EVALUATION OF THE AUTOMATIC IMAGE REGISTRATION FEATURES OF A KV CONE-BEAM CT IMAGING SYSTEM

L. Jánváry, N. Jansen, M. Mathot, E. Lenaerts, P. Martinive, P. A. Coucke
Department of Radiotherapy, Liege University Hospital, Belgium

Keywords: cone-beam CT, image registration, volumetric imaging

Purpose: As a part of the clinical implementation of a kV cone-beam CT (CBCT) volumetric imaging system for new Elekta Synergy linear accelerators, the automatic image registration (IR) system of the XVI Software was studied. We examined the effect of the variability of matching parameters of the software on the results of the patient position errors.

Material and methods: An offline image analysis was performed of 80 CBCT scans on 20 patients for 4 localizations (breast, H&N, pelvis, lung) with 4 possible combinations of 2 sizes of *volume of interest* (VOI): (**L**arge: **L; S**mall: **S**) and 2 *IR methods:* (**B**one: **B**; **G**rey value: **G**). The results of a Manual Matching (**MM**) were chosen as gold standard. The mean displacement vectors of the translational errors (3D vector) were calculated for comparison of the subgroups. We evaluated the *serially repeated matching results* offered by the software, when launching the automatic IR 3 times without resetting, using exactly the same parameters. All clinical decisions were made based on 2 orthogonal MV EPID images as we considered that CBCT needed validation.

Results: The automatic IR was successful in 100% of the pelvis, lung and H&N, but failed in 20% of the measurements of the breast group. The differences between the magnitudes of 3D vectors were significant ($p=0.011$) when comparing **MM** with **LB** (Large-Bone), **LG** (Large-Grey value), and **SG** (Small-Grey value). The only preset combination that wasn't significantly different from **MM** was **SB** (Small-Bone). The *serially repeated matching results* were generally within 1 mm of difference, but there were extreme values: 3.3; 3.1; 2.8; 2.5 mm for breast, lung, H&N and pelvis patients, respectively. The M, Σ and σ for the mean displacement vectors were: 5.9; 3.0; 0.9 mm for breast, 5.5; 3.8; 2.1 mm for lung, 5.2; 2.2; 1.4 mm for pelvis and 2.9; 0.6; 1.5 mm for H&N patient group, respectively, calculated from results of Small-Bone (SB) automatic IR. The M, Σ and σ values of SB CBCT were greater for all translation and rotation errors than that of the 2D portal.

Conclusion: The presets for automatic IR strongly influence the position error magnitude calculated by XVI software. We suggest the use of a relatively small VOI and bone matching as a general approach. 2D portal imaging systematically underestimates the position errors. We plan to continue the accrual of patients to refine validation. Upcoming improvements of the XVI software will further ameliorate the reliability of 3D automatic IR, however human confirmation cannot be omitted.