

Aula 05 – Transformações de intensidade II

Prof. João Fernando Mari

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- Equalização de histograma

Equalização de histograma

Imagem original

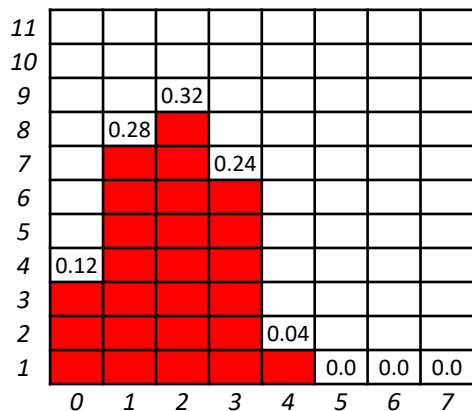
	0	1	2	3	4
0	1	2	2	3	1
1	1	3	3	4	2
2	1	2	3	3	2
3	0	2	2	3	2
4	0	0	1	1	1

5 x 5 pixels = 25 pixels

3 bits ou $2^3 = 8$ níveis de cinza (L).

Intervalo de níveis de cinza: [0, 7]

Histograma normalizado



Equalização de histograma

Imagem original

	0	1	2	3	4
0	1	2	2	3	1
1	1	3	3	4	2
2	1	2	3	3	2
3	0	2	2	3	2
4	0	0	1	1	1

5 x 5 pixels = 25 pixels

3 bits ou $2^3 = 8$ níveis de cinza (L).

Intervalo de níveis de cinza: [0, 7]

Histograma normalizado

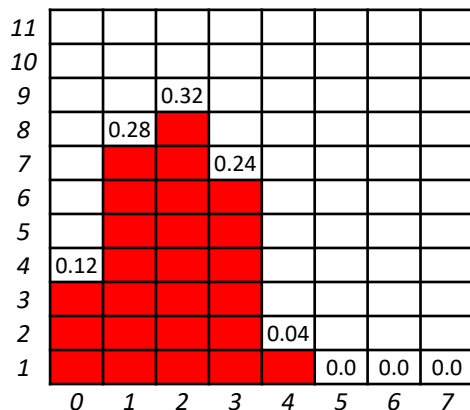
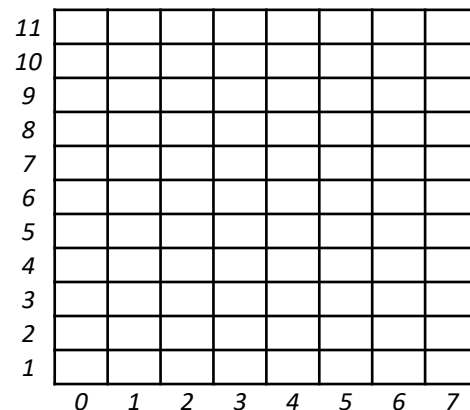


Imagem processada

	0	1	2	3	4
0	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0

Histograma normalizado



Equalização de histograma

Imagem original

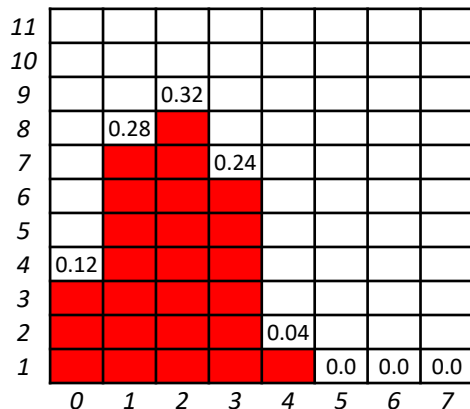
	0	1	2	3	4
0	1	2	2	3	1
1	1	3	3	4	2
2	1	2	3	3	2
3	0	2	2	3	2
4	0	0	1	1	1

5 x 5 pixels = 25 pixels

3 bits ou $2^3 = 8$ níveis de cinza (L).

