Introduction

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Course Profile

Class Name	Digital Image Processing
Online Course	http://elisa.ugm.ac.id
Credits	3 Credits
Assessment	Assignment/Quiz (25%) Final Project (20%) Attendance (05%) Examination (50%)
Course Topics	Introduction The Concept of Digital Image Colour Mode Image Enhancement Segmentation Morphological Processing Representation and Description Interpretation

Assessment Detail

No.	CO	Evaluasi	Metode	Persentase Penilaian
1	CO1	Tugas 1	Formatif	5%
		Soal no 1 - Ujian Tengah Semester	Sumatif	7.5%
		Soal no 1 - Ujian Akhir Semester	Sumatif	10%
2	CO2	Tugas 2	Formatif	5%
		Soal no 2 - Ujian Tengah Semester	Sumatif	7.5%
		Soal no 2 - Ujian Akhir Semester	Sumatif	10%
3	CO3	Tugas 3	Formatif	5%
		Soal no 3 - Ujian Tengah Semester	Sumatif	7.5%
		Soal no 3 - Ujian Akhir Semester	Sumatif	10%
4	CO4	Tugas 4	Formatif	5%
		Soal no 4 - Ujian Tengah Semester	Sumatif	7.5%
		Soal no 4 - Ujian Akhir Semester	Sumatif	10%
5	CO5	Proyek akhir	Formatif	15%
		Kehadiran	Formatif	5%

Grading Criteria

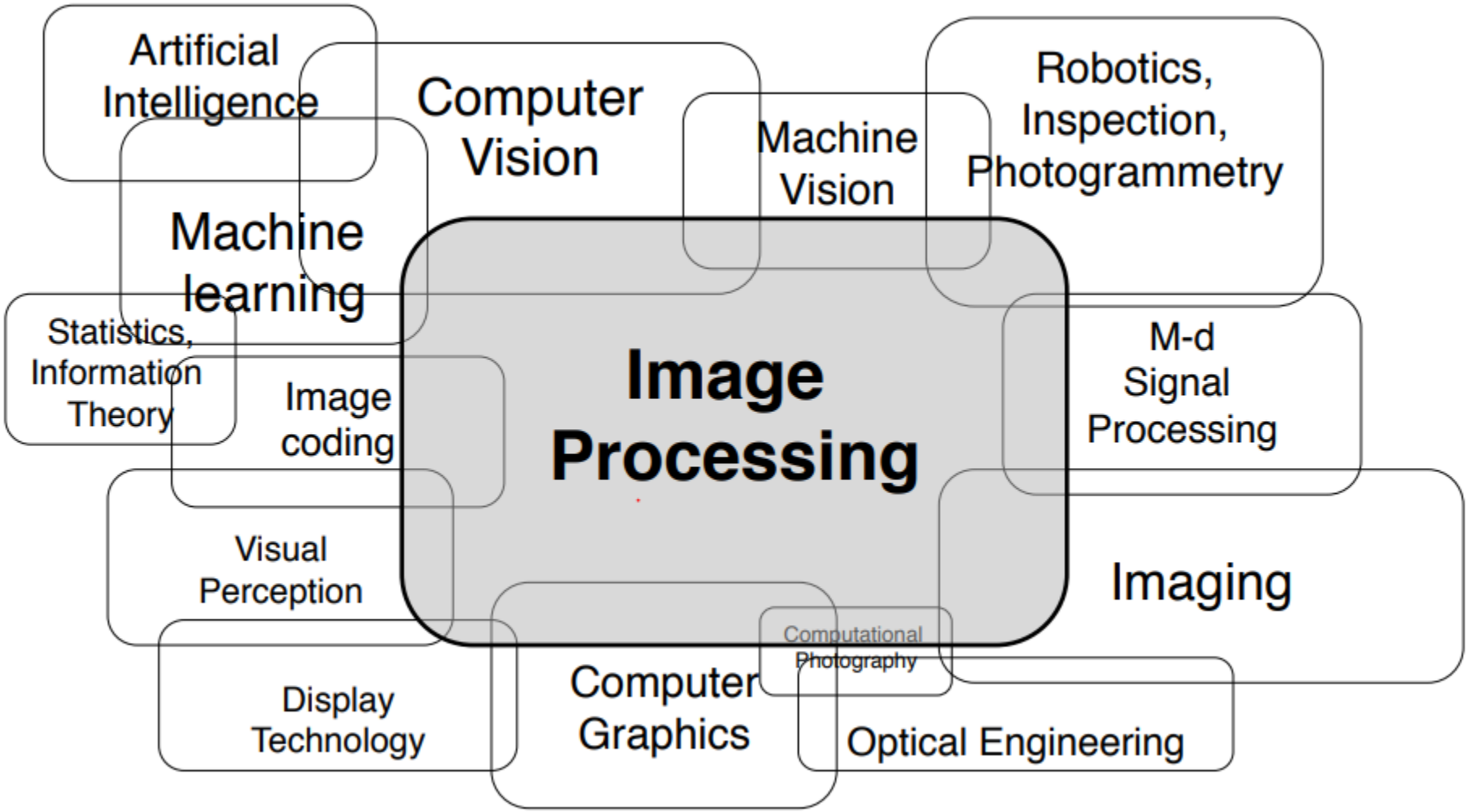
80 ≤ Nilai	A
75 ≤ Nilai < 80	A-
70 ≤ Nilai < 75	A/B
65 ≤ Nilai < 70	B+
60 ≤ Nilai < 65	B
55 ≤ Nilai < 60	B-
50 ≤ Nilai < 55	B/C

45 ≤ Nilai < 50	C+
40 ≤ Nilai < 45	C
35 ≤ Nilai < 40	C-
30 ≤ Nilai < 35	C/D
25 ≤ Nilai < 30	D+
20 ≤ Nilai < 25	D
Nilai < 20	E

Course Rules

- Please be on time (maximum 20 minutes late), otherwise you could not join the class.
- No mobile device/laptop during class
  - If you get caught using mobile phone, you will get -5 points.
- **Individual assignment** should be submitted **before deadline** otherwise you will not get score for that assignment.
- No substitution for quiz
- Examination is usually open book

Digital Image Processing Scope



Basic Image

What is an image?

- An artefact that depicts visual perception
  - A photo or a two-dimensional picture, that has a similar appearance to some subject
- Captured by optical devices.
- Image dimension
  - Two-dimensional: photograph
  - Three-dimensional: statue or hologram.

What is an image?

