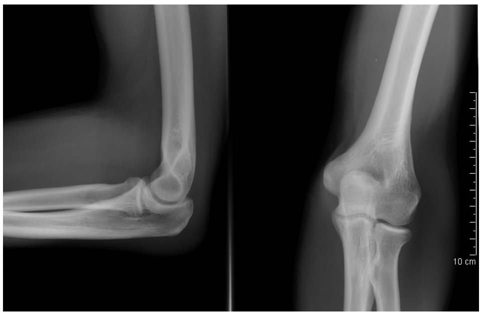
Radiography

Radiography is the use of the property of X-rays to cross materials to view inside objects. The impact on society of this technique has been immense with application fields including medical, non-destructive testing, food inspection, security and archeology.



A plain radiograph of the elbow.

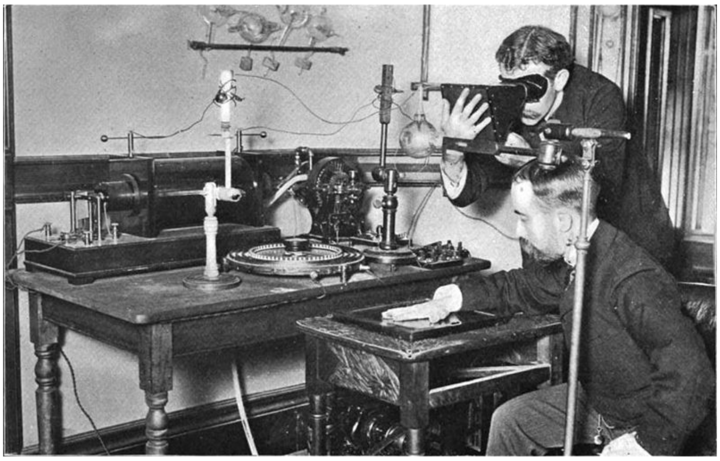
A heterogeneous beam of X-rays is produced by an X-ray generator and is projected toward an object. According to the density and composition of the different areas of the object a proportion of X-rays are absorbed by the object. The X-rays that pass through are then captured behind the object by a detector (film sensitive to X-rays or a digital detector) which gives a 2D representation of all the structures superimposed on each other. In tomography, the x-ray source and detector move to blur out structures not in the focal plane. Computed tomography (CT scanning) is different to plain film tomography in that computer assisted reconstruction is used to generate a 3D representation of the scanned object/patient.

An X-ray from the Vietnam war shows an unexploded grenade embedded in a patient's skull. (As demonstrated by the intubation, the patient is lying down, not standing up. The circumstances behind the image are otherwise unknown.)

Medical and industrial radiography

Radiography is used for both medical and industrial applications (see medical radiography and industrial radiography). If the object being examined is living, whether human or animal, it is regarded as medical; all other radiography is regarded as industrial radiographic work.

History of radiography


Taking an X-ray image with early Crookes tube apparatus, late 1800s.

Radiography started in 1895 with the discovery of X-rays, also referred to as Röntgen rays after Wilhelm Conrad Röntgen who first described their properties in rigorous detail. These previously unknown rays (hence the X) were found to be a type of electromagnetic radiation. It wasn't long before X-rays were used in various applications, from helping to fit shoes, to the medical uses that have persisted. X-rays were put to diagnostic use very early, before the dangers of ionizing radiation were discovered. Indeed, Marie Curie pushed for radiography to be used to treat wounded soldiers in World War I. Initially, many kinds of staff conducted radiography in hospitals, including physicists, photographers, doctors, nurses, and engineers. The medical specialty of radiology grew up over many years around the new technology. When new diagnostic tests were developed, it was natural for the radiographers to be trained in and to adopt this new technology. Radiographers now often do fluoroscopy, computed tomography, mammography, ultrasound, nuclear medicine and magnetic resonance imaging as well. Although a nonspecialist dictionary might define radiography quite narrowly as "taking X-ray images", this has long been only part of the work of "X-ray departments", radiographers, and radiologists. Initially, radiographs were known as roentgenograms.[1]

