SLIIT

Discover Your Future

IT4130 –Image Understanding and Processing

Lecture 01

Course Details

- Lectures: 2 hours/week
- Tutorial: 1 hour/week
- Labs: 2 hours/week
- Contacting the lecturer:
  - Send an email to sanji.c@sliit.lk for an appointment.
  - phone: ext. 4144

Evaluation

- Mid Term exam 20%
- Continuous Assessment 30%
  - Practical Assessment
  - Tutorial Assessment
- Final exam 50%

Organization of the course

- Broad topic areas
  - Introduction
  - Image acquisition and formation
  - Image enhancement
    - Intensity transformations
    - Spatial transformations
  - Restoration and de-noising
  - Edge detection
  - Morphological operations
  - Color Image processing

References

- Digital Image Processing by Rafael C. Gonzalez and Richard E. Woods

- Learning OpenCV: Computer Vision with the OpenCV Library by Gary Bradski and Adrian Kaehler

Digital Image Processing

Why do we need Image Processing?

It is motivated by two major applications:

- Improvement of pictorial information for human perception
- Image processing for autonomous machine application
- Efficient storage and transmission

Human Perception

Employ methods capable of enhancing pictorial information for human interpretation and analysis

Typical Applications:

- Noise Filtering
- Content Enhancement
  - Contrast enhancement
  - De-blurring
- Remote Sensing

