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Internal Assessment Test 1 – October 2024

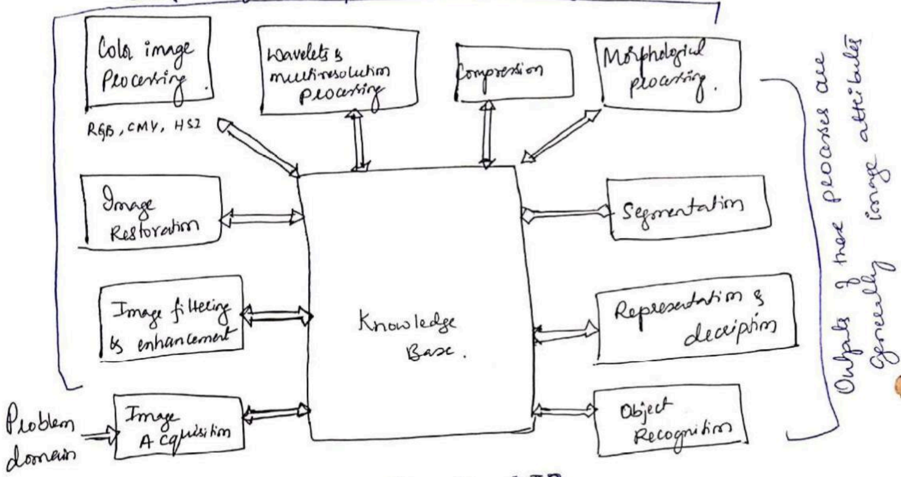
Sub: **DIGITAL IMAGE PROCESSING**		Sub Code: **21CS732**		Branch: **AIML**
Date: **16.10.24**	Duration: **90 min**	Max Marks: **50**	Sem/Sec: **VII - A**	**OBE**

	Answer any FIVE FULL Questions	**MARKS**	**CO**	**RBT**
1	Explain the fundamental steps in digital image processing.	10	CO1	L1

Ans:

Fundamental Steps in Digital Image Processing (2)

outputs of these processes generally are images.



Fundamental Steps in DIP

① **Image acquisition**:- first process in above fig. (DIP)
It involves Image collection, preprocessing (such as Scaling)

② **Image filtering & enhancement**: It is a process of manipulating an image so that more suitable for a specific app.
Specific → Technique which is suitable for x-Ray enhancement is not suitable for satellite image enhancement.

③ **Image Restoration**: Improves the appearance of an image based on mathematical model. Restoration → objective.
Enhancement → Subjective

④ **Color Image Processing**: This area is gaining importance because of significant increase in the use of digital images over the Internet.

(3)

(5) Wavelets (& multiresolution processing): Representing images in various degrees of resolution.
Images are subdivided into similar regions.

(6) Compression: Reduces the storage required to save an image or bandwidth required to transmit it.
Eg: ZIP, JPEG

(7) Morphological processing: Tools for extracting image components that are useful in the representation & description of shape.

(8) Segmentation: Procedure partitions an image into its constituent parts or objects.
Autonomous Segmentation — most imp. tasks in DIP.

(9) Representation & description: o/p of Segmentation stage. i.e raw pixel data constituting either the boundary of a region or all the points in the region itself.
Description: also called as feature selection. deals with extracting attributes that result in some quantitative information of interest.

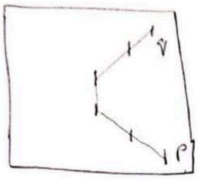
(10) Recognition: assigns a label to an object based on its descriptors.

2	Explain the different kinds of distance measurements that are present. Ans:	10	CO1	L1

Path

(31)

A digital path b/n pixel p having co-ordinates (x,y) to pixel q with (u,v) coordinates is a sequence of connected pixels
(x,y) $(x_0, y_0)(x_1, y_1)$ . . . . (u,v)



Length of the path is count of connected pixels.

If first pixel is same as last pixel i.e. (x,y) = (u,v) it is called closed path.

Distance Measure :-

Dis(p,q) Distance b/n p & q.

(i) Dis (p,q) ≥ 0 If p = q ⟹ Dis(p,q) = 0

(ii) Dis (p,q) = Dis (q,p)

(iii) Dis (p,z) ≤ Dis (p,q) + Dis (q,z)

(1) 0 0 (1) 0 0 (1)
p (x,y)   q (s,t)   z (v,w)

(iv) Euclidean distance

$$Dis_e(p,q) = \sqrt{(x-s)^2 + (y-t)^2}$$

Eg:- For V = {0,1} find the length of shortest 4, 8 & m-paths b/n p & q. Repeat for V = {1,2} for the given image.

