Department of Computer Science and Engineering
National Institute of Technology, Hamirpur

Digital Image Processing CS-325

Laboratory Assignment -3

Topic: Digital Image Histogram Specification (Matching) implementation and interpretation of results

1. Design a program to read a moon.jpg file and apply **histogram specification** on each of the RGB plane of "moon.jpg". Show the input image and processed (both histogram equalization and specification output) image with corresponding histograms. Write the conclusion based on the histogram specification data "HistogramSpecificationData.xlsx" and observation of the output image in terms of dynamic range, contrast, light, dark and dull images.

2. Formulate a program to read moon.jpg file and apply histogram specification on average gray-scaled image of original images416 of "moon.jpg". Show the input image and processed (output) image with corresponding histograms. Write conclusion based on the each of the histogram specification data "HistogramSpecificationData.xlsx" and observation of the output image in terms of dynamic range, contrast, light, dark and dull images.

Study/ Help Material

Suppose that a 3-bit image (L = 8) of size 64 × 64 pixels (MN = 4096) has the intensity distribution in Table 3.1, where the intensity levels are integers in the range [0,L − 1] = [0, 7].

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

Solution: $\boldsymbol{s_0}$ = T($\boldsymbol{r_0}$) = (L-1)$\sum_{j=0}^{\mathbf{0}} \boldsymbol{p_r}(\boldsymbol{r_j})$ = (8-1)$\boldsymbol{p_r}(\boldsymbol{r_0})$ =7*0.19 =1.33

$\boldsymbol{s_1}$ = T($\boldsymbol{r_1}$) = (L-1)$\sum_{j=0}^{\mathbf{1}} \boldsymbol{p_r}(\boldsymbol{r_j})$ = (8-1)[$\boldsymbol{p_r}(\boldsymbol{r_0})$ + $\boldsymbol{p_r}(\boldsymbol{r_1})$] =7[0.19+0.25] =3.08

$\boldsymbol{s_2} = 4.55$, $\boldsymbol{s_3} = 5.67$, $\boldsymbol{s_4} = 6.23$, $\boldsymbol{s_5} = 6.65$, $\boldsymbol{s_6} = 6.68$, $\boldsymbol{and}\ \boldsymbol{s_7} = 7.00$

- The *s* vales are in fractions as they are generated by summing probability values, so round them to nearest integer.

s_0 **=1.33→1**	s_1 **=3.08 →3**	$s_2 = 4.55$**→5**	$\boldsymbol{s_3} = \mathbf{5.67}$**→6**
$s_4 = 6.23$→6	$s_5 = 6.65$→7	$s_6 = 6.68$→7	$s_7 = 7.00$→7

- In the next step, all the values of transformation function:
- G(z_0) = (L-1)$\sum_{j=0}^{0} p_z(r_j)$ =0.00
- G(z_1) = (L-1)$\sum_{j=0}^{1} p_z(r_j)$ = (8-1)[$p_z(z_0)$ + $p_z(z_1)$] = 0.00

- $G(z_2)$ = (L-1)$\sum_{j=0}^{2} p_z(r_j)$ = (8-1)$[p_z(z_0) + p_z(z_1) + p_z(z_2)]$ = 0.00
- $G(z_3)$ = 1.05, $G(z_4)$ = 2.45, $G(z_5)$ = 4.55,
- $G(z_6)$ = 5.95, $G(z_7)$ = 7.00
- For example $G(\boldsymbol{z}_3) = 1.05 \rightarrow 1$, this implies that intensity value of s =1 (obtained after histogram- equalization) will transform to 3.

$G(z_0) = 0.00 \rightarrow 0$	$G(z_1) = 0.00 \rightarrow 0$	$G(z_2) = 0.00 \rightarrow 0$	$G(\boldsymbol{z}_3) = 1.05 \rightarrow 1$
$G(z_4) = 2.45 \rightarrow 2$	$G(z_5) = 4.55 \rightarrow 5$	$G(z_6) = 5.95 \rightarrow 6$	$G(z_7) = 7.00 \rightarrow 7$

z_q	$G(z_q)$
$z_0 = 0$	0
$z_1 = 1$	0
$z_2 = 2$	0
$z_3 = 3$	1
$z_4 = 4$	2
$z_5 = 5$	5
$z_6 = 6$	6
$z_7 = 7$	7

TABLE 3.3
All possible values of the transformation function G scaled, rounded, and ordered with respect to z.

s_k	$\rightarrow$	z_q
1	$\rightarrow$	3
3	$\rightarrow$	4
5	$\rightarrow$	5
6	$\rightarrow$	6
7	$\rightarrow$	7

TABLE 3.4
Mappings of all the values of s_k into corresponding values of z_q.