HCMC University of Technology and Education
Faculty of Electrical & Electronic Engineering

IMAGE PROCESSING

Chapter 2:

Fundamentals

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Fundamentals

1. Introduction
2. Color image
3. Image operators
4. Matrix transforms
5. Problems

Introduction

What is an image?

- A monochrome image is the 2-dimensional light intensity function or brightness of an object shown at spatial coordinates (x,y) of the image
-The maximum value on the range of gray level corresponding to a completely bright point and a point with a gray level of zero is a completely dark point

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What is digital Image?

- The most popular ranges of a digital image with gray level often used in typical sizes: 0 to 255, 0 to 511, 0 to 1023, etc due to binary system.

-The gray levels are almost always set to be nonnegative integer numbers (real numbers)

-This saves a lot of digital storage spaces and significantly in processing digital images.

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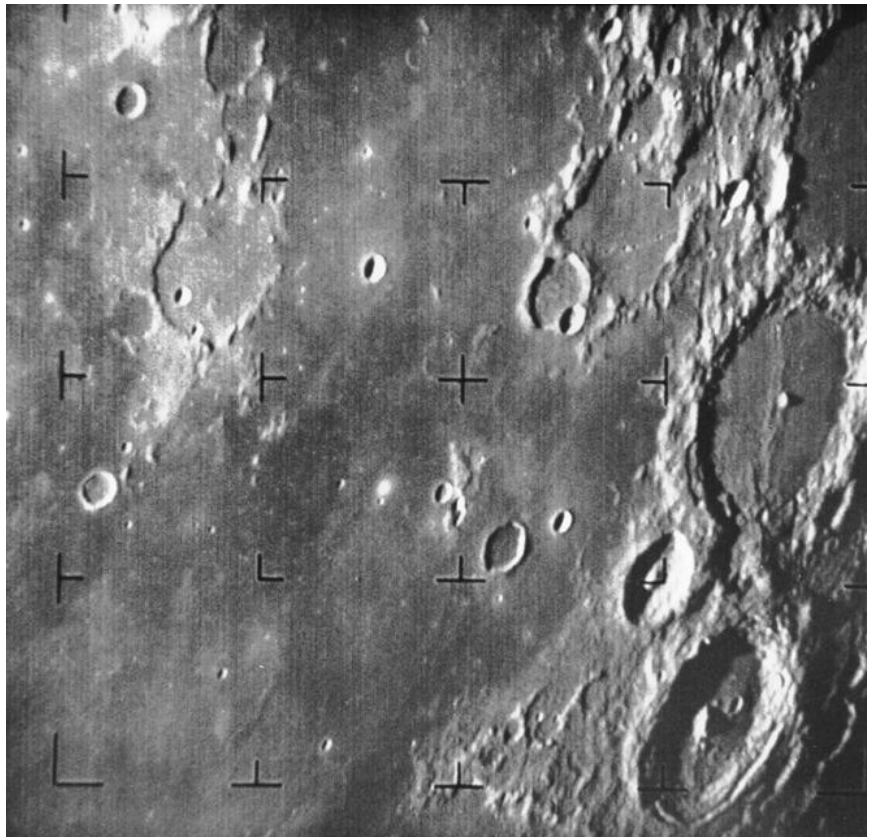
Introduction to the digital Image

- A sample digital image:

- MxN: 662x640

- 8 bit of gray levels: 256

- An image is created by pixels
- f(x,y) is a two-dimensional function, where x and y are spatial coordinates
- the amplitude of f at any pair of coordinates (x,y) is called the intensity or gray level of the image at that point



