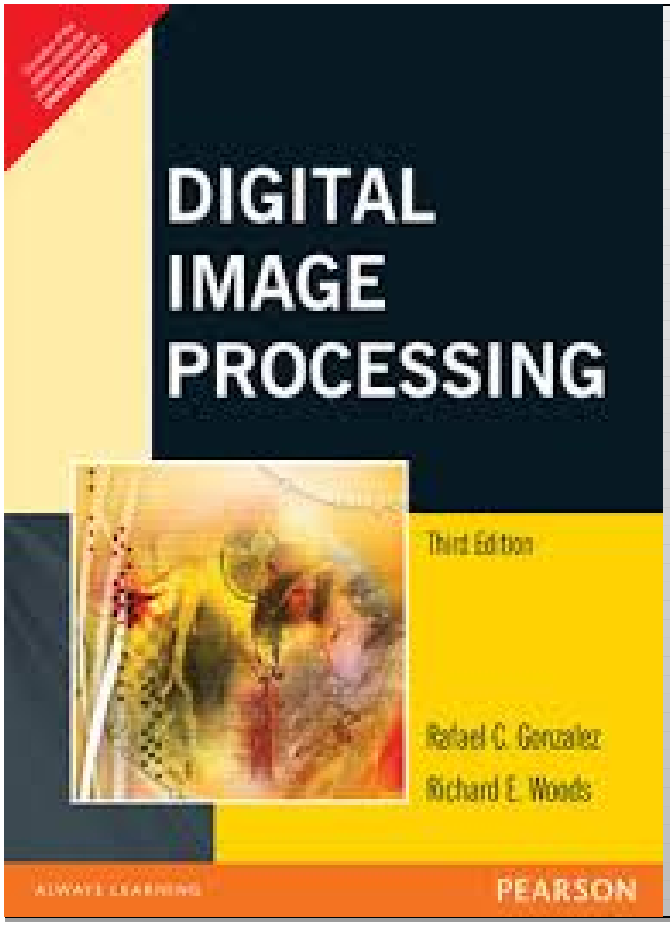
Image Processing

Semester VII

Department of Computer Engineering

Dharmsinh Desai University

Text Book



Title: Digital Image Processing
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Richard E. Woods

Meaning of image processing

In today 's world, each day countless number of images (such as medical, surveillance and remote sensing) are collected using various image acquisition devices.

The course of actions taken to enhance the acquired image quality, to extract meaningful information from the acquired image, and to represent these information in a compact fashion is known as image processing.

Image Processing

Advantage of DIP Techniques

Digital image processing techniques have been significantly improving the accuracy of automatic decision making systems, dramatically reducing human intervention, as a result reducing the manual labor cost significantly.

Image Definition

- An image is defined as a two-dimensional function f(x,y) , where x and y are spatial coordinates and amplitude of f at any pair of coordinates (x,y) is called intensity or gray level of the image at that point.

Image Processing

- Computer vision

Ultimate goal is to use computers to emulate human vision, including learning and being able to make inferences and take actions based on visual inputs.

This area itself is a branch of artificial intelligence (AI) whose objective emulate human intelligence

There are no clear cut boundaries in the continuum from image processing at one to computer vision at the other.

Image Processing

However, one useful paradigm is to consider three types of computerized processes in this continuum.

Low level processing

Involve primitive operations such as **image preprocessing** to **reduce noise**, **contrast enhancement** and **image sharpening**.

Input and output are images.

Image Processing

Mid level processing

Involves tasks such as segmentation (partitioning an image into regions or objects)

Inputs are images and outputs are attributes extracted from those images (e.g. edges, objects)

Higher level processing

“making sense” of an ensemble of recognized objects, as in image analysis and at the far end of the continuum, performing the cognitive functions normally associated with vision.

Image Processing

- Why do we need digital image processing?
  - Improvement of pictorial information for human perception
    - Noise filtering
    - Contrast enhancement
    - De blurring
    - Remote sensing
    - Brain tumor detection
    - Cancer detection
    - Ultra sonogram

Image Processing

- one purpose is improve quality of image by using pictorial information.
- Autonomous machine applications
  - Purpose is extract attributes, features from images
  - Inspection (ex. Bottling plant automation, Boundary Information)
  - Automated inspection (Structure information ,Surface information)
  - Fingerprint Recognition
  - Machine processing of satellite images for weather prediction and crop assessment etc.

Image Processing applications

Noise filtering

Electromagnetic spectrum

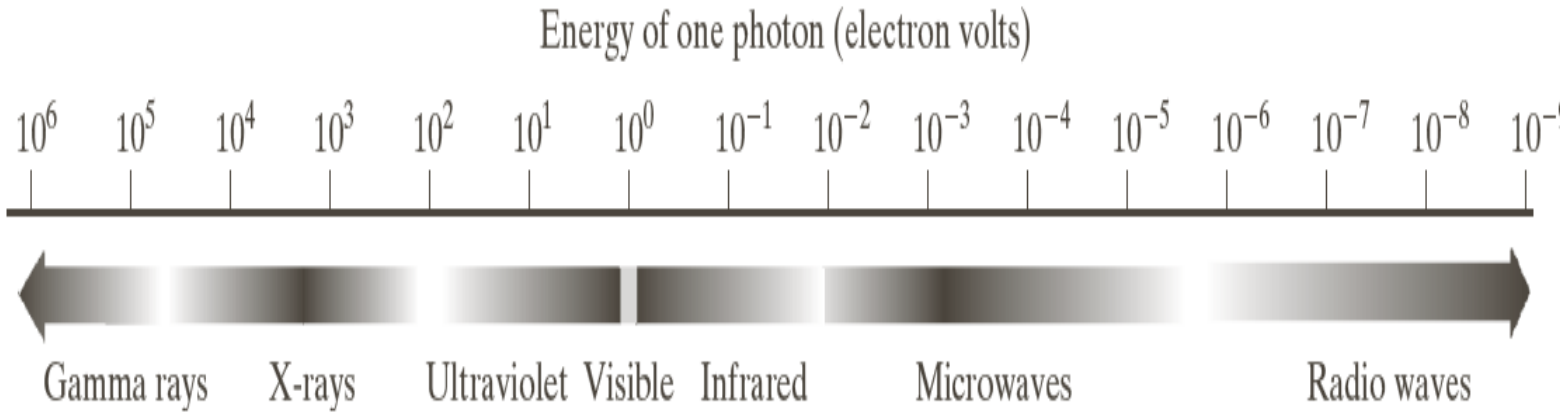


FIGURE 1.5 The electromagnetic spectrum arranged according to energy per photon.

