Abstract

Low Radiation Dose Computed Tomography:
Technology Development and Assessment

Daniel Gómez Cardona

Given the widespread use of x-ray CT in medical imaging and the increasing concern about the potential risks associated with ionizing radiation, multiple strategies to reduce radiation dose in CT while providing acceptable image quality have been proposed. These strategies range from hardware improvements to highly nonlinear denoising algorithms and image reconstruction methods. Current approaches to assess image quality and optimize parameter selection in CT rely on the assumption that CT systems are linear or quasilinear, and fail therefore when implemented on recently introduced highly nonlinear CT systems. This challenging scenario motivates us to (1) assess the extent of this nonlinear behavior in clinical practice, (2) develop a task-based framework for CT parameter optimization that is applicable to both linear and highly nonlinear CT systems, and (3) use this framework to guide the development of low-dose CT technologies. The proposed framework is tailored to a given imaging task and incorporates local measurements of spatial resolution and noise into the so-called mathematical observer models, which have been shown to have a high correlation with human observer performance. In this thesis work, it has been demonstrated that this framework can be effectively used to leverage the synergy between CT hardware and software advances to reduce radiation dose while maintaining the desired imaging performance.