

Purpose: Computational speed and geometric accuracy are important considerations in the application of deformable image registration (DIR) in radiotherapy. The goal was to use clinical data to validate for geometric accuracy, a DIR and atlas-based auto-segmentation (ABAS, CMS-Elekta) platform programmable on a Graphics Processing Unit (GPU) which is capable of improving registration speeds up to 100 fold.

Methods: We restricted our validation to intra-patient registration application although the platform can be used for inter-patient registration. Ten respiratory phase-dependent 3DCT image-sets per patient for 9 patients were used. Demon's algorithm, as implemented in the research release of ABAS, was used to propagate clinician-contoured regions of interests (ROIs) from the reference phase, chosen as the exhale, to the rest of the phases via deformation vector fields (DVF) generated by deformably registering each image-set to the reference. These ROIs shall be called DVF-generated ROIs. Using the same window/level setting, clinician-contoured ROIs were created on the other phases. To compare two ROIs for overlap, we defined an overlap index (OI) as the ratio of overlapping volume to the overlapping plus non-overlapping volume, a related but more conservative index compared to the commonly used dice coefficient (overlapping/average volume).

Results: The average OI computed for the DVF-generated ROIs and the clinician-contoured ROIs on the inhale phase across all patients were tumor (80% +/-6.3%); esophagus (72.0% +/-5.7%); heart (87.1% +/-3.9%); liver (90.6% +/-1.2%); cord (77.1% +/-5.9%); right lung (94.5% +/-1.5%); left lung (94.6% +/-1.7%). Further qualitative analysis via visual inspection by the same clinician resulted in the verification of the DVF-generated ROIs across all phases with a total of 592 out of 594 ROIs receiving satisfactory accuracy scores.

Conclusions: This work verifies that in addition to high registration speed capability, the ABAS-platform programmed on the GPU can achieve accuracy levels required for intra-patient image registration related applications.