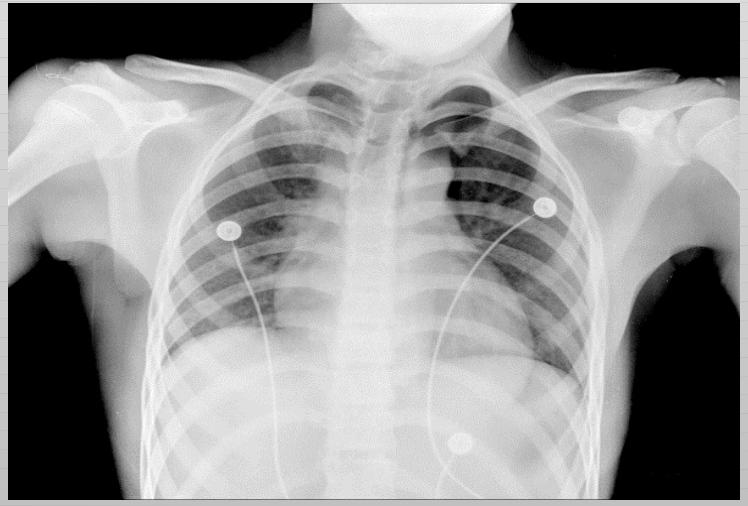
Image Processing

- Gamma-Ray Imaging
  - Used to locate sites of bone pathology such as **infections or tumors.**

Complete bone scan obtained by using gamma-ray imaging

Image Processing

- X-Ray Imaging
  - Used Medical Diagnostics
  - It is generated using X-ray tube , which is a vacuum tube with a cathode and anode.



Chest X-ray generated simply by placing the patient between an X-ray source and a film sensitive to X-ray energy

Image Processing

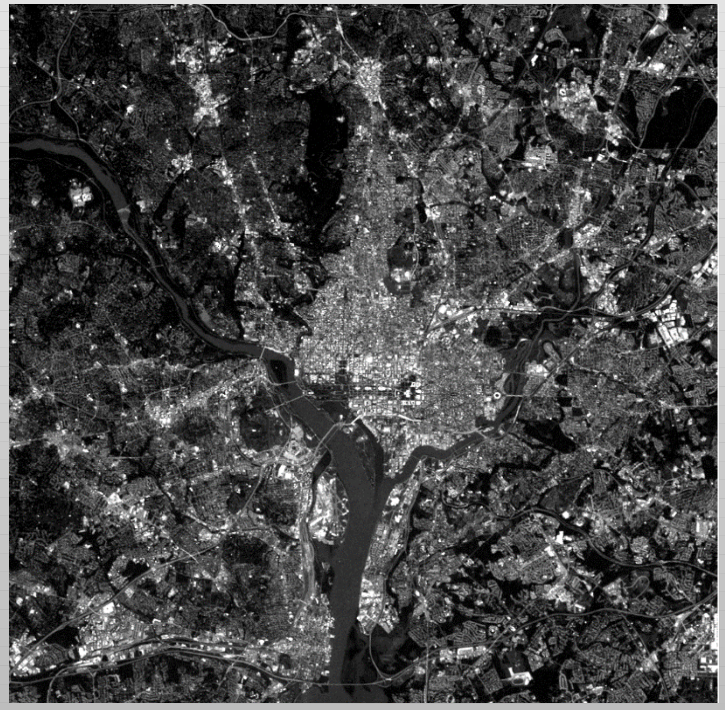
- X-Ray Imaging
  - Angiography is another major application in an area called contrast enhancement radiography.
  - It is used to obtain images(called angiograms) of blood vessels. A Catheter (a small ,flexible, hollow tube) is inserted into the vein.
  - It is also used to examine circuit boards for flaws in manufacturing , such as missing components or broken traces

Image Processing

- Imaging in the visible and infrared bands
  - Infrared band often used in conjunction with visual imaging
  - It is used in remote sensing.
  - Primary function of satellite is to obtain and transmit images of the earth from space for purposes of monitoring environment.

Image Processing

- Imaging in the visible and infrared bands



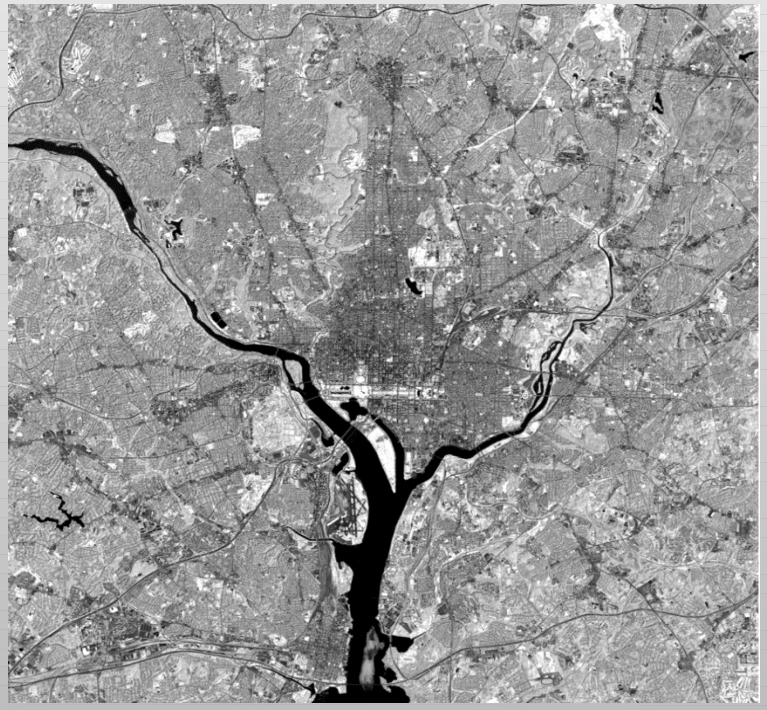


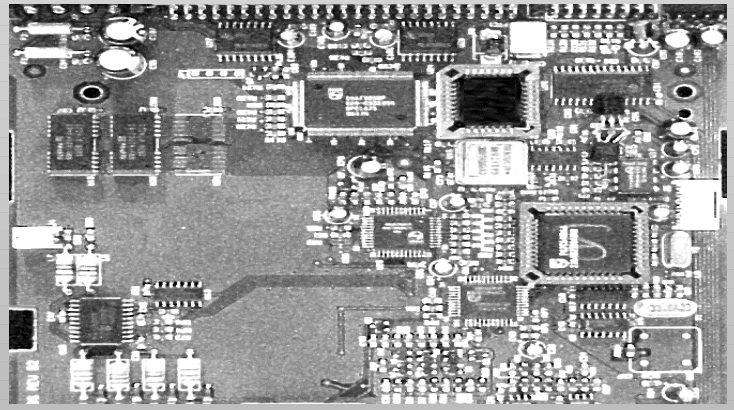
Image Processing

- Imaging in the visible and infrared bands
  - It is part of the NIGHTITME LIGHTS of the world data set
  - It is not difficult to imagine writing a computer program that would use these image to estimate of total electrical energy used by various regions of the world.

