

CS462 Image Processing

Chapter 2

Image Characteristic

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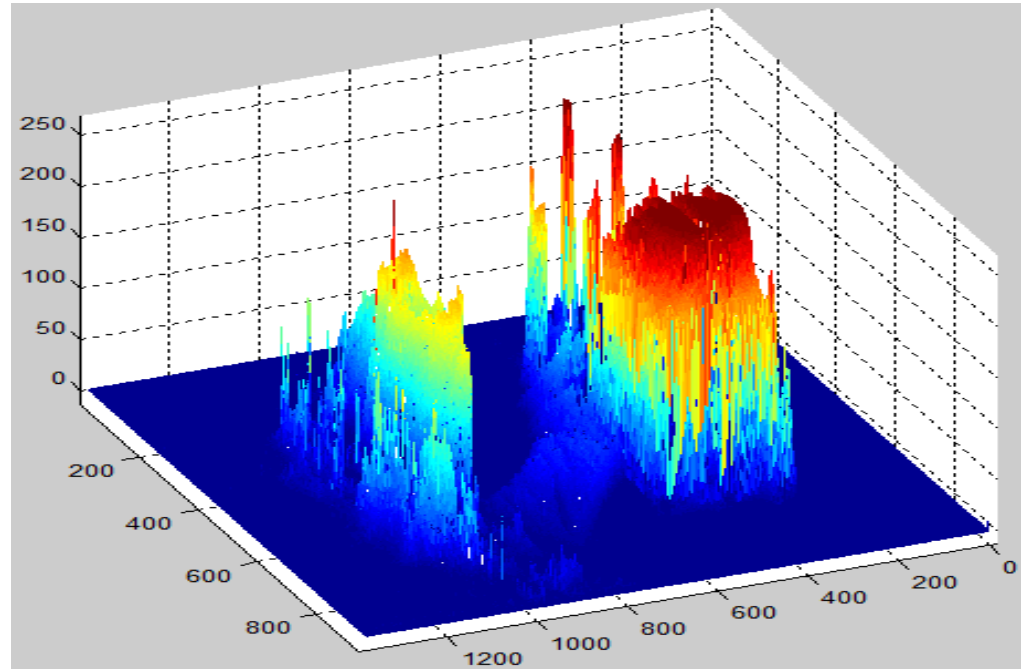
Good photograph and Bad photograph



Image Intensity



Image Intensity



```
mesh(double(im));
```

Image Brightness



Brightness is an attribute of visual perception in which a source appears to be radiating or reflecting light.

Image Brightness



Color Image

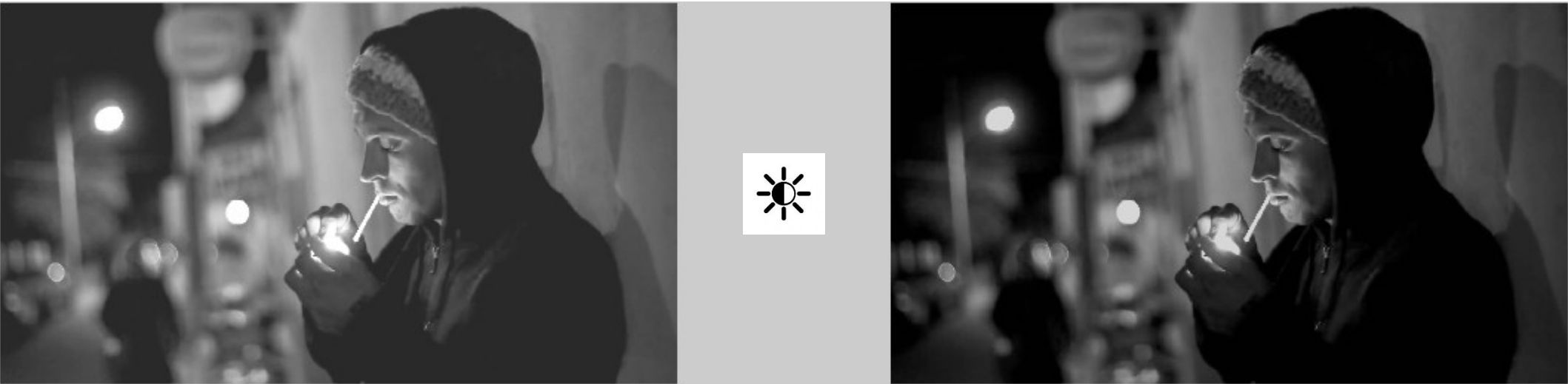


$(R+G+B)/3$



$0.299R + 0.587G + 0.114B$

Brightness Adjustment



I

I'

