Exploiting Symmetries for Weight Matrix design in CT Imaging

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Abstract

The aim of this paper is to propose and compare different methods of constructing the system matrix (SM) of a CT scanner with two objectives: (1) to construct SMs in the shortest possible time (seconds if possible) and store them in an ordinary PC without losing quality, (2) to analyze the possible applications of the proposed method to 3D, taking into account SMs sizes, computing time and reconstruction quality. In order to construct the SM we propose two new field of view (FOV) pixellation schemes of a CT scanner on to a polar coordinate system (polar grid). Over these pixellation schemes we design different methods to calculate the weights for the SM that compact it to a size that can be stored in the RAM of an ordinary PC taking advantage of the polar rotation symmetries of the CT.

The SMs obtained in this way, make speeding up the reconstruction time possible with better quality in reconstructed images than with the classical cartesian SM. Moreover, the SM based on the pixellation schemes on the polar grid are built faster than on the cartesian one.

The reconstructed images using the SM based on pixellation schemes on a polar grid are in a polar form and need to be transformed to display them. Thus, we have also develop a new visualization procedure.

Comparisons between the SMs proposed: the cartesian SM and the classical FBP, are performed using two phantom and a real CT-simulator images. Results, global error, contrast, noise and homogeneity of the reconstructed images are discussed.