Computer Simulation of Multi-leaf Collimated Fields for Radiotherapy Treatment Planning Verification

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1. Introduction

In external beam radiation therapy, linear accelerator technology has significantly improved the precision of treatment by utilizing multi-leaf collimators (MLC) which allow custom-shaped beam apertures required to deliver the desired radiation distribution. However, the introduction of MLC has encountered the financial and practical difficulties of upgrading the X-ray-based radiotherapy treatment simulator to simulate MLC fields. One of the ad-hoc solutions adopted by the radiotherapists is to build by hand a conventional beam shaping through a combination of lead blocks matching the planned MLC profile, a very cumbersome, hazardous and time-consuming task due to manual handling. As a more practical and efficient solution, we propose to integrate to the simulator a software solution for real-time automatic verification of MLC configuration. Our solution is entirely based on computer simulation and vision, which can easily be integrated into the current infrastructures, avoiding new acquisition of expensive equipment.

2. Methods

The basic idea of this project is to provide a real-time qualitative verification of MLC configuration during treatment planning by overlaying the planned leaf positions onto the X-ray images as they are acquired. First, the planned MLC settings are extracted automatically from the treatment plan. Then, images acquired and digitalized from an X-ray intensifier are automatically registered with a simulated MLC overlay using the radiation field edges visible on the X-ray. We developed a method to automatically extract the collimation field from the digitalized images based on adaptive thresholding followed by a Radon transform. An easy-to-use and intuitive interface allows the radiotherapists to interactively adjust the leaves' position and control the display options.

3. Results and Conclusions

Our implementation has been installed in the radiotherapy unit of Hospital Donostia, where it is being evaluated in real clinical conditions. The first clinical trials have produced very encouraging results and the feedback from the radiotherapists has been very positive.

We have developed a low-cost software solution for real-time qualitative verification of MLC configuration during treatment planning which helps to overcome the set-up time and inaccuracies that limit the efficiency of radiotherapy treatments.

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