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Histogram Equalization

1)

r_k	n_k	$Pr(r_k) = n_k / M_n$
$r_0 = 0$	120	0.03
$r_1 = 1$	90	0.02
$r_2 = 2$	55	0.01
$r_3 = 3$	340	0.08
$r_4 = 4$	184	0.04
$r_5 = 5$	750	0.18
$r_6 = 6$	1500	0.37
$r_7 = 7$	523	0.13

$S_0 = 7 \sum_{j=0}^{0} Pr(r_j) = 7 \times 0.03 = 0.21 \rightarrow 0$

$S_1 = 7 \times (0.03 + 0.02) = 0.35 \rightarrow 0$

$S_2 = 7 \times (0.03 + \dots + 0.01) = 0.42 \rightarrow 0$

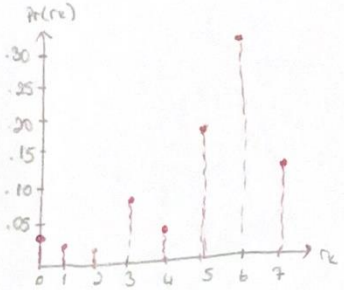
$S_3 = 7 \times (0.03 + \dots + 0.08) = 0.98 \rightarrow 1$

$S_4 = 7 \times (0.03 + \dots + 0.04) = 1.26 \rightarrow 1$

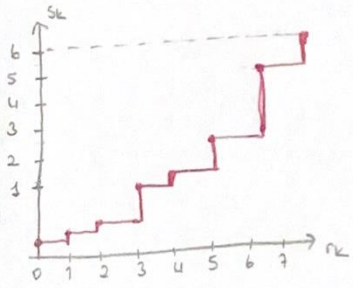
$S_5 = 7 \times (0.03 + \dots + 0.18) = 2.52 \rightarrow 3$

$S_6 = 7 \times (0.03 + \dots + 0.37) = 5.11 \rightarrow 5$

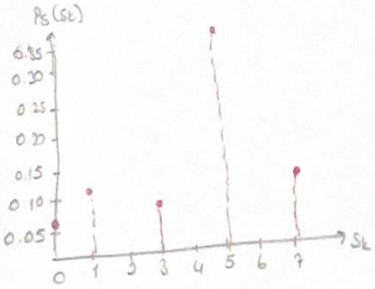
$S_7 = 7 \times (0.03 + \dots + 0.13) = 6.02 \rightarrow 6$



original histogram

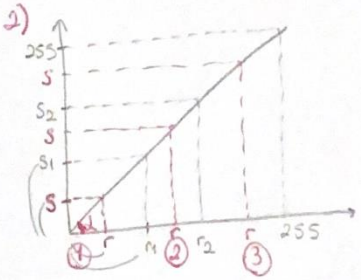


Transformation function



Equalized histogram

2)



1) $S = \frac{S_1}{r_1} \cdot r \rightarrow \frac{S}{S+S_1} = \frac{r}{r+r_1} \Rightarrow S = \frac{S_1}{r_1} \cdot r$

2) $\frac{S_1+S}{S_1+S+S_2} = \frac{r_1+r}{r_1+r+r_2}$

$S_1r_1 + S_1r + S_1r_2 + Sr_1 + Sr + Sr_2 = S_1r_1 + S_1r + S_1r_1 + Sr + S_2r_1 + S_2r$

$S_1r_2 + Sr_2 = S_2r_1 + S_2r$

$r_2(S_1 + S) = S_2(r_1 + r)$

$S_1 + S = \frac{S_2(r_1+r)}{r_2}$

$\boxed{S = \frac{S_2(r_1+r)}{r_2} - S_1}$

3) $\frac{S_2+S}{S_2+S+255} = \frac{r_2+r}{r_2+r+255}$

$S_2r_2 + S_2r + 255S_2 + Sr_2 + Sr + 255S = S_2r_2 + S_2r + Sr_2 + Sr + 255r_2 + 255r$

$255(S_2 + S) = 255(r_2 + r)$

$\boxed{S = r_2 + r - S_2}$