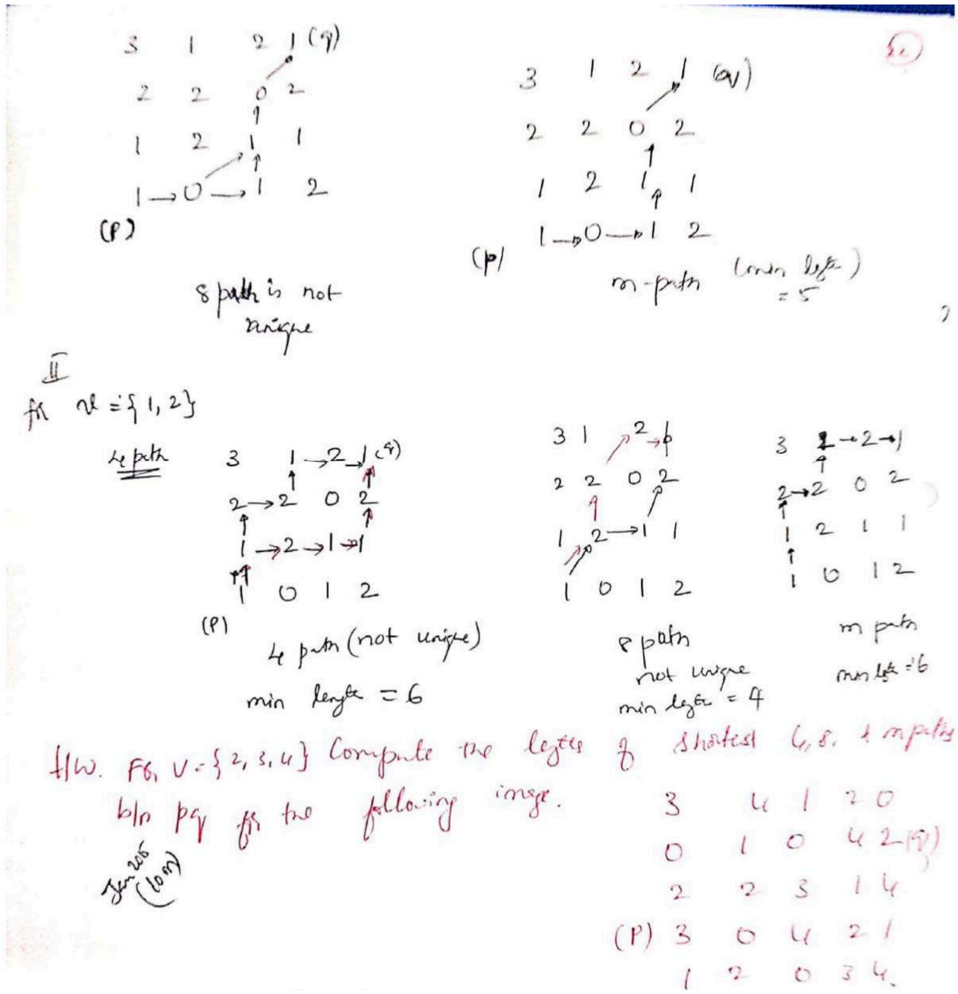
	3	1	2	1 (q)
	2	2	0	2
	1	2	0	1
(p)	1	0	1	2

Sol:

4-path :- $I_{V=\{0,1\}}$

```
  3   1   2   1
  2   2   0↑  2
  ↑1  2   1↑  1
  1 → 0 → 1   2
```

The path starts from p but doesnot reach q as no path exist b/n q & prev. pixel.



