

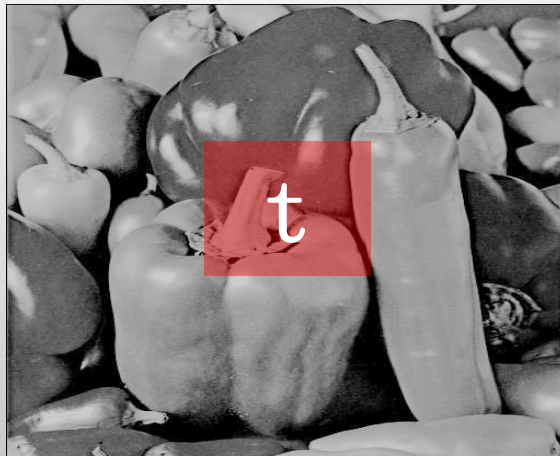


计算机图像处理

COMPUTER IMAGE PROCESSING



$$t = T(s) = \sum_{i=0}^s H(i)$$





$$t = G(u) = \sum_{i=0}^u H'(i)$$

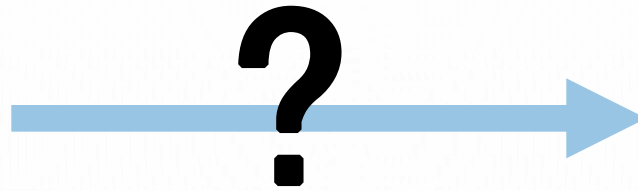




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$$t = T(s)$$

$$t = G(u)$$





$$t = T(s)$$

$$u = G^{-1}(t)$$

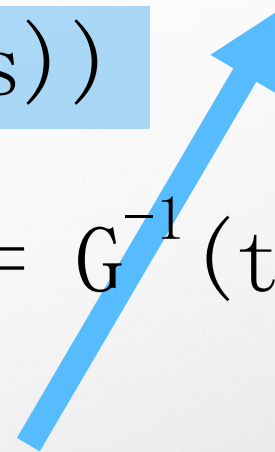
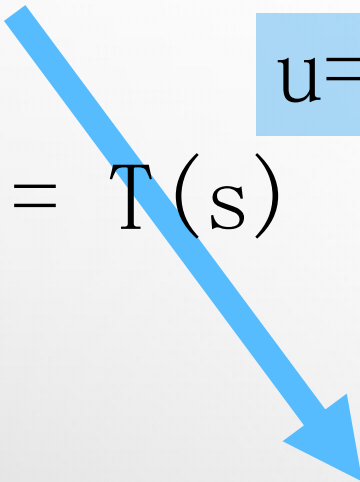


