Lecture 1 - Introduction

Digital Image Processing

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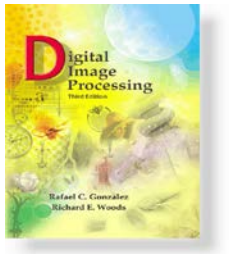
Textbook



Digital Image Processing, 3rd edition, Rafael C. Gonzalez & Richard E. Woods,. 2007, Pearson.

数字图像处理（第三版）
作者:（美）Rafael C. Gonzalez（拉斐尔 C. 冈萨雷斯），Richard E. Woods（理查德 E. 伍兹）著,
出版社: 电子工业出版社

Reference book

数字图像处理基础

作者：阮秋琦

出版社：清华大学出版社

数字图像处理（第2版）

作者：李俊山，李旭辉

出版社：清华大学出版社

数字图像处理（MATLAB版）（第二版）

作者:（美）Rafael C. Gonzalez（拉斐尔 C. 冈萨雷斯）

出版社: 电子工业出版社

Schedule

Week	Date	Topic	Reading	Homework
1	09月18日	Introduction	CH1	
	09月20日	Image fundamentals - Sampling and Quantization	CH2.4	
2	09月25日	Image fundamentals - Pixels	CH2.5	Release: 9/20
	09月27日	Image fundamentals - Operation	CH2.6	Due: 10/9
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15	12月25日	Review		
	12月27日	Final presentation		
16	01月03日	Final presentation		

Assessment

- **Homework (5%*6=30%)**
  - Every 2~3 weeks;
  - Handwriting & Hard copy & Electronic copy & Matlab Codes
  - Due date: the next Tuesday;
- **Midterm (25%) :** Date: 11/6, 90 minutes
- **Quiz (10%) :** missing twice -5%; missing more than twice : -10%
- **Final Project (35%)**
  - Proposal (English) : 400 words including background, objectives and methods; Due date: 11/11.
  - Presentation: 5 minutes; Date: Week 15& 16; PPT in English.
  - Project report (English) : ⩾4000 words following the format of IEEE Transaction; ⩾15 references, Coding⩾100 lines; Due date: 1/10 (the end of Week 17)
  - Course will be failed if the final report is missing

Lecture 1 - Introduction

This lecture will cover:

- What is a digital image?
- What is digital image processing?
- Examples of digital image processing
- Steps of digital image processing
- Methods of digital image processing