Intervalo de níveis de cinza: [0, 7]

Histograma normalizado



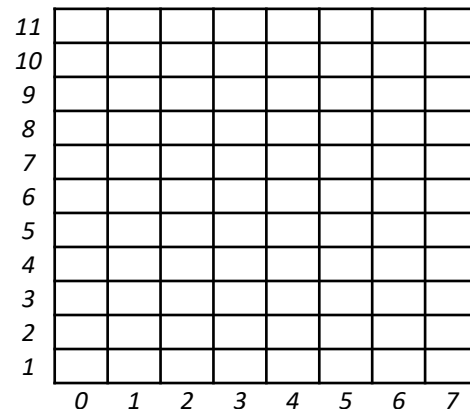
$$s_k = T(r_k) = (L - 1) \sum_{j=0}^k p_r(r_j)$$

k	p'	s _k =T(r _k)
0		
1		
2		
3		
4		
5		
6		
7		

Imagem processada

	0	1	2	3	4
0	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0

Histograma normalizado



Equalização de histograma

Imagem original

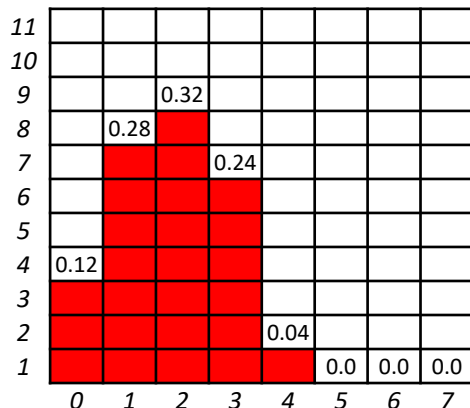
	0	1	2	3	4
0	1	2	2	3	1
1	1	3	3	4	2
2	1	2	3	3	2
3	0	2	2	3	2
4	0	0	1	1	1

5 x 5 pixels = 25 pixels

3 bits ou $2^3 = 8$ níveis de cinza (L).

Intervalo de níveis de cinza: [0, 7]

Histograma normalizado



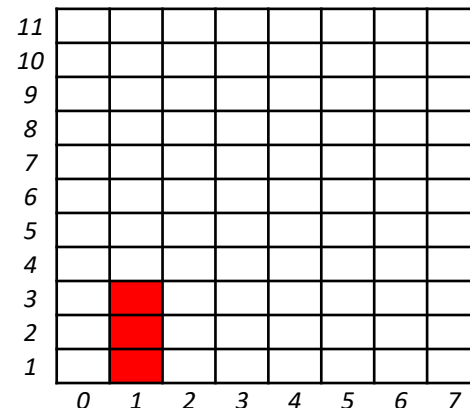
$$s_k = T(r_k) = (L - 1) \sum_{j=0}^k p_r(r_j)$$

k	p'	s _k =T(r _k)
0	7 × (0.12)	= 0.84
1		
2		
3		
4		
5		
6		
7		

Imagem processada

	0	1	2	3	4
0	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	1	0	0	0	0
4	1	1	0	0	0

Histograma normalizado



Equalização de histograma

Imagem original

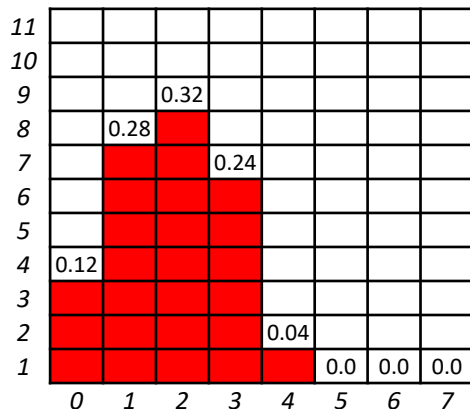
	0	1	2	3	4
0	1	2	2	3	1
1	1	3	3	4	2
2	1	2	3	3	2
3	0	2	2	3	2
4	0	0	1	1	1

5 x 5 pixels = 25 pixels

3 bits ou $2^3 = 8$ níveis de cinza (L).

