Introduction to Signal and Image Processing

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Various Types of signals

1 Dimensional

2 Dimensional and

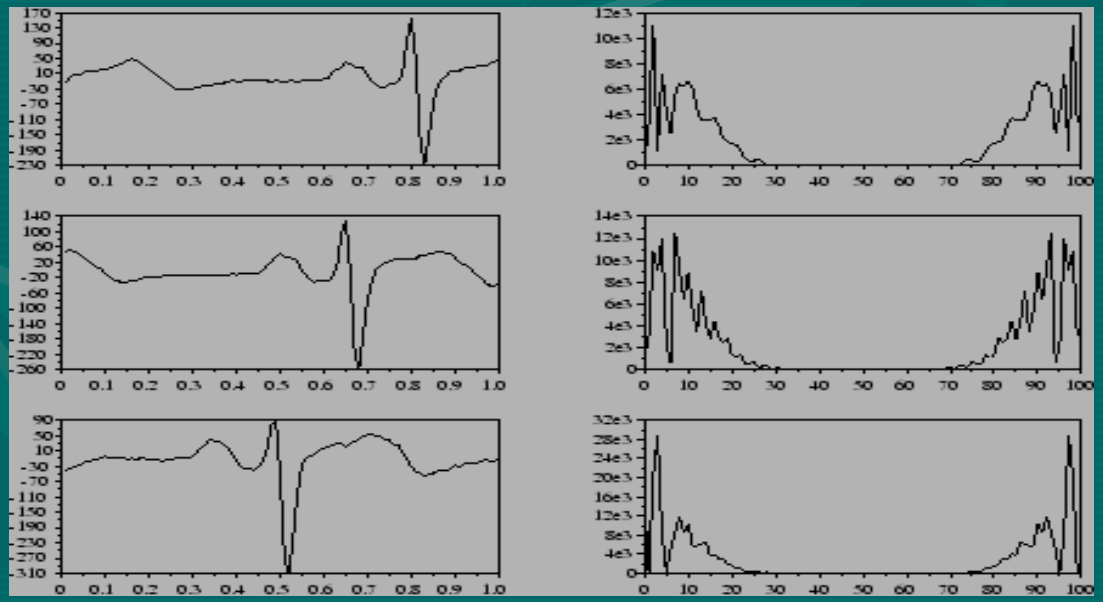
3 Dimensional Signals

1D Signal Examples

1 Voice signals

2 ECG and EEG Signals

Power spectrum of EEG Signals



2 D Signals


HESKEY
8
Phil Noble / AP


Mike Hewitt / Allsport


Patrick Gardin / AP

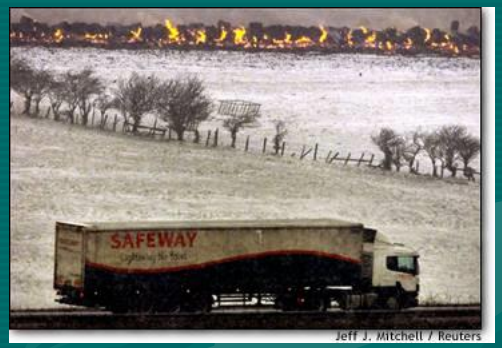