Infrared satellite image

Image Processing

- Imaging in the visible and infrared bands
  - A major area of imaging in the visual spectrum is in automated visual inspection of manufactured goods. Ex. Controlled Board.
  - A typical image processing task with products like this is to inspect them missing parts



Controller Board

Image Processing

- Imaging in the visible and infrared bands
  - Bottles
  - The objective here is to look for bottles that are not filled up to an acceptable level.

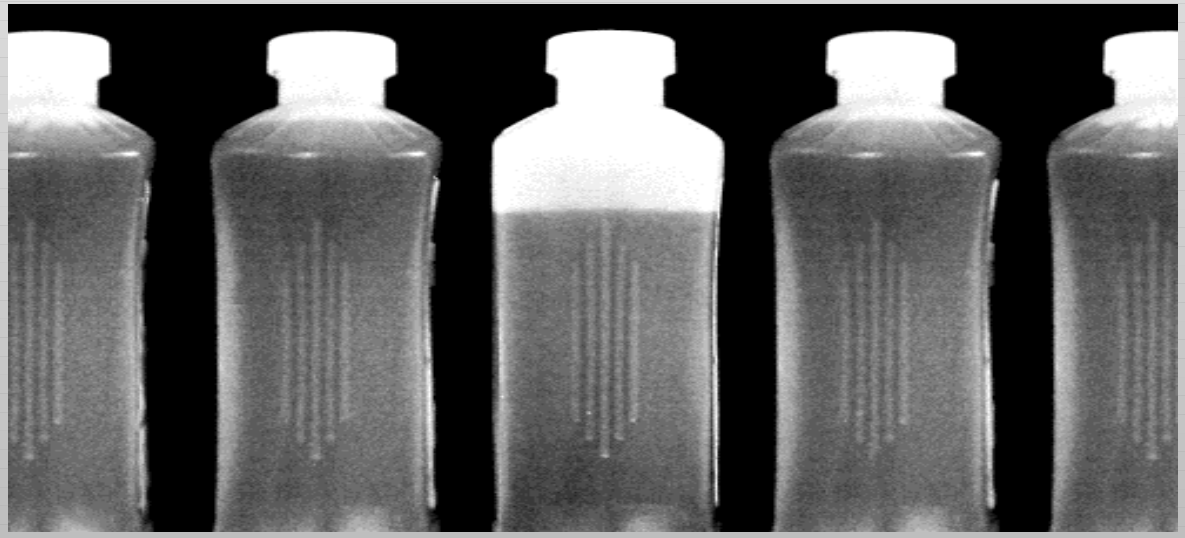
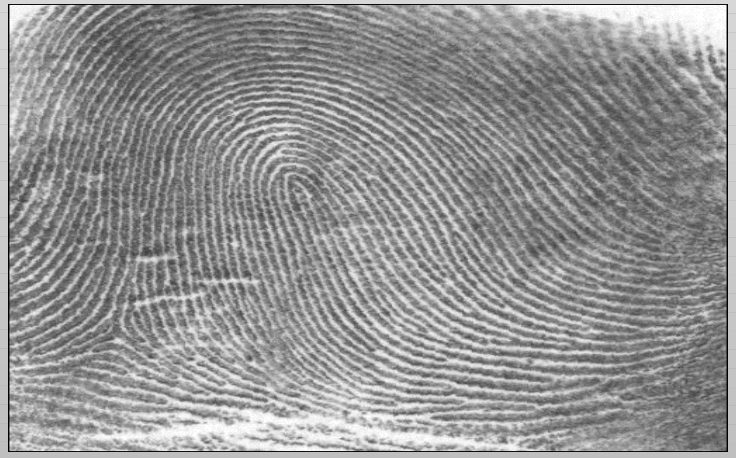


Image Processing

- Imaging in the visible and infrared bands
  - Thumb print
  - These images are processed by computer to enhance them or find features that aid in the automated search of a database for potential matches.



Thumb Print

Image Processing

- Imaging in the visible and infrared bands
  - Applications of digital image processing in this area include automated counting and in law enforcement , the reading of serial number for the purpose of tracking and identifying bills.

Number Plate

Image Processing

- Imaging in the Microwave band
  - The dominant application of imaging in the microwave band is radar. 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.
  - Some radar can penetrate clouds and under certain conditions can also see through vegetation, ice and dry sand.
  - In many cases, radar is the only way to explore inaccessible regions of the earth surface.

Image Processing

- Imaging in the Microwave band
  - It shows a space borne radar image covering a rugged mountainous area of southeast Tibet , about 90 KM east of the city of Lhasa.