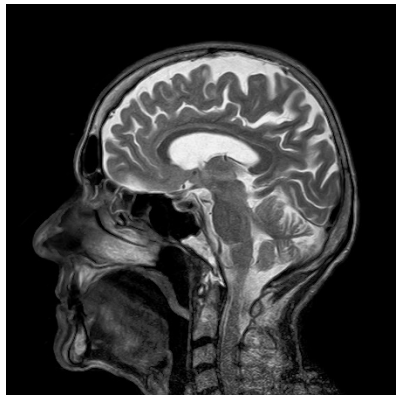
Image

① **A reproduction or imitation of form of a person or thing.**

② **The optical counterpart of an object produced by a lens, mirror, etc.**

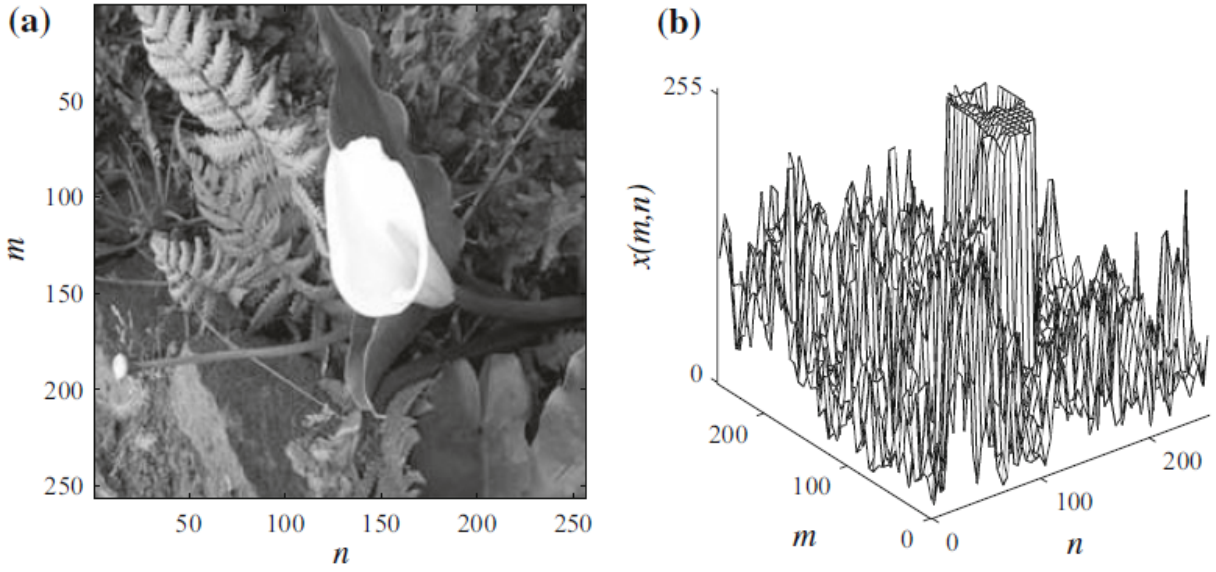
.....Noah Webster






Digital image

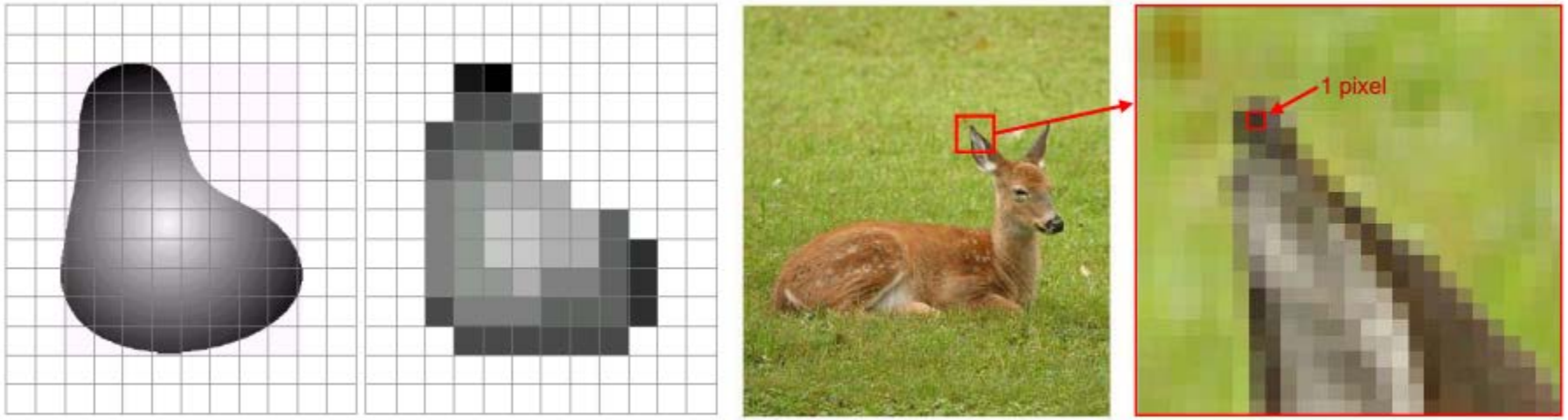
- **A visual representation in form of a function *f*(*x*,*y*), where**
  - *f* is related to the intensity or brightness (color) at point
  - (*x*, *y*) are spatial coordinates
  - *x*, *y*, and the amplitude of *f* are finite and discrete quantities



(a) A 256X256 image with 256 gray levels; (b) its amplitude profile

Pixel

- Composed of a finite number of elements - Pixel
- A pixel has a location and intensity information typically represent gray levels, colors, heights, opacities, etc.
- Digitization implies that a digital image is an approximation of a real scene.



