The minimum value is 0, use it to replace the middle element.

ii) For dilation multiply and take the maximum value as the new value.

$$\begin{bmatrix} 1 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 & 1 \end{bmatrix}$$

<u>CPE 544</u>

— Image Segmentation (Region Based, Edge Based), Ad

Region Based: ① Global Thresholding ② Local Thresholding. ③ Active contour

Edge based: ① Graph court ② Gaussian

* Look @ the different types of Image Segmentation

* Understand Object detection

* Why do we need Image Segmentation?
It is very helpful in healthcare Industries unlike object detection. It can be used to identify the shape of a cancerous cell but Object detection only creates a bounding box.

Image segmentation Based on Clustering E.g KMeans is one of the most commonly used clustering.

* State on Image segmentation under clustering

* State the steps involved

* Try to read up GLCM and LBP
  - Look at principle of operation
  - Look at distance between pixels
  - Look at how to implement θ value

GLCM
{
LBP

* Look at feature extraction method

* Try to read up SVM. (SVM is supervised)

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