ELASTIC REGISTRATION OF LUNG CT IMAGES WITH LOG UN-BIASED DEFORMATIONS AND RIGIDITY CONSTRAINT

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The proposed method is an integrated framework for elastic image registration with log-unbiased deformations and a spatially variable constraint to reduce image folding and retain the rigidity of the bones. To efficiently solve the large system of linear equations produced by the elastic registration technique we use the method proposed by Fischer and Modersitzki[1] which utilizes Fast Fourier transform to obtain a direct solution for the linear system of equations. To restrict image folding we add another external force term based on the work of Yanovsky et. al.[2] which uses the statistical distribution of the Jacobian maps in the logarithmic space to produce unbiased transformations. The deformation of the bony structures is prevented by filtering of the deformation field. The spatially varying filter proposed by Staring et. al.[3] is used for this purpose. The filter preserves the local linearity of the deformations. All the images are first registered using rigid transformations to achieve rigid alignment between the fixed and the moving images. Sum of squared differences is used as the similarity measure as the images belong to the same modality. Gradient descent optimization is used for convergence of the algorithm. A multi-resolution strategy having 4 levels of resolution are used to recover large deformations. At the start of each resolution the lung masks are used as the fixed and the moving images to drive the registration and after a few iterations the lung masks are replaced by the actual images. The deformation field produced every iteration is composed with the earlier transformation. The composition of the deformation field helps to achieve faster convergence and also a smoother deformation field. The only parameter value that changes with the image dataset is the weighing factor for Yanovsky term. For large deformations a weighing factor of 0.3 is used for the Yanovsky term while for medium and small deformations we use a weighing factor of 0.5. The code has been implemented on a Windows workstation of Intel Xeon CPU AT 2.4 GHz with 12 GB main memory and was designed using the ITK framework. The algorithm is semi-automatic.

References

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