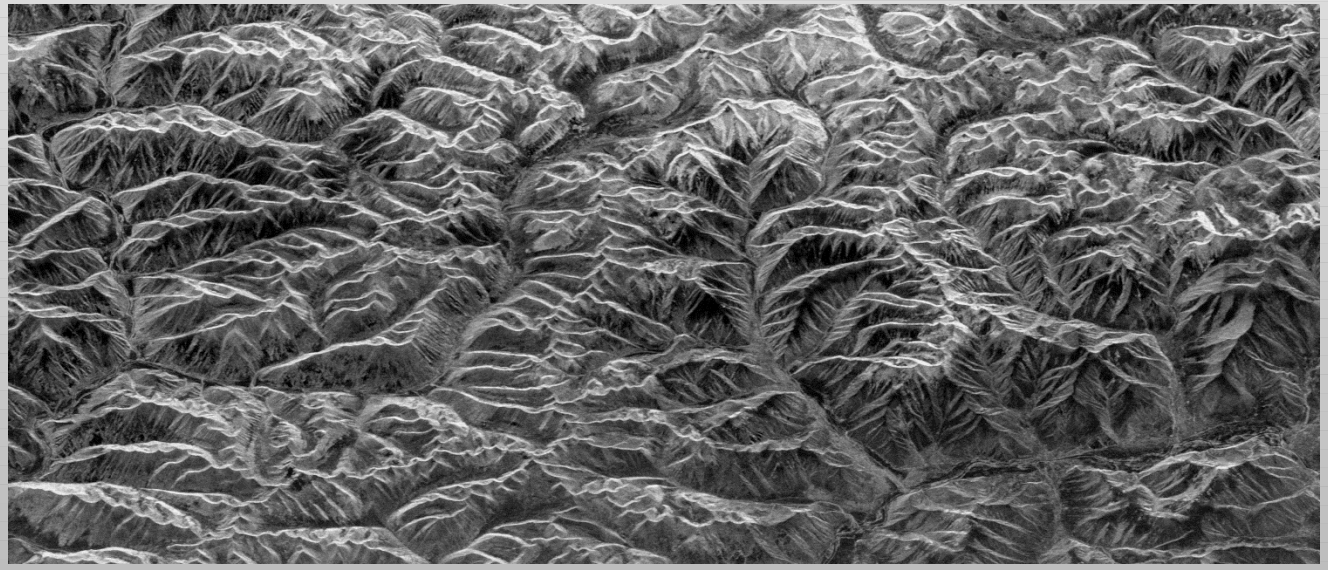
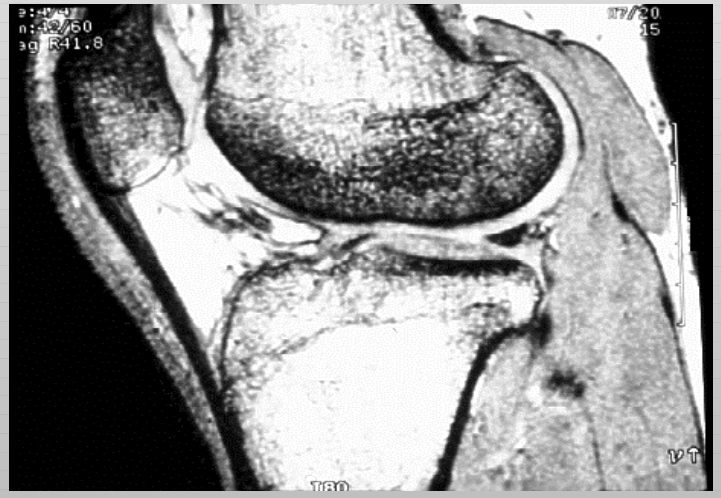
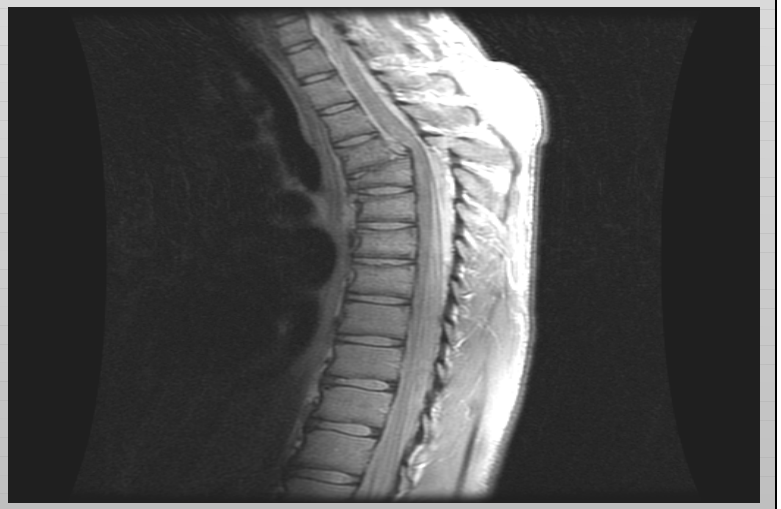


Image Processing

- Imaging in the Radio band
  - It is used in MRI (Magnetic Resonance Imaging)
  - This technique places a patient in a powerful magnet and passes radio waves through his or her body in short pulses.