Filtering

Noisy Image

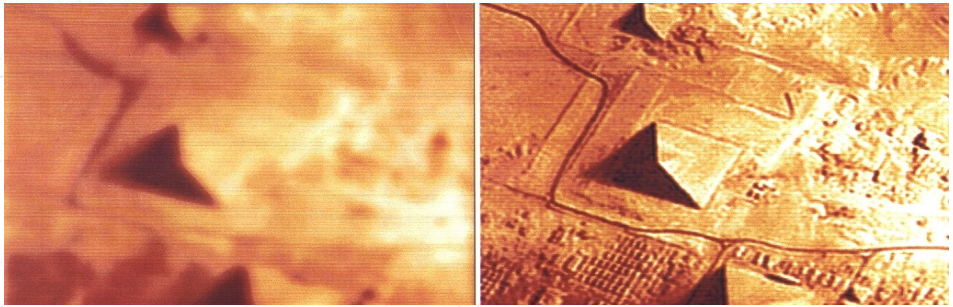
Filtered Image

Image Enhancement

Low contrast Image

Enhanced Image

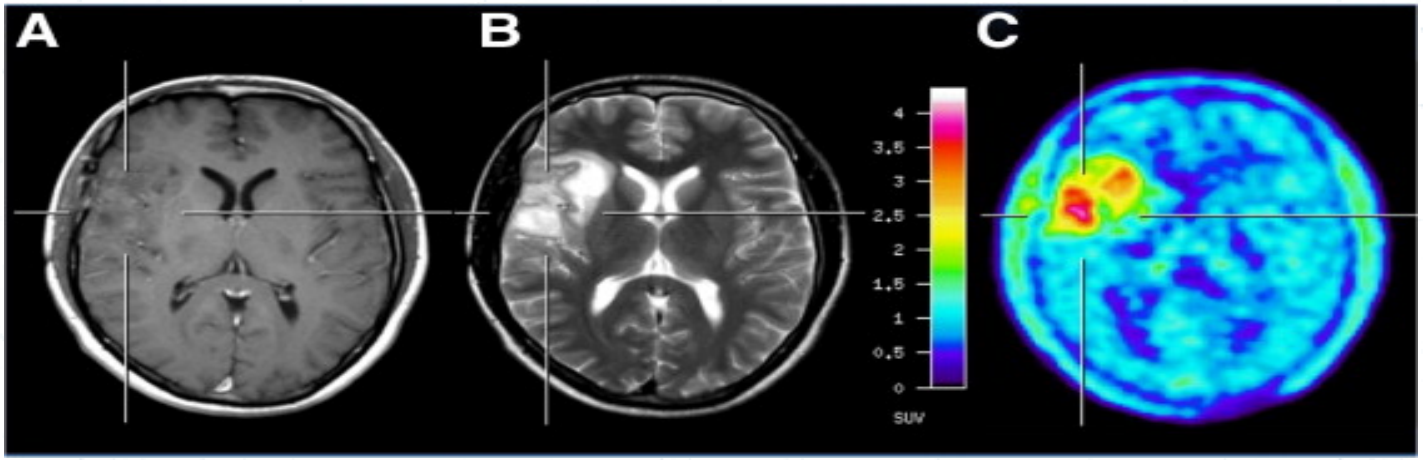
Image De-blurring



Defocused De-blurred

Motion Blurred De-blurred

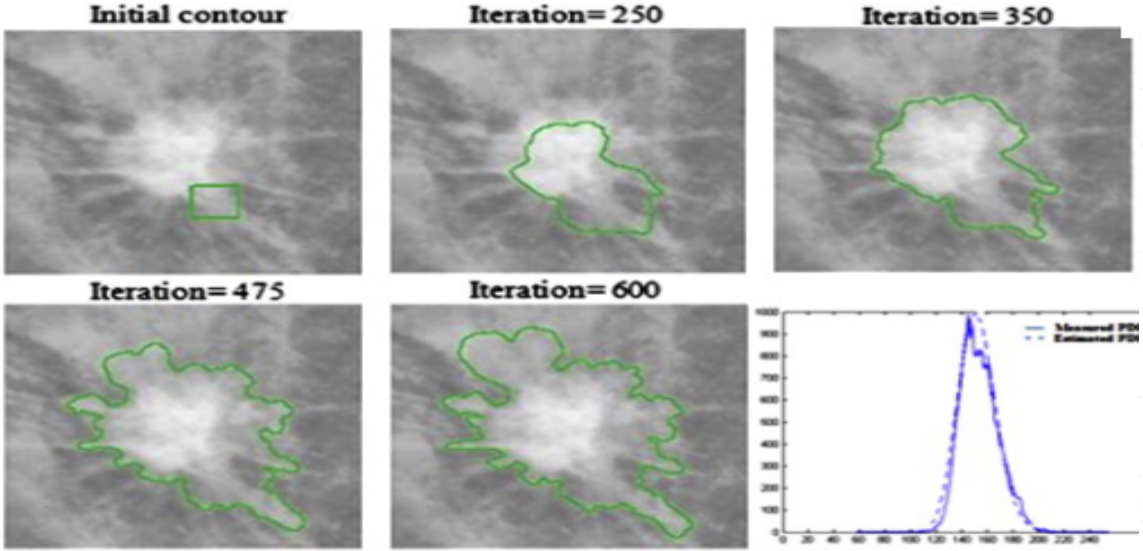
Medical Imaging



Brain Tumor

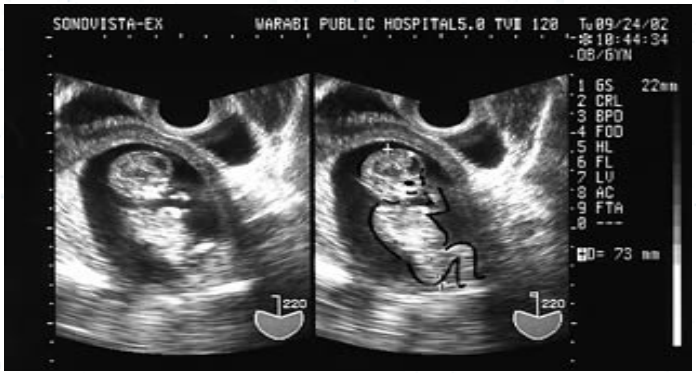
Medical Imaging

Mammogram



Cancer Detection

Medical Imaging

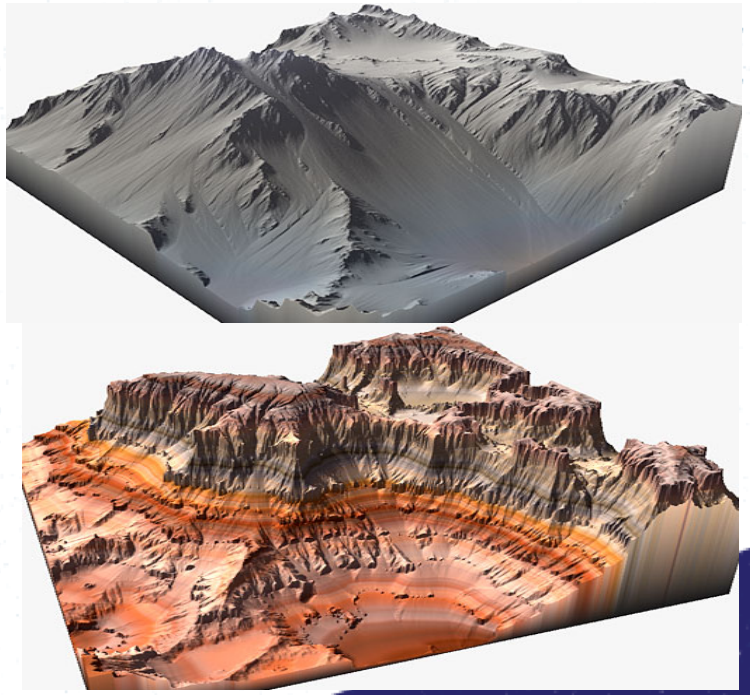


Ultra Sonogram

Remote Sensing

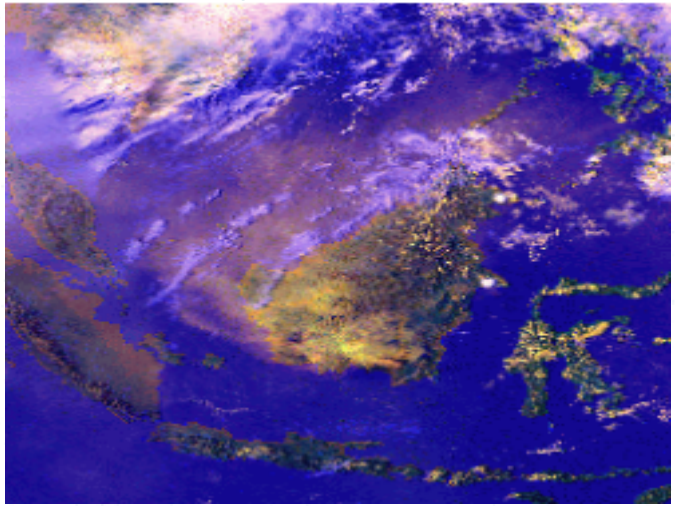
Satellite Image

Remote Sensing



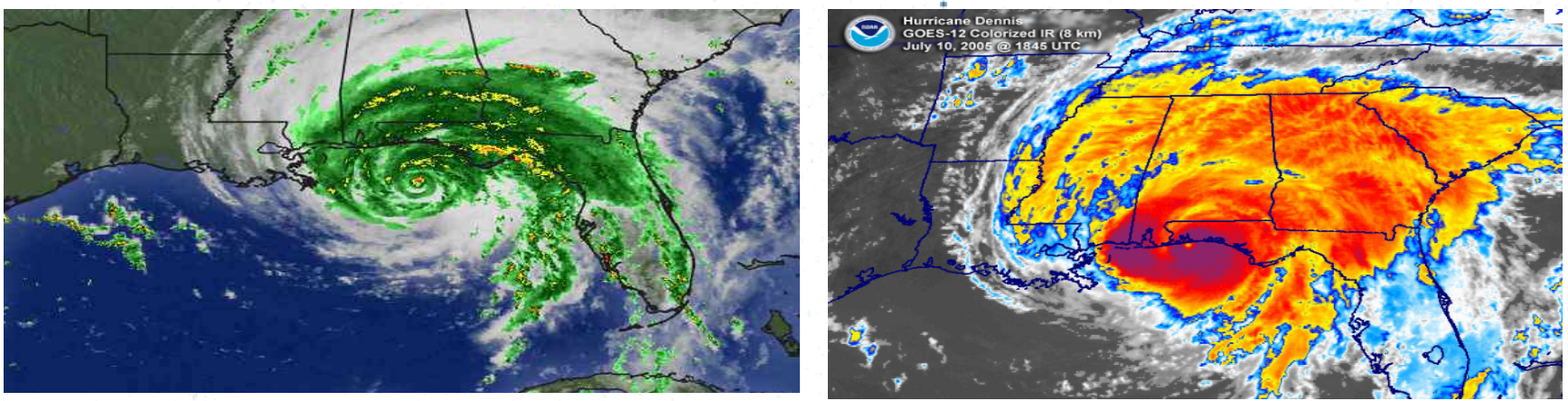
Terrain Mapping

Remote Sensing