Andy Barron / Reno Gazette-Journal


Sydney Morning Herald

More 2D Signals


Eric Miller / Reuters


Mark Garkfinkel / The Boston Herald



Jeff J. Mitchell / Reuters

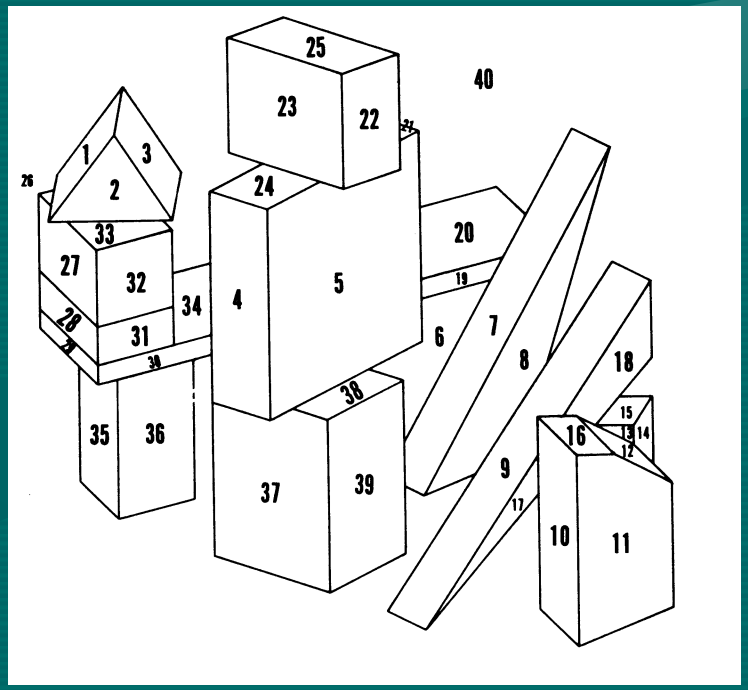

Monroe County Sheriffs Department / Newsmakers


Uno Andersson / AP

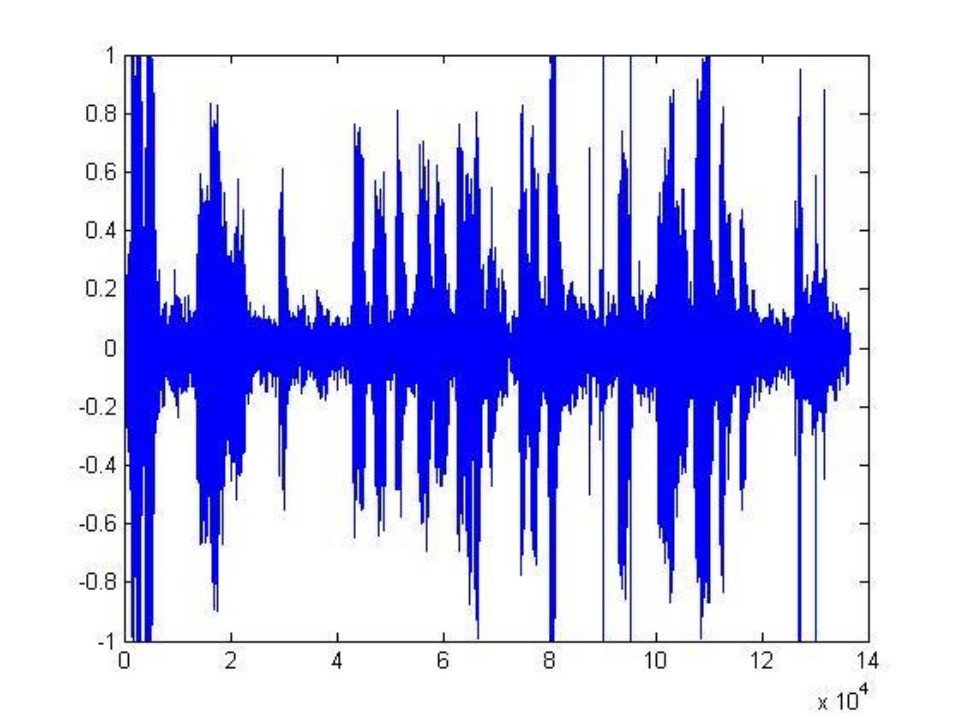

NASA via AFP

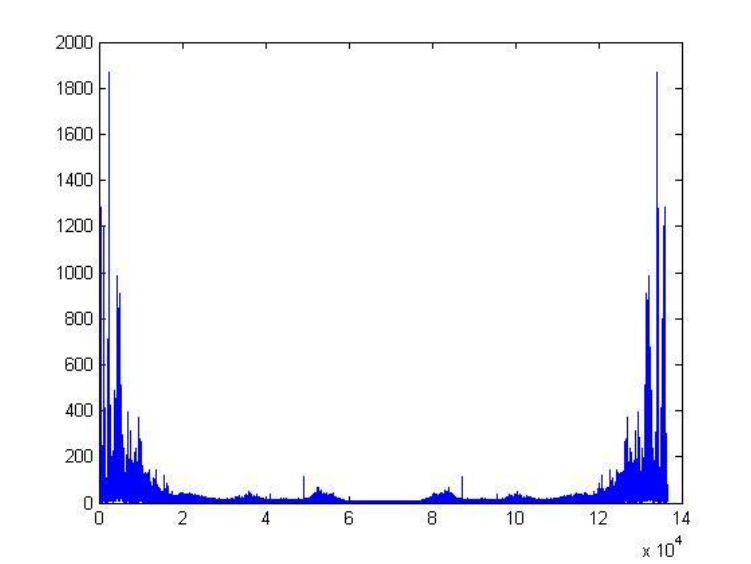
From Turing to Marr
Images from visible range only?
Can you see sound?