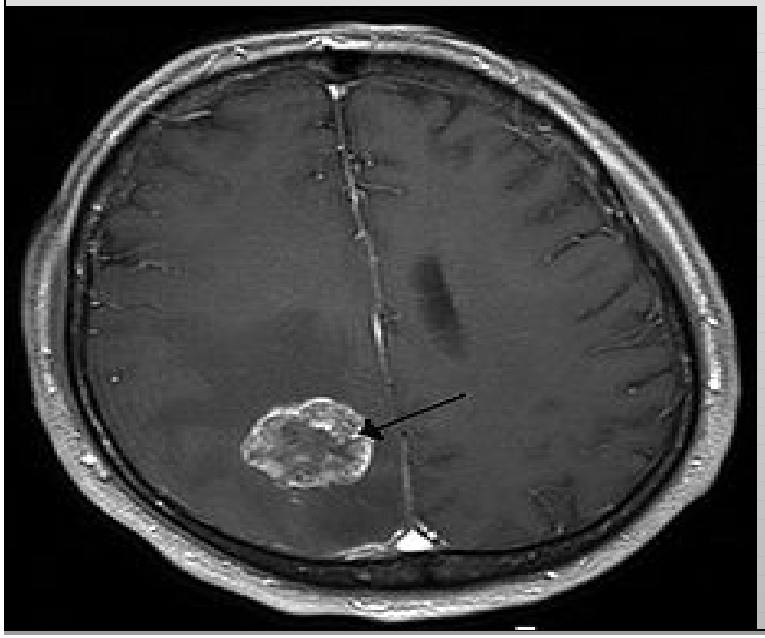




Imaging in Medical domain: X-rays, CT scans, MRI scans, Ultrasound

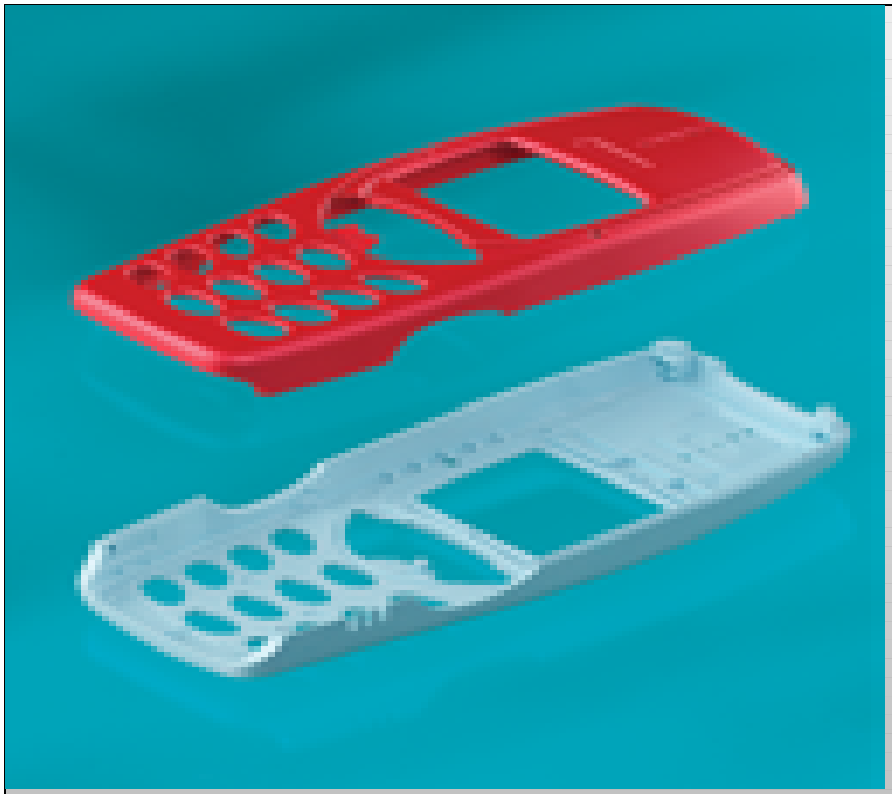
Medical applications

Brain Tumor



Sonogram

surface inspection



testing for:
color,
soiling,
scratches and
damage
checking for shape

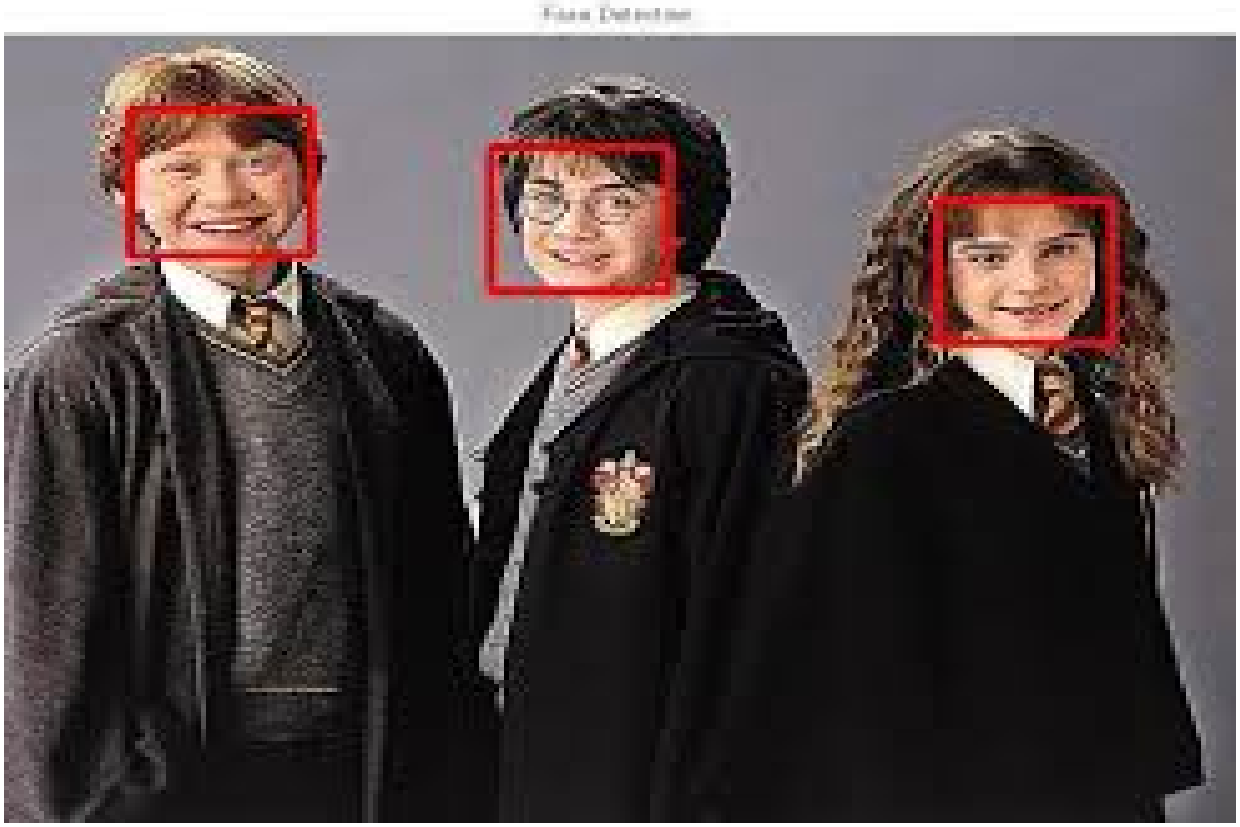
Disposable syringes

completeness
inspection
testing for:
correct assembly,
completeness,
writing,
damage and color

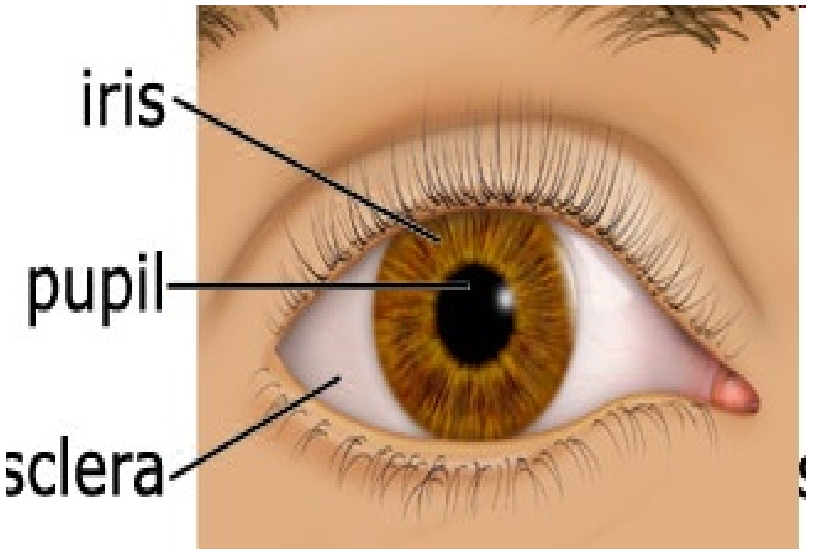
Cosmetic bottles

printing check
testing for:
color,
completeness,
size,
legibility and
precision details