Equipment

Sources

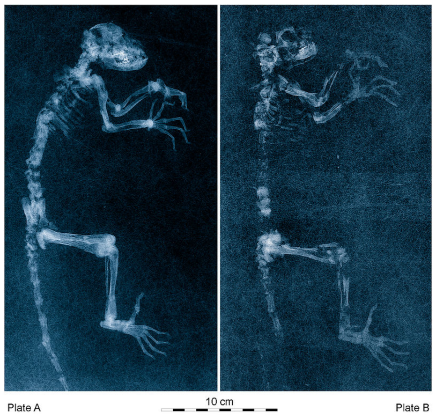
A number of sources of X-ray photons have been used; these include X-ray generators, betatrons, and linear accelerators (linacs). For gamma rays, radioactive sources such as ^{192}Ir, ^{60}Co or ^{137}Cs are used.

Detectors

A range of detectors including photographic film, scintillator and semiconductor diode arrays have been used to collect images.

Theory of X-ray attenuation

X-ray photons used for medical purposes are formed by an event involving an electron, while gamma ray photons are formed from an interaction with the nucleus of an atom.[2] . In general, medical radiography is done using X-rays formed in an X-ray tube. Nuclear medicine typically involves gamma rays.



Radiographs of the *Darwinius* fossil Ida.

The types of electromagnetic radiation of most interest to radiography are X-ray and gamma radiation. This radiation is much more energetic than the more familiar types such as radio waves and visible light. It is this relatively high energy which makes gamma rays useful in radiography but potentially hazardous to living organisms.

The radiation is produced by X-ray tubes, high energy X-ray equipment or natural radioactive elements, such as radium and radon, and artificially produced radioactive isotopes of elements, such as cobalt-60 and iridium-192. Electromagnetic radiation consists of oscillating electric and magnetic fields, but is generally depicted as a single sinusoidal wave. While in the past radium and radon have both been used for radiography, they have fallen out of use as they are radiotoxic alpha radiation emitters which are expensive; iridium-192 and cobalt-60 are far better photon sources. For further details see commonly used gamma emitting isotopes.

Gamma rays are indirectly ionizing radiation. A gamma ray passes through matter until it undergoes an interaction with an atomic particle, usually an electron. During this interaction, energy is transferred from the gamma ray to the electron, which is a directly ionizing particle. As a result of this energy transfer, the electron is liberated from the atom and proceeds to ionize matter by colliding with other electrons along its path. Other times, the passing gamma ray interferes with the orbit of the electron, and slows it, releasing energy but not becoming dislodged. The atom is not ionised, and the gamma ray continues on, although at a lower energy. This energy released is usually heat or another, weaker photon, and causes biological harm as a radiation burn. The chain reaction caused by the initial dose of radiation can continue after exposure, much like a sunburn continues to damage skin even after one is out of direct sunlight.

For the range of energies commonly used in radiography, the interaction between gamma rays and electrons occurs in two ways. One effect takes place where all the gamma ray's energy is transmitted to an entire atom. The gamma ray no longer exists and an electron emerges from the atom with kinetic (motion in relation to force) energy almost equal to the gamma energy. This effect is predominant at low gamma energies and is known as the photoelectric effect. The other major effect occurs when a gamma ray interacts with an atomic electron, freeing it from the atom and imparting to it only a fraction of the gamma ray's kinetic energy. A secondary gamma ray with less energy (hence lower frequency) also emerges from the interaction. This effect predominates at higher gamma energies and is known as the Compton effect.

In both of these effects the emergent electrons lose their kinetic energy by ionizing surrounding atoms. The density of ions so generated is a measure of the energy delivered to the material by the gamma rays.

