Purpose:

We developed a video image-guided real-time patient motion monitoring system for helical Tomotherapy (VGRPM-Tomo), and its clinical utility was evaluated using a motion phantom.

Methods:

The VGRPM-Tomo consisted of three components: an image acquisition device consisting of two PC-cams, a main control computer with a radiation signal controller and warning system, and patient motion analysis software, which was developed in house. The system was designed for synchronization with a beam on/off trigger signal to limit operation during treatment time only and to enable system automation. In order to detect the patient motion while the couch is moving into the gantry, a reference image, which continuously updated its background by exponential weighting filter (EWF), is compared with subsequent live images using the real-time frame difference-based analysis software. When the error range exceeds the set criteria (\(I'_{\text{movement}}\)) due to patient movement, a warning message is generated in the form of light and sound. The described procedure repeats automatically for each patient. A motion phantom, which operates by moving a distance of 0.1, 0.2, 0.5, and 1.0 cm for 1 and 2 sec, respectively, was used to evaluate the system performance at maximum couch speed (0.196 cm/sec) in a Helical Tomotherapy (HD, Hi-art, Tomotherapy, USA). We measured the optimal EWF factor (\(I^\pm\)) and \(I'_{\text{movement}}\), which is the minimum distance that can be detected with this system, and the response time of the whole system.

Results:

The optimal \(I^\pm\) for clinical use ranged from 0.85 to 0.9. The system was able to detect phantom motion as small as 0.2 cm with tight \(I'_{\text{movement}}\), 0.1% total number of pixels in the reference image. The measured response time of the whole system was 0.1 sec.

Conclusions:

The VGRPM-tomo can contribute to reduction of treatment error caused by the motion of patients and increase the accuracy of treatment dose delivery in HD.

Funding Support, Disclosures, and Conflict of Interest:
This work was supported by the Technology Innovation Program, 10040362, Development of an integrated management solution for radiation therapy funded by the Ministry of Knowledge Economy (MKE, Korea).

This idea is protected by a Korean patent (patent no. 10-1007367).