Pragmatic method to minimize the discrepancy of grayscale values of teeth caused by exomass effect in dental CBCT of a small field of view

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Dental cone-beam computed tomography (CBCT) is becoming a standard examination protocol in clinical practice for anatomic imaging of jaws prior to dental implant placement. In addition, CBCT of a small field of view (FOV) employing a small-area flat panel detector is important for low-dose endodontic treatment [1]. However, in dental CBCT of a small FOV, the discrepancy of grayscale values between anterior (e.g., incisors) and posterior (e.g., molars) teeth typically appear on the reconstructed CBCT image owing to the exomass effect [2] where dental structures placed outside the scan FOV induce the fluctuations of grayscale values. These fluctuations become more pronounced in smaller FOVs, leading to a detrimental impact, particularly, in measuring tissue density crucial for dental implant placement [3-4]. In this study, we propose a pragmatic method to minimize the discrepancy of grayscale values of teeth in dental CBCT of a small FOV. Figure 1 shows the simplified diagram of the proposed method. The method is based on our experimental observations that there is a tendency to gradually increase grayscale values from anterior to posterior teeth in CBCT image of a small FOV, and grayscale values are directly related to the strength of the Ram-Lak filter (i.e., *sinc* function) represented in the spatial domain. Thus, using a heuristic weight of 1.085 for tooth number 16 (wisdom tooth) with respect to a reference weight of 1 for tooth number 8 (central incisor), the grayscale values of the other teeth were properly adjusted by linear interpolation to minimize their discrepancy. Figure 2 shows some preliminary simulation results: 3D numerical mouth phantom with a small FOV that was centered at tooth numbers of 8, 10, 12, 14, and 16, and CBCT images reconstructed using the standard filtered backprojection algorithm before and after applying the proposed method. Figure 3 shows the intensity profiles measured along the line (red) in Fig. 2 and the average gray values measured inside the corresponding teeth. According to our preliminary results, the proposed method is effective to minimize the discrepancy of grayscale values of teeth in dental CBCT of a small FOV. More quantitative simulation and experimental results will be presented in the paper.

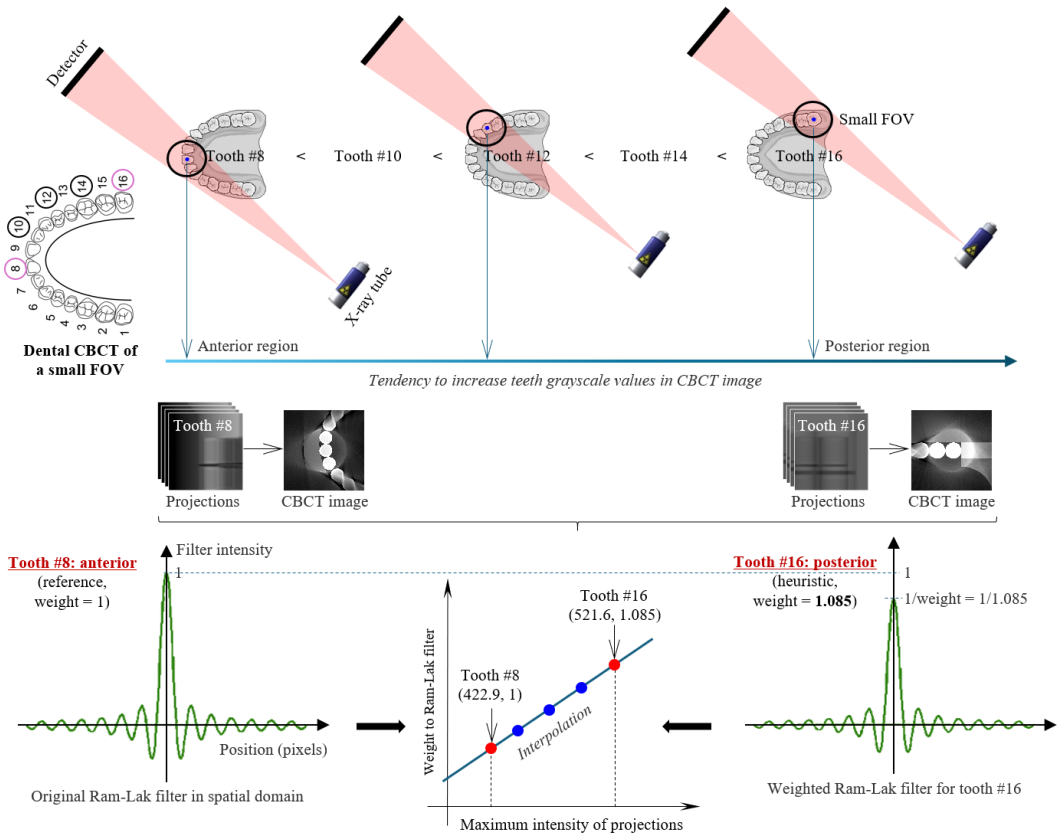

Figure 1. Simplified diagram of the proposed method to minimize the discrepancy of gray values of teeth caused by exomass effect in dental CBCT of a small FOV.

