Imaging And Processing Basics

BY

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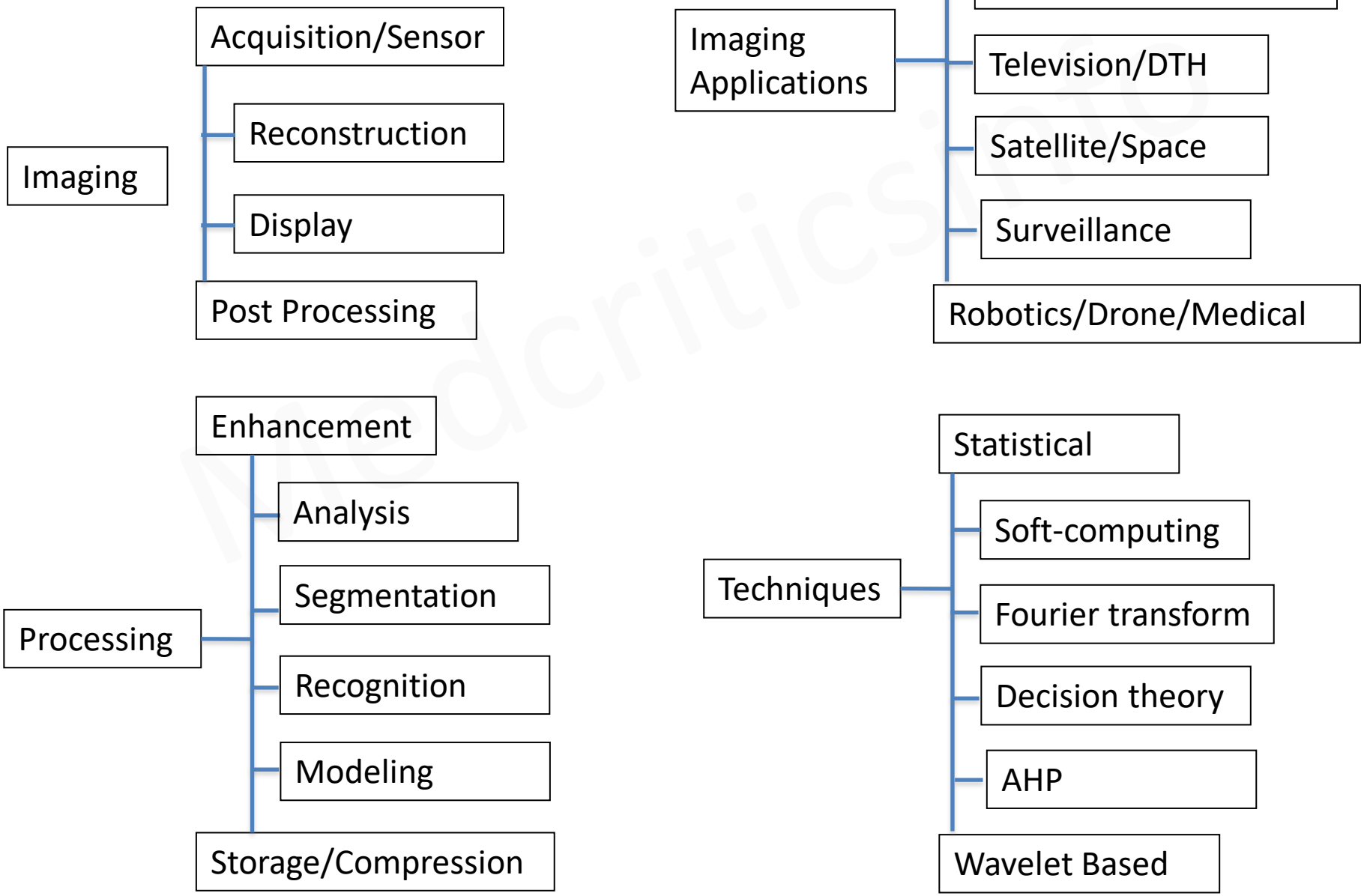
Imaging Techniques

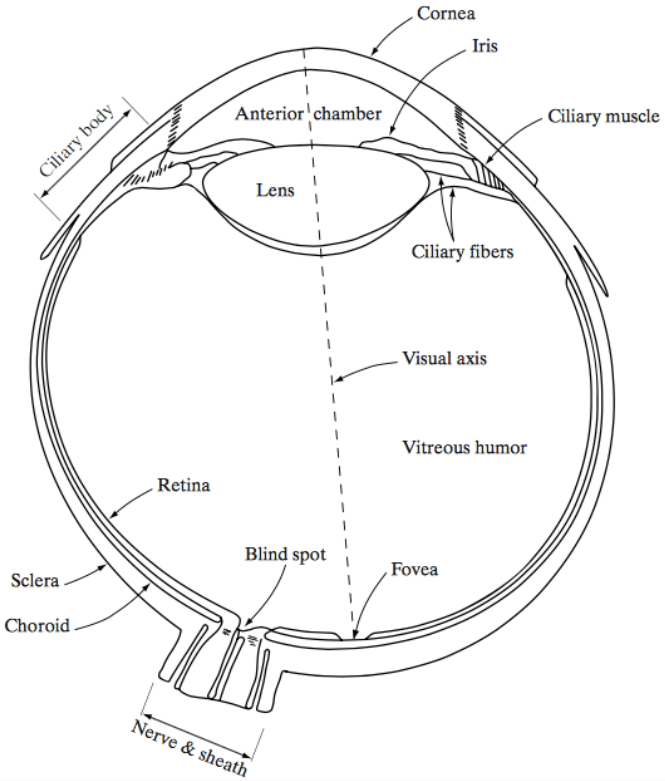


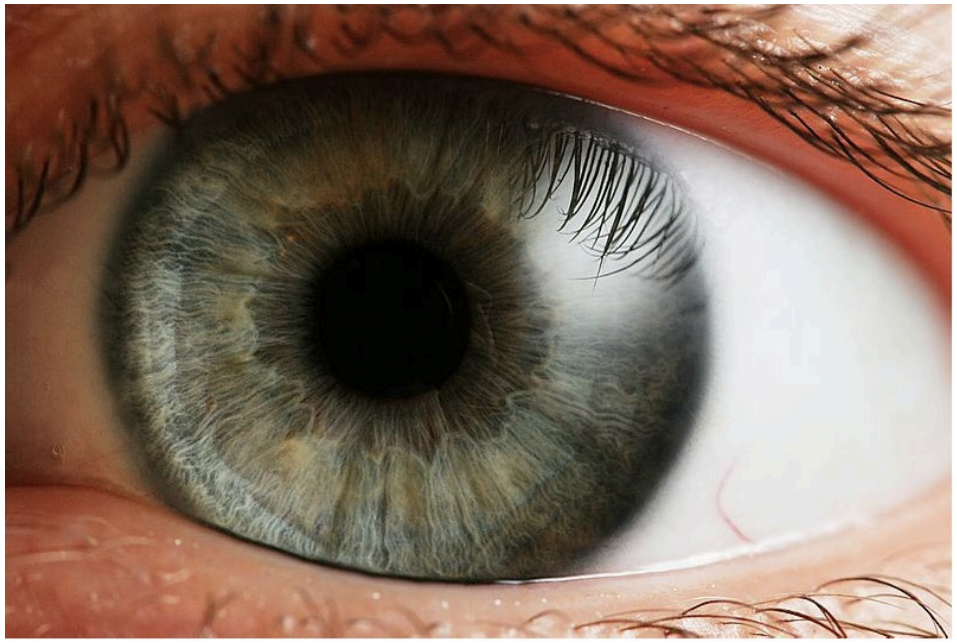
[Book on Image processing
http://users.dcc.uchile.cl/~jsaavedr/libros/dip_gw.pdf](http://users.dcc.uchile.cl/~jsaavedr/libros/dip_gw.pdf)