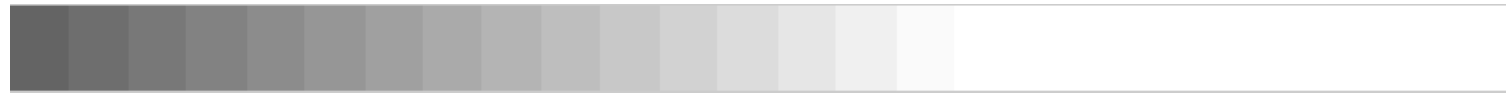
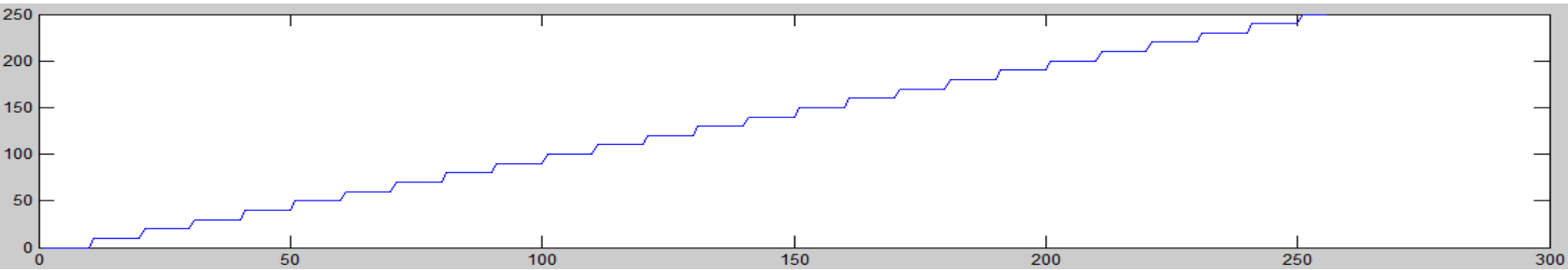
$$I' = I - c$$

$$\text{im2} = \text{im} - 40$$

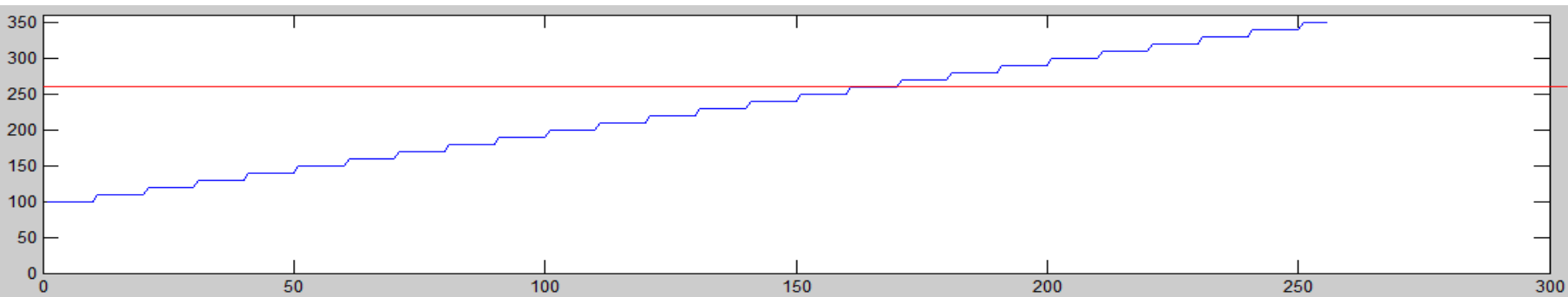
What is the good brightness ?



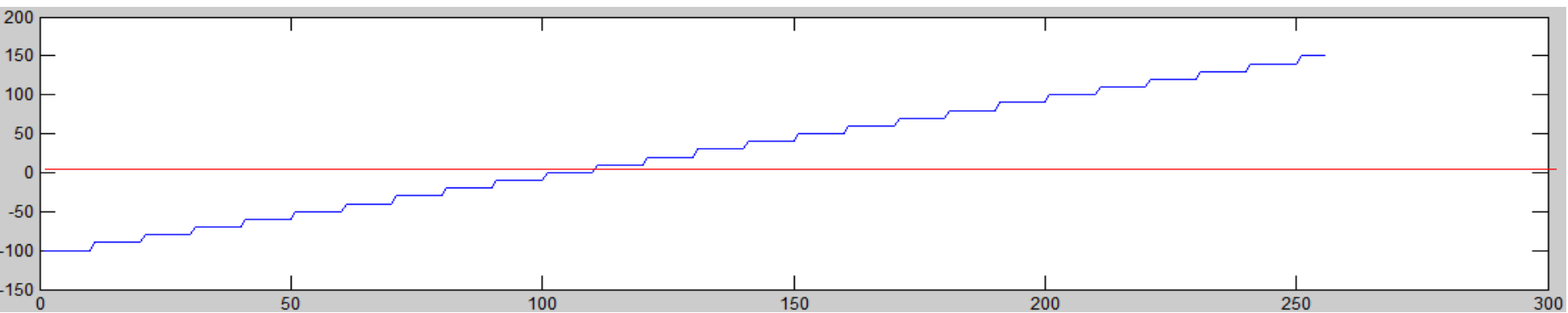
+ 0



+ 100



- 100



Question !

207	24	40	36	167
230	71	247	107	9
32	139	244	233	216
232	244	123	202	238
161	246	204	244	173

I

Image **I** is represented in Uint8.

Please determine the
final value of image **I** after adjust
brightness to +50 ?

$$I = [\dots]$$

$$c = 50$$

$$I' = ?$$

Sol. $I' = I + c$

255	74	90	86	217
255	121	255	157	59
82	189	255	255	255
255	255	173	252	255
211	255	254	255	223

Image Contrast

Contrast is the difference in [luminance](#) or [color](#) that makes an object (or its representation in an image or display) distinguishable



Low contrast

High contrast

Image Contrast



Contrast Adjustment

$$f = \frac{259 \times (c + 255)}{255 \times (259 - c)}$$

$$I' = (f \times (I - 128)) + 128$$

Where

- c = contrast level
- f = contrast correction factor
- I = source image
- I' = contrast corrected image



-128



0



+128

Question !

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I

Image **I** is represented in Uint8.
Please determine the
final value of image **I** after adjust
contrast to +50 ?

