Digital Image Processing

Instructor: Hossein Pourghassem
Islamic Azad University of Najafabad
Department of Electrical Engineering

References

- Fundamentals of Digital Image Processing, A. K. Jain,
Evaluation

- Assignments 5 Point
- Final exam 10 Point
- Final Project 5 Point

Definitions

- Image Processing
- Computer Vision
- Low Level Processes: Primitive operations such as image preprocessing to reduce noise, contrast enhancement and image sharpening (input and output of this stage are image).
- Mid-Level Processes: segmentation, description and recognition (classification). (input is image and output is extracted attribute of image in this stage).
- High Level Processes: understanding groups of objects (making sense).
Image Formation

World | Optics | Sensor | Digital Representation

World: reality
Optics: focus {light} from world on sensor
Sensor: converts {light} to {electrical energy}
Signal: representation of incident light as continuous electrical energy
Digitizer: converts continuous signal to discrete signal
Digital Rep.: final representation of reality in computer memory

Initial Examples of Imagery

Figure 1.1 A digital picture produced in 1921 from a coded tape by a telegraph printer with special type faces. (McFarlane.)

Figure 1.2 A digital picture made in 1922 from a tape punched after the signals had crossed the Atlantic twice. Some errors are visible. (McFarlane.)
Digital Image Processing

The electromagnetic spectrum

- Gamma-Ray Imaging.
- X-Ray Imaging.
- Ultraviolet Imaging.
- Visible and Infrared Imaging.
- Microwave Imaging (Radar).
- Radio band Imaging.
- Other Imaging Modalities (Sound).
Example of Gamma-Ray Imaging

Example of X-Ray Imaging.
Example of Ultraviolet Imaging

Spectral image of normal and abnormal corn

Example of Visible Imaging

Microscopic Images of Biologic material
Example of Infrared Imaging

Figure 1.10 LANDSAT satellite images of the Washington, D.C. area. The numbers refer to the thematic bands in Table 1.1. (Images courtesy of NASA.)

Islamic Azad University of Najafabad, Department of Electrical Engineering, Dr. H. Pourghassem

Example of Infrared Imaging

Islamic Azad University of Najafabad, Department of Electrical Engineering, Dr. H. Pourghassem
The unique feature of imaging radar is its ability to collect data over virtually any region at any time, regardless of weather or ambient lighting conditions.

Radio band Imaging

FIGURE 1.16
Spaceborne radar image of mountains in southeast Tibet. (Courtesy of NASA.)

FIGURE 1.17
MRI images of a human (a) knee, and (b) spine. (Image (a) courtesy of Dr. Thomas R. Gust, Division of Anatomical Sciences, University of Michigan Medical School, and (b) Dr. David R. Pickens, Department of Radiology and Radiological Sciences, Vanderbilt University Medical Center.)
**Other Imaging Modalities (Ultrasound)**

- Ultrasound imaging in geological exploration, industry and medicine.

**Important Stages in Image Processing**

- Image Acquisition
- Preprocessing (Enhancement and Restoration):
  - Enhancement is subjective.
  - Restoration is objective.
- Segmentation
- Representation and Description
- Recognition and Interpretation
- Knowledge base
Important Stages in Image Processing

Image Acquisition

- Imaging sensor & capability to digitize the signal collected by the sensor:
  - Video camera
  - Digital camera
  - Conventional camera & analog-to-digital converter
Preprocessing

- To improve the image to ensure the success of further processes.

  e.g.
  - enhancing contrast
  - removing noise
  - identifying information-rich areas.

Segmentation

- To partition the image into its constituent parts (objects)

  Autonomous segmentation (very difficult)
  - Can facilitate or disturb subsequent processes.

  Output (representation):
  - Raw pixel data, depicting either boundaries or whole regions (corners vs. texture for example).
  - Need conversion to a form suitable for computer processing.
**Representation & Description**

- Feature selection (description) deals with extracting:
  - features that result in quantitative information of interest or
  - features that are important for differentiating one class of objects from another.

**Recognition & Interpretation**

- **Recognition:**
  - To assign a label to an object based on information provided by the descriptors.

- **Interpretation:**
  - To assign meaning to a group of recognized objects.
Knowledge-Base

- **Knowledge-base Image Processing**
  - Guides the operation of each processing module and controls the interaction between modules.
  - Interpret and deduce high level information (semantic features) from low level information feature (visual features).

Comments

- Image enhancement for human visual interpretation usually stops at preprocessing.

- Recognition and interpretation are associated with image analysis applications where the objective is automation (automated extraction of information from images).
Components of an Image Processing System

Network

- Image displays
- Computer
- Mass storage
- Hardecopy
- Specialized image processing hardware
- Image processing software
- Problem domain
- Image sensors

Fundamental steps in digital Image processing

Outputs of these processes generally are images

- CHAPTER 6: Color image processing
- CHAPTER 7: Wavelets and multiresolution processing
- CHAPTER 8: Compression
- CHAPTER 9: Morphological processing
- CHAPTER 10: Segmentation
- CHAPTER 11: Representation & description
- CHAPTER 12: Object recognition

Knowledge base