

No. of pages: 2

No. of questions: 2

Total marks: 30

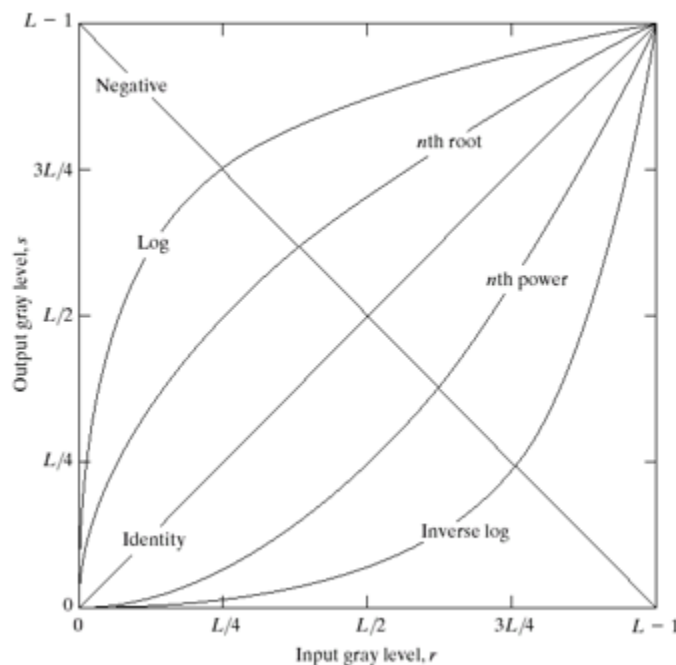
Question ① (15 marks)

Choose the correct answer:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
b	b	a	a	c	c	b	d	d	c	b	a	c	a	b

Question ② (5 marks)

- a) Explain with drawing the intensity transformation functions? What is the problem arising from using full scale contrast stretching? (3 marks)



Negative:

$$s = L - 1 - r$$

Log:

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

Inverse Log:

$$s = e^{cr} - 1$$

Power-law:

$$s = cr^Y$$

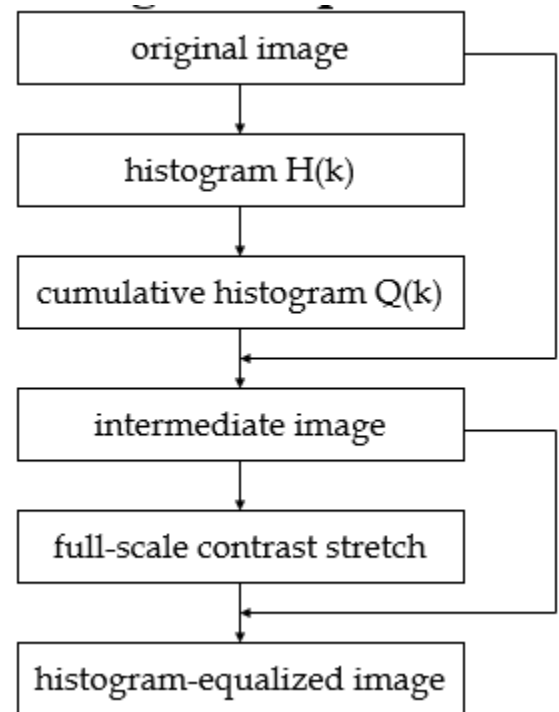
.....

Then explain intensity transformation functions

The major problem arising from using full scale contrast stretching when using an image with big gap which will increase using this technique.

b) Draw and explain the block diagram of the histogram equalization algorithm.

(2 marks)



Then explain the sequence of block diagram

Question ③ (10 marks)

For a 4x4, 4bits/pixel image shown.

- Find the full-scale contrast stretched image.
- Find the histogram equalized image.
- Draw the histogram of the three images and compare between them.