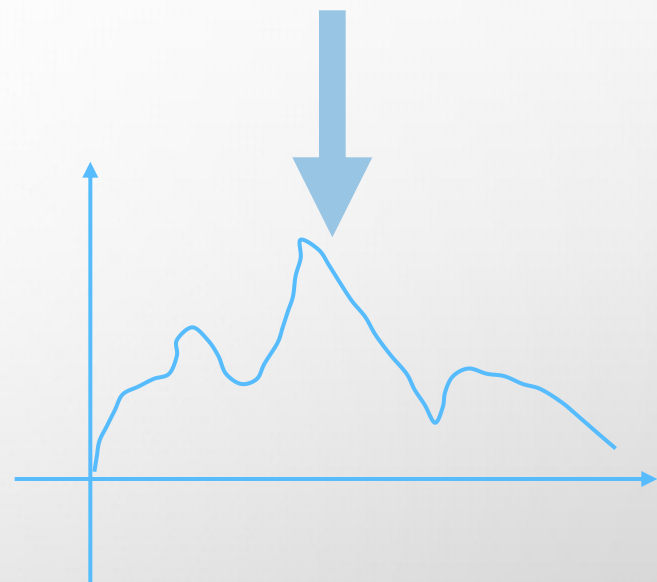


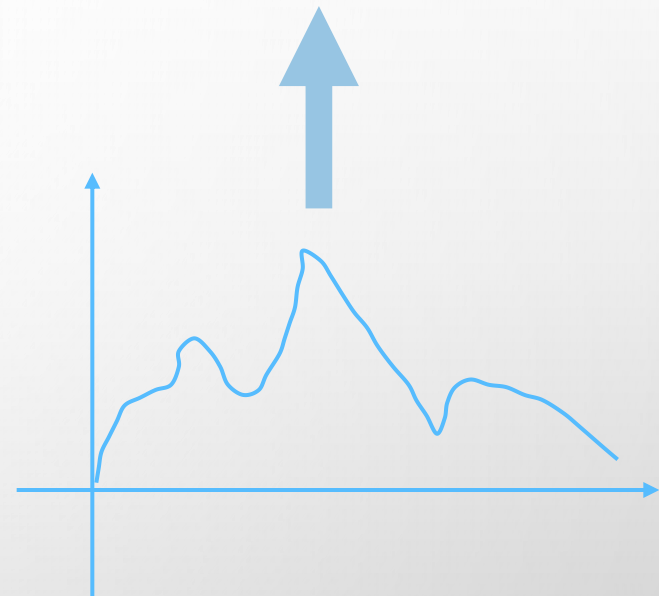
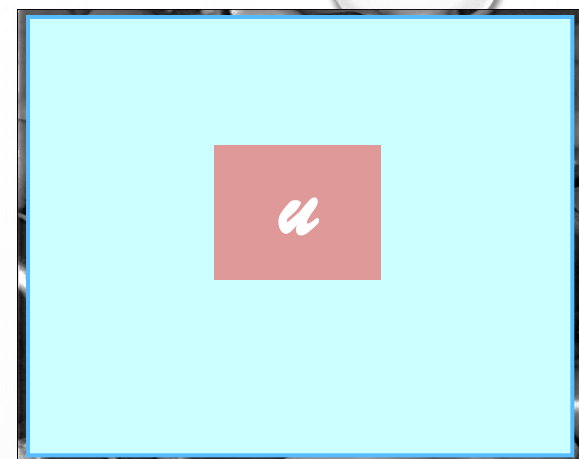
$$u = G^{-1}(t) = G^{-1}(T(s))$$

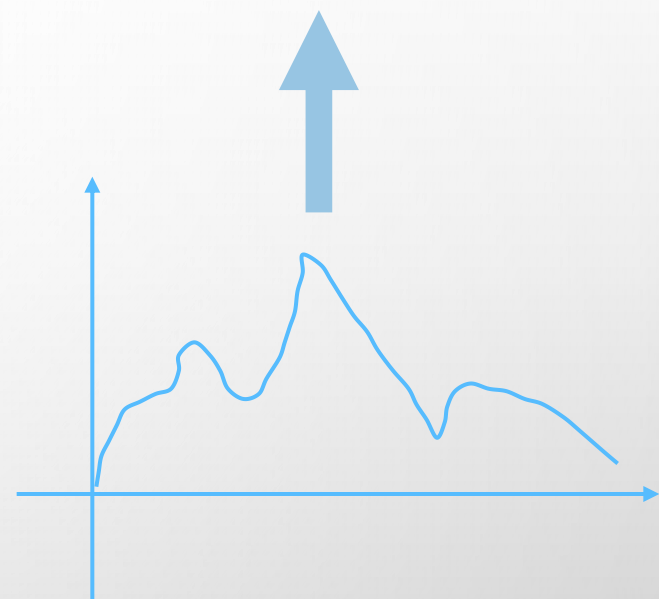
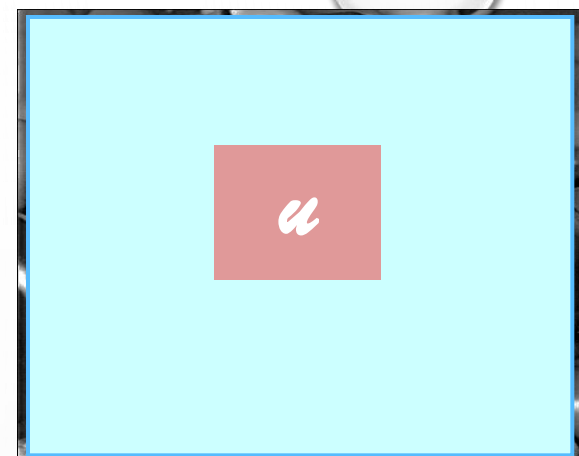
$$t = T(s)$$

