Model-based scatter correction method for improving image visibility in CBCT with an offset-detector configuration

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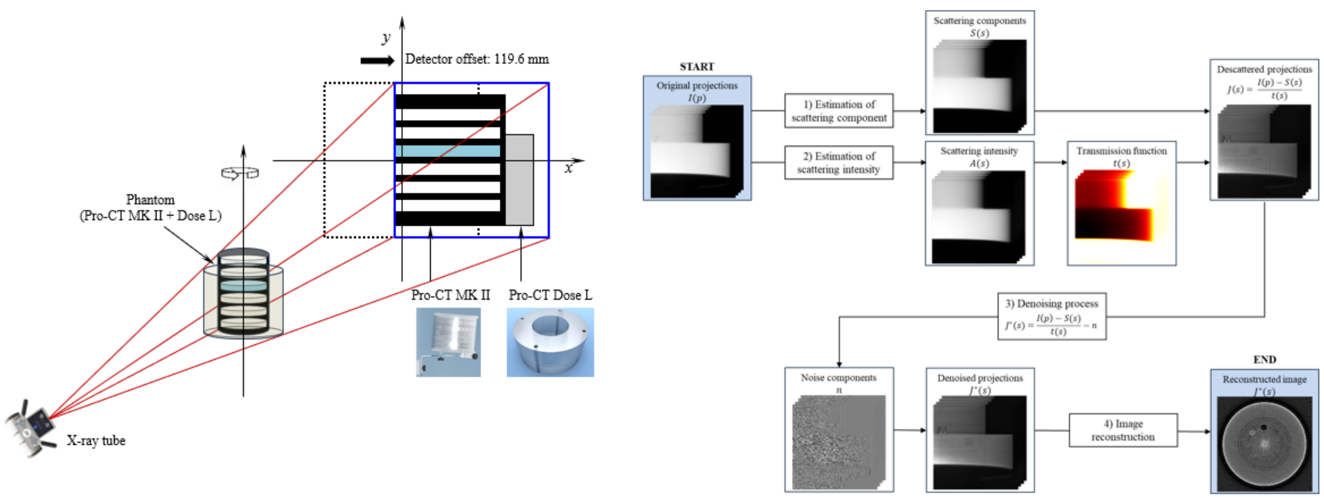
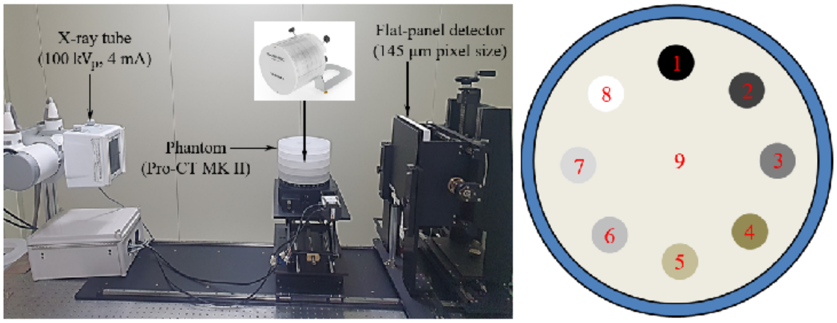
Continuing our research on X-ray research and development for industrial nondestructive testing, we established a prototype cone-beam computed tomography (CBCT) with an offset-detector configuration that can increase scan field of view by a factor of two. In CBCT, image visibility is often limited owing to the artifacts caused by scattered X-rays and noise. Several methods, including antiscatter grid technique for the reduction of scatters, phase-contrast imaging as another image contrast modality, etc., have been extensively investigated in attempt to overcome these difficulties. However, those methods typically require higher radiation dose and/or special equipment. In this study, as another approach, we propose a new model-based scatter correction method where the intensity of scattered X-rays and the transmission function of a given object are estimated directly from the original projections and then subtracted from them to improve the image visibility. Thereafter, CBCT image is reconstructed using the standard filtered backprojection algorithm. Figure 1 shows the schematic of a CBCT geometry with an offset-detector configuration and the simplified flowchart of the proposed scatter correction method. We conducted an experiment using a quantitative test phantom (Pro-CT MK II + Pro-CT Dose L) to validate the efficacy of the proposed method. Figure 2 shows an experimental setup and a quantitative phantom used in this study. According to our preliminary results (Figs 3 and 4), the image characteristics of the resulting CBCT image obtained using the proposed method were uniquely different from those in original CBCT image in that most of the structures in the examined object were discernable, these improving the image visibility in CBCT considerably. Consequently, the degradation of image characteristics by scattered X-rays and noise was effectively recovered, demonstrating the efficacy of the proposed scatter correction method. More quantitative experimental results will be presented in the paper.



