UNIVERSITI TEKNOLOGI MARA

THE DOCTORAL RESEARCH ABSTRACTS

Volume: 7, Issue 7 May 2015

SEVENTH ISSUE

INSTITUTE of GRADUATE STUDIES

Leading You To Greater Heights, Degree by Degree

IGS Biannual Publication

Name :
Noor Diyana Osman

Title :
Development of a Phantom and Metal Artifact Correction (MAC) Algorithm for Post-Operative Spine Computed Tomography (CT) Imaging

Supervisor :
Prof. Dr. Md Saion Salikin (MS)

Dr. M Iqbal Saripan (CS)

The assessment of post-operative spine using computed tomography (CT) imaging is so challenging in the presence of metal artifacts induced by spinal implants. Metal artifacts can severely affect the quality of CT images, and mislead the diagnosis interpretation. The artifacts are due to the beam hardening, photon starvation effect, and inappropriate correction algorithm during image reconstruction. Knowledge on factors affecting the artifacts is crucially important to minimize these artifacts. The main aim of this study is to develop a novel technique for suppression of metal artifacts and this study generally consists three main parts. The first part is the development of a simple phantom useful for metal streaking analysis performed in the second part of this work. A customized phantom was constructed with tissue-equivalent materials and various metal inserts to simulate the streaking artifacts similar to the clinical findings in post-operative spine imaging. In this work, a thorough study on factors influencing the magnitude of metal streak artifacts is presented. There are 3 different variables studied which were metal insert characteristics, exposure factors, and reconstruction parameters. The phantom was scanned using Siemens Definition AS+ CT scanner in Radiology Department, HUSM. All phantom images were acquired using standard field of view (FOV) of 230mm with various acquisition and reconstruction protocols depending on the parameters studied. Standardized regions of interest (ROIs) were defined within the streaking region to obtain 1625 attenuation measurements in Hounsfield units (HU). All data are displayed as mean ± standard deviation (SD). The severity of metal streak in each image was determined by CT fluctuation, and noise at each ROI. Results show similar degrees of streaking artifacts noted in phantom images compared with the clinical CT outcomes. From artifacts analysis, it is found that smaller size and low density metal implants produce less severe artifacts. The result shows increased kVp and mAs has reduced streak artifacts with reduction in image noise and enhanced signal-to-noise ratio (SNR) values. A sharper kernel reduces metal streaks, but produces significantly higher noise ($P < 0.05$) in the images as compared to smooth kernel. Thicker slice also reduced metal artifacts and noise in image. The last part is the development of a metal artifact correction (MAC) algorithm and evaluation of the proposed algorithm in artifacts reduction in CT images. The MAC algorithm was developed in MATLAB environment and was applied on virtual sinogram which directly computed through forward projection of CT images. The missing projection data due to metal region is detected and extracted using an improved technique of dual-step adaptive thresholding. Then, the missing data are replaced by interpolated values by using the spline cubic interpolation. The interpolated and metal-only images were reconstructed and fused together to obtain the final corrected images. The corrected and non-corrected phantom images were compared to evaluate the performance of the proposed MAC. It is shown that the streaking region close to metal inserts was reduced after applying the MAC algorithm. The result also shows significant reduction in image noise, and SNR is enhanced in corrected images. As a conclusion, the fabricated phantom is useful for metal streak analysis with a broad range of parameters can be studied and cost effective. It is concluded that the proposed algorithm allows significant reduction of the streaking artifacts in both phantom and clinical CT images.

*** (MS) = Main Supervisor (CS) = Co Supervisor**