Femur Statistical Atlas Construction Based on Two-level 3D Non-rigid Registration

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CAS09, September, 2009.

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Abstract

The statistical atlas is a 3D medical image analysis tool towards more patient-oriented and more efficient diagnosis. The atlas includes information on geometry and their variation across populations. The comparison and information from other patients is very useful for the objective quantitative diagnosis. The statistical atlas can also be used to solve other challenging problems such as image segmentation. As a key to build statistical atlases, 3D registration remains an important yet unsolved problem in the medical image field due to the geometrical complexity of anatomical shapes and computational complexity caused by the enormous size of volume data.

Method: In this work we developed a two-level framework to efficiently solve 3D non-rigid registration and applied the method to the problem of building statistical atlases of femur. Compared with a general multi-resolution framework, we employed an interpolation to propagate the matching instead of repeating the registration scheme in each resolution. The registration procedure is divided into two levels: a low-resolution solution to the correspondences and mapping of surface models using Chui and Rangarajan's thin-plate spline (TPS) based algorithm [25], followed by an interpolation to achieve high-resolution matching. After that, principal component analysis (PCA) is used to build the statistical atlas. Experimental results show the shape variation learned from the atlas, and also demonstrate that out method significantly improves efficiency of registration without decreasing accuracy of atlases.

Notes

- **Number of pages:** 21

Text Reference

Chenyu Wu, P. E. Murtha, and Branislav Jaramaz, "Femur Statistical Atlas Construction Based on Two-level 3D Non-rigid Registration ," *CAS09*, September, 2009.

BibTeX Reference

```
@inproceedings{Wu_2009_6443,
  author = "Chenyu Wu and P. E. Murtha and Branislav Jaramaz",
  title = "Femur Statistical Atlas Construction Based on Two-level 3D Non-rigid Registration ",
  booktitle = "CAS09",
  month = "September",
  year = "2009",
}
```