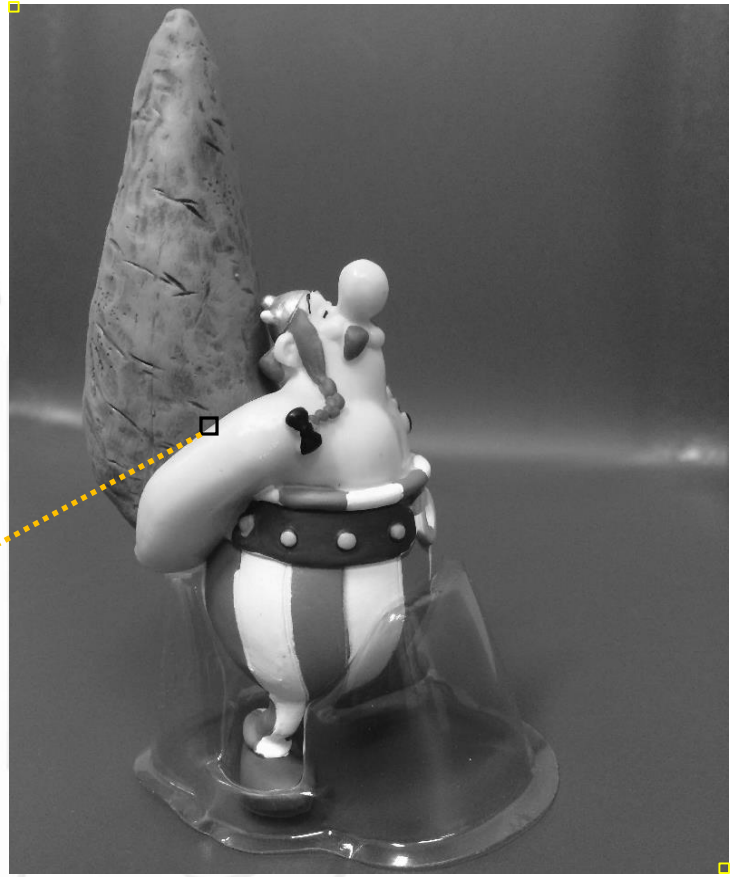
- Mathematically:
  - An image is a two-dimensional function f(x,y), where x and y are the spatial (plane) coordinates, and the amplitude of f at any pair of coordinates (x,y) is called the intensity of the image at that level.

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

Pixel intensity value

$f(1,1) = 103$

Pixel location



rows columns

$f(645{:}650,1323{:}1328) =$

83	82	82	82	82	82
82	82	82	81	81	81
82	82	81	81	80	80
82	82	81	80	80	79
80	79	78	77	77	77
80	79	78	78	77	77

$f(2724,2336) = 88$

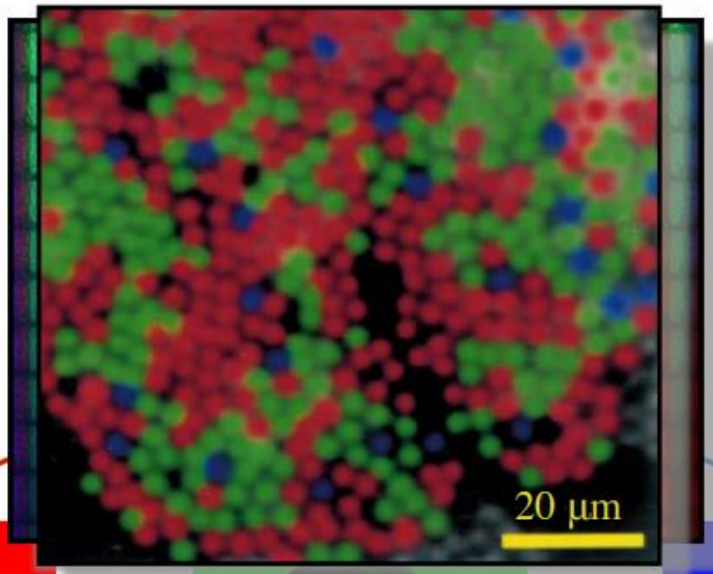
Consider the following image (2724x2336 pixels) to be 2D function or a **matrix** with **rows** and **columns**

In 8-bit representation Pixel intensity values change between 0 (Black) and 255 (White)

What is a digital image?

- A digital image is a numeric representation, normally binary, of a two-dimensional image.
- Image dimension
  - Two-dimensional, such as a photograph or screen display
  - Three-dimensional, such as a statue or hologram.

