PhD Thesis Title: Endorectal Digital Prostate Tomosynthesis

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Graduation Date: 8/3/2018
Available Online: https://digitalcommons.lsu.edu/gradschool_dissertations/4582/

ABSTRACT:

There are several areas of prostate cancer (PCa) management that may benefit from high image resolution. Some of these areas include imaging permanent brachytherapy implants or small, aggressive lesions. Current PCa imaging methods can have inadequate resolution for imaging these areas. Endorectal digital prostate tomosynthesis (endoDPT), an imaging method that combines an external x-ray source and an endorectal x-ray sensor, can produce three-dimensional images of the prostate region with a high image resolution when compared to typical methods. This high resolution may improve PCa management and increase positive outcomes for affected men.

This dissertation presents the initial development of endoDPT, which includes system design, image quality assessment, and examples of possible applications to prostate imaging. Experiments were conducted using computational phantoms, physical phantoms, and canine prostate specimens.

The initial system design was performed computationally and three methods of endoDPT image reconstruction were developed: shift and add (SAA), back projection (BP), and filtered BP (FBP). A physical system was developed using an XDR intraoral x-ray sensor and a GE radiography unit. The resolution and radiation dose of endoDPT were measured and compared to a GE computed tomography (CT) scanner. Canine prostate specimens that approximated clinical cases of PCa management were imaged and compared to the endoDPT, the above CT scanner, and a GE magnetic resonance imaging (MRI) scanner.

This study found that the resolution of endoDPT was significantly higher than the CT scanner. Furthermore, the radiation dose of endoDPT was significantly lower than the CT scanner in the regions of the phantom that were not in the endoDPT field of view (FoV). Inside the endoDPT FoV, the radiation dose ranged from significantly less than to significantly greater than CT. The endoDPT images of the canine prostate specimens demonstrated qualitative improvements in resolution compared to CT and MRI scanners. But, the endoDPT had difficulty in visualizing larger structures, such as the prostate border.

Overall, this study has demonstrated that the endoDPT has a higher image resolution when compared to the typical methods of PCa imaging. Future work will be focused on the development of a prototype system that improves scanning efficiency that can be used to optimize endoDPT and perform pre-clinical studies.

References to author publications that relate specifically to the dissertation:

1. NA