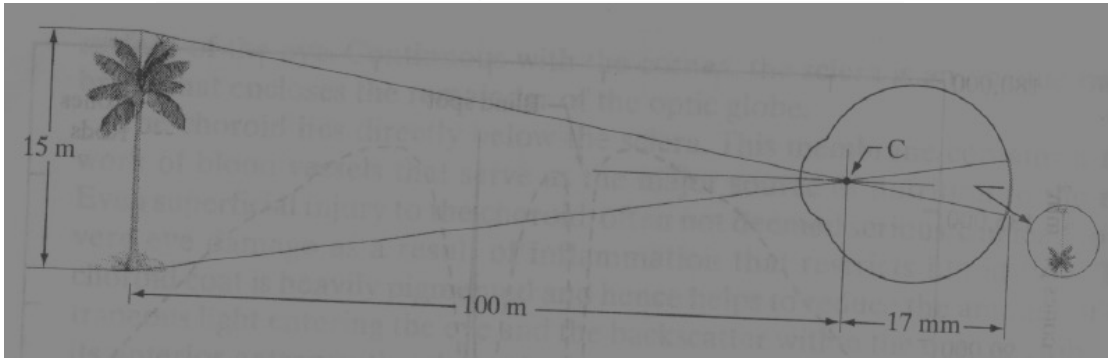
Image Basics

1. Visual perception
2. Image acquisition
3. Sampling and quantization
4. Pixels and Histogram
5. Histogram processing

Image formation on Eye







Eye --- 20mm size camera

Lens -- Fibers (water, fat, protens)

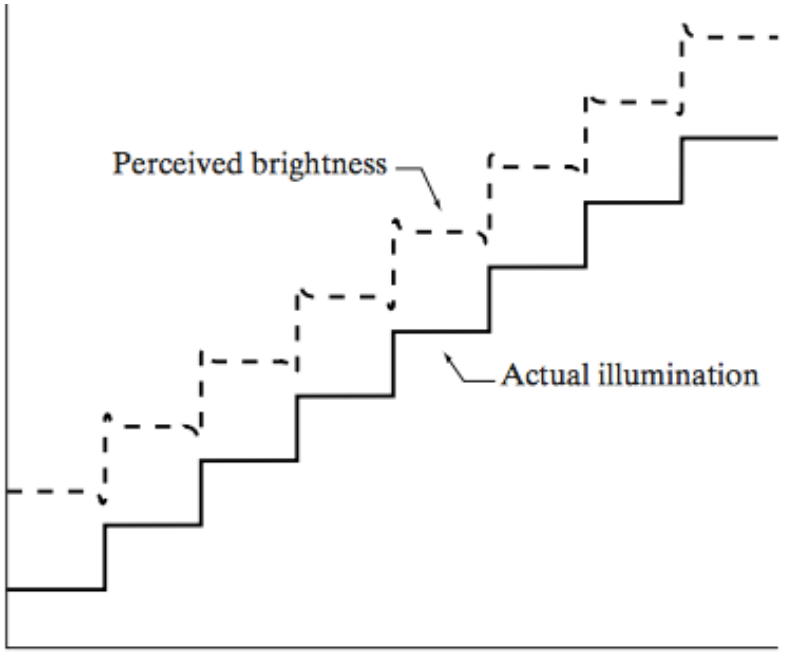
Inner most layer -- Retina

Rods-- distributed over retina

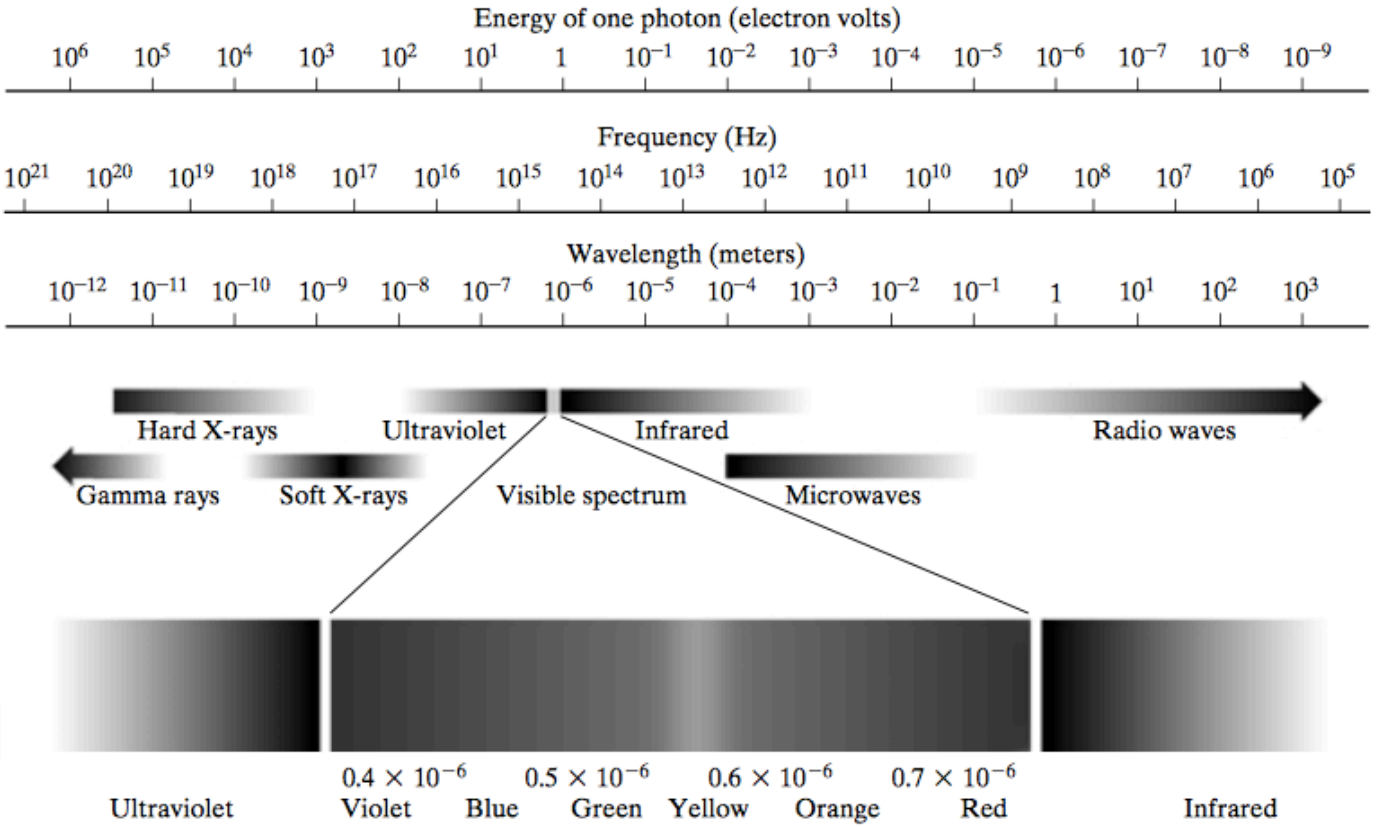
Rods are connected optic nerves

1o million color/32-64 grey shades

Behavior of Grey shaded



Electromagnetic spectrum



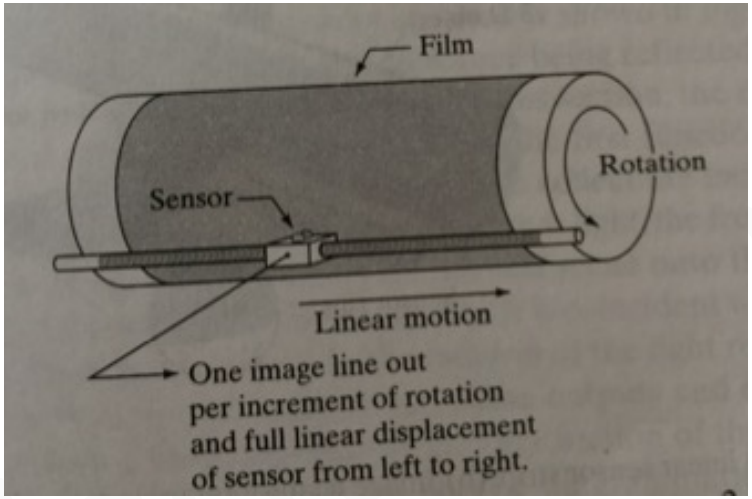
color	wavelength interval	frequency interval
red	~ 700–635 nm	~ 430–480 THz
orange	~ 635–590 nm	~ 480–510 THz
yellow	~ 590–560 nm	~ 510–540 THz
green	~ 560–490 nm	~ 540–610 THz
blue	~ 490–450 nm	~ 610–670 THz
violet	~ 450–400 nm	~ 670–750 THz

