
Image Processing and Computer Vision (IPCV)



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Example Solutions for Classroom Assignment 5 (C5)

Problem 1 (Point Transformations)

- (a) First, we calculate the histogram of the image, i.e. we count the occurrence frequency of all grey values from the 3bit range $(0, \dots, 7)$.

Grey value index i	1	2	3	4	5	6	7	8
Grey value v_i	0	1	2	3	4	5	6	7
Frequency p_i	0	4	10	9	9	6	2	0

The image consists of $N = 40$ pixels and we have $2^3 = 8$ different grey values. Thus the desired number of pixels for each value is $q_i = \frac{40}{8} = 5$.

To apply the histogram equalisation we first compute the accumulated histogram:

Grey value index i	1	2	3	4	5	6	7	8
$s_i := \sum_{j=1}^i p_j$	0	4	14	23	32	38	40	40

For $r = 1, \dots, 8$, we are looking for the largest index k_r such that $s_{k_r} \leq r \cdot 5$:

Index r	1	2	3	4	5	6	7	8
k_r	2	2	3	3	4	4	5	8
s_{k_r}	4	4	14	14	23	23	32	40
$r \cdot 5$	5	10	15	20	25	30	35	40

Let $k_0 := 0$. We map the grey values $v_{k_{r-1}+1}, \dots, v_{k_r}$ to new grey value

w_r for $r = 1, \dots, 8$:

- $r = 1$: $v_{k_0+1}, \dots, v_{k_1} \Leftrightarrow v_1, \dots, v_2 \Rightarrow v_1, v_2$ are mapped to $w_1 = 0$
 $r = 2$: $v_{k_1+1}, \dots, v_{k_2} \Leftrightarrow v_3, \dots, v_2 \Rightarrow \nexists$, there is no mapping to $w_2 = 1$
 $r = 3$: $v_{k_2+1}, \dots, v_{k_3} \Leftrightarrow v_3, \dots, v_3 \Rightarrow v_3$ is mapped to $w_3 = 2$
 $r = 4$: $v_{k_3+1}, \dots, v_{k_4} \Leftrightarrow v_4, \dots, v_3 \Rightarrow \nexists$, there is no mapping to $w_4 = 3$
 $r = 5$: $v_{k_4+1}, \dots, v_{k_5} \Leftrightarrow v_4, \dots, v_4 \Rightarrow v_4$ is mapped to $w_5 = 4$
 $r = 6$: $v_{k_5+1}, \dots, v_{k_6} \Leftrightarrow v_5, \dots, v_4 \Rightarrow \nexists$, there is no mapping to $w_6 = 5$
 $r = 7$: $v_{k_6+1}, \dots, v_{k_7} \Leftrightarrow v_5, \dots, v_5 \Rightarrow v_5$ is mapped to $w_7 = 6$
 $r = 8$: $v_{k_7+1}, \dots, v_{k_8} \Leftrightarrow v_6, \dots, v_8 \Rightarrow v_6, v_7, v_8$ are mapped to $w_8 = 7$

The equalised image is given by

7	7	7	0	2	2	2	4
6	6	6	6	7	4	2	4
6	6	6	4	7	4	4	4
6	6	4	4	7	2	2	2
0	0	7	7	0	2	2	2

and its histogram is

Grey value index i	1	2	3	4	5	6	7	8
Grey value w_i	0	1	2	3	4	5	6	7
Frequency	4	0	10	0	9	0	9	8

(b) The histograms are given in the following way:

