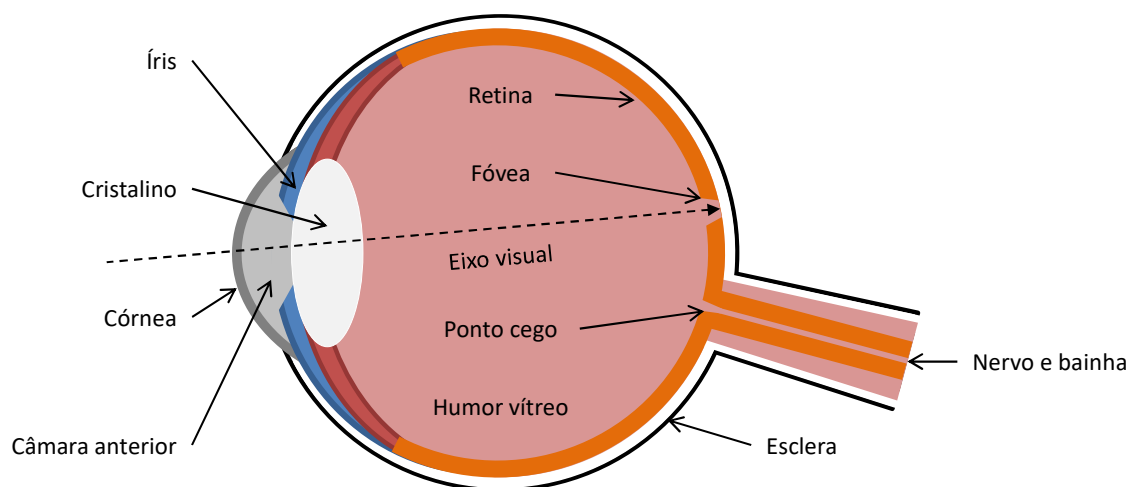


Aula 2a – Fundamentos da imagem digital

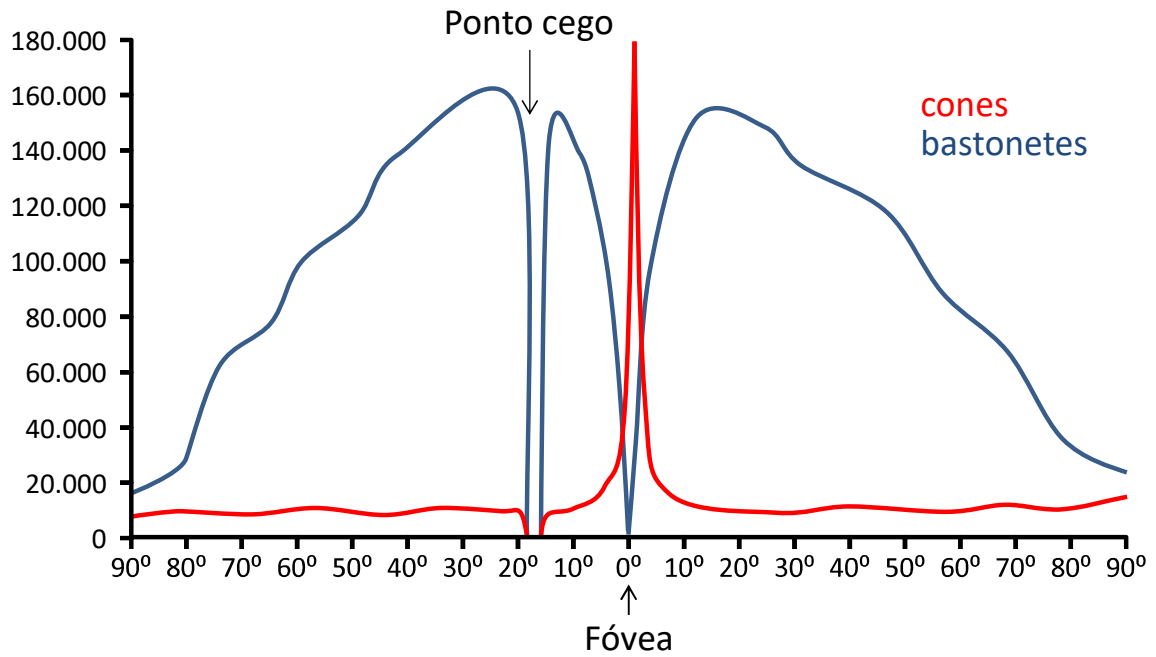
Prof. João Fernando Mari

joaof.mari@ufv.br

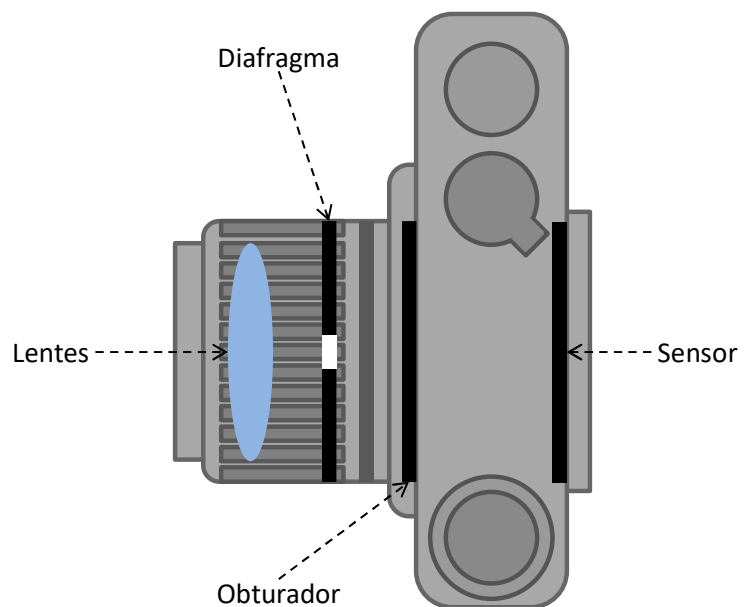
O olho humano



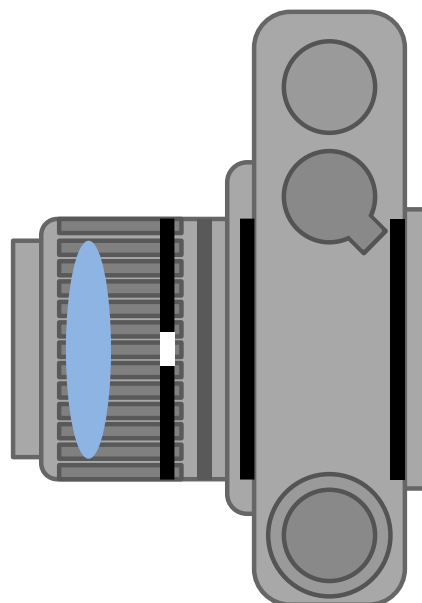
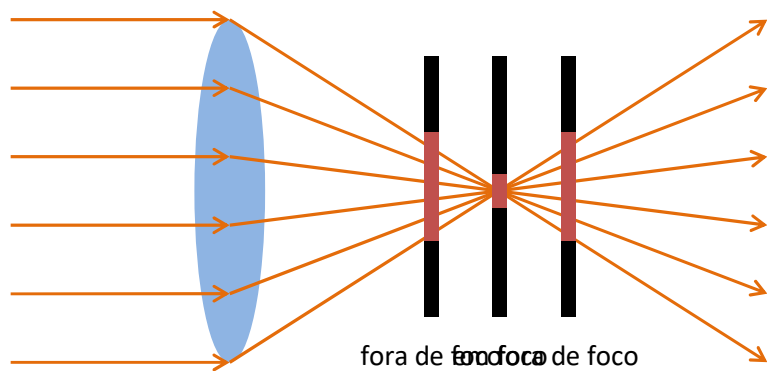
O olho humano



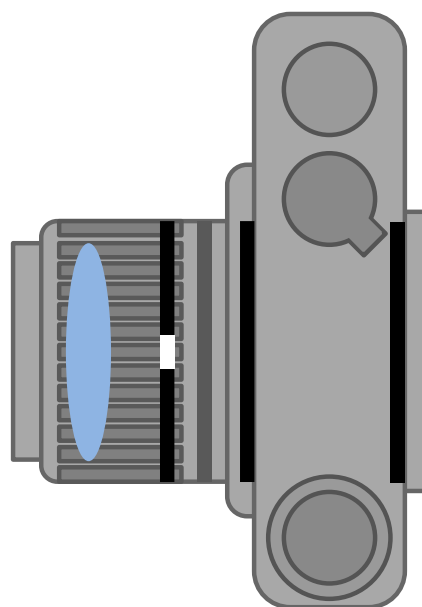
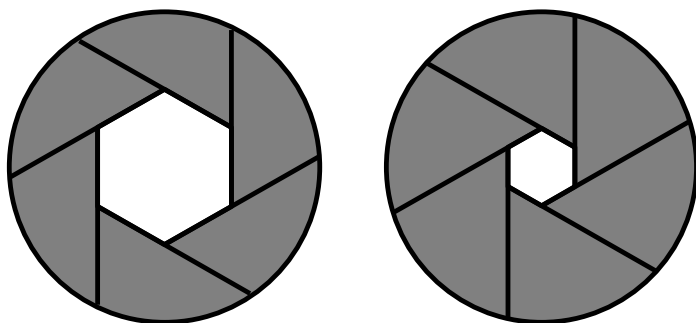
Câmera fotográfica - lentes



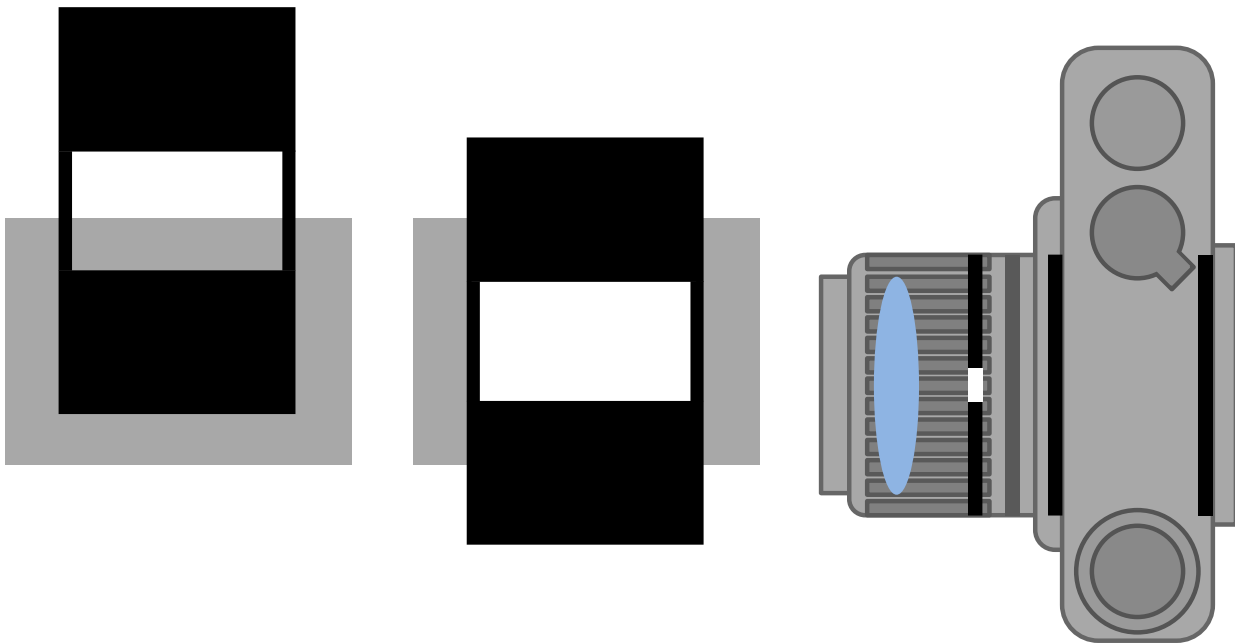
Câmera fotográfica - lentes



Câmera fotográfica - diafragma

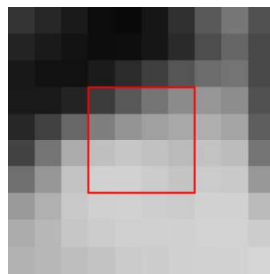


Câmera fotográfica - obturador



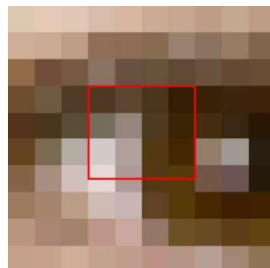
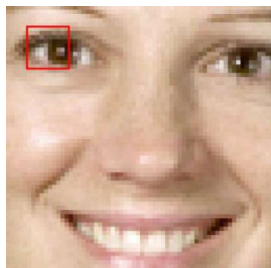
A imagem digital

Imagem de intensidades (níveis de cinza):



60	127	192	209
89	147	198	210
117	160	193	204
140	168	186	197

Imagem colorida (RGB):



78	118	211	231
56	108	202	218
36	91	200	214
92	149	176	174
70	133	161	155
49	124	158	150
75	80	81	83
52	58	57	57
28	33	17	21
51	59	69	85
30	36	38	58
3	3	4	11

Imagens coloridas - RGB



vermelho - R (red)



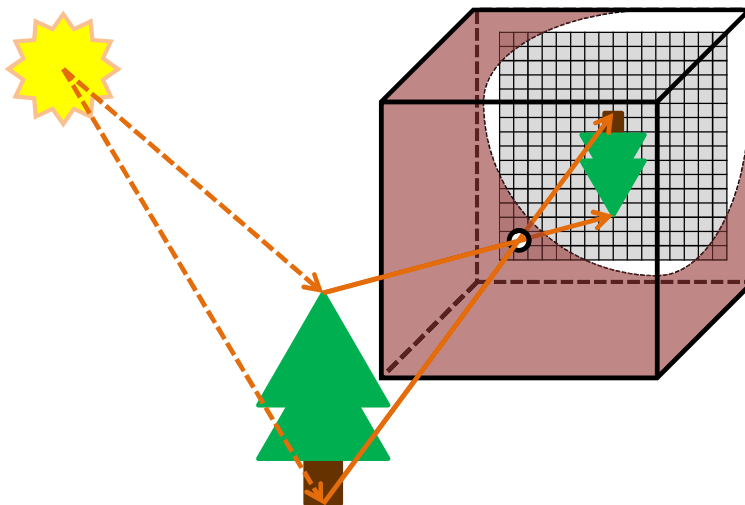
verde - G (green)



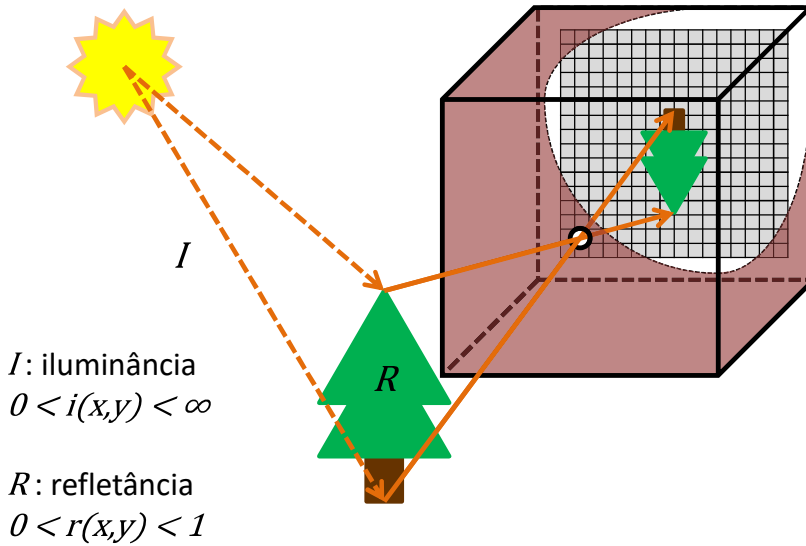
azul - B (blue)



Aquisição de imagens



Aquisição de imagens



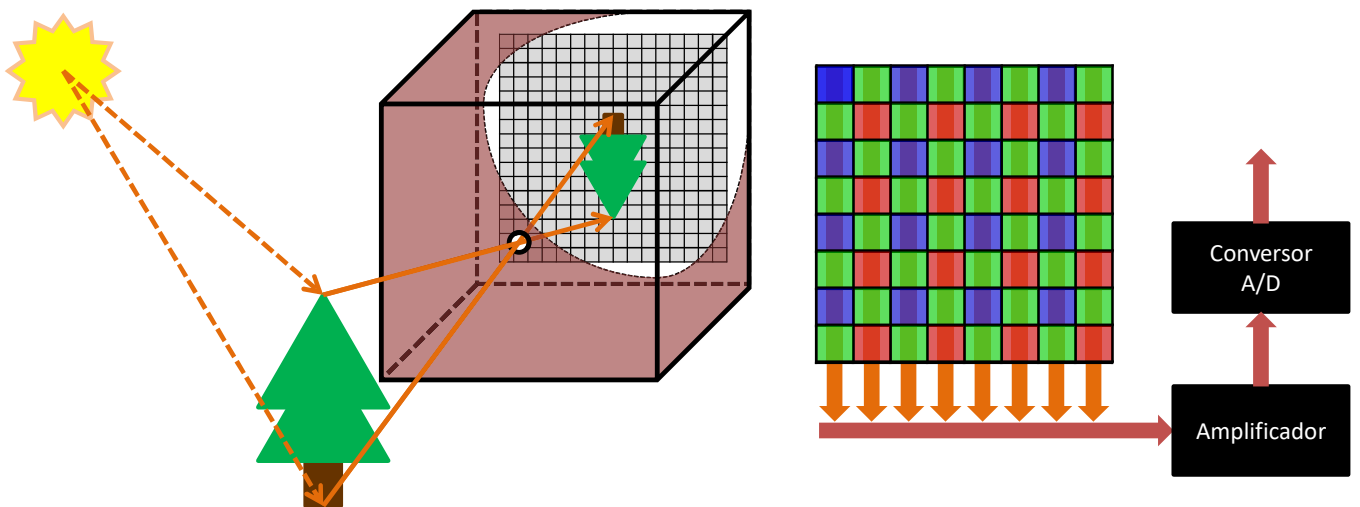
$$f(x, y) = i(x, y) \times r(x, y)$$

$i(x, y)$	(em lux ou lúmen/m ²)
900	Dia ensolarado
100	Dia nublado
10	Escritório
0,001	Noite clara

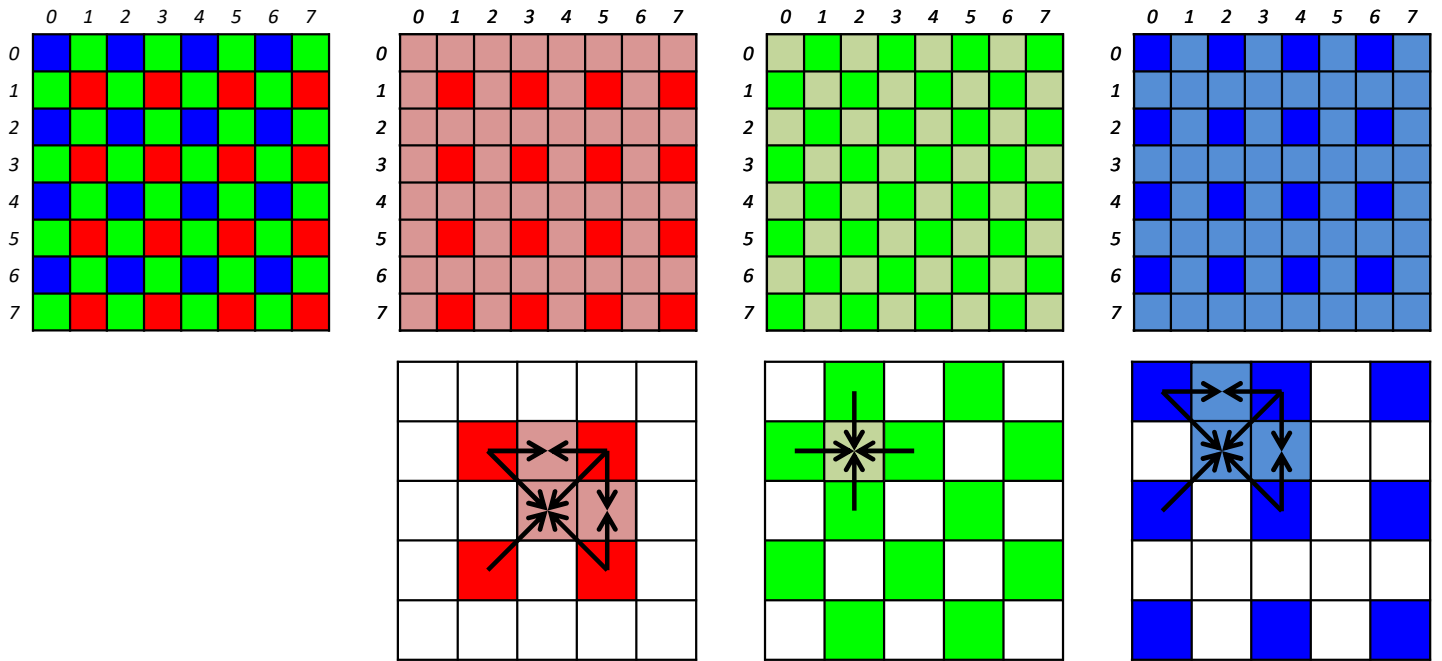
$r(x, y)$	
0,93	Neve
0,80	Parede branca
0,65	Aço inoxidável
0,01	Veludo preto

MARQUES FILHO, O.; VIEIRA NETO, H. Processamento digital de imagens. Brasport, 1999.

