Abstract

Fluence field modulated computed tomography: implemented using digital beam attenuation (DBA)
Timothy P. Szczykutowicz

Purpose: Patient specific dose avoidance for CT has generated academic and industrial interest in both 2 dimension and tomographic x-ray imaging. However, the ability to modulate dose dynamically (i.e. from projection to projection) in computed tomography is currently limited to changing the overall magnitude for some fixed dose distribution. This work aims to implement an experimental system capable of a dynamically changing the dose distribution for every projection angle. In doing so, an important question can be answered, namely, if a finer level of dose modulation is available, can image quality be improved at equal dose or can image quality be maintained at a lower dose? **Methods:** Dynamic modulation is accomplished using wedge shaped modulators that change the amount of attenuation as a function of fan angle. The modulators are arranged in overlapping pairs such that as a given pair of wedges increases their overlap, their composite thickness increases. To evaluate the performance of the design, a simulation environment was created to model different wedge materials, sizes, and numbers. In addition, an experimental prototype was constructed which consisted of 10 Fe wedges. The prototype was used to experimentally verify the simulation environment results and to test the feasibility of the device. **Results:** The results support the hypothesis that a finer level of dose modulation is beneficial. It was found, experimentally, that dose reductions of 3.6 times were obtainable using the DBA. In addition, large reductions in the required dynamic range of the x-ray detectors were also possible; the DBA required a dynamic range of 3.7 compared to 84.2 for a non-DBA scan. The scatter to primary ratio was also seen to decrease by a factor of 4 using the DBA. **Conclusions:** The DBA should allow for a new level of patient specific imaging and may allow for new imaging acquisition methods like photon counting detectors and volume of interest imaging to become clinically feasible.

Abstract

Fluence field modulated computed tomography: implemented using digital beam attenuation (DBA)
Timothy P. Szczykutowicz

Purpose: Patient specific dose avoidance for CT has generated academic and industrial interest in both 2 dimension and tomographic x-ray imaging. However, the ability to modulate dose dynamically (i.e. from projection to projection) in computed tomography is currently limited to changing the overall magnitude for some fixed dose distribution. This work aims to implement an experimental system capable of a dynamically changing the dose distribution for every projection angle. In doing so, an important question can be answered, namely, if a finer level of dose modulation is available, can image quality be improved at equal dose or can image quality be maintained at a lower dose? **Methods:** Dynamic modulation is accomplished using wedge shaped modulators that change the amount of attenuation as a function of fan angle. The modulators are arranged in overlapping pairs such that as a given pair of wedges increases their overlap, their composite thickness increases. To evaluate the performance of the design, a simulation environment was created to model different wedge materials, sizes, and numbers. In addition, an experimental prototype was constructed which consisted of 10 Fe wedges. The prototype was used to experimentally verify the simulation environment results and to test the feasibility of the device. **Results:** The results support the hypothesis that a finer level of dose modulation is beneficial. It was found, experimentally, that dose reductions of 3.6 times were obtainable using the DBA. In addition, large reductions in the required dynamic range of the x-ray detectors were also possible; the DBA required a dynamic range of 3.7 compared to 84.2 for a non-DBA scan. The scatter to primary ratio was also seen to decrease by a factor of 4 using the DBA. **Conclusions:** The DBA should allow for a new level of patient specific imaging and may allow for new imaging acquisition methods like photon counting detectors and volume of interest imaging to become clinically feasible.