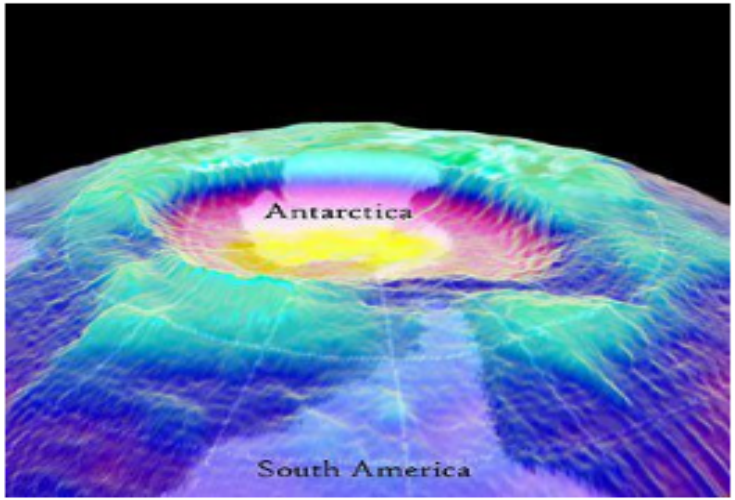
Borneo Fire

Weather Forecasting



Hurricane over Dennis 1990

Atmospheric Study



Source: NASA

Ozone Hole

Astronomy

Galaxy

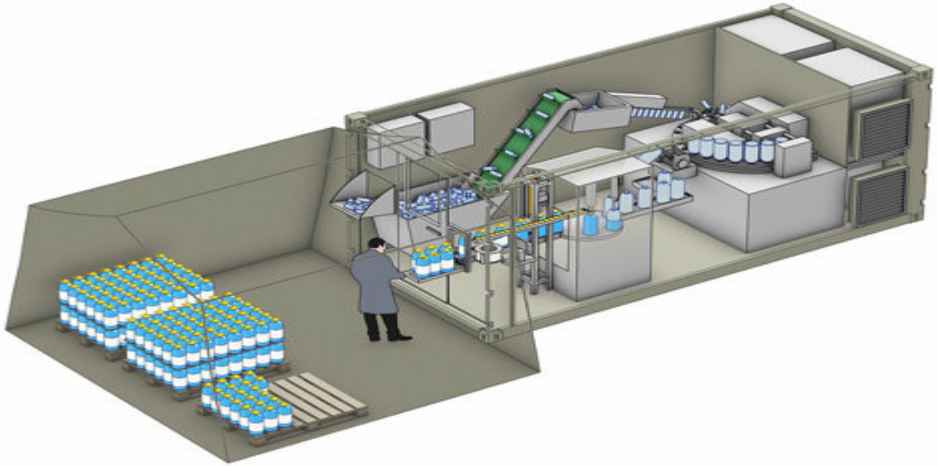
Machine Vision Applications

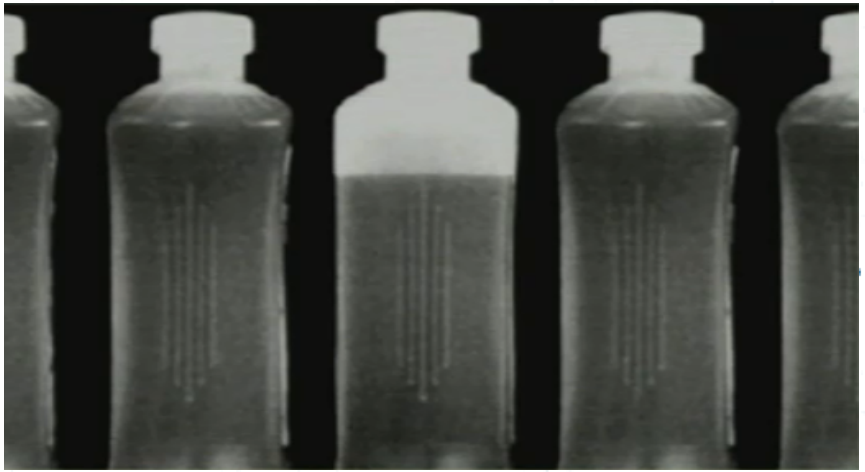
Here the interest is on procedures for extraction of image information suitable for computer processing

Typical Applications:

- Industrial Machine Vision for product assembly and inspection
- Automated Target detection and tracking
- Finger print recognition
- Machine processing of aerial and satellite imagery for weather prediction and crop assessments