$$u = G^{-1}(t)$$









直方图规定化处理

直方图规定化

直方图规定化

(1) 对原始图像的直方图进行均衡化:

$$t_k = T(s_k) = \sum_{i=0}^k p_s(s_i) \quad k = 0, 1, \dots, M-1$$

(2) 同样对规定图像计算能使规定的直方图均衡化:

$$t_l = T_u(u_j) = \sum_{j=0}^l p_u(u_j) \quad l = 0, 1, \dots, N-1$$

(3) 将原始直方图对应映射到规定的直方图

$$\left| \sum_{i=0}^k p_s(s_i) - \sum_{j=0}^l p_u(u_j) \right| \quad \begin{array}{l} k = 0, 1, \dots, M-1 \\ l = 0, 1, \dots, N-1 \end{array}$$

直方图规定化

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$$\left| \sum_{i=0}^k p_s(s_i) - \sum_{j=0}^l p_u(u_j) \right|$$

s_i 对应 u_i
 $k = 0, 1, \dots, M-1$
 $l = 0, 1, \dots, N-1$

直方图规范化

例

原始图像各灰度级对应的概率分布

灰度级	0	1	2	3	4	5	6	7
像素	790	1023	850	656	329	245	122	81
概率	0.19	0.25	0.21	0.16	0.08	0.06	0.03	0.02

规定直方图概率分布

灰度级	0	1	2	3	4	5	6	7
概率	0.0	0.00	0.00	0.15	0.20	0.30	0.20	0.15

直方图规定化

例

直方图规定化步骤:

(1) 对原始直方图操作:

$t_0 = 1(0.19)$	$n_{t_0} = 790$	$p_t(s_{t_0}) = 0.19$
$t_1 = 3(0.19 + 0.25 = 0.44)$	$n_{t_1} = 1023$	$p_t(s_{t_1}) = 0.25$
$t_2 = 5(0.44 + 0.21 = 0.65)$	$n_{t_2} = 850$	$p_t(s_{t_2}) = 0.21$
$t_3 = 6(0.65 + 0.16 = 0.81)$	$n_{t_3} = 656$	$p_t(s_{t_3}) = 0.16$
$t_4 = 6(0.81 + 0.08 = 0.91)$	$n_{t_4} = 329$	$p_t(s_{t_4}) = 0.08$
$t_5 = 7(0.89 + 0.06 = 0.95)$	$n_{t_5} = 245$	$p_t(s_{t_5}) = 0.06$
$t_6 = 7(0.95 + 0.03 = 0.98)$	$n_{t_6} = 122$	$p_t(s_{t_6}) = 0.03$
$t_7 = 7(0.98 + 0.02 = 1.00)$	$n_{t_7} = 81$	$p_t(s_{t_7}) = 0.02$

直方图规定化

例

(2) 对规定直方图图像操作:

灰度级	0	1	2	3	4	5	6	7
概率	0.0	0.00	0.00	0.15	0.20	0.30	0.20	0.15

$$v_0 = 0.00 = T_u(u_0) \quad v_1 = 0.00 = T_u(u_1)$$

$$v_2 = 0.00 = T_u(u_2) \quad v_3 = 0.15 = T_u(u_3)$$

$$v_4 = 0.35 = T_u(u_4) \quad v_5 = 0.65 = T_u(u_5)$$

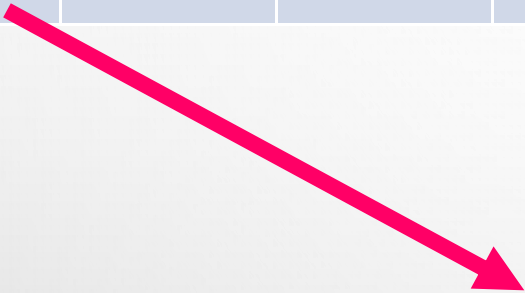
$$v_6 = 0.85 = T_u(u_6) \quad v_7 = 1.00 = T_u(u_7)$$

