RECONSTRUCTION OF TOMOGRAPHIC IMAGES CORRUPTED BY A SLICE SENSITIVITY PROFILE WITH APPLICATIONS TO THE INSPECTION OF MANUFACTURED ITEMS

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ABSTRACT

Computed Tomography has become common in today's world as a method to image objects for product testing. The process of obtaining the images is very complex, and much research has been done to analyze and remove image artifacts to give the true representation of the object being examined. Currently there are many algorithms in use for image reconstruction but these are often not enough to remove all artifacts that are present.

A major source of artifacts in images from x-ray computed tomography are partial volume effects caused by the finite width of the tomographic slices. These partial volume effects will appear as a blending of materials across different tomographic slices, removing the delineations that were once present. This is of special importance when imaging manufactured objects because this material blending can mask defects that may be present.

This thesis describes a coherent abstraction of an x-ray computed tomography machine. The basic tenants of filtered backprojection algorithm are explained along with a general projection measurement system and the causes of other artifacts. We show that the effects of the finite slice width can be represented by a convolution between the object being imaged and a system response function called a slice sensitivity profile (SSP).

To remove these partial volume effects we use the Richardson-Lucy (RL) algorithm, which was designed to deblur astronomical images blurred by a point spread function. This algorithm is also equivalent to one used by by Shepp and Vardi to reconstruct images from PET. We also present a version of the RL algorithm that is regularized using the total variation metric. Derivations for both algorithms are presented as well.

The algorithms are tested with synthetic data that has been corrupted by an SSP and Poisson noise. The results between the two are compared using a three-dimensional object. In our tests we show that although both preform well in removing the blending of materials the version regularized by a total variation

metric yields a result with a substantially smaller noise artifact. We also show how these algorithms could help resolve defects in manufactured items that were not obvious before because of the partial volume effects.