Automated Inspection



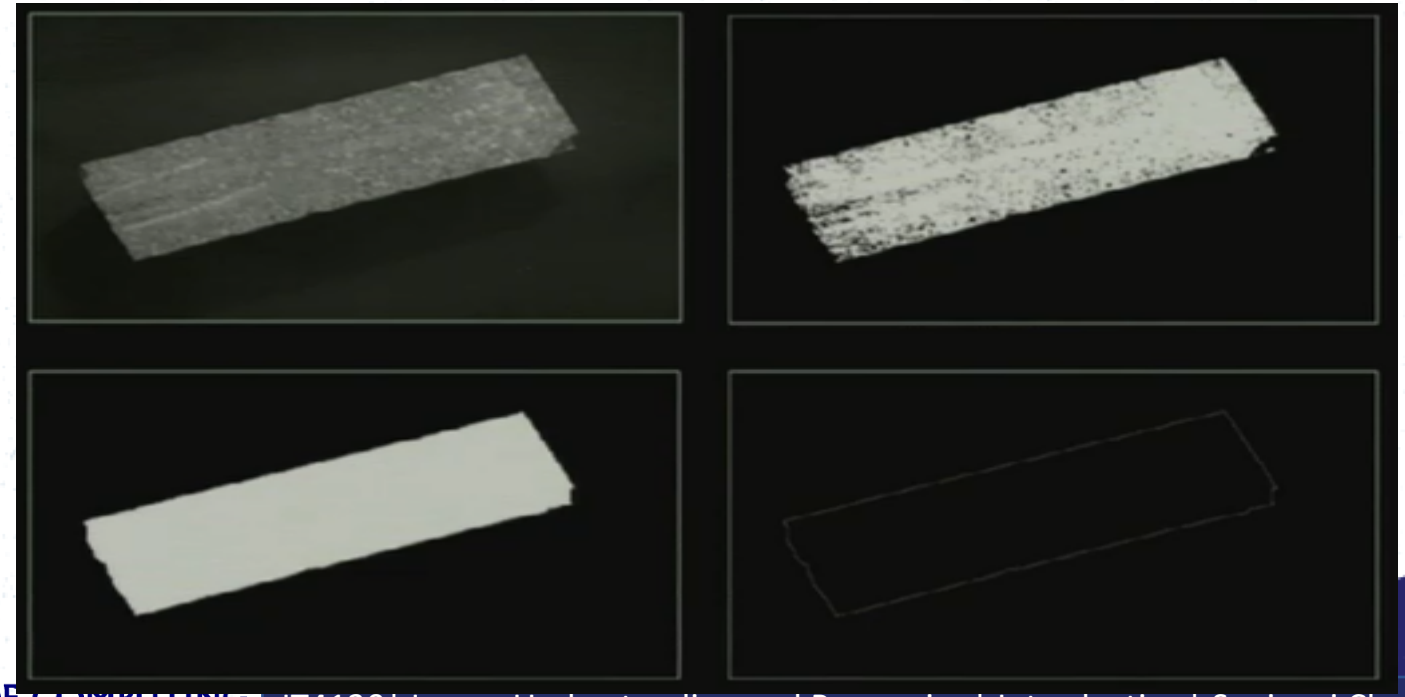


Bottling Plant Automation

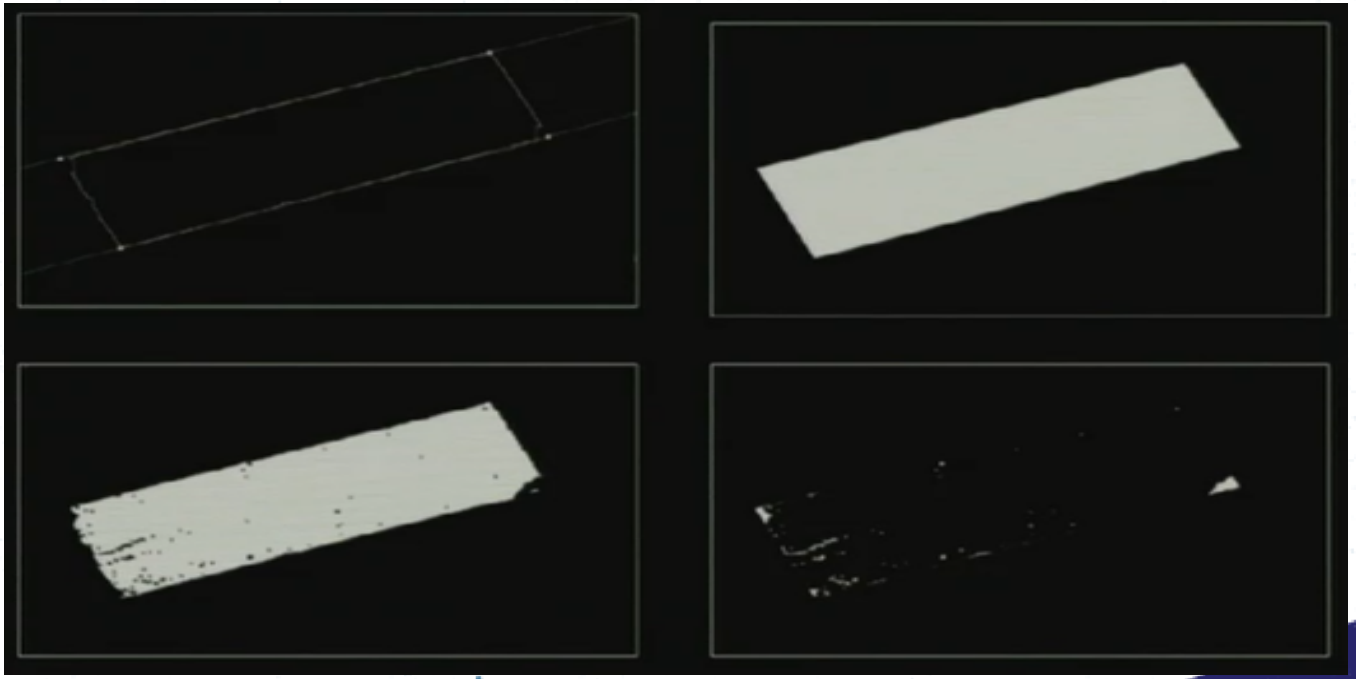
Boundary Information

Importance of
Boundary Information

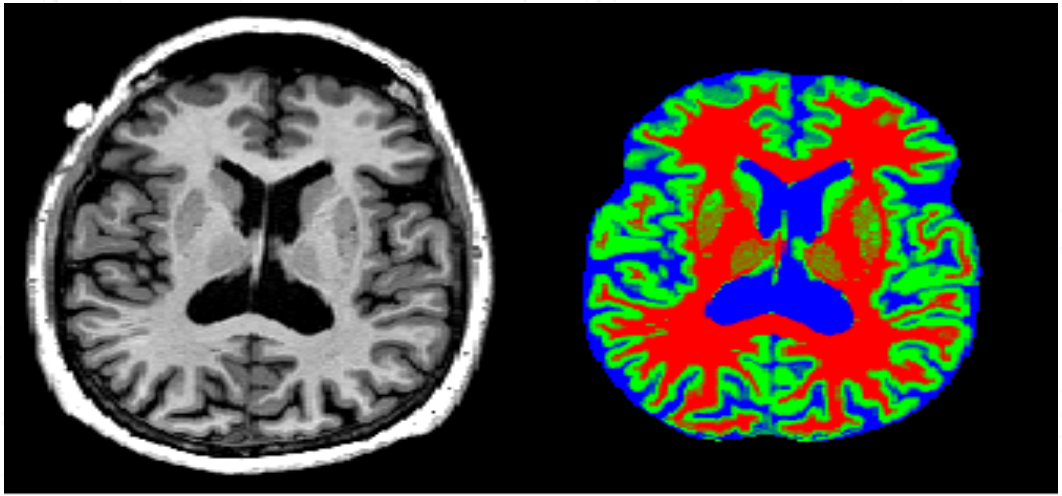
Automated Inspection



Automated Inspection

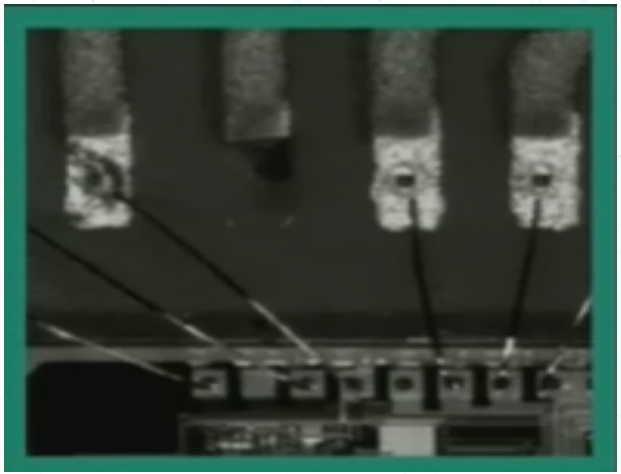


Automated Inspection



Inspection of MRI

Automated Inspection



Inspection of IC Manufacturing

Video Sequence Processing

The major emphasis of image sequence processing is detection of moving parts

This has various applications:

- Detection and tracking of moving targets for security surveillance purpose
- To find out the trajectory of a moving target
- Monitoring the movements of organ boundaries in medical applications

MathWorks

