AbstractID: 10662 Title: A Novel Inverse-Consistent Feature-Based Non-Rigid Registration Method that Improves the Mapping of Organs with Large-Scale Deformations

Purpose: Unidirectional feature-based registration methods can result in inconsistent correspondence between the forward and the backward transformation and in incoherent anatomical mapping. The aim of this work is to develop, test and validate an inverse-consistent feature-based non-rigid registration method in order to improve the registration of organs that exhibit large deformations. **Methods and Materials:** Thin Plate Splines Robust Point Matching (TPS-RPM) is a unidirectional algorithm that iteratively calculates the correspondence and the transformation between two point sets (e.g., anatomical structures, organs). An inverse-consistent version of TPS-RMP (IC-TPS-RPM) was developed that jointly estimates the forward and the backward transformations and that uses both transformations to determine the correspondence. IC-TPS-RPM was compared with TPS-RPM by registering organs with large deformations in five patients. For each patient the contoured cervix-uteri and bladders on a series of three variable bladder filling CT-scans (empty to full) were employed. The mean ratio between the volume of full bladder and the volume of empty bladder was 5.7. The registration accuracy error, the inverse-consistency error, the residual distances after transforming anatomical landmarks and the registration time were calculated using both algorithms. **Results:** The registrations performed with IC-TPS-RPM have on average 10% and 70% better accuracy and inverse-consistency, respectively when compared with the non-symmetric TPS-RPM. By using IC-TPR-RPM the residual distances after transforming anatomical landmarks for the registration of full to empty bladder reduced by 47% and by 11% for all landmarks. Moreover, the registration time for computing the forward and the backward transformations decreased by 29%. **Conclusions:** Compared with TPS-RPM the new IC-TPS-RPM method improves the registration accuracy, the inverse-consistency and the anatomical correspondence. For cases with large deformations accurate transformations were obtained with IC-TPS-RPM, while TPS-RPM failed. Furthermore, IC-TPS-RPM requires less time to compute the forward and the backward transformations.