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A numerical approach to estimate the absorbed dose distribution in cone-beam computed tomography

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Dedicated dental cone-beam computed tomography (CBCT) examinations are being greatly increased for not only therapeutic but also cosmetic purposes. While, therefore, patient-specific dose management will be a great concern, the average dose measurement with a cylindrical phantom is the only method for the dose estimation in CT. However this standard CT dose index method is aimed at quality control of the CT scanners and is not suitable for patient-specific dose estimations [1]. Other alternative to estimate patient doses is the Monte Carlo method, but it requires extremely high computational cost, although it provides accurate estimates.

In this study, we develop a numerical approach to estimate the patient-specific dose distributions in the CBCT. The algorithm is fundamentally based on the ray-tracing technique and the dose distributions are estimated in a two-step process: the absorbed dose due to the primary photons first and then that due to the scattered photons, as demonstrated in Fig. 1. The validation of the algorithm is performed by the experimental measurements. The detailed description of the algorithm will be given, including the effects of parameters used for calculations, such as the number of projections, the number of spectral bins, the number of voxels, and the size of scattering kernel, on the performance. The parameter optimization is crucial for the acceleration of the proposed method.

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