A Brief History



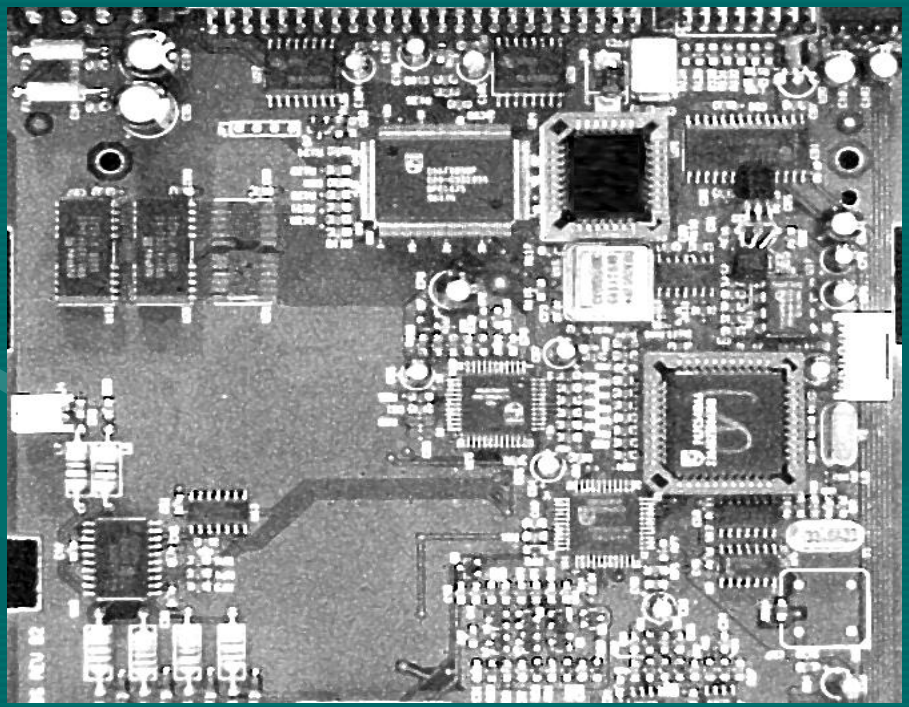
Here is the visual of Sound waves

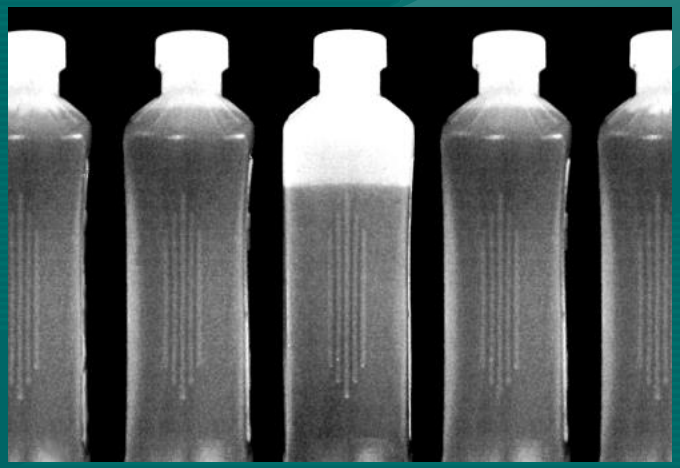




Imaging in the Visible Band

- Automated visual inspection of manufactured goods





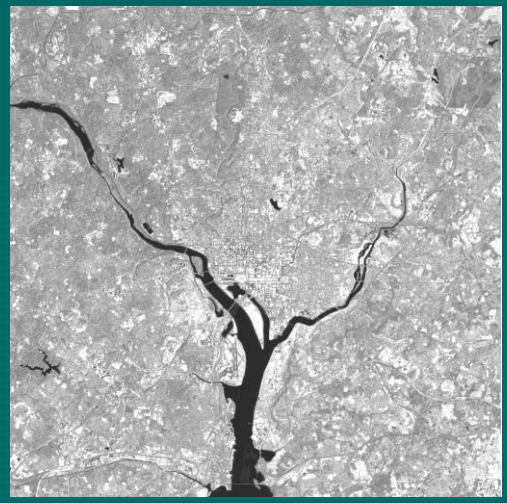
Imaging in the Visible Band