Colour Components



Red $R[x,y]$

Green $G[x,y]$

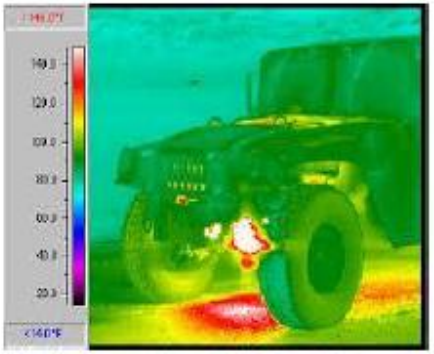
Blue $B[x,y]$

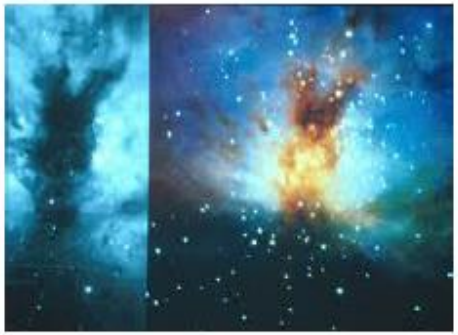
Monochrome image

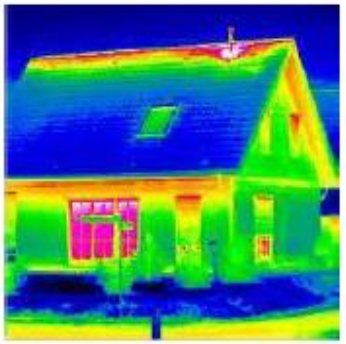
$R[x,y] = G[x,y] = B[x,y]$

Color Images

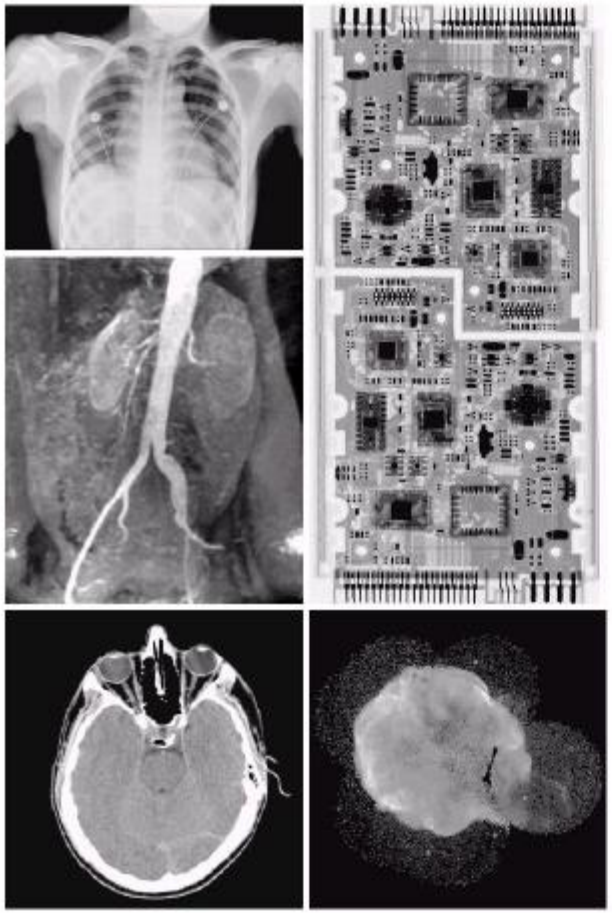
Infrared Images







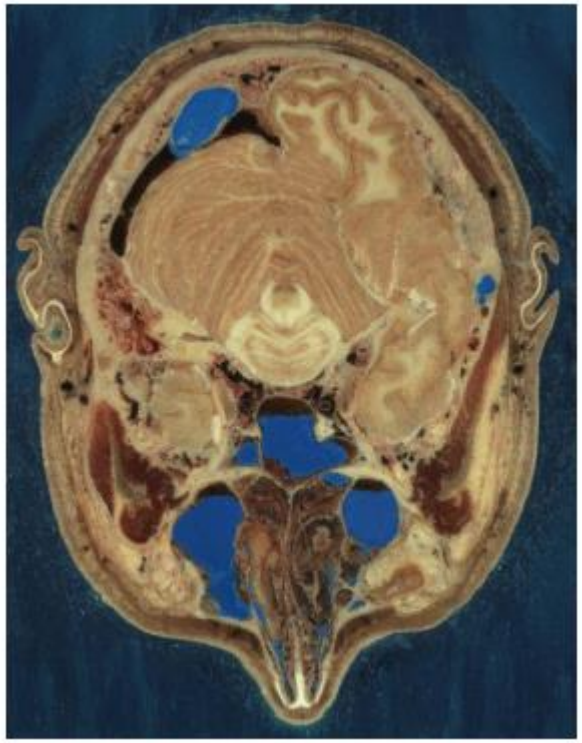
X-Ray Images



a b d c e

(a) Chest X-ray. (b) Aortic angiogram. (c) Head CT. (d) Circuit boards. (e) Cygnus Loop.

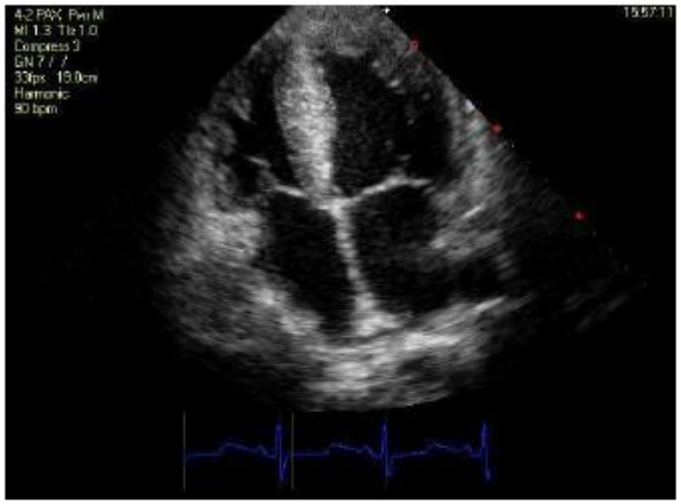
CT: Computer Tomography



Ultra Sound Images

surgeryencyclopedia.com

Fetal ultrasound during the second to third trimester.

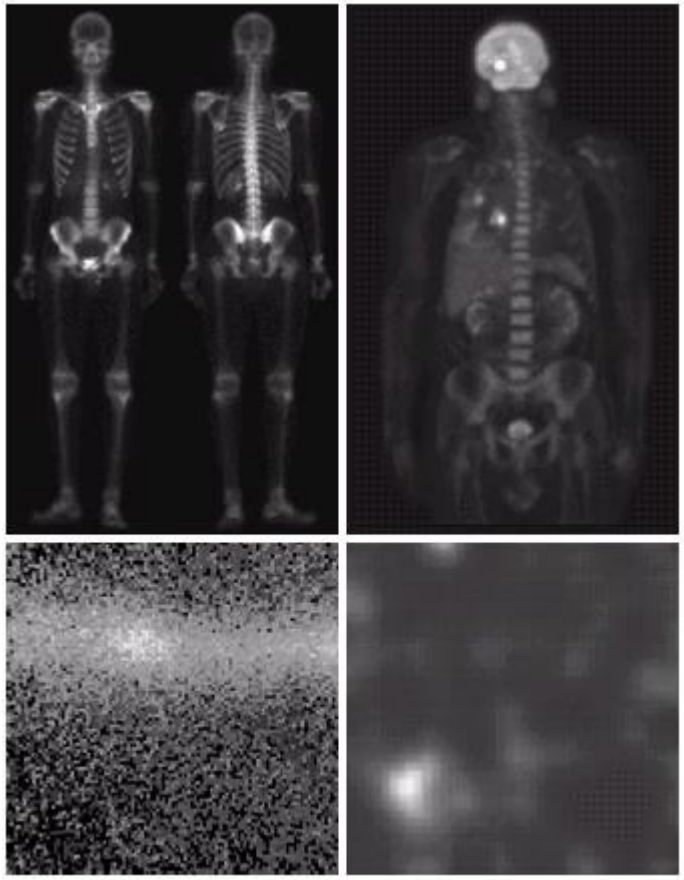


Four chambers of the **heart** imaged as an echocardiogram.
fas.org

Gama Ray Image

a b
c d

(a) Bone scan. (b) PET image. (c) Cygnus Loop. (d) Gamma radiation.



Digital Image Processing

Why do we process images?

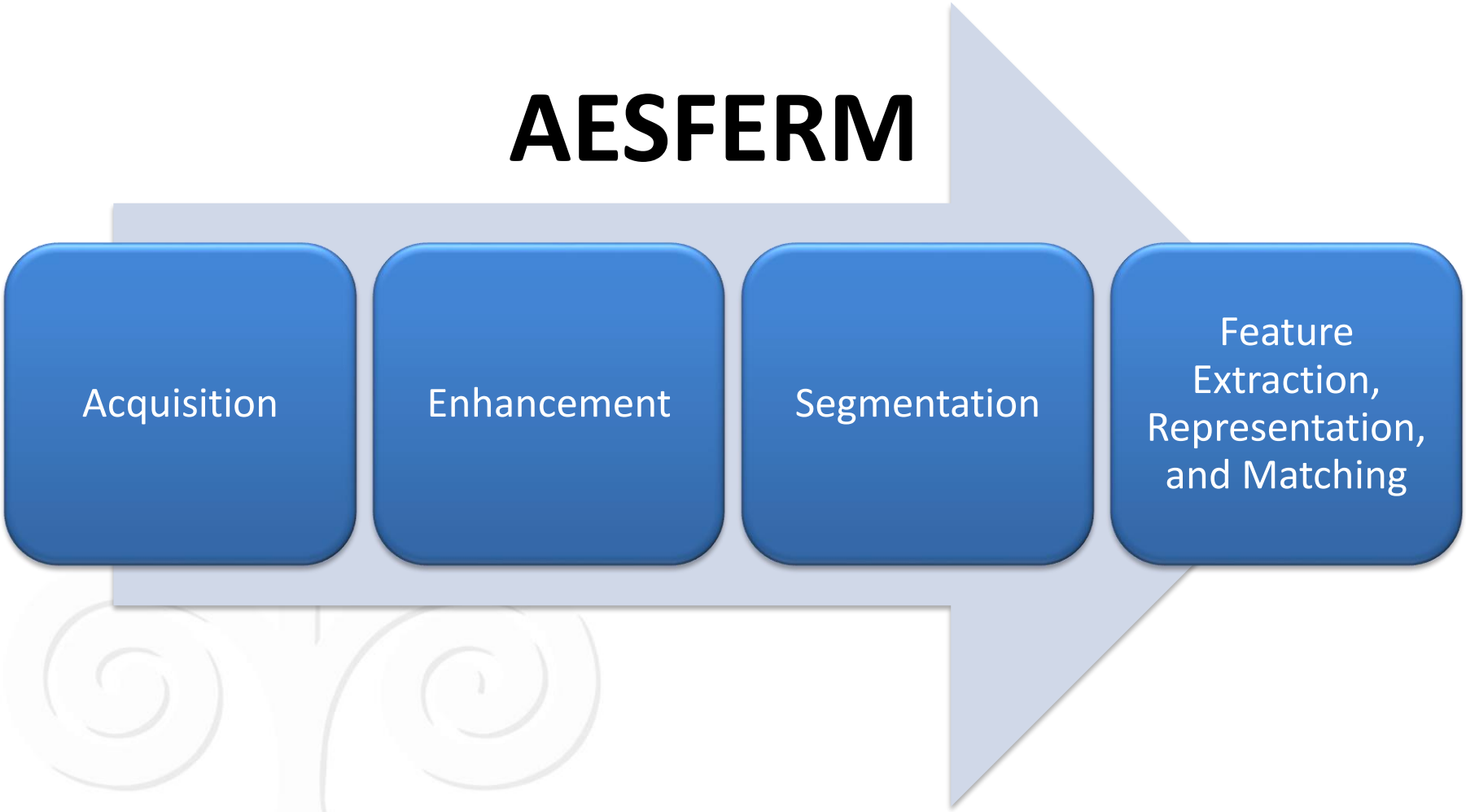
- Acquire an image
  - Correct aperture and color balance
  - Reconstruct image from projections
- Prepare for display or printing
  - Adjust image size
  - Color mapping
- Facilitate picture storage and transmission
  - Image compression
- Enhance and restore images
- Extract information from images
  - Edge
  - Border