The digitized intensity and location value of image Pixel

Digital image

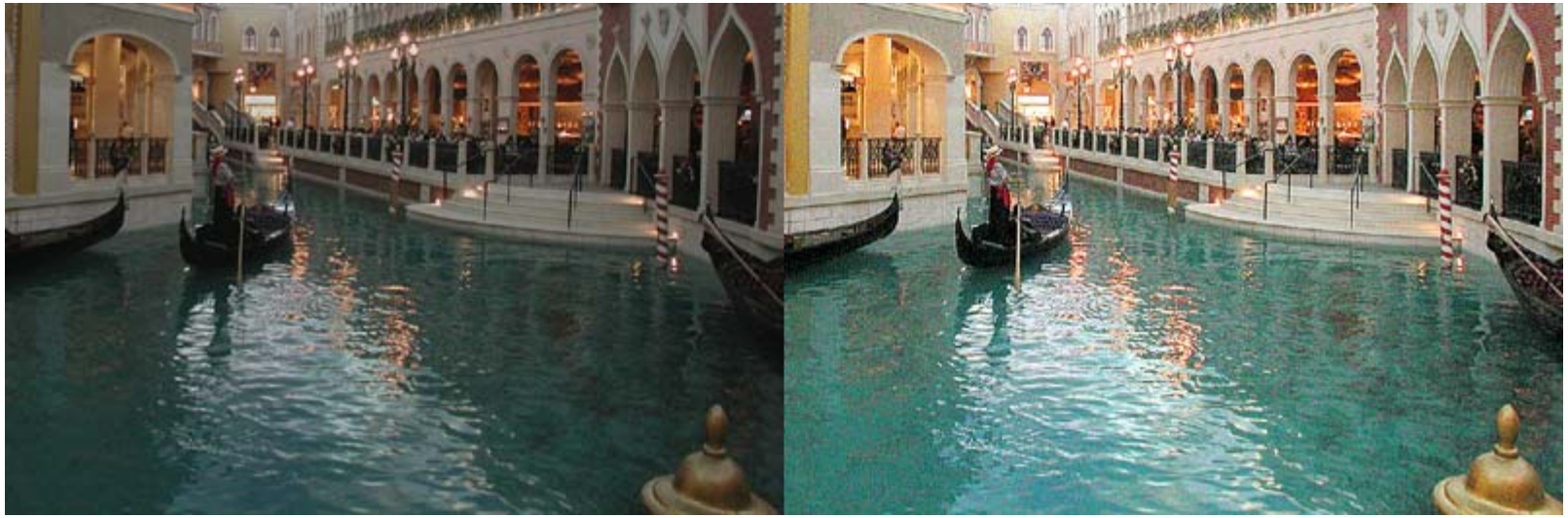
Images that have more than two coordinate dimensions,

- f [x, y, z] 3-D monochrome image (e.g., optical hologram)
- f [x, y, t] time-varying monochrome image over continuous time domain
- f [x, y, tn] time-varying monochrome image with discrete time samples (cinema)
- f [x, y, λ] spectral image with continuous domain of wavelengths
- f [x, y, λn] multispectral image, discrete set of wavelengths
- f [x, y, tn, λm] discrete samples in time and wavelength, e.g., color movie
- f [x, y, z, t, λ] reality

Digital image processing

Definition: <u>Processing digital images by means of a digital computer.</u>

AKA: Computer image processing



Digital image processing

Digital image processing vs Computer graphics (CG)?

Goal

Why do we need image processing

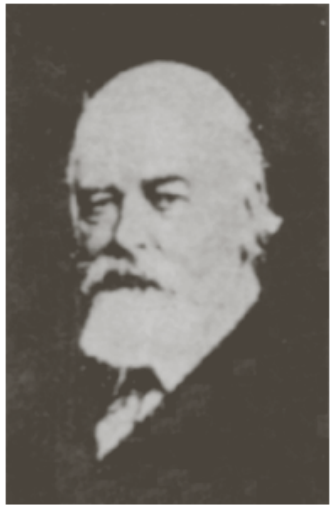
- Improvement of pictorial information for human interpretation
- Processing of image data for autonomous machine perception
  - Storage
  - Transmission
  - Representation
  - Description
  - Recognition
  - …… Many more.

Image processing is ubiquitous!

History of image processing

Early stage of digital image

A digital picture produced from a coded tape in 1921



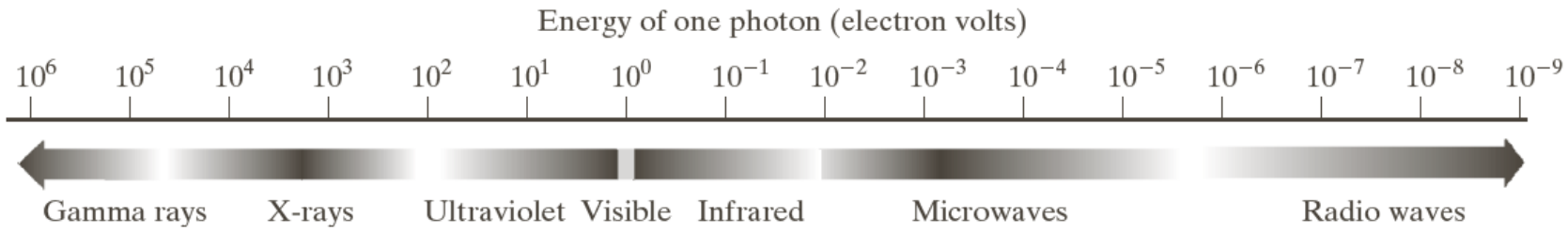
A digital picture from a tape punched after the signal had crossed the Atlantic twice in 1922

Unretouched cable picture transmitted from London to New York by 15-tone equipment in 1929

