SAB Meeting 9 - 10 February 2011

Project: The Virtual Skeleton Database

WP 3: Statistical Finite Element Modeling for the VSD

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Introduction

Biomechanical information as well as their variations in populations are important for implant design. Current tools rely on sparse data or on a limited number of cadaver tests.

The objectives of this WP are:

- to extract mechanical information from medical images
- to include them in a statistical model
- to produce statistical "stiffness" models

Application to:

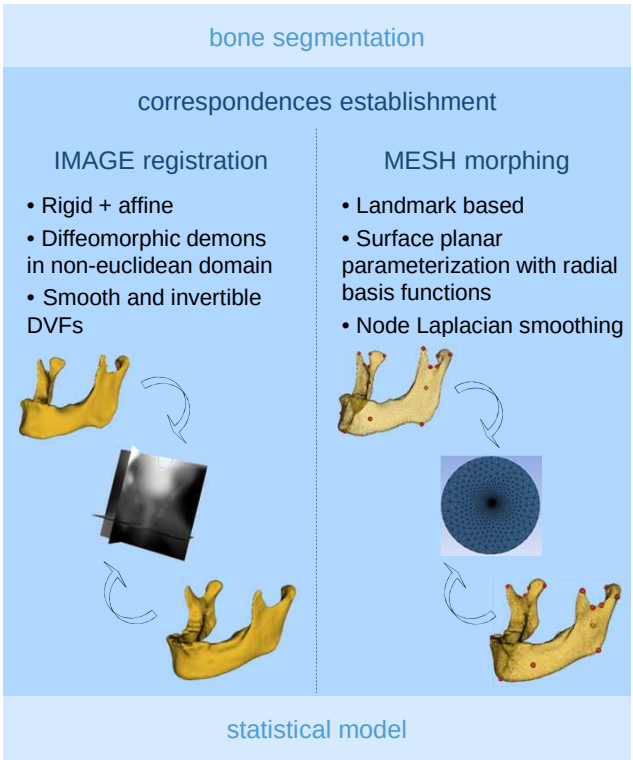
- implant design optimization
- patient-specific planning

Methods

Two main aspects have been specifically investigated:

1. *Correspondence establishment*

   In order to create a correct statistical model, correspondences have to be precise. Two methods are compared: an image-based and a mesh-based approach

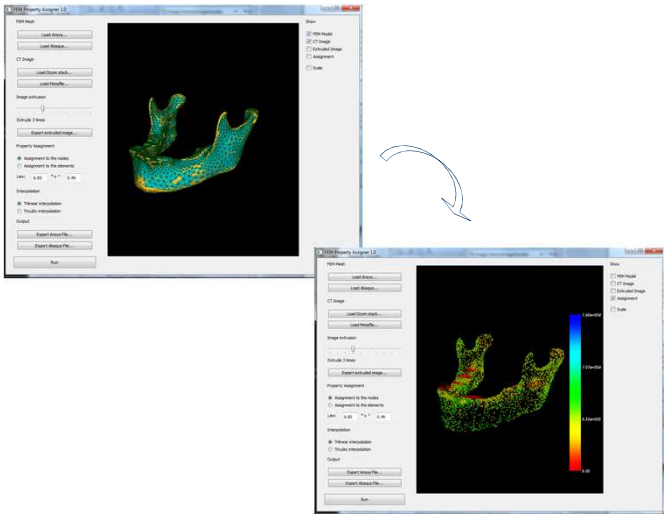


Comparison of the two methods based on:

- *Surface evaluation*: Hausdorff distance between the original bone and the registered/morphed one
- *Volume evaluation:* comparison as superimposition of the different bone regions (cortical, trabecular, marrow)
- *Model evaluation:* comparison of compactness, generality and specificity

2. *Mechanical properties extrapolation*

   A tool has been created in order to convert image grey levels into bone mechanical properties. Inhomogeneous Young's modulus are assigned automatically to the finite element mesh



Nodes on the surface might lie slightly outside the bone boundaries defined on the images. Our solution was to extend the cortical bone layer in order to obtain a reliable bone stiffness

Discussion and conclusion

- An automatic pipeline to combine bone shape and mechanical information has been developed
- Further steps involve:
  - transition from a feasibility study to a validated process able to be used for specific applications
  - bone-implant evaluation based on the instances created by the model
  - application to plate design for toothless patients

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