- Processing of fingerprints for automated search of a database
- Automated license plate reading

Imaging in the Visible/Infrared Band

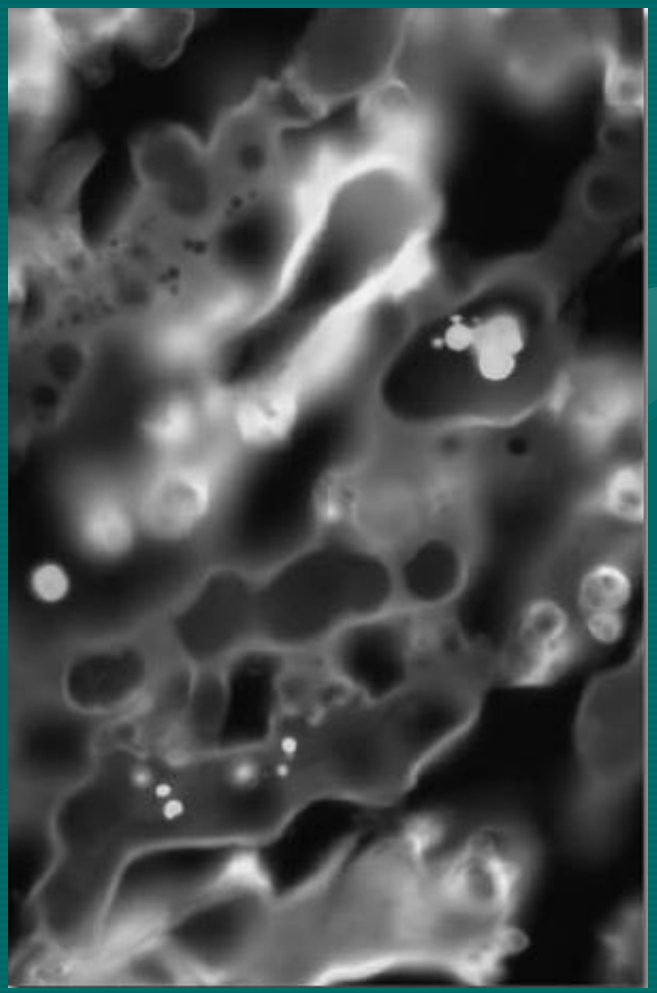
- Remote sensing: to obtain images of the earth from space for purposes of monitoring environmental conditions
- Usually a scene is imaged in several bands





