4D-CT Reconstruction from Sparse View of Deforming Objects via Initial Shape Morphing

Hisayoshi Kaneda[1], Yutaka Ohtake[1], Tatsuya Yatagawa[1], Hiromasa Suzuki[1], Yukie Nagai[2], Akira Monkawa[3], Yuka Miura[3], Tomoko Gessei[3]

[1]School of Engineering, The University of Tokyo, Japan, [1]Mechanical Systems Engineering, Tokyo Metropolitan University, Japan, [1]3D Manufacturing Sector, Tokyo Metropolitan Industrial Technology Research Institute, Japan

X-ray computed tomography (CT) has been widely used for nondestructive analyses for industrial materials due to its capability of scanning the internal structures. Recently, its application for deforming objects has grown to be enormous, particularly for destruction processes of lattice structures, metal foams, and fiber reinforced plastics. However, we can get only a limited number of projection images for reconstructing time-varying CT (4D-CT) volumes of such deforming objects. Owing to the limited number of accessible projection images, the method of 4D-CT scanning has not been well established. We overcome this difficulty by morphing an object surface of the initial shape before deformation. In our method, we capture the initial shape accurately by the ordinary CT scanning. Then, the surface of the initial shape is consecutively morphed between two successive time frames using a variant of the level set method based on volume fraction that is proportional to CT values. The level set morphing is applied to the voxels near the object boundary in order to adjust CT value integrals to the detector pixel values. Eventually, our method reduces the number of required projection images significantly. Furthermore, the morphing can avoid time-consuming CT volume reconstruction to reduce the overall computational time.