Video Processing in MATLAB

Ramnarayan Krishnamurthy

Movement Detection

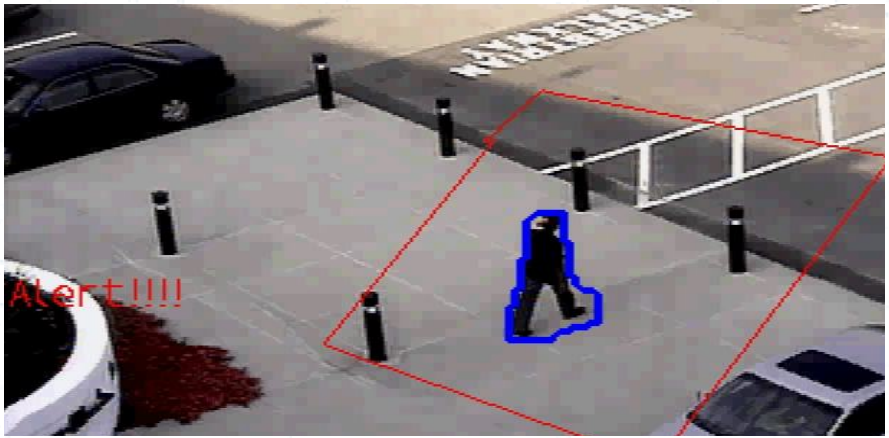


Image Compression

An image usually contains lot of redundancy that can be exploited to achieve compression

- Pixel Redundancy
- Coding Redundancy
- Psycho-visual Redundancy

Application:

- Reduced storage
- Reduced the Bandwidth

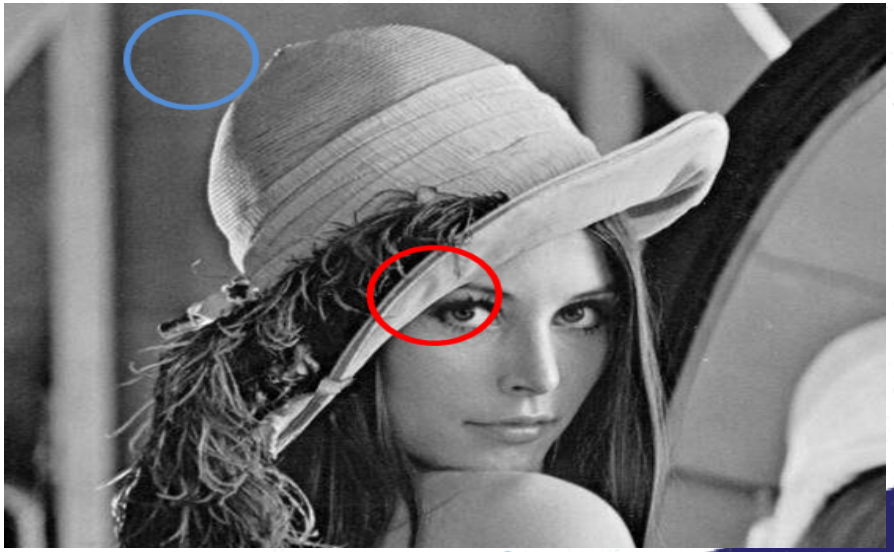


Image Compression

Original Image

1 : 55

1 : 156

Image Compression: JPEG

JPEG quality level

File size in bytes

Some History

- In 1920s, submarine cables were used to transmit digitized newspaper pictures between London and New York – Bartline Systems
- Specialized printing equipments were used to code the pictures for cable transmission and its reproduction on the receiving end

