COMP 411 Digital Image & Video Processing

DR. YUE LIU (JUNE)

COMPUTING PROGRAM

MACAO POLYTECHNIC UNIVERSITY

Before we start

Books

- Digital Image Processing (Global version, 4th edition)
- Digital Image Processing Using Matlab (2nd edition)

Hours

- 1.5*2 hours per week, 15 weeks (including final exam)

Evaluations

- Project/Assignment: 30%
- Test (mid-term): 20%
- Final Exam: 50%

Before we start

Canvas

- Zoom Link for online teaching
- Lecture notes
- Supplementary materials
- Coursework (release, submission, marking)

Programming tools

- Scilab (version 6.0.2^{+}) with IPCV toolbox
- Matlab (version R2016a^{+})

Before we start

Prerequisite

- Basic Programming Skill
- Basic Data Structure and Algorithm Skill
- Basic Multimedia knowledge (COMP311)

More importantly

- Willing to learn
- Willing to interact
- Willing to investigate
- Willing to practice (programming!)

Before we start

Assignment

- Two assignments
- Theoretical knowledge plus programming (Matlab/Scilab)

Project

- One project
- Open-ended
- Design & analysis

Test

- One mid-term test (20%)

Before we start

Contact

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Introduction to Digital Image and Video Processing

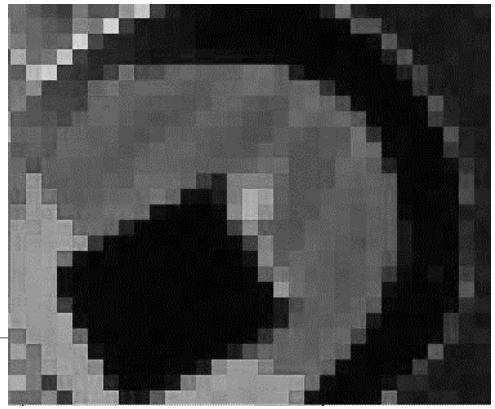
Introduction

‘One picture is worth more than ten thousand words.’

-Anonymous

Poster for the ‘Hope Project’

Basic concepts



- Image (monochrome)
  - A two-dimensional function $f(x,y)$, where x and y are spatial coordinates and the amplitude of f at any pair of coordinates (x,y) is called the intensity or grey level of the image at that point.
- Digital image
  - if x, y and the intensity values of f are all finite, discrete values, the image is a digital image.
- Picture element-Pixel
  - A digital image is composed of a finite number of elements (*pixels*), each of which has a particular location and value(s).