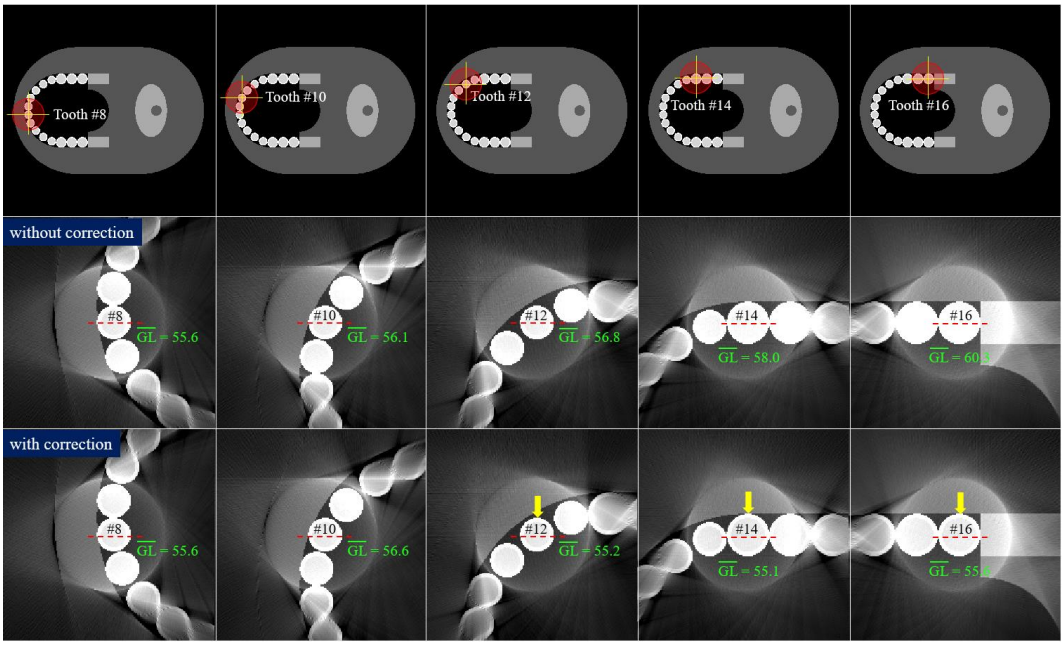

Figure 2. Preliminary simulation results: 3D numerical mouth phantom with a small FOV that was centered at tooth number of 8, 10, 12, 14, and 16 (top), and CBCT images reconstructed using the FBP algorithm before (middle) and after (bottom) applying the proposed method. The dynamic range of the CBCT images was set to [2, 57].

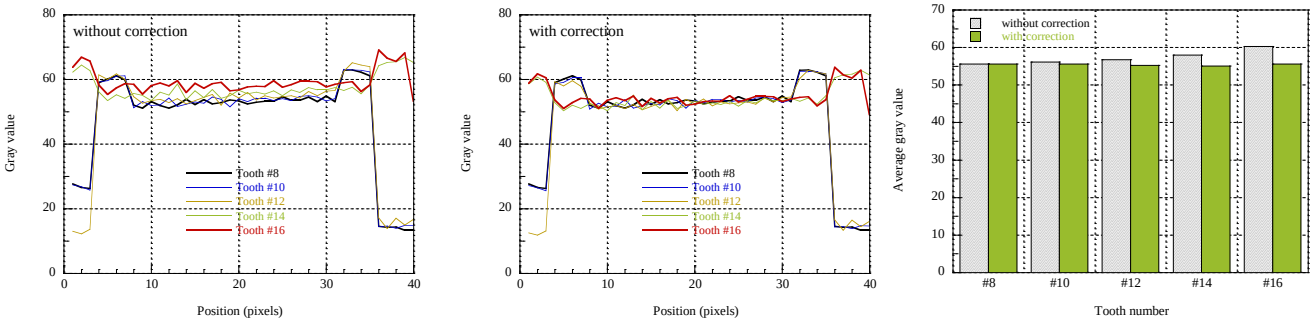

Figure 3. Intensity profiles measured along the line (red) in Fig. 2 and the average gray values measured inside tooth number of 8, 10, 12, 14, and 16.

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