Chapter 1. Introduction

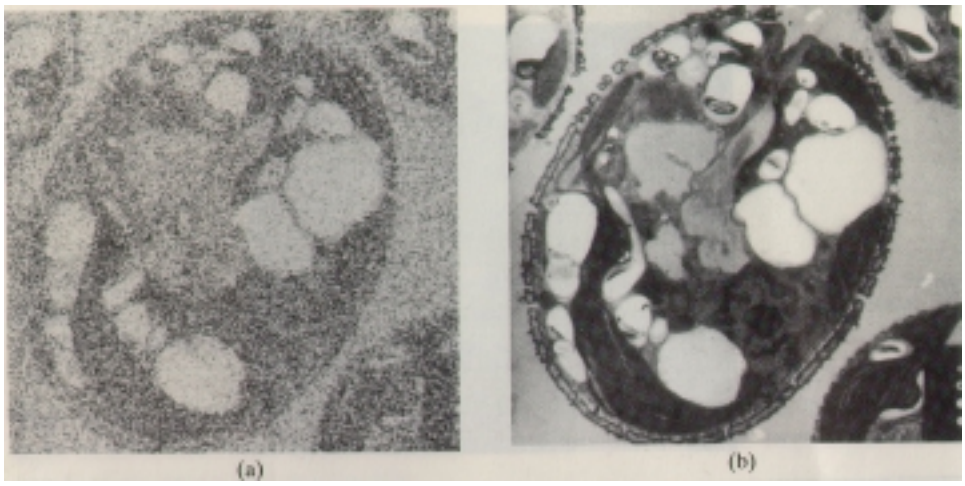
1.1 Background

Interest in DIP

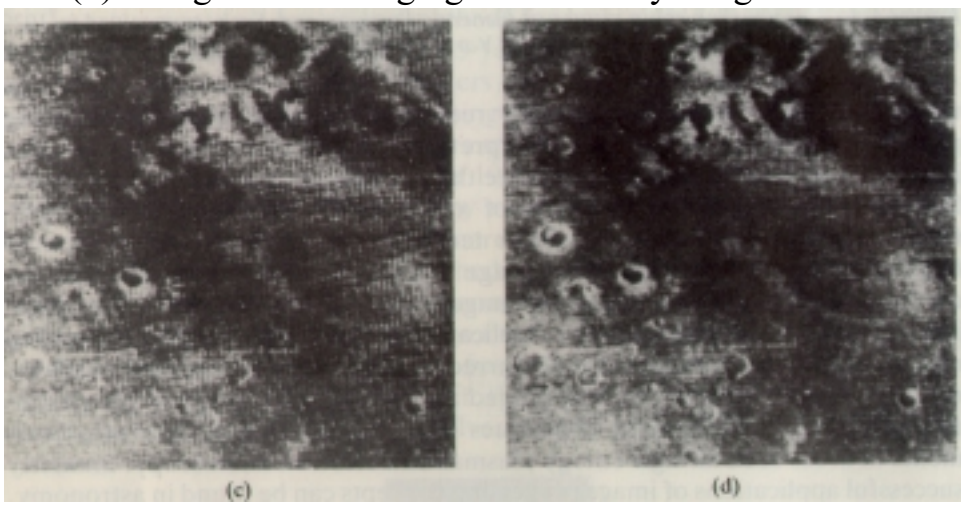
- human interpretation
- machine perception

- In medicine, for easier interpretation of x-rays and other biomedical images
  - enhance the contrast
  - code the intensity levels onto colors
    : methods capable of enhancing pictorial information for human interpretation and analysis
- Geographers
  - use the similar techs. to study pollution pattern from aerial and satellite imagery
- Archeology
  - image restoration
- Physics
  - image enhancement in areas such as high-energy plasmas and electron microscopy.
- Successful applications of image processing concepts
  - astronomy, biology, nuclear medicine, defense, industry, law enforcement

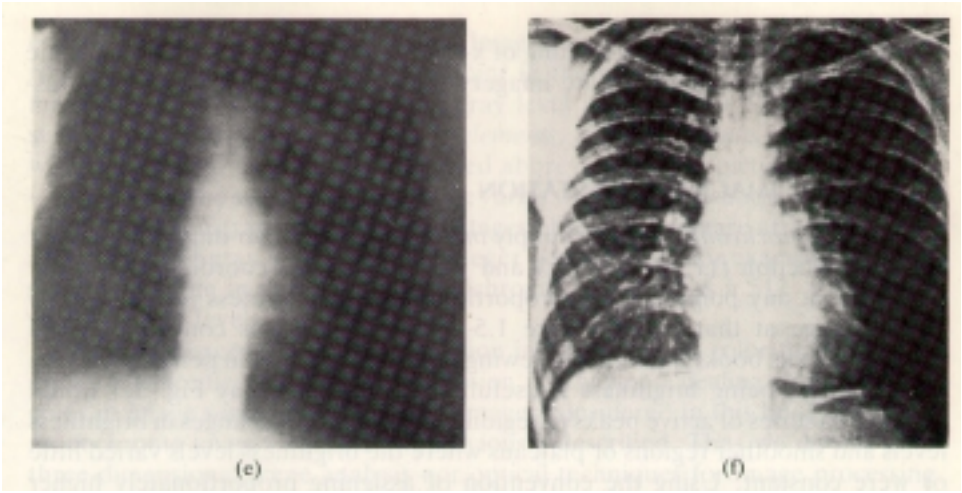
Example of human interpretation



(a) : image of cell heavily corrupted by electronic noise
(b) : image after averaging several noisy images



