Challenges on Tomographic Image Reconstruction

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Modalities for X-ray computed tomography (CT), single photon emission CT (SPECT), positron emission tomography (PET) enable us to visualize the inside of human body as tomographic images. Medical doctors and radiologists make radiologic interpretations according to tomographic images presented by the modalities, for example, whether a tumor is inside human body. Tomographic images are reconstructed by computation based on projection-slice and inverse-problem theories. Roughly speaking, we have two types of image-reconstruction methods: one is based on Fourier transform and the other is based on difference or differential equations. Compared with Fourier transform methods, equation-based methods can reconstruct images with few artifacts even from insufficient data measured in low X-ray dose and/or the small number of measurement angles, although equation-based methods take a long time to solve the equations, where artifacts mean misrepresentations of object structures produced by image reconstruction.

To solve equations efficiently, collaborators and I have been working on the development of fast computation systems using general-purpose computing on graphic processing units, very large-scale integration with customized analog electronic circuits, vectorization in source codes of computer programs. We have also been working on artifact-reduction problems using techniques on machine learning. These systems and techniques can contribute to dose reduction in X-ray CT inspection and reduction of time required for scintigraphy inspection using SPECT and PET devices.