Intervalo de níveis de cinza: [0, 7]

Histograma normalizado



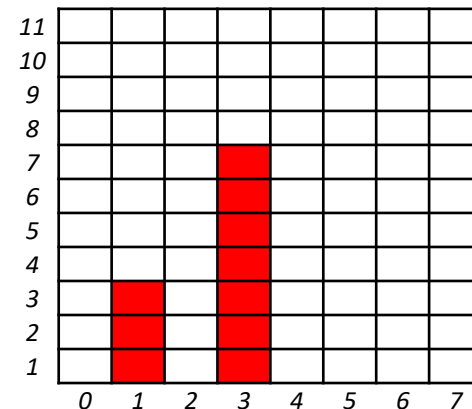
$$s_k = T(r_k) = (L - 1) \sum_{j=0}^k p_r(r_j)$$

k	p'	$s_k = T(r_k)$
0	$7 \times (0.12)$	$= 0.84$
1	$7 \times (0.12 + 0.28)$	$= 2.80$
2		
3		
4		
5		
6		
7		

Imagem processada

	0	1	2	3	4
0	3	0	0	0	3
1	3	0	0	0	0
2	3	0	0	0	0
3	1	0	0	0	0
4	1	1	3	3	3

Histograma normalizado



Equalização de histograma

Imagem original

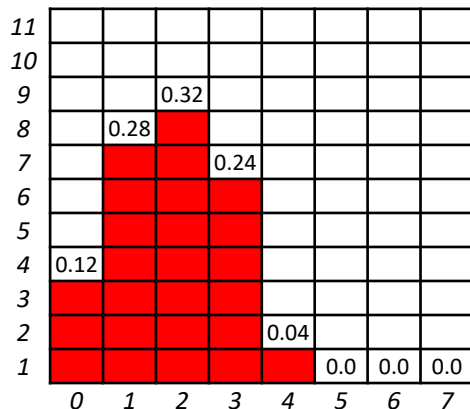
	0	1	2	3	4
0	1	2	2	3	1
1	1	3	3	4	2
2	1	2	3	3	2
3	0	2	2	3	2
4	0	0	1	1	1

5 x 5 pixels = 25 pixels

3 bits ou $2^3 = 8$ níveis de cinza (L).

Intervalo de níveis de cinza: [0, 7]

Histograma normalizado



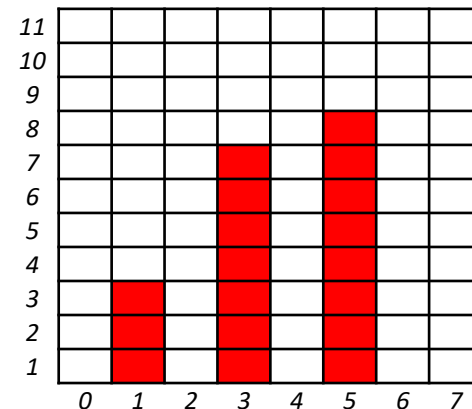
$$s_k = T(r_k) = (L - 1) \sum_{j=0}^k p_r(r_j)$$

k	p'	$s_k = T(r_k)$
0	$7 \times (0.12)$	= 0.84 = 1
1	$7 \times (0.12 + 0.28)$	= 2.80 = 3
2	$7 \times (0.12 + 0.28 + 0.32)$	= 5.04 = 5
3		
4		
5		
6		
7		

Imagem processada

	0	1	2	3	4
0	3	5	5	0	3
1	3	0	0	0	5
2	3	5	0	0	5
3	1	5	5	0	5
4	1	1	3	3	3

Histograma normalizado



Equalização de histograma

Imagem original

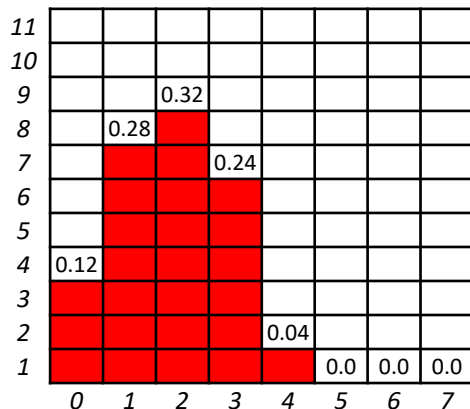
	0	1	2	3	4
0	1	2	2	3	1
1	1	3	3	4	2
2	1	2	3	3	2
3	0	2	2	3	2
4	0	0	1	1	1

5 x 5 pixels = 25 pixels

3 bits ou $2^3 = 8$ níveis de cinza (L).