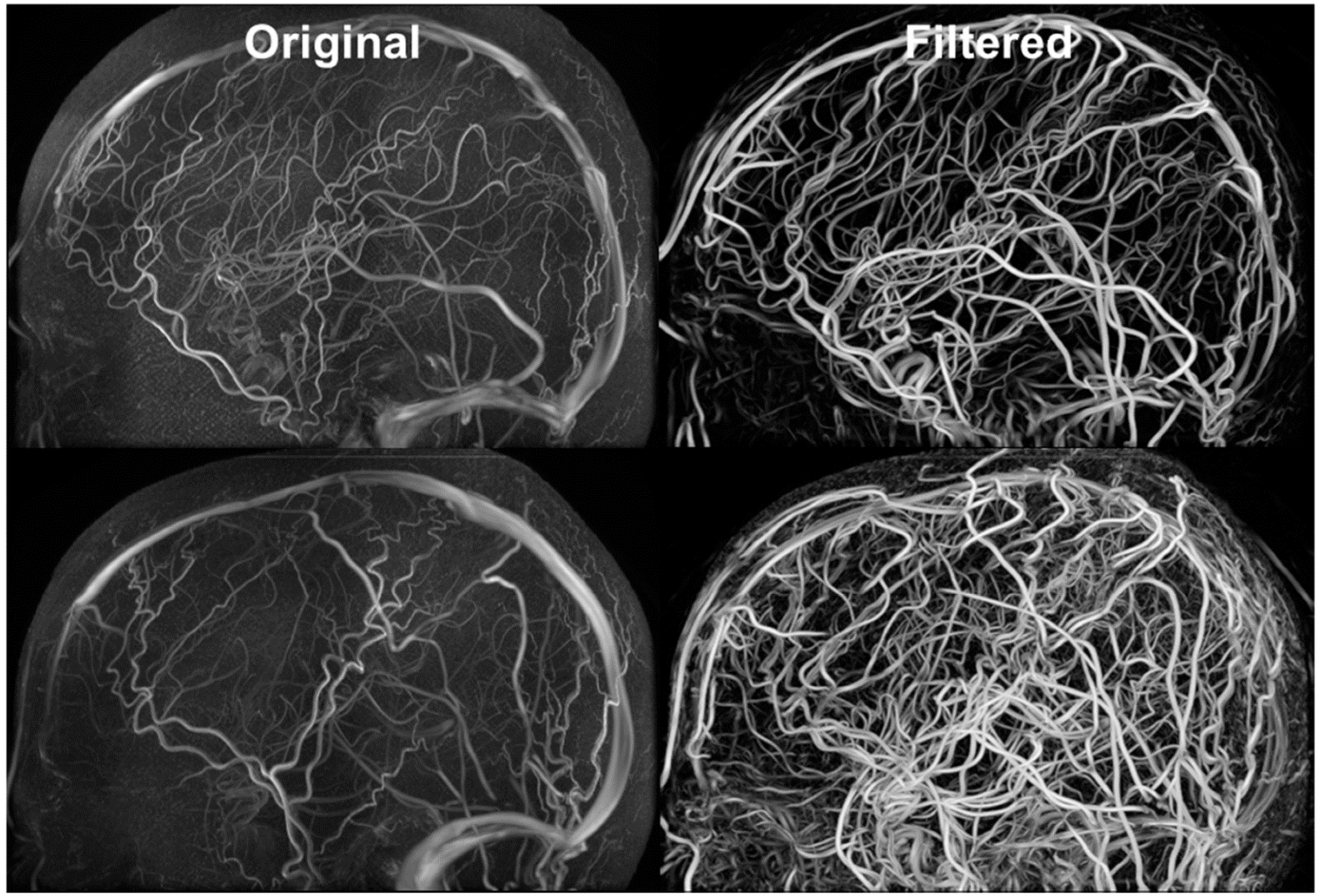
History of image processing

Modern digital image processing

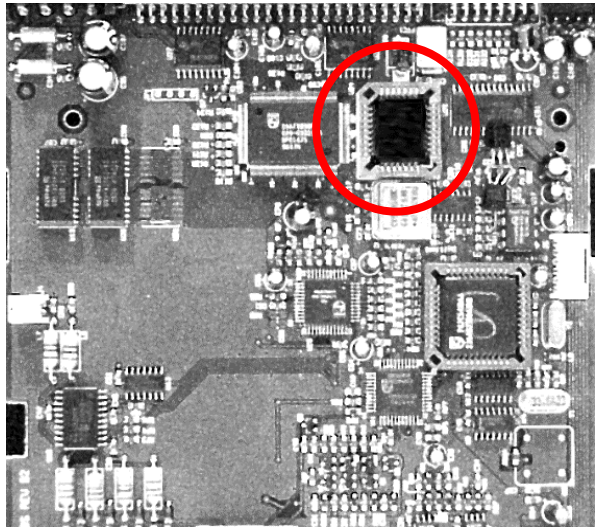
- 1960s - Improvements in computing technology and develop of the space program
- 1970s – Medical application
- Until present, digital image processing techniques has been explored to
  - All kinds of tasks
  - All kinds of areas
  - All kinds of sources