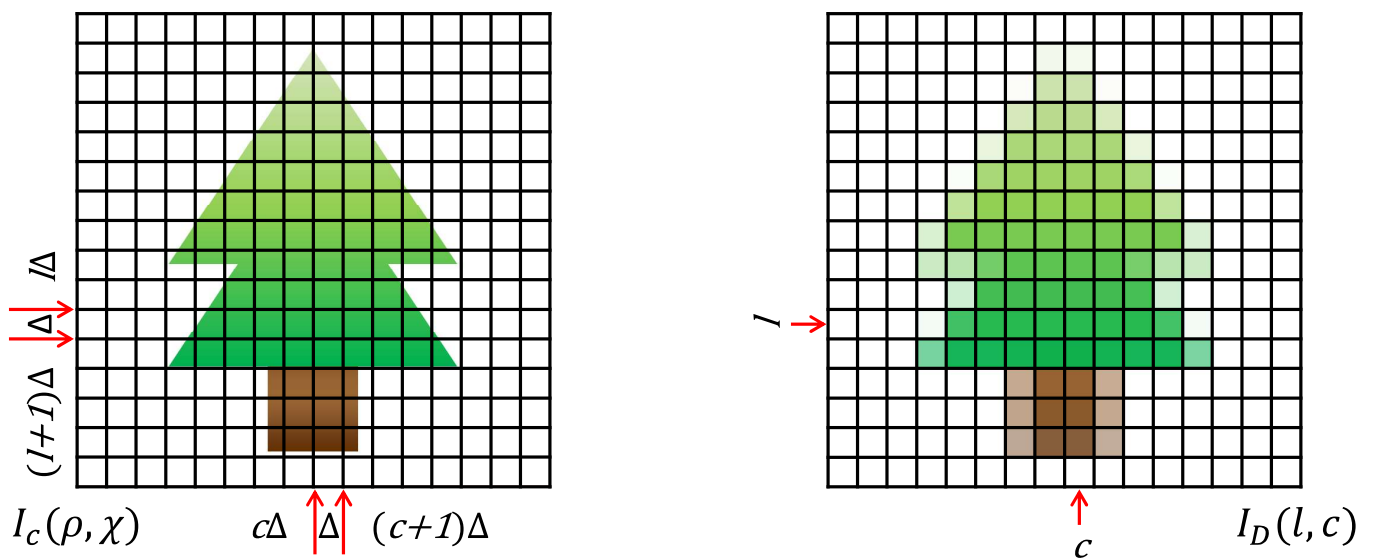
Aquisição de imagens



Sensores CCD e padrão de Bayer



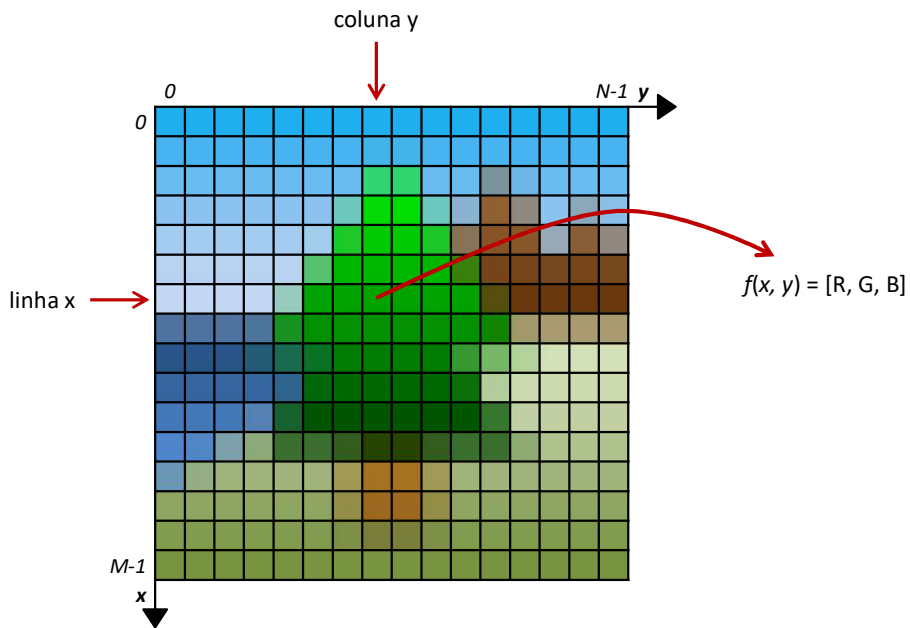
Amostragem



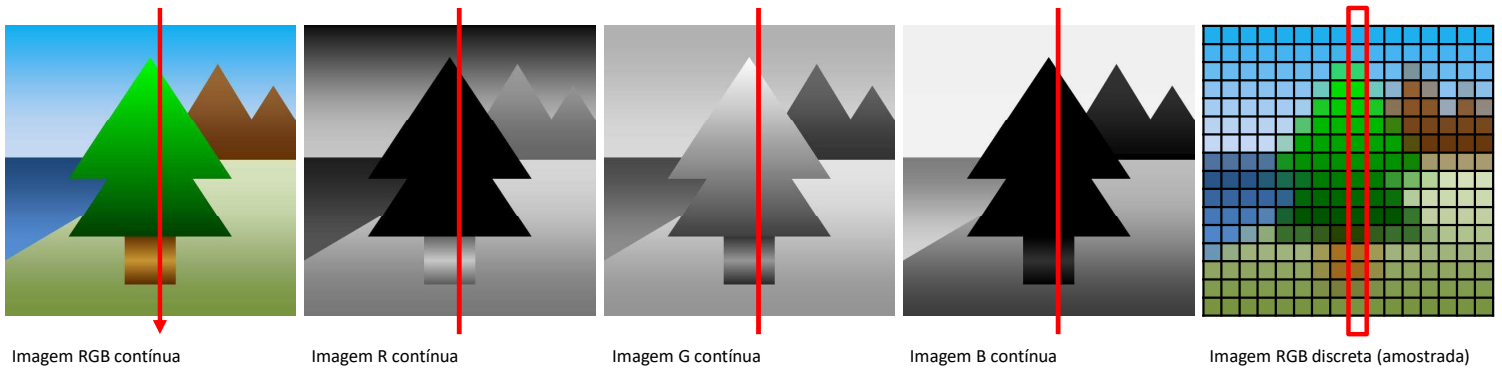
$$I_D = \frac{1}{\Delta^2} \int_{l\Delta}^{(l+1)\Delta} \int_{c\Delta}^{(c+1)\Delta} I_c(\rho, \chi) \delta\rho \delta\chi$$

