Application for QIBA Project Funding

Title of Proposal: Methodology and Reference Image Set for Volumetric Characterization and Compliance		
QIBA Committee/Subgroup:		
NIBIB Task Number(s) which this project addresses:		
Project Coordinator or Lead Investigator Information:		
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Institution/Company: Duke University Medical Center		
Amount Requested:		

Project Description

Our ability to accurately characterize a lesion is fundamentally limited by the varying confluence of anatomical background surrounding the lesion. As such, simplistic phantoms based on uniform or fixed constructs have limited relevance to clinical conditions in quantifying a varying lesion. Trials based on actual clinical images are in a sense ideal, but they also suffer from a lack of ground truth: it is nearly impossible to fully know the true size and morphology of a lesion in vivo, as subsequent pathological validations are rare, and even if done, the lesion can be deformed in the resection process.

The objective of the present project is to compare and make publicly available methodologies to insert realistic lesions into clinical CT images, and to ultimately develop an image dataset of clinical CT scans with lesions inserted using these methods. The dataset provides anatomical variability as exists in actual clinical datasets, while at the same time the synthetic nature of the lesions offers the advantage of known truth. Multiple datasets can potentially be rendered as varying lesions can be reinserted countless times at various locations, thus “refreshing” the test set. The lesions can be multiplied into additional clones with statistical variability, yet share the same generalized properties at that of the modeled lesions.

There are two general approaches that one may consider in adding a lesion to a CT dataset. One may blend-in a volume of interest (VOI) containing a lesion into a normal VOI in another CT image (Technique 1). This technique has the advantage of simplicity and computational ease; however, additional processing steps may be required to simulate the effects of differences in image acquisition methods and non-linear iterative reconstruction algorithms. These effects can be accounted for directly if one uses a lesion mask that is added to the target image in the projection space, and the projection data reconstructed along with the added lesion (Technique 2). In this proposal, we explore these approaches in terms of their relative advantages and disadvantages in the context of a thorax phantom, building towards a test set that can be used for quantitative validation and compliance.

This project will be pursued in 2 years, with a plan that the deliverables of each year will stand on their own merits. The deliverables of the year 1 of this project are 1) a rigorous comparison of different methods for inserting lesions into CT images, 2) a comprehensive set of phantom images, and 3) a publicly available

software system for addition of realistic lesions into any CT dataset for evaluation and validation of quantitative performance. The deliverables for year 2 of the project are 1) a complete reference database of 100 hybrid clinical image sets (based on LIDC) with confirmed and validated added lesions for gold-standard quantitative evaluation, and 2) an initial comparison of select software packages for volumetric quantification using this reference dataset. Since the deliverables of both years 1 and 2 are meaningful and significant, the project can be terminated at the end of year 1 if funding for year 2 is not available.