Intervalo de níveis de cinza: [0, 7]

Histograma normalizado



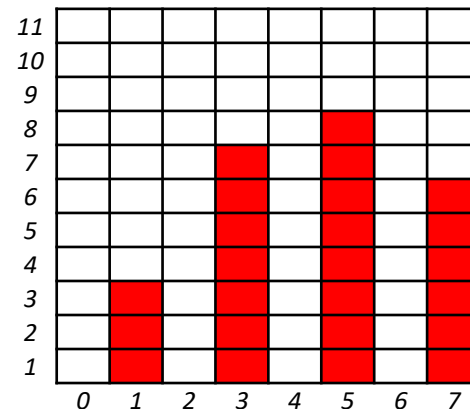
$$s_k = T(r_k) = (L - 1) \sum_{j=0}^k p_r(r_j)$$

k		p'	$s_k = T(r_k)$
0	$7 \times (0.12)$	= 0.84	= 1
1	$7 \times (0.12 + 0.28)$	= 2.80	= 3
2	$7 \times (0.12 + 0.28 + 0.32)$	= 5.04	= 5
3	$7 \times (0.12 + 0.28 + 0.32 + 0.24)$	= 6.72	= 7
4			
5			
6			
7			

Imagem processada

	0	1	2	3	4
0	3	5	5	7	3
1	3	7	7	0	5
2	3	5	7	7	5
3	1	5	5	7	5
4	1	1	3	3	3

Histograma normalizado



Equalização de histograma

Imagem original

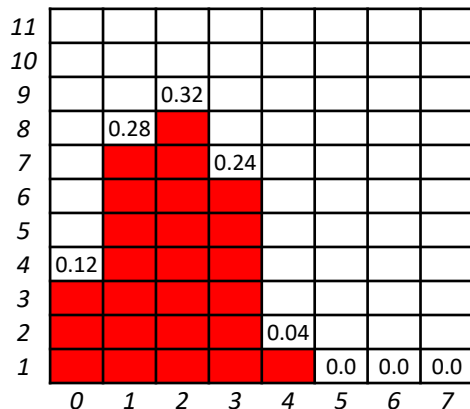
	0	1	2	3	4
0	1	2	2	3	1
1	1	3	3	4	2
2	1	2	3	3	2
3	0	2	2	3	2
4	0	0	1	1	1

5 x 5 pixels = 25 pixels

3 bits ou $2^3 = 8$ níveis de cinza (L).

Intervalo de níveis de cinza: [0, 7]

Histograma normalizado



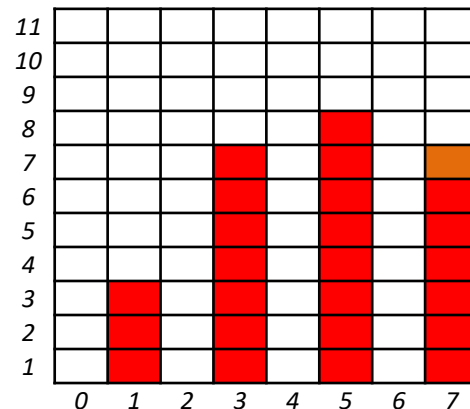
$$s_k = T(r_k) = (L - 1) \sum_{j=0}^k p_r(r_j)$$

k	p'	$s_k = T(r_k)$
0	$7 \times (0.12)$	= 0.84 = 1
1	$7 \times (0.12 + 0.28)$	= 2.80 = 3
2	$7 \times (0.12 + 0.28 + 0.32)$	= 5.04 = 5
3	$7 \times (0.12 + 0.28 + 0.32 + 0.24)$	= 6.72 = 7
4	$7 \times (0.12 + 0.28 + 0.32 + 0.24 + 0.04)$	= 7.00 = 7
5		
6		
7		

Imagem processada

	0	1	2	3	4
0	3	5	5	7	3
1	3	7	7	7	5
2	3	5	7	7	5
3	1	5	5	7	5
4	1	1	3	3	3

Histograma normalizado



Equalização de histograma

Imagem original

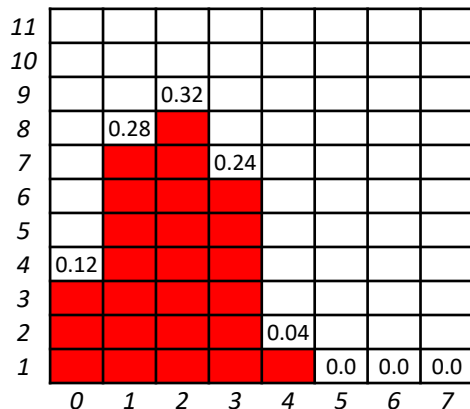
	0	1	2	3	4
0	1	2	2	3	1
1	1	3	3	4	2
2	1	2	3	3	2
3	0	2	2	3	2
4	0	0	1	1	1

5 x 5 pixels = 25 pixels

3 bits ou $2^3 = 8$ níveis de cinza (L).