Sol.

$$\mathbf{I} = [\dots]$$

$$c = 50$$

$$\mathbf{I}' = ?$$

$$f = \frac{259 \times (c + 255)}{255 \times (259 - c)}$$

$$f = \frac{259 \times (50 + 255)}{255 \times (259 - 50)} = 1.4822$$

$$\mathbf{I}' = (f \times (\mathbf{I} - 128)) + 128$$

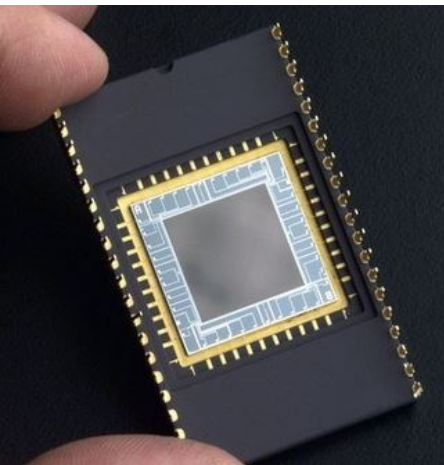
245	0	0	0	185
255	43	255	96	0
0	144	255	255	255
255	255	120	237	255
176	255	240	255	194

Sensor efficiency

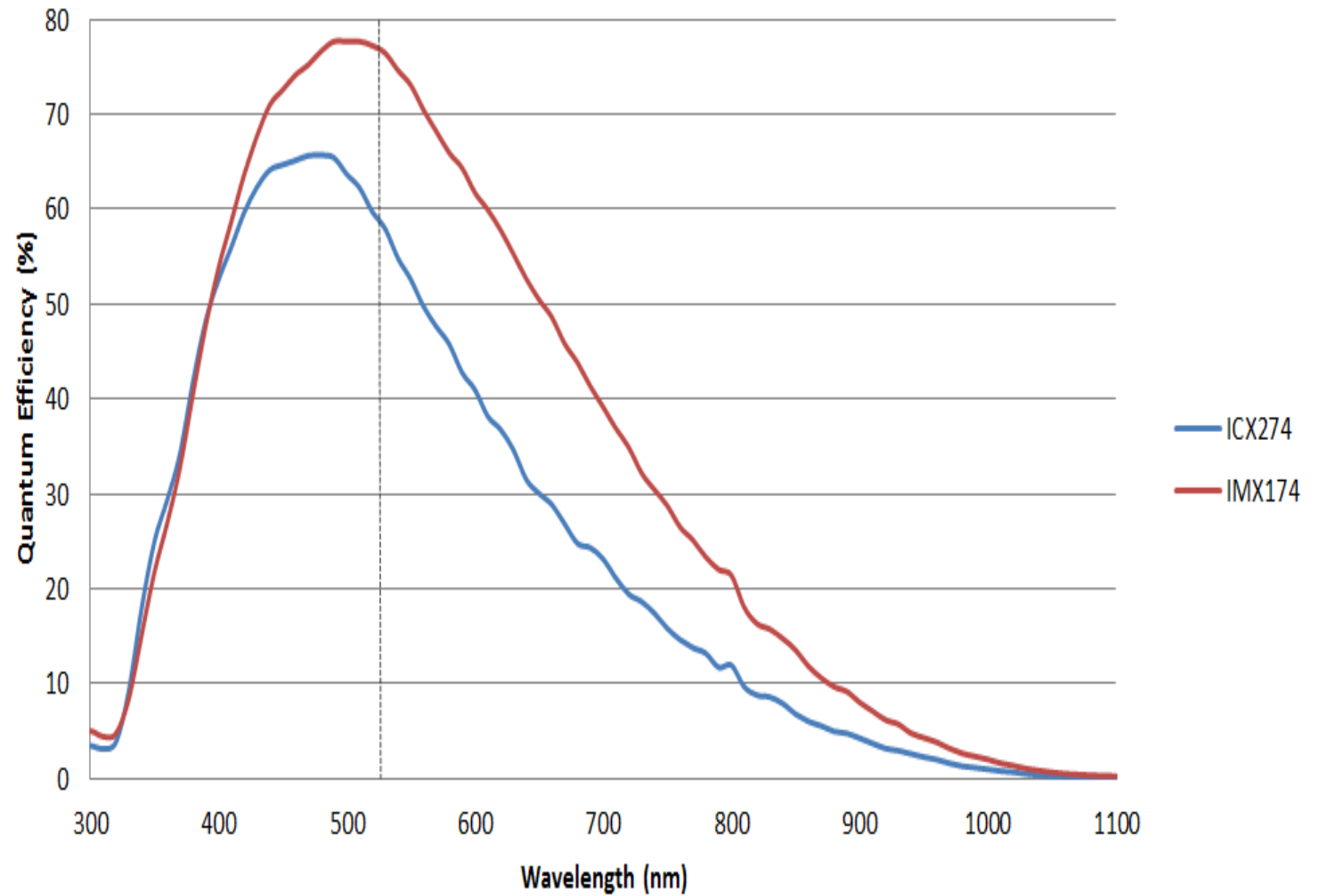
SONY



IMX 174

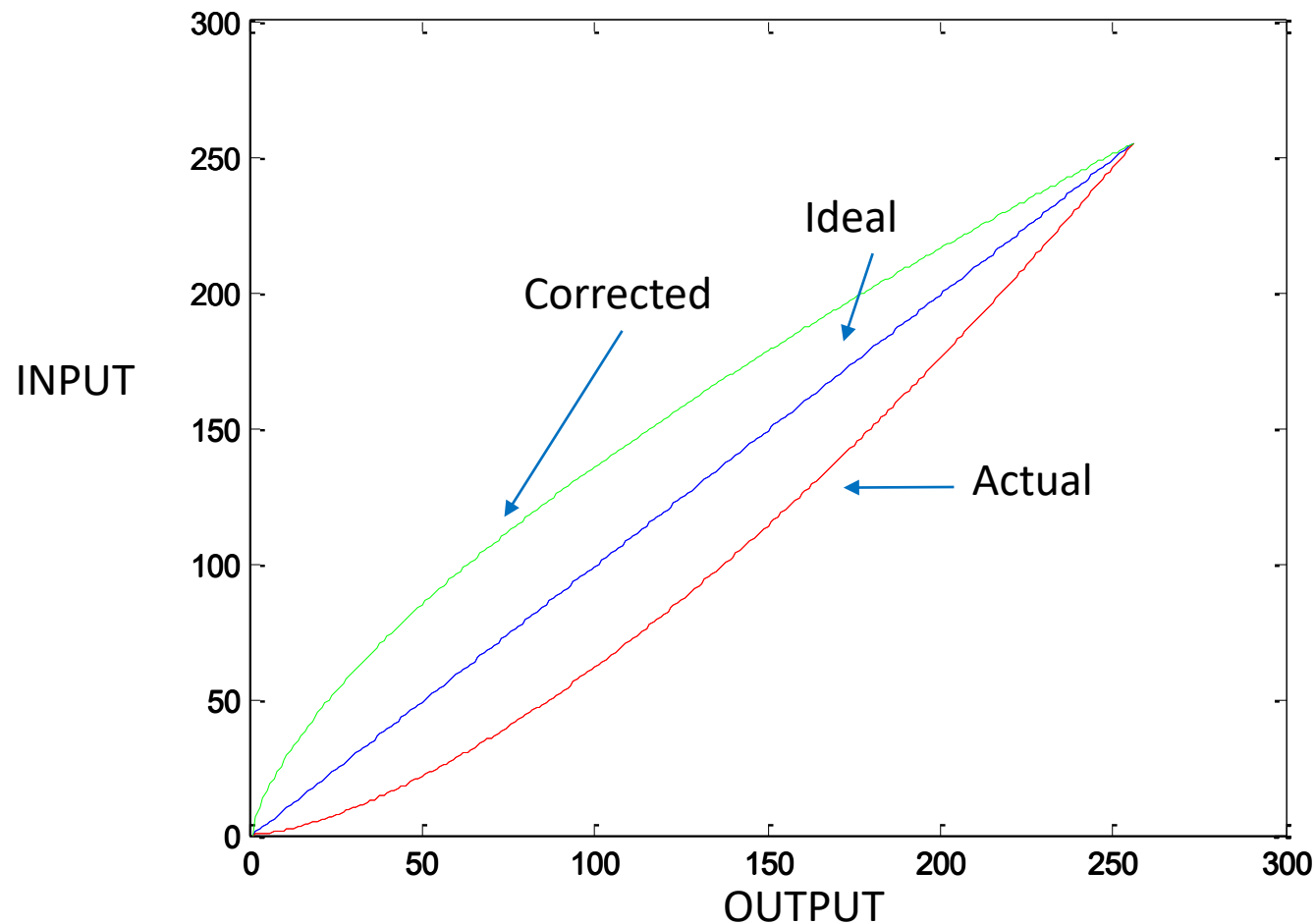


ICX 274



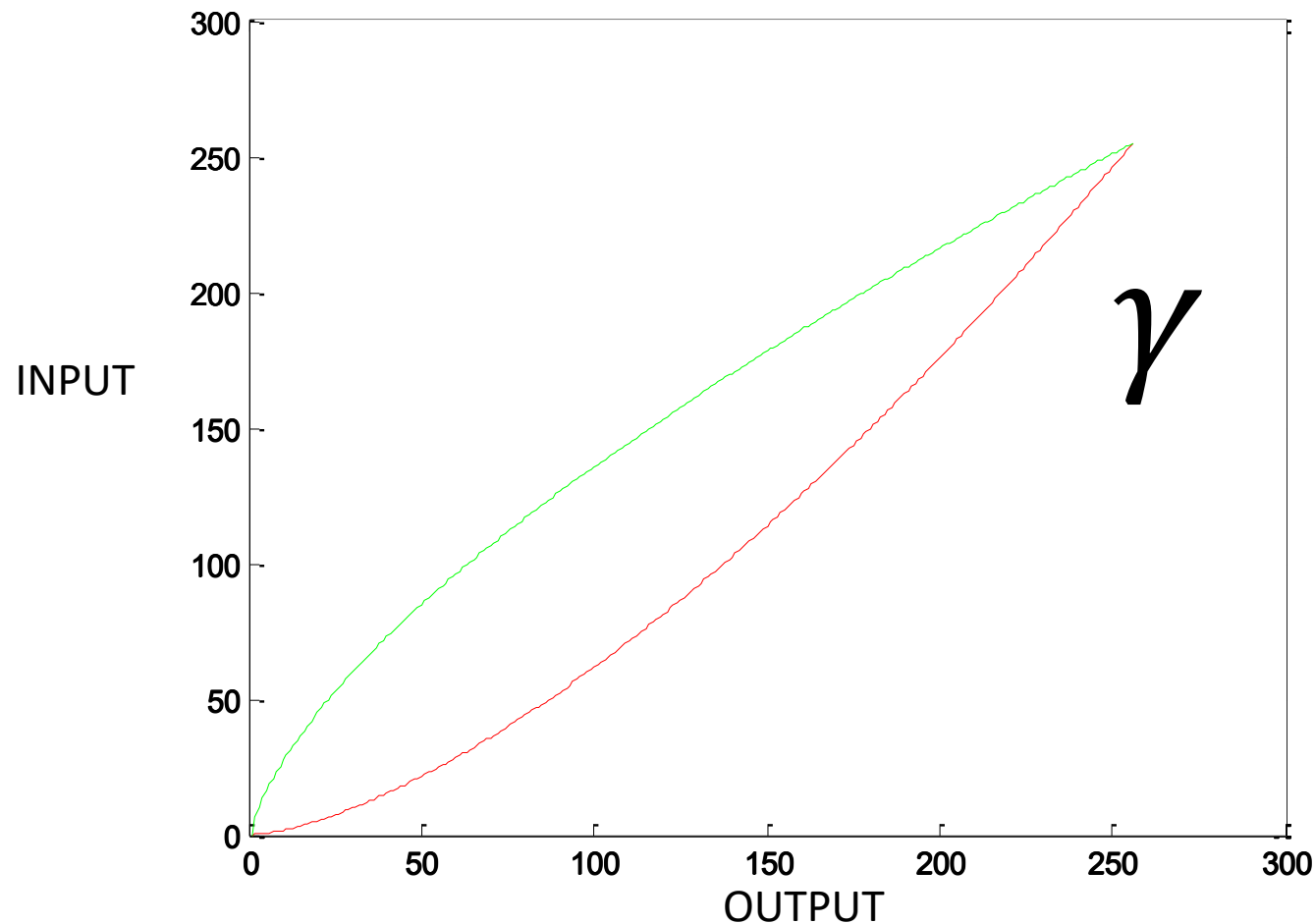
Gamma Correction

Gamma correction, **gamma nonlinearity**, **gamma encoding**, or often simply **gamma**, is the name of a nonlinear operation used to code and decode [luminance](#) or [tristimulus values](#) in [video](#) or [still image](#) systems



Gamma Correction

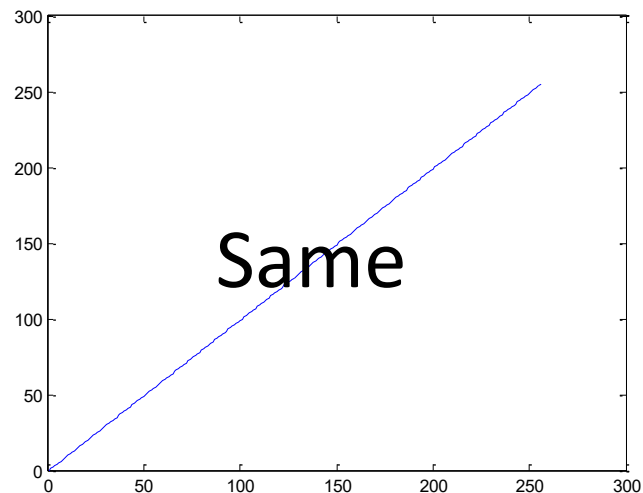
Gamma correction, **gamma nonlinearity**, **gamma encoding**, or often simply **gamma**, is the name of a nonlinear operation used to code and decode [luminance](#) or [tristimulus values](#) in [video](#) or [still image](#) systems