Digital Image Processing (DIP)

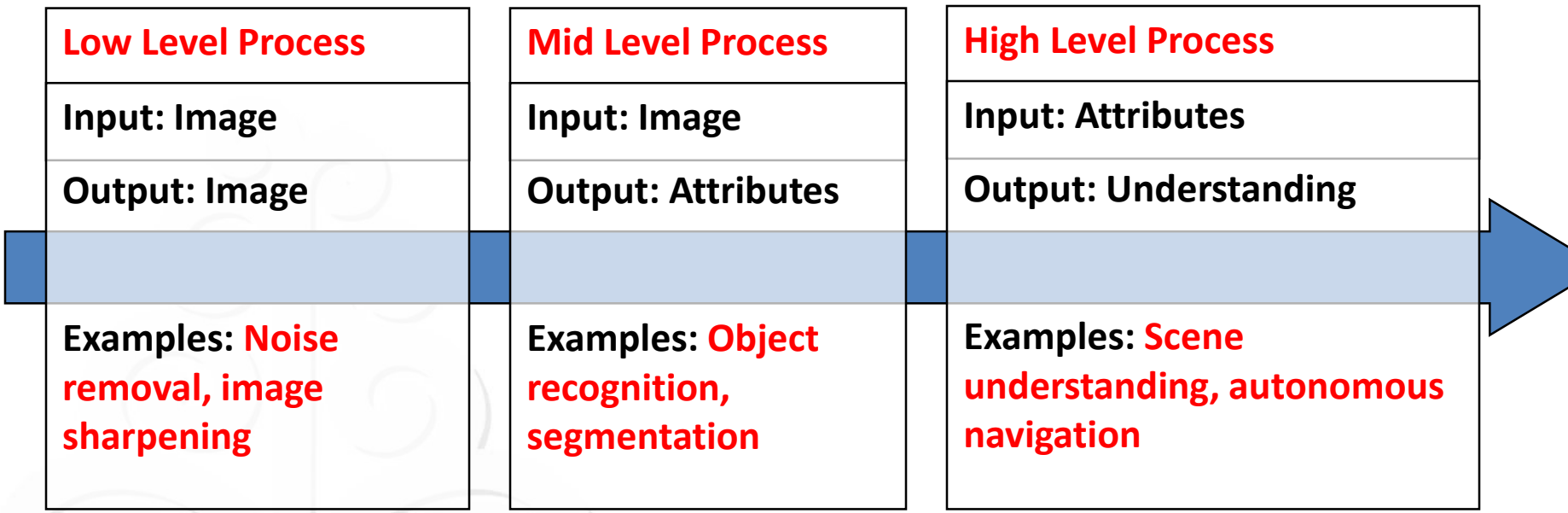
- The use of computer algorithms to perform image processing on digital images
- Digital image processing goals:
  - To get an enhanced image
  - To extract some useful information from images
- It is a type of signal processing

DIP Steps

AESFERM



DIP Techniques



DIP Techniques

- Image enhancement
- Image restoration
- Color image processing
- Image compression
- Morphological processing
- Segmentation
- Object recognition

Image Enhancement

- The process to improve image quality, both contrast and brightness.

