TEXTBOOK FOR CT-SCAN TECHNICIANS

As per the Diploma and Certificate Courses on Radiography and CT-scan

Highlights

- Comprehensive coverage of cross-sectional anatomy on CT-scan
- Includes equipments, physics and procedures of CT-scan
- Concise guide on diagnosis of CT-images
- Special emphasis on radiation hazards and protection

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Foreword
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CHAPTER

Components of CT Scanner

In CT two-dimensional pictures represent three-dimensional human body. The images are produced by converting electrical energy to X-ray photons, the X-ray photons pass through 360° at a point. The density of the different parts of the body changes the intensity of photons passing through it. The computer processes the differences in transmitted X-ray photon numbers to produce data that recreates and displays sequential images as 2D CT sections on the monitor which can be converted to CT film.

CT scan combines a series of X-ray images taken from different angles around the body and uses computer processing to create cross-sectional images (slices) showing tissues inside the body, at the level of the section. CT scan unit depicted in **Figure 1.**

CT SCANNING HARDWARE (FIG. 2)

- Generator
- Scanning unit (gantry)
  - X-ray tubes
  - Photon detectors
  - X-rays shielding elements
- Patient table
- Image processor
- Console (control unit)

Fig. 1: CT scan unit.

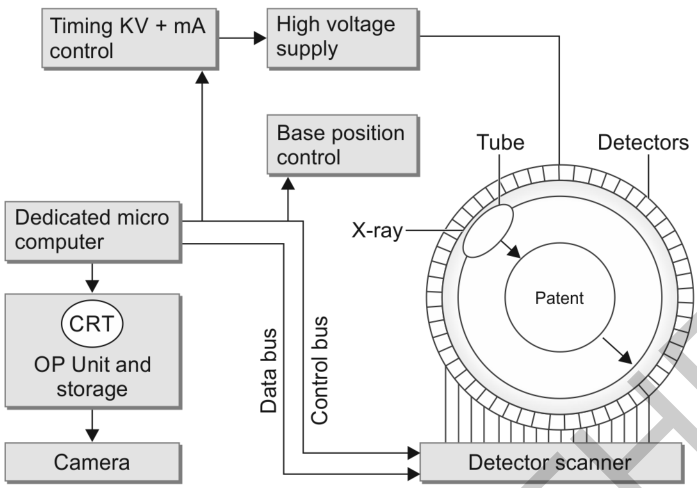

Fig. 2: Line diagram of CT unit.

X-RAY GENERATOR

CT scanners today use high frequency generators to produce X-ray required for CT protocols. The operating frequency ranges from 5 to 50 kHz and generator power can range from 15 to 60 KW which supports exposure technique from 80 to 140 kV and 30 to 500 mA.

Slip ring technology eliminated the need for cables and allows continuous rotation of the gantry components without interference of cables.

THE SCANNING UNIT (GANTRY)

Gantry is the scanning unit. It contains the X-ray tube with shielding and photon detectors. The X-ray tube and photon detectors are positioned opposite each other and are made to rotate 360° in one direction around the patient.

The gantry tilt is the angle formed between the X-ray tube plane and the vertical plane in modern machines, gantry tilt ranges between -25 degrees and +25 degrees.

The use of slip rings in gantries allows continuous complete circular movements of the internal elements without the internal circuits and cables becoming entangled. The gantry contains round opening with diameter of 60-85 cm for the table and the patient to pass through.

X-ray Tube

The X-ray tube converts moving electrons into X-ray photons. The X-ray tube is composed of a cathode assembly, an anode assembly, and a rotor, all contained in a tube envelope and together called the tube insert. The air/gas inside the tube envelope is evacuated, forming a vacuum.

The X-ray tube cathode filament is made of tungsten, it expels the electrons by thermionic emission. The current from the X-ray generator passing through the filament boils off electrons. The emitted electrons are accelerated by the potential difference between the cathode and anode toward the tungsten anode.

The X-ray tube needs the design which will absorb high heat levels generated from the high-speed rotation of the anode and the bombardment of electrons upon the anode surface. An X-ray tubes heat capacity is expressed in heat units. Modern CT systems utilize X-ray tubes that have a heat capacity of approximately 2 to 7 million heat units (MHU) with cooling rates as fast as 1 mhu/min. CT X-ray tubes utilize a combination of oil and air-cooling systems to eliminate heat and maintain continuous operation.

CT tubes utilize a bigger filament than conventional radiography X-ray tubes which increases the size of the effective focal spot. Decreasing the anode or target angle decreases the size of the effective focal spot.