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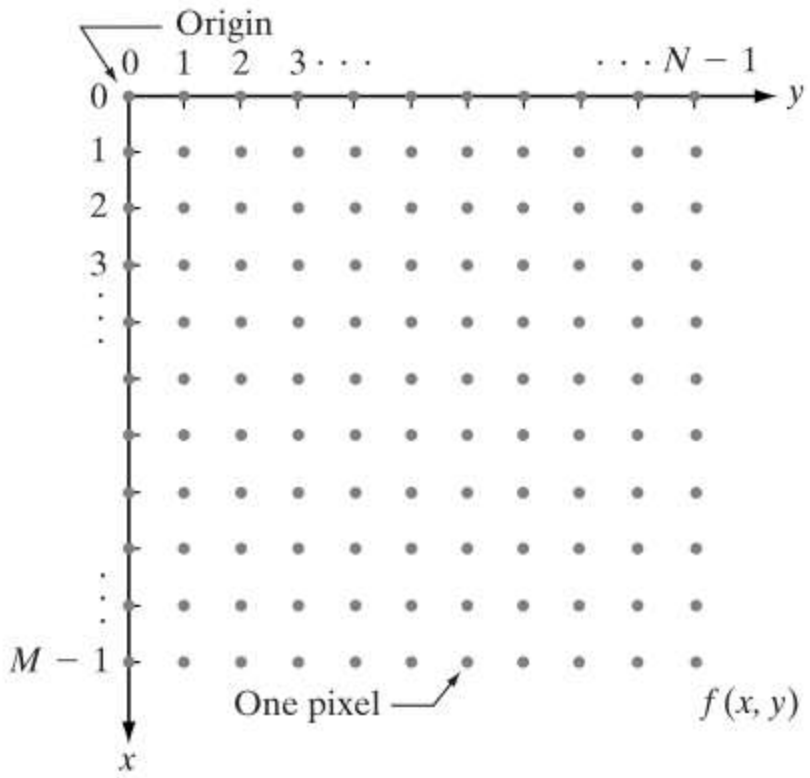


where *NxM (pixel)* and *G (number of gray levels)* is the integer power of 2 ($G=2^m$)

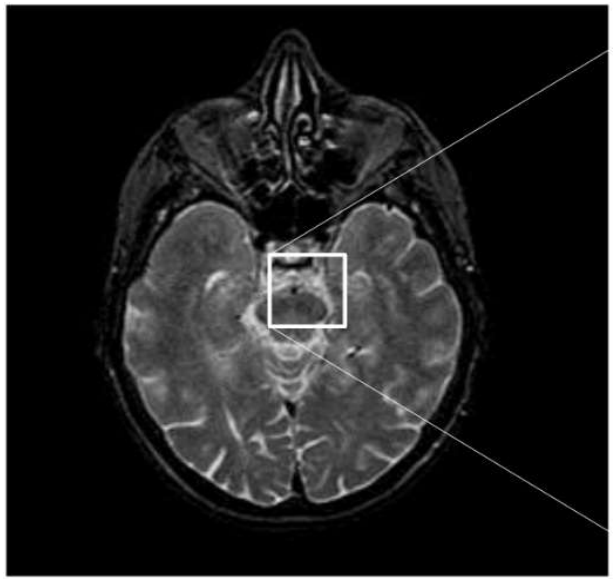
$$0 \le f(x,y) \le G-1$$

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

Image storage

- Memory size for storage: **b = MxNxm (bit)**

Where MxN: size of image; m: number of bits of gray level



173	145	141	170	159	146	165	211
124	99	121	173	174	158	182	223
78	94	120	144	140	140	145	163
116	139	127	115	149	160	129	112
130	129	104	97	131	146	146	142
88	81	73	76	86	86	104	147
72	70	74	80	61	61	72	115
68	71	73	72	75	75	72	75

Example

Given an image with 512x512 pixels, grey levels are 256 (2^m, m=8). Using this expression **b = NxNxm = 262.144 byte = 2.097.152 bit**

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Image resolution

The density of pixels in an image is viewed as its own resolution

Depending on size of an image

Original image

Fundamentals

Image resolution

A 1024x1024, 8-bit image subsampled down to size 32x32 pixels.