Intervalo de níveis de cinza: [0, 7]

Histograma normalizado



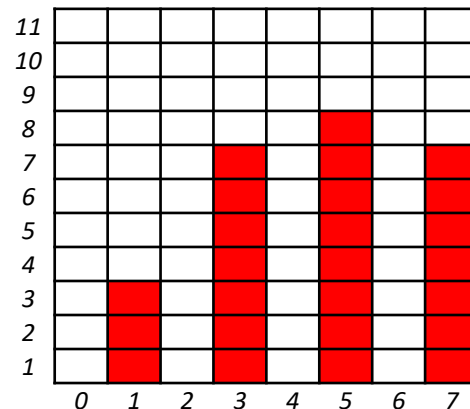
$$s_k = T(r_k) = (L - 1) \sum_{j=0}^k p_r(r_j)$$

k	p'	$s_k = T(r_k)$
0	$7 \times (0.12)$	= 0.84 = 1
1	$7 \times (0.12 + 0.28)$	= 2.80 = 3
2	$7 \times (0.12 + 0.28 + 0.32)$	= 5.04 = 5
3	$7 \times (0.12 + 0.28 + 0.32 + 0.24)$	= 6.72 = 7
4	$7 \times (0.12 + 0.28 + 0.32 + 0.24 + 0.04)$	= 7.00 = 7
5	$7 \times (0.12 + 0.28 + 0.32 + 0.24 + 0.04 + 0)$	= 7.00 = 7
6		
7		

Imagem processada

	0	1	2	3	4
0	3	5	5	7	3
1	3	7	7	7	5
2	3	5	7	7	5
3	1	5	5	7	5
4	1	1	3	3	3

Histograma normalizado



Equalização de histograma

Imagem original

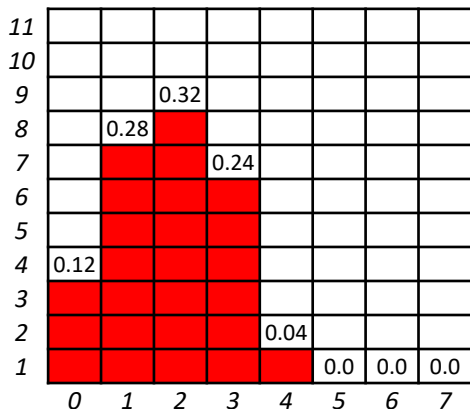
	0	1	2	3	4
0	1	2	2	3	1
1	1	3	3	4	2
2	1	2	3	3	2
3	0	2	2	3	2
4	0	0	1	1	1

5 x 5 pixels = 25 pixels

3 bits ou $2^3 = 8$ níveis de cinza (L).

Intervalo de níveis de cinza: [0, 7]

Histograma normalizado



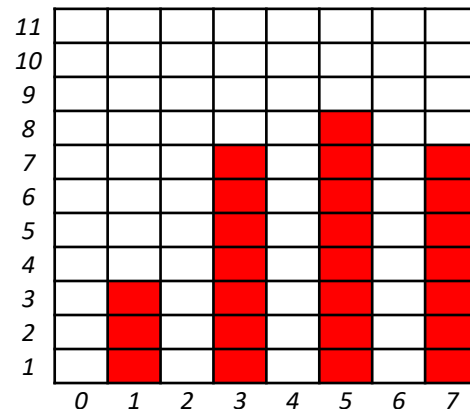
$$s_k = T(r_k) = (L - 1) \sum_{j=0}^k p_r(r_j)$$

k	p'	$s_k = T(r_k)$
0	$7 \times (0.12)$	= 0.84 = 1
1	$7 \times (0.12 + 0.28)$	= 2.80 = 3
2	$7 \times (0.12 + 0.28 + 0.32)$	= 5.04 = 5
3	$7 \times (0.12 + 0.28 + 0.32 + 0.24)$	= 6.72 = 7
4	$7 \times (0.12 + 0.28 + 0.32 + 0.24 + 0.04)$	= 7.00 = 7
5	$7 \times (0.12 + 0.28 + 0.32 + 0.24 + 0.04 + 0)$	= 7.00 = 7
6	$7 \times (0.12 + 0.28 + 0.32 + 0.24 + 0.04 + 0 + 0)$	= 7.00 = 7
7		