Visible range

400- 700nm

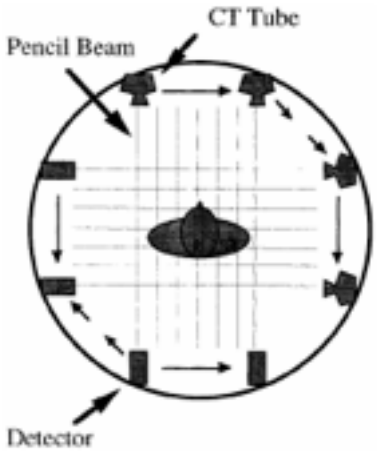
Image Acquisition

Camera

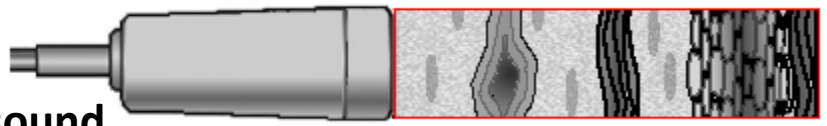


Scanner

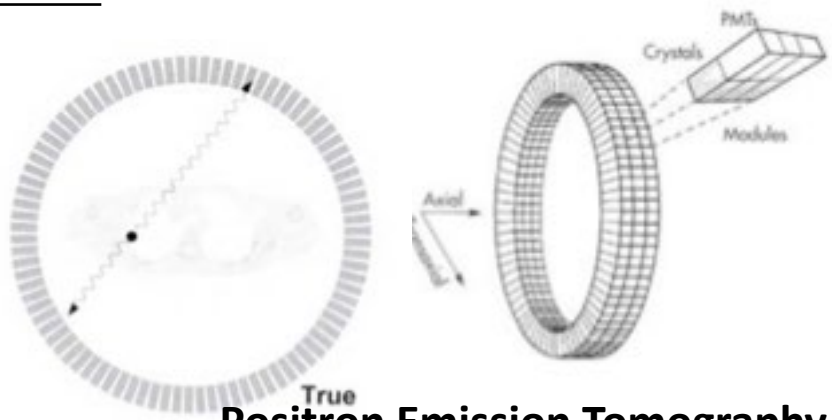
TV Camera



Computer Tomography

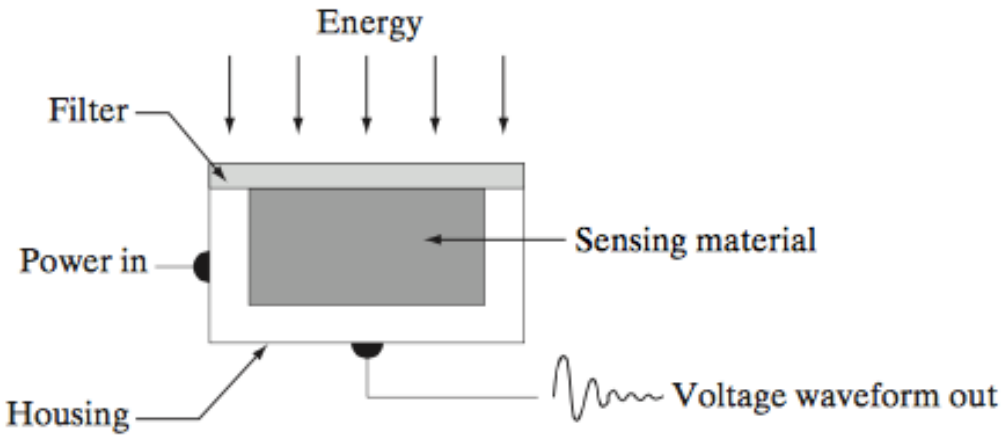


Ultrasound



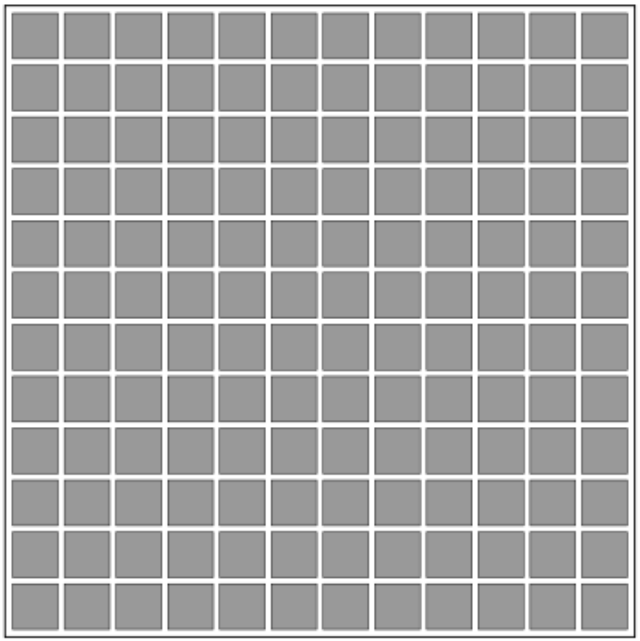
Positron Emission Tomography

Image Sensor



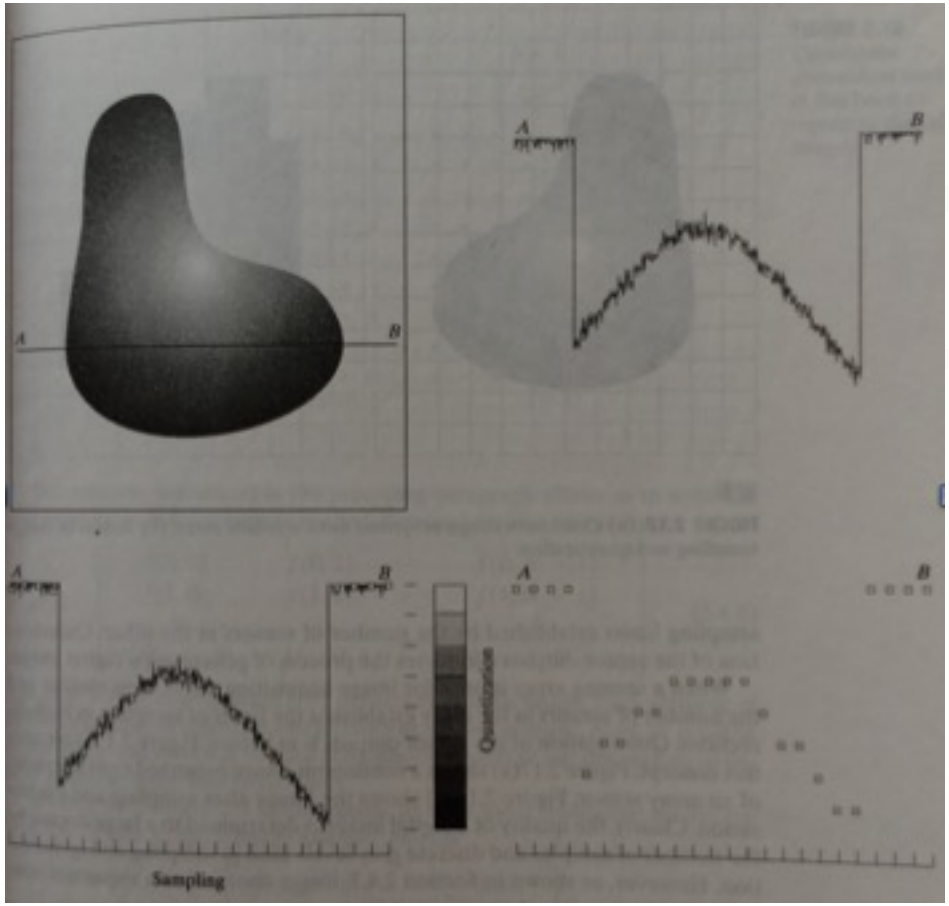
Single Sensor

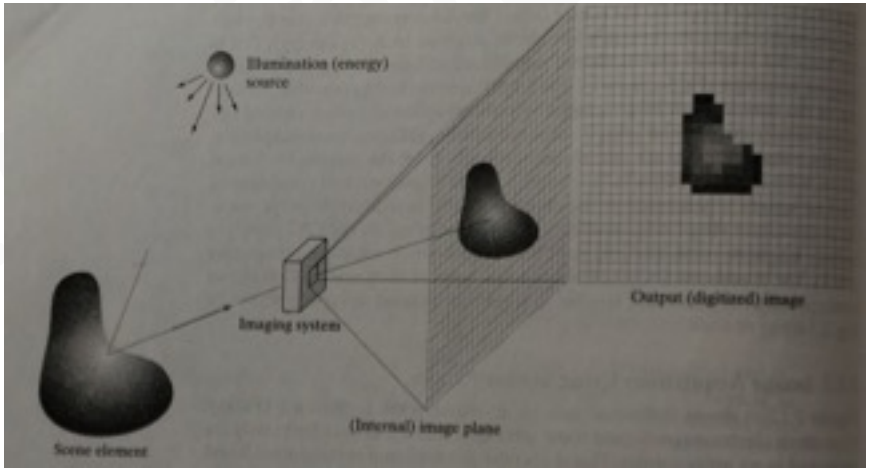
Line Sensor



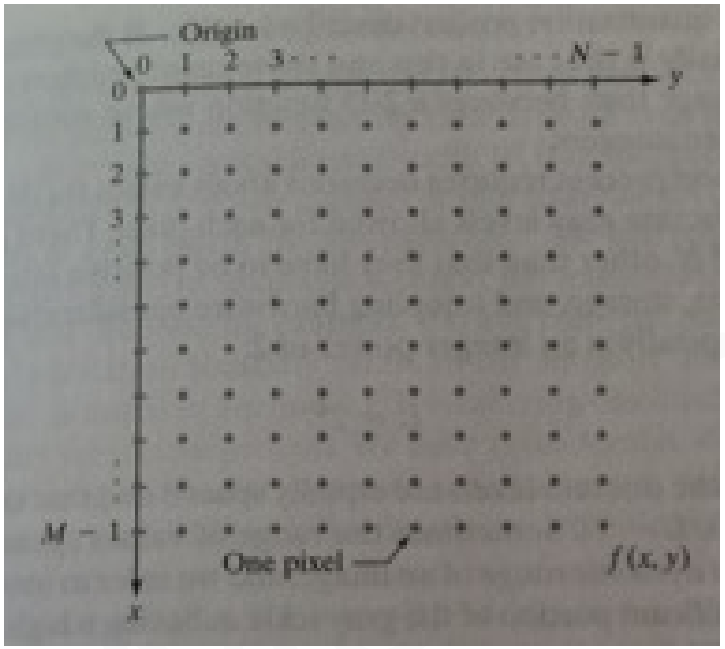
Array Sensor

Sampling and Quantization





Representation of Digital Images



$$f(x,y) = \begin{bmatrix} f(0,0) & f(0,1) & \cdots & f(0,N-1) \\ f(1,0) & f(1,1) & \cdots & f(1,N-1) \\ \vdots & \vdots & & \vdots \\ f(M-1,0) & f(M-1,1) & \cdots & f(M-1,N-1) \end{bmatrix}$$

$$\mathbf{A} = \begin{bmatrix} a_{0,0} & a_{0,1} & \cdots & a_{0,N-1} \\ a_{1,0} & a_{1,1} & \cdots & a_{1,N-1} \\ \vdots & \vdots & & \vdots \\ a_{M-1,0} & a_{M-1,1} & \cdots & a_{M-1,N-1} \end{bmatrix}$$

- **Pixels**
- **Spatial Resolution**
- **Memory**
- **Aspect ratio**

Image Size

Number of rows	rows
Number of columns	cols
Number of bits per pixel	bpp

Size of an image = rows * cols * bpp

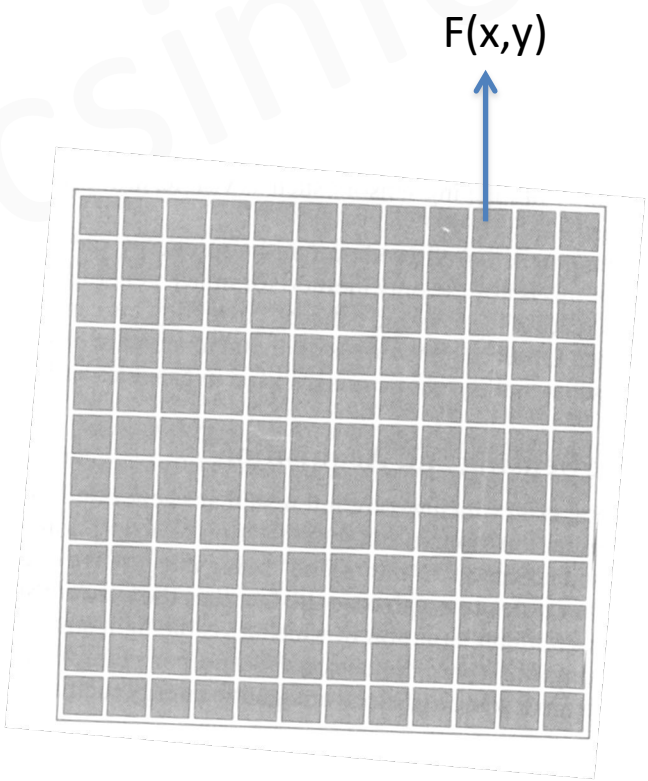


Image Size

64X64X3 = 12288 Byte

128X128X3 = 49152 Byte

256X256X3 = 196608 Byte

1024X1024X3 = 3145728 byte

1024X1024X30X3 = 94371840 byte

Aspect Ratio

Aspect ratios are mathematically expressed as *x*:*y* (pronounced "x-to-y") and *x* × *y* (pronounced "x-by-y"), with the latter particularly used for:
Aspect ratio is the relationship of the width of a video image compared to its height.

Pixel dimensions, such as 640x480 or 1280x1024