The most common means of measuring the variations in a beam of radiation is by observing its effect on a photographic film. This effect is the same as that of light, and the more intense the radiation is, the more it darkens, or exposes, the film. Other methods are in use, such as the ionizing effect measured electronically, its ability to discharge an electrostatically charged plate or to cause certain chemicals to fluoresce as in fluoroscopy.

Obsolete terminology

The term *skiagrapher* was used until about 1918 to mean *radiographer*. It was derived from Ancient Greek words for 'shadow' and 'writer'.

See also

- CAD Systems (Computer Aided Diagnosis)
- Radiation
- Radiation contamination
- List of civilian radiation accidents
- Radiographer
- Projectional radiography
- Shadowgraphs
- Background radiation

References

[1] Ritchey, B; Orban, B: "The Crests of the Interdental Alveolar Septa," *J Perio* April 1953
[2] Radiation Detection and Measurement 3rd Edition, Glenn F. Knoll : Chapter 1, Page 1: John Wiley & Sons; 3rd Edition edition (26 Jan 2000): ISBN 0-471-07338-5

- Carestream. *(*http://www.kodak.com/global/en/health/productsByType/index.jhtml?pq-path=2/521/2970)"
- Agfa. *(*http://www.piribo.com/publications/medical_devices/companies_medical/agfa_medical_device_company_intelligence_report.html)"
- *A review on the subject of medical X-ray examinations and metal based contrast agents*, by Shi-Bao Yu and Alan D. Watson, Chemical Reviews, 1999, volume 99, pages 2353–2378
- *Composite Materials for Aircraft Structures* by Alan Baker, Stuart Dutton (Ed.), AIAA (American Institute of Aeronautics & Ast) ISBN 1-56347-540-5

External links

- Online Radiologic Website Free For Radiographers and Radiologists: (http://www.mdct.com.au) Free Online Text Books, more than 5000 cases online with CT and MRI correlation. Its Free to become a member.
- Online Radiographic Positions and Procedures Guide: (http://www.rtstudents.com/radiology-positions.htm) Have access to positioning information anywhere with this quick and easy procedure manual.
- MedPix (http://rad.usuhs.edu/medpix/index.html) Medical Image Database
- NIST's XAAMDI: X-Ray Attenuation and Absorption for Materials of Dosimetric Interest Database (http://physics.nist.gov/PhysRefData/XrayMassCoef/cover.html)
- NIST's XCOM: Photon Cross Sections Database (http://physics.nist.gov/PhysRefData/Xcom/Text/XCOM.html)
- NIST's FAST: Attenuation and Scattering Tables (http://physics.nist.gov/PhysRefData/FFast/Text/cover.html)
- Radiography Review (http://www.radiographyreview.com) Great site to review all aspects of radiography prior to your ARRT exam.
- Radiography Forums (http://www.radiologyforums.com) An online community for staff radiographers and radiography students.
- Australian Institute of Radiography (http://www.air.asn.au)
- American College of Radiology (http://www.acr.org/)
- Radiography Guide (http://www.radiographyguide.com) Follow a student blogger in radiography school and refresh those old clinical skills.

- UN information on the security of industrial sources (http://www.iaea.org/Publications/Booklets/SealedRadioactiveSources/industry_lessons.html)
- RadiologyInfo - (http://radiologyinfo.org/en/sitemap/modal-alias.cfm?modal=xray) The radiology information resource for patients: Radiography (X-rays)
- The Society of Radiographers (http://www.sor.org/) Definitive information on the practice of Radiography Professionals
- Sumer's Radiology Site (http://www.sumerdoc.blogspot.com/) Radiology Blog working as an Online Radiology Magazine
- Nick Oldnall's radiography site (http://www.xray2000.co.uk/)
- EUROPEAN SOCIETY OF RADIOLOGY (http://www.esr-online.org)
- What is Radiology? (http://rad.usuhs.edu/whatis.html)
- New York State Society of Radiologic Technologists (http://www.nyssrs.org) web site

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