Quantitative assessment of prior image constrained compressed sensing in the context of cardiac CT imaging

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The task of obtaining high-quality time-resolved volumetric images of the heart has challenged the minds of imaging researchers for decades. While this problem is difficult, the high incidence of cardiovascular disease (CVD) in the developed world makes this problem all the more urgent. CVD is currently the most common cause of death in the United States. In this context, the role of imaging is dual; it can provide early diagnosis and can also enable cost-effective treatment of heart disease. This dissertation focuses on how to perform cardiac computed tomography (CT), while delivering a minimal dose of ionizing radiation. The enabling technology is the prior image constrained compressed sensing (PICCS) image reconstruction framework, which was developed and implemented at the University of Wisconsin--Madison. Two applications of PICCS are examined: CT myocardial perfusion imaging and time-resolved interventional cardiac cone-beam CT. Several technical issues specific to these applications are described and evaluated. The performance of the method is characterized using quantitative image quality metrics so as to determine its limitations. Based on the results presented in this dissertation, one should better understand the potential role of PICCS in cardiac CT at the diagnostic and the interventional levels.