(c) : picture of the Martian.
(d) : picture after computer processing



(e)(f): by contrast and edge enhancement

(g) : image blurred by uniform motion during exposure
(h) : after application of a deblurred algorithm

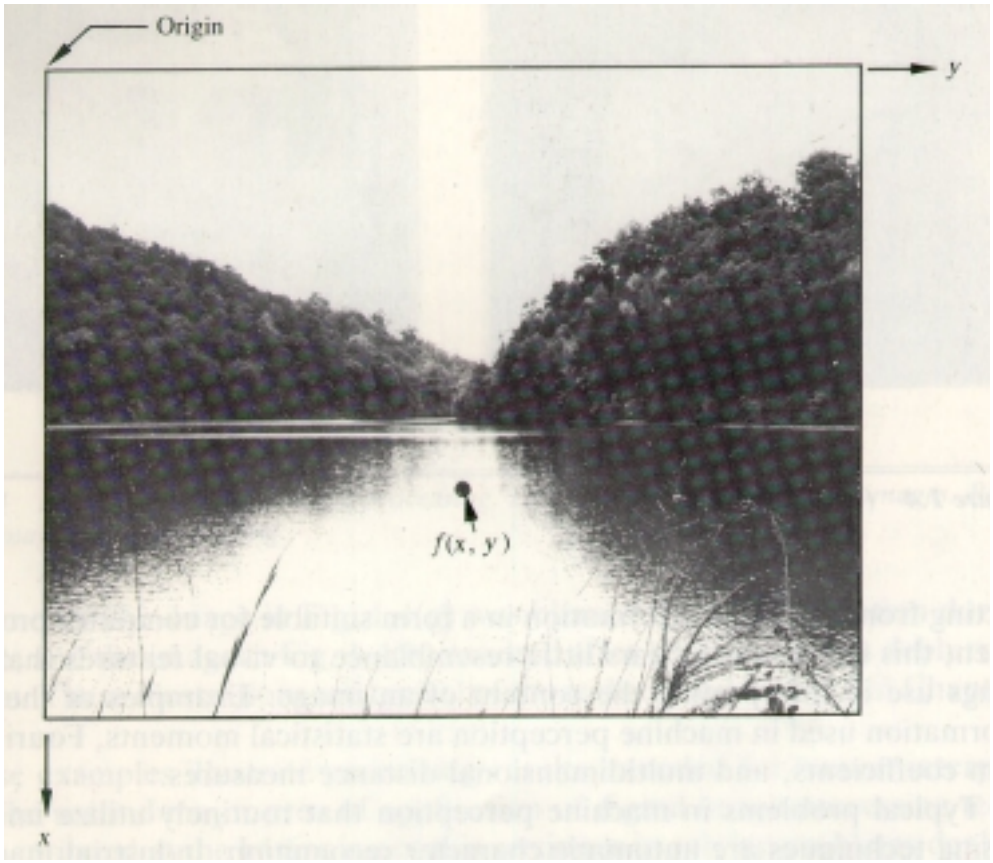
Example of machine perception

- Image information suitable for computer processing.(machine perception)
  - statistical moments, Fourier transform coefficient , multidimensional distance measures.
- Typical problems in machine perception
  - automatic character recognition, industrial machine vision for product assembly and inspection.
  - Military recognizance, automatic processing fingerprints

- Screening of x-ray and blood samples
- Machine processing of aerial and satellite imagery for weather prediction and crop assessment