Aspect Ratio: 1.33:1, 1.37:1, 1.43:1, 1.50:1, 1.56:1, 1.66:1, 1.75:1, 1.78:1, 1.85:1, 2.00:1

Resolution: dots per inch, lines per inch, pixels per inch

Aspect Ratio vs Memory

If you are given an image with aspect ratio of 6:2 of an image of pixel resolution of 480000 pixels given the image is an gray scale image.
And you are asked to calculate two things.
Resolve pixel resolution to calculate the dimensions of image??
Calculate the size of the image??
SOLUTION:
GIVEN:
Aspect ratio: c:r = 6:2
Pixel resolution: c * r = 480000
Bits per pixel: grayscale image = 8bpp
FIND:
Number of rows = ?
Number of cols = ?
SOLVING FIRST PART:

Equation 1. c:r = 6:2 → c = 6 r / 2

Equation 2. c = 480000/r

Comparing both equations → $\frac{6r}{2} = \frac{480000}{r}$

$r^2 = \sqrt{\frac{480000*2}{6}}$

That gives r = 400.

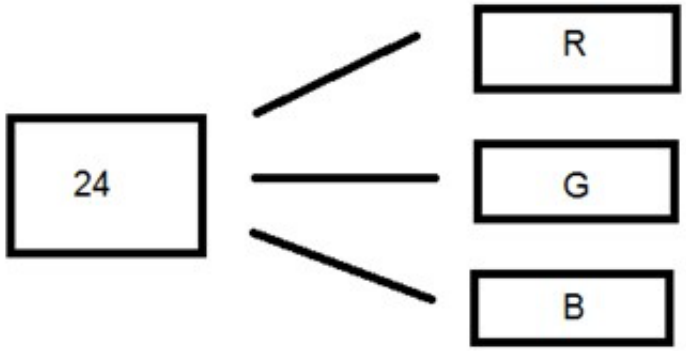
Put r in equation 1, we get → c = 1200.

So rows = 400 cols = 1200.

SOLVING 2ND PART:
Size = rows * cols * bpp
Size of image in bits = 400 * 1200 * 8 = 3840000 bits
Size of image in bytes = 480000 bytes
Size of image in kilo bytes = 48 kb (approx).

24 bit color format

RGB color model:



Color:White
IMAGE:

DECIMAL CODE:
(255,255,255)

Color:Yellow
IMAGE:

DECIMAL CODE:
(255,255,0)

Color:Green
IMAGE:

DECIMAL CODE:
(0,255,0)

Color:Red
IMAGE:

DECIMAL CODE:
(255,0,0)

Color Blue
IMAGE:

DECIMAL CODE:
(0,0,255)

Gray color:
COLOR: GRAY
IMAGE:

DECIMAL CODE:
(128,128,128)

RGB Conversion to Gray

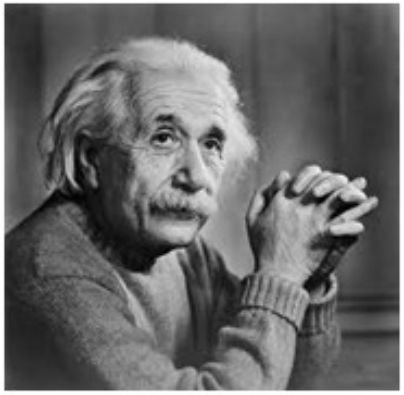


Three different colors have three different wavelength and have their own contribution in the formation of image , so we have to take average according to their contribution , not done it averagely using average method. Grayscale = (R + G + B / 3)

