CARS2013
The 27th International Congress of Computer Assisted Radiology and Surgery
at Heidelberg, Germany, June 26-29, 2013.

TITLE: Cone beam CT image processing for metal-induced streak artifact reduction by iterative reconstruction

Authors: Yoshihiko Hayakawa, Jian Dong, XinYuan Zhang, Dai Miyanaka and Kumkum Anwar
Affiliations: Dept. of Computer Science, Kitami Institute of Technology
165, Koen-cho, Kitami, Hokkaido 0908507 JAPAN
Phone: +81-157269326 (my lab.) FAX: +81-157269344 (dept. office)
Yoshihiko Hayakawa <hayakawa@cs.kitami-it.ac.jp> profession:Medical Image Processing/Medical Informatics
Jian Dong <dongjian2007happy@yahoo.co.jp> Zhang XinYuan <wt823270happy@yahoo.co.jp>
Dai Miyanaka <d_haldcyu@yahoo.co.jp> Kumkum Anwar <kumkum.anwar57@yahoo.com>
Contribution: Lecture, CMI session

- - - - - - - - - -

Cone beam CT image processing for metal-induced streak artifact reduction by iterative reconstruction

Yoshihiko Hayakawa[1], Jian Dong[1], XinYuan Zhang[1], Dai Miyanaka[1] and Kumkum Anwar[1]
[1]Kitami Institute of Technology, Dept. of Computer Science, Kitami, Hokkaido, Japan

Keywords: X-ray Cone Beam Computed Tomography; dento-alveolar region; metal-induced artifact: iterative restoration

Purpose

X-ray CT images in the dento-alveolar region are sometimes rendered unusable for diagnostic purposes due to the appearance of streak artifacts. They are mainly caused by the existence of metallic prosthetic appliances. We have applied modified iterative restoration methods for the processing of Multi-Detector Row CT (MDCT) images[1-4]. The purpose of the study is to reduce metal-induced streak artifacts appeared on dental and maxillofacial cone beam CT (CBCT) images by the application of modified iterative restoration methods.

Methods

We took advantage of the aspect that adjacent CBCT images often depict similar anatomical structures within the resulting collection of a lot of thin-slice images. CBCT images having induced streak artifacts were processed using the projection data of adjacent CBCT images (Fig.1). A modified iterative restoration, the maximum likelihood-expectation maximization (ML-EM) reconstruction algorithm, was employed. It approximates between the processed image and the original projection data. First the projection data of an intact image was obtained, and then the next image which had streak artifacts was

processed. The projection data of the processed image were obtained and the ML-EM method was applied to the next image again. Then the successive iterative restoration was carried out. We applied the ordered subset-expectation maximization (OS-EM) reconstruction algorithm for the processing. The small ROI (region of interest) setting was applied for calculation loading reduction. Then it was tried that the successive processing for maxilla-mandible CBCT images was employed in the direction from head to foot and for mandible CBCT images in the direction from foot to head. We call this as the reversal point processing. Parameters in processing methods were selected by referring results in MDCT images.

Results

Successive adjacent images were processed. Each iterative restoration was carried out fifty times. Metal-induced streak artifacts were observed on processed images at the initial stage, but some of them either suppressed or disappeared as the iteration progressed. Both the OS-EM method and small ROI setting were possible to work for reducing the calculation loading. The reversal point processing was effective for the artifact reduction while keeping the anatomical reproducibility. Examples of three-dimensional images are shown in Fig. 2.

Conclusion

The modified ML-EM method was effective to reduce streak artifacts in X-ray CT images in dento-alveolar region. The OS-EM method and small ROI setting worked for the fast calculation. The reverse point processing was also effective. We now try the faster calculation loading using GPGPU/CUDA programming and the image-noise reduction using Gaussian- Laplacian pre-filtering.