1.2 Digital Image Representation

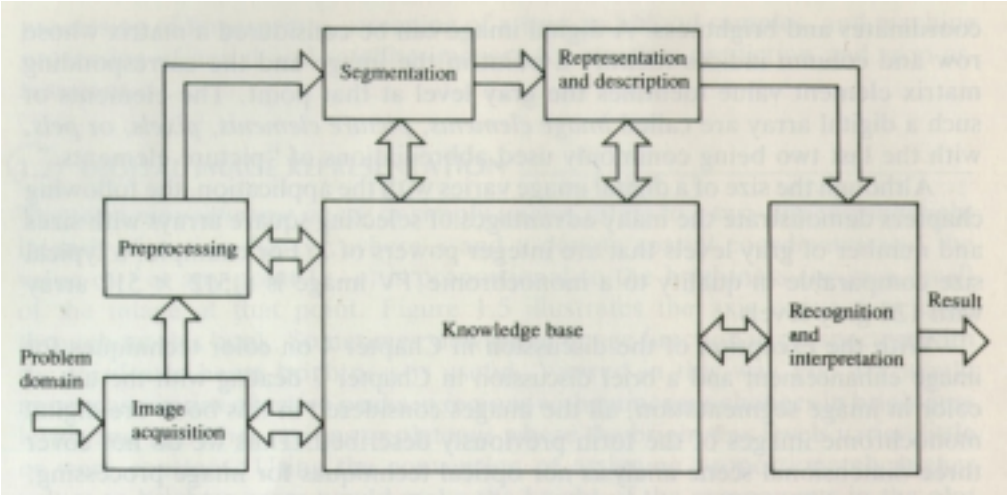
- (monochrome) image
  - 2-D light intensity function f (x,y)
    : proportional to the brightness (or gray level)



- brightness : the third axis

- digital image : f (x,y)
  - digitized both in spatial coordinates and brightness
  - considered as a matrix
  - element of digital array
    : image elements, pictures element, pixels, pels

1.3 Fundamental Steps in Image processing



- The first step : image acquisition
  - a monochrome or color TV (1/30 sec)
  - line-scan camera
  - analog output
  - A/D Converter : digitizer
- The second step : preprocessing
  - image improvement
    - ✓ contrast enhancement
    - ✓ noise removement
    - ✓ isolating region (alphanumeric information)
- The third step : image segmentation
  - partition image into constituent part
  - very difficult task
  - in character recognition : extract individual characters and words from the background
  - output : raw pixel data, constituting either the boundary of a region of all the points in the region itself
- Representation
  - boundary representation
    - ✓ focus on external shape characteristics such as corners or

inflections
- regional representation
  - ✓ focus on internal properties such as texture of skeletal shape

- Description (feature selection)
  - feature extraction
  - in character recognition
    - ✓ lakes (holes), bays : important feature
- Recognition
  - Assign a label to an object based on information provided by descriptors.
- Interpretation
  - assign meaning to an ensemble of recognized object
- Knowledge base
  - detailing regions of an image : very simple
  - interrelated list of all major possible defects in a materials inspection problems : very complex
  - guiding the operation of each processing module
  - control the interaction between modules
  - the comm. between processing modules generally is based on prior knowledge of what a result should be
  - feedback request through the knowledge base to other module (ex. segmentation)

Result of image processing
- processing function
  - ✓ image analysis
  - ✓ recognition, interpretation (automatically)

1.4 Elements of Digital Image Processing System

1) acquisition
2) storage
3) processing
4) communication
5) display

1.4.1 Image Acquisition

- Physical device
  - sensitive to a band in the electromagnetic energy spectrum (such as x-ray, ultraviolet, visible, infrared violet)
  - electrical signal output, 디지털카메라, scanner, MRI, PET
- Digitizer
  - electrical output → digital form

1.4.2 Storage

Three categories of digital storage

1) short term storage for use during processing
2) on-line storage for relatively fast recall
3) archival storage

- Short term storage
  - computer memory
  - frame buffer (video rate, 30 frames/sec) →instantaneous image zoom, scroll, pan
  - physical site of card
  - usually 32Mbytes
- On-line storage
  - magnetic disks
    - ✓ Winchester disk : hundreds of Mbytes
  - magneto-optical (MO) storage
    - ✓ laser and specialized material technologies
    - ✓ Gbytes of storage
  - characteristics : frequent access to data

- jukebox : hold 30 to 100 optical disks

- Archival storage
  - massive storage but infrequent need for access
  - high density magnetic tape : 6400 B/in
    - ✓ short shelf life (about 7 years)
    - ✓ need of controlled storage environment
  - write-once-read-many (WORM)
    - ✓ 1 GB on $5\frac{1}{4}$ in. disk
    - ✓ 6 GB on 12 in. disk
    - ✓ 10 GB on 14 in. disk
    - ✓ not erasable
    - ✓ shelf life : up 30 years

1.4.3 Processing

- Processing of image
  - algorithmic form
  - mainly implemented in S/W
  - H/W implementation : need for speed : low-light microscopy (image averaging)
  - H/W + S/W : today's image processing system
- Image processing system
  - late in 1980s ~ early in the 1990s
    - ✓ the form of single board designed to be compatible with industry standard buses. PC and workstations
  - the principal imaging H/W : digitizer + frame buffer + ALU
  - image processing S/W
    - ✓ obtained commercially
    - ✓ combined with other S/W (spread sheet, graphics)

1.4.4 Communications

- 9.6kbps modem
  - 512×512 8 bit image : 5minutes
  - data compression, decompression

1.4.5 Display

- CRT
- Printing devices