AbstractID: 13830 Title: Performance of multiplexing x-ray imaging based on multi-beam x-ray source technology

Purpose:

Multiplexing technique has been widely used in telecommunication, magnetic resonance imaging (MRI), and various spectroscopic applications to drastically increase system throughput. The recent development of carbon nanotube (CNT) field emission based multi-beam x-ray source technology provides us an opportunity to adopt multiplexing for x-ray imaging. In this study we report our recent simulation work on the imaging quality assessment of multiplexing x-ray imaging under different noise environments.

Method and Materials:

A computer model was built to simulate the imaging behavior of a multi-beam x-ray system. The imaging parameters, including x-ray tube current, exposure time, number of x-ray beams and noise composition (quantum noise and electronic noise), can be easily controlled to evaluate the system performance under different imaging environments. In the simulation, the noise composition was varied from the photon noise limited case (100% photon noise) to the electronic noise limited case (100% electronic noise).

Results:

Our results indicated that the performance of multiplexing x-ray imaging is closely related to the noise composition of the imaging system. Under the photon noise limit, multiplexing/demultiplexing procedure magnifies the noise and degrades the imaging quality and multiplexing x-ray imaging is always outperformed by its sequential counterpart. However the performance of multiplexing x-ray imaging gradually improves as the fraction of electronic noise in the total noise increases. In the electronic noise limited case, multiplexing is indeed able to speed up system imaging throughput.

Conclusion:

Under appropriate imaging conditions, multiplexing x-ray radiography has the potential to achieve higher imaging speed without significantly sacrificing the imaging quality. It could be used for applications such as image-guided radiation therapy (IGRT) for which imaging speed instead of imaging quality is the main concern of the task. We are hoping that this study can provide us a guideline to better identify future multiplexing x-ray imaging related applications.