Pengantar Pengolahan Citra

(Bagian 2)

IF4073 Interpretasi dan Pengolahan Citra

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Computer Vision

- *Computer vision* merupakan proses otomatis yang mengintegrasikan sejumlah besar proses untuk persepsi visual, seperti akuisisi citra, pengolahan citra, klasifikasi, pengenalan (*recognition*), dan membuat keputusan.

- *Computer vision* terdiri dari teknik-teknik untuk mengestimasi ciri-ciri objek di dalam citra, pengukuran ciri yang berkaitan dengan geometri objek, dan menginterpretasi informasi geometri tersebut.

- *Vision = Geometry + Measurement + Interpretation*

- Pada hakikatnya, *computer vision* mencoba meniru cara kerja sistem visual manusia (*human vision*).

- *Human vision* sesungguhnya sangat kompleks. Manusia melihat objek dengan indera penglihatan (mata), lalu citra objek diteruskan ke otak untuk diinterpretasi sehingga manusia mengerti objek apa yang tampak dalam pandangan matanya.

- Hasil interpretasi ini mungkin digunakan untuk pengambilan keputusan (misalnya menghindar kalau melihat mobil melaju di depan).

- Proses-proses di dalam *computer vision* dapat dibagi menjadi tiga aktivitas:
  1. Memperoleh atau mengakuisisi citra digital.
  2. Melakukan teknik komputasi untuk memperoses atau memodifikasi data citra (operasi-operasi pengolahan citra).
  3. Menganalisis dan menginterpretasi citra dan menggunakan hasil pemrosesan untuk tujuan tertentu, misalnya memandu robot, mengontrol peralatan, memantau proses manufaktur, dan lain-lain.

- Proses-proses di dalam *computer vision* dalam hirarkhi sebagai berikut :

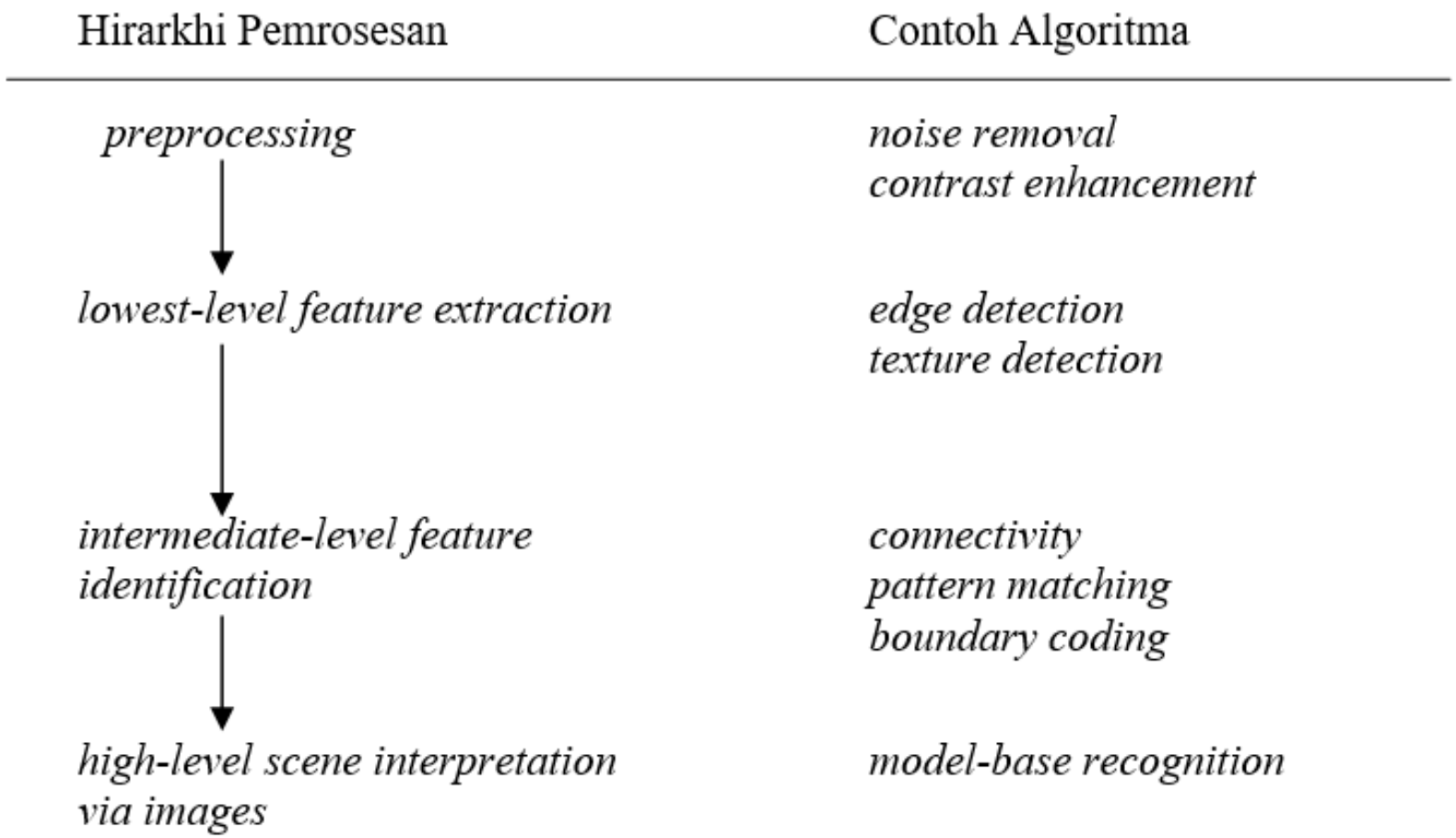
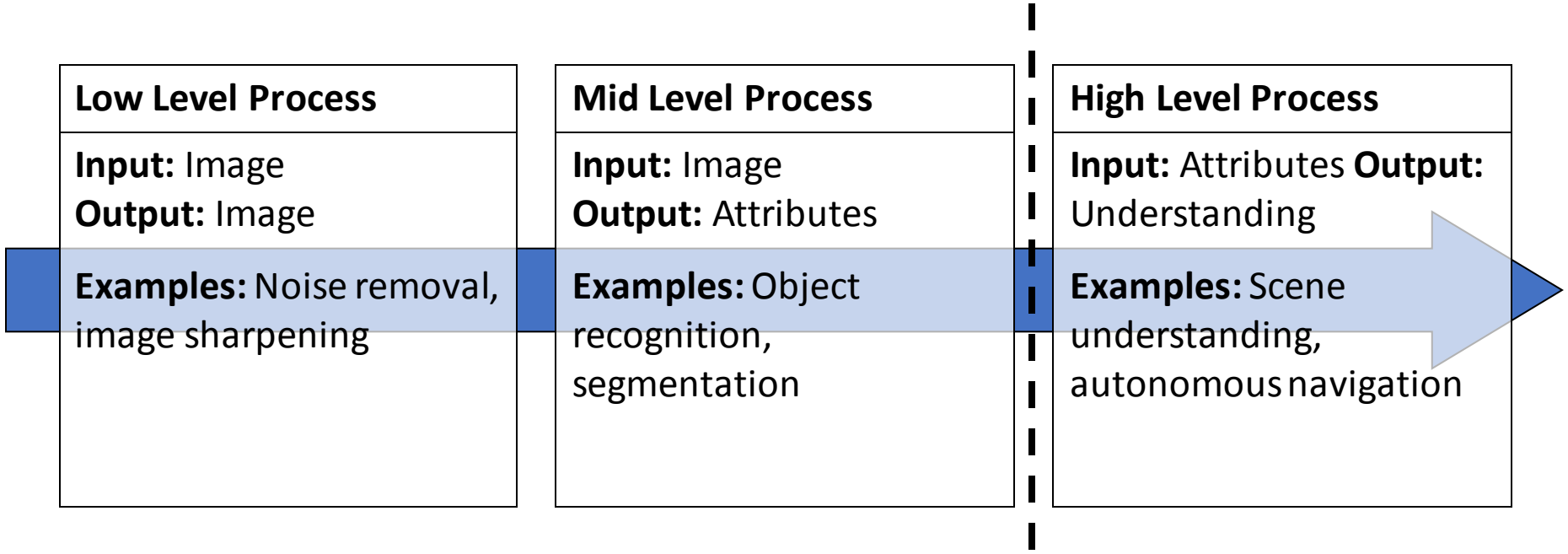


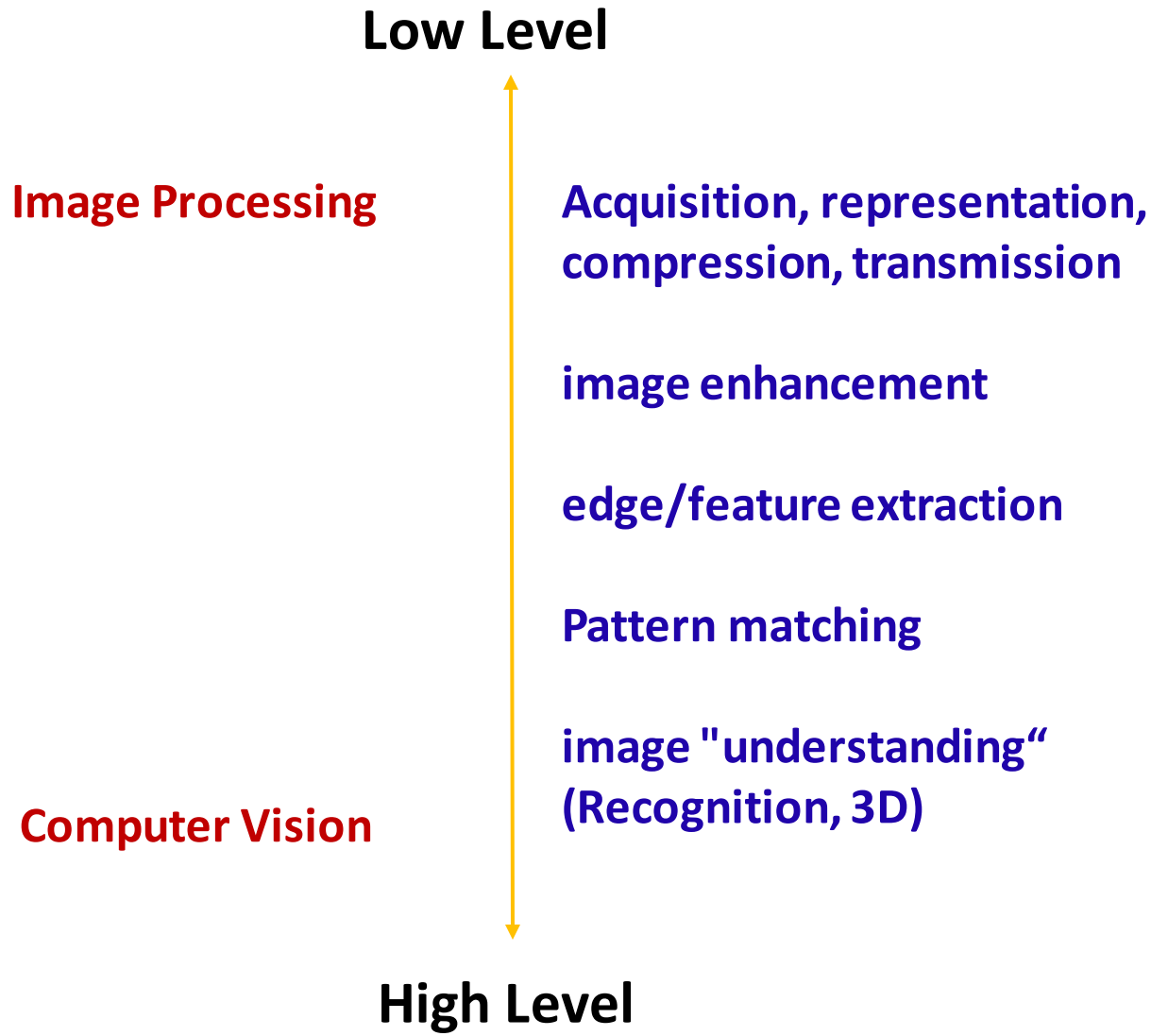
Image Processing → Computer Vision

• Rangkaian kesauan dari *image processing* ke *computer vision* dapat dipecah menjadi low-, mid- dan high-level processes



Sumber: Yacov Hel-Or, *Image Processing*, Spring 2010

Image Processing v.s. Computer Vision



Sumber: Yacov Hel-Or, *Image Processing*, Spring 2010

Image Acquisition
License Plate Extraction
License Plate Segmentation
Character Recognition
JRE 366
JRE366