Q.No	Question	Marks	CO	Level
3	Use the Nearest Neighbour interpolation and Bilinear interpolation techniques to calculate the intensity of the resized image of size 6x6.	10	CO1	L3

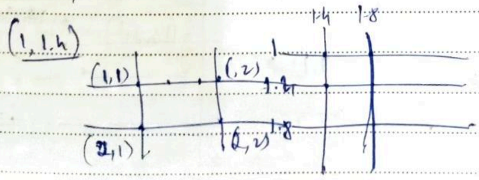
r/c	***1***	***2***	***3***
1	**160**	**80**	**160**
2	**40**	**40**	**20**
3	**10**	**16**	**25**

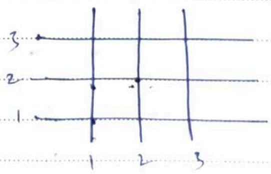
Ans:

Nearest Neighbour Interpolation

	1	2	3
1	160	80	160
2	40	40	20
3	10	16	25

	1	1.4	1.8	2.2	2.6	3.0
1	160	160	80	80	160	160
1.4	160	160	80	80	160	160
1.8	40	40	40	40	20	20
2.2	40	40	40	40	20	20
2.6	10	10	16	16	25	25
3.0	10	10	16	16	25	25





Bilinear Interpolation

	1	2	3
1	160	80	160
2	40	40	20
3	10	16	25

	1	1.4	1.8	2.2	2.6	3.0
1	160	128	96	96	128	160
1.4	112	93	74	72	88	104
1.8						
2.2						
2.6						
3.0	10					25

$g(1,1.4) = f(1,1) * 0.6 + f(1,2) * 0.4$
$= 160 \times 0.6 + 80 * 0.4$
$= 128$

$g(1,1.8) = f(1,1) * 0.2 + f(1,2) * 0.8$
$= 160 \times 0.2 + 80 * 0.8$
$= 96$

$g(1,2.2) = f(1,2) * 0.8 + f(1,3) * 0.2$
$= 80 * 0.8 + 160 \times 0.2$
$= 96$

$g(1,2.6) = f(1,2) * 0.4 + f(1,3) * 0.6$
$= 80 \times 0.4 + 160 \times 0.6$
$= 128$

$g(1.4,1) = f(1,1) * 0.6 + f(2,1) * 0.4$
$= 160 \times 0.6 + 40 \times 0.4$
$= 112$

$g(1.4,2.6) = g(1.4,2) * 0.4 + g(1.4,3) * 0.6$
$= (64 * 0.4) + (104 *$ [illegible]

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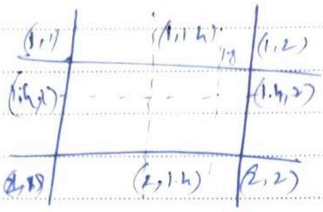
g(1.4, 1.4)



g(1.4, 1.4) = g(1, 1.4) * 0.6 + g(2, 1.4) * 0.4

g(2, 1.4) = f(2,1) * 0.6 + f(2,2) * 0.4
= (40 × 0.6) + (40 × 0.4)
= 40

g(1.4, 1.4) = 128 * 0.6 + 40 * 0.4
= 93

g(1.4, 1.8) = g(1, 1.8) * 0.6 + g(2, 1.8) * 0.4

g(2, 1.8) = f(2,1) * 0.2 + f(2,2) * 0.8
= (40 × 0.2) + (40 * 0.8)
= 8 + 40

g(1.4, 1.8) = (96 * 0.6) + (40 * 0.4)
= 73.6
= 74

g(1.4, 2.2) = g(1.4, 2) * 0.8 + g(1.4, 3) * 0.2
g(1.4, 2) = f(1,2) * 0.6 + f(2,2) * 0.4
= 80 × 0.6 + 40 × 0.4
= 64
g(1.4, 3) = f(1,3) * 0.6 + f(2,3) * 0.4
= 160 × 0.6 + 20 × 0.4 = 104
g(1.4, 2.2) = (64 * 0.8) + (104 * 0.2) = 72

4	How many digital paths are present from p to q? Please compute the lengths of the paths. Let V={1, 2}	10	CO1	L3

3	1	2	1(q)
2	2	0	2
1	2	1	1
1(p)	0	1	2

Ans:

4) Digital Paths

* The digital paths from pixel p of coordinate (x,y) to q with coordinate (s,t) of ~~freque~~ intensity f is given by three paths

- 4-path
- 8-path
- m-path

* This paths should follow adjacency of them

	0	1	2	3
0	3	1	2	1(q)
1	2	2	0	2
2	1	2	1	1
3	1(p)	0	1	2

Four - path

(a) ⇒ P(3,0) → P(2,0) → P(1,0) → P(1,1) → P(0,1) → P(0,2) → P(0,3)

1 → 1 → 2 → 2 → 1 → 2 → 1

It has length of 6.