Basic concepts

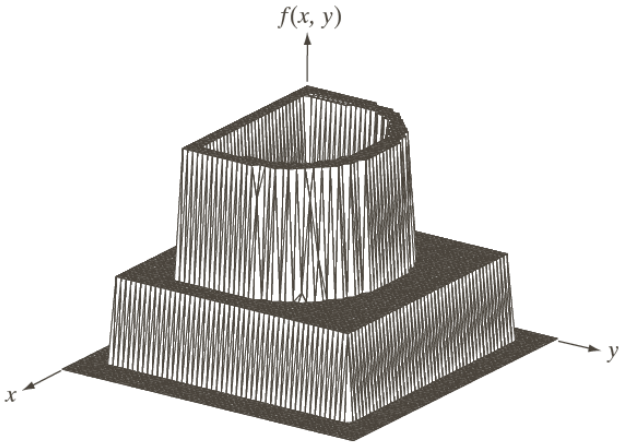


Image plotted as a surface

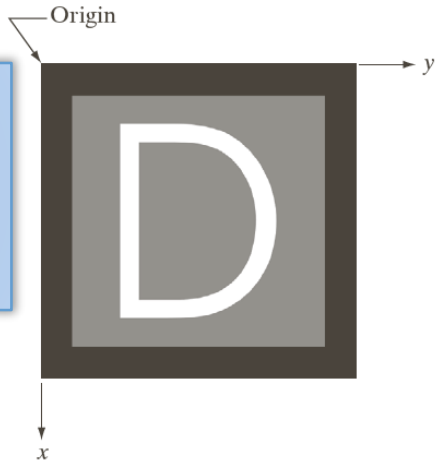


Image displayed as a visual intensity matrix

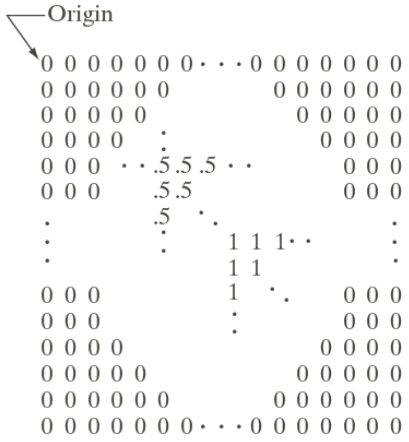


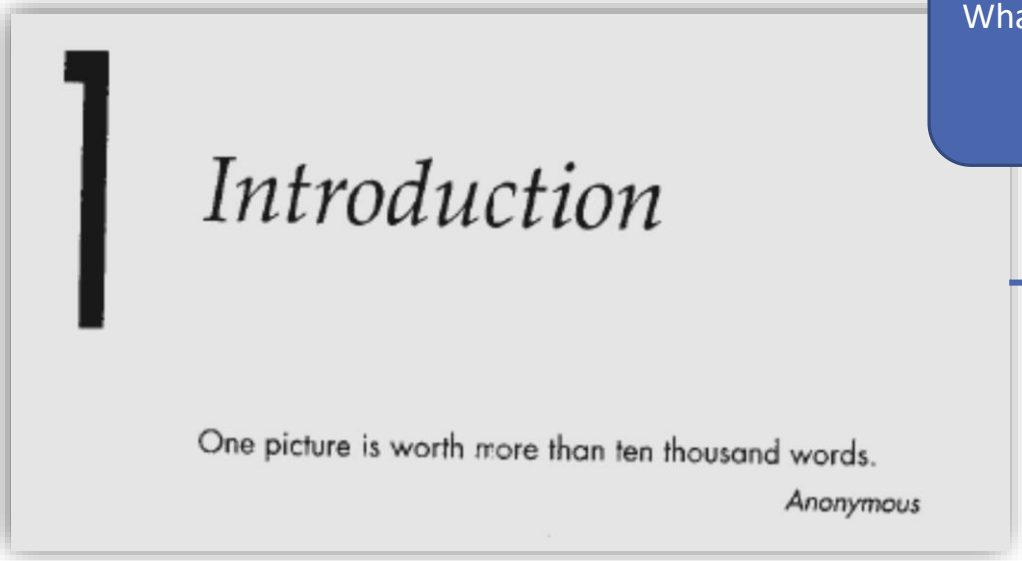
Image shown as a 2-D numerical matrix

Three types of image processing

- **Low Level**
  - Primitive operations. eg. noise reduction, contrast enhancement and image sharpening
  - Both input and output are *images*.
- **Mid Level**
  - Tasks like segmentation (partitioning an image into regions or objects), recognition (description of those objects to reduce them to a form suitable for computer processing) and classification of individual objects.
  - Input are *images* but output are *attributes* extracted from images.
- **High Level**
  - 'Making sense' of an ensemble of recognized objects as in image analysis and performing cognitive functions.

Example: Text recognition

What types of image processing is involved?



Contrast/brightness adjustment, thresholding, sharpening,
Character segmentation
Character recognition (Feature extraction, Machine learning)

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1 Introduction
One picture is worth more than ten thousand words.
Anonymous
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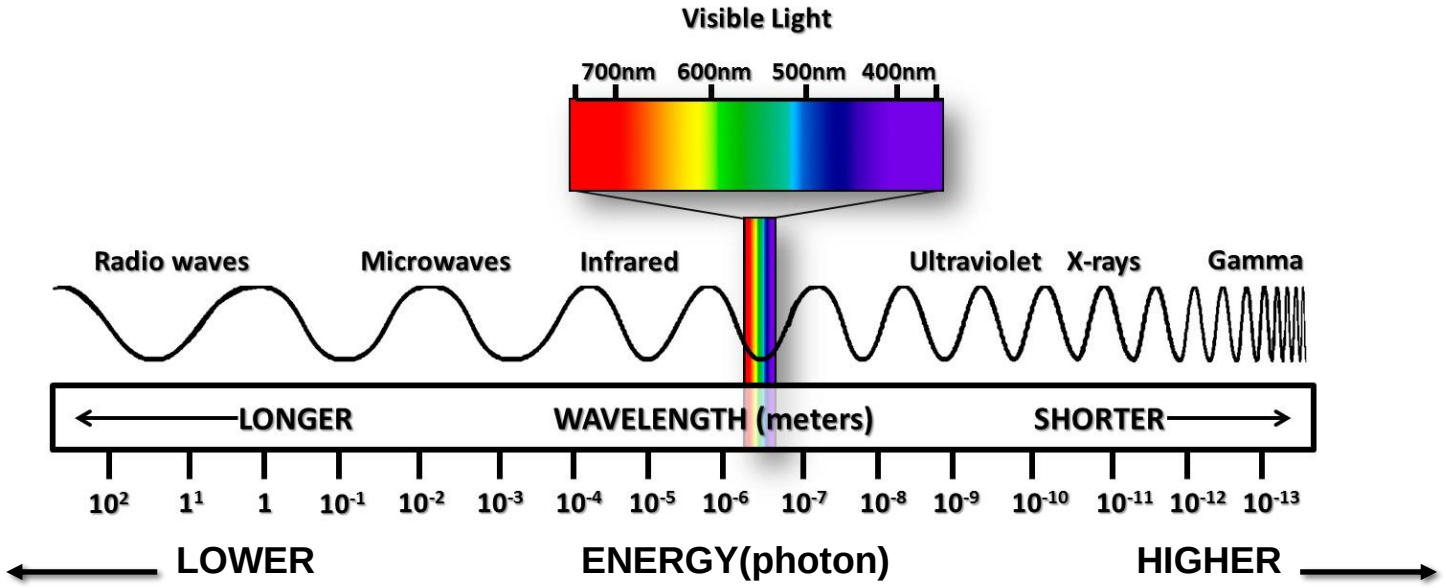
EM spectrum