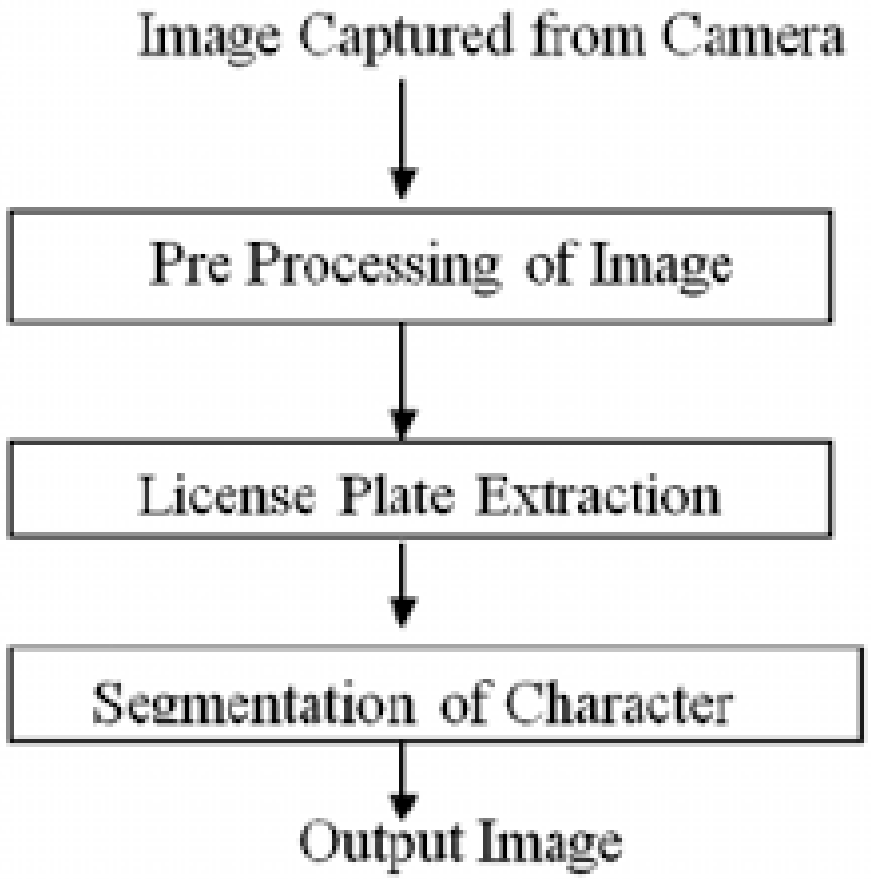
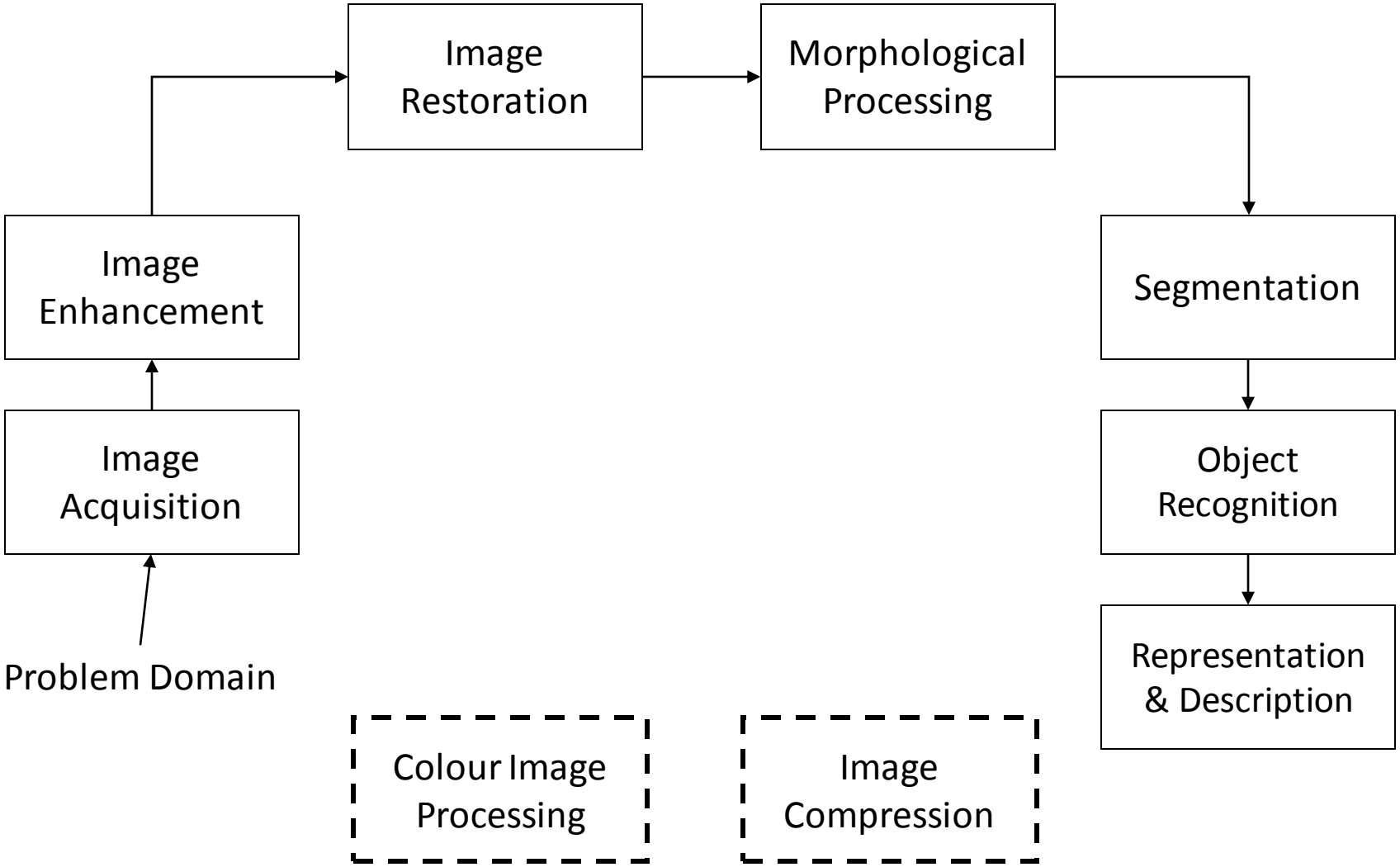


Image Captured from Camera
Pre Processing of Image
License Plate Extraction
Segmentation of Character
Output Image

Sumber: Yacov Hel-Or, *Image Processing*, Spring 2010

Key Stages in Digital Image Processing



Key Stages in Digital Image Processing: Image Aquisition

Sumber: Yacov Hel-Or, *Image Processing*, Spring 2010

Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Image Restoration

Morphological Processing

Image Enhancement

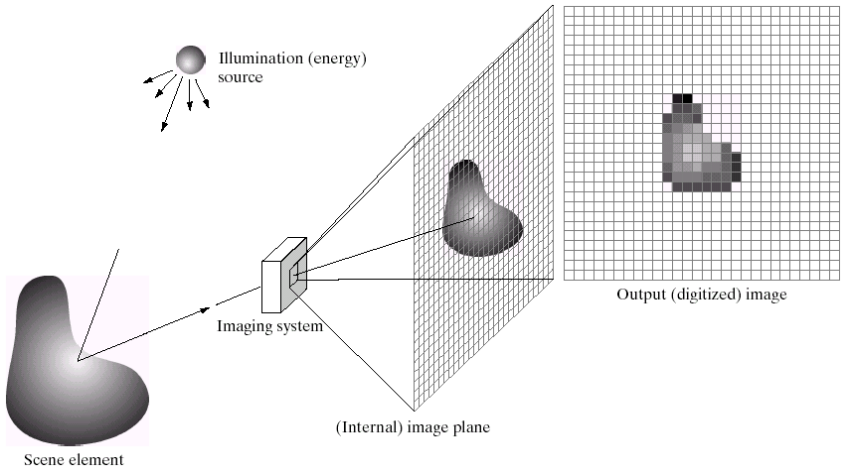
Segmentation

Image Acquisition

Object Recognition

Problem Domain

Representation & Description

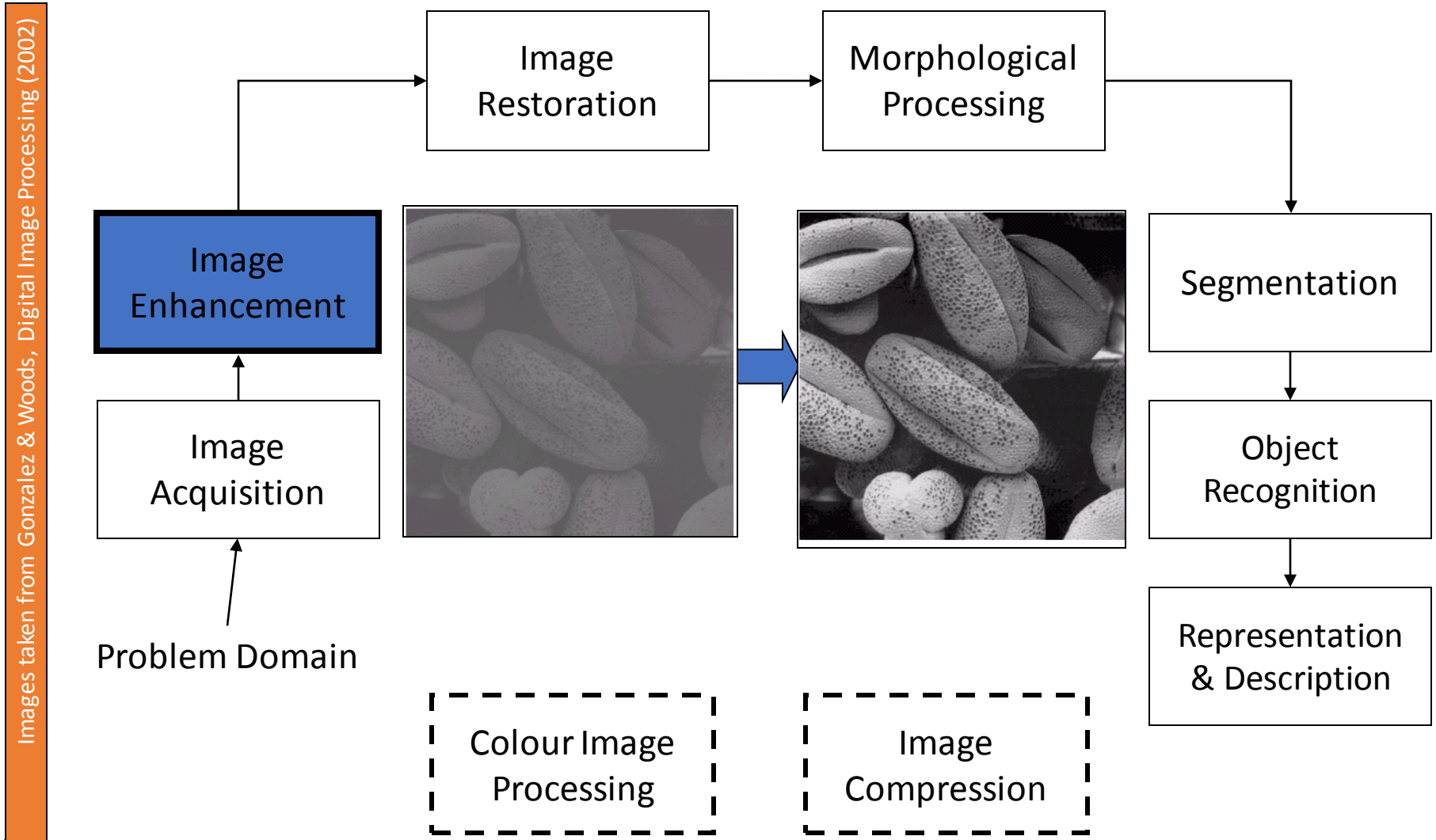


Colour Image Processing

Image Compression

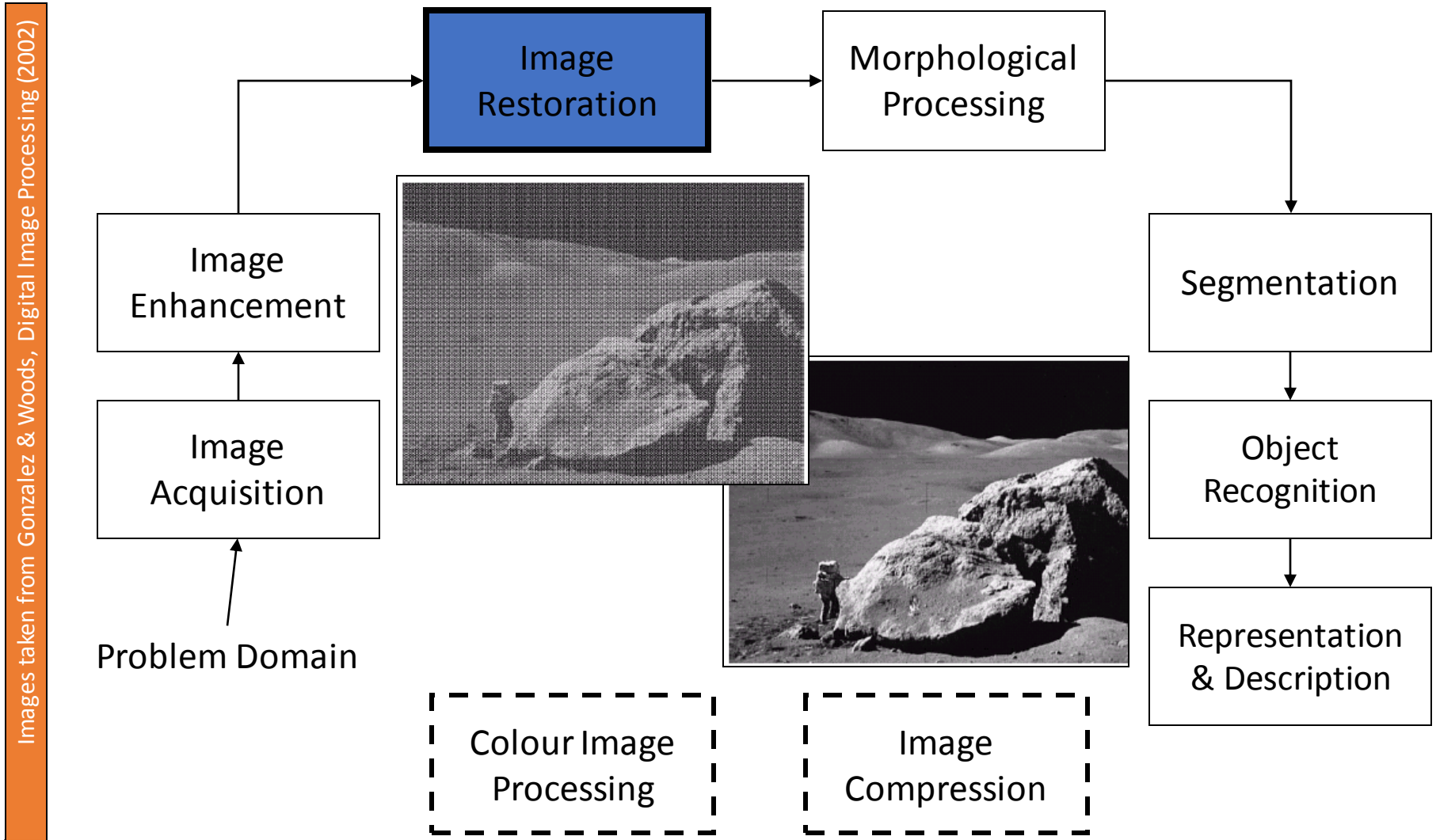
Key Stages in Digital Image Processing: Image Enhancement