(b) ⇒ P(3,0) → P(2,0) → P(2,1) → P(2,2) → P(2,3) → P(1,3) → P(0,3)

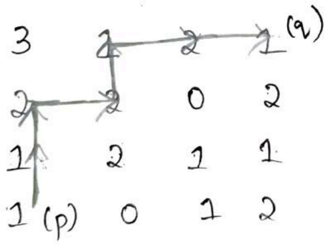
1 → 1 → 2 → 1 → 1 → 2 → 1

It has length of 6.

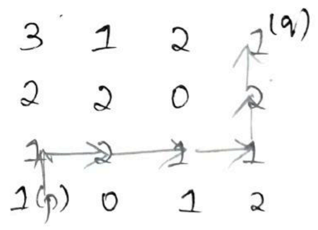
(c) ⇒ P(3,0) → P(2,0) → P(2,1) → P(1,1) → P(0,1) → P(0,2) → P(0,3)

It also has length of 6.

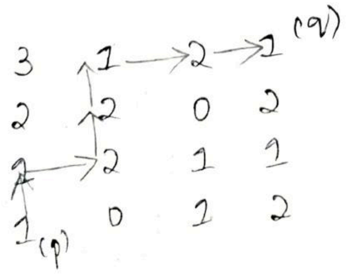
(a)



(b)

