

# **Lecture 24 – Review**

## **This lecture will cover:**

- Fundamentals of medical imaging
- Summary of imaging modalities
  - imaging physics
  - Imaging techniques
  - Instrumentation
  - Imaging characteristics
  - Specific technologies
- Other contents

# Fundamentals of medical imaging

## ➤ Diagnostic Test

## ➤ Image Acquisition

- Data acquisition
- Dynamic range and resolution
- Sampling frequency and bandwidth

## ➤ Image Characteristics

- Spatial resolution
- Contrast
- Noise
- Image artifacts

## ➤ Image Processing

- Basic image operation
- Spatial operation
- Image filtering

# Summary of image modalities

- imaging physics
- Imaging techniques
- Instrumentation
- Imaging characteristics
- Specific technologies

# Comparison of Imaging modalities

Imaging modalities	2D	3D	Other technology
X-ray	Planar radiography	CT	Angiography, fluoroscopy,
Nuclear medicine	Gamma camera	SPECT, PET/TOF PET	
MRI		MRI	fMRI
Ultrasound	B-mode, M-mode,	Multi-dimension arrays	Doppler ultrasound

# Imaging Physics

## ➤ X-ray:

Differential absorption of X-rays by various tissues.

## ➤ Nuclear medicine:

Measure the concentration of radiotracer molecules which are involved in a metabolic process.

## ➤ MRI:

- Magnetic Resonance-stimulate transition between the energy levels;
- The induced voltage is proportional to the time rate of change of the magnetic flux

## ➤ Ultrasound imaging:

Detecting reflected energy from the boundaries between tissues with different acoustic and physical properties

# Imaging techniques

## ➤ X-ray:

- Linear and mass attenuation coefficient
- Radon transform and filtered back-projection method

## ➤ Nuclear medicine:

Radioactive decay:  $\alpha$ -,  $\beta$ -,  $\gamma$ -decay

## ➤ MRI:

- Gradient magnetic fields
- The K-space and image reconstruction
- Basic imaging sequences

## ➤ Ultrasound imaging:

A-, M- and B-mode; Doppler ultrasound

# Instrumentation

## ➤ X-ray:

X-ray tube, filters, collimators, anti-Scatter grid, detectors(CR, DR, Photon counting detector),

## ➤ Nuclear medicine:

Radio tracer, Detector scintillation crystal, Photomultipliers tubes, Anger position network, Pulse height analyzer,

## ➤ MRI:

Magnet, three magnetic field gradient coils, RF transmit and receive coil, electronic circuits to control the 3 components

## ➤ Ultrasound imaging:

Single element transducer, array transducer.

# Imaging characteristics

- Signal-to-noise ratio;
- Resolution;
- Contrast-to-noise ratio;
- Artifacts;



# Specific Technologies

- Contrast agents
- X-ray:
  - Angiography, mammography, fluoroscopy,
  - Digital X-ray Tomosynthesis, Dedicated scanners, Dual-source and dual-energy CT, Electron beam tomography
- Nuclear medicine:
  - Time-of-flight PET
- MRI:
  - Magnetic resonance angiography(TOF MRA), Positive/negative contrast agent, fMRI
- Ultrasound imaging:
  - Doppler ultrasound (pulse wave, phase shift, spectral Doppler)

# Other contents

## ➤ Radiation protection

- Radiation dose and measurement
- Ionizing radiation biological effects
- Fundamental principles of radiation protection
- Methods of exposure control
- Medical radiation protection

## ➤ Medical image computing and visualization