Sumber: Yacov Hel-Or, *Image Processing*, Spring 2010



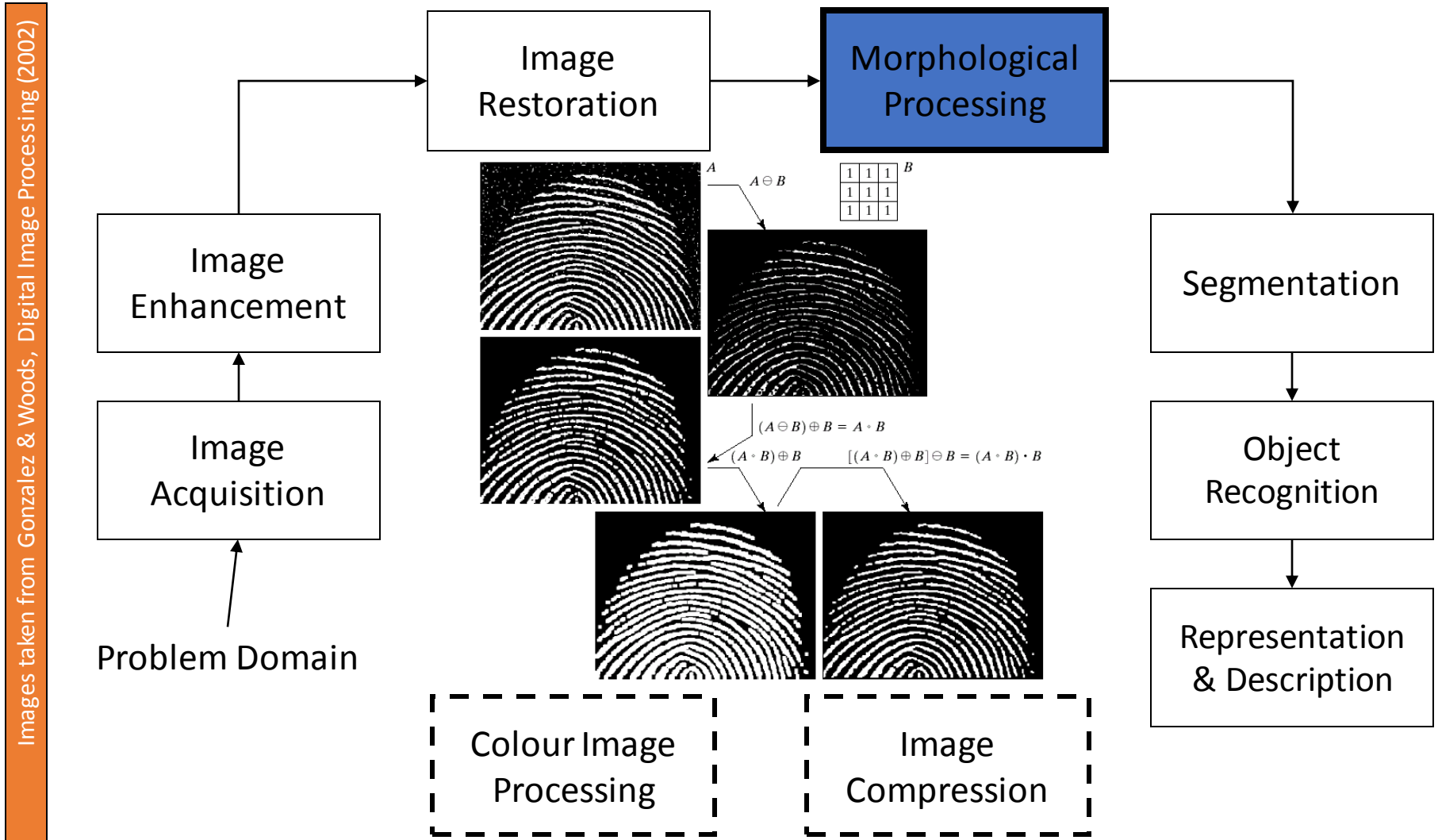
Key Stages in Digital Image Processing: Image Restoration

Sumber: Yacov Hel-Or, *Image Processing*, Spring 2010



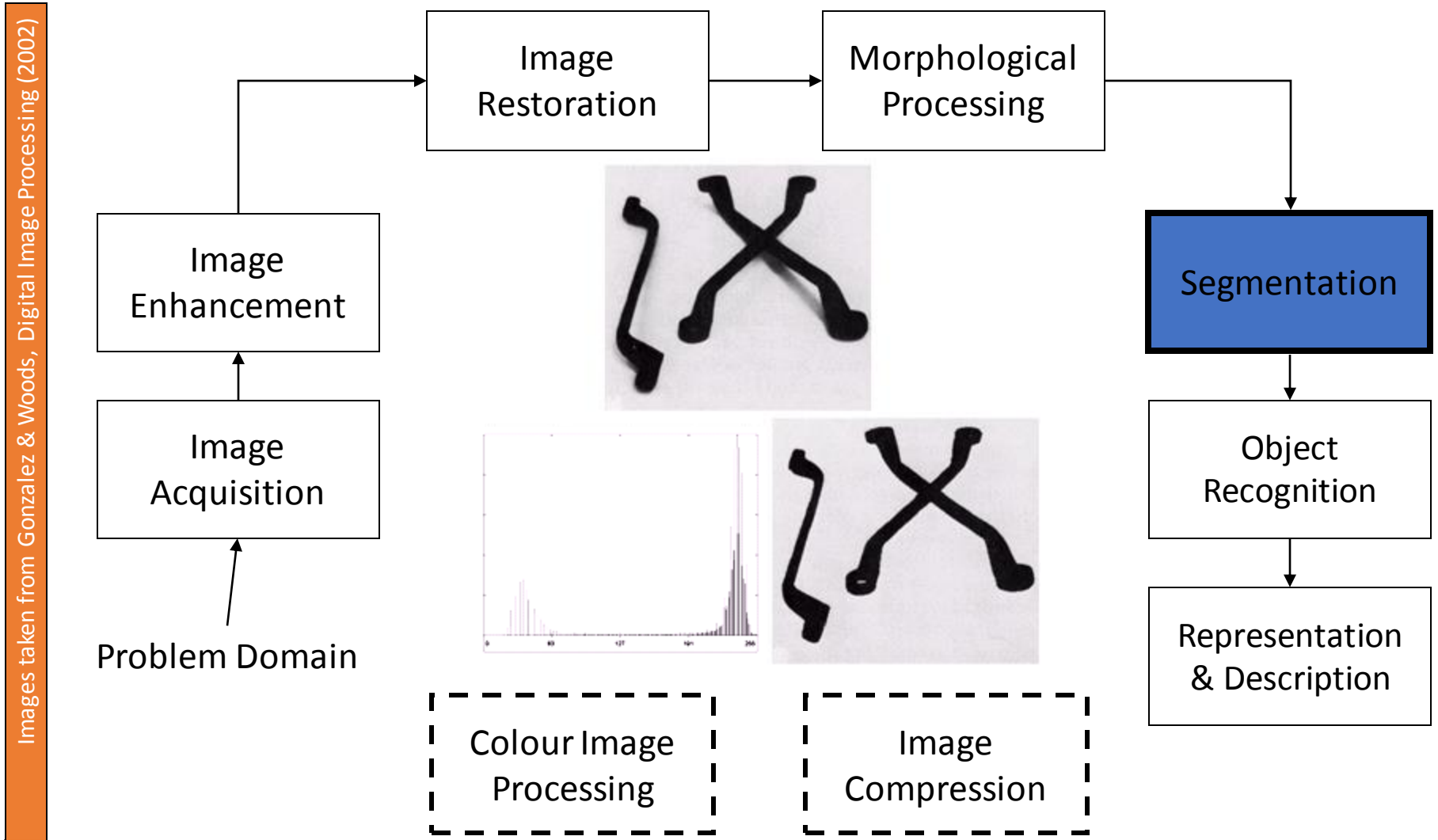
Key Stages in Digital Image Processing: Morphological Processing

Sumber: Yacov Hel-Or, *Image Processing*, Spring 2010



Key Stages in Digital Image Processing: Segmentation

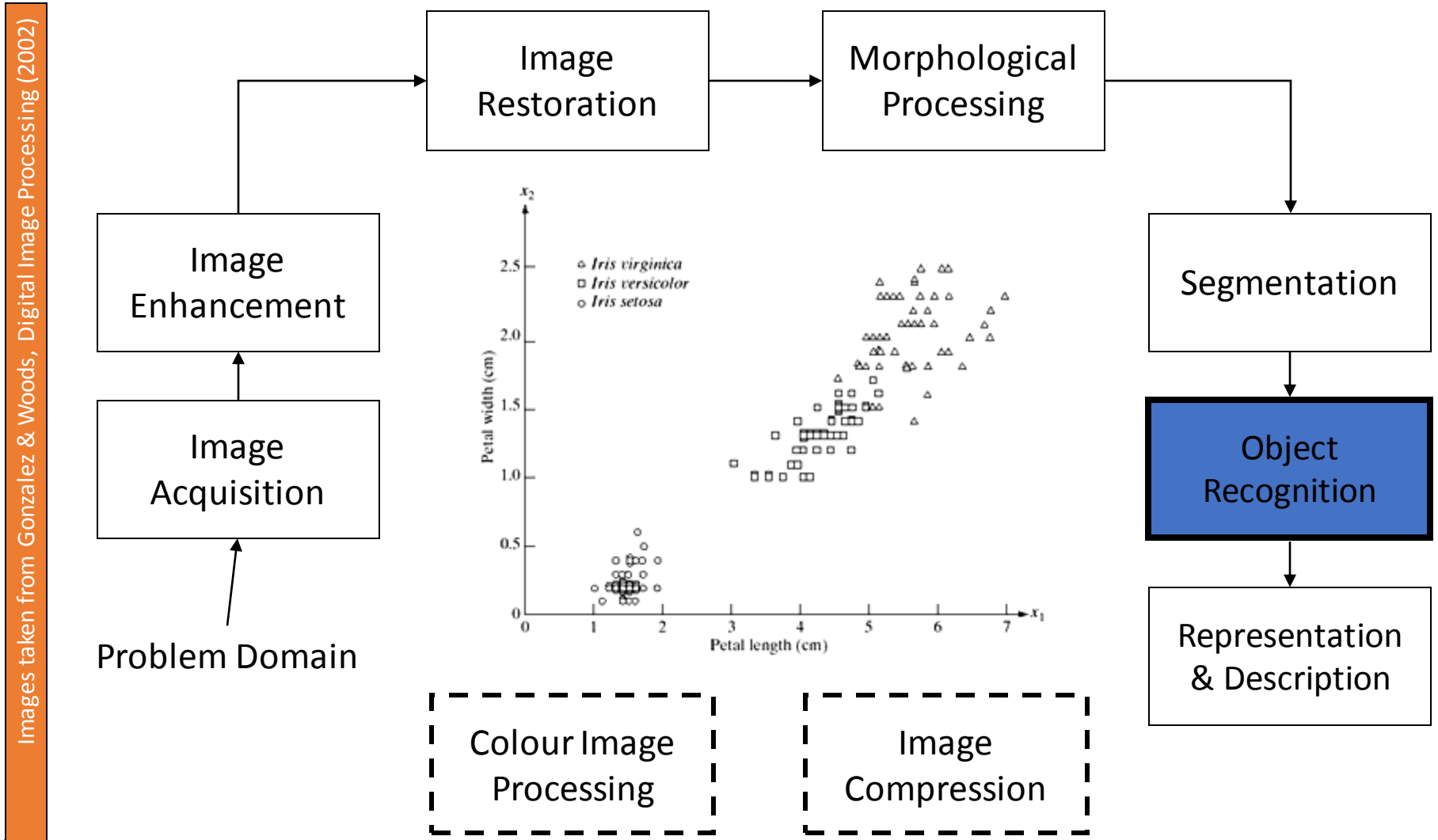
Sumber: Yacov Hel-Or, *Image Processing*, Spring 2010



