ROHINI COLLEGE OF ENGINEERING AND TECHNOLOGY
AUTONOMOUS INSTITUTION
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DEPARTMENT OF BIOMEDICAL ENGINEERING

VII Semester

OBT357 BIOTECHNOLOGY IN HEALTH CARE

UNIT- 5 BASICS OF IMAGING MODALITIES

5.2 Computer Tomography

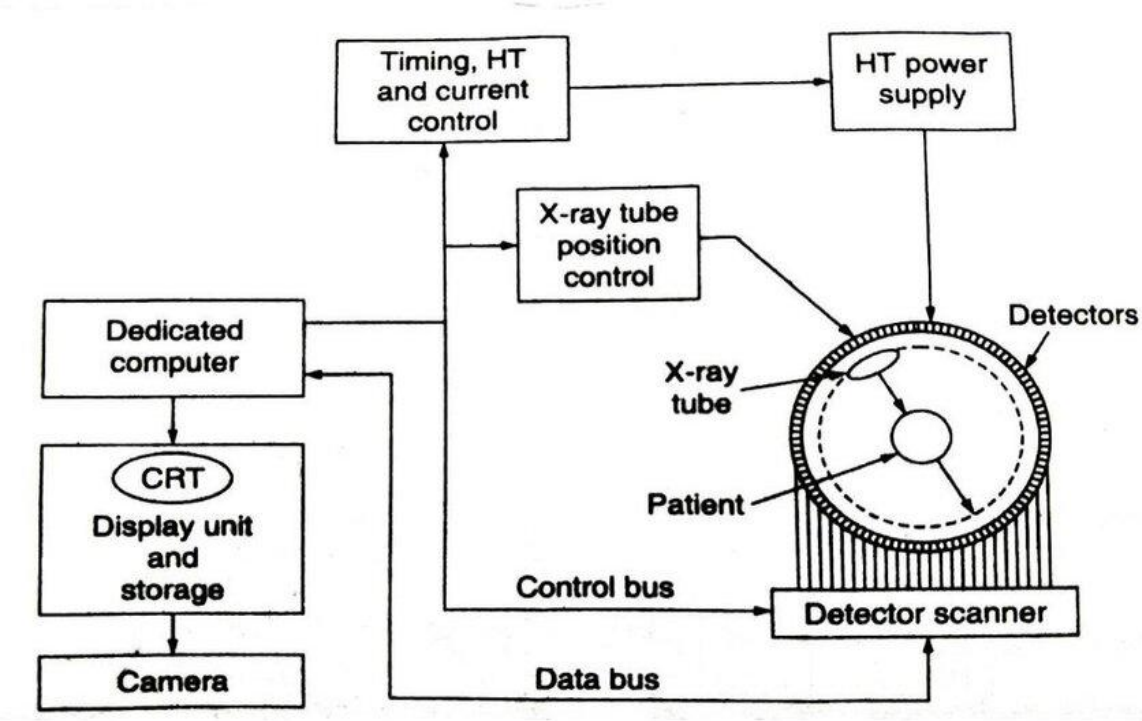
Computer tomography (CT) is a noninvasive medical imaging technique that uses rotating X-rays and computer processing to create detailed cross-sectional images, or "slices," of organs, bones, and tissues inside the body.

- CT scans use X-rays to create detailed images of internal structures by directing the X-rays at the body from different angles and measuring the intensity of the X-rays that pass through the body with detectors.
- A special type of X-ray detector called a multi-slice detector is used in CT scans, which can acquire multiple images at the same time from different angles, allowing for the creation of detailed cross-sectional images of the body.
- The images obtained from CT scans are then processed by a computer and can be viewed in different ways, such as cross-sectional slices, 3D images, and even virtual reality images.

Components of a CT Scanner

1. **X-ray Tube**: Generates X-rays by accelerating electrons from a cathode to an anode, producing a rotating or fan-shaped beam. High-voltage power supplies (20–140 kVp) drive this process.
2. **Detectors**: Arrays of solid-state detectors (e.g., scintillation crystals paired with photodiodes) capture X-rays after they pass through the patient, converting them into electrical signals for image reconstruction.
3. **Gantry**: A rotating frame housing the X-ray tube and detectors, allowing them to circle the patient to capture multiple angles. The gantry includes a patient aperture for positioning.

4. **Patient Table**: A motorized table that moves the patient through the gantry, enabling sequential or helical scanning of the body.
5. **High-Voltage Power Supply**: Provides the necessary voltage and current to operate the X-ray tube, with precise control for varying imaging protocols.
6. **Collimators and Filters**: Collimators shape the X-ray beam to the scan area, while filters remove low-energy X-rays to reduce dose and enhance image quality.
7. **Data Acquisition System (DAS)**: Collects and digitizes signals from the detectors, converting raw data into a format suitable for image processing.
8. **Computer System**: Processes the digitized data using algorithms (e.g., filtered back projection or iterative reconstruction) to reconstruct 2D or 3D images. Includes a workstation for operator control and image display.
9. **Control Console**: Allows technologists to set scan parameters (e.g., kVp, mA, slice thickness) and monitor the procedure.



Computed Tomography Imaging

Working Principle:

- The diagram illustrates the working principle of a **CT (Computed Tomography) scanner**.
- An X-ray tube mounted on a rotating gantry emits X-rays that pass through the patient, where they are attenuated by different tissues.
- Opposite the tube, an array of detectors captures the transmitted X-rays and converts them into electrical signals.
- These signals are sent via the detector scanner through a data bus to a dedicated computer. Simultaneously, the timing, high-tension (HT), and current control system regulate the HT power supply, which drives the X-ray tube, while the position control system ensures precise tube rotation around the patient.
- The computer processes the raw detector data using reconstruction algorithms to generate cross-sectional images, which are displayed on a CRT unit and stored for future use.
- A camera can also capture the images for documentation. Together, these components enable CT scanners to produce detailed internal images of the body with high accuracy.

Applications:

- **Diagnosis**: Detects abnormalities like tumors, fractures, infections, and internal bleeding.
- **Guidance**: Assists in procedures like biopsies or radiation therapy planning.
- **Screening**: Used for conditions like lung cancer or coronary artery disease.
- **Emergency Medicine**: Rapid assessment of trauma, stroke, or acute abdominal issues.

Advantages:

- Fast imaging (seconds to minutes), ideal for emergencies.
- High-resolution images of bones, organs, and soft tissues.
- Non-invasive and widely available.
- Can image large areas of the body in a single scan.

Limitations:

- **Radiation Exposure**: CT uses ionizing radiation, posing a small risk of cancer with repeated exposure.
- **Contrast Risks**: Contrast agents can cause allergic reactions or kidney issues in some patients.
- **Cost**: More expensive than standard X-rays.
- **Limited Soft Tissue Contrast**: Less effective than MRI for detailed soft tissue imaging (e.g., brain or muscles).

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