論文の内容の要旨

論文題目　**Four-dimensional dose calculation using in-treatment cone beam computed tomography and linear accelerator log data**
（治療中コーンビーム断層画像と医療用加速器の動作記録を用いた４次元線量分布計算)

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With recent developments, the record and verification system for high-precision radiotherapy during dose delivery plays an important role in quality control and assurance. An investigation of robust techniques for actual dose verification is currently one of the active areas of research in radiation therapy. The aim of this study is to develop a reliable technique of *in vivo* dosimetry for a moving target based on in-treatment data. This thesis is composed of 3 parts; (1) the analysis of log data in the state-of-the-art digital linear accelerator (LINAC) using an electric portal imaging device (EPID); (2) the analysis of the density-override method in dose calculation; and (3) the study of the four-dimensional (4D) dose calculation based on the 2 other studies outlined above.

After the introduction, in Chapter 2, the position of the multi-leaf collimator (MLC) recorded in the log data is analyzed by using the EPID. From the comparison, the difference was 0.88 ± 0.93 mm. As an estimate of the dose difference, an approximately 1-mm difference of MLC position does not effectively affect the dose distribution for the delivery of volumetric modulated arc therapy (VMAT). This result justified the use of the log data for actual dose verification.

In Chapter 3, the influence of the image quality in the dose calculation is discussed. Due to image degradation, it is well known that use of cone-beam computed tomography (CBCT) for dose calculation yields a large uncertainty in dose distribution. In this thesis, the method that utilizes the information of the anatomical mean densities inside the region of interest (ROI) obtained by the treatment planning computed tomography (CT) is employed. Applying the ROI mapping method to the same planning CT as in the original plan for 3 lung cancer patients, the accuracy of the ROI mapping method was within 1.2%.

In Chapter 4, the 4D dose calculation with the ROI mapping method was

performed by use of the in-treatment 4D CBCT and LINAC log data, both of which were acquired during treatment. In a study using a moving phantom, 4D dose calculation well reproduced the measurement in comparison with the 3D dose calculation. Actual dose distributions for three lung cancer patients with this technique were compared with those of the plan. A small but significant dose difference between the 3D and 4D calculations was observed for the case of large target traveling. In addition, day-to-day fluctuation of the delivered dose was observed for all the patients.
The importance of *in vivo* dosimetry for a moving target is apparent. The present technique and the findings of this study will contribute to maintain the quality of high-precision radiation therapy.