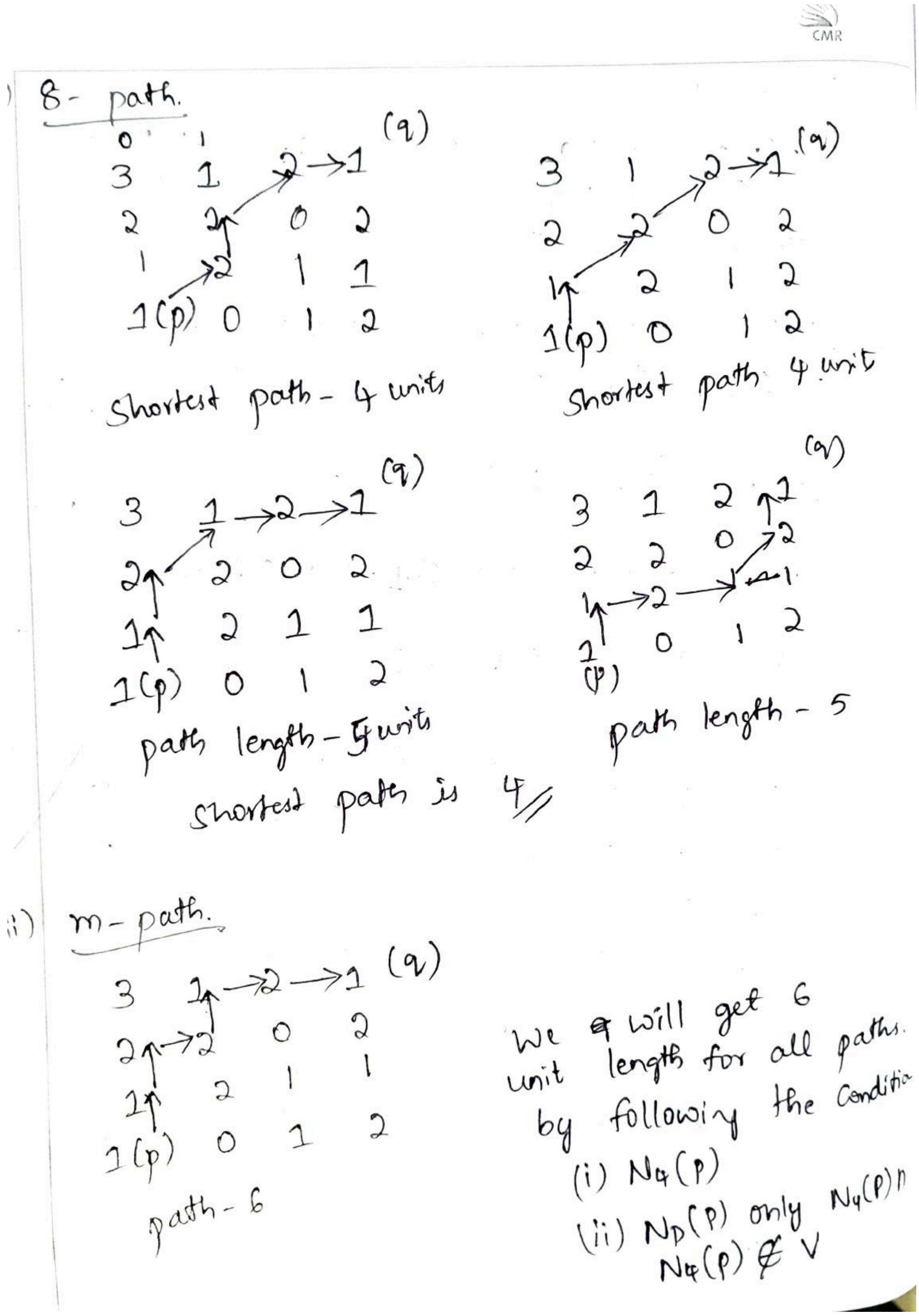


(c)



∴ The shortest path ~~test~~ length is 6.

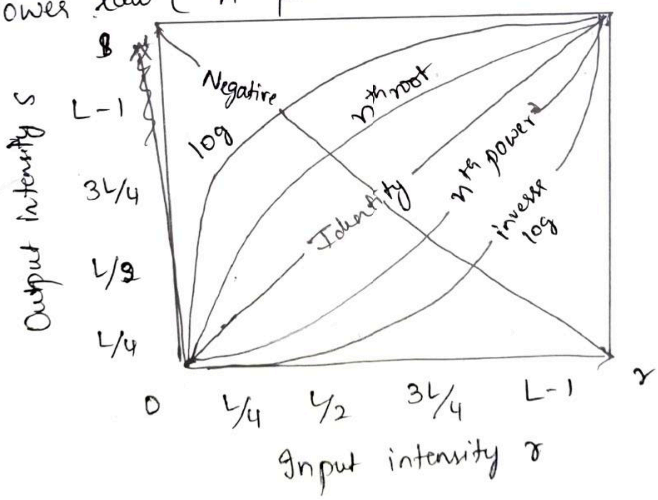
The no. of paths 3.

				
5	What are some of the basic intensity transformations functions? Ans:	10	CO2	L1

5. Intensity transformations are very important functions.

* It has a 2d function f(x,y) with coordinates x,y and input intensity r, & output intensity s.
* The transformation function is S= T(r). where T transforms r.
* It is a 1 dimensional function, so the image is stored in a 1d array. and can look the data in look up table.

⇒ Types are
(i) Linear (negative & identity)
(ii) Logarithmic (log & inverse)
(iii) Power law (nth power & nth root).



(i) Linear:-
* It has identity function which shows ~~sho~~ that

whatever is the input is the same for output.

→ **Negative:-**

The intensity values are considers in a range [0, L-1] and given as

$$S = L - 1 - r$$

- It is considered in reverse, which gives the output as photographic negative
- It is used mainly to highlight & white & gray color.

i) **Logarithmic function:-**

- It is given by

$$S = \log c(1+r)$$

- The logarithmic function is narrow and increases slowly for lower intensities ~~and said~~ (input) and will be wider for output. reverse of inverse log
- Its main function is to expand dark ~~pickel~~ pixels and compress high-level pixel.
- It is used mainly in dynamic range.

ii) **Power-law (Gamma)**

- It is given by

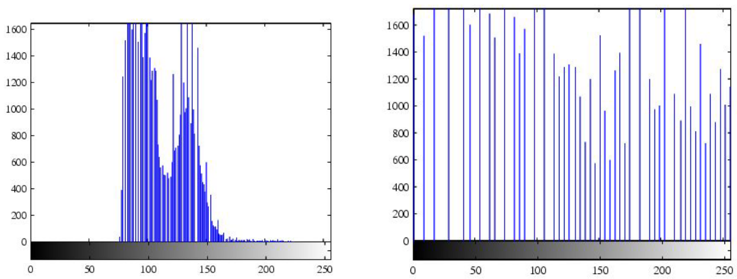
$$S = c r^{\gamma}$$

Where
γ is the constant.
- It is sometimes written as $s = c(r+\varepsilon)^{\gamma}$ where ε is the offset but the offset is ignorant.
- It works similar to log but has more powers.
- It can be used for gamma correction.

) Piecewise:-
- It is complementary used for artibutes,
- It is complex
> Constrast streching:-
The intensity is streched (expanded)
> Intensity slicing:-
Highlighting the intensity of interest.
> Bit-plane slicing:-
The pixel is the no. which has bits.