A imagem digital

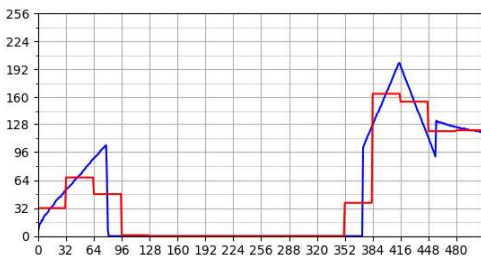
M linhas
N colunas
M × N pixels



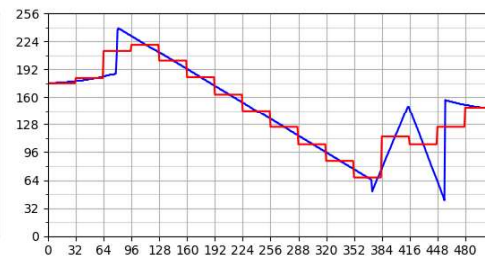
Amostragem



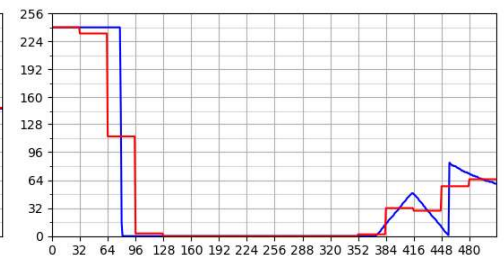
Amostragem do canal R



Amostragem do canal G



Amostragem do canal B



Amostragem

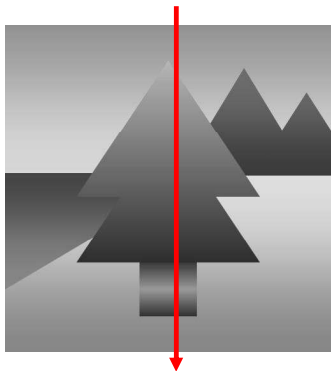
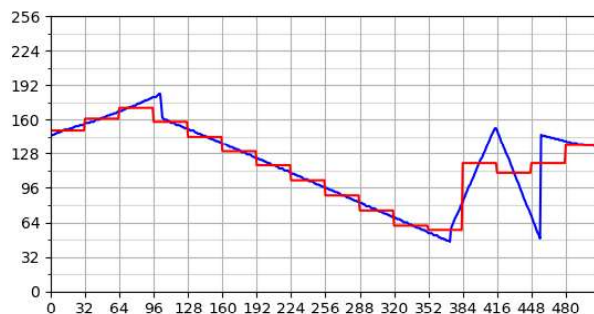


Imagem em níveis de cinza continua



Amostragem da imagem em níveis de cinza

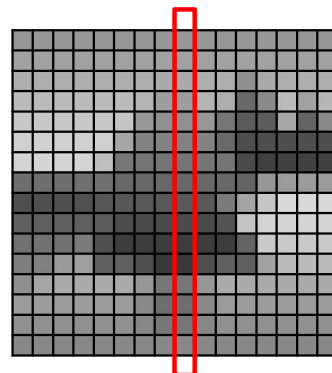


Imagem em níveis de cinza discreta (amostrada)