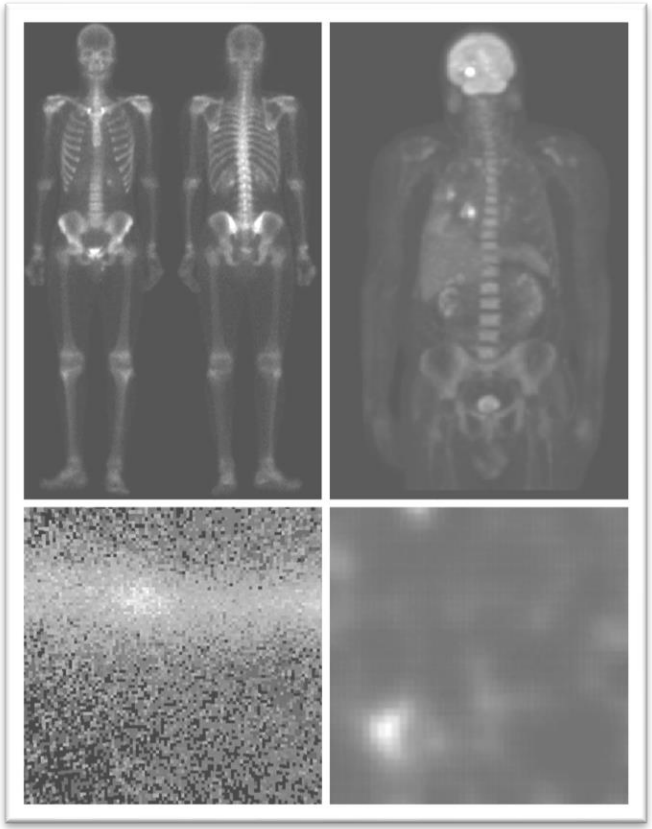
- Human vision are limited to the visual band (400nm-700nm) of electromagnetic (EM) spectrum.
- Imaging machines covers the whole EM spectrum.



Gamma-Ray Imaging

Used by nuclear medicine and astronomical observations.