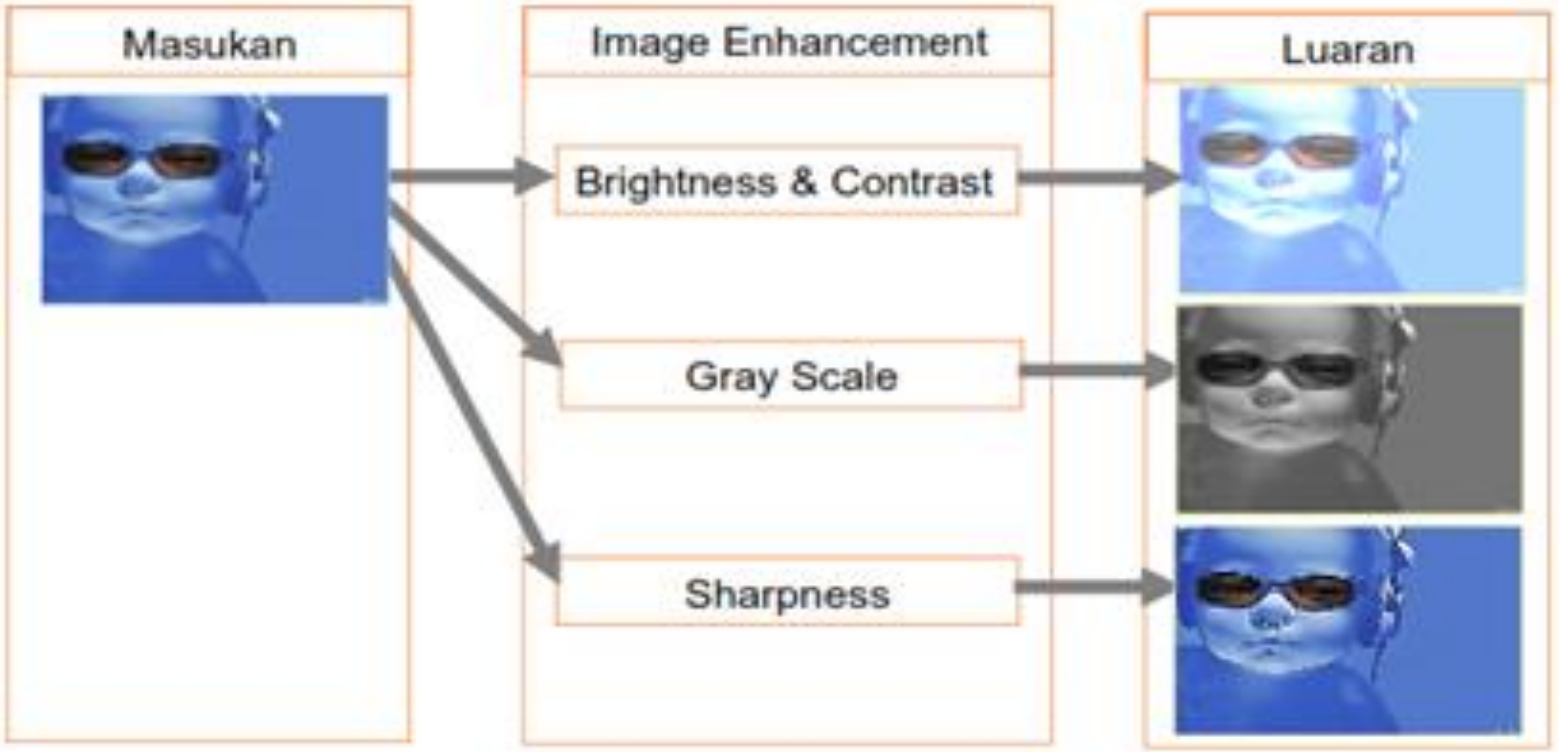


Image Restoration

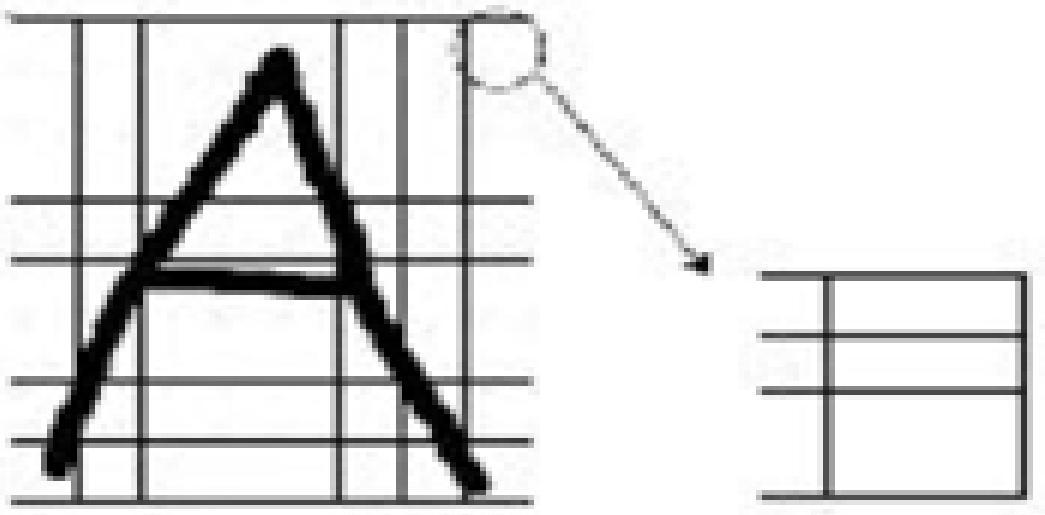
- The process of improving the image model, usually associated with the shape of the image

Color Image Processing

- A process that involves colored images, either in the form of image enhancements, image restoration, or others

Image Compression

- The process used to change the size of the data in the image so that the image size becomes smaller and does not occupy large storage memory



Morphological Processing

- Process to obtain information stating the description of a form in the image so that the image becomes easier to analyse.

Segmentation

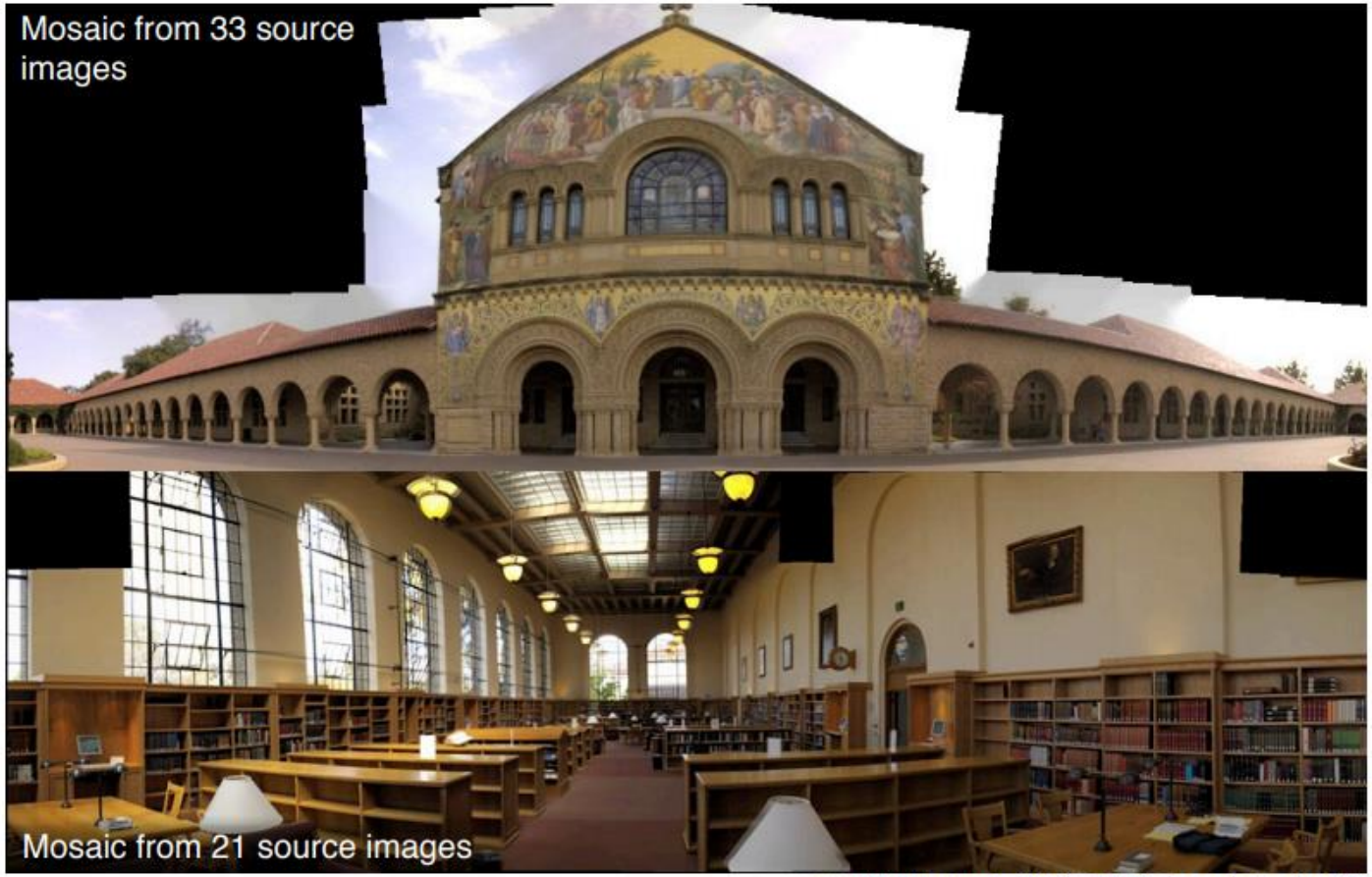
- The process of distinguishing or separating objects in an image, such as separating objects with their background