直方图规定化

例

(3) 映射结果:

t0	t1	t2	t3	t4	t5	t6	t7
0.19	0.44	0.65	0.81	0.91	0.95	0.98	1.00



v0	v1	v2	v3	v4	v5	v6	v7
0.00	0.00	0.00	0.15	0.35	0.65	0.85	1.00

t0	t1	t2	t3	t4	t5	t6	t7
v3	v4	v5	v6	v6	v7	v7	v7

直方图规定化

例

(3) 映射结果:

t0	t1	t2	t3	t4	t5	t6	t7
0.19	0.44	0.65	0.81	0.91	0.95	0.98	1.00

v0	v1	v2	v3	v4	v5	v6	v7
0.00	0.00	0.00	0.15	0.35	0.65	0.85	1.00

t0	t1	t2	t3	t4	t5	t6	t7
v3	v4	v5	v6	v6	v7	v7	v7

直方图规定化

例

(3) 映射结果:

t0	t1	t2	t3	t4	t5	t6	t7
0.19	0.44	0.65	0.81	0.91	0.95	0.98	1.00

v0	v1	v2	v3	v4	v5	v6	v7
0.00	0.00	0.00	0.15	0.35	0.65	0.85	1.00

t0	t1	t2	t3	t4	t5	t6	t7
v3	v4	v5	v6	v6	v7	v7	v7

直方图规定化

例

(3) 映射结果:

t0	t1	t2	t3	t4	t5	t6	t7
0.19	0.44	0.65	0.81	0.91	0.95	0.98	1.00

v0	v1	v2	v3	v4	v5	v6	v7
0.00	0.00	0.00	0.15	0.35	0.65	0.85	1.00

t0	t1	t2	t3	t4	t5	t6	t7
v3	v4	v5	v6	v6	v7	v7	v7

直方图规定化

例

(3) 映射结果:

t0	t1	t2	t3	t4	t5	t6	t7
0.19	0.44	0.65	0.81	0.91	0.95	0.98	1.00

v0	v1	v2	v3	v4	v5	v6	v7
0.00	0.00	0.00	0.15	0.35	0.65	0.85	1.00

t0	t1	t2	t3	t4	t5	t6	t7
v3	v4	v5	v6	v6	v7	v7	v7

直方图规定化

例

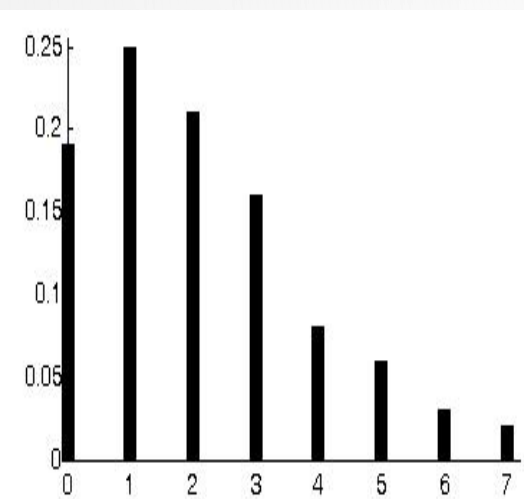
原始图像	0	1	2	3	4	5	6	7
目标图像	3	4	5	6	6	7	7	7