a b
c d

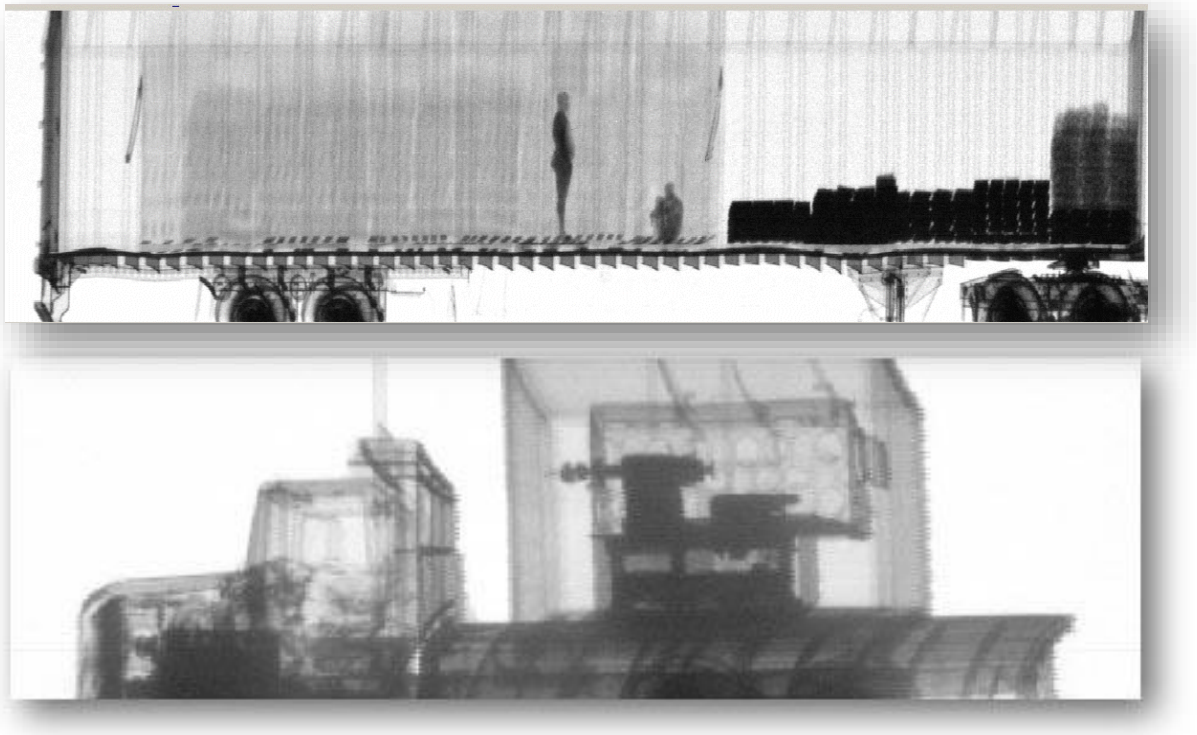


(a) Bone scan
(b) PET image
(c) Cygnus loop
(d) Gamma radiation from a reactor valve

Gamma-Ray Imaging

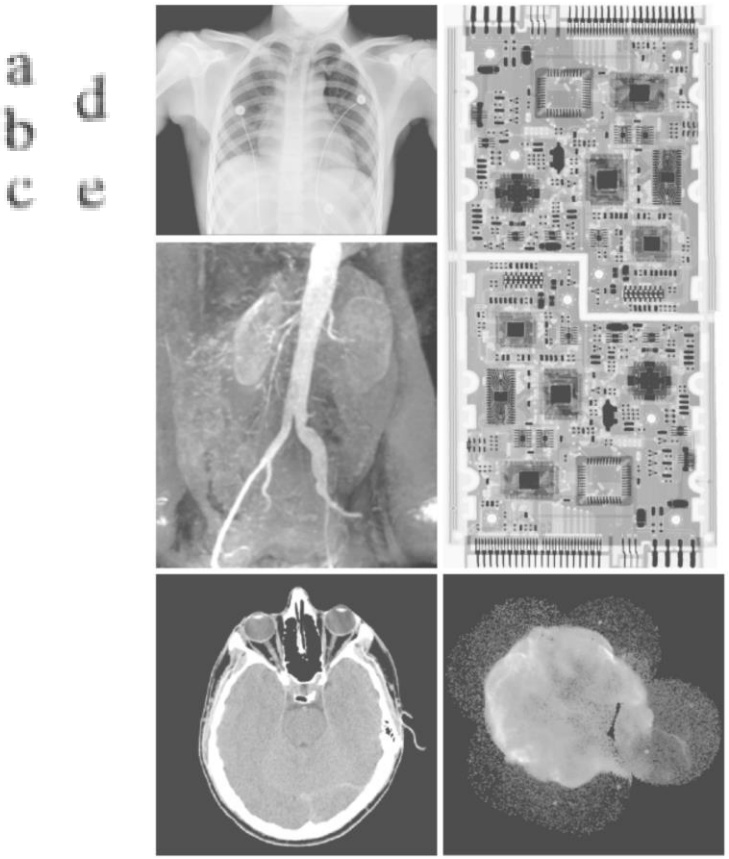
Used for truck scanning

- Identify high-density regions which is too thick to penetrate which would be the most likely to hide nuclear threats.