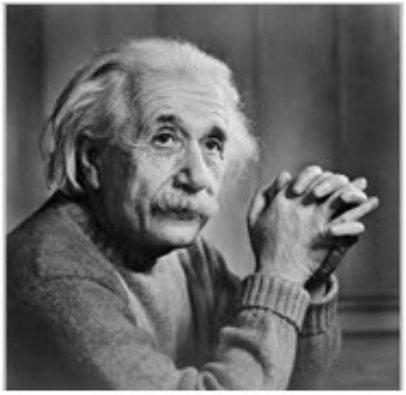
Weighted method or luminosity method

New grayscale image = ((0.3 * R) + (0.59 * G) + (0.11 * B))

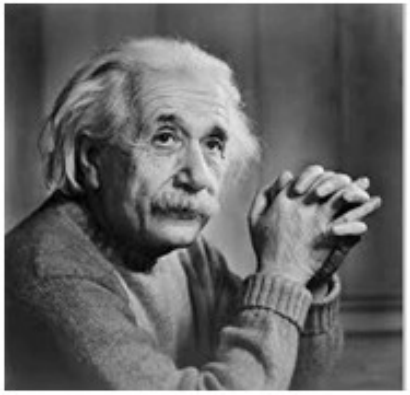
Reducing Gray level



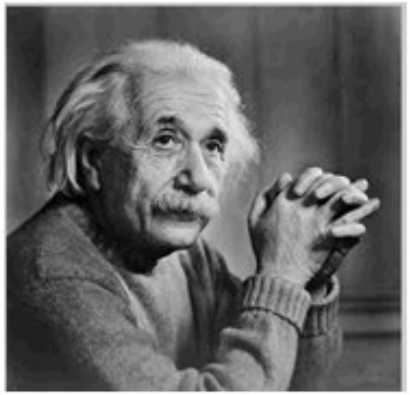
256 Bit



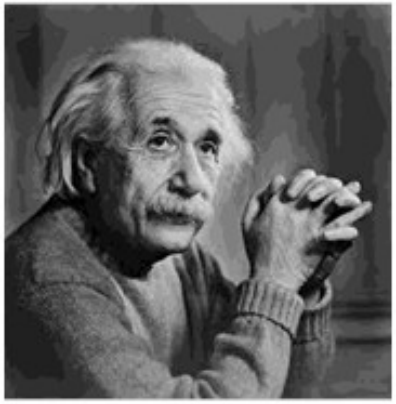
128 bit



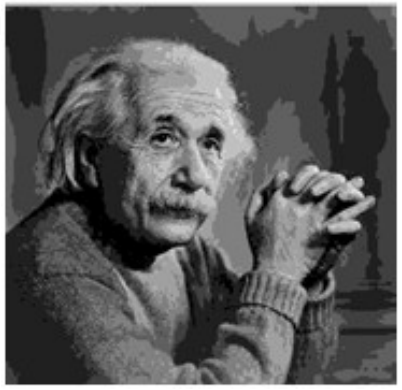
64 bit



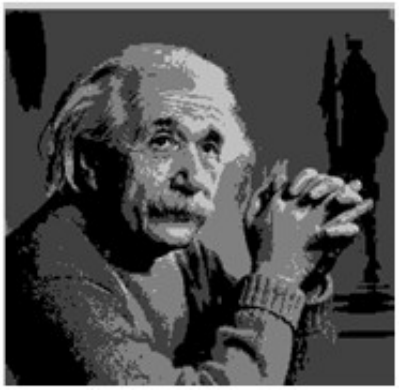
32 bit



16 Bit



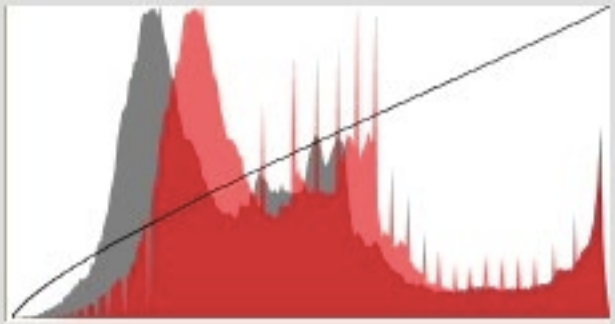
8 bit

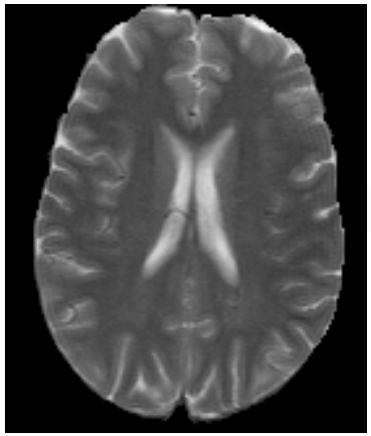


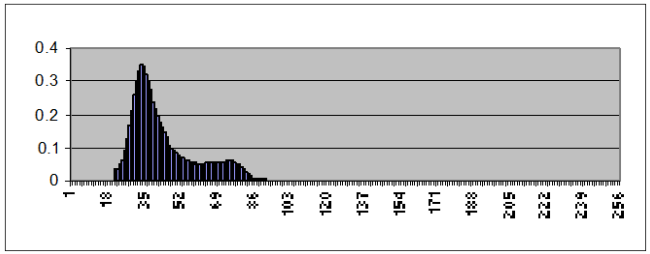
4 bit

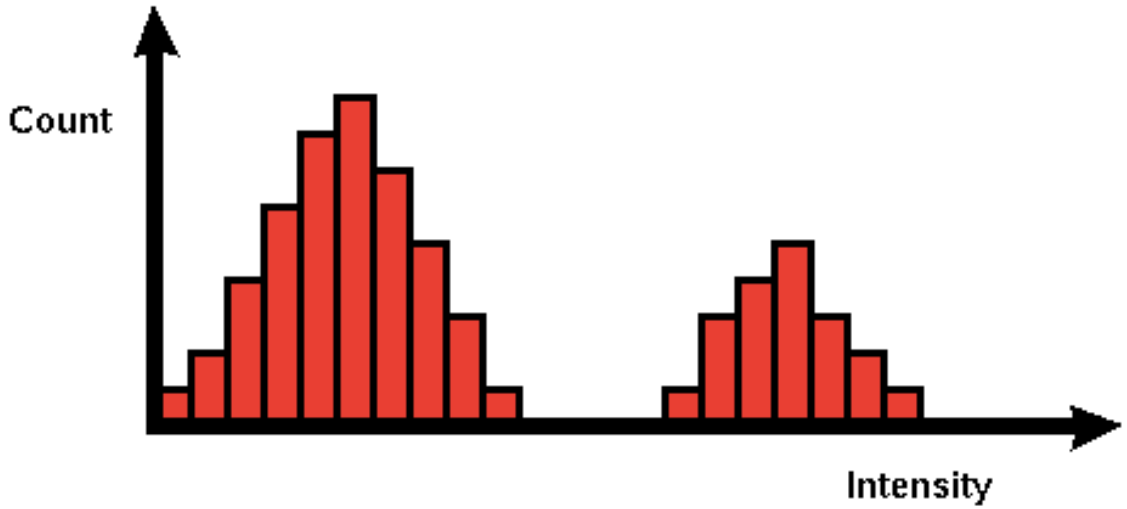
2 bit

Image and Histogram









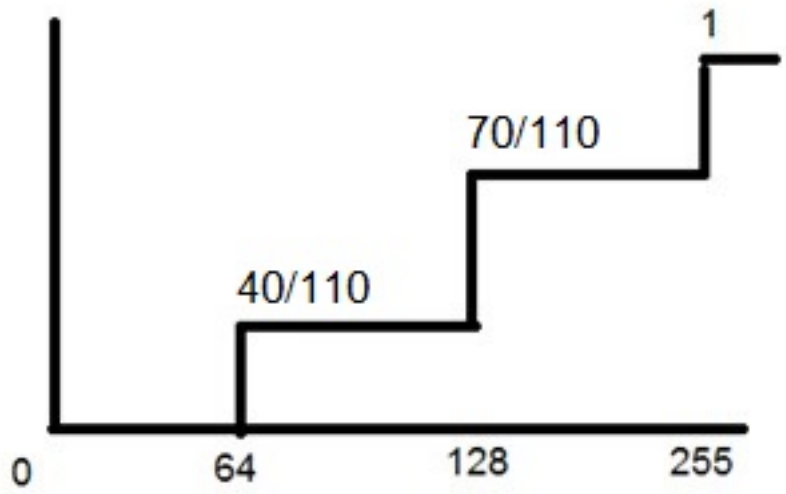
PMF Probability Mass Function

CDF Cumulative distribution function

PMF Probability Mass Function
CDF Cumulative distribution function

1	2	7	5	6
7	2	3	4	5
0	1	5	7	3
1	2	5	6	7
6	1	0	3	4

Matrix



CDF

0	2	2/25
1	4	4/25
2	3	3/25
3	3	3/25
4	2	2/25
5	4	4/25
6	3	3/25
7	4	4/25

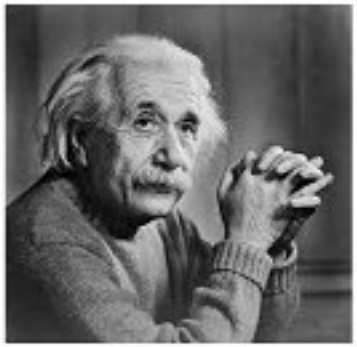
PMF

PMF: gives the probability of each number in the data set or you can say that it basically gives the count or frequency of each element.

