AbstractID: 5086 Title: Comparison of seven similarity measures for intensity-based 3D/3D image registrations on CBCT

Purpose: The goal of this study is to evaluate seven similarity measure functions for an intensity-based rigid-body 3D/3D image registration. The registration method was specifically designed to localize prostates on cone-beam CT (CBCT) images, acquired for the use of daily patient setup, accomplished by maximizing the similarity from the corresponding simulation CT in an iterative fashion.

Methods and Materials: Registrations were conducted with seven different similarity measure functions (**NCC**-normalized cross-correlation, **EOD**-entropy of difference, **MI**-mutual information, **CR**-correlation ratio, **GC**-gradient correlation, **GD**-gradient difference, and **PI**-pattern intensity), three different transformations (translation only, translation plus couch rotation, and translation plus three rotations), and two preprocessing methods (window-leveling and histogram equalization). For accuracy and robustness estimation, prostate calcifications were identified on the images from four prostate patients (4 simulation CTs + 27 CBCTs), and the average calcification distances (errors) were measured after registrations. Each registration was marked as "converged" if it had less than 5 mm error, and the average distance was used as an accuracy index.

Results:

In general the histogram equalization and higher degree of transformation freedom improved the accuracy. The only exception was NCC, which performed better without histogram equalization. In the order of better performance, we found the convergence rate and accuracy were (96%, 1.7±1.0mm) for GC, (96%, 1.8±1.0mm) for GD, (96%, 1.8±1.0mm) for PI, (93%, 2.0±1.0mm) for NCC, (81%, 2.9mm) for CR, (78%,2.5mm) for MI, (44%, 2.1mm) for EOD.

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Conclusions:

Among the seven similarity measure functions, registrations utilizing GC, GD, and PI showed the least prostate localization error on daily CBCT images. Such 3D-3D image registration will be critical in order to make the future use of CBCT more objective, efficient, and accurate.