Cone Beam CT Image Processing: Acceleration by GPGPU for metal artifact reduction, 3D-filtering and region-growing methods for 3D visualization

M. Shinoda[1], Y. Hayakawa[1], M. Hirose[1], T. Onoue[1], D. Miyanaka[1], X. Zhang[1], J. Dong[1], C. Kober[1,2]
[1]Kitami Institute of Technology, Computer Science, Kitami, Hokkaido, Germany
[2]Hamburg University of Applied Sciences, Faculty of Life Sciences, Hamburg, Germany

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Purpose

Dental CBCT scanning are performed to observe precise bone morphology. Metallic prosthetic appliances cause unavoidable streak artifacts, thus the bone morphology is overlapped or damaged [1]. But our previous reconstruction algorithms showed the metal-induced artefact reduction on MDCT images [2-4]. Therefore, successive iterative methods, 3D filtering and region growing were examined to improve accuracy of bone morphology on CBCT images [5]. Multi-planar reconstruction (MPR) images were obtained as a quality evaluation standard. A GPGPU (general purpose graphic processing unit) machine was assembled to reduce processing time.

Methods

Metal-induced streak artifacts appear gradually on a series of CT images and we focus on that adjacent images often depict similar anatomical structures. Therefore we used the projection data of adjacent image in sequence. First the statistical iterative method, both ML-EM (Maximum Likelihood-Expectation Maximization) and OS-EM (Ordered Subsets-Expectation Maximization), for artifact reduction was developed. Secondly three dimensional filtering method of Laplacian sharpening following with Gaussian smoothing and the region growing method were applied for the quality improvement. The region growing is the judgment of the 6-nearest neighborhood voxels of the start point meeting either the segmentation condition or not, MPR images at mid-sagittal plane in maxilla were presented. Since both solutions are time-consuming to meet the clinical appliance, a GPGPU machine was assembled to reduce the processing duration.

Results

The successive iterative reconstruction was effective in reducing streak artifacts on CBCT slices. It was found that the 3D Gaussian-Laplacian filter, which was the twenty-six neighbours method, improved the image quality when line profiles of each MPR images showed CT data changes. The region growing method with dilation and erosion led to the better segmentation. The CUDA (compute unified device architecture) programming on GPGPU reduced the calculation time significantly.

Conclusion

Solutions of successive iterative reconstruction methods, three-dimensional filtering and region growing methods, were effective in improving quality of CBCT images. Moreover, GPGPU application realized the time reduction.

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