Medical Image Processing for Diagnostic Applications

X-ray Basics

Online Course – Unit 9

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Topics

X-ray Devices

X-ray

Two devices are typically used to convert X-rays into intensity images:

- image intensifiers (II), introduced ∼1940,
- flat panel detectors (FP or FD), introduced ∼2000.

Notes:

- Both technologies are still used in hospitals.
- Modern equipment is mostly shipped with flat panels.
- Research systems use flat panels, image intensifiers are obsolescent.

Image artifacts in X-ray imaging can have many sources. In the following units we consider artifacts that are due to the used detector technology.

X-ray Tube

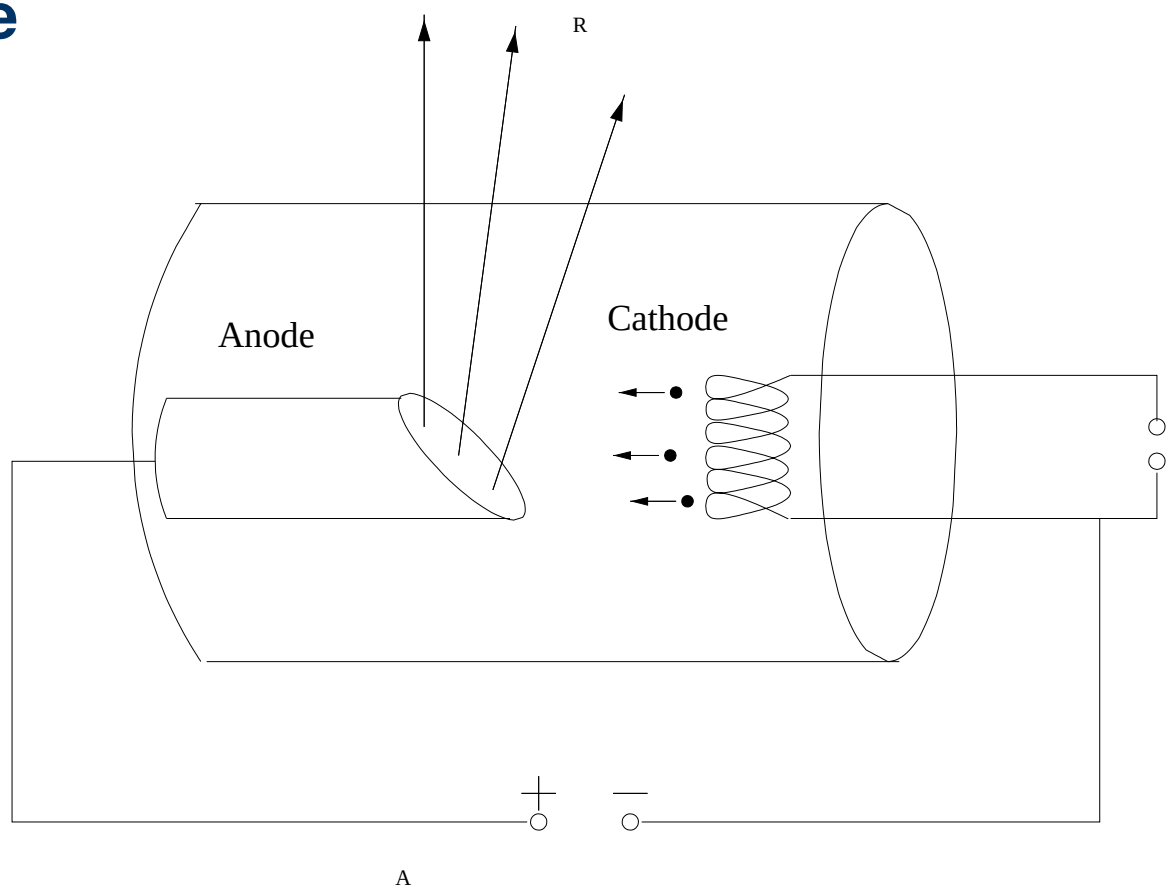

Figure 1: Concept of a traditional X-ray tube (R: ray emission, A: power source)

X-ray Tube: Heel Effect

The ***heel effect*** causes a gray level ramp in X-ray images:

actual trajectory depends on where the anode is hit

-> intesity is inhomogenius :(

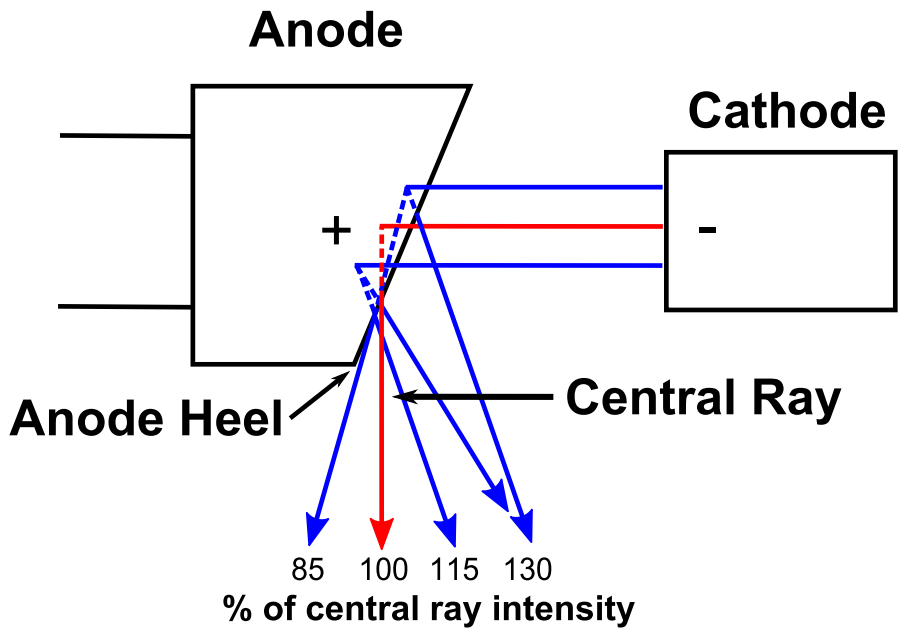

Figure 2: Scheme of the heel effect: rays with longer pathways through the anode are more likely absorbed.

The elimination of such inhomogeneities is discussed in upcoming units.

STRATON X-ray Tube

anode rotates for cooling purposes

The **engineers from Erlangen** who developed this X-ray tube were under the final four for the “Deutschen Zukunftspreis” 2005! (*en.:* German future prize)

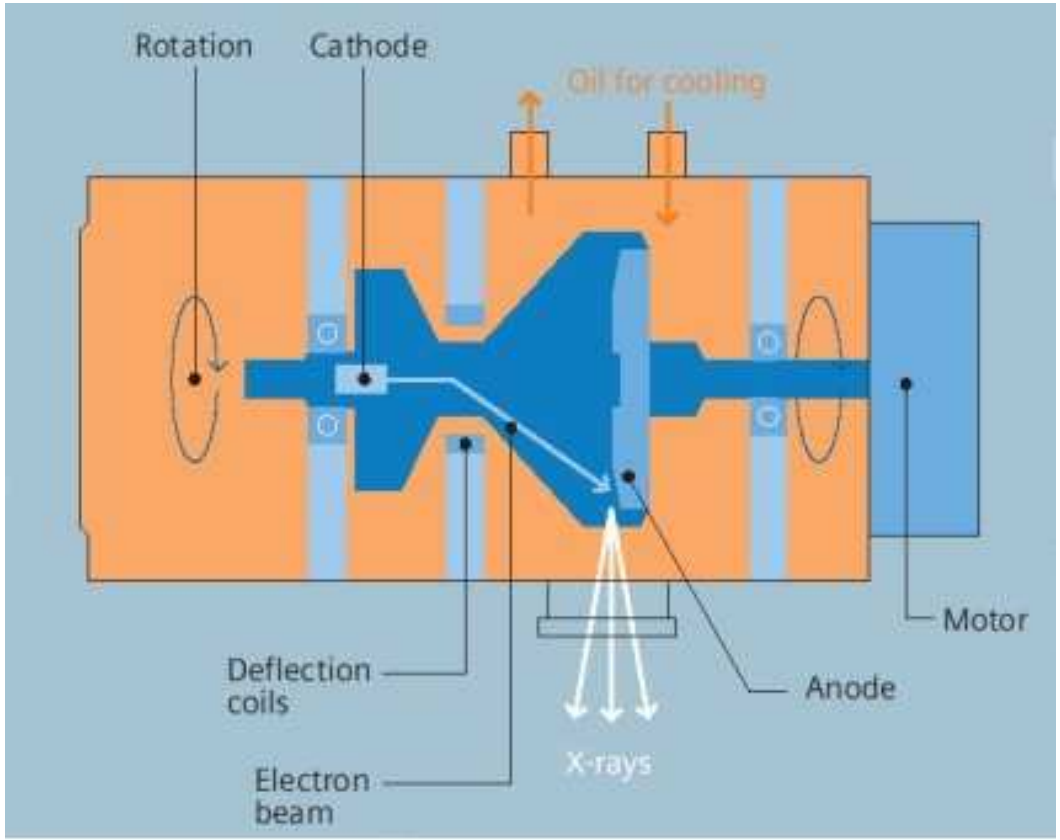

Figure 3: Concept of the STRATON X-ray tube (image courtesy of Siemens AG)

X-ray Tubes: Comparison

Figure 4: Traditional X-ray tube (left), Straton X-ray tube (right) (images courtesy of Siemens Healthcare)

X-Ray Detectors

different methodes -> different preprocessing methodes

big

small

Figure 5: Image intensifier (left), flat panel detector (right) (images courtesy of Siemens Healthcare)

X-Ray Detectors in Cardiology

Figure 6: C-arm device with image intensifier (left) and flat panel detector (right) (images courtesy of Siemens Healthcare)

Topics

Take Home Messages

- Over time different designs for X-ray emission and measurement devices have been developed.
- There are physical effects inherent to the system design that might degrade your images and therefore need preprocessing.

Further Readings

An excellent overview of different detectors used in X-ray equipment can be found in

> Heinz Morneburg, ed. *Bildgebende Systeme für die medizinische Diagnostik: Röntgendiagnostik und Angiographie, Computertomographie, Nuklearmedizin, Magnetresonanztomographie, Sonographie, integrierte Informationssysteme*. 3rd ed. Publicis MCD Verlag, June 1995 (in German).

Information on the distortion correction products can be found on the vendors' homepages. Try, for instance, www.healthcare.siemens.com.