The anode angle of a conventional radiography tube is between 7° and 10°. In CT, this angle is decreased to help alleviate some of the effects caused by the heel effect.

Photon Detectors

Detectors collect information regarding the degree to which each anatomic structure attenuated the beam during the exposure. Instead of film to record, the attenuated beam digital X-ray detectors collect the information.

The two basic detector types used in CT are scintillation (solid-state) and ionization (xenon gas) detectors. Current detectors use scintillation (solid-state) detectors.

Individual detector elements are affixed to a circuit board. Solid state crystal detectors are made from a variety of materials, such as cadmium tungstate, cesium iodide, bismuth germanate and ceramic rare earth compounds like gadolinium or yttrium.

Now all scanners are multi-slice and have 8-64 or more rows of detectors. There are generally 1000-2000 detectors

When the X-ray beam travels through the patient, it is attenuated by the anatomical structures it passes through. The CT process relies on collecting attenuated photon energy and converting it to an electrical signal, which is then converted to a digital signal for computer reconstruction. A detector is a crystal that when struck by an X-ray photon produces light or electrical energy.

The two types of detectors utilized in CT systems are scintillation or solid state and xenon gas detectors. Scintillation detectors utilize a crystal that fluoresces when struck by an X-ray photon which produces light energy. A photodiode which transforms the light energy into electrical or analog energy is attached to the scintillation portion of the detector. The strength of the detector signal is proportional to the number of attenuated photons that are successfully converted to light energy and then to an electrical or analog signal.

The signal represents an absorption or attenuation profile which is obtained for each view or projection and every detector in the detector array is responsible for this task. The most frequently used scintillation crystals are made of bismuth germanate and cadmium tungstate.

It is important that detectors are placed as close to one another as possible. Scintillation detectors convert 99 to 100% of the attenuated photons into a useable electrical signal.

X-Ray Shielding Elements

X-rays that do not travel in a straight path from the X-ray tube to the detector that is in line with the beam but instead reach an off-path, detector lead to reconstruct an accurate representation of what signal was derived from original location. Phenomenons and inaccuracies in image processing, result in image "noise," which reduces the contrast between imaged structures that is a critical element for maintaining image quality and enabling interpretation of the anatomy and pathology.

PATIENT TABLE

The patient's table moves through the gantry during the scan. The distance of table moves during a complete rotation of the gantry is referred to as the table pitch or detector pitch. Table pitch equals the forward table movement in millimeters during a complete gantry rotation divided by beam collimation (the slice thickness in mm). Faster moving tables are described as having greater pitches. Increased table speed reduces scanning time and radiation dose but reduces image resolution if the circuitry of the machine cannot process the information as quickly as the table moves.

IMAGE PROCESSOR

The formation of a CT image is a distinct three phases process. The scanning phase produces data, but not an image. The reconstruction phase processes the acquired data and forms a digital image. The visible and displayed analog image (shades of gray) is produced by the digital-to analog conversion phase.

CT scan combines a series of X-ray images taken from different angles around your body and uses computer processing to create cross-sectional images (slices) of the bones, blood vessels and soft tissues inside the body. The digital signal is stored as bits and bytes on the processor chip as data that contains information about the scan. This data can be manipulated using mathematical algorithms to represent the 3D structure in different ways as different types of images. In general, formulas are applied to convert the data from its original reference values to new values, referred to as "transformation."

Images are displayed on monitor screen. Monitor screens are composed pixels. Each pixel represents a two-dimensional projection of a three-dimensional volume, which is termed a voxel. Each voxel and pixel are assigned a Hounsfield number reflecting the amount of photon energy absorbed and measured by the detector, which reflects the density of the object at the time of the scan. The larger the number, the greater the brightness of the displayed pixel.

CONSOLE

Often there are two different control consoles, one used by the CT scan operator, and the other used by the radiologist.

TEXTBOOK FOR CT-SCAN TECHNICIANS

Textbook for CT-scan Technicians is a wonderful contribution to the field of imaging technology. With this marvelous book of medical imaging technology, students of all levels can excel in performance with confidence. This book covers from basic anatomy to technological advancements with lucid presentation and makes it an excellent source for radiography students and teaching faculty of imaging technology. It is a must-have for every medical college library.

This book helps students of all levels of medical imaging technology and can do extremely well with confidence.

Salient Features

- It is a must-have book for Radiographer and CT-Scan Technician, undergoing Diploma or Certificate Courses.
- It is very useful for teachers who teach "Radiography".
- The language used is simple and understandable.
- It contains meticulously labeled illustrations for better understanding.
- It includes answers to questions asked in theory and practical examinations.

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