Simultaneous EPR 3D image reconstruction and visualization during acquisition of projection data

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Introduction Electron paramagnetic resonance imaging (EPRI) allows the visualization of free radicals in biological samples. To investigate the reduction of spin probes, the acquisition of 3D projection data has recently been achieved in 30 s in a live animal experiment and 6 s in a phantom experiment (1, 2). However, image reconstruction and visualization of 3D objects were carried out after the data acquisition, which takes more time than the data acquisition itself. We report here the development of EPR imaging software that can reconstruct a 3D image while simultaneously acquiring projection data, and can visualize a 3D image immediately after reconstructing it.

Concept of software development To reconstruct 3D images during the acquisition of projection data, an array of projection data is sent to a reconstruction program every time each projection data set is obtained. A reconstruction program based on the filtered back-projection (FBP) method, written in FORTRAN, runs in the background of a LabVIEW-based data acquisition program for 3D EPR imaging. If the duration of each FBP is faster than the acquisition time of each projection data set, the image reconstruction will be finished by the end of the measurement. To visualize the 3D image, a volume rendering program was developed using OpenGL 2.0. The FBP and volume rendering programs are executed as external programs and are started by the data acquisition program (Fig. 1). All programs were developed and tested on a MacPro personal computer (two dual-core Intel Xeon 2.66 GHz, Apple).

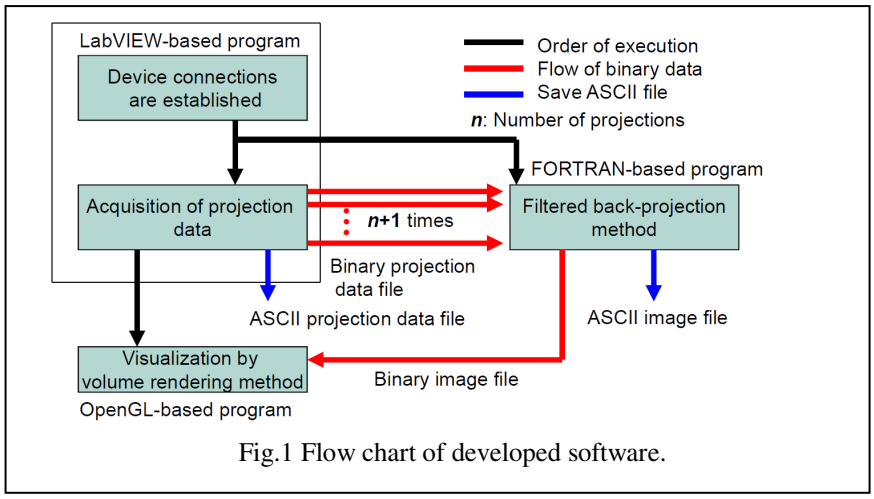

Fig.1 Flow chart of developed software.

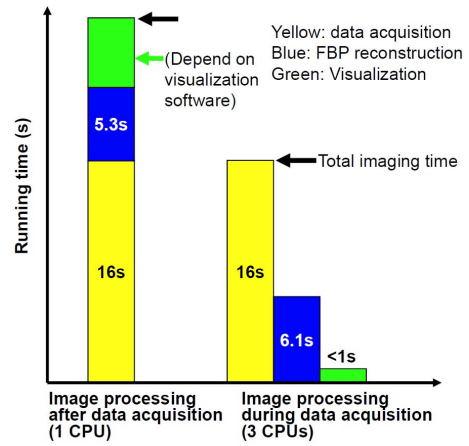

Fig. 2 Total imaging time with 81 projections and 128×128×128 voxels. The number of simultaneously running CPUs was shown in the parenthesis.

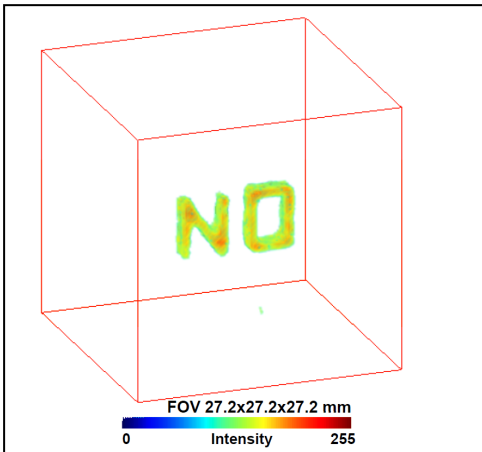

Fig. 3 Volume rendered image of TAM radicals in distilled water. The voxels with intensity more intensity than half maximum intensity value were rendered.

Evaluation We prepared a phantom that had the letters "N" and "O" filled with 3 mM of triarylmethyl (TAM) radicals in distilled water (0.12 ml). The imaging was performed with a home-built 650-MHz CW-EPR imager with 81 projections and a 0.15-s field scan time (2). The computation time of the FBP reconstruction during data acquisition was shorter than the duration of the data acquisition, which is a necessary condition to finish reconstruction of a 3D image during the data acquisition (Fig. 2). The volume rendered image in Fig. 3 was shown within 1 s after the end of data acquisition.

Summary Simultaneous EPR 3D image reconstruction and visualization with the acquisition of projection data was successfully carried out. This is expected to be useful for analyzing the reduction of free radicals in biological samples.

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References

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2. Sato-Akaba H, Fujii H, Hirata H, Rev Sci Instrum (in press).