TwinSight: Digital Orthopedic Twins

Adaptive meshing for numerical simulation in biomechanics

H2020 SOCIETAL CHALLENGES: Biomedicine and Health Care
PRODUCTIVE SECTOR: Biomedicine and Health Care

PROBLEM DESCRIPTION

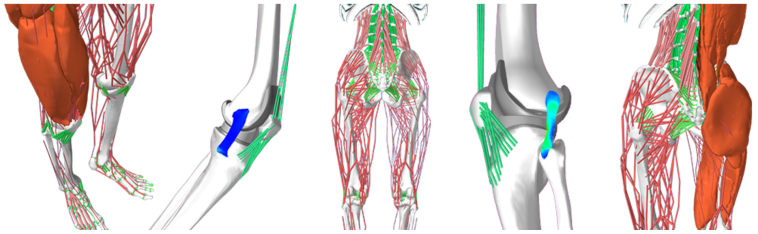
Automatic finite element (FE) meshing of anatomical structures based on medical images is a complex procedure. The resulting meshes can produce inaccurate solutions due to the poor shape of some cells or a poor mesh resolution in some regions.

CHALLENGES AND GOALS

- Quantifying the discretization error
- 3D meshes from complex anatomical structures
- Sophisticated mathematical models

MATHEMATICAL AND COMPUTATIONAL METHODS

TwinSight creates accurate patient-specific numerical models for orthopedic surgery. These models are based on discretizations of anatomical structures from medical images, and use finite element analysis to predict the biomechanical behavior of bones and soft tissues.
These predictions are used by clinical staff to adjust therapeutic strategies, such as total knee replacement, so as to maximize functional performance and patient satisfaction.
The TwinSight/CNRS collaboration aims at quantifying the error related to the discretization of the modeling domains and optimizing the mesh accordingly. This approach ensures that the numerical results are reliable while reducing the computational cost.
The underlying mathematical tools used in the project are related to goal oriented a posteriori error estimates.



Patient-specific FE models of muscles and bones for orthopedic surgery

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Results and Benefits

We have implemented goal oriented a posteriori error estimates for hyperelastic models of the soft tissue with active and passive constitutive laws. The underlying mathematical techniques form the cornerstone of the solution to the challenging modeling issue that the collaboration between TwinSight and the CNRS is tackling.

Biomechanical models with controlled error

A significant advancement in the pipeline of numerical simulation which opens the way to more accurate and reliable patient-specific digital twins.

LMB, CNRS, France

TexiSense, TwinSight, France