Imagem processada

	0	1	2	3	4
0	3	5	5	7	3
1	3	7	7	7	5
2	3	5	7	7	5
3	1	5	5	7	5
4	1	1	3	3	3

Histograma normalizado



Equalização de histograma

Imagem original

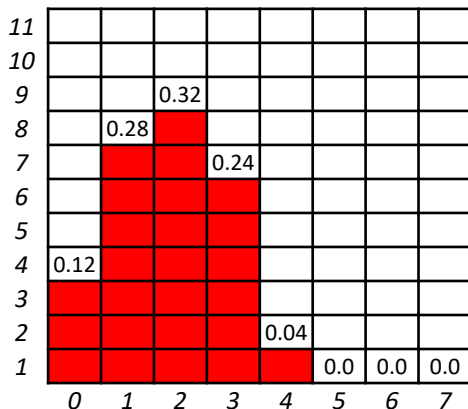
	0	1	2	3	4
0	1	2	2	3	1
1	1	3	3	4	2
2	1	2	3	3	2
3	0	2	2	3	2
4	0	0	1	1	1

5 x 5 pixels = 25 pixels

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Intervalo de níveis de cinza: [0, 7]

Histograma normalizado



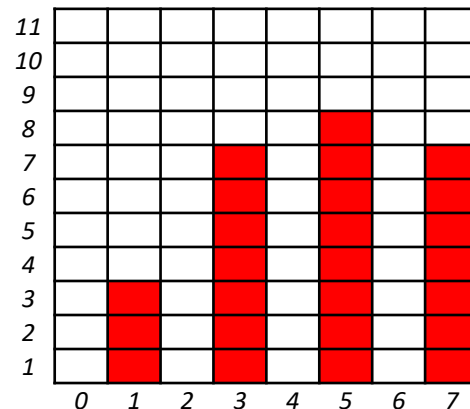
$$s_k = T(r_k) = (L - 1) \sum_{j=0}^k p_r(r_j)$$

k	p'	$s_k = T(r_k)$
0	$7 \times (0.12)$	= 0.84 = 1
1	$7 \times (0.12 + 0.28)$	= 2.80 = 3
2	$7 \times (0.12 + 0.28 + 0.32)$	= 5.04 = 5
3	$7 \times (0.12 + 0.28 + 0.32 + 0.24)$	= 6.72 = 7
4	$7 \times (0.12 + 0.28 + 0.32 + 0.24 + 0.04)$	= 7.00 = 7
5	$7 \times (0.12 + 0.28 + 0.32 + 0.24 + 0.04 + 0)$	= 7.00 = 7
6	$7 \times (0.12 + 0.28 + 0.32 + 0.24 + 0.04 + 0 + 0)$	= 7.00 = 7
7	$7 \times (0.12 + 0.28 + 0.32 + 0.24 + 0.04 + 0 + 0)$	= 7.00 = 7

Imagem processada

	0	1	2	3	4
0	3	5	5	7	3
1	3	7	7	7	5
2	3	5	7	7	5
3	1	5	5	7	5
4	1	1	3	3	3

Histograma normalizado



Equalização de histograma

Imagem original

	0	1	2	3	4
0	1	2	2	3	1
1	1	3	3	4	2
2	1	2	3	3	2
3	0	2	2	3	2
4	0	0	1	1	1

5 x 5 pixels = 25 pixels
3 bits ou $2^3 = 8$ níveis de cinza (L).
Intervalo de níveis de cinza: [0, 7]

