FEASIBILITY STUDIES OF A DIGITAL BEAM ATTENUATOR SYSTEM FOR DIAGNOSTIC RADIOGRAPHY (MEDICAL IMAGING, X-RAY FILTERS)

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The human body provides a wide range of transmission for x-radiation used in medical diagnosis. Behind dense structures in the body, the image is recorded at low signal amplitudes and suffers from increased scatter fractions and noise which degrade image quality. In response to this problem we have developed a system to generate a heavy-metal compensating filter, called the digital beam attenuator, for diagnostic radiology. When placed between the x-ray tube and patient, the attenuator modulates the x-ray beam producing a more uniform exposure distribution reaching the detector. All areas are imaged at maximum signal amplitudes and with a more uniform scatter distribution and equalized quantum statistics.

The fabrication process begins with a low-dose patient image acquired electronically and processed in a digital image processor to calculate the attenuator thickness needed to compensate the patient's transmission characteristics. A dot-matrix printer under computer control deposits an organic material containing cerium oxide onto a sheet of paper to form the attenuator. The attenuator can be positioned automatically in the x-ray beam before acquisition of an equalized image either photographically or with a suitable electronic detector.

Phantom studies demonstrate the advantages of acquiring radiographs with the digital beam attenuator. In digital subtraction angiography, the opacification signal in compensated images is obtained at maximal signal amplitudes to improve the signal-to-noise ratio and with a more uniform scatter distribution to decrease image degradation. In chest radiography, the attenuator is blurred geometrically by the x-ray tube focal spot and suppresses large transmission variations contributed by low spatial frequency structures. All areas of the chest are imaged in the linear region of the film characteristic curve improving the visibility of higher spatial frequency structures especially in retrocardiac, mediastinal, and subdiaphragmatic areas. A digital beam attenuator can be used to advantage in any situation where the image quality is degraded by problems which accompany a radiographic signal having a wide dynamic range.