Key Stages in Digital Image Processing: Object Recognition

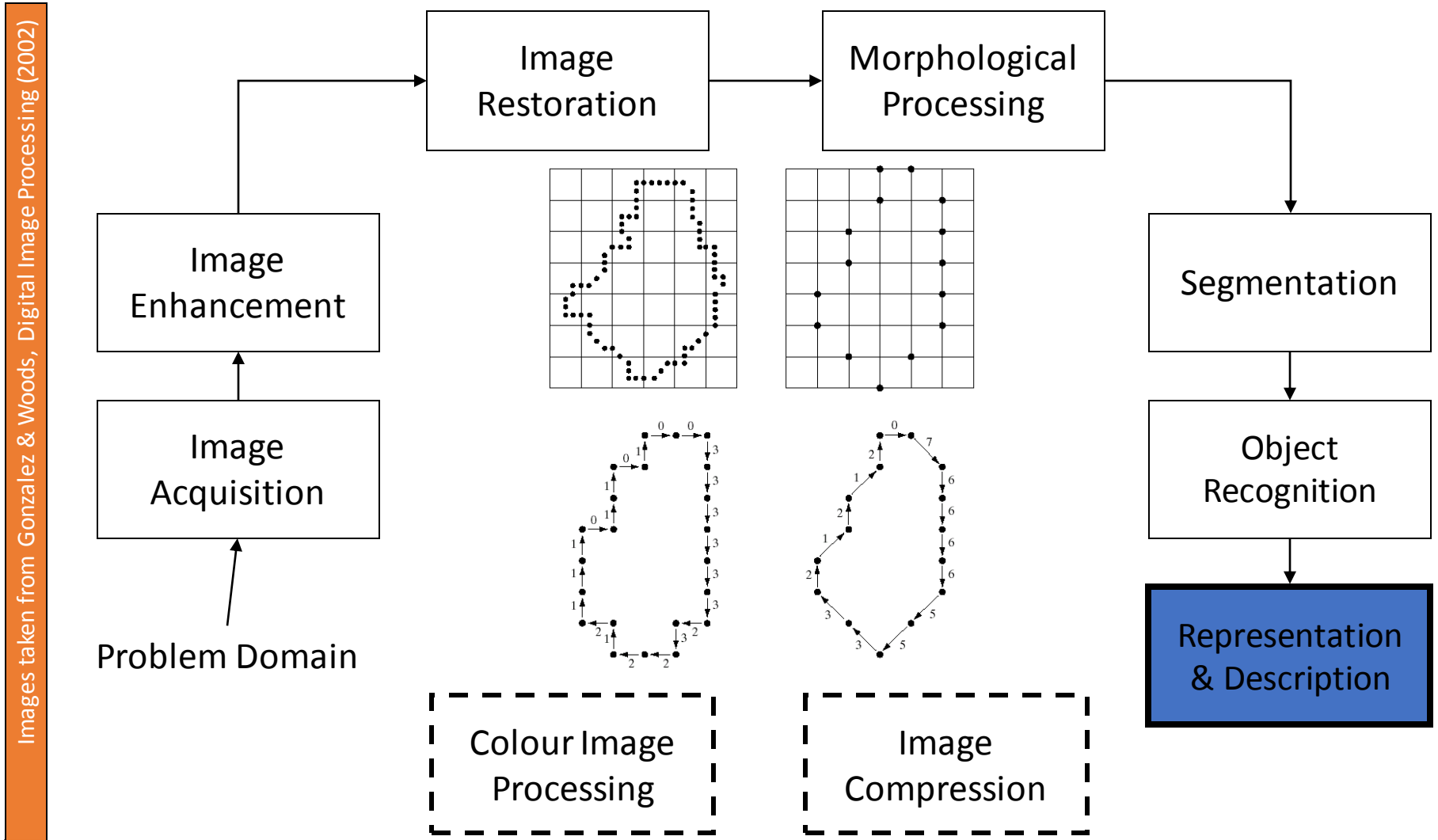
Sumber: Yacov Hel-Or, *Image Processing*, Spring 2010

Images taken from Gonzalez & Woods, Digital Image Processing (2002)



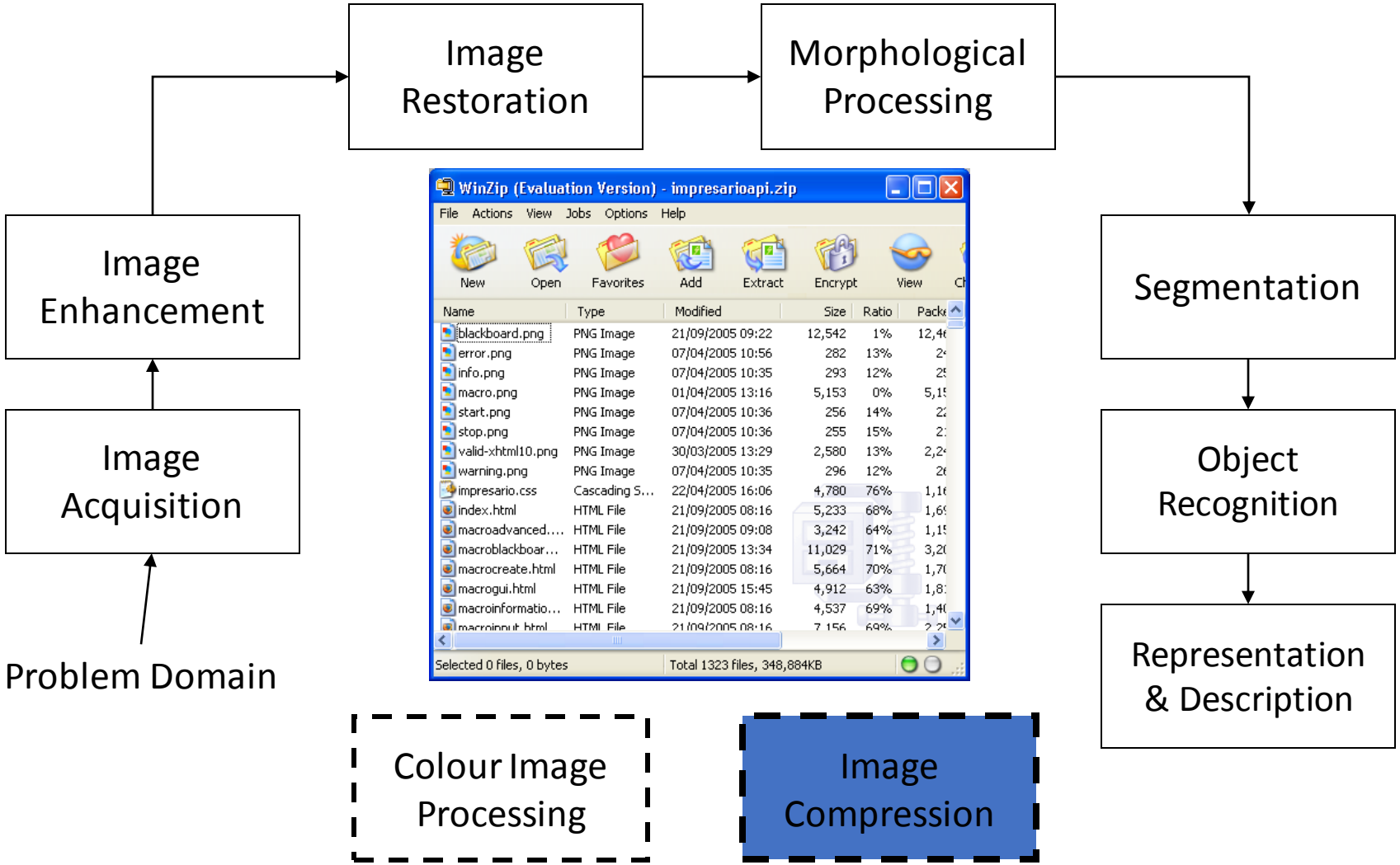
Key Stages in Digital Image Processing: Representation & Description

Sumber: Yacov Hel-Or, *Image Processing*, Spring 2010



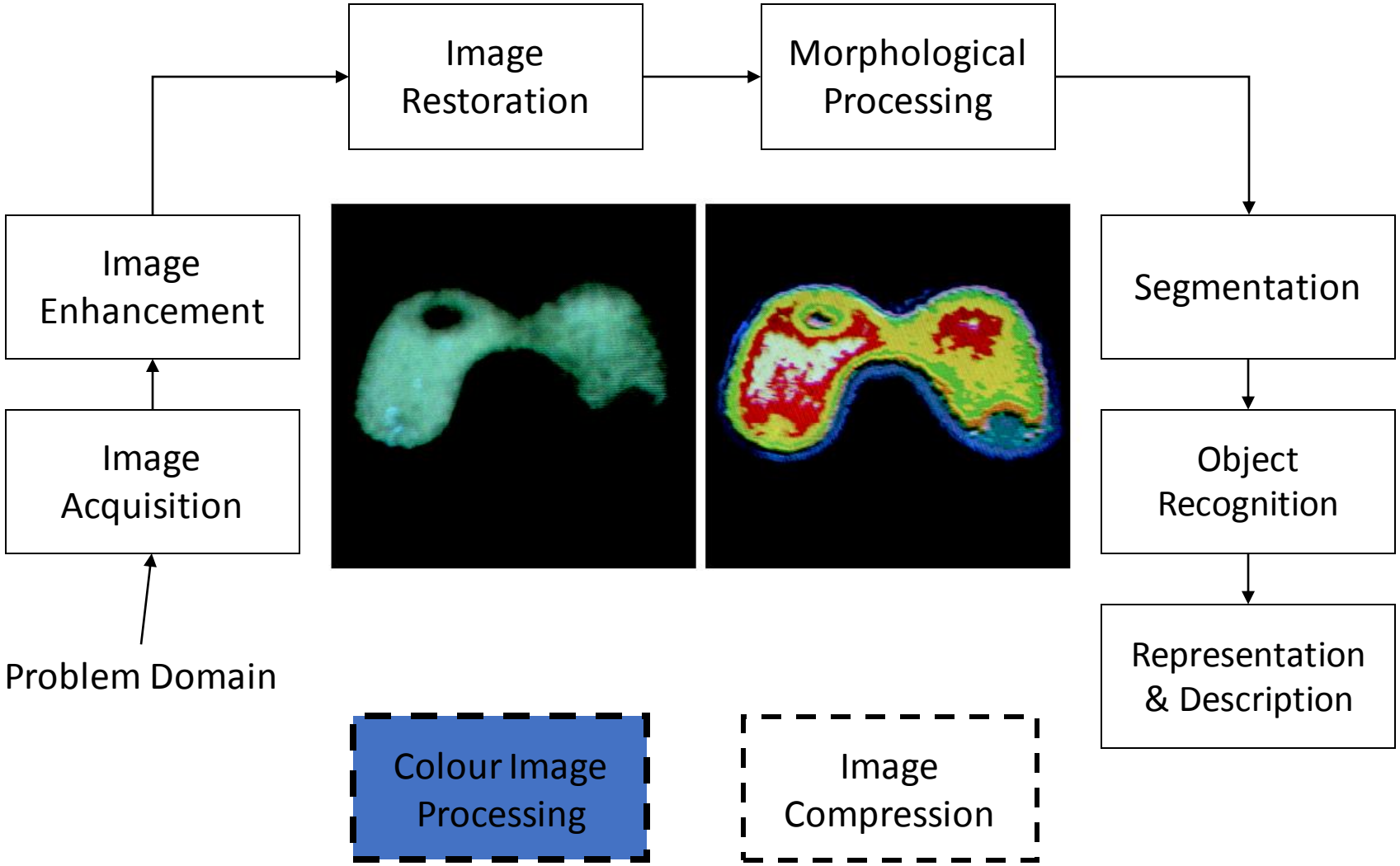
Key Stages in Digital Image Processing: Image Compression

Sumber: Yacov Hel-Or, *Image Processing*, Spring 2010



Key Stages in Digital Image Processing: Colour Image Processing

Sumber: Yacov Hel-Or, *Image Processing*, Spring 2010



Aplikasi Pengolahan Citra (dan *Computer Vision*)

- *Image editing …*

1. *Cropping*

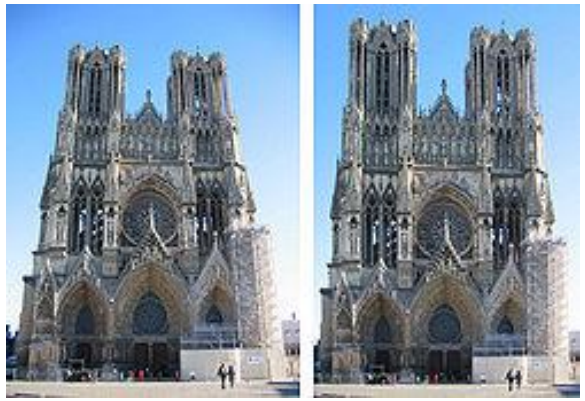
2. Removal of unwanted element

Aplikasi Pengolahan Citra (dan *Computer Vision*)

- *Image editing …*

3. **Selective color change**

4. **Perspective correction and distortion**



Aplikasi Pengolahan Citra (dan *Computer Vision*)

- *Image editing …*

5. **Selecting and merging of images**

Aplikasi Pengolahan Citra (dan *Computer Vision*)

- *Image editing*

6. Special effects

Aplikasi Pengolahan Citra (dan *Computer Vision*)

Image Inpainting 1

Sumber: Yacov Hel-Or, *Image Processing*, Spring 2010

Aplikasi Pengolahan Citra (dan *Computer Vision*)

Image Inpainting 2

Images of Venus taken by the Russian lander Ventra-10 in 1975

Sumber: Yacov Hel-Or, *Image Processing*, Spring 2010

Aplikasi Pengolahan Citra (dan *Computer Vision*)

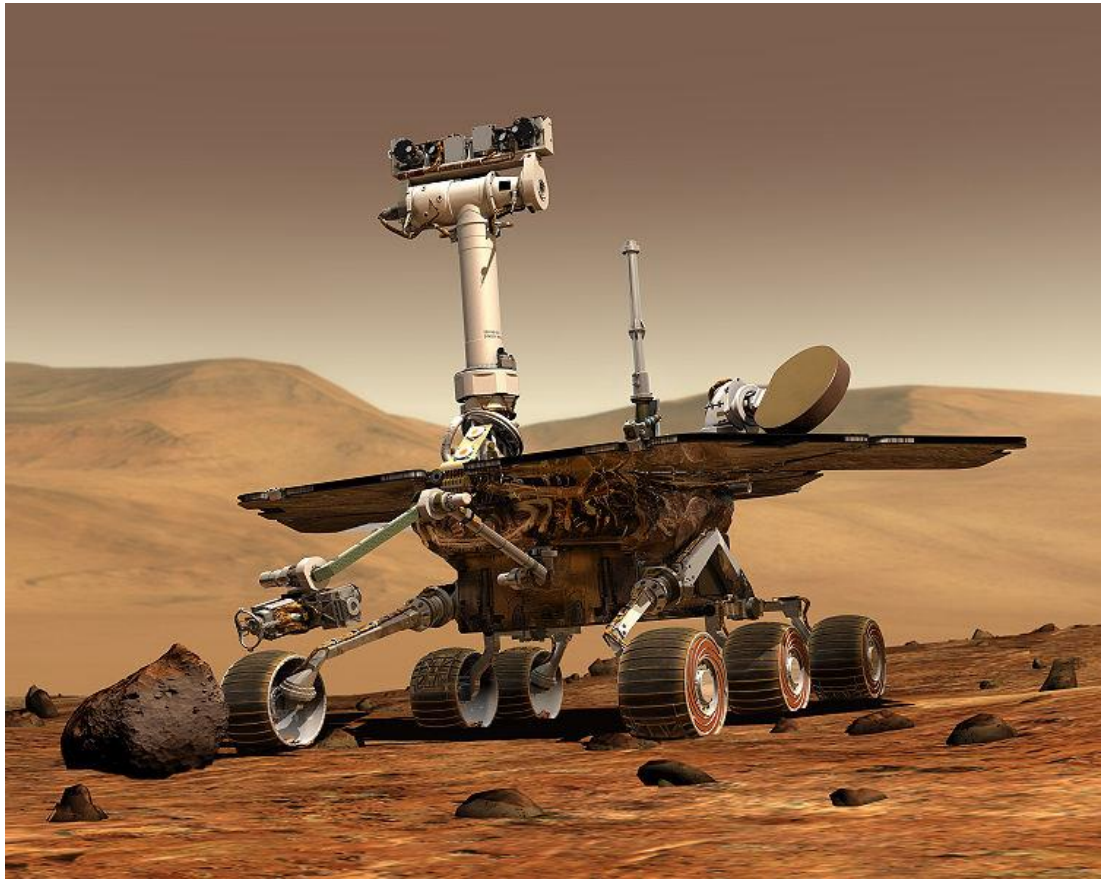
Video Inpainting

Y. Wexler, E. Shechtman and M. Irani 2004

Sumber: Yacov Hel-Or, *Image Processing*, Spring 2010

Aplikasi Pengolahan Citra (dan *Computer Vision*)