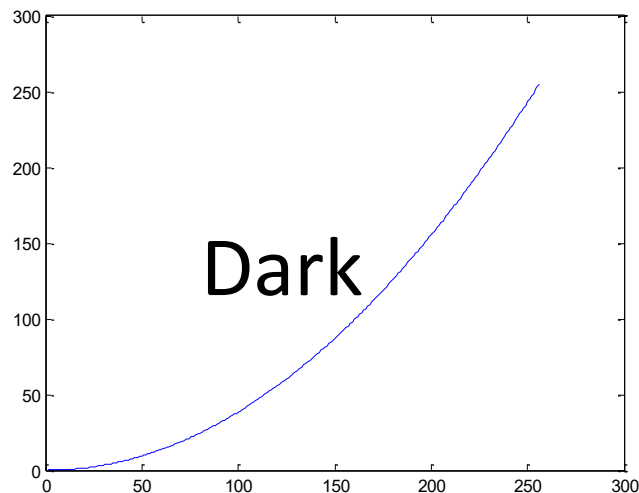
Gamma Correction

$$I' = 255 \times \left(\frac{I}{255} \right)^\gamma$$

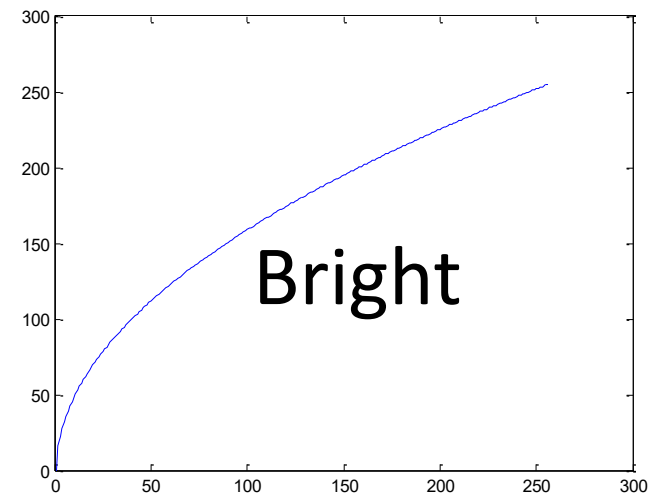
Where $\gamma = \textit{Gamma Value}$



$$\gamma = 1$$

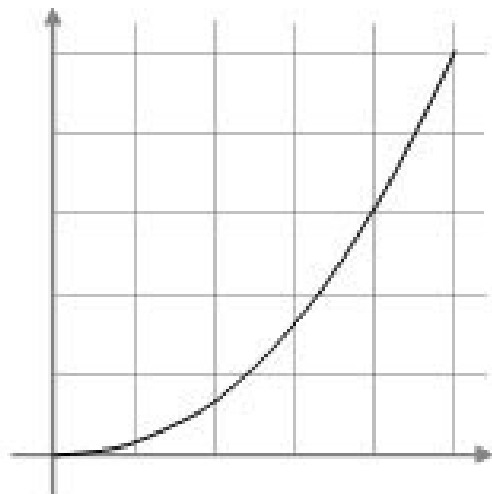


$$\gamma = 2$$



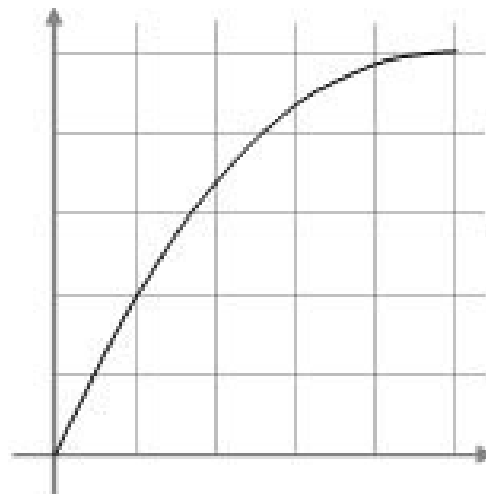
$$\gamma = \frac{1}{2}$$

Gamma Correction



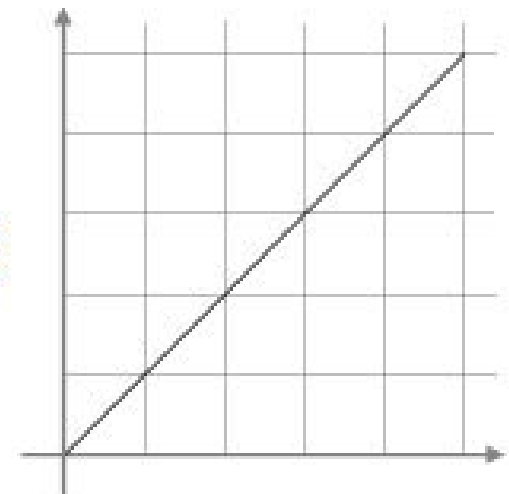
Gamma characteristics of monitors

X



Color information adjusted to match gamma characteristics

=



Color handling approaching the " $y = x$ " ideal

Gamma Correction



Brightness



Contrast



Gamma



Question !

207	24	40	36	167
230	71	247	107	9
32	139	244	233	216
232	244	123	202	238
161	246	204	244	173

I

Sol.

Image **I** is represented in Uint8.

Please determine the final value of image **I** after adjust gamma to 2?

$$\mathbf{I} = [\dots]$$

$$\gamma = 2$$

$$\mathbf{I}' = ?$$

$$\mathbf{I}' = 255 \times \left(\frac{\mathbf{I}}{255} \right)^\gamma$$

168	2	6	5	109
207	19	239	44	0
4	75	233	212	182
211	233	59	160	222
101	237	163	233	117

Average of Intensity Value

Arithmetic mean of all pixel

$$k = \sum_X \sum_Y I(x, y) / (|X| \times |Y|)$$

Where

$I(x, y)$ = Pixel at coordinate x, y

$|X|$ is the width of image

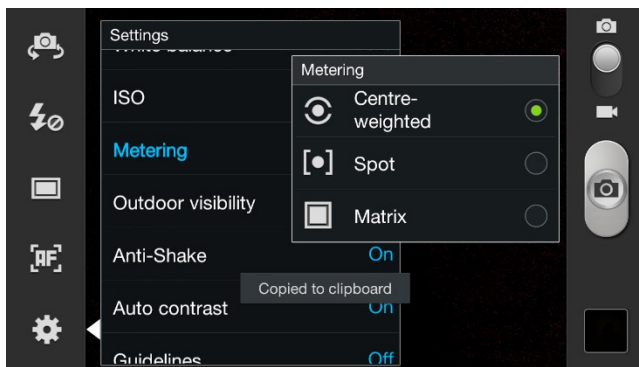
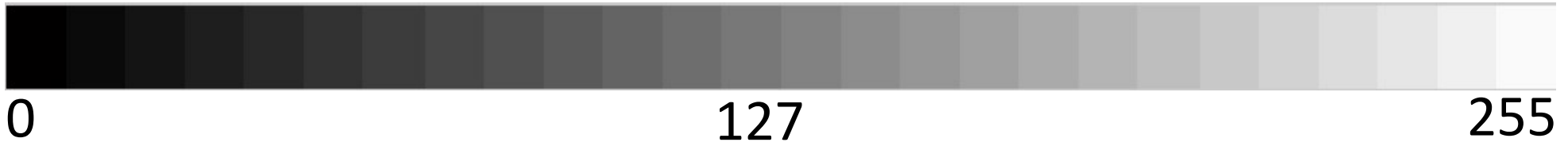
$|Y|$ is the height of image

k is an averaged image

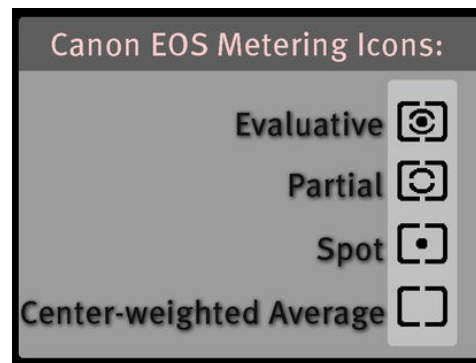
What is the good brightness and contrast ?