Object Recognition

- A process that is carried out to identify any objects in an image

DIP-based Applications

Image Snitching



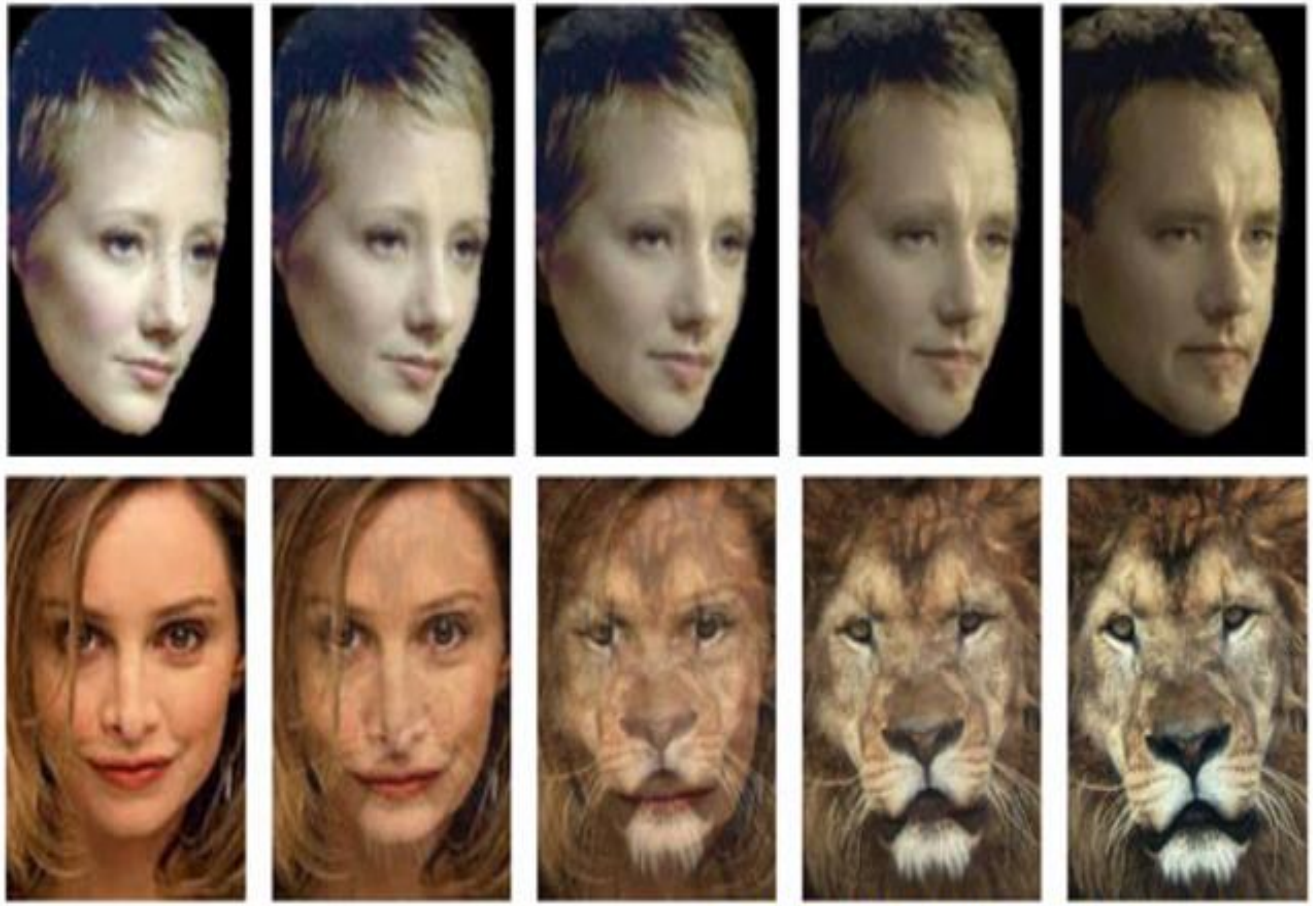
source: M. Borgmann, L. Meunier, EE368 class project, spring 2000.

Google Jump

facebook 360

light.co

Face Morphing



Source: Yi-Wen Liu and Yu-Li Hsueh, EE368 class project, spring 2000.

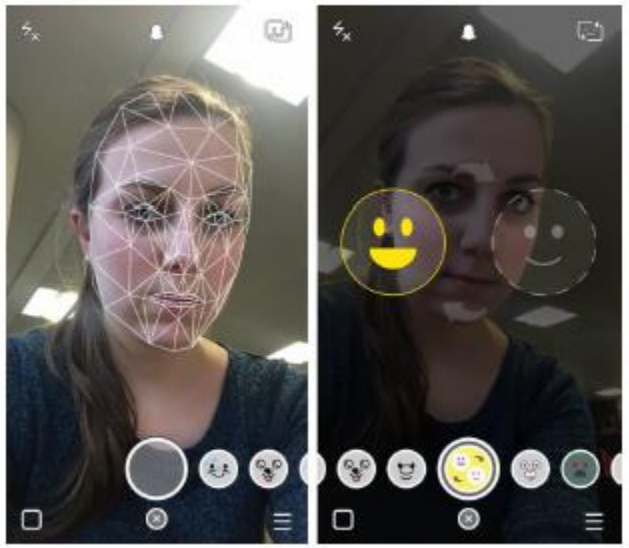
Optical Character Recognition

- Convert scanned docs to text

Digit recognition, AT&T labs
http://www.research.att.com/~yann/

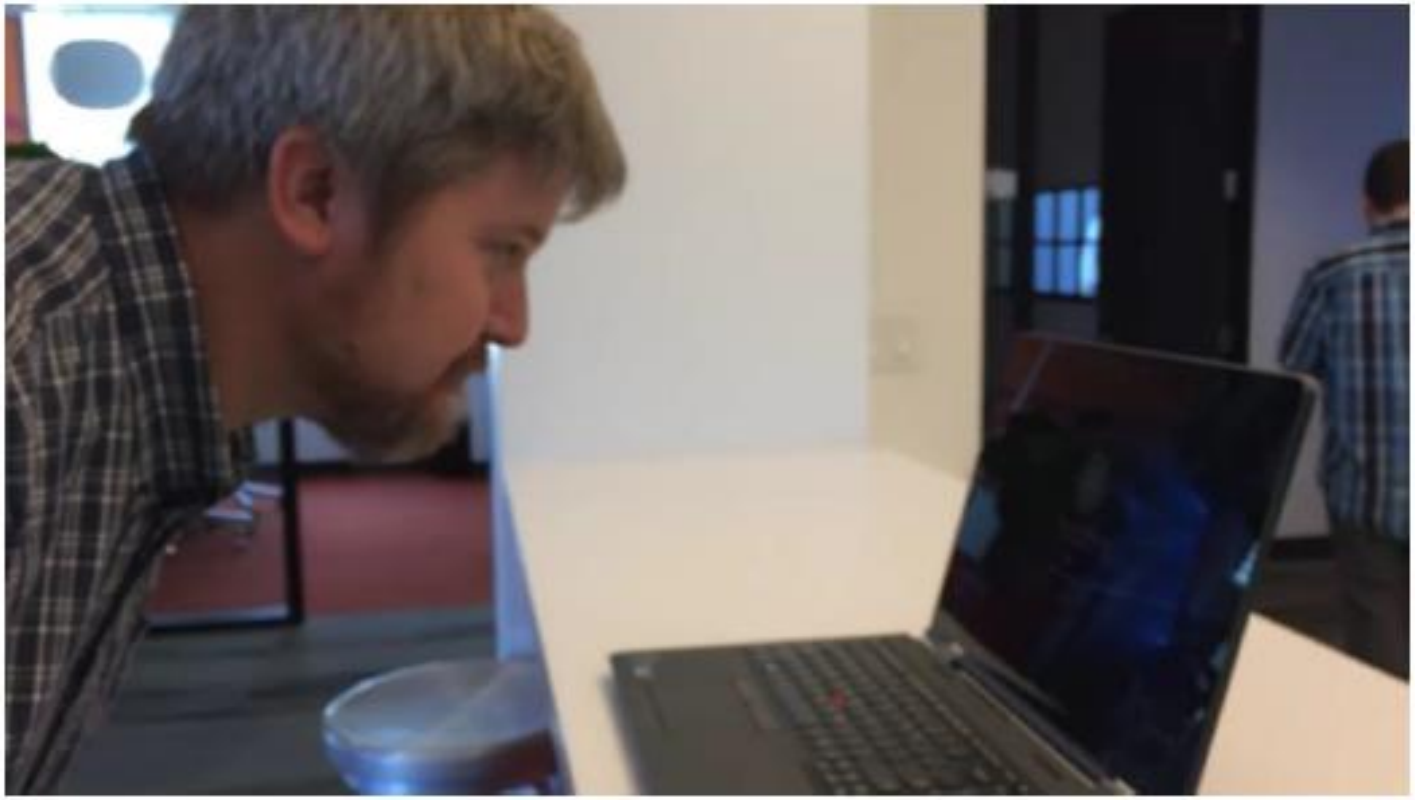
License plate readers
http://en.wikipedia.org/wiki/Automatic_number_plate_recognition