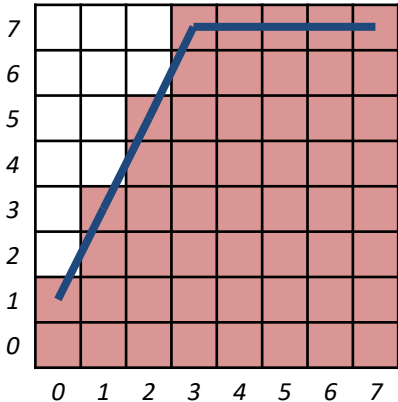
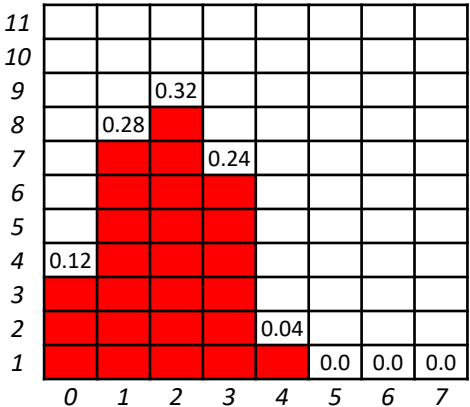
$$s_k = T(r_k) = (L - 1) \sum_{j=0}^k p_r(r_j)$$

k		p'	$s_k = T(r_k)$
0	$7 \times (0.12)$	= 0.84	= 1
1	$7 \times (0.12 + 0.28)$	= 2.80	= 3
2	$7 \times (0.12 + 0.28 + 0.32)$	= 5.04	= 5
3	$7 \times (0.12 + 0.28 + 0.32 + 0.24)$	= 6.72	= 7
4	$7 \times (0.12 + 0.28 + 0.32 + 0.24 + 0.04)$	= 7.00	= 7
5	$7 \times (0.12 + 0.28 + 0.32 + 0.24 + 0.04 + 0)$	= 7.00	= 7
6	$7 \times (0.12 + 0.28 + 0.32 + 0.24 + 0.04 + 0 + 0)$	= 7.00	= 7
7	$7 \times (0.12 + 0.28 + 0.32 + 0.24 + 0.04 + 0 + 0)$	= 7.00	= 7

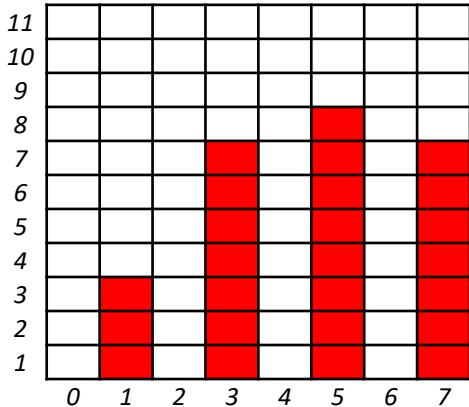
Imagem processada

	0	1	2	3	4
0	3	5	5	7	3
1	3	7	7	7	5
2	3	5	7	7	5
3	1	5	5	7	5
4	1	1	3	3	3

Histograma normalizado



Histograma normalizado



- MARQUES FILHO, O.; VIEIRA NETO, H. Processamento digital de imagens. Brasport, 1999.
 - Disponível para download no site do autor (Exclusivo para uso pessoal)
 - <http://dainf.ct.utfpr.edu.br/~hvieir/pub.html>
 - Seções 3.1 e 3.2
- GONZALEZ, R.C.; WOODS, R.E.; Processamento Digital de Imagens. 3ª edição. Editora Pearson, 2009.
 - Disponível na Biblioteca Virtual da Pearson.
 - Seções 3.1 até 3.2.3
- J. E. R. Queiroz, H. M. Gomes. Introdução ao Processamento Digital de Imagens. RITA. v. 13, 2006.
 - <http://www.dsc.ufcg.edu.br/~hmg/disciplinas/graduacao/vc-2016.2/Rita-Tutorial-PDI.pdf>
 - Seção 3

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@misc{mari_im_proc_2023,
  author = {João Fernando Mari},
  title = {Transformações de intensidade II},
  year = {2023},
  publisher = {GitHub},
  journal = {Introdução ao Processamento Digital de Imagens - UFV},
  howpublished = {\url{https://github.com/joaofmari/SIN392_Introduction-to-digital-image-processing_2023}}
}
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FIM