- This picture was produced by a telegraphic printer

Brief History

- Bartlane System was capable of coding 5 distinct brightness levels
- This was increased to 15 levels by 1929

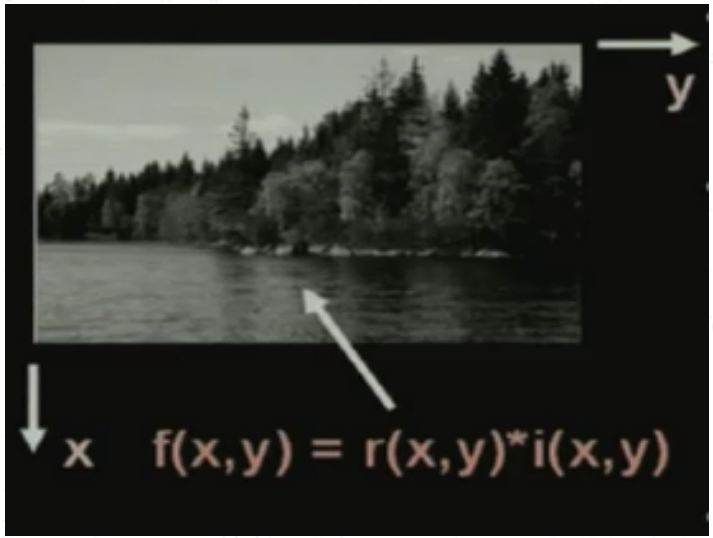
Brief History

- In 1921, printing procedure was changed to photographic reproduction from taps perforated at telegraph receiving terminals
- This improved both tonal quality and resolution

Brief History

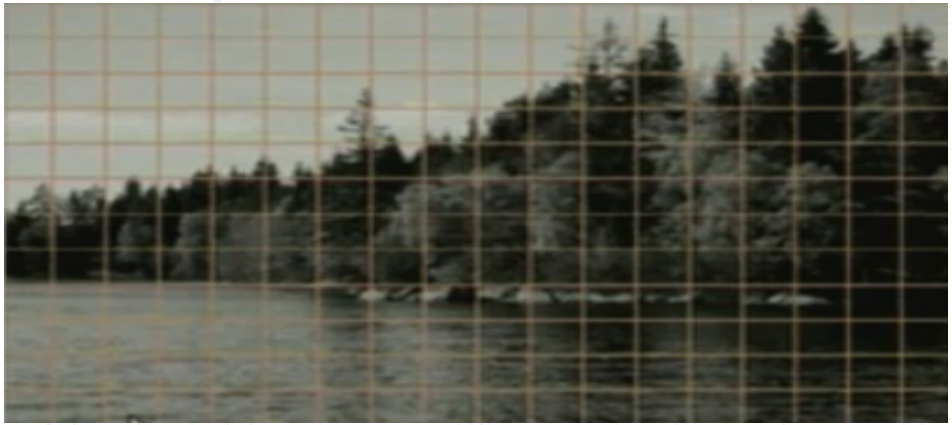
- Improvement of processing techniques continued for next 35 years
- In 1964 computer processing techniques were used to improve the pictures of moon transmitted by Ranger 7 at Jet Propulsion Laboratory
- This was the basis of modern Image Processing Techniques

Image Representation



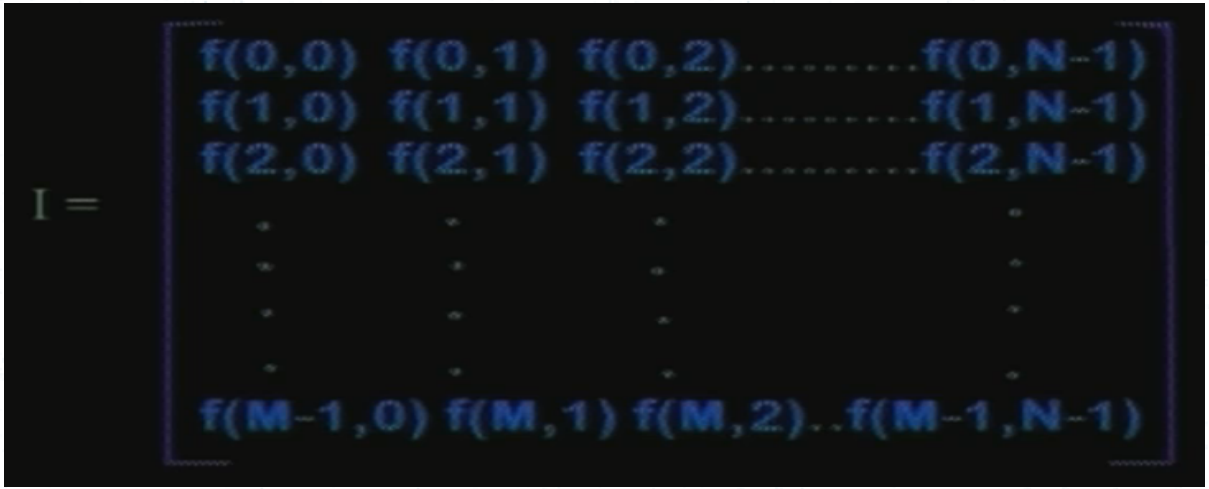
- An image is a 2D light intensity function f(x,y)
- A digital image f(x,y) is discretized both in spatial coordinates and brightness
- It can be considered as a matrix whose row, column indices specify a point in the image and the element value identifies gray level value at that point
- These elements are referred to as **pixels**