Too dark

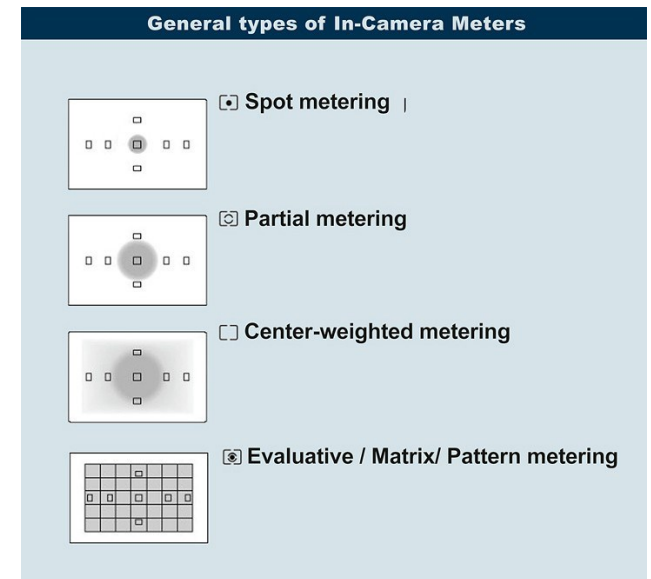
Too bright



Galaxy S3



Canon EOS



Average of Intensity Value

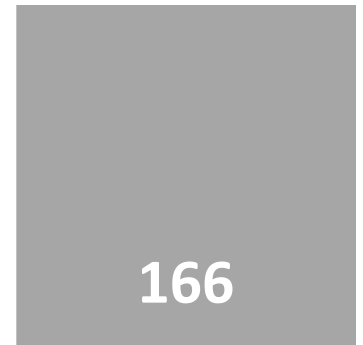
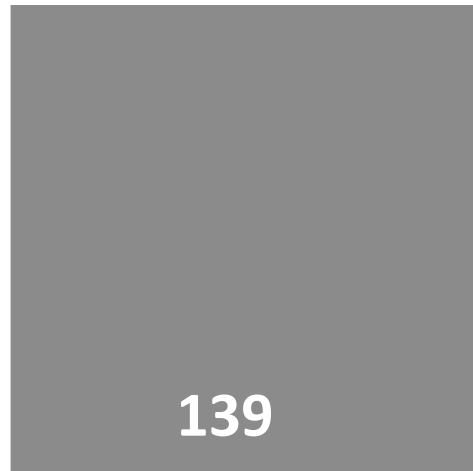
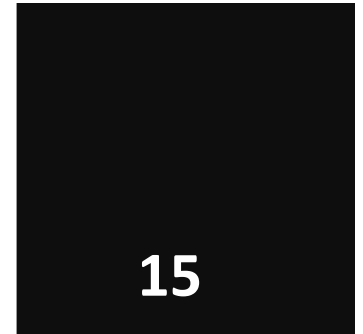
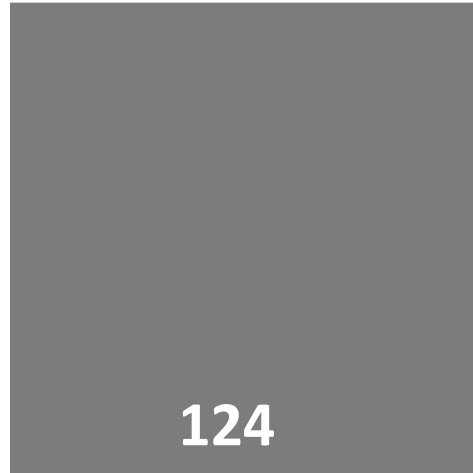


Image correction (brightness)



95

☀ +33



γ 1/1.6



Question !

203	112	120	118	183
215	135	223	154	105
116	169	222	216	208
216	222	162	201	219
180	223	202	222	186

I

Image **I** is represented in Uint8.

This image is too bright, so please adjust the brightness using average method.