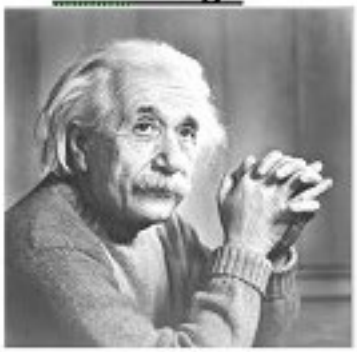
CDF function: Calculates the cumulative sum of all the values that are calculated by PMF. It basically sums the previous one.

INCREASING BRIGHTNESS USING HISTOGRAM SLIDING

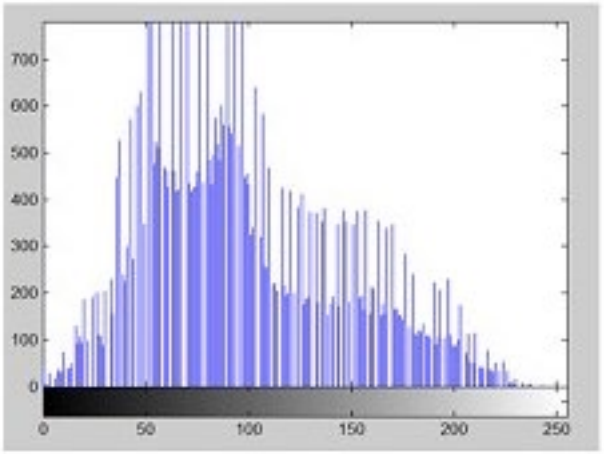
Old image



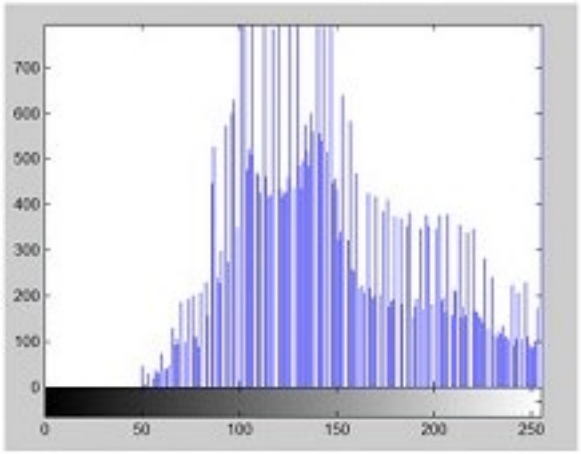
New image



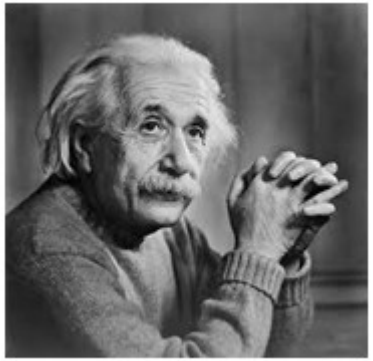
Old histogram



New Histogram



Histogram based image negative



Original Image

Negative

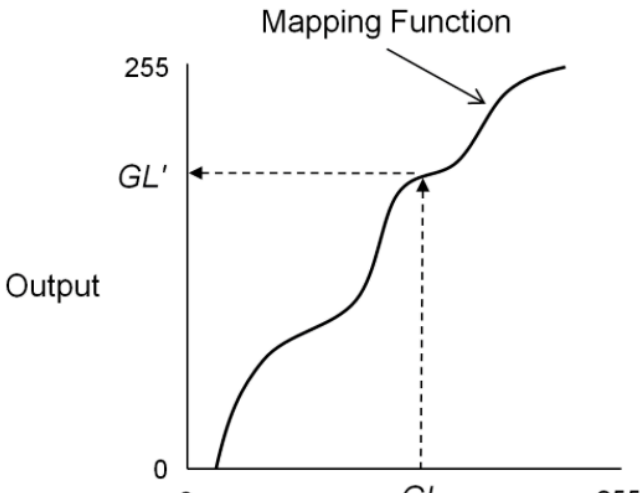
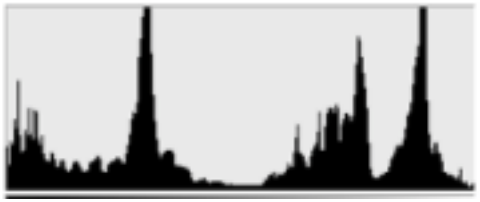
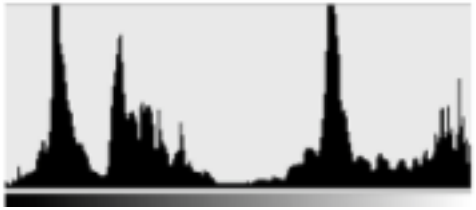
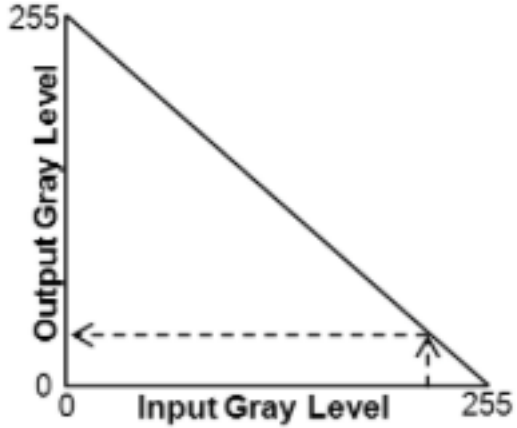


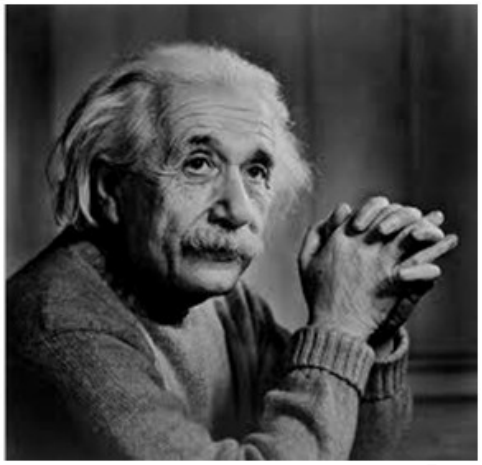
Image Negative Function $s = (L - 1) - r$ $s = 255 - r$