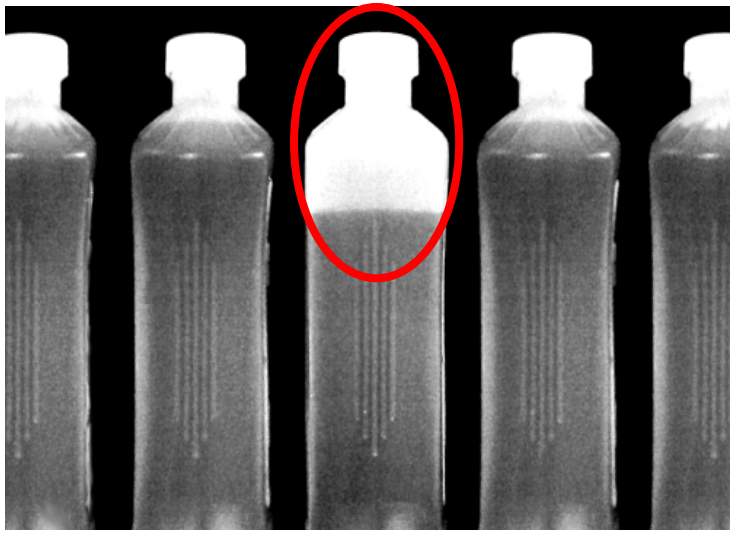


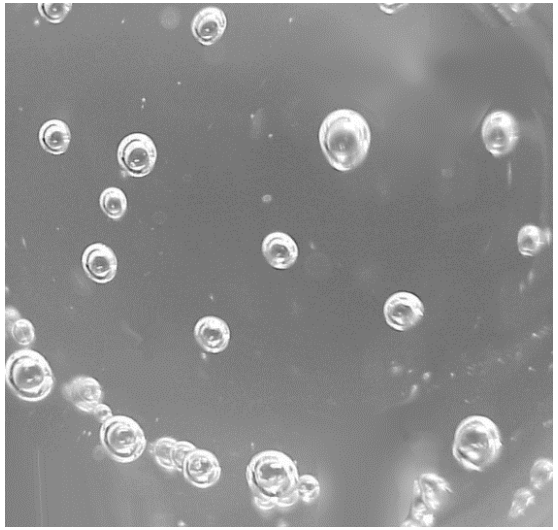
Application - Medicine



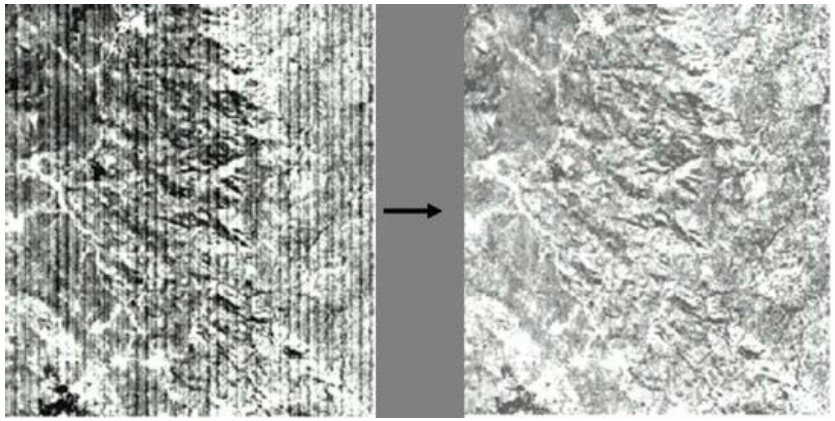
Application - Industry

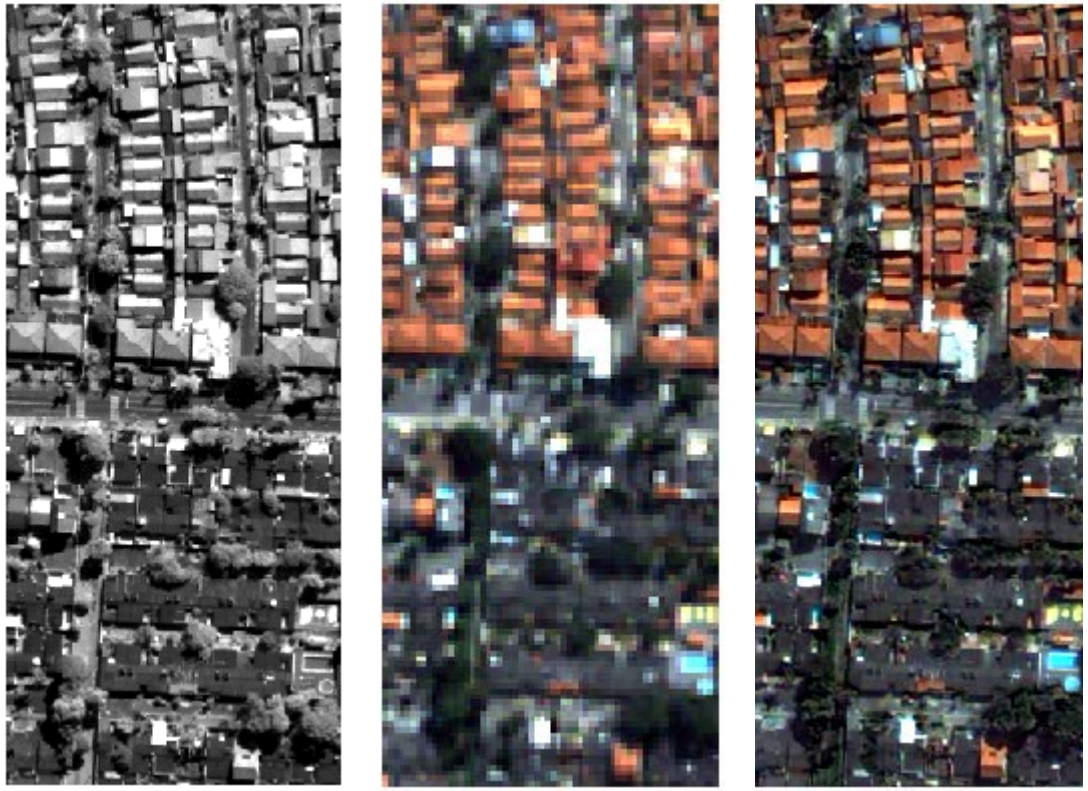




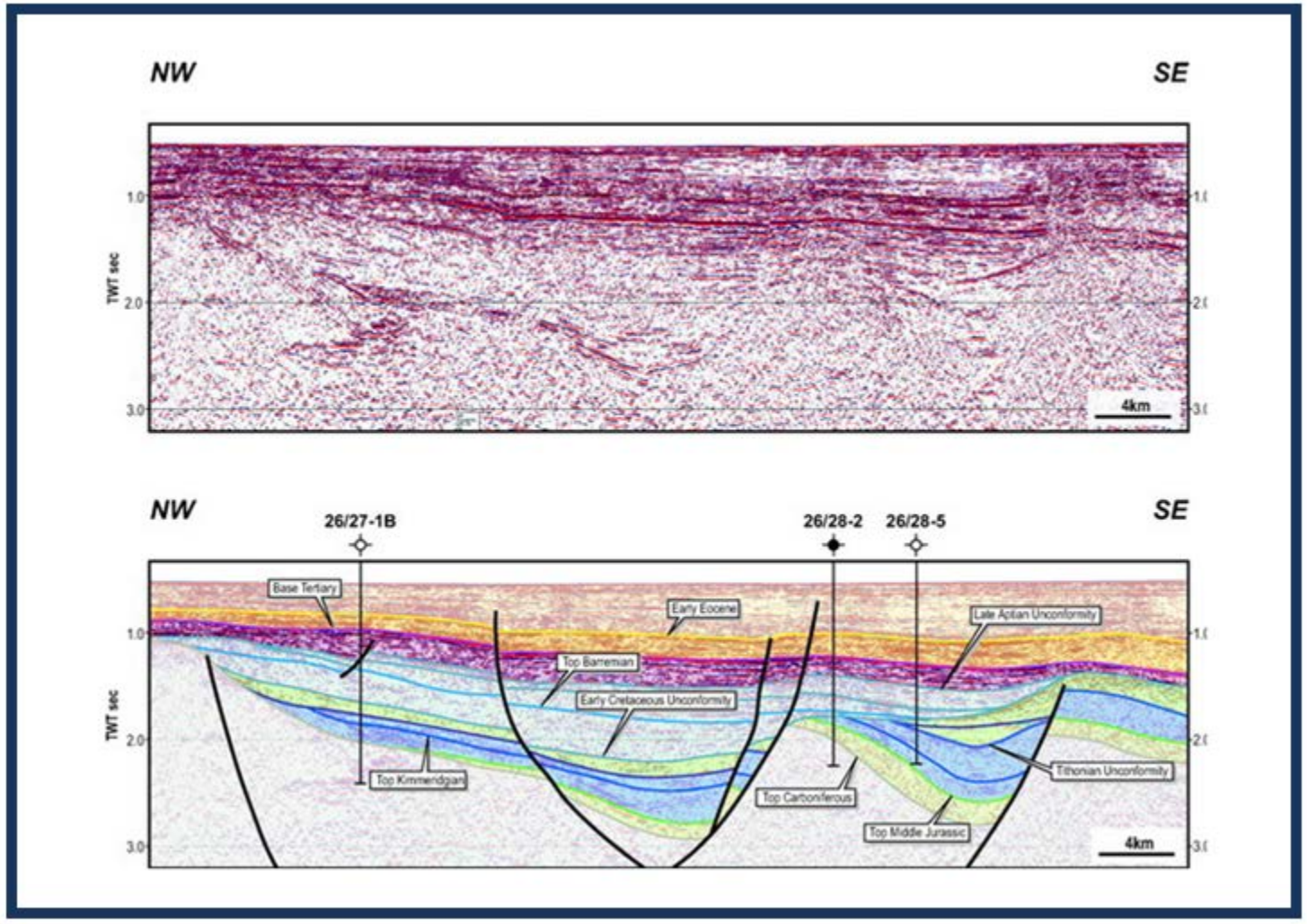


Application – Remote sensing

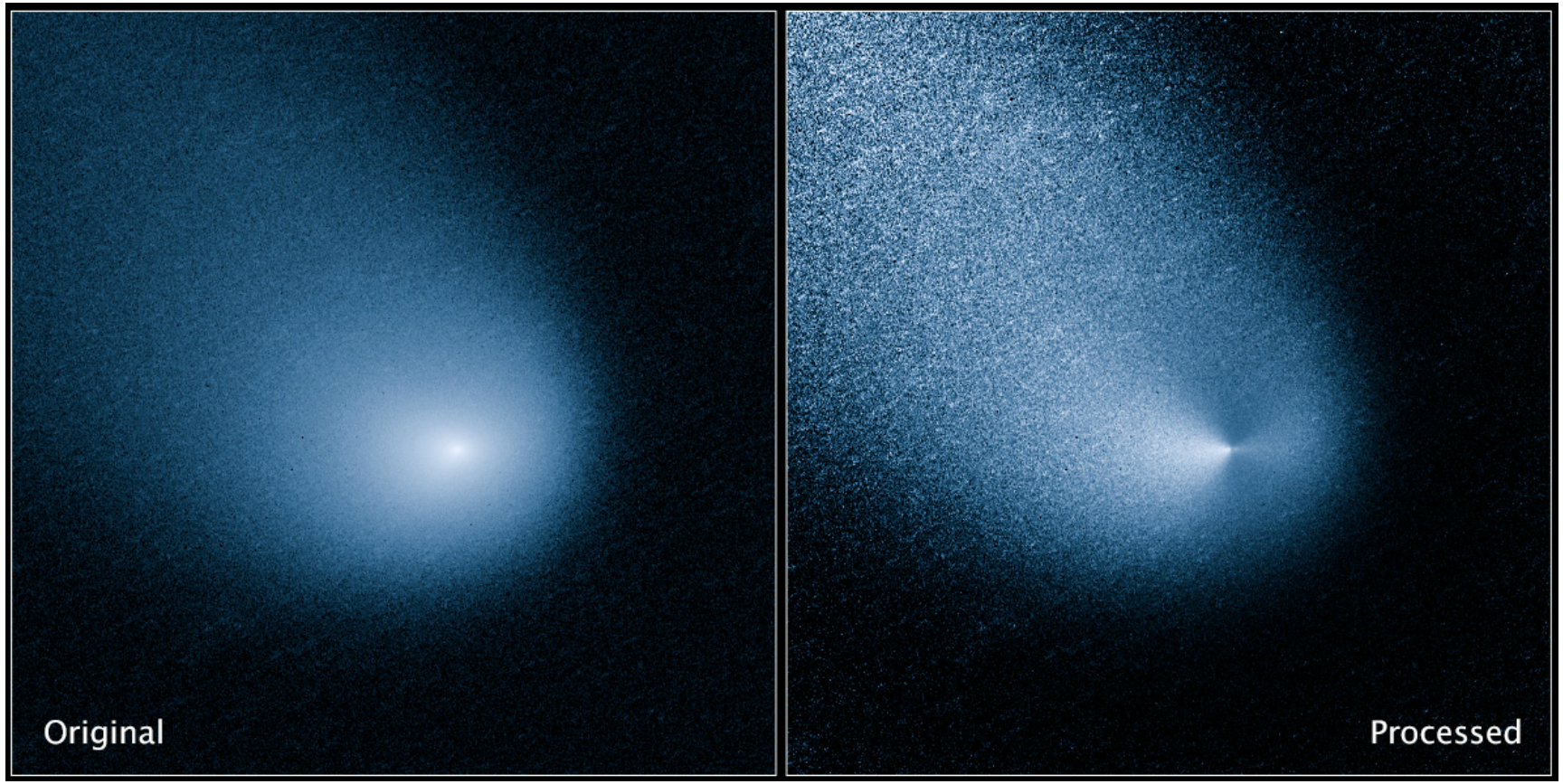




Application – Seismic imaging

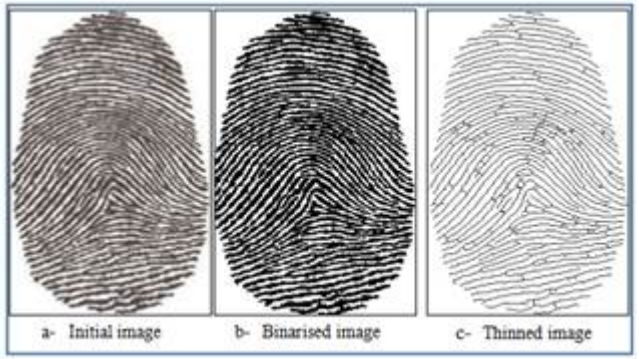


Application – Astronomical image

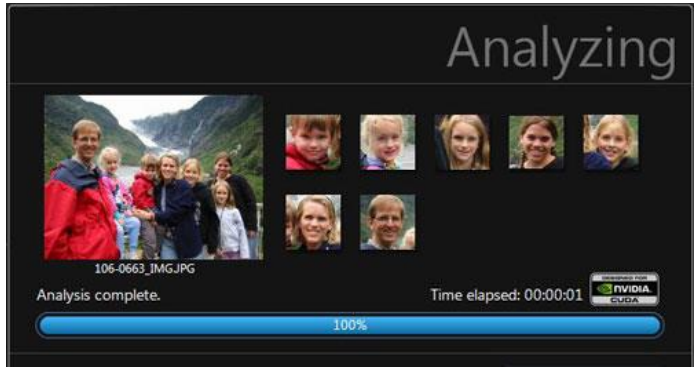