- *Robotika*



Aplikasi Pengolahan Citra (dan *Computer Vision*)

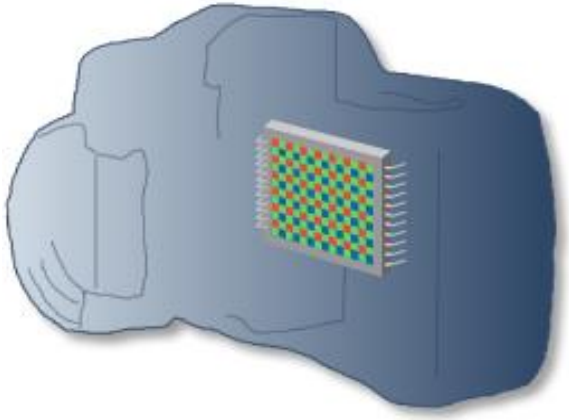
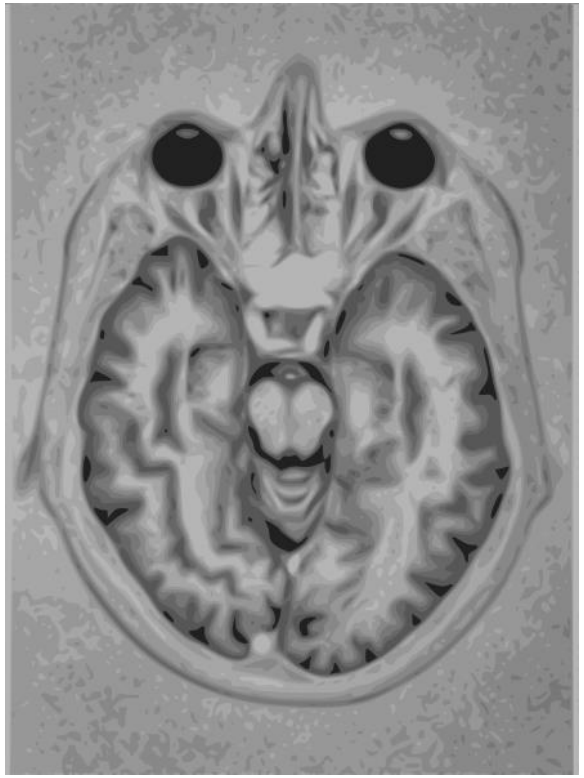


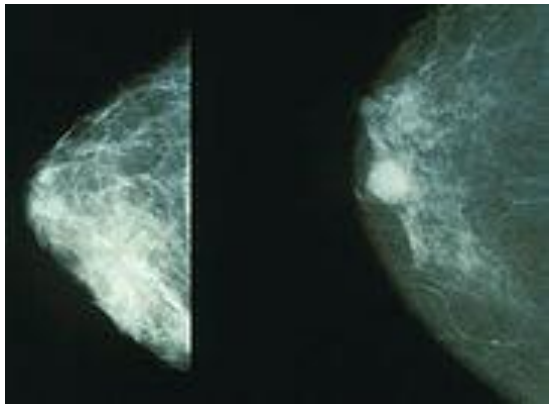
Image Demosaicing

Aplikasi Pengolahan Citra (dan *Computer Vision*)

- Medis



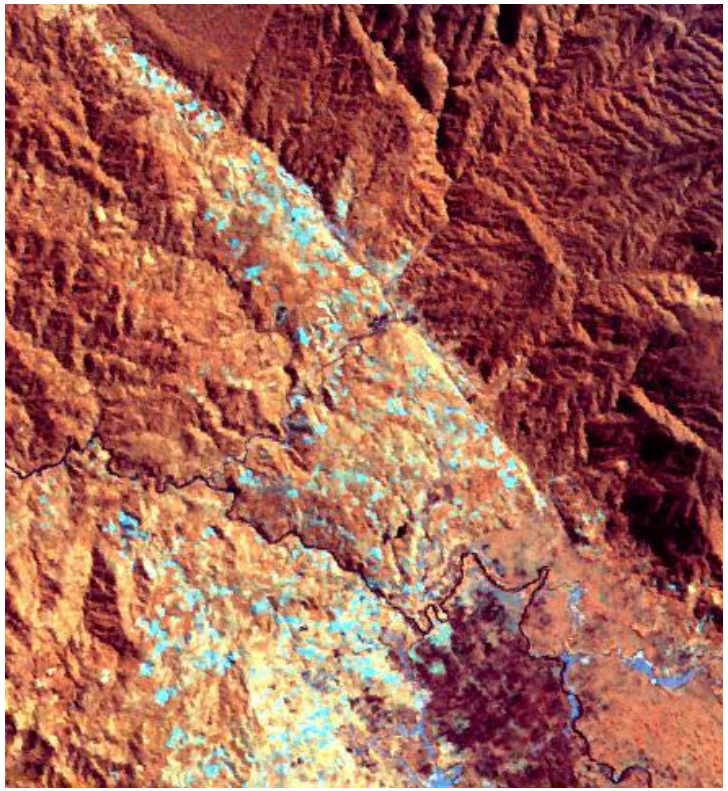
Magnetic resonance imaging (MRI) of brain



Normal (left) versus cancerous (right) mammography image.

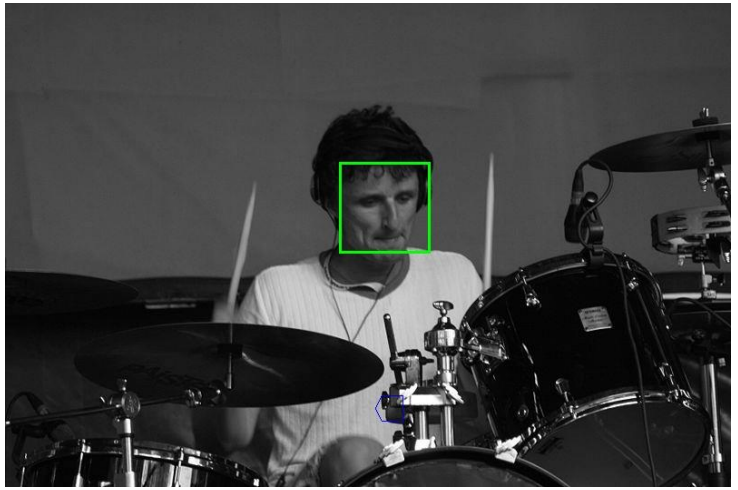
Aplikasi Pengolahan Citra (dan *Computer Vision*)

- *Remote sensing*



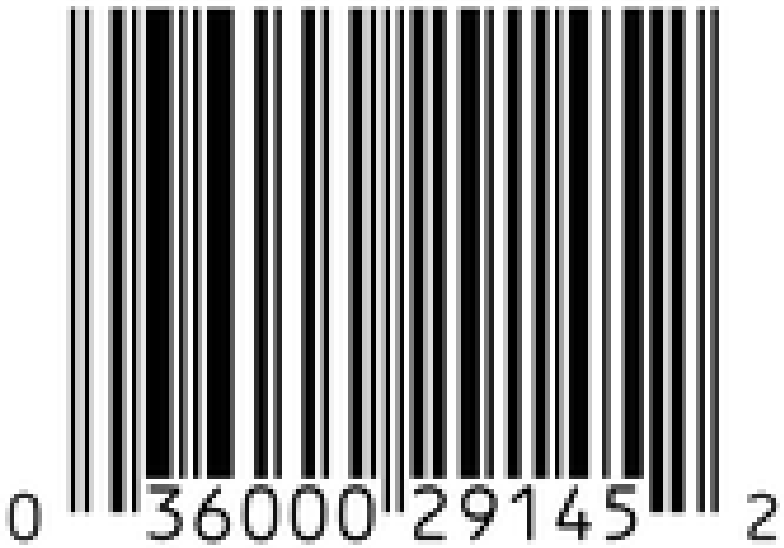
Aplikasi Pengolahan Citra (dan *Computer Vision*)

- *Face detection*

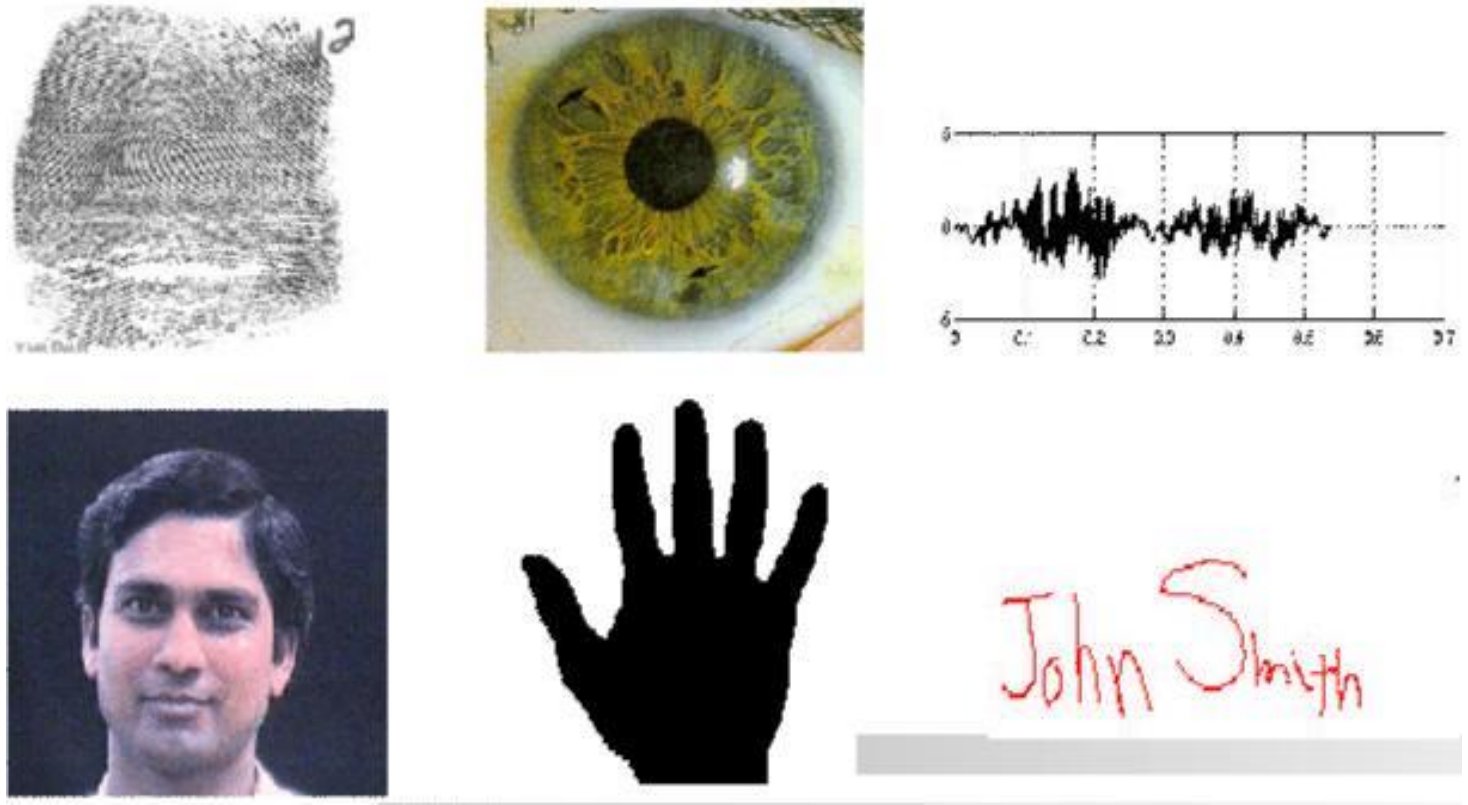


Aplikasi Pengolahan Citra (dan *Computer Vision*)

- Perdagangan



Aplikasi Pengolahan Citra (dan *Computer Vision*)



