TE 354 – Pengolahan Citra Digital

02 – Digital Image Fundamentals

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Basic Problems

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Image Processing Problems

There are many image processing applications and problems, we will consider the following basic classes of problems

- Image Representation & Modeling
- Image Enhancement
- Image Restoration
- Image Analysis
- Image Reconstruction
- Image Data Compression

Image Representation & Modeling

In image representation one is concerned with characterization of the quantity that each picture element (pixel) represents.

Image

- represent luminance of objects in a scene (taken by ordinary camera)
- represent the absorption characteristics of the body tissue (X-ray imaging)
- represent radar cross section of a target (radar imaging)
- represent the temperature profile of a region (infrared imaging)
- represent the gravitational field in an area (geophysical imaging)

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Image representation and modeling

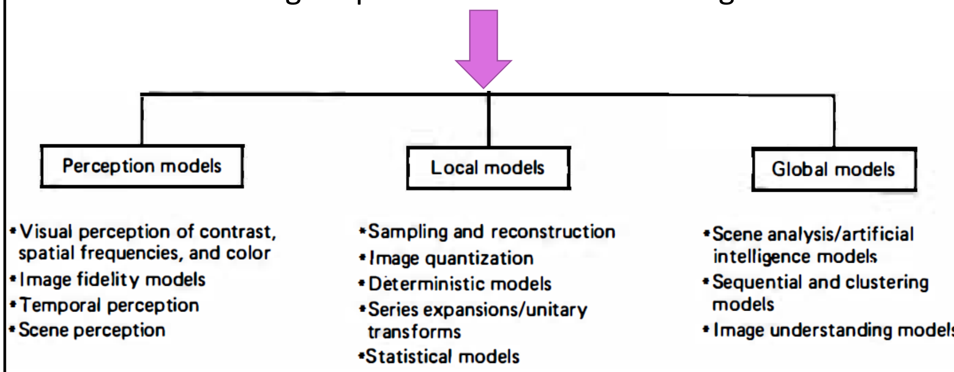

Image Enhancement

The goal is to accentuate certain image features for subsequent analysis or for image display.

- Contrast and Edge enhancement
- Pseudo coloring
- Noise filtering
- Sharpening
- Magnifying

Image enhancement is useful in feature extraction, image analysis, and visual information display

Image Restoration

Image restoration refers to removal or minimization of known degradations in an image. This includes deblurring of images degraded by the limitations of a sensor or its environment, noise filtering, and correction of geometric distortion or non-linearities due to sensors.

The image of an object can be expressed as

$$g(x,y) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} h(x,y;\alpha,\beta) f(\alpha,\beta)\, d\alpha\, d\beta + \eta(x,y)$$

- $g(x,y)$: The image
- $h(x,y;\alpha,\beta)$: point spread function
- $f(\alpha,\beta)$: The object
- $\eta(x,y)$: additive noise function

Image Analysis

- Image analysis is concerned with making quantitative measurements from an image to produce a description of it.
- Image analysis techniques require extraction of certain features that aid in the identification of the object
- Segmentation technique are used to isolate the desired object from the scene so that the measurements can be made on it subsequently.
- Quantitative measurements of object features allow classification and description of the image

Image Reconstruction

- Image reconstruction from projections is a special class of image restoration problems where a two- (or higher) dimensional object is reconstructed from several one-dimensional projections.
- Planar projections are thus obtained by viewing the object from many different angles.

Image Reconstruction

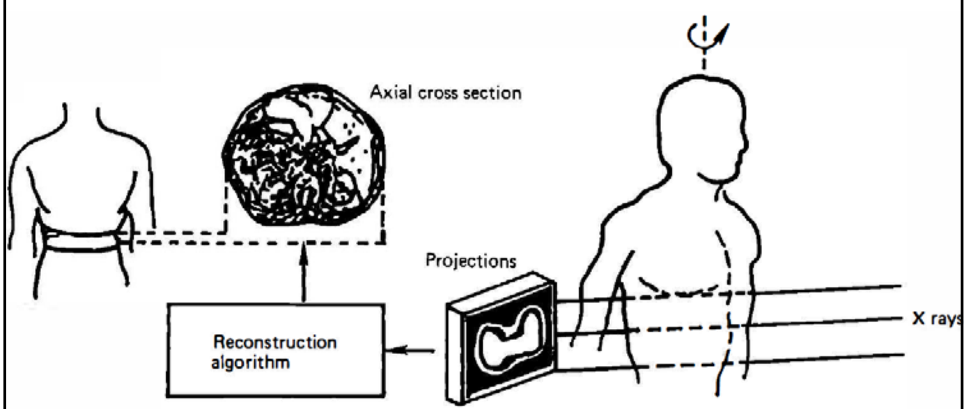

Image Data Compression

The amount of data associated with visual information is so large that its storage would require enormous storage capacity.

