Point cloud registration for anatomical measurements

Project Management and Software Development for Medical Applications

General Info

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Project Abstract

With this project, the student will implement a point cloud mesh registration method, capable of accurately perform the registration of segmented meshes from medical imaging to a template mesh of each of the heart structures. By registering the heart structure meshes, the student will be able to study the variability of these meshes through a target population.

Background and Motivation

Understanding the anatomical variability of a target population is a critical success factor for R&D in implant development. Device fitting or even medical treatments can be optimized if the anatomical landmarks and distances are known. When looking at a large data batch size, we can have an insight on how these measurements vary throughout the target population and hence adapt implant design, sizing or fitting and still reduce the costs in production and minimizing the implant failure rate.

These anatomical landmarks are extracted from medical images or three-dimensional surface meshes of the anatomical bodies, the latter derived from the images. This is a time consuming and challenging task, often performed by experienced radiologists or physicians. In order to study the variability of the position of these landmarks or the extension of the measurements, these meshes have to be registered to a template mesh.

The scope of this work is to improve the accuracy and performance of the registration approach and take it to medical relevance or even clinical practice.

Student's Tasks Description

- Create flexible, adaptable template meshes for the heart structures
- Improve the non-rigid registration method's accuracy
- Study the variability of the anatomical measurements in a target population
- Weekly present findings and discuss drawbacks to the team.

At the end of the project, the student shall have the following outcome: an accurate non-rigid registration algorithm for complex geometries with all the relevant source code in a GIT repo. Virtonomy will provide supervision with medical industrial computer vision training and software development experience.

Technical Prerequisites

- Experience with Python
- Basic knowledge of medical image processing and surface meshes (or point cloud meshes)
- Good understanding and experience with GIT
- Strong mathematics background

References

https://github.com/garyptchoi/spherical-conformal-map

Choi, G., Liu, Y., & Lui, L. M. (2022). Free-boundary conformal parameterization of point clouds. Journal of Scientific Computing, 90(1), 1-26.

Zhang, D., Choi, G. P., Zhang, J., & Lui, L. M. (2022). A unifying framework for n-dimensional quasi-conformal mappings. SIAM Journal on Imaging Sciences, 15(2), 960-988.

Please send the completed proposal to ardit.ramadani@tum.de, lennart.bastian@tum.de and tianyu.song@tum.de. Please note that this proposal will be evaluated by the BMC coordinators and will be assigned to a student only in case of acceptance.