

博士論文（要約）

Time-ordered cone-beam CT image reconstruction

（ コーンビーム CT の時間並進的 4 次元画像再構成法 ）

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## 論文の内容の要旨

論文題目 Time-ordered cone-beam CT image reconstruction

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Four-dimensional (4D) cone-beam CT (CBCT) techniques have been used in clinical sites of image-guided radiotherapy (IGRT), especially in the treatment of lung tumors and other tumors accompanying respiratory motion. However, those techniques suppose periodic motion such as respiration, and there are few attempts using CBCT to visualize organs accompanying time-ordered non-periodic motion and deformation. The purpose of this study is to visualize time-ordered motion including gastrointestinal activities and motion of rectal gas and stools.

Reconstruction methods used in this study belong to two categories: Feldkamp-Davis-Kress (FDK) method and maximum *a posteriori* probability (MAP) method. The FDK method is the conventional one in CBCT reconstruction and widely used in medical region. One of the advantages in use of FDK method is that it works with a small computational effort. On the other hand, this

method requires the projection data from more than 180-degree plus fan-angle to obtain the successful reconstruction images. Therefore, with the slow gantry rotation such as in the linear accelerator (LINAC), the FDK method accompanies the poor temporal resolution. The temporal resolution could be improved with the narrower projection angle range. Lacking the information due to the narrower projection angle range, however, the reconstructed image would be significantly degraded. A tradeoff of this approach between temporal resolution and image degradation was discussed in Chapter 2. In Chapter 3, a MAP reconstruction combined with initial image sets is proposed to resolve the problem with regard to narrower projection angle ranges. In addition to the total variation minimization approach and prior information constrained approach, both of which are previously proposed in the situation where the information is lacked, the constraint arising from time-ordered chain is newly introduced in order to improve temporal resolution. This new reconstruction method is named as Time-ordered chain graph model (TCGM) method. Two types of projection data sets are used for reconstruction test; clinical patients' pelvic region and virtually created digital phantom containing an air sphere moving 3 cm along longitudinal axis during one rotation of projection source around the phantom. Especially, the temporal resolution is analyzed with above digital phantom.

The present study demonstrates the feasibility of time-ordered 4D CBCT reconstruction dealing with time-ordered motion and deformation. Deformation of intestine and rectum, and motion of

flatus and stool could be visualized by the presented method. The digital phantom results show that

MAP method with TCGM improves its temporal resolution.