TABLE 1.1a Data Volumes of Image Sources (in Millions of Bytes)

National archives	12.5×10^9
1 h of color television	28×10^3
Encyclopeadia Britannica	12.5×10^3
Book (200 pages of text characters)	1.3
One page viewed as an image	.13

TABLE 1.1b Storage Capacities (in Millions of Bytes)

Human brain	125,000,000
Magnetic cartridge	250,000
Optical disc memory	12,500
Magnetic disc	760
2400-ft magnetic tape	200
Floppy disc	1.25
Solid-state memory modules	0.25

Image Data Compression

Storage and/or transmission of such data require large capacity and /or bandwidth, which could be very expensive. Image data compression techniques are concerned with reduction of the number of bits required to store or transmit images without any appreciable loss of information

Digital Image

Image Sampling and Quantization

To create a digital image, we need to convert the continuous sensed data into digital form.

continuous with respect to the x- and y-coordinates, and also in amplitude

Sampling

Digitizing the coordinate values

Quanti zation

Digitizing the amplitude values

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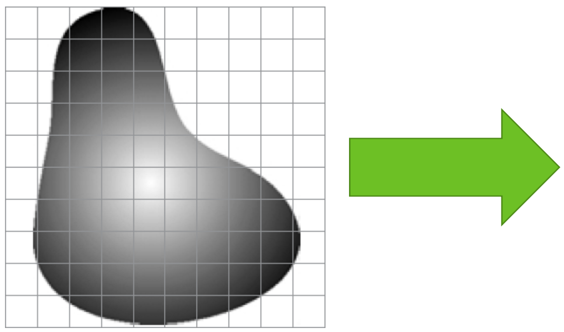
Image Sampling and Quantization



M rows

image *f(x, y)*

The result of sampling and quantization is a matrix of real numbers

N columns

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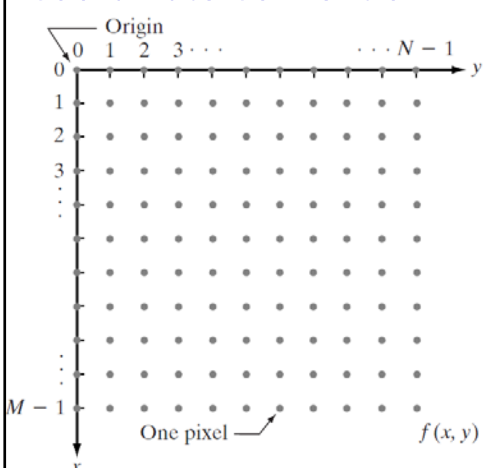
Coordinate Convention



Each element of this matrix array is called an *image element*, *picture element*, *pixel*, or *pel*

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

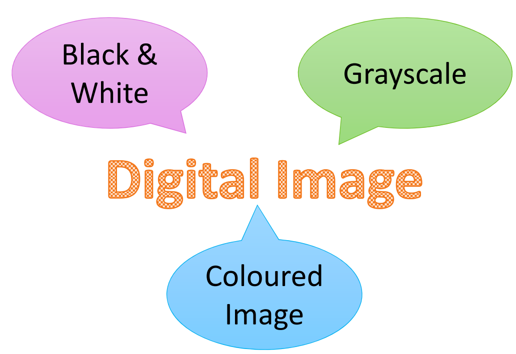
Convention in MATLAB

Digital image represented in MATLAB matrix

$$\texttt{f} = \begin{bmatrix} \texttt{f(1, 1)} & \texttt{f(1, 2)} & \cdots & \texttt{f(1, N)} \\ \texttt{f(2, 1)} & \texttt{f(2, 2)} & \cdots & \texttt{f(2, N)} \\ \vdots & \vdots & & \vdots \\ \texttt{f(M, 1)} & \texttt{f(M, 2)} & \cdots & \texttt{f(M, N)} \end{bmatrix}$$

$$\texttt{f}(1,1) = f(0,0)$$

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



The number of colours in an image depends on the colour depth (the number of bits per pixel

Colour Depth

The number of distinct colours that can be represented by a pixel depends on the number of bits per pixel (bpp)

Gray Level

Colours in image

$$= 2^{bpp}$$

Colour Depth (Gray Level)

- 1 bpp = 2 colours (Black and White)
- 2 bpp = 4 colours
- 3 bpp = 8 colours
- 8 bpp = 256 colours
- 16 bpp = 65,536 colours ("Highcolor")
- 24 bpp = 16.7 million colours ("Truecolor")

Storage Requirements

Size = rows * columns * bpp

Storage Requirements

Let the resolution of a digital image be 256 x 256. It is an 8 bit grayscale image. How many KBs are required to store this image?