规定化后的直方图

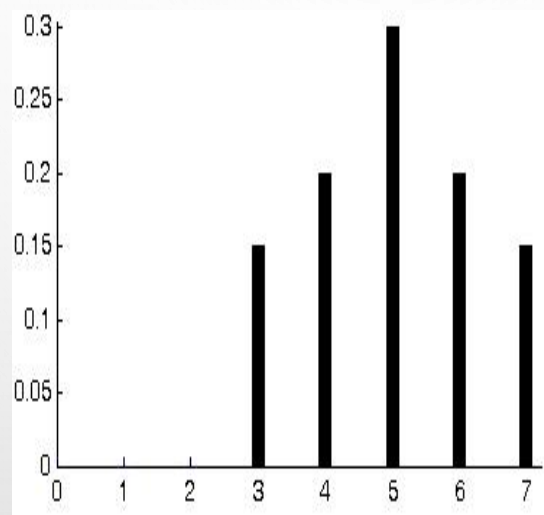
灰度级	0	1	2	3	4	5	6	7
像素	0	0	0	790	1023	850	985	448
概率	0.00	0.00	0.00	0.19	0.25	0.21	0.24	0.11

直方图规定化

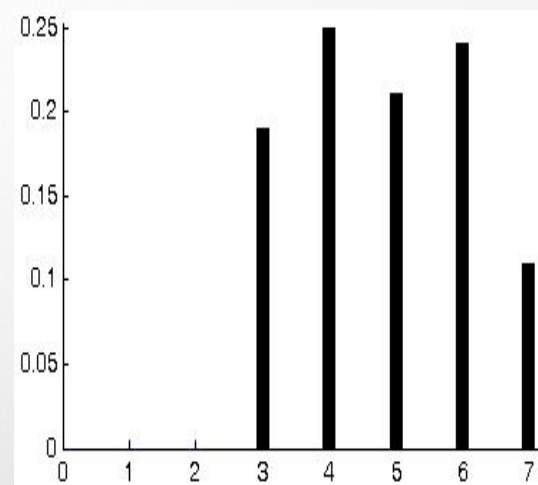
结果



原始直方图



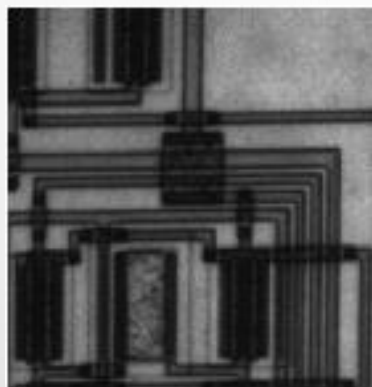
规定直方图



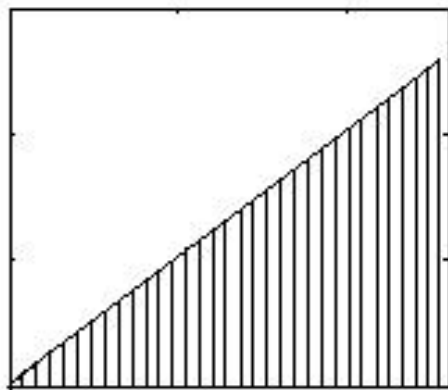
结果直方图

直方图规定化

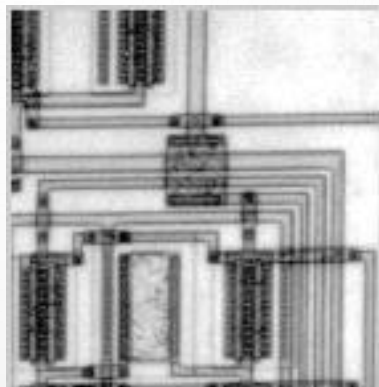