Face Detection



- Digital Camera
- Snapchat Application
- Automatic Facebook Tagging

Login Without Password



Login Without Password

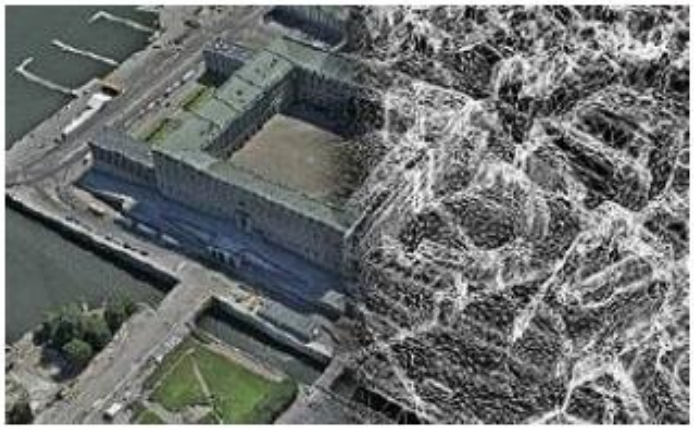
Style Transfer

Original photos

Style examples

Elias Wang, Nicholas Tan, EE368, 2016/17

3D Reconstruction



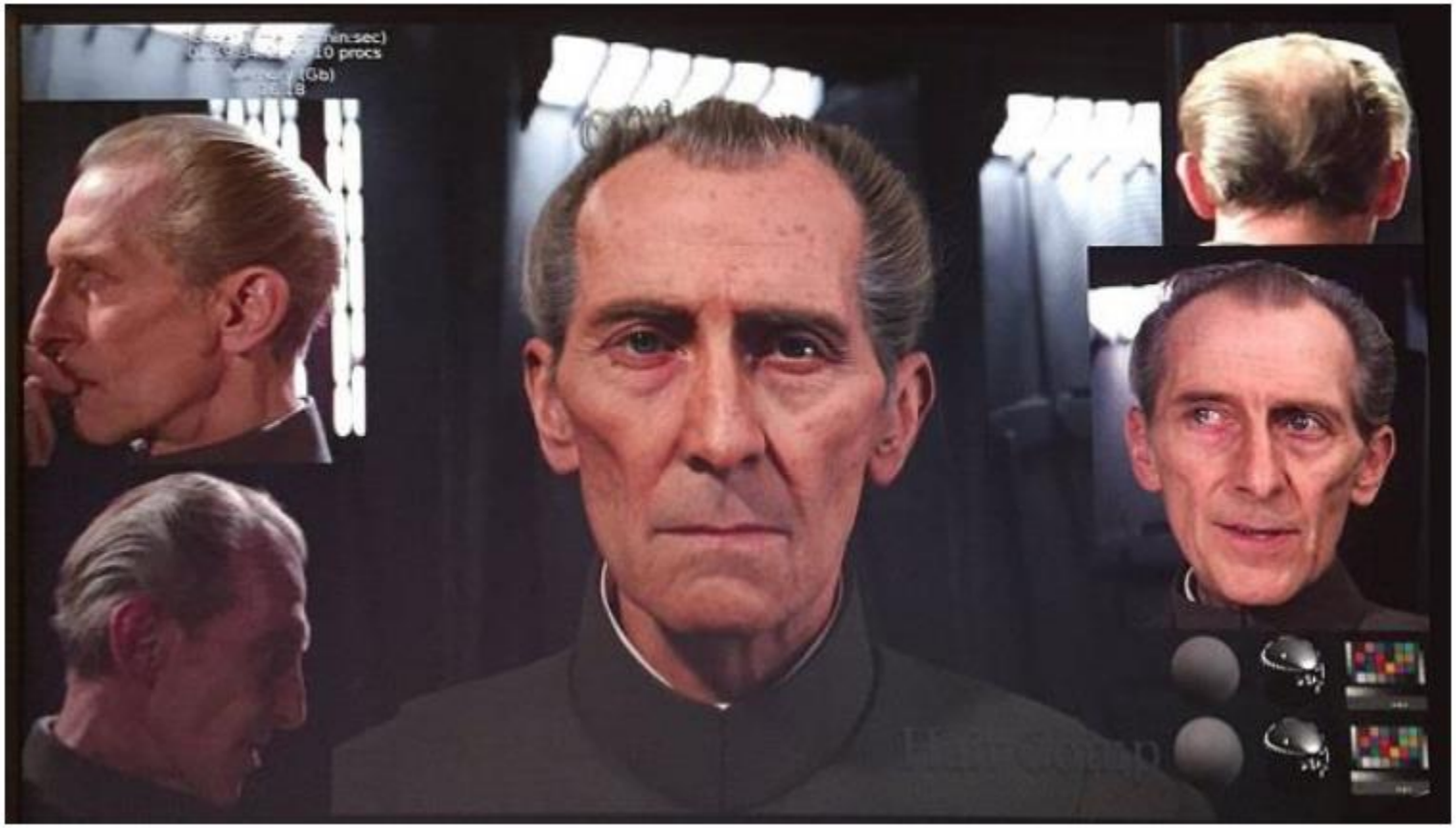
Building Rome in a Day: Agarwal et al. 2009