References

[1] Kondo A, Hayakawa Y, Dong J, Honda A (2010) Iterative correction applied to streak artifact reduction in an X-ray computed tomography image of the dento-alveolar region. Oral Radiol 26(1):61-65

[2] Dong J, Kondo A, Abe K, Hayakawa Y (2011) Successive iterative restoration applied to streak artifact reduction in X-ray CT image of dento-alveolar region. Intl J Comp Assist Radiol & Surg, 6(5):635-640

[3] Kannenberg S (2011). Quantitative evaluation concept of artifact reducing algorithms for medical CT-data, Bachelor-thesis, Hamburg Univ. of Applied Sciences

[4] Dong J, Hayakawa Y, Kannenberg S, Kober C (2013) Metal-induced streak artifact reduction using iterative reconstruction algorithms in X-ray CT image of the dento-alveolar region. Oral Surg Oral Med Oral Pathol Oral Radiol 115(2):e63-73

- Figure legends

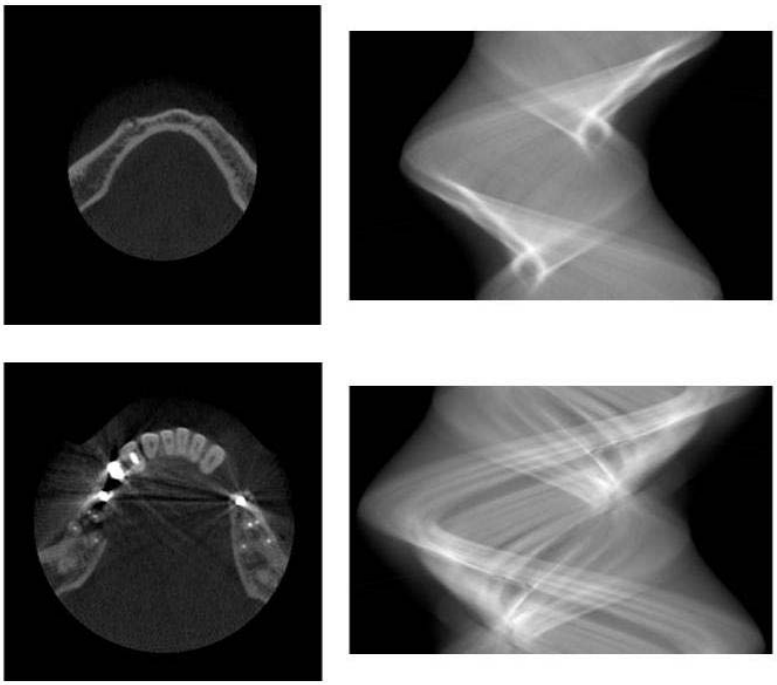

Fig. 1 CBCT image (left) and the projection data (right) which is is called a sinogram. There are an artifact-free CBCT image and the projection data on the upper row and an CBCT image having artifacts on the lower row.

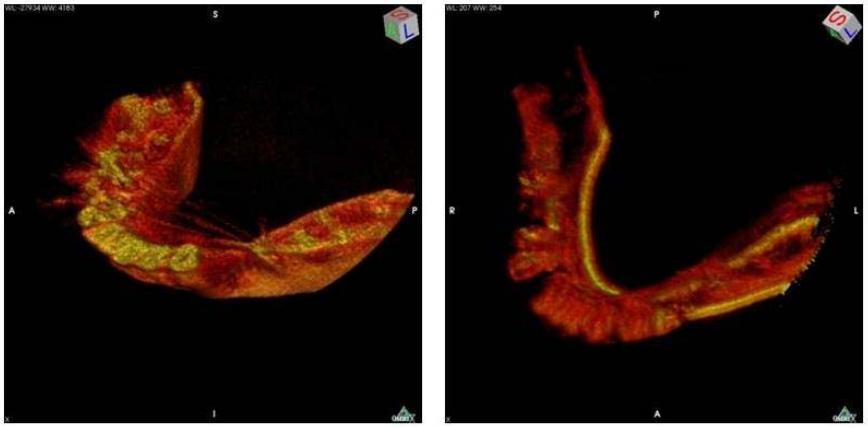

Fig. 2 Examples of three-dimensional images: 3D image with artifacts (left) and 3D image followed by our artifact-reduction processing (right).

The 27th International Congress of Computer Assisted Radiology and Surgery (CARS2013) at Heidelberg, Germany, June 26-29, 2013. （国際コンピュータ支援放射線学外科学会議, Heidelberg, Germany, 6 月 26-29 日）

International Journal of Computer Assisted Radiology and Surgery（コンピュータ支援放射線医学外科学会雑誌, Vol.8, Suppl.1, pp.S249–S250, 2013-06.

http://www.cars-int.org/

http://link.springer.com/journal/11548/8/1/suppl/page/3

http://link.springer.com/article/10.1007/s11548-013-0876-9