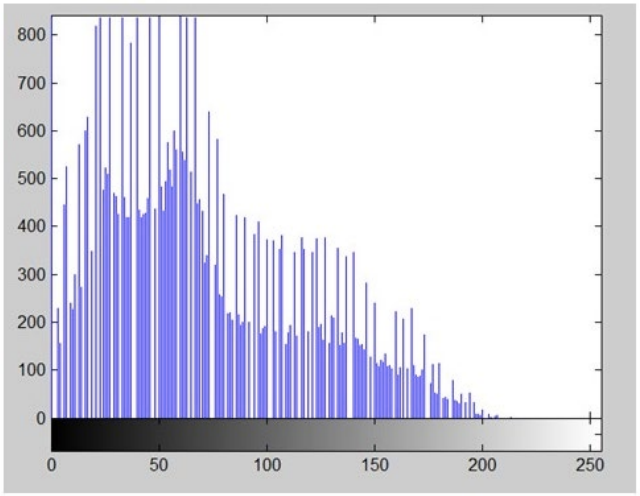


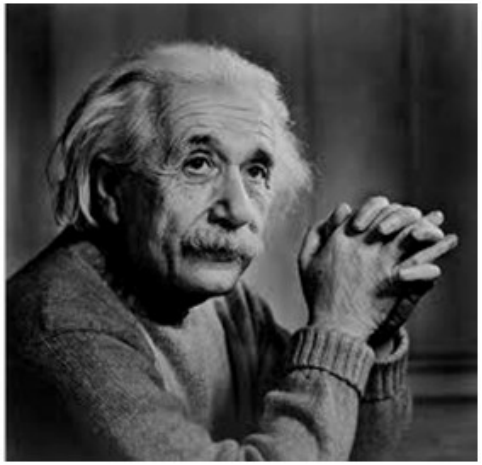


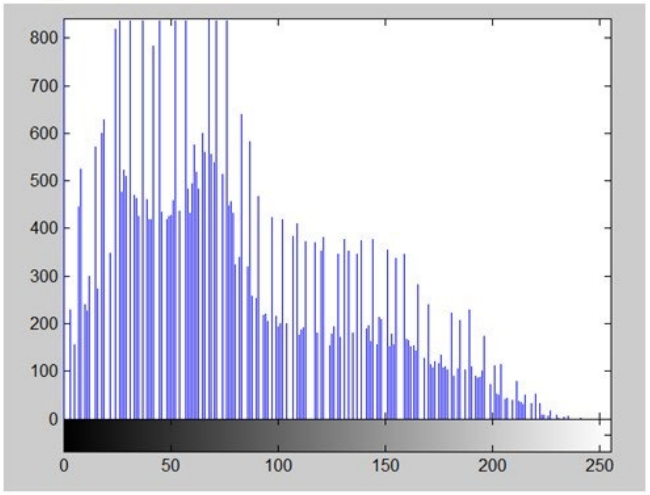


Histogram Stretching



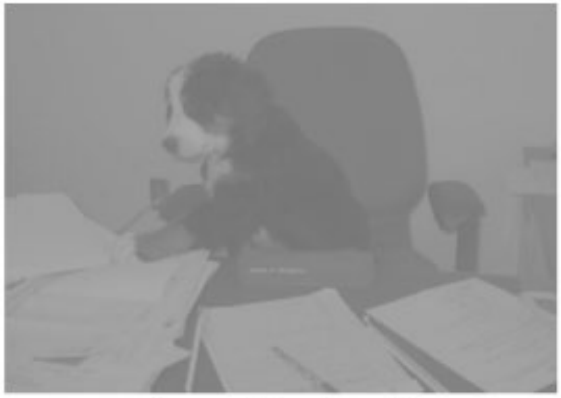




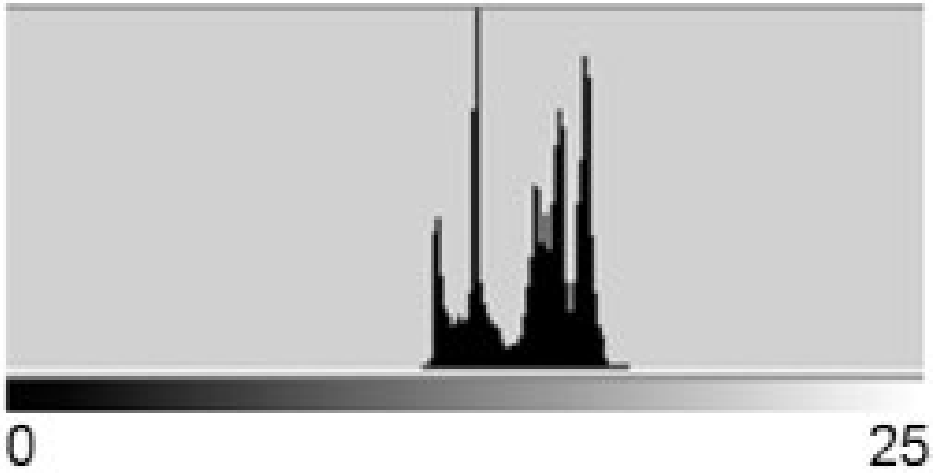


$$g(x,y) = \frac{f(x,y) - fmin}{fmax - fmin} * 2^{bpp}$$

Contrast Stretching

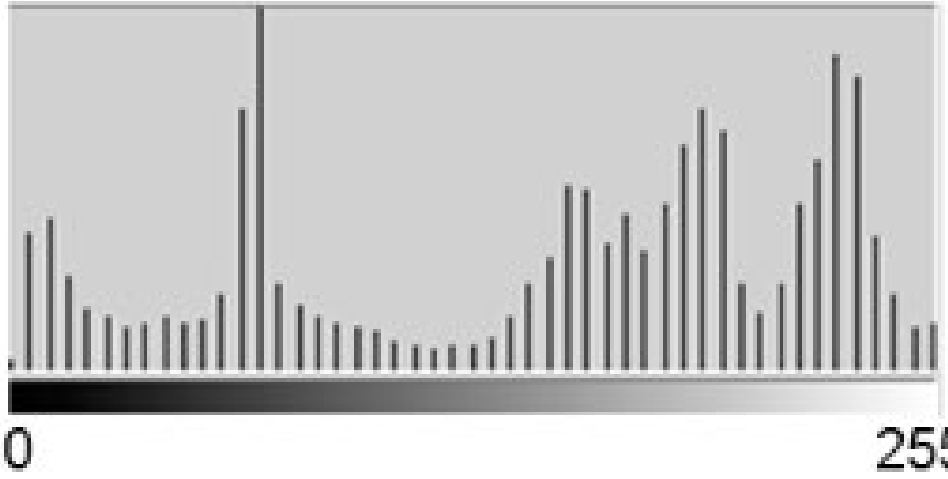


Low Contrast



Note contouring

High Contrast



Gray level transformation

- Linear
- Logarithmic
- Power – law

- http://www.tutorialspoint.com/dip/dip_quick_guide.htm

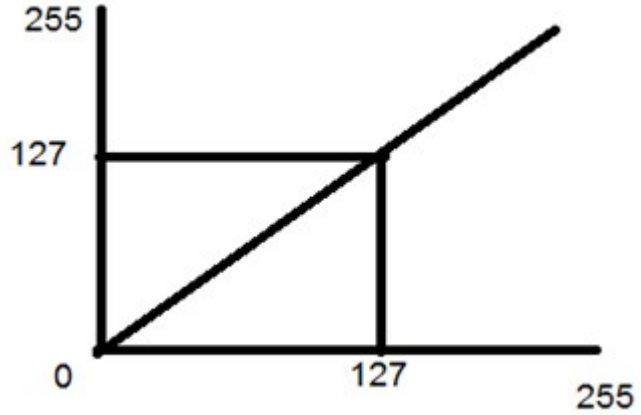


Image Linear Function

Logrithmic **Power Law (10)** **Power Law (10)**

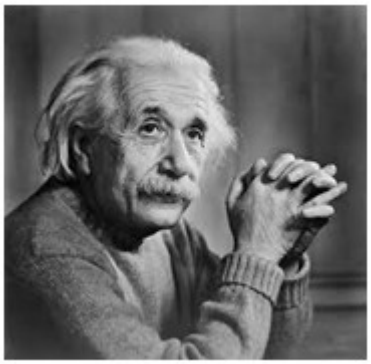



Image Log Function $s = c \log(r + 1)$.

Image Power law Function $s=cr^{\gamma}$ $s=cr^{(1/2.5)}$

United States Patent [19]

Kim

[11] **Patent Number: 5,923,383**

[45] **Date of Patent: Jul. 13, 1999**

[54] **IMAGE ENHANCEMENT METHOD USING HISTOGRAM EQUALIZATION**

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[21] Appl. No.: **08/883,707**

[22] Filed: **Jun. 27, 1997**

[30] **Foreign Application Priority Data**

Jun. 27, 1996 [KR] Rep. of Korea 96-24412

[51] **Int. Cl.**^{6} **H04N 5/14**

[52] **U.S. Cl.** **348/672**; 348/671; 382/169

[58] **Field of Search** 348/671, 672; 382/168, 169; 358/522, 455; H04N 5/14

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[57] **ABSTRACT**

In an image enhancement method is disclosed using a histogram equalization for an input image expressed in a predetermined number of gray levels. While calculating the probability density function of the gray levels of the input image, for use in a histogram equalization, the number of occurrences of each gray level are constrained not to exceed a predetermined value. Then a histogram equalization is performed on the input image based on the calculated probability density (or distribution) function. As a result, the mean brightness of the input image does not change significantly by the histogram equalization. Additionally, noise is prevented from being greatly amplified.

7 Claims, 2 Drawing Sheets

https://docs.google.com/viewer?url=patentimages.storage.googleapis.com/pdfs/US5923383.pdf

US5923383 A cont.