Efeitos da resolução espacial

1,7 pol



300 ppi – 512 x 512



1,7 pol. a 150 ppi – 256 x 256



1,7 pol. a 75 ppi – 128 x 128



1,7 pol. a ~38 ppi – 64 x 64



1,7 pol. a 19 ppi – 32 x 32

Efeitos da resolução espacial

1,7 pol.
512 x 512 pixels
300 ppi



0,85 pol.
256 x 256 pixels
300 ppi



0,43 pol.
128 x 128 pixels
300 ppi



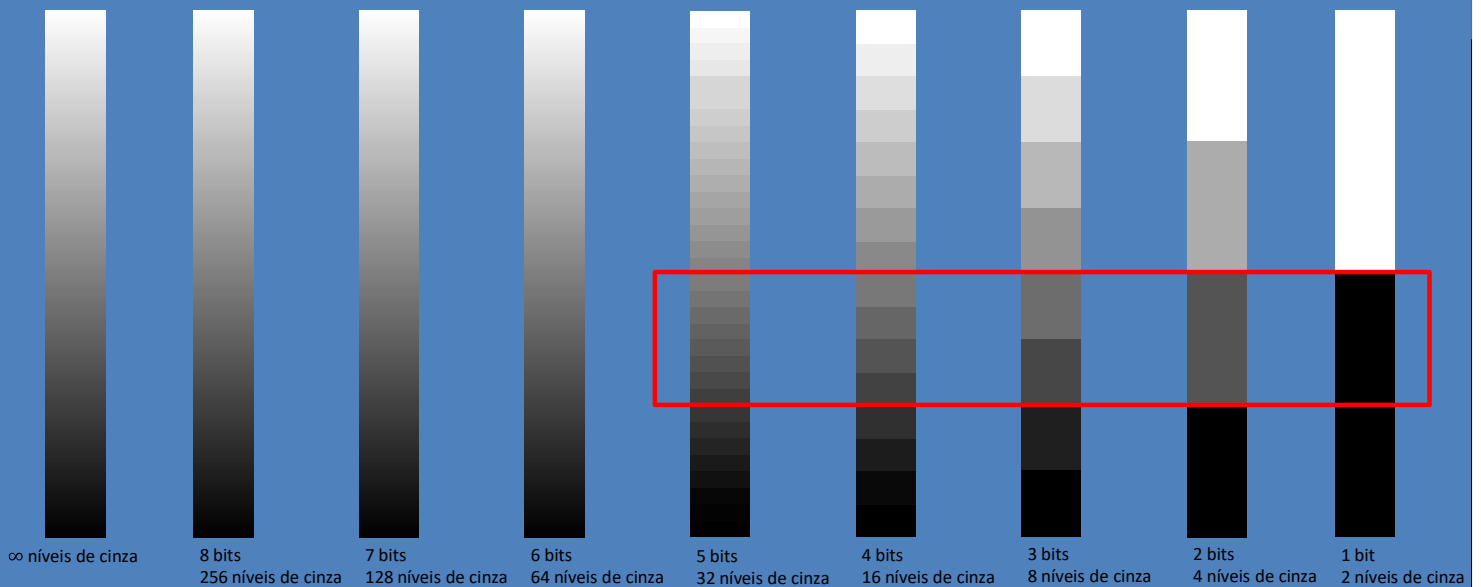
0,21 pol.
64 x 64 pixels
300 ppi



0,11 pol.
32 x 32 pixels
300 ppi



Resolução de intensidade



Efeitos da resolução de intensidades



8 bits. $2^8 = 256$ níveis de cinza



7 bits. $2^7 = 128$ níveis de cinza



6 bits. $2^6 = 64$ níveis de cinza



5 bits. $2^5 = 32$ níveis de cinza



4 bits. $2^4 = 16$ níveis de cinza



3 bits. $2^3 = 8$ níveis de cinza

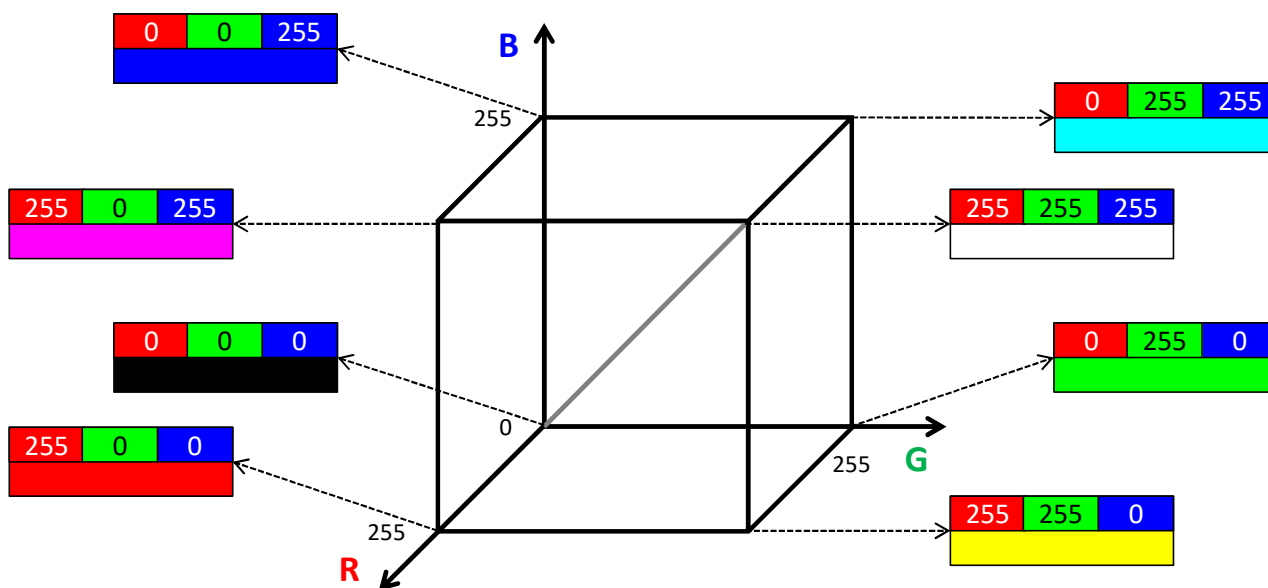


2 bits. $2^2 = 4$ níveis de cinza



1 bit. $2^1 = 2$ níveis de cinza

O espaço de cores RGB



Referencias

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>

Seção 2.1

GONZALEZ, R.C.; WOODS, R.E.; **Processamento Digital de Imagens**. 3ª edição. Editora Pearson, 2009.

Disponível na Biblioteca Virtual da Pearson.

Seções: 2.1, 2.2, 2.3 e 2.4

Alan Peters. **Lectures on Image Processing**. Vanderbilt University, 2019.

https://archive.org/details/Lectures_on_Image_Processing

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 2

Referencias

As imagens usadas nos slides estão disponíveis na biblioteca scikit-image

<https://scikit-image.org/docs/dev/api/skimage.data.html>

Referencias e material complementar

Felipe Arruda. **Vídeo explica como funciona o sensor CCD das câmeras digitais.** Tecmundo, 2012.

<https://www.tecmundo.com.br/fotografia-e-design/23626-video-explica-como-funciona-o-sensor-ccd-das-cameras-digitais.htm>

Bill Hammack. **CCD: The heart of a digital camera (how a charge-coupled device works).** YouTube. Canal: engineerGuy.

<https://www.youtube.com/watch?v=wsdmt0De8Hw&feature=youtu.be>

Raymond Siri. **CMOS Animation Sequence.** Vimeo

<https://vimeo.com/103279734>

Raymond Siri. **CCD Animation Sequence.** Vimeo

<https://vimeo.com/103279733>

Referencias e material complementar

Rafael Helerbrock. **Quais são os limites da visão humana?** Mundo Educação

<https://mundoeducacao.uol.com.br/fisica/quais-sao-os-limites-visao-humana.htm>

Francie Diep. **Humans Can Only Distinguish Between About 30 Shades Of Gray.** Popular Science, 2015.

<https://www.popsoci.com/humans-can-only-distinguish-between-about-30-shades-gray/>

Luciana Galastri. **Humanos conseguem distinguir apenas 30 tons de cinza.** Galileu, 2015.

<https://revistagalileu.globo.com/Ciencia/noticia/2015/02/humanos-conseguem-distinguir-apenas-30-tons-de-cinza.html>