Face detection



Iris detection



finger print detection

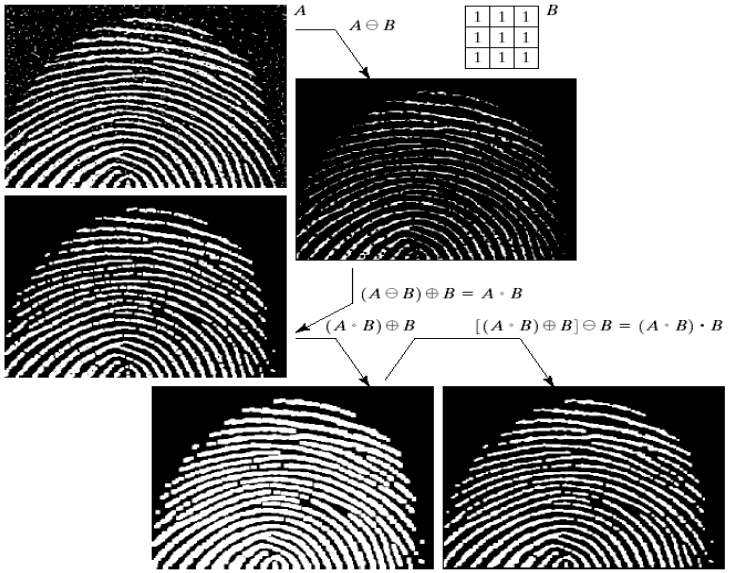
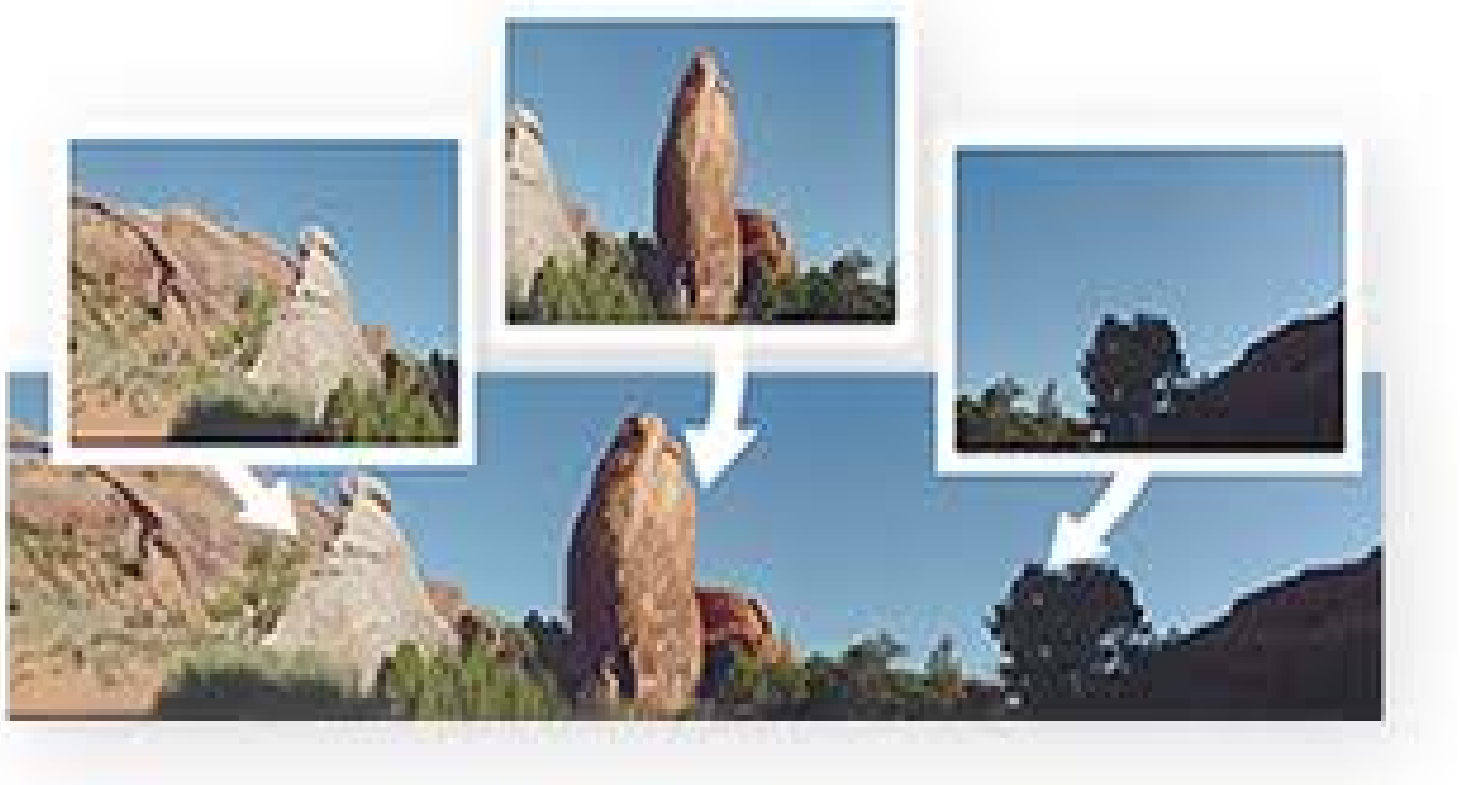
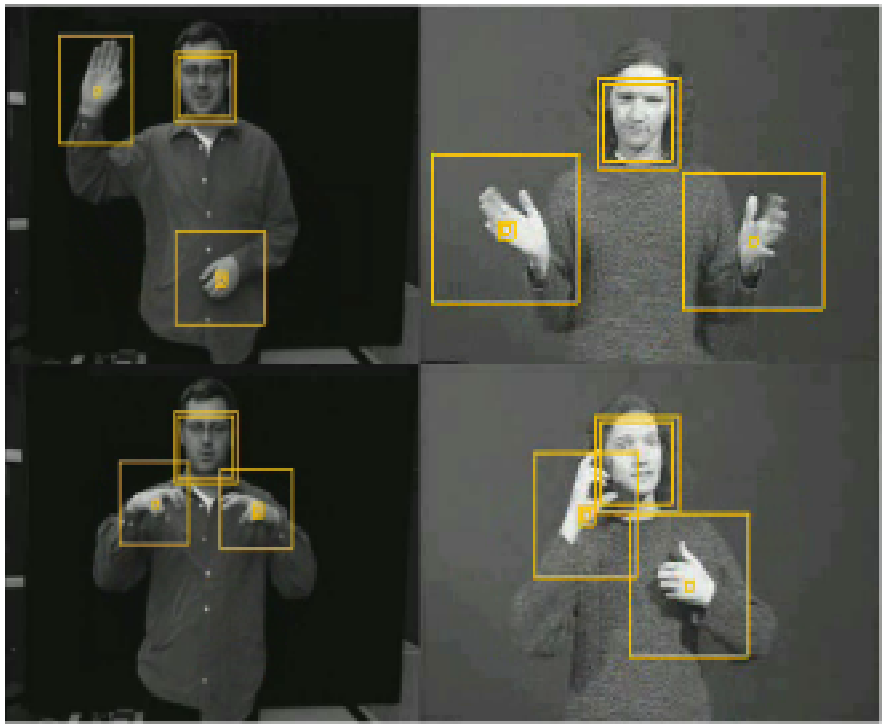
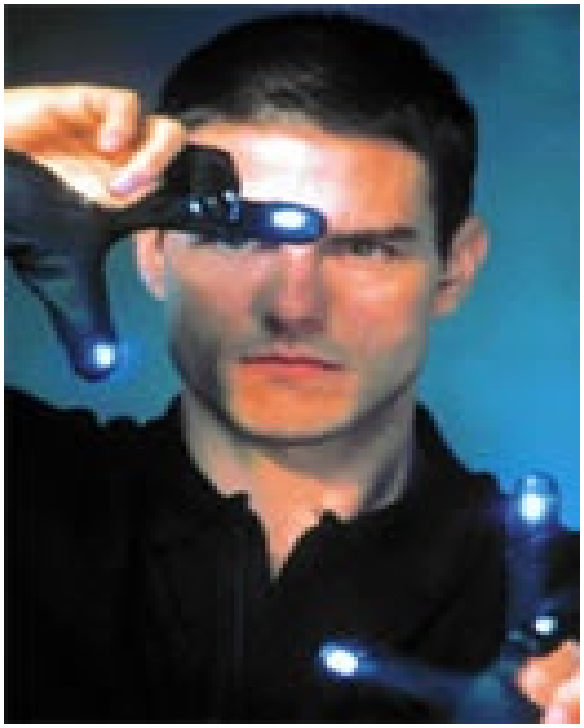