2	8	9	9
2	3	10	9
8	3	3	11
8	3	10	11

(Hint: the equation of contrast stretch is $s = \text{round}\left((2^B - 1) \cdot \frac{r - r_{\min}}{r_{\max} - r_{\min}} \right)$)

- First try: full-scale contrast stretch $r_{\min} = 2$ $r_{\max} = 11$

$$s = \text{round}\left((2^B - 1) \cdot \frac{r - r_{\min}}{r_{\max} - r_{\min}} \right) = \text{round}\left(15 \cdot \frac{r - 2}{11 - 2} \right) = \text{round}\left(\frac{5}{3}(r - 2) \right)$$

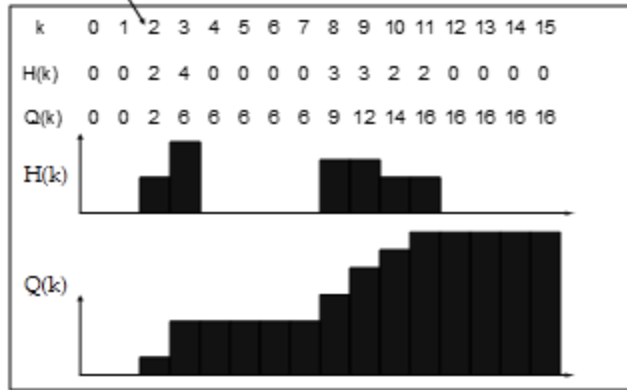
- 2 \rightarrow round(0) = 0;
- 3 \rightarrow round(1.67) = 2;
- 8 \rightarrow round(10.00) = 10;
- 9 \rightarrow round(11.67) = 12;
- 10 \rightarrow round(13.33) = 13;
- 11 \rightarrow round(15) = 15;

The resulting image is:

0	10	12	12
0	2	13	12
10	2	2	15
10	2	13	15

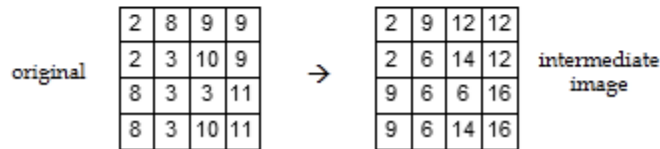
2	8	9	9
2	3	10	9
8	3	3	11
8	3	10	11

Cumulative Histogram



Intermediate Image

k	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
H(k)	0	0	2	4	0	0	0	0	3	3	2	2	0	0	0	0
Q(k)	0	0	2	6	6	6	6	6	9	12	14	16	16	16	16	16



Full-Scale Contrast Stretch of Intermediate Image



$$s = \text{round} \left((2^8 - 1) \cdot \frac{r - r_{min}}{r_{max} - r_{min}} \right) = \text{round} \left(15 \cdot \frac{r - 2}{16 - 2} \right) = \text{round} \left(\frac{15}{14} (r - 2) \right)$$

- 2 → round(0) = 0;
- 6 → round(4.29) = 4;
- 9 → round(7.50) = 8;
- 12 → round(10.71) = 11;
- 14 → round(12.86) = 13;
- 16 → round(15) = 15;

final result:	<table border="1"><tr><td>0</td><td>8</td><td>11</td><td>11</td></tr><tr><td>0</td><td>4</td><td>13</td><td>11</td></tr><tr><td>8</td><td>4</td><td>4</td><td>15</td></tr><tr><td>8</td><td>4</td><td>13</td><td>15</td></tr></table>	0	8	11	11	0	4	13	11	8	4	4	15	8	4	13	15
0	8	11	11														
0	4	13	11														
8	4	4	15														
8	4	13	15														
histogram equalized image																	

Histogram Comparison

4	8	6	6
6	4	11	8
8	8	9	10
8	11	10	7

0	10	12	12
0	2	13	12
10	2	2	15
10	2	13	15

0	8	11	11
0	4	13	11
8	4	4	15
8	4	13	15

original

direct full-scale contrast stretch

histogram-equalized