(a) (b)

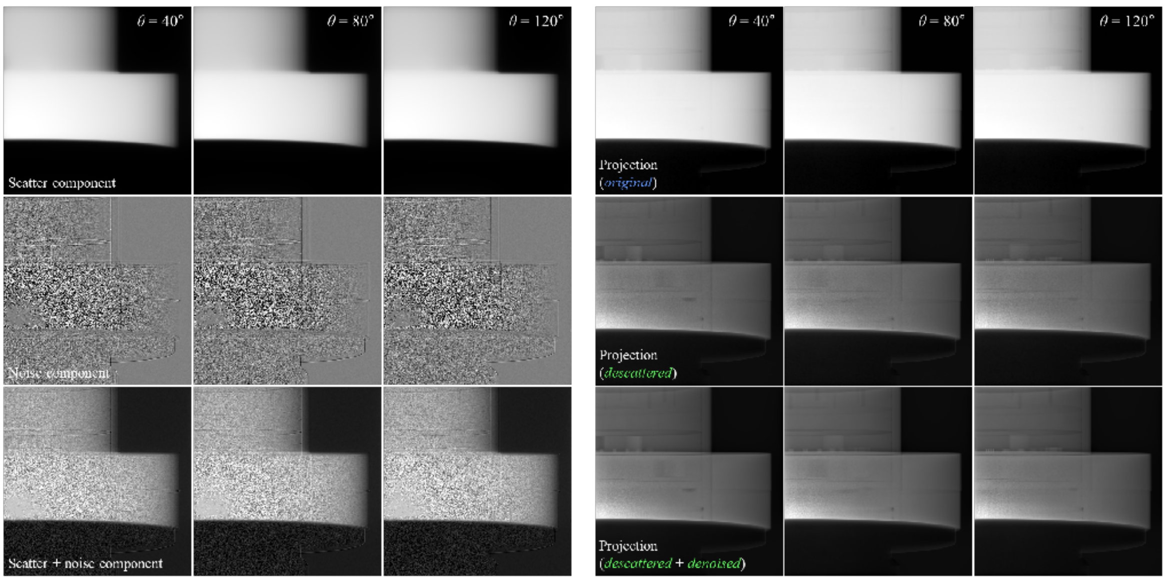
Figure 1. (a) Schematic of a CBCT geometry with an offset-detector configuration and (b) the simplified flowchart of the proposed scatter correction method.



Module no.	Material
1	Air
2	LDPE
3	ABS
4	Water
5	PA-6
6	PET
7	POM-C
8	PTFE
9	PMMA

(a) (b)

Figure 2. (a) Experimental setup and (b) quantitative test phantom (Pro-CT MK II + Pro-CT Dose L, Diagnomatic Inc.) used in this study and its specification.



(a) (b)

Figure 3. Preliminary results: (a) estimated scatter and noise components and (b) resulting projection images before and after applying the proposed scatter correction method.

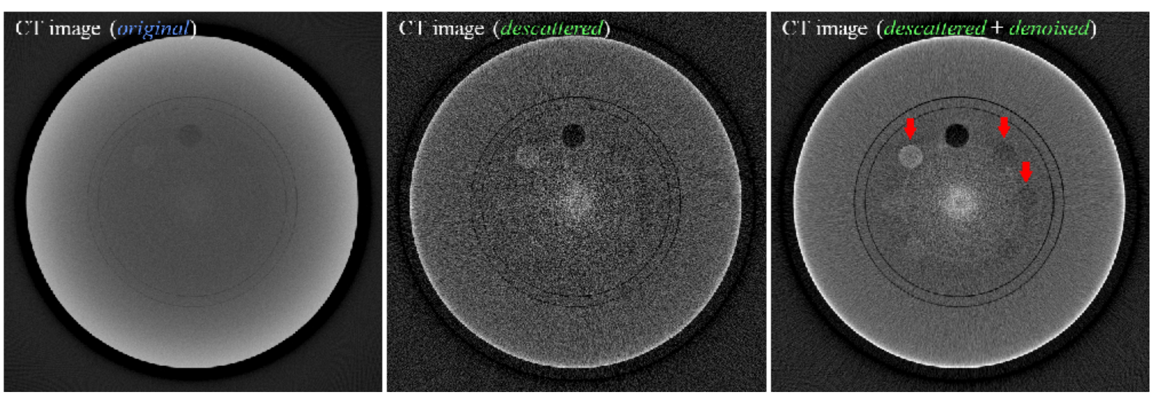


Figure 4. Resulting CBCT images reconstructed using the standard FBP algorithm before and after applying the proposed scatter correction method.

Reference

[1] E. Dumont et al., Nova Science, 2010, p. 635-670.