

**AbstractID: 5607 Title: Deformable Registration using Regularization that Accommodates Local Tissue Rigidity**

**Purpose:** Existing methods for deformable image registration typically use homogeneous regularization to encourage global smoothness. Less work has been done to incorporate voxel-level tissue-specific elasticity information. Ignoring differences in elasticity can, however, result in non-physiological registrations, such as bone warping. We propose an approach to incorporate tissue rigidity information using a spatial variant regularization.

**Method and Materials:** Regularized image registration algorithms estimate the deformation by minimizing a cost function, consisting of a dis-similarity metric and regularization. To account for tissue-type-dependent rigidity information, we incorporate into the cost function a non-rigidity penalty: an integral of stiffness index for local deformation weighted by spatial variant regularization factor depending on tissue type. For CT data, a simple monotonic increasing function of the CT number is used as a rigidity index for local tissue type. A necessary and sufficient condition for stiff local deformation is derived, and the local non-stiffness is measured by the deviation of local Jacobian from orthonormality using the Frobenius norm. Tensor B-Splines are used to parameterize the deformation field. A multi-resolution scheme and gradient-based approach are applied for optimization. Performance was assessed by registering 3D thorax CT-images obtained from different breathing phases.

**Results:** Experiments with clinical data demonstrate higher accuracy for inhale-exhale thorax CT registration with the proposed approach. We observe comparable intensity match as the unregularized approaches, but more physiologically reasonable results with respect to different tissue types; in particular bone warping phenomena is eliminated in general.

**Conclusion:** This work provides a way to incorporate tissue-type-dependent information into deformable registration framework with regularization design. Inference from image intensity avoids explicit segmentation, and is robust to partial volume effect. Our formulation based on local Jacobian and Frobenius norm provides analytical expression for the regularization and its derivative. More physiological results are achieved with minor computation expense.

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