Image stitching



Human Computer Interface: Gesture recognition, Face recognition from video

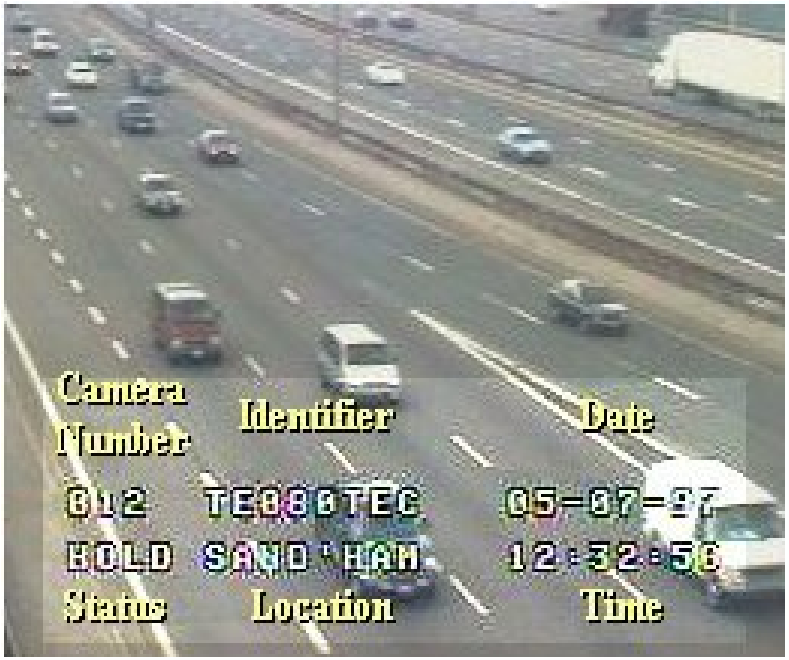


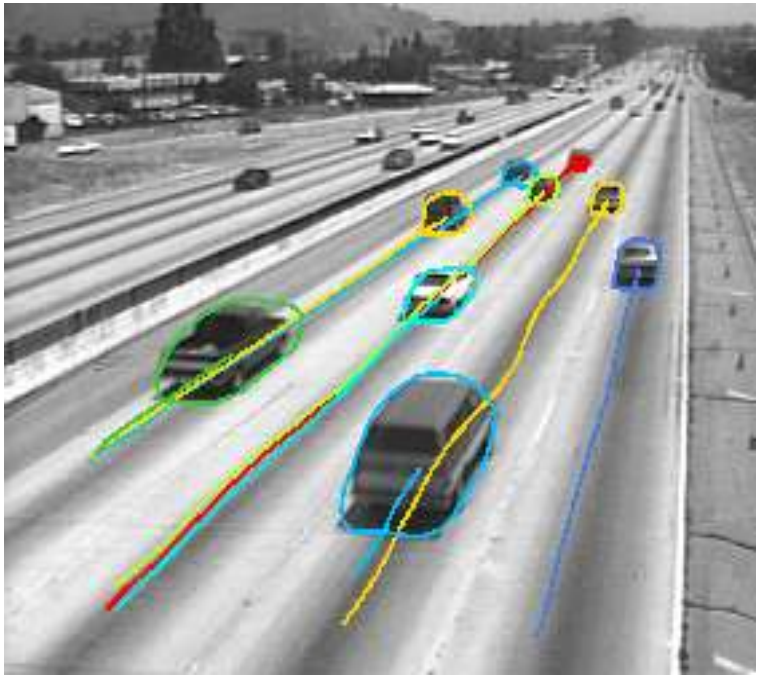


Artistic and Visual Effects: Computer Graphics, Animation, Special Effects

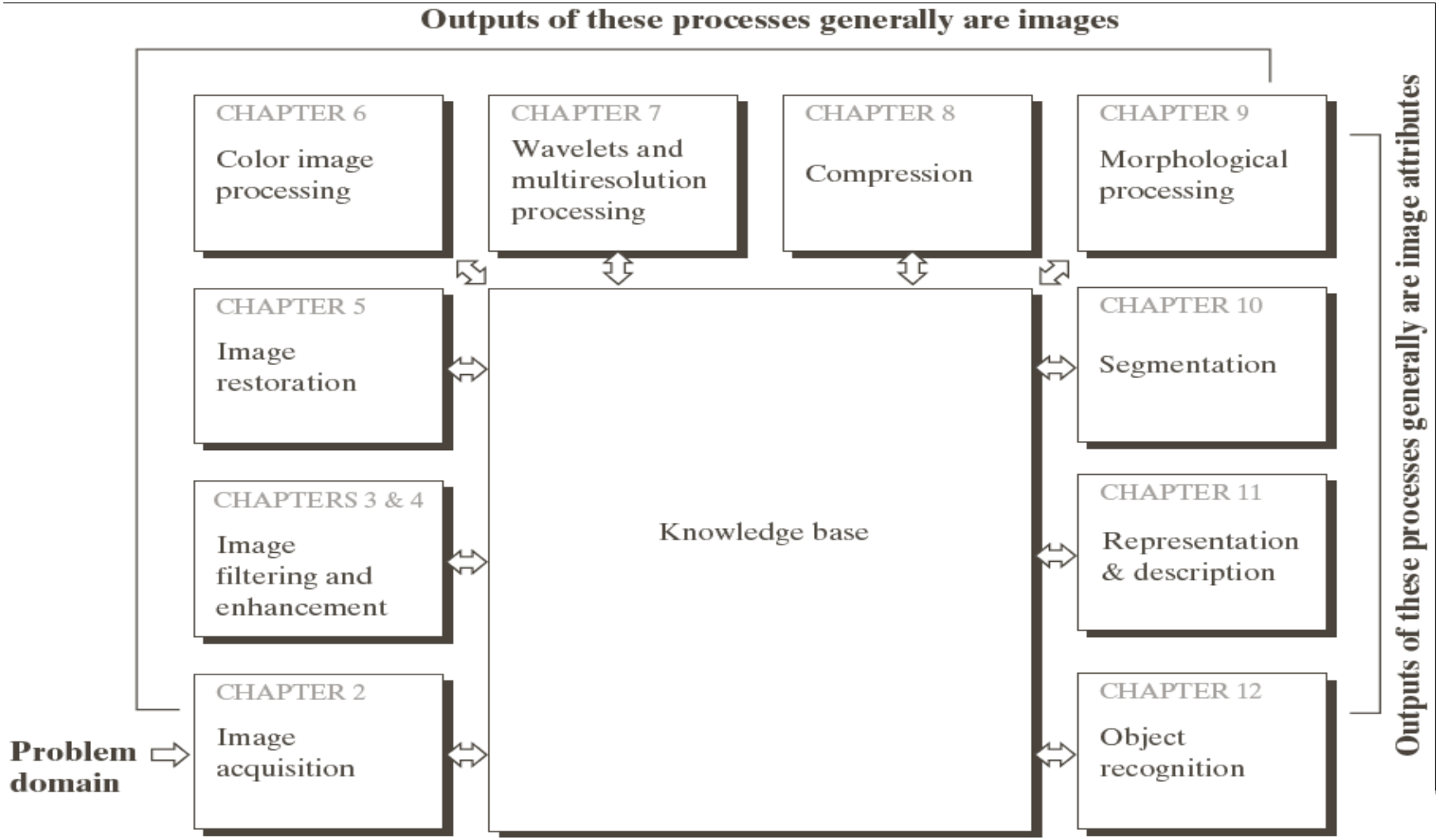
Video Doorbell & Video Security

Traffic Monitoring





Fundamental steps in digital image processing



Fundamental steps in digital image processing

- Image acquisition : involves preprocessing
- Image Enhancement: Process of manipulating an image so that the result is more suitable than the original for a specific application
- Image Restoration : deals with improving the appearance of an image

Image enhancement is subjective and image restoration is objective

Restoration techniques is based on mathematical or probabilistic models of image degradation while enhancement is based on human subjective preferences

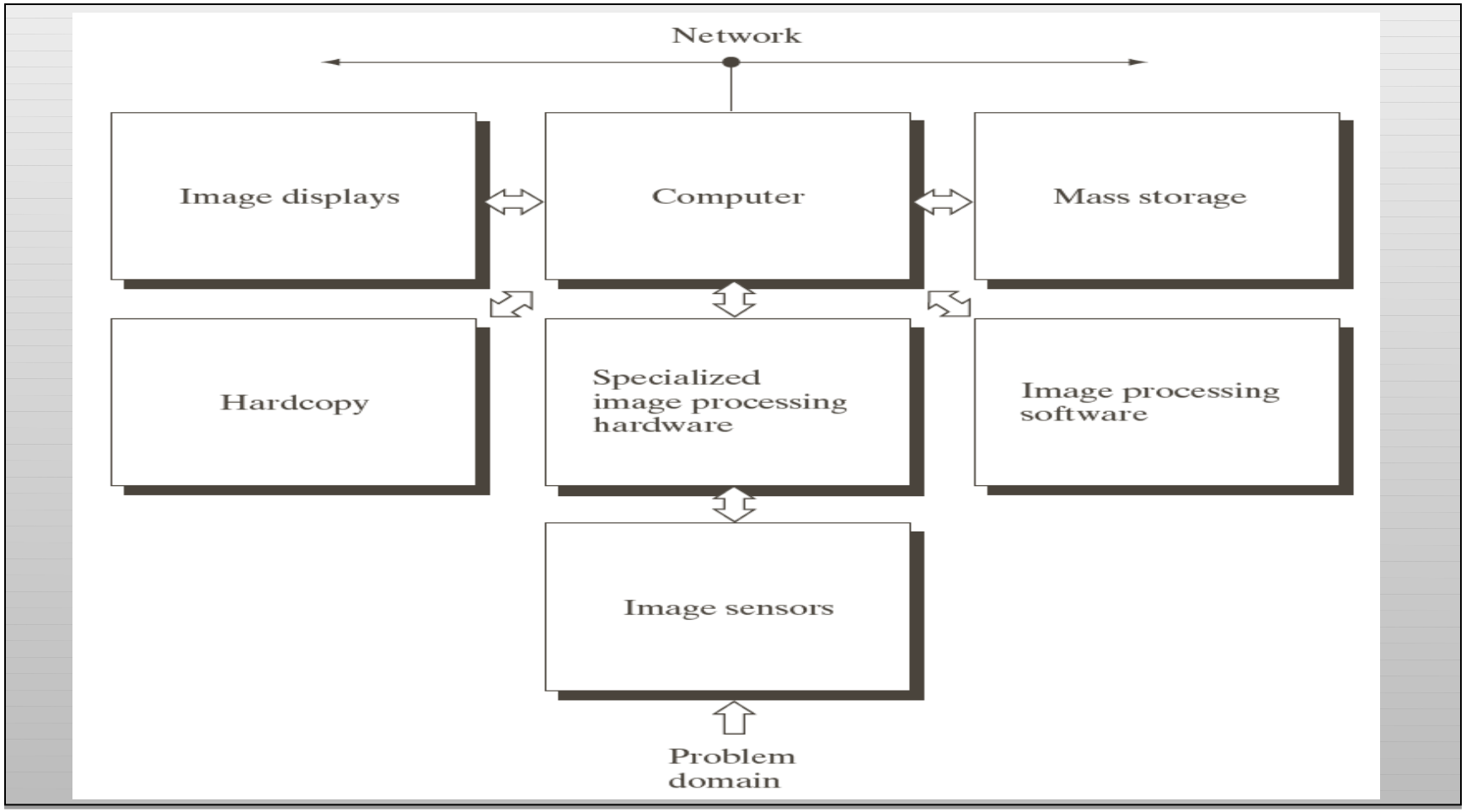
Fundamental steps in digital image processing

- Color image processing : area that has been gaining in importance because of the significant increase in the use of digital images over the internet.
- Wavlets : representing images in various degrees of resolution.
- Compression: deals with techniques for reducing the storage required to save an image or bandwidth required to transmit.
- Morphological processing : deals with tools for extracting image components that are useful in the representation and description of shape.

Fundamental steps in digital image processing

- Segmentation : partition an image into its constituent parts or objects.
- Representation and description: it follows output of segmentation stage , which is usually is raw pixel data, constituting either the boundary of region.
- Example: Set of pixels separating one image region from another.
- Object recognition : process that assigns a label (e.g. Vehicle) to an object based on its descriptors.

Components of a general purpose image processing system



Components of a general purpose image processing system

- Image sensors: two elements are required to acquire digital images.
- The first is physical device that is sensitive to the energy radiated by the object we wish to image.
- The second called a digitizer, is a device for converting the output of the physical sensing device into digital form.
- Specialized image processing hardware usually consists of the digitizer and hardware that performs arithmetic and logical operations in parallel on entire images .
- Computer in an image processing system is a general – purpose computer .

Components of a general purpose image processing system

- Software for image processing consists of specialized modules that perform specific tasks .
- Mass Storage :
  - Short term storage for use during processing
  - Online storage
  - Archival storage
- Image displays in use today mainly color TV monitors(included graphics card)
- Hardcopy devices like printer, film cameras, heat sensitive devices .
- Networking is a default function in any computer system .

Thank you