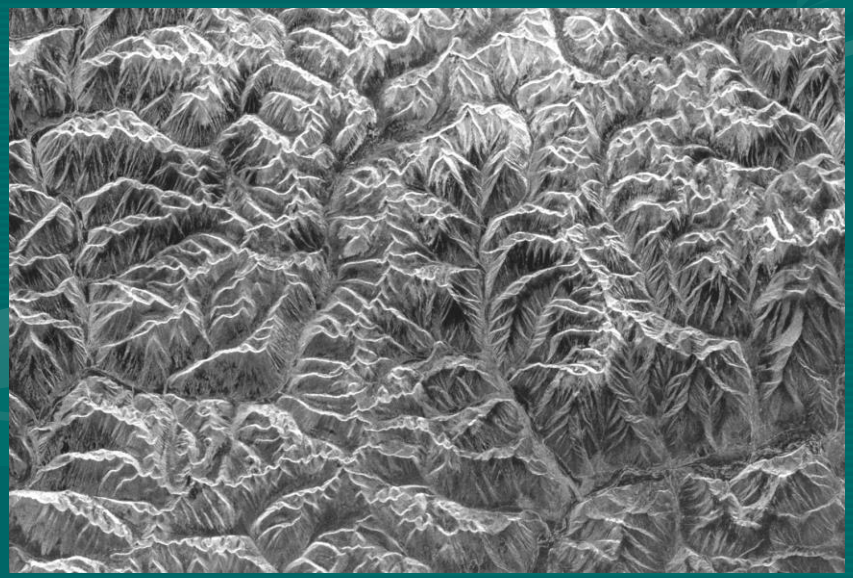
Imaging in the Ultraviolet (UV) Band

- Ultraviolet light is used in fluorescence microscopy.
- Fluorescence: a phenomena in which some material (called fluorescent) emit visible light when ultraviolet light is directed at them.



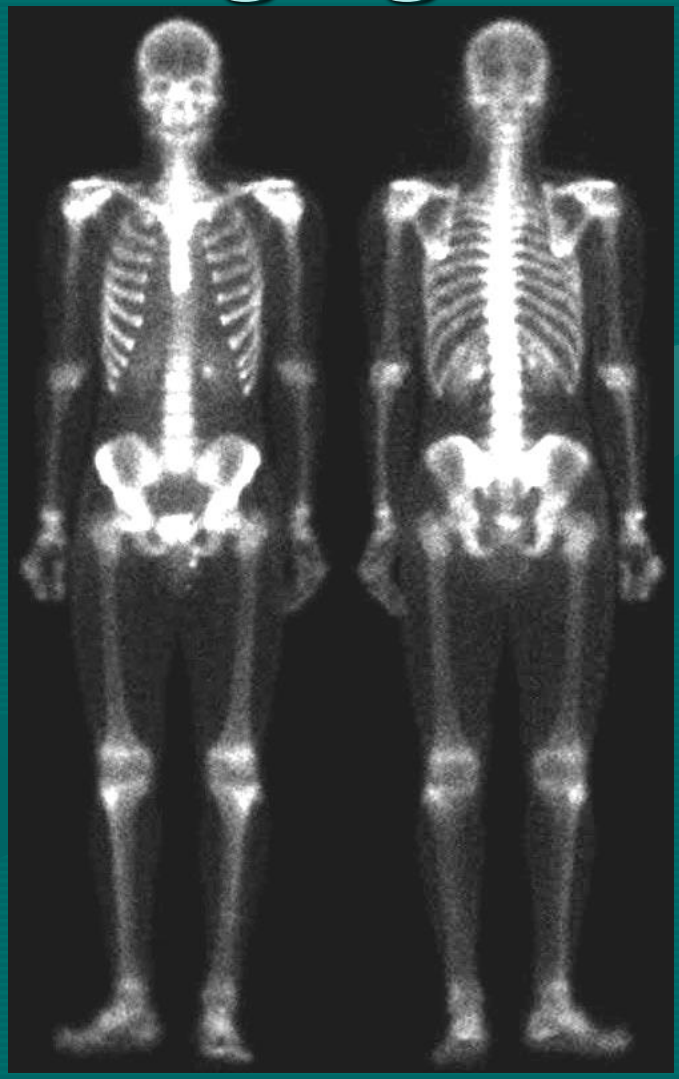
Imaging in the Microwave Band

- The dominant application of imaging in the microwave band is radar, where radar works like a flash camera.
- Unique feature: able to collect data over virtually any region at any time regardless of weather or lighting condition.



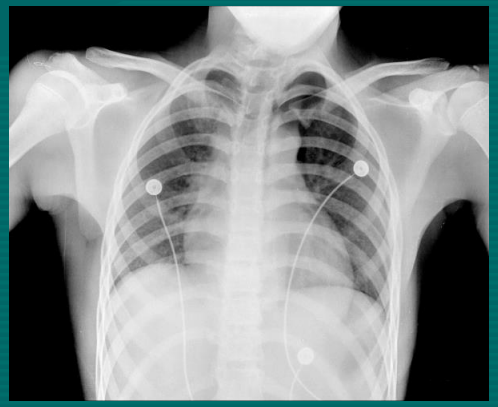
Gamma-ray Imaging

- Imaging based on gamma rays.
- Nuclear medicine: inject the patient with a radioactive isotope that emits gamma rays. Images are produced from the emissions collected by gamma ray detectors.