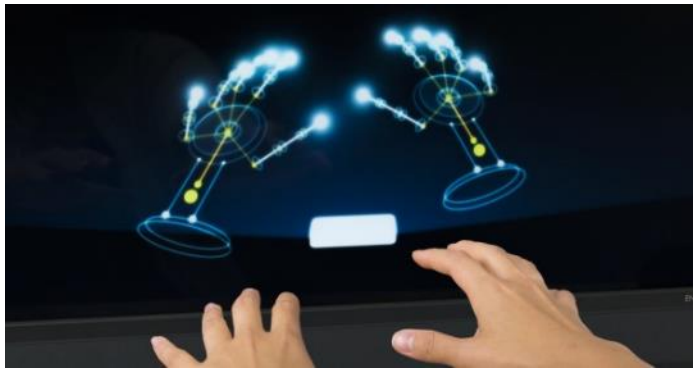
Application – Law enforcement

- Enhancement of CCTV footage
- License plate number recognition
- Face recognition
- Finger print recognition …etc



Application – HCI





Human Computer Interface

- Face recognition
- Gesture recognition
- Optical character recognition (OCR)
- Autonomous vehicles

Stage of DIP

Low level process	Mid level process	High level process
INPUT: Image **OUTPUT:** Image **EXAMPLE:** Denoise Contrast enhancement Image sharpening	**INPUT:** Image **OUTPUT:** Attributes **EXAMPLE:** Segmentation Description Recognition	**INPUT:** Attributes **OUTPUT:** Understanding **EXAMPLE:** Image analysis Image understanding

There are no clear-cut boundaries
from image processing to computer vision

Fundamental Steps in DIP

- Image acquisition
- Image enhancement
- Image restoration
- Image reconstruction
- Image compression
- Image segmentation
- Image representation and description
- Object recognition

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Applied methods in DIP

- **Spatial domain**
  - Pixel processing – grey processing
  - Neighborhood processing – gradient algorithm, Laplacian operator, smoothing operator, convolution algorithm
- **Frequency domain**
  - Discrete Fourier Transform (DFT)
  - Discrete Cosine Transform (DCT)
  - Discrete Wavelet Transform (DWT)
  - Walsh-Hadamard Transform (WHT)

Tools: Orthogonal transformation, Filtering, Convolution, Statistics etc.

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