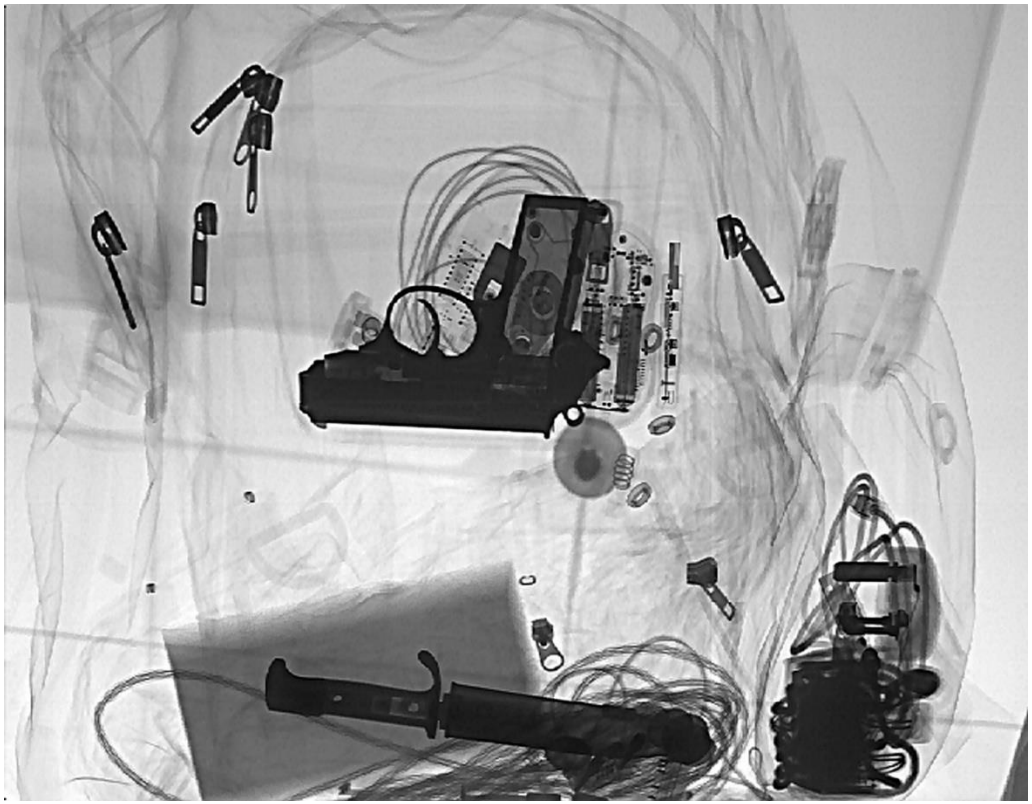
X-ray Imaging

Used for medical diagnostics, astronomy.



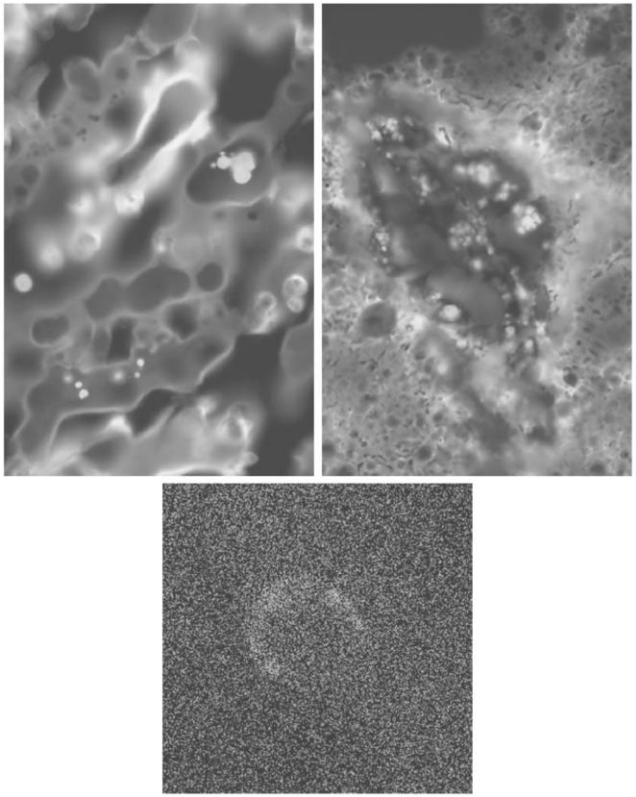
(a) Chest X-ray
(b) Aortic angiogram
(c) Head CT
(d) Circuit boards
(e) Cygnus loop

X-ray Imaging



Ultraviolet Band Imaging

Used in lithography, industrial inspection, microscopy, lasers, biological imaging and astronomical observations.



(a) Normal corn
(b) Smut corn

(c) Cygnus loop

Imaging in visible and infrared band

Used in light microscopy, astronomy, remote sensing, industry and law enforcement.

(a) Surface of audio CD 1750x.

(b) LANDSAT images of Padma river.

(c) Satellite image of Hurricane from NASA.

(d) DMSP Infrared satellite image of the US.

