Evaluation of a patient motion monitoring system in radiotherapy treatment based on optical motion detection

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1. Introduction

We present a system based on real-time imaging techniques for the automatic detection of patient motions during external beam radiotherapy sessions. The main objective of this system is to assist the therapist during the radiation delivery by automatically checking online the position of the patient. Our approach is non-invasive as it does not need any prior preparation of the patient, like placing markers or any other artefacts. The system makes use of images of the patient acquired during a training period. The current prototype is being validated in the radiotherapy treatment room of an oncological hospital.

2. Methods

Our system has been designed as an open platform where the number and disposition of the optical sensors may vary in every installation. This flexibility allows us to test different camera configurations, either position, orientation or focal length, in order to get the maximum accuracy and robustness. The motion estimation detection is carried out by processing filters that perform background subtraction techniques on the acquired images to detect areas of movement. The detected movement regions can be generated by either the breathing and unpredictable movements of the patient or by the movements of the gantry. The current filters are able to identify the nature of the movement and therefore to take the right decision accordingly.

3. Results

The use of different cameras with different focal lengths and position/orientation inside the treatment room allows the system to check several patient areas with different magnification factors. Although the cameras were never directly exposed to irradiation, an increasing number of pixels of the CCD chip of the cameras became irresponsive over the course of time due to radiation damage. By applying a median filter to the images, this effect was almost completely suppressed. We are currently measuring the degradation of the image along the time, in order to estimate the time life of a CCD before it becomes completely unusable.

4. Conclusion

The outcome of the experimental application of video technology confirms its potential as a tool for automatic detection of patient movements caused either by breathing or other unpredictable movements. The real-time feedback on the patient's position given by the system provides operators with appropriate visual indices and allows them to take suitable countermeasures in case of severe movements.