Sol.

$$k = 181$$

$$c = 181 - 127 = 54$$

$$I' = I - 54$$

$$I = [\dots]$$

$$c = ?$$

$$k = ?$$

149	58	66	64	129
161	81	169	100	51
62	115	168	162	154
162	168	108	147	165
126	169	148	168	132

Gray card

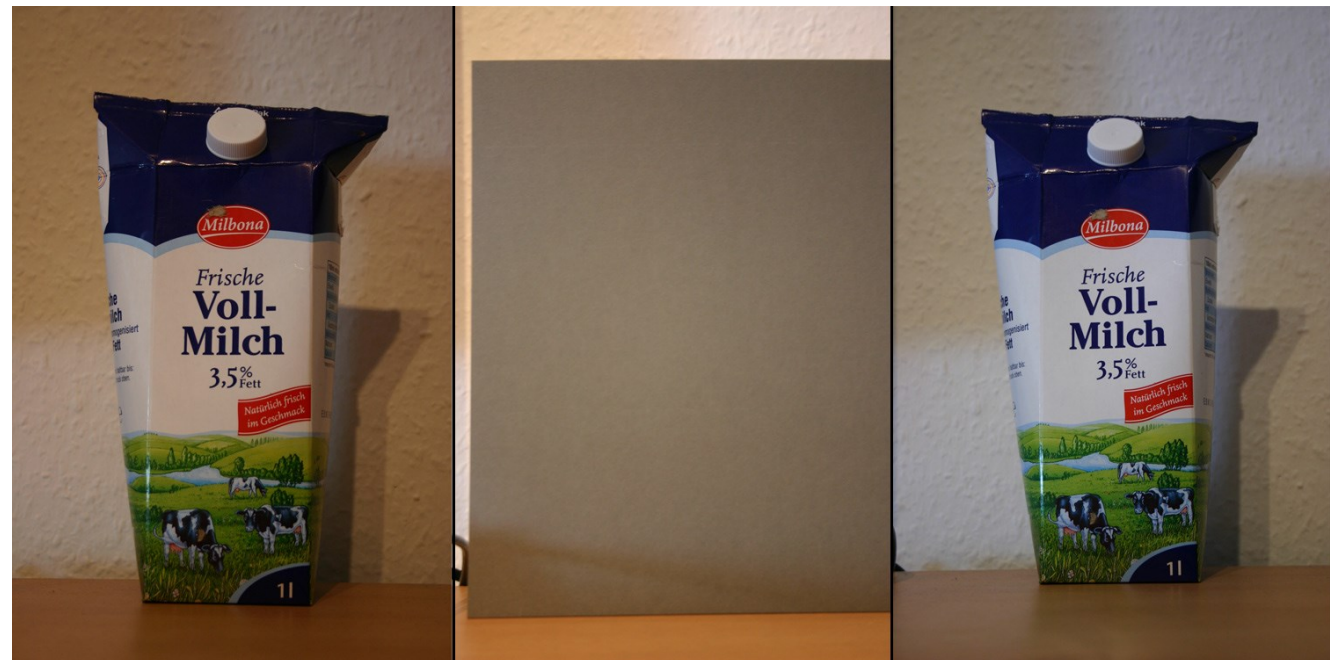
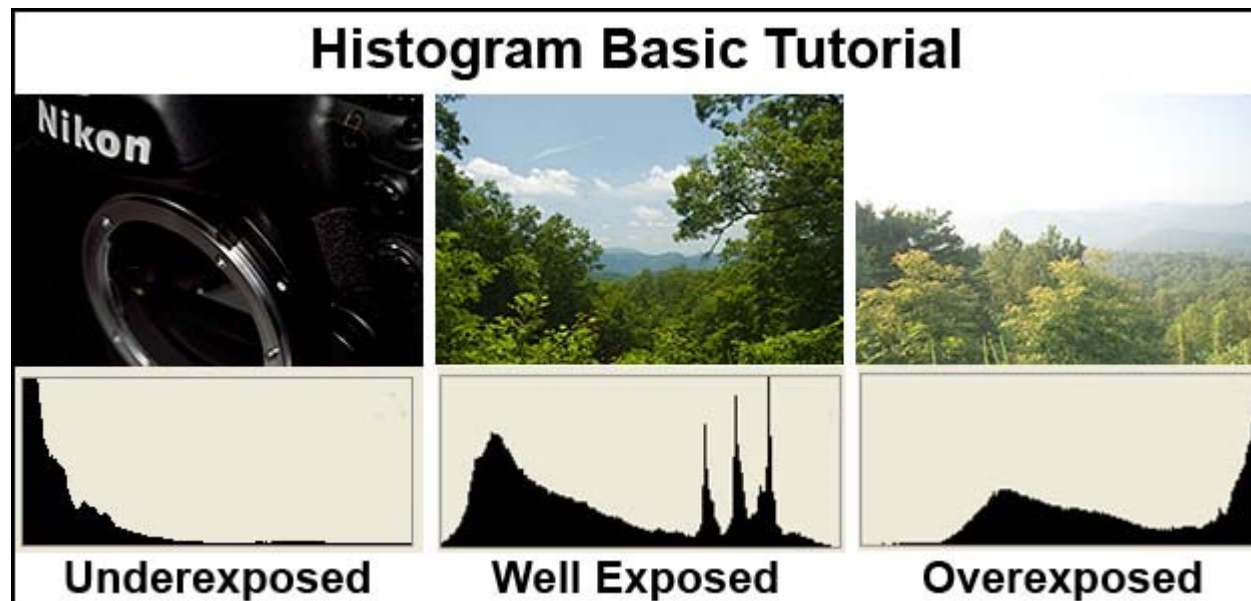


Image Histogram

An **image histogram** is a type of [histogram](#) that acts as a [graphical representation](#) of the [tonal](#) distribution in a [digital image](#).^[1] It plots the number of [pixels](#) for each tonal value.



Matlab image processing function

Floor the number:

```
im2=floor(im);
```

Round the number:

```
im2=round(im);
```

Change type to double precision:

```
im2=double(im);
```

Show double precision matrix as image:

```
imshow(im,[0 255]);
```

Arithmetic mean:

```
c= mean(mean(im));
```

Light metering method

<http://digital-photography-school.com/metering-modes-and-how-your-camera-meter-works/>