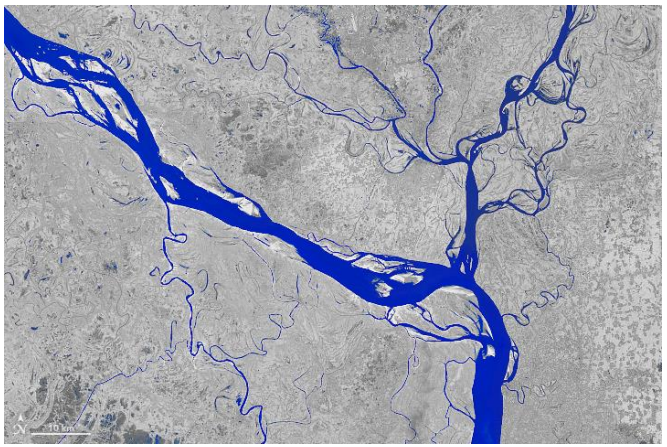
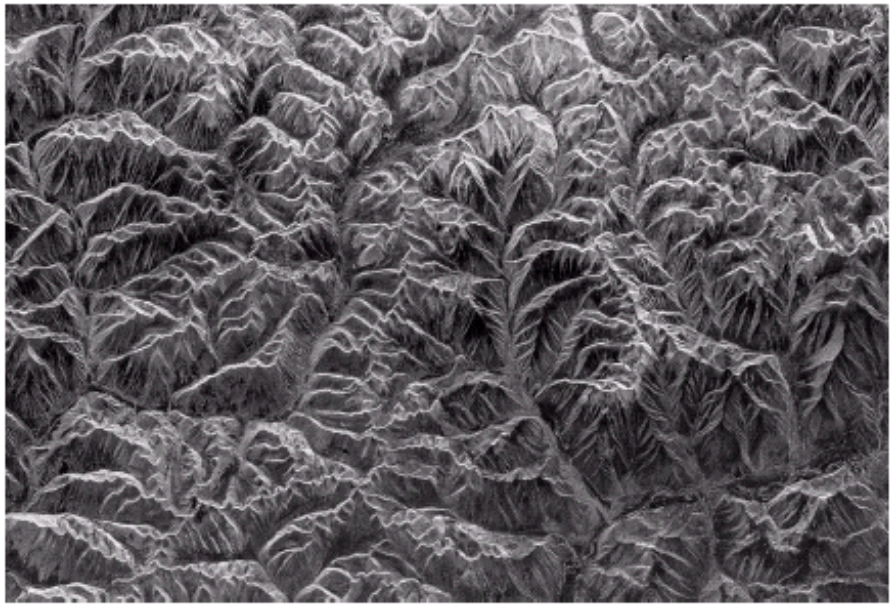


Image in microwave band

Dominant application: radar

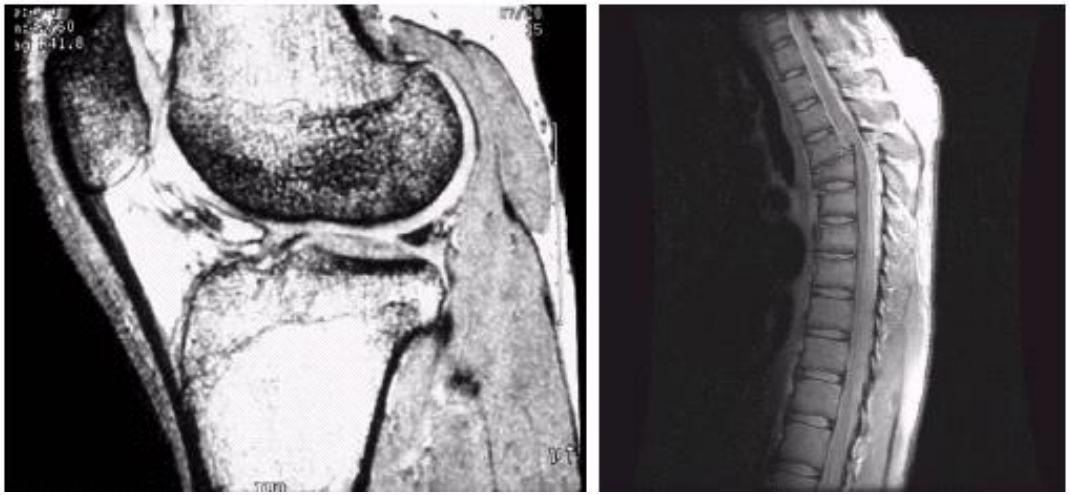
Unique feature of imaging radar is its ability to collect data over virtually any region at any time, regardless of weather or ambient lighting conditions.