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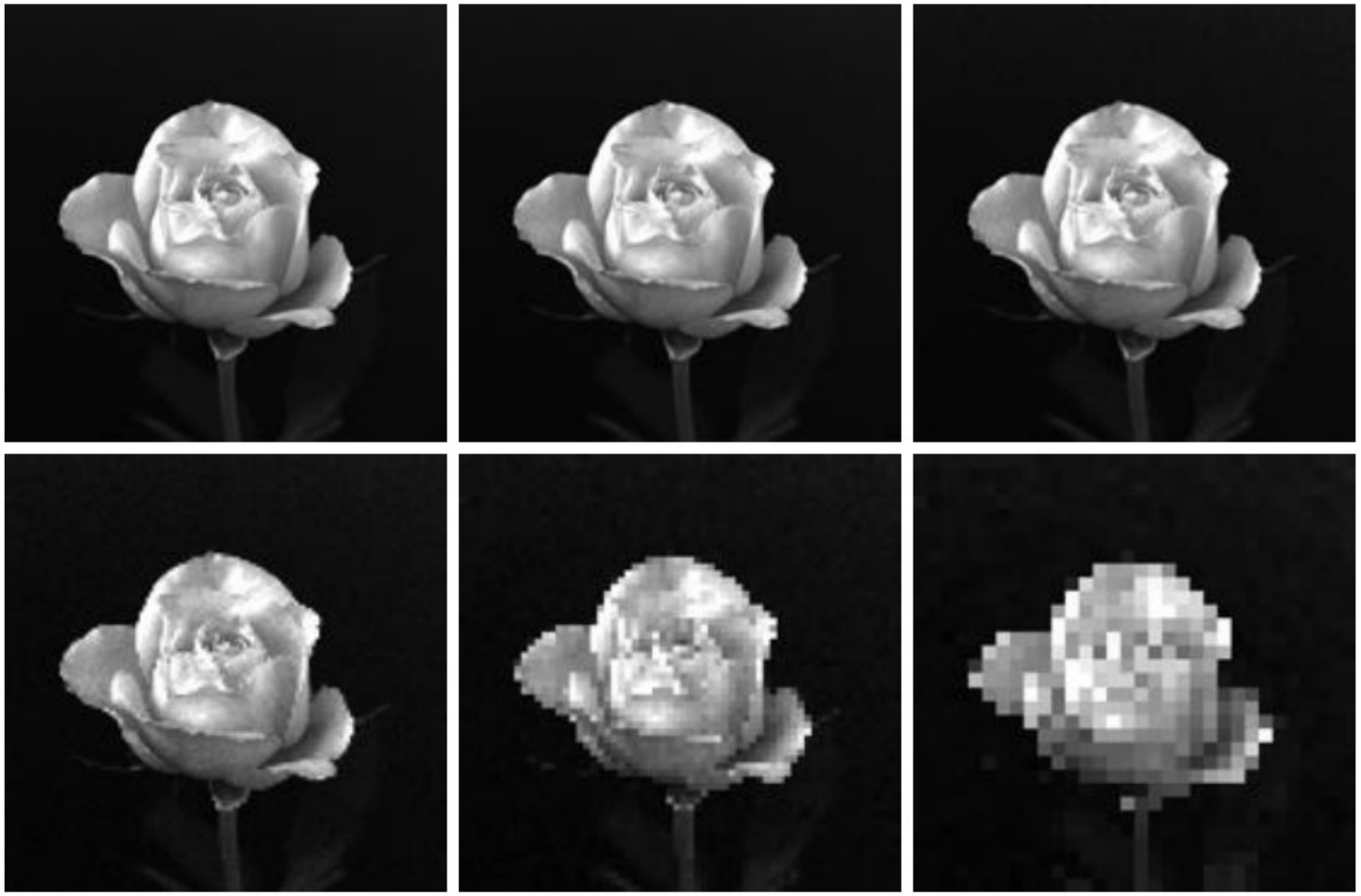
Image resolution



(a) 1024x1024, 8-bit image; (b) 512x512 image resampled into 1024x1024 pixels by row and column duplication; (c) through (f) 256x256, 64x64, and 32x32 images resampled into 1024x1024 pixels.

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Image resolution depending on the value of m (bit)

m=8 m=7 m=6

Fundamentals

Image resolution depending on the value of m (bit)

m=2 m=1

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Image compression is related to the image size and file size (image format used)

The size of the uncompressed original image is calculated using the formula:

$$b = \text{MxNxm (bit)}$$

m=*BitDepth: grey bit number*

$$I = \text{MxNxm/8 (byte)}$$

The compression ratio, CR is calculated as follows:

$$CR = I \,/\, FileSize$$

FileSize is the size of the image file in byte depending on the image format used

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Image compression is related to the image size and file size (image format used)

Example

Given the image with NxM=512x512 and 256 gray levels and the image has been compressed to be *Filesize*=11831. Calculate compression ratio, *CR* of the image after compressing

The compression ratio of the image, *CR* is calculated as follows:

$$I = M \text{ x } N \text{ x } m / 8 = 512 \times 512 \times 8 / 8 = 2^{18}$$

$$CR = I / Filesize = 2^{18} / 11831 \approx 22.15$$

More examples

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Problem 1

Given an image with M=1024x512 pixels, grey levels are 2^m , m=16. Calculate the memory bit of the image.

Problem 2

Given an image with MxN=512x256 pixels, grey levels are 256 (2^m , m=8). Calculate memory size in byte and bit?

Problem 3

Given an image with NxM pixels, in which grey levels m=10 and N=1024. Determine M=?, if $b=50x2^{15}$ byte.

Problem 4

Given an image f with M= 2 Mega pixels and N= 4 Mega pixels, grey level is m=8 and CR=64. Determine:

a. Capacity of image, *I* (byte) to save this image.

b. Filesize of image in byte

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The End