

# AbstractID: 2935 Title: Multi-resolution rigid registration of ultrasound and CT based on similarity measures

## **Purpose:**

In radiation therapy, registration of real-time ultrasound (US) images to CT/MR images is valuable in reducing patient setup errors. Any registration process starts with rigid registration. At present practice this often is done manually by visual inspection. This study investigates the use of similarity measures as the basis of US to CT registration. This approach is potentially faster and less prone to errors compared to segmentation or landmarks based approaches.

## **Methods and Materials:**

A special phantom with objects visible in both CT and US was constructed and imaged. 3D-US images were obtained using a 2D probe attached to a mechanical translator. US and CT datasets were co-registered using an iterative registration algorithm that includes: an interpolator, a similarity metric and an optimizer all working at multiple resolution. The fitness of a similarity metric to the registration task was studied by translational and rotational perturbations of rigid transforms to compute functional trends of a similarity score versus deviation. Metrics, if effective, should guide the optimizer back to the true position. A multi-resolution technique was employed to improve speed. Resolution degradation is guided by voxel sizes of both modalities toward isotropic resolution. A general purpose optimizer, Simplex, was used along with the nearest neighbor interpolation method.

## **Results:**

The Simplex optimizer demonstrated feasibility but not speed. In evaluating similarity metrics, square differences expectedly failed in this multi-modality registration, while mutual information (MI) and cross correlation (CC) were reasonable. Randomly rigid perturbations of up to  $\pm 10$ mm translations and  $\pm 5^\circ$  rotations from the true position converged to a visually accurate position within clinically acceptable limits of 1.0mm shifts and  $1.0^\circ$  rotations.

## **Conclusions:**

Similarity based registration using CC or MI is feasible and effective even on raw US/CT images. Future improvement will include image filtering, adding a weighting bias, or selecting a better optimizer.