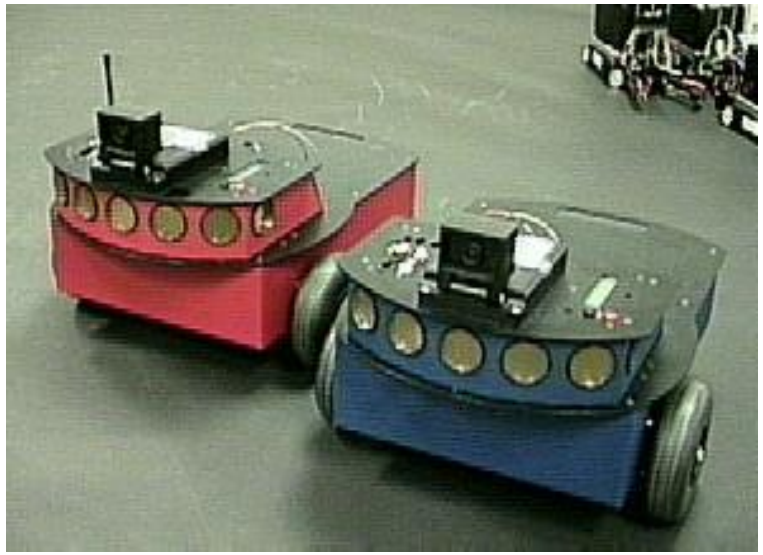
Biometrics

Sumber: Dr. Sanjeev Kumar, *Mathematical Imaging Techniques*, Department of Mathematics, IIT Roorkee

Aplikasi Pengolahan Citra (dan *Computer Vision*)

- Land, Underwater, Space

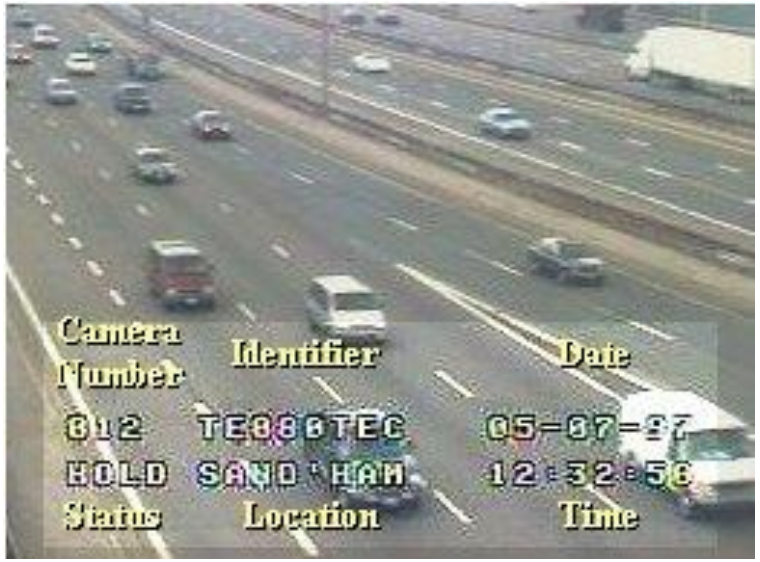
Autonomous Vehicles

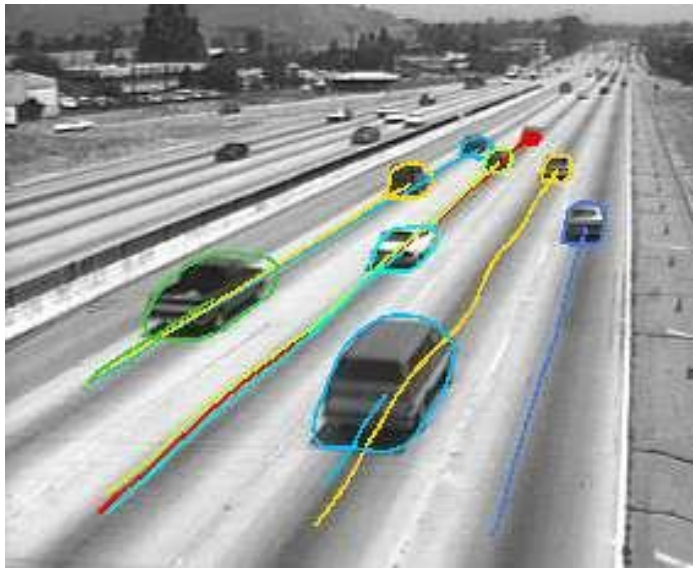


Sumber: Dr. Sanjeev Kumar, *Mathematical Imaging Techniques*, Department of Mathematics, IIT Roorkee

Aplikasi Pengolahan Citra (dan *Computer Vision*)

Traffic Monitoring

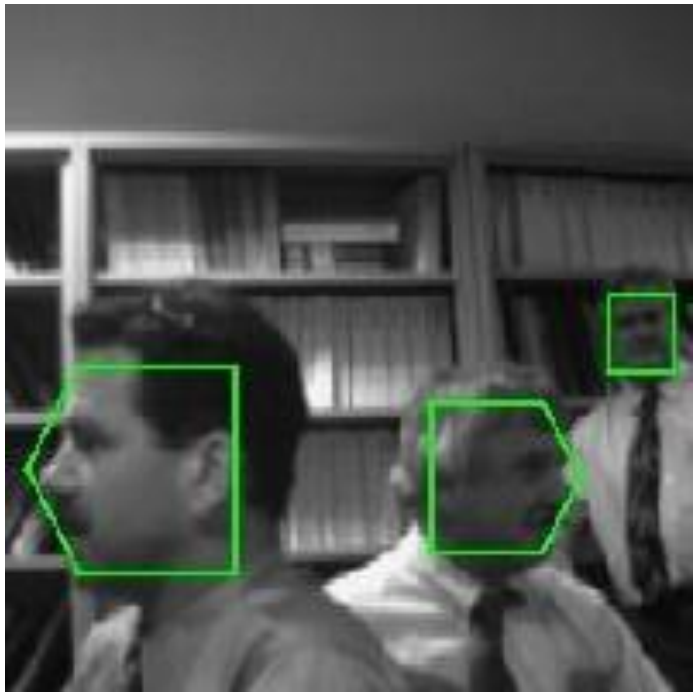




Sumber: Dr. Sanjeev Kumar, *Mathematical Imaging Techniques*, Department of Mathematics, IIT Roorkee

Aplikasi Pengolahan Citra (dan *Computer Vision*)

Face Detection



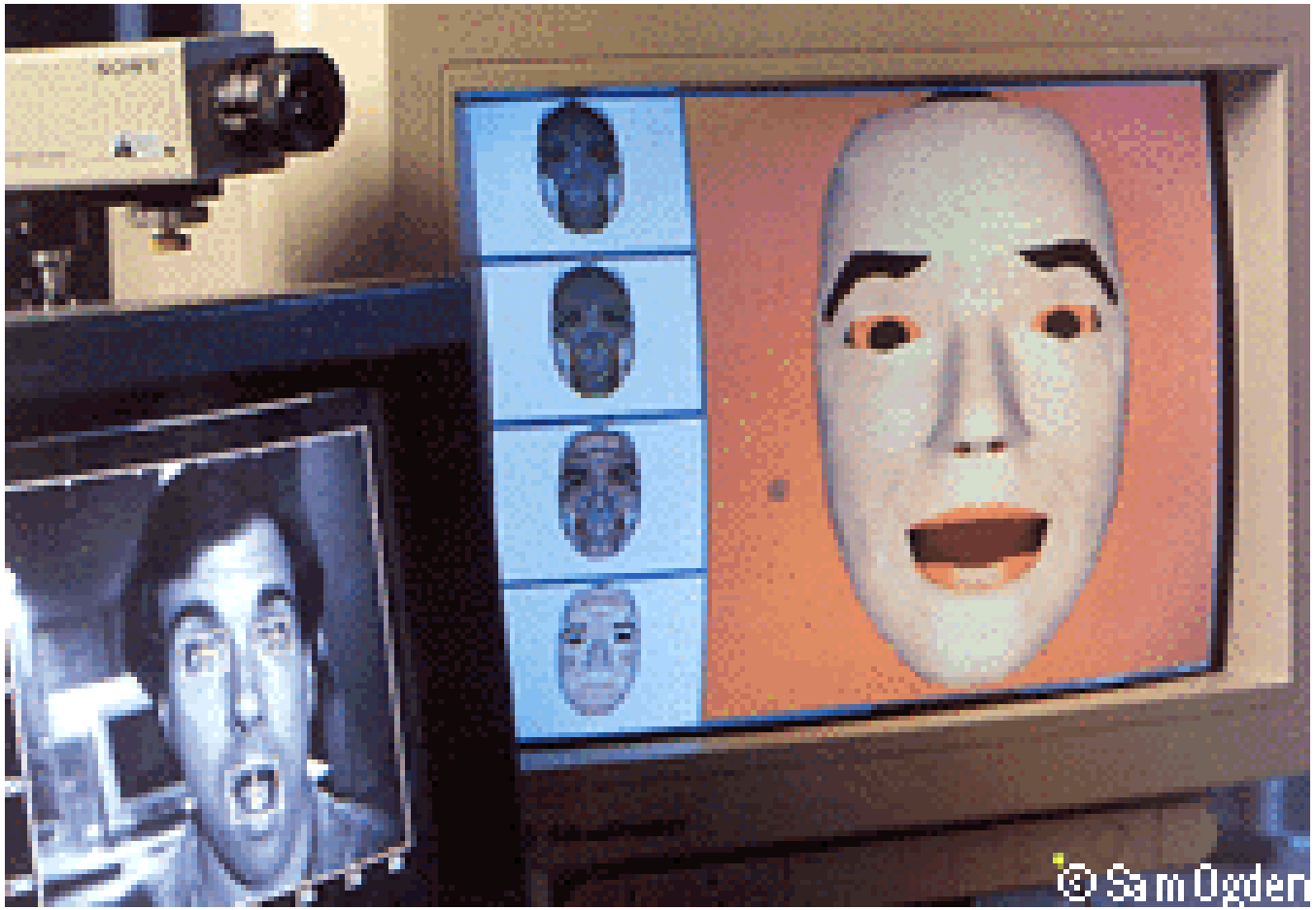
Sumber: Dr. Sanjeev Kumar, *Mathematical Imaging Techniques*, Department of Mathematics, IIT Roorkee

Aplikasi Pengolahan Citra (dan *Computer Vision*)

Face Recognition

Sumber: Dr. Sanjeev Kumar, *Mathematical Imaging Techniques*, Department of Mathematics, IIT Roorkee

Aplikasi Pengolahan Citra (dan *Computer Vision*)



Facial Expression Recognition

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Aplikasi Pengolahan Citra (dan *Computer Vision*)

- Smart Human-Computer User Interfaces
- Sign Language Recognition

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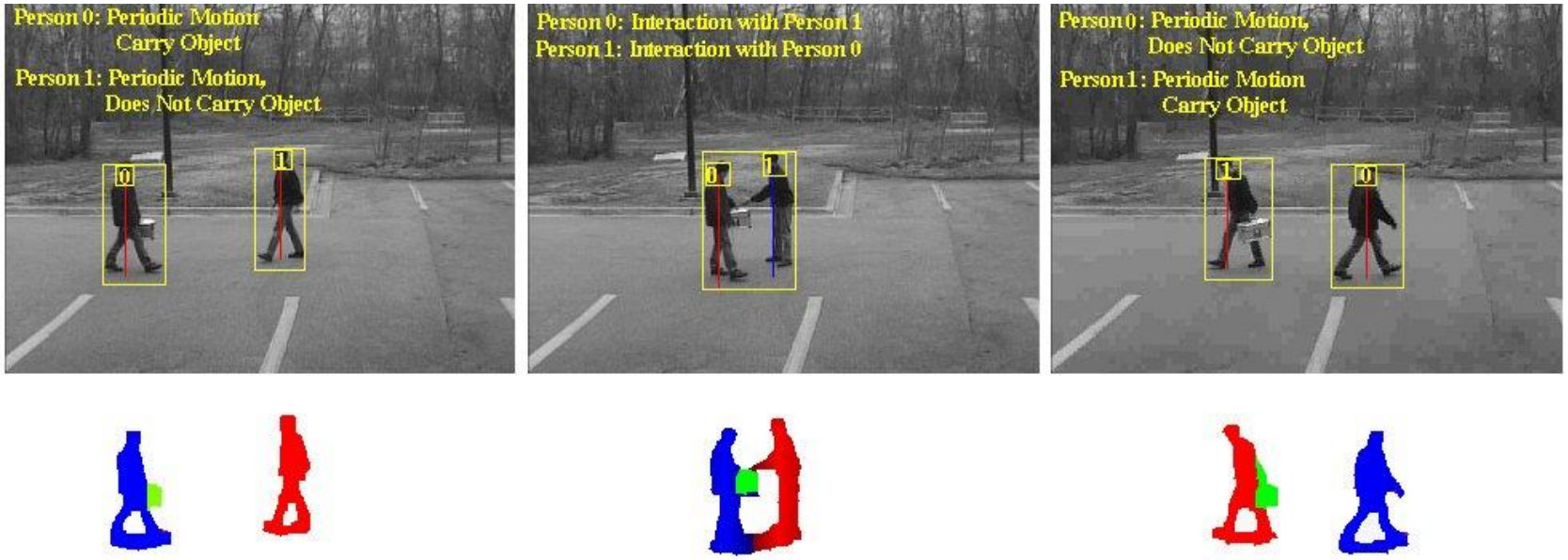
Hand Gesture Recognition

Aplikasi Pengolahan Citra (dan *Computer Vision*)

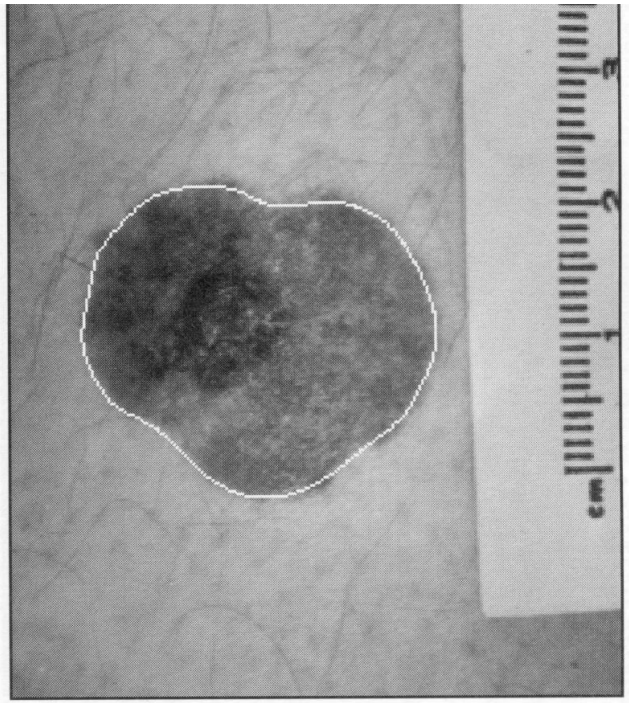
Human Activity Recognition



Sumber: Dr. Sanjeev Kumar, *Mathematical Imaging Techniques*, Department of Mathematics, IIT Roorkee