Size (Storage Capacity) = 256 x 256 x 8
= 524,288 bits
= 65,536 bytes
= 64 KB

Black and White Images

- Binary Image
- Intensity of Black = 0
- Intensity of White = 1

Grayscale Image

- 8 bit grayscale image has 256 pixel intensities
- Range : 0 to 255
- Intensity of Black = 0
- Intensity of Gray = 127
- Intensity of White = 255

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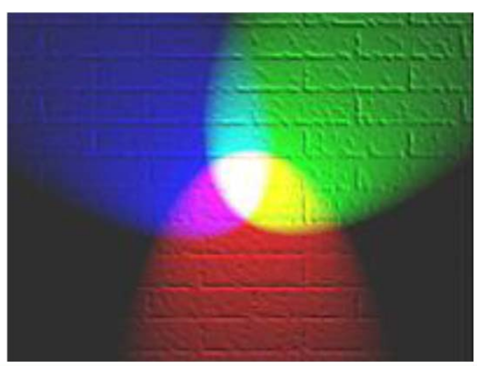
Colour Images

- Different models used for colour images
- RGB : combination of 3 planes (channels)
- In MATLAB, 3 different 2-D arrays, each for Red, Green, and Blue



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Colour Images

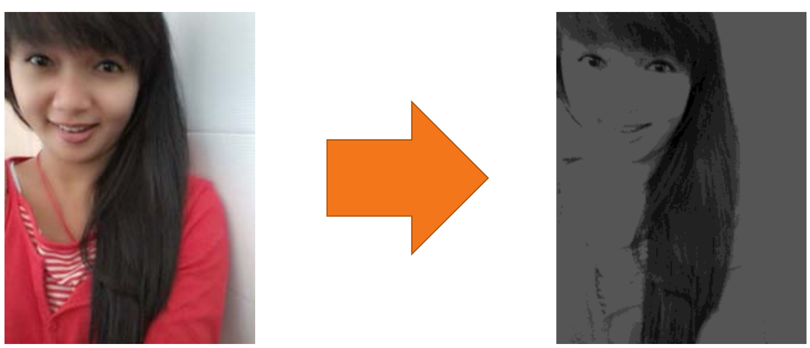
R

G

B

Colour Image to Grayscale Image

Grayscale = (R + G + B) / 3



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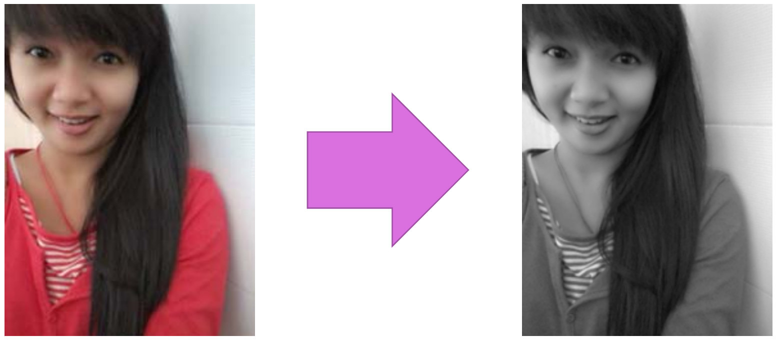
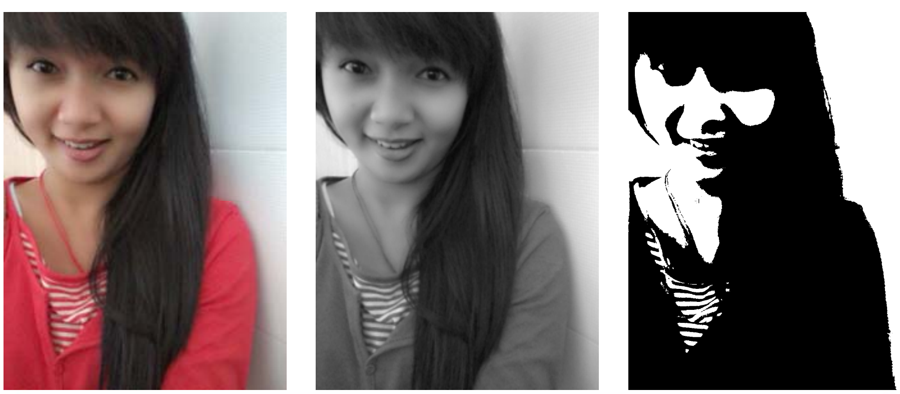
Colour Image to Grayscale Image

Weighted Conversion
Grayscale = (0.3 * R + 0.59 * G + 0.11 * B)



Different Type of Images

Same picture in three different modes



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