Medical Image Registration

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Image Registration

Image registration is the process of aligning two or more images of the same scene taken at different times, from different viewpoints, or by different sensors.

It's used to match corresponding features and structures in the images, allowing for comparison, integration, or further analysis.

In image registration tasks, the large Deformations are difficult problems. Because handling large deformations between images requires sophisticated non-rigid registration techniques.

Medical Image Registration

Medical image registration is used to align and overlay images of the same anatomical structure obtained from different imaging modalities (e.g., MRI, CT, X-ray) or at different times.

This alignment enables healthcare professionals to compare, analyze, and integrate information from multiple sources, enhancing diagnosis, treatment planning, and monitoring.

Implicit Neural Representations (INR)

INR: The idea is to use MLP with periodic activation functions for optimisation.

$$Loss = L_{data}((M \circ \Phi)(X), F(X)) + L_{reg}(\Phi), X = (x_1, x_2, x_3)$$

Advantage: faster than traditional methods

Bottleneck: can only get deformation fields

Large deformation diffeomorphic metric mapping (LDDMM)

LDDMM: The idea is to use a time-dependent velocity vector field to describe the deformation.

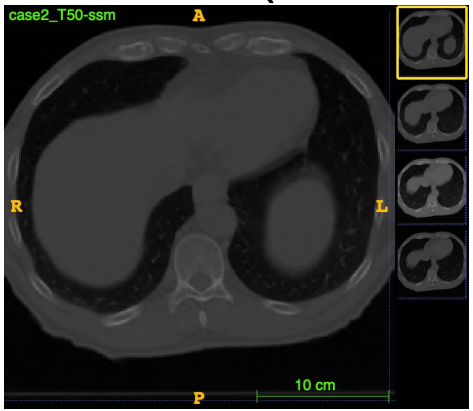
- $\frac{d}{dt}\Phi_t(X) = v_t(\Phi_t(X))$
- $\Phi_1 = \Phi_0 + \int_0^1 v_t(\Phi_t(X))dt$

Advantage: 1. can solve large deformation problems 2. can describe the registration process in details

Bottleneck: expensive during the computation

Experiments

Case 2 (error = 1.8534 mm), axial = 85



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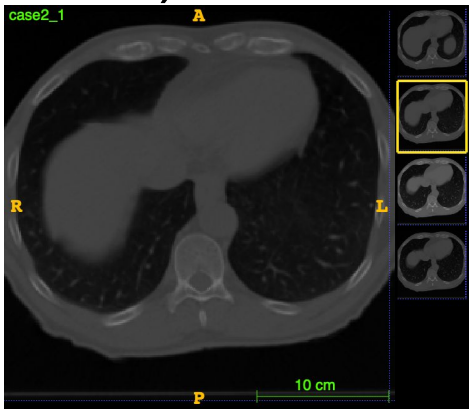
DF1



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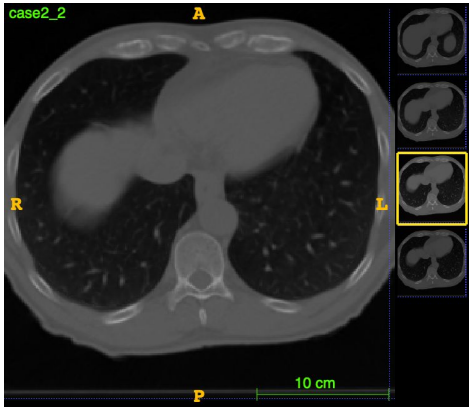
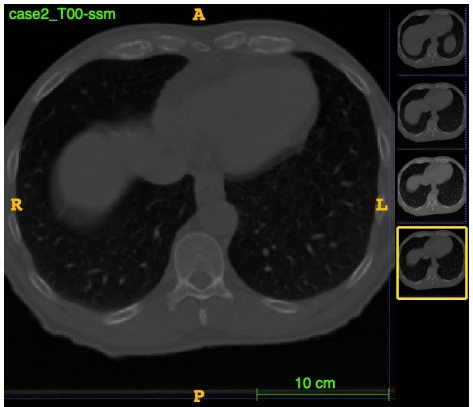
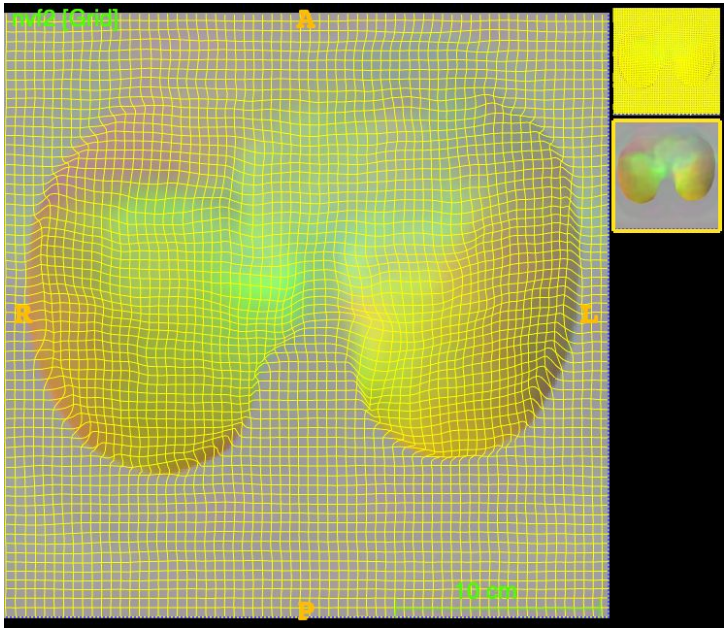
DF2





Case 2 (error = 1.8534 mm), axial = 85



Deformation Field

Thanks