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Research Article

Towards a Noninvasive Intracranial Tumor Irradiation Using 3D Optical Imaging and Multimodal Data Registration

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Abstract

Conformal radiotherapy (CRT) results in high-precision tumor volume irradiation. In fractioned radiotherapy (FRT), lesions are irradiated in several sessions so that healthy neighbouring tissues are better preserved than when treatment is carried out in one fraction. In the case of intracranial tumors, classical methods of patient positioning in the irradiation machine coordinate system are invasive and only allow for CRT in one irradiation session. This contribution presents a noninvasive positioning method representing a first step towards the combination of CRT and FRT. The 3D data used for the positioning is point clouds spread over the patient's head (CT-data usually acquired during treatment) and points distributed over the patient's face which are acquired with a structured light sensor fixed in the therapy room. The geometrical transformation linking the coordinate systems of the diagnosis device (CT-modality) and the 3D sensor of the therapy room (visible light modality) is obtained by registering the surfaces represented by the two 3D point sets. The geometrical relationship between the coordinate systems of the 3D sensor and the irradiation machine is given by a calibration of the sensor position in the therapy room. The global transformation, computed with the two previous transformations, is sufficient to predict the tumor position in the irradiation machine coordinate system with only the corresponding position in the CT-coordinate system. Results obtained for a phantom show that the mean positioning error of tumors on the treatment machine isocentre is 0.4 mm. Tests performed with human data proved that the registration algorithm is accurate (0.1 mm mean distance between homologous points) and robust even for facial expression changes.