Spaceborne radar image of mountains in southeast Tibet

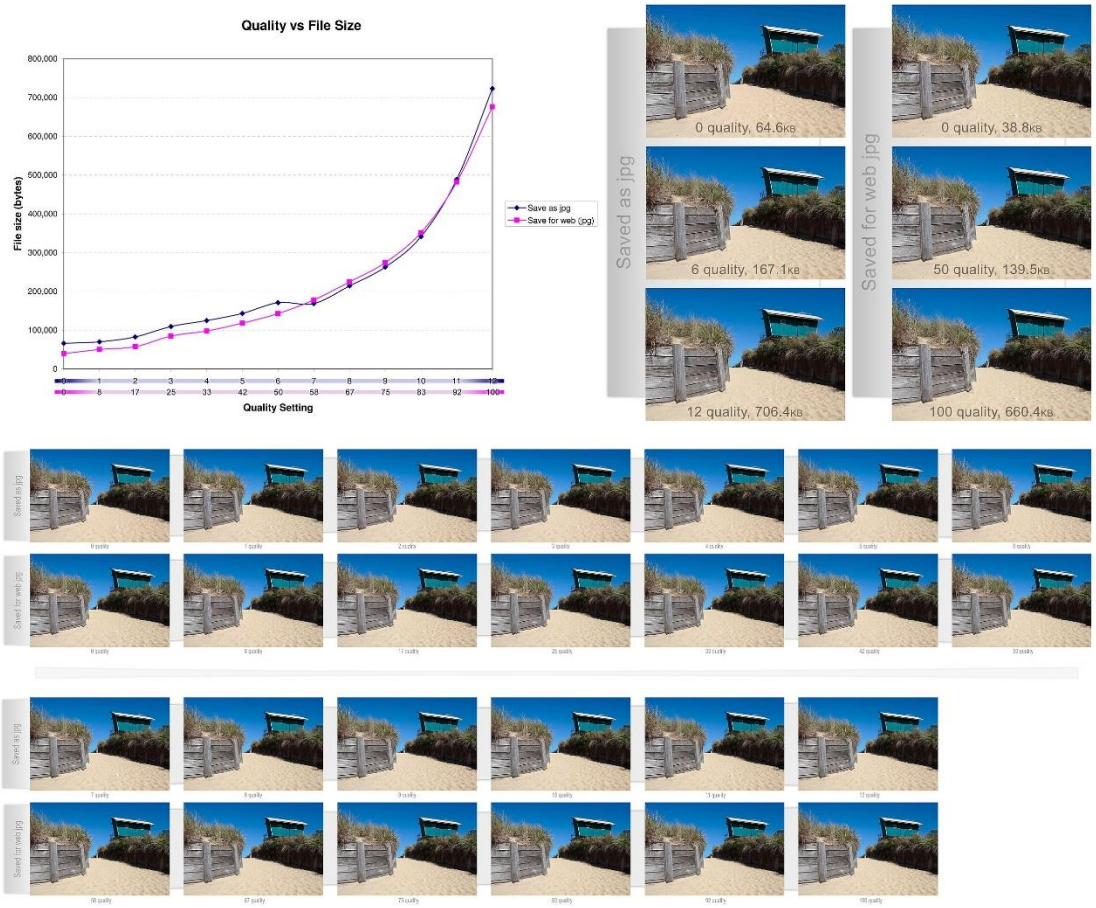
Image in radio band

Application: magnetic resonance imaging (MRI)



MRI images of human knee and spine

Image Compression



https://en.wikipedia.org/wiki/Image_compression

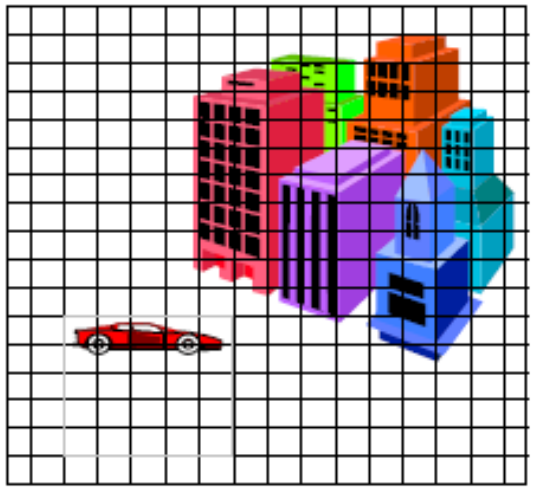
Video

A video consists of a time-ordered sequence of frames(images).