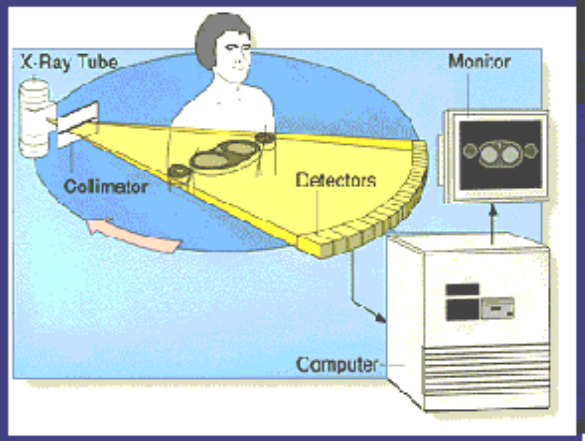


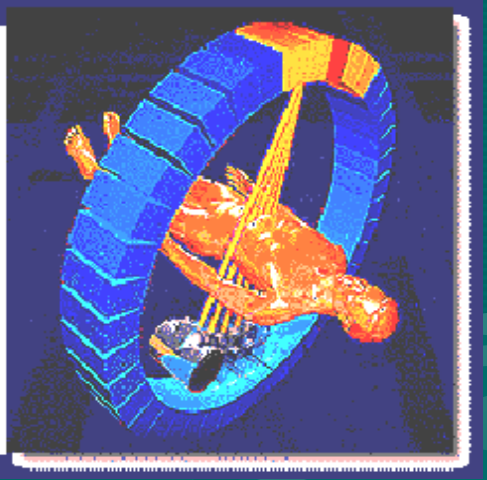
X-ray Imaging

- X-rays are used extensively in medical imaging and in industry.
- X-ray tube: a cathode which is heated and releases electrons. Electrons fly at high speed to the positively charged anode.
- When the electrons strike a nucleus, energy is released in the form of X-ray radiation.
- The intensity of the X-ray is modified by absorption as it passes through the patient.



CT



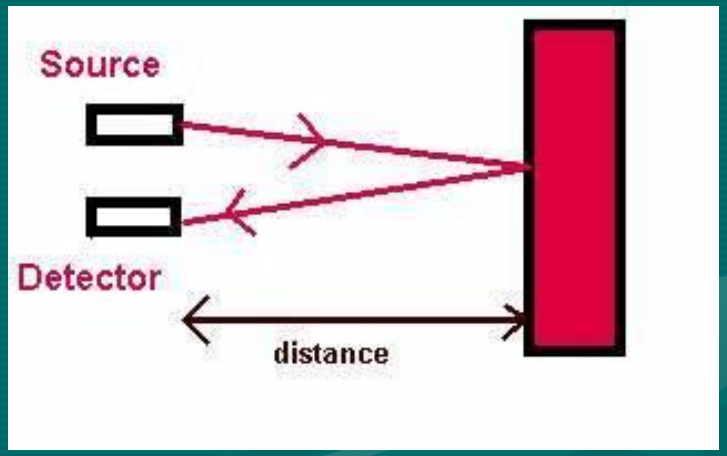


Acoustic (Ultrasound) Imaging

- Ultrasound imaging used mainly in obstetrics.
- Basic procedure in ultrasound imaging:
  1. Ultrasound system transmits high-frequency (1 to 5 MHz) sound pulses into the body.
  2. The sound waves travel into the body and hit a boundary between tissues (e.g., soft tissue and bone). Some of the sound waves are reflected back to the probe, while some travel on further until they reach another boundary.

