2922 Evaluation of EPID Ghosting Effects in IMRT Fluence Maps

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Purpose/Objective(s): Electronic portal imaging devices (EPIDs) are increasingly being used not only to patient setup verification and detection of organ motion but as quality control tool to test multileaf collimators and Intensity Modulated Radiation Therapy (IMRT) dose/fluence distributions.

The purpose of this work was to investigate the importance of ghosting effects, reported to occur in some portal devices, when acquiring fluence maps from IMRT fields.

Materials/Methods: The EPID uses a multi-frame acquisition mode to compose the resultant fluence distribution image, corresponding to the sum of the various images acquired during treatment delivery, each corresponding to a different segment of the field. To evaluate the importance of ghosting effects we used a set of simple intensity pattern fields. Images acquired using the multi-frame mode, with no time delay between the different segments composing the field, were compared to images created by manually summing portal images of each segment imposing a delay of several minutes between their acquisition and to images acquired using Kodak X-Omat films. Images were processed using freeware software ImageJ and compared using RIT 113 software. The relative number of monitor units per segment was also changed.

All measurements were done using 18 MV photon beams from a Siemens Primus linear accelerator equipped with a Siemens OPTIVUE 500 a-Si EPID.

Results: Ghosting effects corresponding to an increased EPID response of the order of 2% were observed when one of the segments had a number of monitor unit 10 times the other segments. When using all segments with approximately 10 monitor units, typical of IMRT fields, no ghosting effect was observed.

Conclusions: Studies emphasize the need of a unique investigation of the dose-response characteristics of any type of EPID used for IMRT dosimetric applications, including ghosting effects. This evaluation should be done prior to the use of EPID to acquired IMRT fields fluence maps. The same procedure will be followed using 6 MV photon beams.

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2923 Automated Analysis Software for the Objective Assessment and Optimisation of Radiotherapy Image Quality

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Purpose/Objective(s): Imaging is playing an increasing role in all stages of radiotherapy, with images from different modalities being interpreted in the same clinical and geometrical contexts. However, the methods used to assess image quality have historically differed between modalities and are often subjective, hindering inter-modality comparisons and overall optimisation. The 'IQ Works' package aims to overcome this by performing a fully objective, quantitative and consistent performance evaluation of any radiotherapy imaging modality.

Materials/Methods: Regardless of the specific modality, most phantoms for image quality evaluation tend to consist of the same atomic test components in different geometrical configurations. An extensible framework has been developed comprising modules for analysing each of these components. 'Analysis trees' for particular phantoms are interactively constructed from these modular building blocks, then stored in a phantom library. These can be recalled for subsequent rapid and fully-automatic processing of any phantom's images. Analysis modules include the assessment of alignment, geometric linearity, characteristic curve (including Hounsfield Unit/electron density calibration), uniformity, spatial resolution in terms of modulation transfer function (MTF), noise power spectrum (NPS) and detective quantum efficiency. Each module is rigorously tested on standard test images and compared against independent methods. Comprehensive reports are generated and the results stored in a database to facilitate trend and statistical analyses. Individual test results are checked to ensure they lie within pre-defined tolerances, with the user being alerted if not.

Results: For five years, IQ Works has been utilised routinely in the quality assurance program in Edinburgh. The new system is more comprehensive and robust, yet also far more straightforward and efficient, reducing the time required for routine testing to less than a fifth. As such, complex assessments are now routinely performed by therapists rather than physicists. All analysis modules produce results in close agreement ($<1\%$) with independent methods. Analysis schemes have been developed for multi-slice and cone-beam CT, digital radiography/fluoroscopy (simulators and linac-mounted), EPIDs, DRRs, MRI and soft-copy displays. Detailed analyses have yielded valuable results, such as highlighting differences of $>6\%$ in CT HU calibration curve depending on acquisition settings and providing early indicators of deterioration requiring technical intervention. IQ Works has assisted in commissioning linac-mounted cone-beam CT by enabling clinically relevant comparisons with conventional CT scanners.

Conclusions: The IQ Works system can readily model new commercial and bespoke phantoms and is an efficient means of objectively assessing the image quality of radiotherapy imaging modalities. For the first time, meaningful inter-modality comparisons of image quality throughout the treatment chain can be performed, leading to better overall optimisation. Furthermore, complex assessments can be performed by any staff group. The package has been adopted as the basis of a new open-source analysis system launched by a consortium consisting of the IPEM, CT Users Group and other parties in the UK. The package may be downloaded free from http://www.iqworks.org.

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2924 Quality Assurance Program for a Kilovoltage Cone-Beam CT Guided Radiation Therapy System

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Purpose/Objective(s): The use of new technology necessitates a comprehensive quality assurance (QA) program to maintain and monitor system performance characteristics. Currently, there have been less published recommendations and guidelines for a QA program to verify the functionality, accuracy, stability, and CBCT mage quality of the kilovoltage (KV) cone-beam CT guided