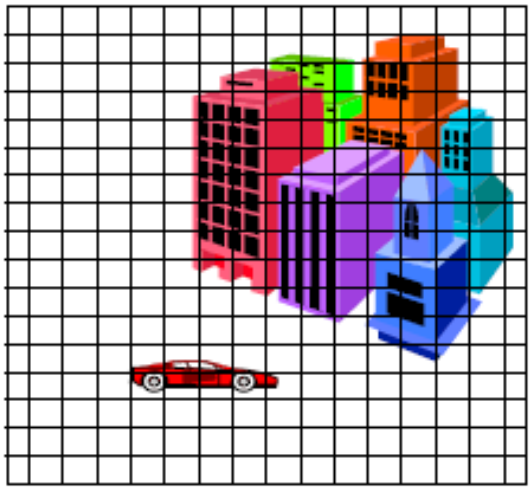
- The illusion of motion is given by displaying frames with a certain frequency. e.g. 30 frames/sec
- The number of frames showed each second depends on the spatial resolution of the frames (cinema, TV) as well as on the amplitude of the motion.

Video Compression

An obvious solution to video compression would be *predictive coding* based on previous frames.

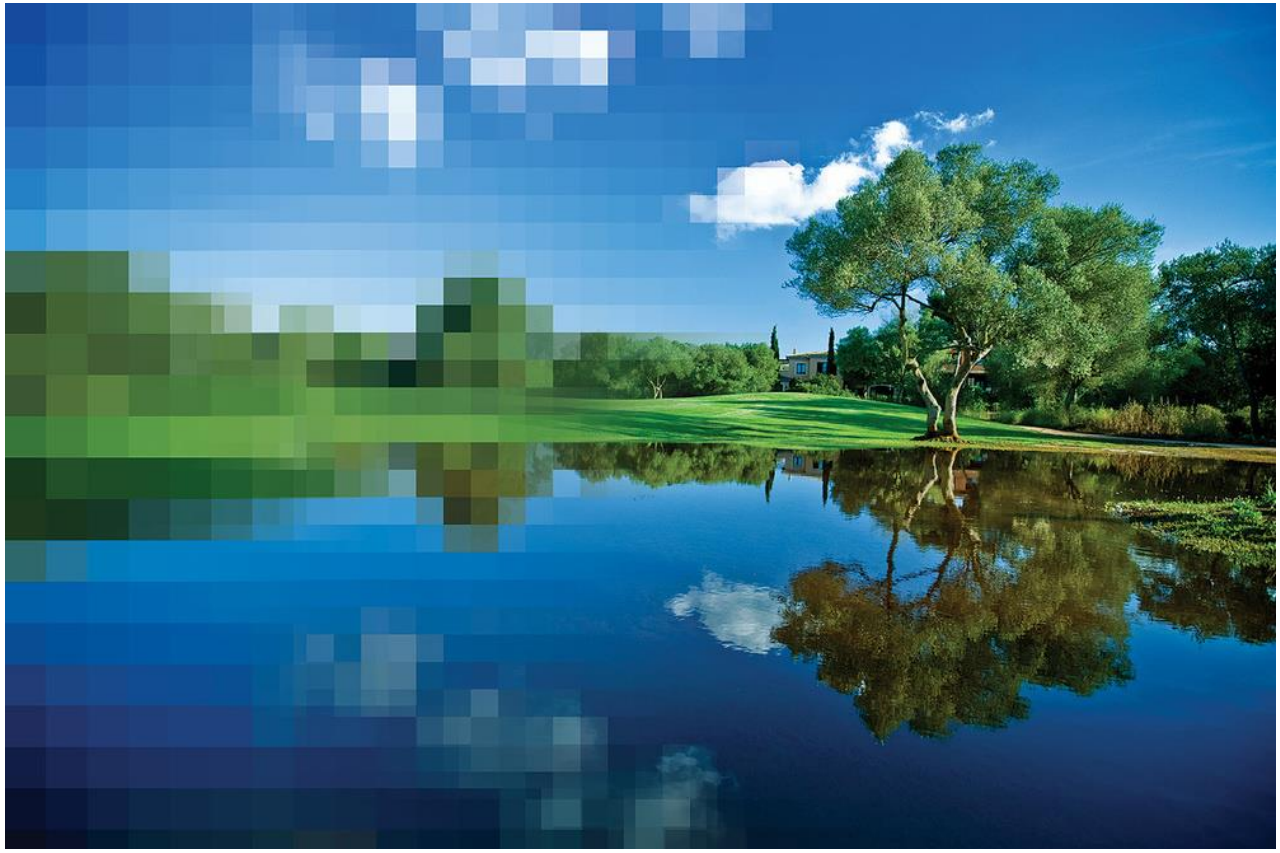


Frame(N-1)



Frame(N)

Video Compression



Q&A