Human Shape Capture

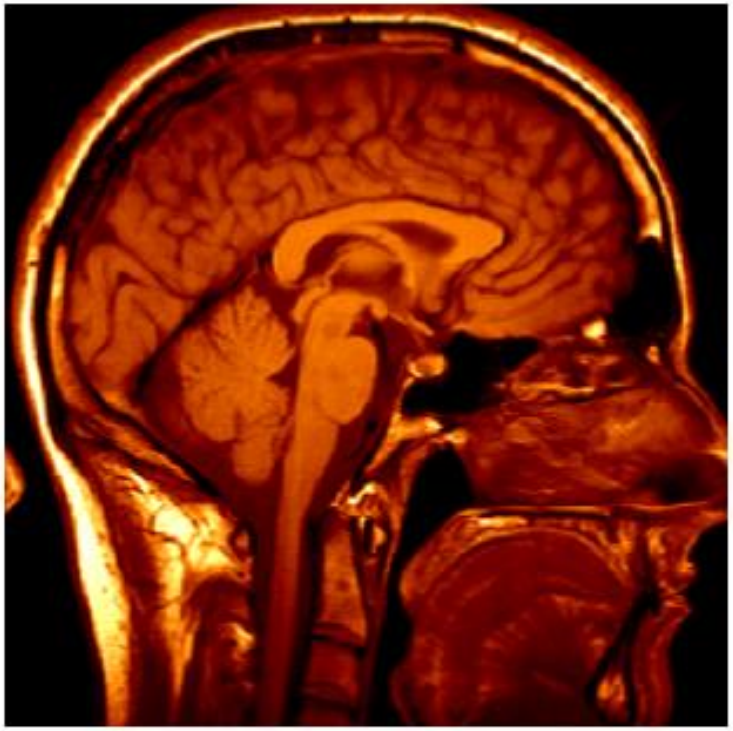
Human Shape Capture

Human Shape Capture

Special Effects: Shape Capture



Medical Imaging

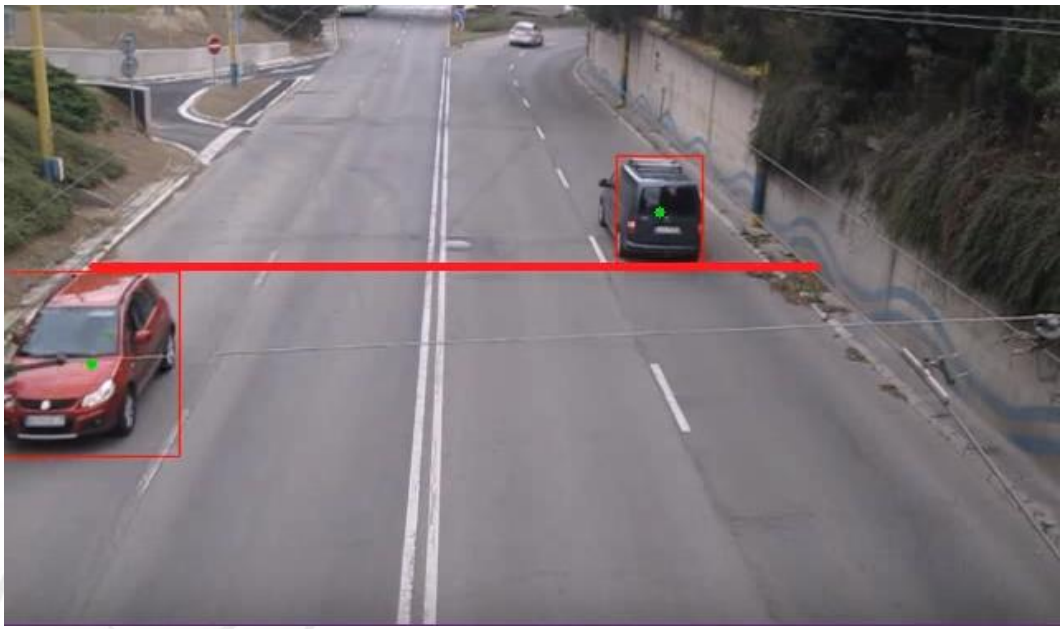


3D imaging
MRI, CT

Image guided surgery
Grimson et al., MIT

Traffic Monitoring

- One of the application in traffic monitoring is vehicle classification in counting



https://www.youtube.com/watch?v=z1Cvn3_4yGo

Surveillance System

- Sample cases
  - Abandoned baggage detection
  - Smoke and fire detection

http://islab.ulsan.ac.kr/ISS2016/ResultVideo/AbandonedObjectDetection/AOD-D04Out.mp4

https://www.youtube.com/watch?v=sK7eVFU1hLs

https://www.youtube.com/watch?v=DtWQiDlnPuU https://www.youtube.com/watch?v=DuRy-L5qWpc

Traffic Sign Recognition

- Classify the type of traffic sign

https://www.youtube.com/watch?v=lr5_4XXgjDY

Reading

- Popular text books
  - William K. Pratt, „Introduction to Digital Image Processing,“ CRC Press, 2013.
  - l R. C. Gonzalez, R. E. Woods, „Digital Image Processing,“ 4th edition, Pearson, 2018
- Software-based books
  - R. C. Gonzalez, R. E. Woods, S. L. Eddins, „Digital Image Processing using Matlab,“ 2nd edition, Gatesmark Publishing, 2009.
  - l G. Bradski, A. Kaehler, „Learning OpenCV,“ O‘Reilly Media, 2008.

Final Project

- Group project, ideally teams of 5-7 students
- Develop, implement and test/demonstrate an image processing algorithm
- Topics: DIP based Smart City Applications
  - Do not be overly ambitious in your project goals!
- Grade:
  - Technical quality, significance, and originality 50%
  - Written report 25%
  - Poster/demo 25%
- Schedules
  - Proposal submission: **August 31, 2018**
  - Report submission: **November 10, 2018**
  - Project presentation: Poster presentation and demo (Time: TBA)

Project Proposal

- Written project proposal in pdf format
- Submit by email to **wahyo@ugm.ac.id**
- Submit early for a head start, but no later than deadline otherwise your team will get -5 points/days.
- Proposal must contain:
  - Title
  - Names and email addresses of all team members
  - Description of the goals of the project (200-400 words)
  - Methodology
  - 3+ references
  - Indication whether you will use an Android device

Challenge Project (Optional)

- You may submit your group project to any competitions such as GEMASTIK.
- Your team will get following rewards according to achievements

Achievement	Reward	Notes
Finalist	A-	Attendance >= 9 meeting
Winner	A	Attendance >= 9 meeting

- To get this reward, you should submit the certificate before Final-Term Examination

THANK YOU

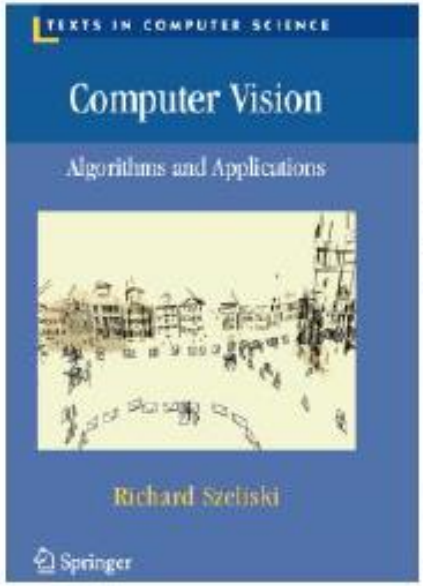
Mengakar Kuat
Menjulang
Tinggi

Final Project

- Group project, ideally teams of 5-7 students
- Select following tasks
  - Fire/smoke detection
  - Flood detection
  - Cancer detection on medical image
  - Fish classification
  - Vehicle type classification (model, brand, color)
  - Skin disease detection
  - Pornography image classification
  - Facial expression recognition
  - Identification card recognition
  - Tourist object

Text Book

Computer Vision: Algorithms and Applications



http://szeliski.org/Book/