6	What is Histogram equalization? Briefly explain with an example.	10	CO2	L2

Ans:
Popular method for image enhancement
Also useful in image analysis
Transform the intensity values so that the histogram of the output image approximately matches the flat (uniform) histogram.



The discrete form of the Histogram Equalization transform is

$$s_k = T(r_k) = (L-1)\sum_{j=0}^{k} P_r(r_j) \quad ...(1)$$

Where $P_r(r) = n_r / MxN$, L total number of levels.

For a specific value of sk we can compute the transformation function as

$$s_k = G(z_q) = (L-1)\sum_{i=0}^{q} P_z(z_i) \quad ......(2)$$

Example

r_k	n_k	$p_r(r_k) = n_k/MN$
$r_0 = 0$	790	0.19
$r_1 = 1$	1023	0.25
$r_2 = 2$	850	0.21
$r_3 = 3$	656	0.16
$r_4 = 4$	329	0.08
$r_5 = 5$	245	0.06
$r_6 = 6$	122	0.03
$r_7 = 7$	81	0.02

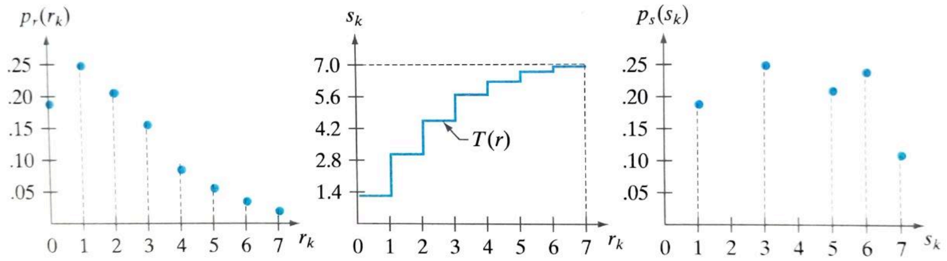
Similarly, $s_1 = T(r_1) = 3.08$, $s_2 = 4.55$, $s_3 = 5.67$, $s_4 = 6.23$, $s_5 = 6.65$, $s_6 = 6.86$, and $s_7 = 7.00$. This transformation function has the staircase shape shown in Fig. 3.19(b).

At this point, the s values are fractional because they were generated by summing probability values, so we round them to their nearest integer values in the range $[0, 7]$:

$$s_0 = 1.33 \rightarrow 1 \quad s_2 = 4.55 \rightarrow 5 \quad s_4 = 6.23 \rightarrow 6 \quad s_6 = 6.86 \rightarrow 7$$
$$s_1 = 3.08 \rightarrow 3 \quad s_3 = 5.67 \rightarrow 6 \quad s_5 = 6.65 \rightarrow 7 \quad s_7 = 7.00 \rightarrow 7$$

These are the values of the equalized histogram. Observe that the transformation yielded only five distinct intensity levels. Because $r_0 = 0$ was mapped to $s_0 = 1$, there are 790 pixels in the histogram equalized image with this value (see Table 3.1). Also, there are 1023 pixels with a value of $s_1 = 3$ and 850 pixels with a value of $s_2 = 5$. However, both r_3 and r_4 were mapped to the same value, 6, so there are $(656 + 329) = 985$ pixels in the equalized image with this value. Similarly, there are $(245 + 122 + 81) = 448$ pixels with a value of 7 in the histogram equalized image. Dividing these numbers by $MN = 4096$ yielded the equalized histogram in Fig. 3.19(c).

Because a histogram is an approximation to a PDF, and no new allowed intensity levels are created in the process, perfectly flat histograms are rare in practical applications of histogram equalization using the method just discussed. Thus, unlike its continuous counterpart, it cannot be proved in general that discrete histogram equalization using Eq. (3-15) results in a uniform histogram (we will introduce later in



r_k	n_k	$p_r(r_k) = n_k/MN$	CDF p_r	S_k	S_k	$p_s(s_k)$
0	790	0.19	0.19	1.33	1	0.19
1	1023	0.25	0.44	3.08	3	0.25
2	850	0.21	0.65	4.55	5	0.21
3	656	0.16	0.81	5.67	6	0.24
4	329	0.08	0.89	6.23	6	0.24
5	245	0.06	0.95	6.65	7	0.1
6	122	0.03	0.98	6.86	7	0.1
7	81	0.02	1	7	7	0.1

CI **CCI** **HOD**

--All the Best--