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Normalized metal artifact reduction using CNR-based metal segmentation in dental computed tomography

In dental computed tomography (CT), the image quality is usually degraded when patients have metallic objects such as metal implants or metal prosthesis, inducing several detrimental effects such as photon starvation, beam hardening, and photon scattering, all of which contribute to producing metal artifacts [1]. Although various metal artifact reduction (MAR) methods have been developed in dental CT, no MAR algorithm that can robustly remove metal artifacts has been universally accepted because the resulting image quality can vary substantially, depending on the patient, scanning system, and reconstruction method. A simple approach to MAR is to use interpolation-based methods where the trace of metallic objects on the sinogram is identified and then modified by interpolating the pixel values around the metal trace. Although interpolation-based methods are computationally efficient, new artifacts are often introduced in the corrected CT image owing to the interpolation errors. Normalized MAR (NMAR) algorithms based on sinogram normalization interpolation have been investigated to overcome this difficulty, and their outperformance compared to the existing interpolation-based methods has been demonstrated [2]. In this study, we revisited the NMAR approach with a new elaborate metal segmentation scheme based on contrast-to-noise ratio (CNR) measurement. Figure 1 shows a simplified diagram of the proposed MAR process that consists of three main steps: CNR-based metal segmentation, generation of a residual artifact-free prior, and sinogram completion followed by CT reconstruction. In the metal segmentation, CNR difference between the edge of the metal area and its neighborhoods in CT image is measured and used to identify the metal trace more precisely than the commonly used thresholding method. We conducted a simulation and experiment to verify the efficacy of the proposed MAR method. Figures 2 and 3 show our preliminary simulation and experimental results, which indicate that the proposed MAR method reduced metal artifacts considerably in dental CT and showed an image quality better than those obtained by the existing MAR methods in reducing streak artifacts without introducing any contrast anomaly. More quantitative simulation and experimental results will be presented in the paper.

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