Aplikasi Pengolahan Citra (dan *Computer Vision*)

skin cancer



breast cancer

Medical Applications

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Aplikasi Pengolahan Citra (dan *Computer Vision*)

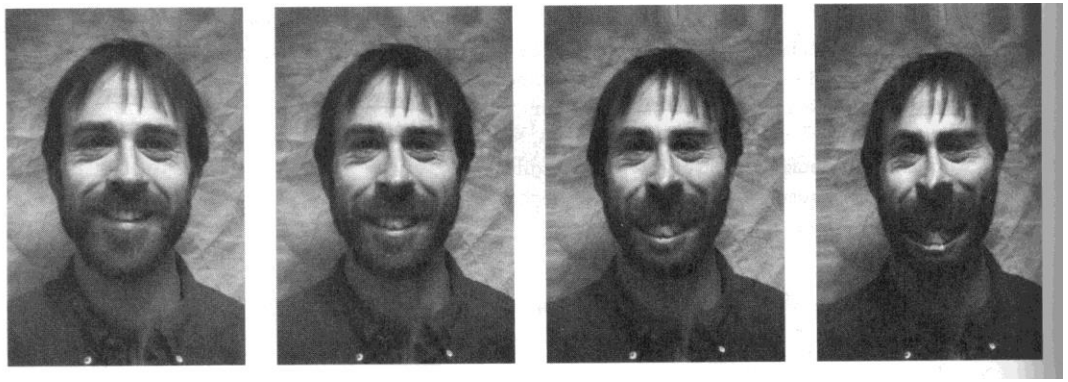
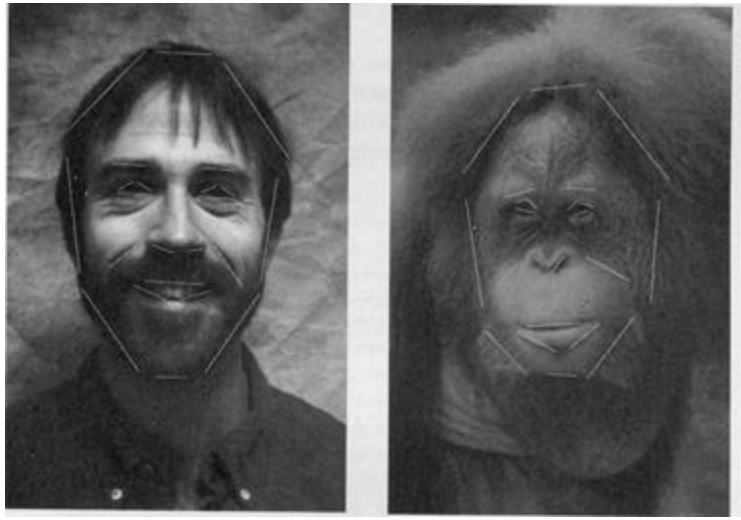
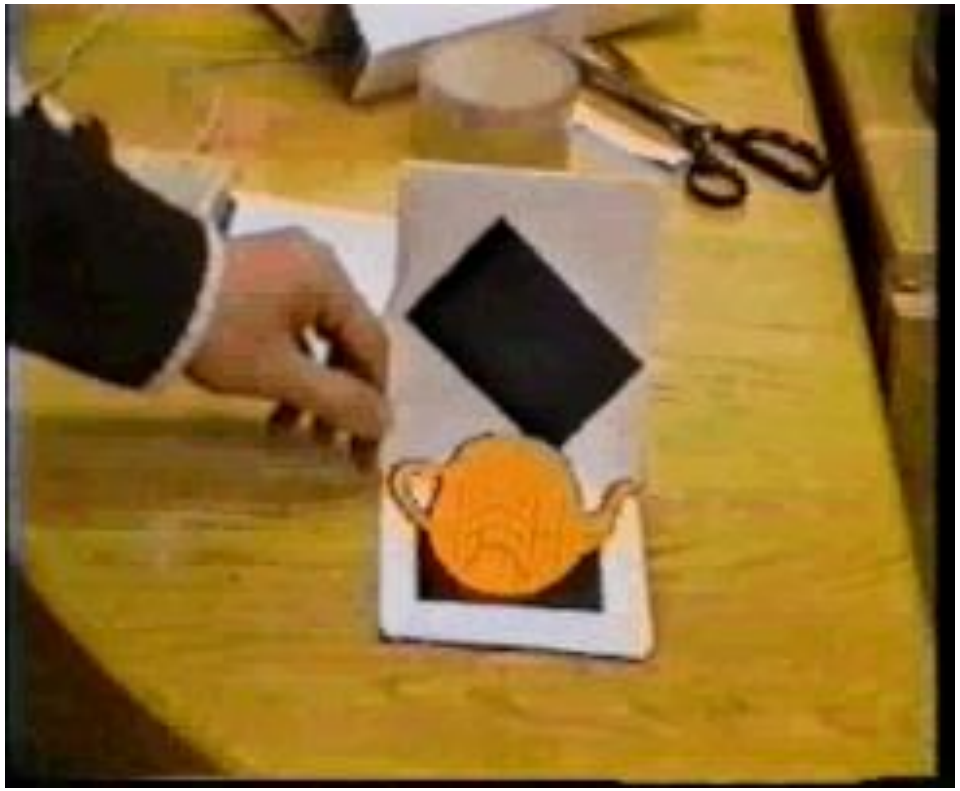


Image Morphing



Sumber: Dr. Sanjeev Kumar, *Mathematical Imaging Techniques*, Department of Mathematics, IIT Roorkee

Aplikasi Pengolahan Citra (dan *Computer Vision*)

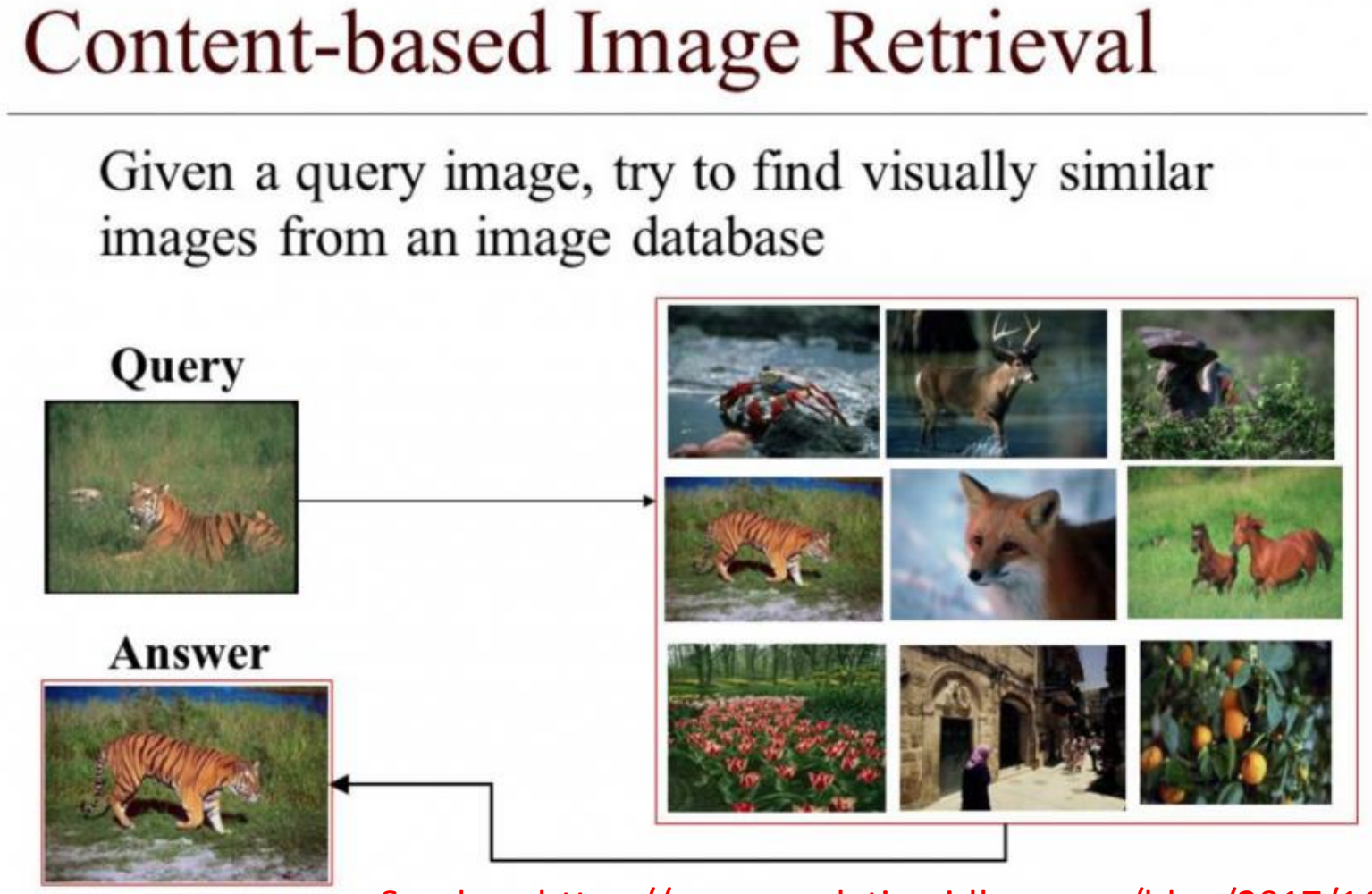


Sumber: Dr. Sanjeev Kumar, *Mathematical Imaging Techniques*, Department of Mathematics, IIT Roorkee

Inserting Artificial Objects into a Scene

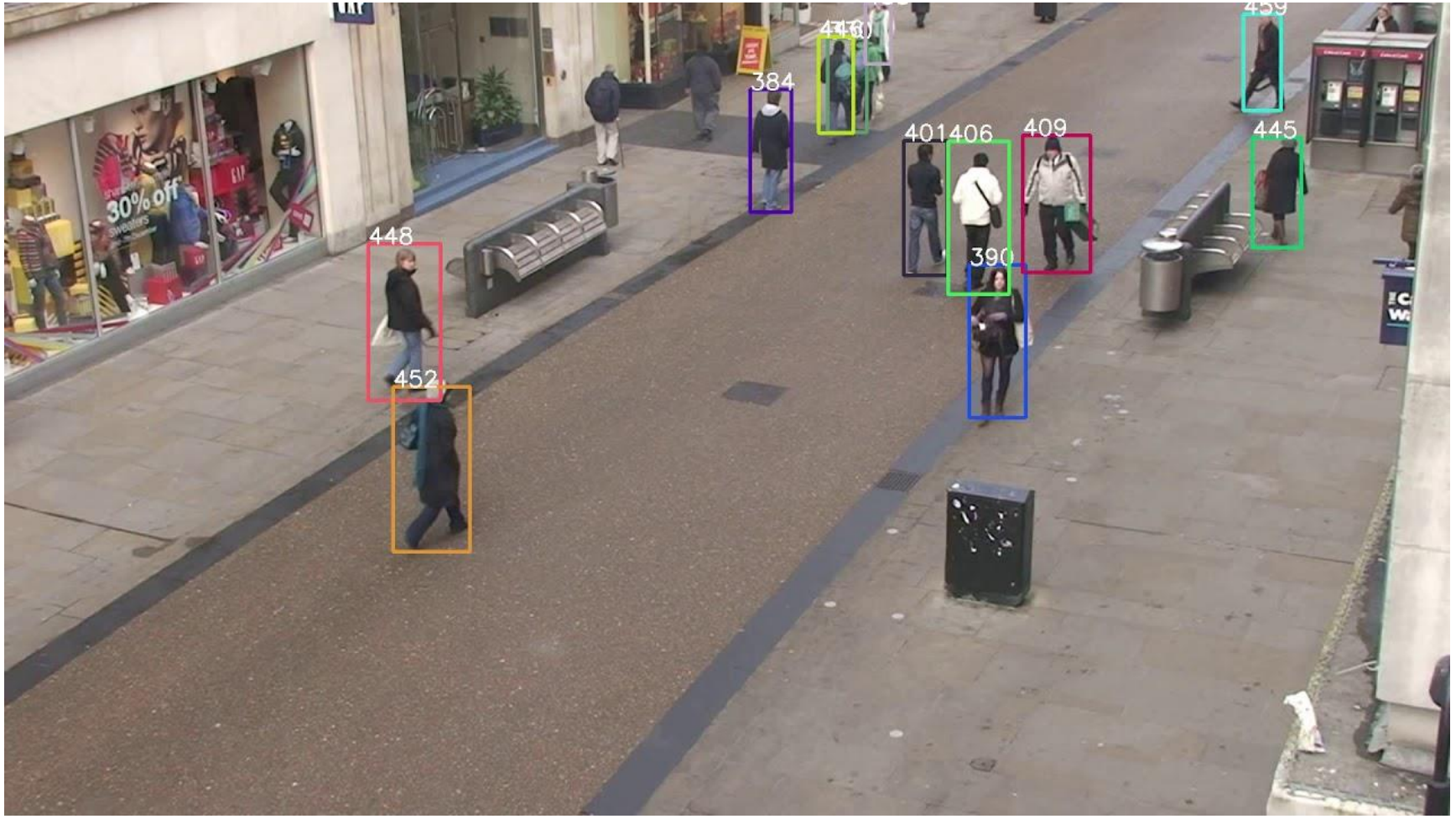
Aplikasi Pengolahan Citra (dan *Computer Vision*)

An image retrieval system is a computer system for browsing, searching and retrieving images from a large database of digital images



Sumber: https://www.analyticsvidhya.com/blog/2017/11/information-retrieval-using-kdtree/

Aplikasi Pengolahan Citra (dan *Computer Vision*)



Human tracking

Citra Uji Standard

- Terdapat sejumlah citra yang sering dipakai sebagai citra uji di dalam pengolahan citra atau *computer vision*.

