CT Image Reconstruction via Multiple Science Computing

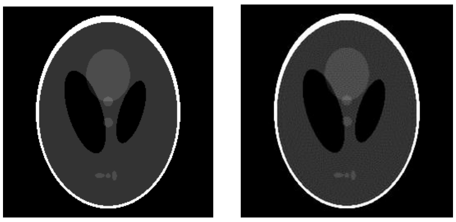
Program in ICT, Prof. Yuichi Tanji

Email: tanji.yuichi@kagawa-u.ac.jp

1. Background

Computed Tomography (CT) is widely used in Japan, which means that Japanese is the most medically exposed in the world. This is because a filtered back-projection (FBP) method is used in CT apparatus produced by domestic makers. To obtain a high-quality image without artifacts, a large amount of projection data is required, which implies high X-ray doses so that is not preferable. A continuous-time dynamical system is proposed to reconstruct images by Prof. Fujimoto of Kagawa University, et al. Compared with the FBP method, this method can produce a high-quality image even from a small amount of projection data, but it is time-consuming. In this study, I collaborate with Prof. Fujimoto and study an efficient high-quality image reconstruction via multiple science computing such AI, large-scale convex optimization algorithm, and high-performance computing.

2. Experimental Results



Original Reconstruction

Figure1: Image reconstruction

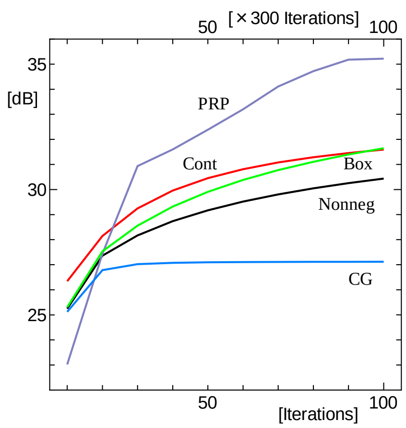


Figure 2: Image quality

Figure 3: Deep-learning machine

We applied the proposed methods to 256 × 256 Shepp–Logan phantom image in Fig. 1, which imitates a skull. Since the original image is 256×256 pixels, we need to solve the convex optimization problems with the number of variables 65,536. Using the continuous-time dynamical system (Cont), conjugate gradient method (CG), conjugate gradient method with nonnegative constraint (Nonneg), conjugate gradient method with box constraint (Box), and nonlinear conjugate gradient method (PRP), the image reconstruction was carried out as shown in Fig. 2. The reconstructed image obtained from the nonlinear conjugate gradient method is shown in Fig. 1, which is visually almost same with the original image. Table 1 shows the comparison of computational time, in which the conjugate gradient method with box constraint is 300 times faster than the continuous-time dynamical system.

Table 1: Comparison of computation time

Cont	CG	Nonneg	Box	PRP
1874 s	5.50 s	5.59 s	5.59 s	63.83 s

Using the deep-learning machine in Fig. 3 which is used for AI, we can accelerate the image reconstruction some ten times faster than that with Table 1. We also study the prediction by AI and acceleration using Multi GPUs, which are graphical processors, for the continuous-time dynamical system.

3. Future Works

Medical images are usually exposed to a noisy environment. Thus, an optimization method considering noise should be developed. We also apply the proposed method to MRI, which reduces the patient's burden to shorten the diagnosis time.

We try to challenge various optimization problems related to medical imaging.