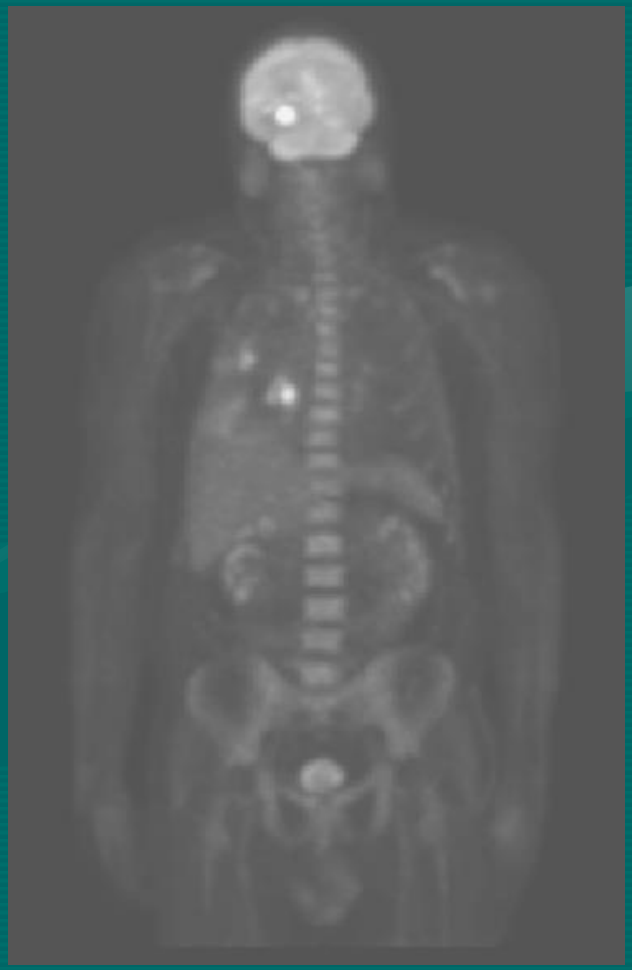
Acoustic (Ultrasound) Imaging

3. The reflected waves are picked by the probe and relayed to a computer.
4. The computer calculates the distance from the probe to the tissue using the speed of sound in tissue.
5. The system displays the distance and intensities of the echoes on the screen, forming a two-dimensional image.



PET

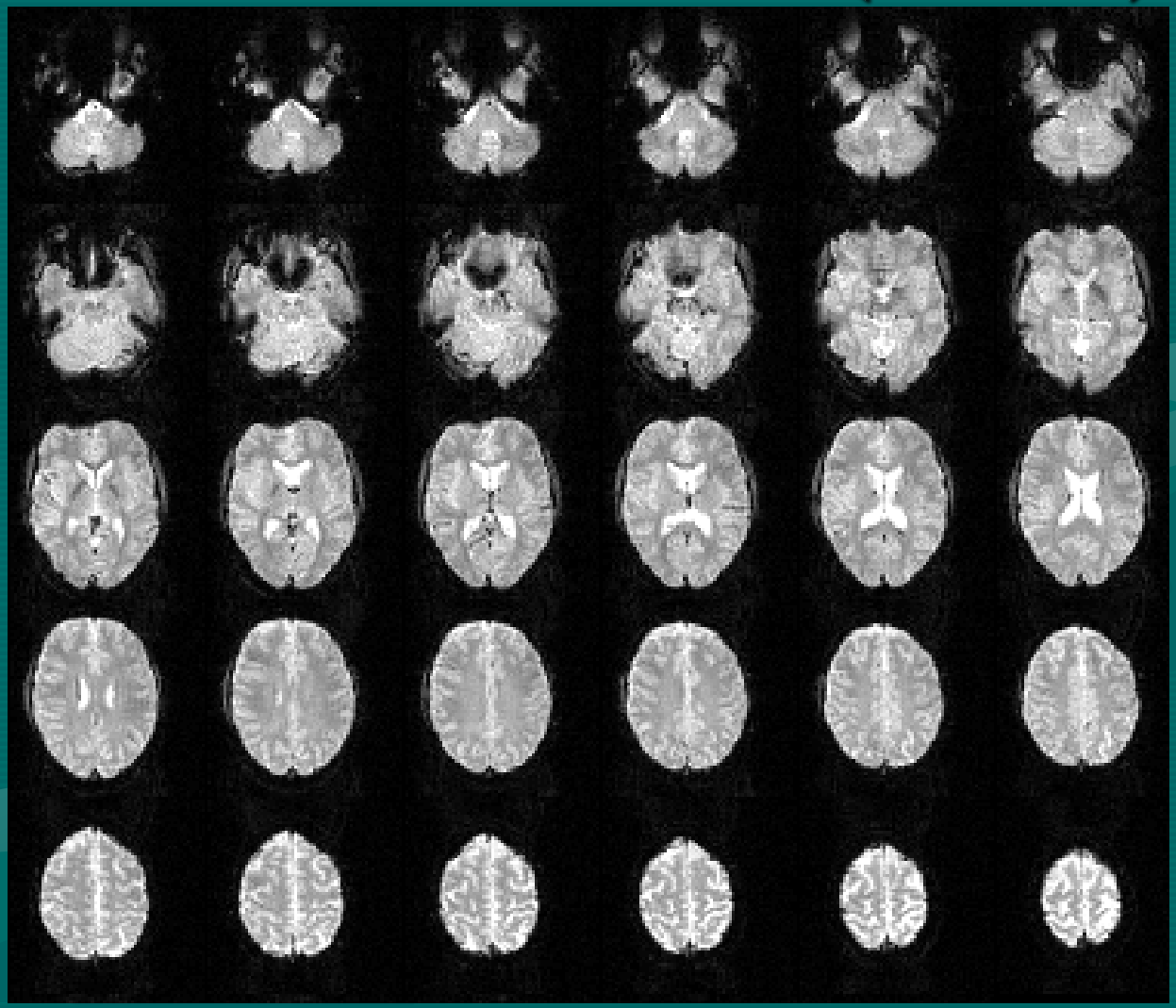
- Positron Emission Tomography (PET): the patient is given a radioactive isotope that emits positron.
- Positron generates gamma rays which are detected and an image is created.