效果



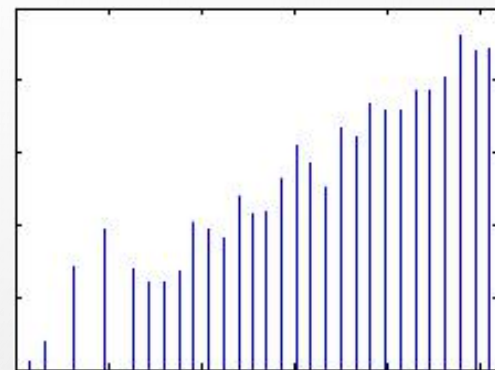
原始图像



规定直方图

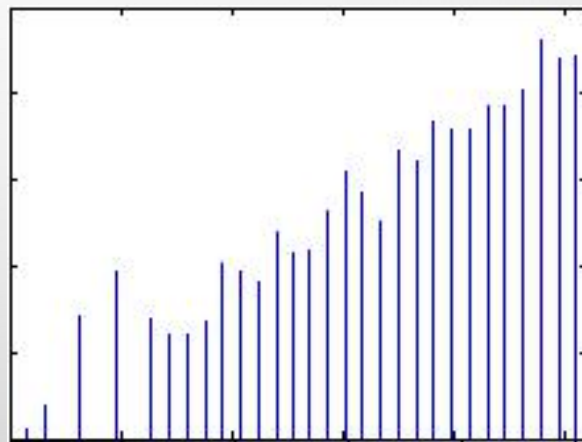
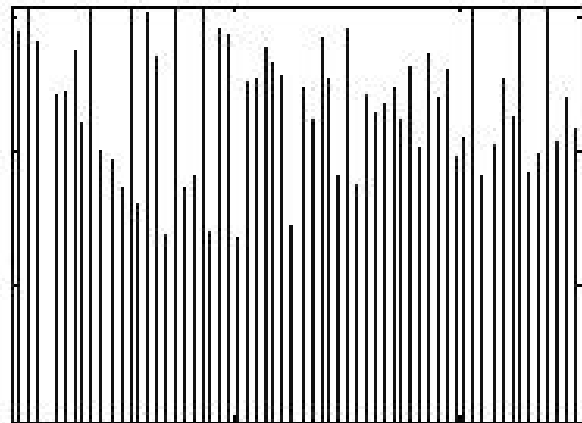
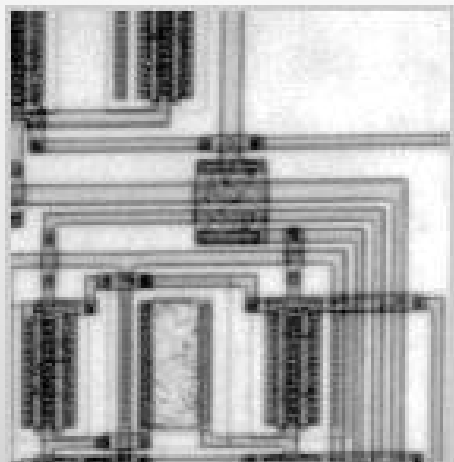
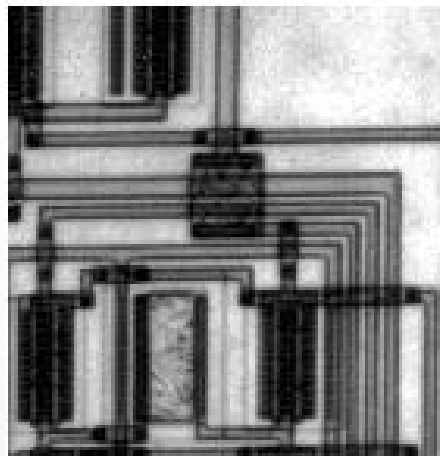
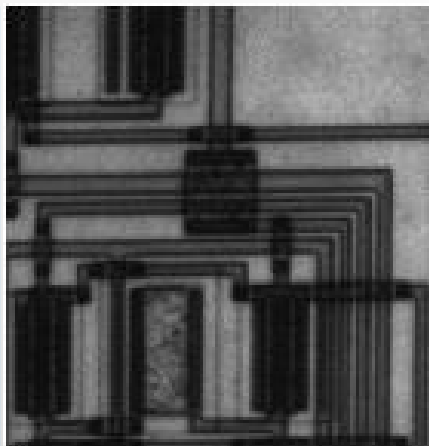


规定化后的图像



规定化后直方图

原图



均衡化后效果图

规定化后效果图

程序呢？