Program status on the dynamic tomography at sub-second time scale

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INTRODUCTION

With the availability of third generation Synchrotron Radiation (SR) sources, SR-μCT has evolved as an increasingly accepted and utilized technique for quantitative characterizing the 3D internal structure of samples in different research fields [1-3]. Generally, SR-μCT need a large number of projections that will no doubt decreasing the temporal resolution of SR-μCT thus hinders its applications in some research fields, and increasing the dose delivered to the sample.

In order to overcome this problem, the imaging group at SSRF has launched a program that aiming to realize dynamic tomography at sub-second time scale. Firstly, the compressed sensing (CS) theory based reconstruction algorithm is employed to sharply reduce the required SR-μCT projections number. Secondly, a detector reformation model, realizing by merging digital high-speed camera and scintillator reformation, will be utilized to accelerate SR-μCT data collecting speed. Moreover, the GPU base parallel computing technique will be utilized to speed up the reconstruction. The results of compressed sensing based reconstruction will be presented here.

THEORY and METHODS

The experimental data were collected at the X-ray biomedical imaging beamline (BL13W) at the Shanghai Synchrotron Radiation Facility (SSRF), Shanghai, China. Two sample are used during the experiment.

Firstly, a live ant is put into a plastic tube, the energy of 14 keV, SDD=0.5 m and a CCD detector with an effective pixel size of 9 μm were used to acquire the data. The purpose of this experiment is to collect 50 projections as fast as possible. Finally 50 projections are collected in 17s when the detector reaches its limit.

Secondly, the sample is Fructus Foeniculi that is a kind of fruit traditional Chinese medicines. The energy of 14 keV, SDD=0.1 m and a CCD detector with an effective pixel size of 3.7 μm were used to acquire the data. Totally 1440 projections are collected to test the algorithm.

RESULTS

Figure 2: the reconstruction results of live ant sample after phase retrieval: (a) FBP result, (b): the result of CS based algorithm.

CONCLUSIONS

Our preliminary the results shown that the CS based SR-μCT reconstruction algorithm can obtain comparable results, comparing to FBP algorithm, when utilized about 1/5 of the FBP’s projection number. This means reasonable results can be obtained, by utilizing about 50 projections, for a specific sample; moreover, the results also show CT reconstruction from incomplete data is possible by CS based algorithm. Considering 100 Hz frame rate with acceptable image quality is achievable for the detector model based on digital high-speed camera, we believe dynamic tomography at sub-second time scale is feasible.

REFERENCES


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