- Citra-citra tersebut sering disebut sebagai *standard test image*, baik citra *grayscale* maupun citra berwarna.

- Umumnya citra uji berukuran persegi (N x N) untuk memudahkan beberapa operasi pengolahan citra yang mengasumsikan citra masukan sebagai citra persegi.

- Empat citra uji standard yang popular dan digunakan secara luas adalah citra *Lena*, *mandrill*, *camera*, dan *pepper*.

- Koleksi citra uji dapat dilihat di laman situs web saya: http://informatika.stei.itb.ac.id/~rinaldi.munir/Koleksi/Citra%20Uji/CitraUji.htm

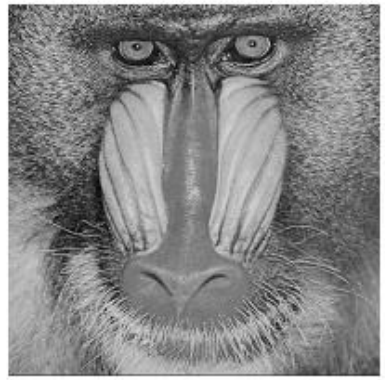
Lena, 256 × 256

Peppers 512 × 512

Zelda 512 × 512

Bird 256 × 256

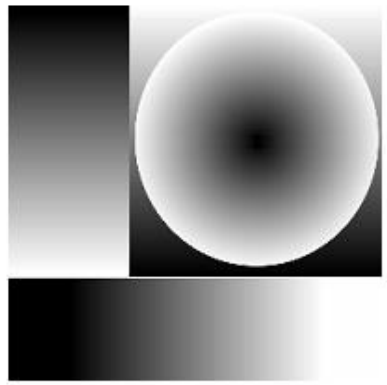
Camera 256 × 256



Mandrill 512 × 512

Barbara 512 × 512

Boat 512 × 512

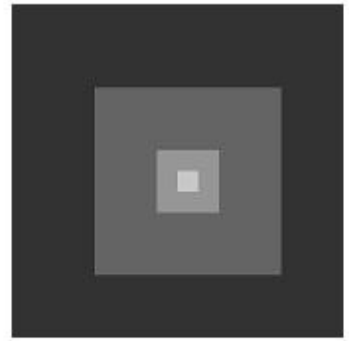


Slope 256 × 256

San Fransisco 256 × 256

Collie 256 × 256

Circle 256 × 256



Squares 256 × 256

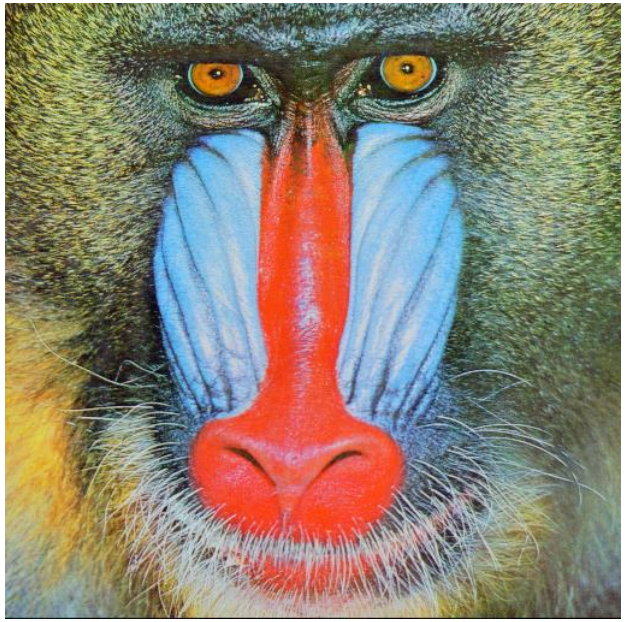
Text 256 × 256

Mountain 640 × 480

Goldhill 512 × 512

Eltoro 512 × 512

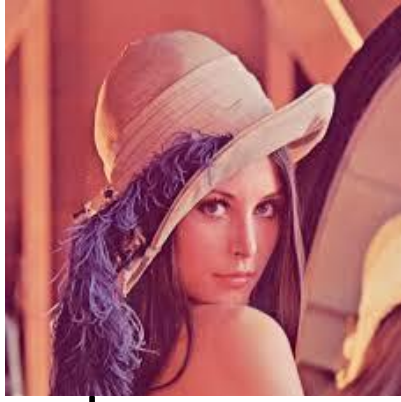
Girl 256 × 256



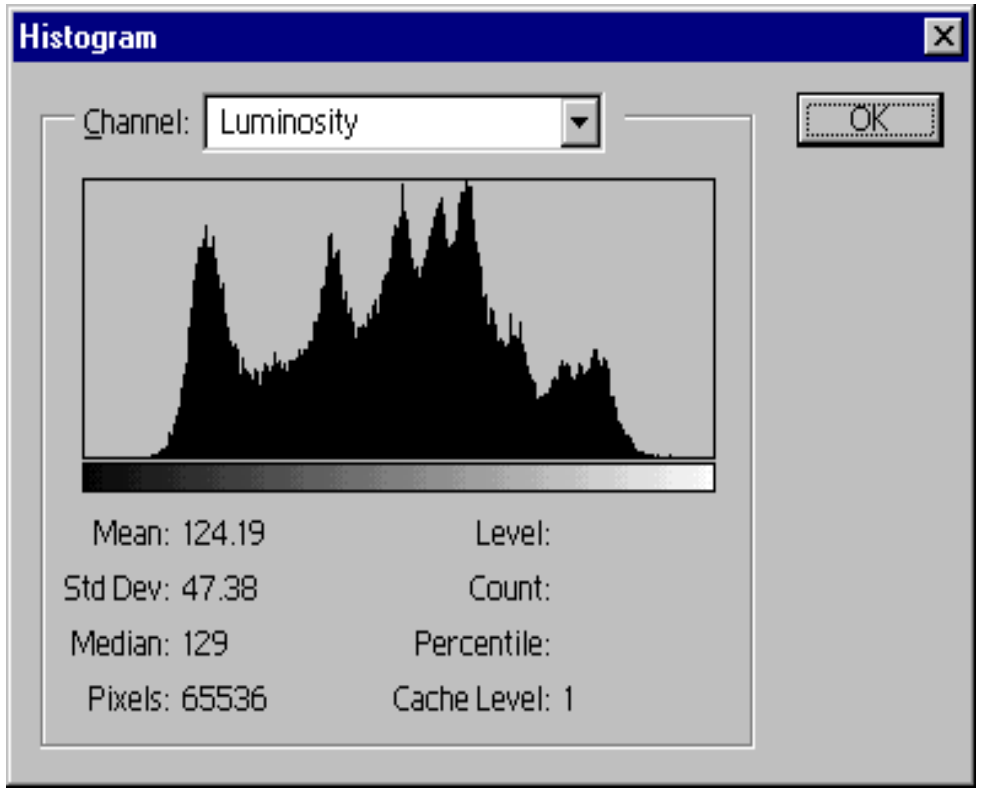
Empat citra popular dalam bidang *image processing*

Citra uji lainnya:

Sejarah Citra Lena



- **Lenna** atau **Lena** adalah nama citra uji standard yang digunakan secara luas di dalam bidang pengolahan citra sejak tahun 1973.
- Lena adalah citra seorang model Swedia bernama Lena Söderberg, yang dipotong dari majalah *Playboy*.
- Foto Lena dari majalah tersebut dipindai oleh Alexander Sawchuk, dia memerlukan foto wajah untuk ditampilkan di dalam sebuah artikel ilmiahnya di sebuah konferensi IEEE.
- Alasan penggunaan citra Lena sebagai citra uji adalah karena citra ini memiliki detil yang bagus, tekstur, dan bayangan, tetapi yang paling penting adalah nilai-nilai *pixel*-nya tersebar secara merata (histogram).
- Tidak dipungkiri juga alasan karena ia seorang wanita cantik, seorang model, dan seorang artis.

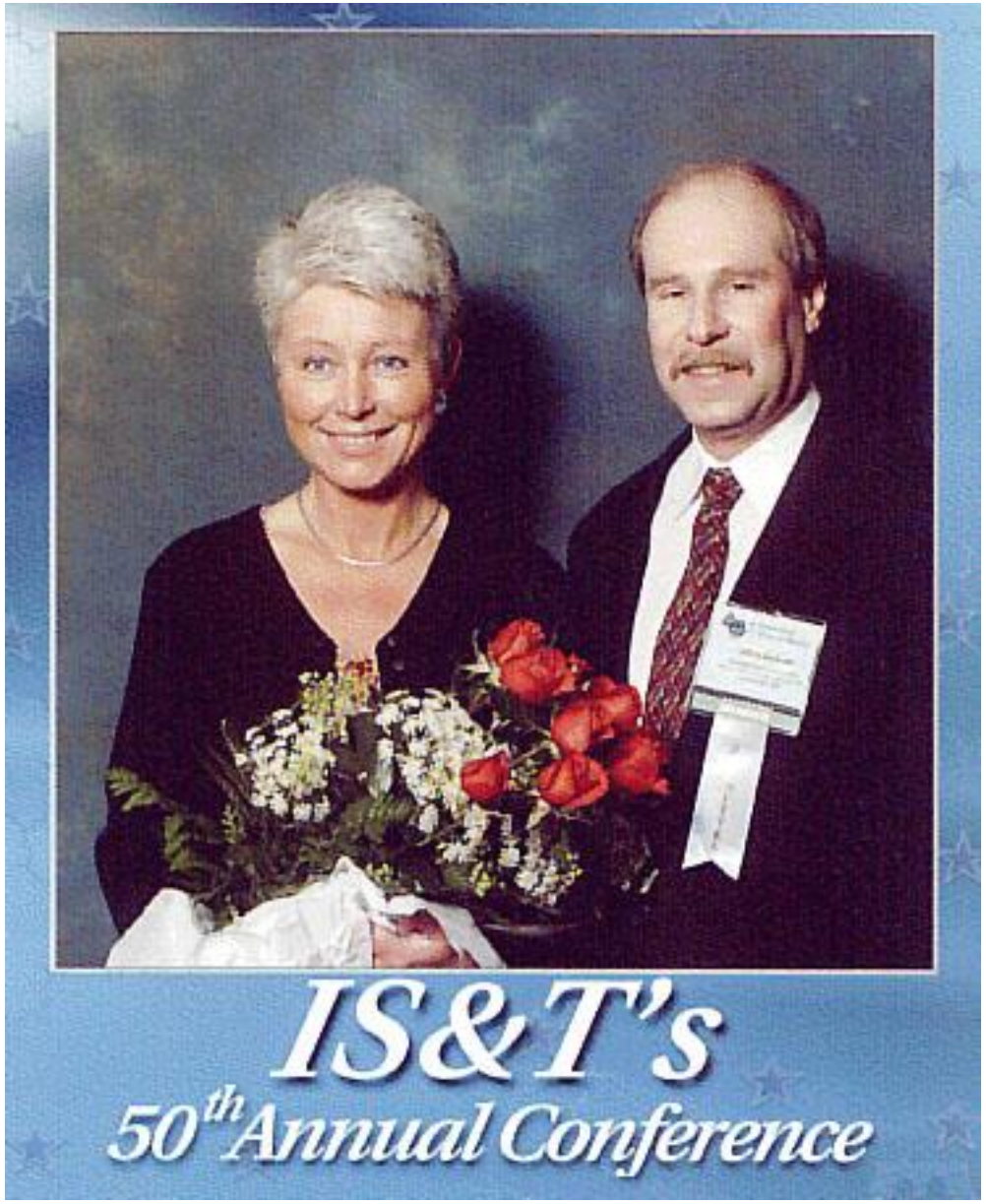

Histogram
Channel: Luminosity
OK
Mean: 124.19
Std Dev: 47.38
Median: 129
Pixels: 65536
Level:
Count:
Percentile:
Cache Level: 1

- Sejarah pertama kali citra Lenna dipakai sebagai citra uji ditulis sebagai berikut:

> Alexander Sawchuk estimates that it was in June or July of 1973 when he, then an assistant professor of electrical engineering at the University of Southern California Signal and Image Processing Institute (SIPI), along with a graduate student and the SIPI lab manager, was hurriedly searching the lab for a good image to scan for a colleague's conference paper. They got tired of their stock of usual test images, dull stuff dating back to television standards work in the early 1960s. They wanted something glossy to ensure good output dynamic range, and they wanted a human face. Just then, somebody happened to walk in with a recent issue of *Playboy*.
> The engineers tore away the top third of the centerfold so they could wrap it around the drum of their Muirhead wirephoto scanner, which they had outfitted with analog-to-digital converters (one each for the red, green, and blue channels) and a Hewlett Packard 2100 minicomputer. The Muirhead had a fixed resolution of 100 lines per inch and the engineers wanted a 512×512 image, so they limited the scan to the top 5.12 inches of the picture, effectively cropping it at the subject's shoulders.

Sumber: Wikipedia

Lena Söderberg tahun 1997:



Currently, Lenna lives near Stockholm and works for a government agency supervising handicapped employees archiving data using, appropriately, computers and scanners.

Sumber: http://www.ee.cityu.edu.hk/~lmpo/lenna/Lenna97.html

Lena saat ini:

I discovered that the last time she'd appeared in public was in 2015, as a "special guest" at an image processing industry conference in Quebec City.

"I'm just surprised that it never ends," Forsen says about her unusual fame.

Sumber: https://www.wired.com/story/finding-lena-the-patron-saint-of-jpegs/

Sumber bahan ajar ini

1. Yacov Hel-Or, *Image Processing*, Spring 2010
2. Dr. Sanjeev Kumar, *Mathematical Imaging Techniques*, Department of Mathematics, IIT Roorkee