Image Representation



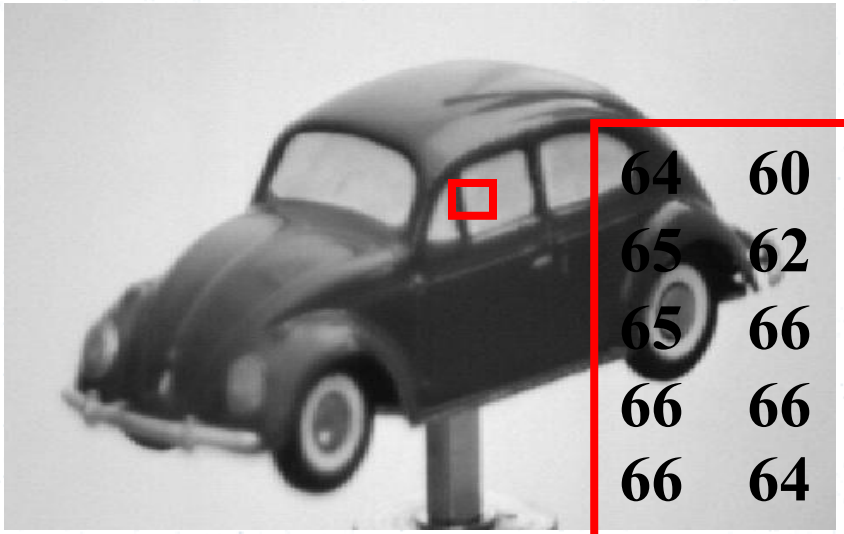
- Spatial discretization by grids
- Intensity discretization by quantization

Image Representation



- Image Size: 256 x 256, 512x 512, 640x 480, 1024x 1024, etc…

Image Representation



64	60	69	100	149	151	176	182	179
65	62	68	97	145	148	175	183	181
65	66	70	95	142	146	176	185	184
66	66	68	90	135	140	172	184	184
66	64	64	84	129	134	168	181	182
59	63	62	88	130	128	166	185	180
60	62	60	85	127	125	163	183	178
62	62	58	81	122	120	160	181	176

Image Representation

	x = 58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
41	210	209	204	202	197	247	143	71	64	80	84	54	54	57	58
42	206	196	203	197	195	210	207	56	63	58	53	53	61	62	51
43	201	207	192	201	198	213	156	69	65	57	55	52	53	60	50
44	216	206	211	193	202	207	208	57	69	60	55	77	49	62	61
45	221	206	211	194	196	197	220	56	63	60	55	46	97	58	106
46	209	214	224	199	194	193	204	173	64	60	59	51	62	56	48
47	204	212	213	208	191	190	191	214	60	62	66	76	51	49	55
48	214	215	215	207	208	180	172	188	69	72	55	49	56	52	56
49	209	205	214	205	204	196	187	196	86	62	66	87	57	60	48
50	208	209	205	203	202	186	174	185	149	71	63	55	55	45	56
51	207	210	211	199	217	194	183	177	209	90	62	64	52	93	52
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53	204	206	203	209	195	203	188	185	183	221	75	61	58	60	60
54	200	203	199	236	188	197	183	190	183	196	122	63	58	64	66
55	205	210	202	203	199	197	196	181	173	186	105	62	57	64	63

Three types of images:

- Gray-scale images

  $I(x,y) \in [0..255]$

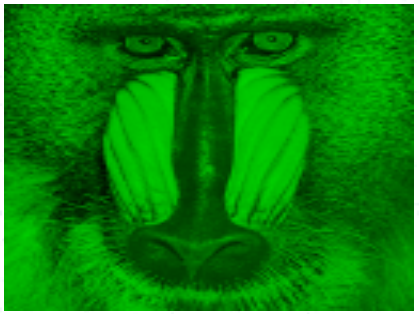
- Binary images

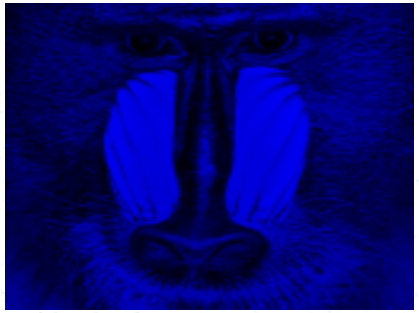
  $I(x,y) \in \{0 , 1\}$

- Color images

  $I_R(x,y)$ $I_G(x,y)$ $I_B(x,y)$

Color Image





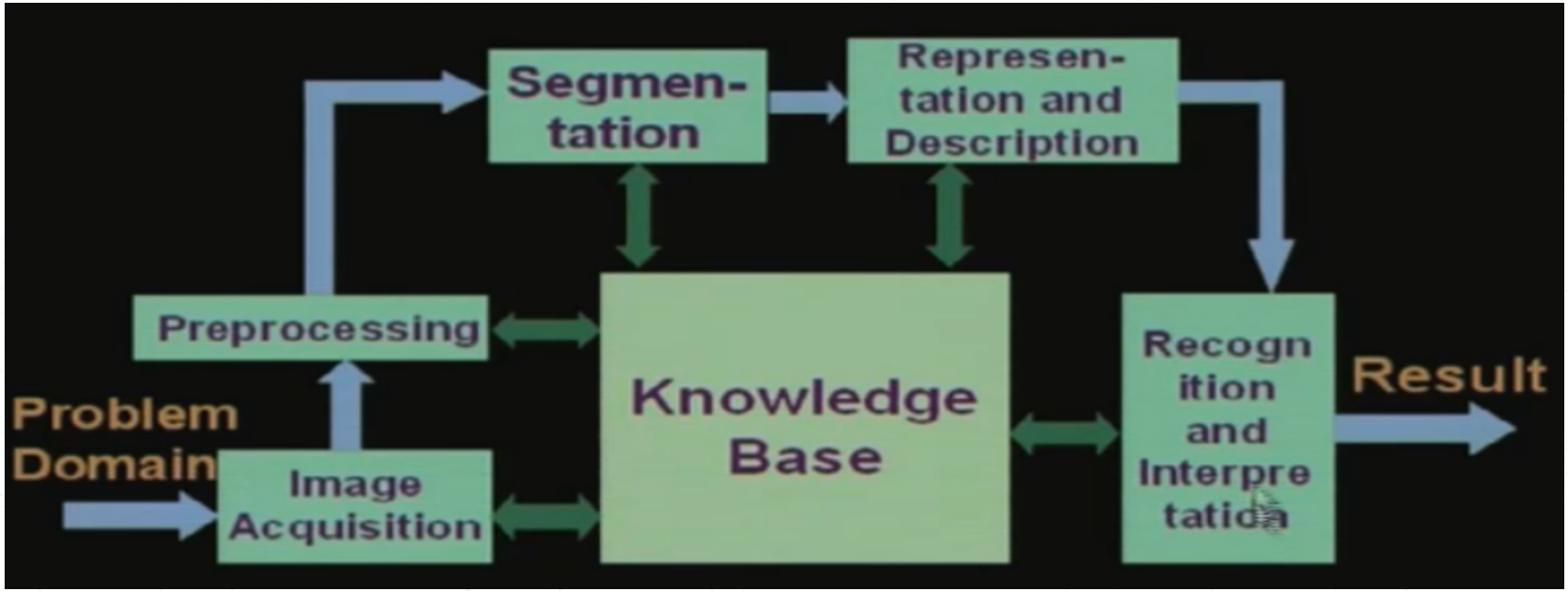
Steps in Digital Image Processing

- **Image Acquisition**: An imaging sensor and the capabilities to digitize the signal produced by the sensor
- **Preprocessing**: Enhance the image quality, filtering, contrast enhancement, etc…
- **Segmentation**: Partitions an input image into constitute parts of objects

Steps in Digital Image Processing

- **Description/Feature Selection**: Extracts description of image objects suitable for further computer processing
- **Recognition & Interpretation**: Assigning a label to the object based on the information provided by the descriptor. Interpretation assigns meaning to a set of labeled objects
- **Knowledge Base**: Knowledge Base helps for efficient processing as well as inter module cooperation

Steps in Digital Image Processing



The initial step in any image processing technique is

Select one:

a. Segmentation

b. Masking

c. Image acquisition

d. Normalization

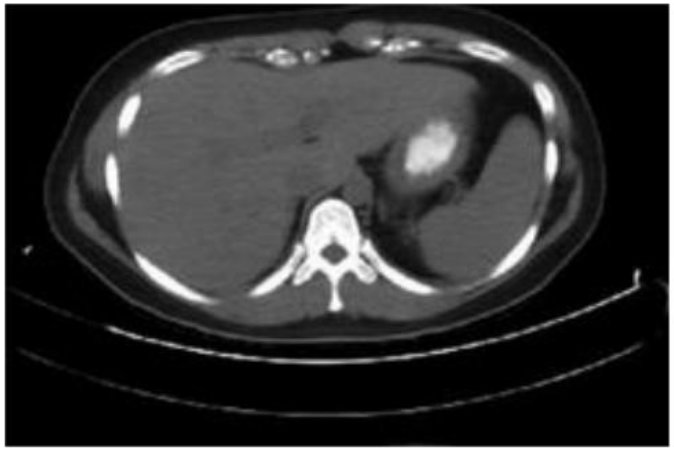
e. None of the above

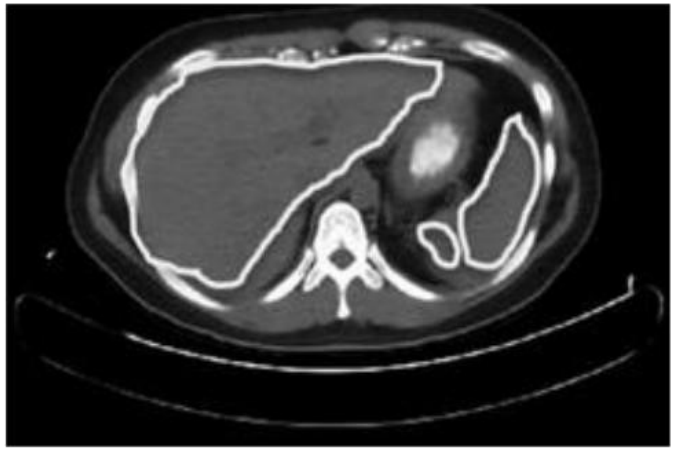
_____ is the most reliable and accurate bio-metric identification technique.

Select one:

- a. Computer vision
- b. Iris recognition
- c. Medical imaging
- d. Remote sensing
- e. None of the above

Consider the input and output images given below.





Which of the following image processing technique gives the given output image?

Select one:

- a. Noise reduction
- b. Boundary Detection
- c. Image Segmentation
- d. De-blurring
- e. None of the above

As a final year project requirement, assume you have to send a square image with a length of 2048 pixels to your group members. The image is a color image with each color having 256 intensity levels. If the mail system allows you to send files up to a maximum size of 8 MB (MegaBytes).

What is the total number of bits required to store the original image?

Select one:

- a. 2048*2048*8 bits
- b. 2048*2048*256 bits
- c. 2048*2048*256*3 bits
- d. 2048*2048*8*3 bits
- e. None of the above

As a final year project requirement, assume you have to send a square image with a length of 2048 pixels to your group members. The image is a color image with each color having 256 intensity levels. If the mail system allows you to send files up to a maximum size of 8 MB (MegaBytes).

How many bits of each color will it require to compress and send the file to your group members in such a way that it retains the important features of the image?

Select one:

- a. 7 bits
- b. None of the above
- c. 8 bits
- d. 6 bits
- e. 5 bits