ELASTIC IMAGE REGISTRATION USING COMPOSITION OF DEFORMATION FIELDS

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The method presented here uses the classic elastic image registration technique. The Navier Lame' linear partial differential equations shown in eqn (1) define the external forces ' F ' (based on image similarity) , internal forces (regularizing forces) and the displacement field 'u' for the elastic model.

$$F = \mu \Delta \mathbf{u} + (\lambda + \mu) \nabla div(\mathbf{u}) ....(1)$$

The Lame' constants 'μ' and 'λ' control the material properties of the elastic model. 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. 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. All the parameters are preset and remain the same for all datasets 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 fully-automatic.

References

[1]Fischer B, Modersitzki J. Fast inversion of matrices arising in image processing. *Numerical Algorithms*. 1999;22(1):1-11.