1. Field of the Invention
The present invention relates to an image enhancement method. More particularly, it relates to an image enhance ment method using a histogram equalization.
This application for an image enhancement method using histogram equalization

Claim

1. A histogram equalization method for image enhancement by equalizing an input image expressed in a predetermined number of gray levels, the method comprising the steps of:(a) calculating a probability density function of gray levels of the input image, wherein a number of occurrences of each gray level in the probability density function is constrained to be within a predetermined value; and(b) performing a histogram equalization on the input image based on the probability density function of gray levels calculated in said step (a).

(12) **United States Patent**
Obrador

(10) **Patent No.: US 7,058,220 B2**
(45) **Date of Patent: Jun. 6, 2006**

(54) **METHOD AND SYSTEM FOR PROCESSING IMAGES USING HISTOGRAMS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 688 days.

(21) Appl. No.: **10/133,413**

(22) Filed: **Apr. 29, 2002**

(65) **Prior Publication Data**

US 2003/0202692 A1 Oct. 30, 2003

(51) **Int. Cl.**
G06K 9/00 (2006.01)
G06K 9/68 (2006.01)

(52) **U.S. Cl.** **382/168**; 382/218

(58) **Field of Classification Search** 382/154, 382/164, 168, 170, 172, 181, 218, 219, 220, 382/260, 278, 305; 358/3.13, 3.26, 505, 358/522, 524, 530; 348/672; 708/304
See application file for complete search history.

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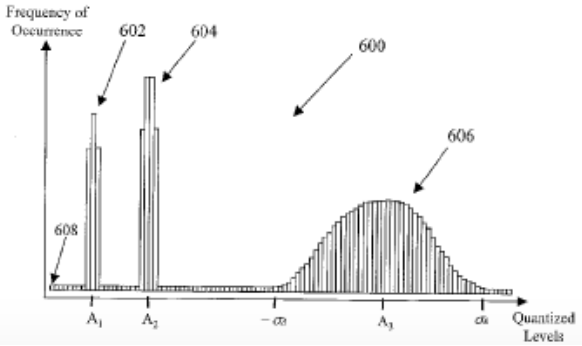
Primary Examiner—Amri Alavi

(57) **ABSTRACT**

A method and system are disclosed for processing images using histograms. In accordance with exemplary embodiments of the present invention, first image data is received for a first image. A first histogram of the first image is generated using the first image data. At least one peak from the first histogram is selectively removed to generate a modified first histogram. The first image is processed using the modified first histogram.

46 Claims, 9 Drawing Sheets

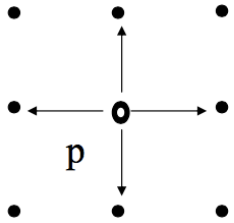


https://docs.google.com/viewer?url=patentimages.storage.googleapis.com/pdfs/US7058220.pdf

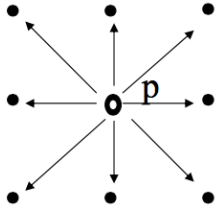
Field of the Invention

The present invention relates to image processing. More particularly, the present invention relates to a method and system for processing images using histograms.

Pixel Neighbor Adjacency Distance



$N_4(p)$



$N_8(p)$

Neighboring pixels

Adjacency:

- **Two pixels are connected if they are neighbors and their gray levels satisfy some specified criterion of similarity.**

For example, in a binary image two pixels are connected if they are 4-neighbors and have same value (0/1).

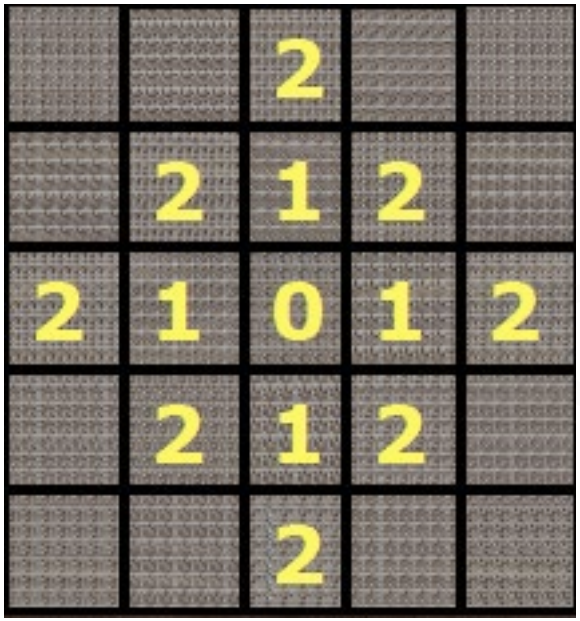
Let V be set of gray levels values used to define adjacency.

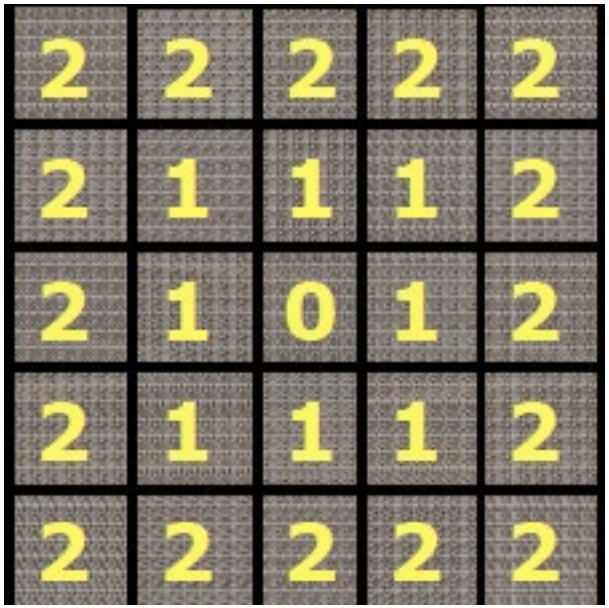
- **4-adjacency: Two pixels *p* and *q* with values from V are 4-adjacent if q is in the set N4(*p*).**
- **8-adjacency: Two pixels *p* and *q* with values from V are 8-adjacent if q is in the set N8(*p*).**
- **m-adjacency: Two pixels *p* and *q* with values from V are madjacent if,**

– q is in N4(P).

– q is in ND(p) and the set [ ] is empty
(has no pixels whose values are from V).

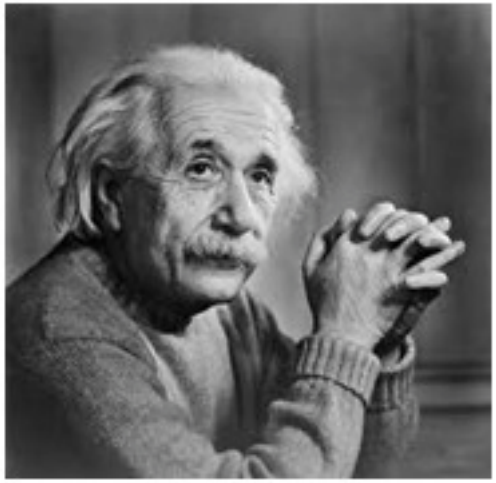
Euclidean Distance between pixels

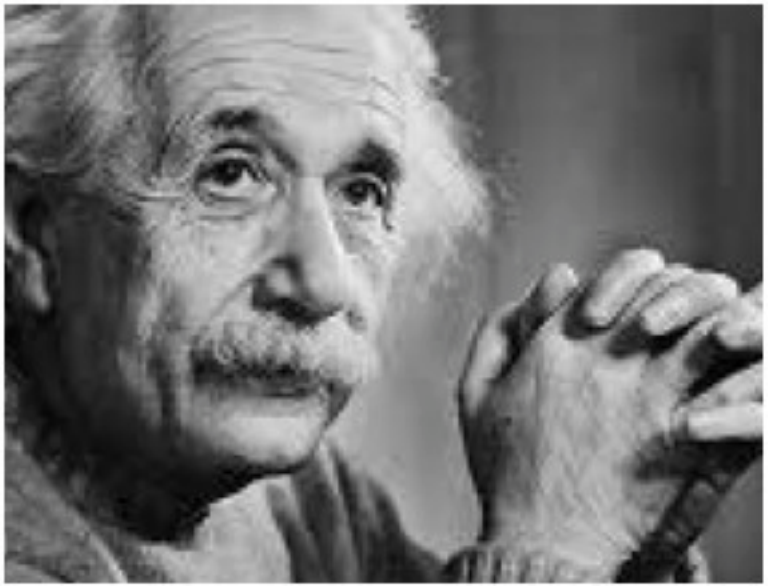




Zooming

- **Optical**
- **Digital**





Pixel replication or (Nearest neighbor interpolation)

1	1	2	2
3	3	4	4

Original

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

Replication by Modeling