MRI

- Magnetic Resonance Imaging (MRI): The magnet radio waves pass through a patient' body in short pulses.
- Each pulse causes a responding pulse emitted by the patient's tissue.
- The signal origin and strength are determined by a computer, which produces a two dimensional image of a section of the patient.

Functional MRI (fMRI)



Applications

- **In Medicine**
  - Enhance the contrast or code the intensity levels into colour for easier representation of X-Rays and other Bio-Medical Images
- **In Geography**
  - - Study pollution patterns from aerial and satellite imagery.
- **In Archaeology**
  - - Used to process degraded images of unrecoverable objects or experimental results too expensive to duplicate
  - - Restoration of blurred pictures that were the only available records of rare artefacts lost or damaged after being photographed.

Applications ...

- **In Physics**
  - Enhance images of experiments in areas such as high-energy plasmas and electron microscopy.
- **Other Application Areas**
  - Law Enforcement
  - Defence
  - Industrial Applications (E.g. Vision based automation)
  - Surveillance
  - Biology

Applications …

Applications of Image processing depends on the ***type of operation required for a particular image.*** These operations can be

- Image Enhancement
- Image Restoration
- Image Compression
- Image Transforms/Filtering

Problems in machine perception that utilizes image processing techniques

Automatic Character Recognition

Industrial Machine Vision for product assembly and inspection

Military recognizance

Automatic processing of fingerprints

Screening of X-Rays and blood samples

machine processing of aerial and satellite images for weater prediction and crop assessment

Why Digital Image Processing ?

Processing for human interpretation:

- Enhancement
- Contrast
- Assignment of colors for different levels of brightness in a greyscale image
- Removal of blurring that results from camera motion, incorrect focussing
- Combining of two images (Registration, Morphing) - Construction of panoramic images.

Processing for Machine Perception (Information required is different)

Different from visual features used by human beings to interpret the contents of an image

Requires : Statistical Moments, Fourier Transform Coefficients, Multidimensional distance measures

Digital Image Representation

Image refers to a two-dimensional light intensity function ***f(x,y)***, where ***x*** and ***y*** denote spatial coordinates and the value of f at any point is proportional to the brightness (or gray level) of the image at that point.

Digital Image Representation

- A digital image is an image ***f(x,y)*** that has been discretized both in spatial coordinates and brightness.
- A digital image : A matrix whose row and column indices identify a point in the image and the corresponding matrix element gives the grey level at that point.
- The elements of such a digital image are called image elements, picture elements, pixels or pels.

Image seen with Its 3rd dimension