AN INTERACTIVE CLINICAL INTERFACE FOR MR IMAGE-BASED COMPUTATIONAL MECHANICS MODELING OF THE HUMAN CARDIOVASCULAR SYSTEM


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Requirements

Clinical modeling is special
- individual variation → patient specific modeling
- save patient's life → accurate modeling
- time is severely limited → quick modeling
Accurate Modeling

- volumetric image based modeling
- medical images contain noise and artifacts
- hard to construct automatically
- needs experience and expertise

interactive modeling system is needed.
Quick Modeling

- quick modeling using preconstructed prototype.

Diagram:

1. Patient → Medical images
2. Medical images → extract coarse geometry and topology
3. Model prototype database → retrieve model prototype
4. Model prototype → matching & fitting
5. Patient specific model
"Model" in Database includes
- original medical image data
- computational grids
- pre-calculated physical properties
Quick Modeling

- quick modeling using preconstructed prototype.

1. Patient → Medical images
2. extract coarse geometry and topology
3. Model prototype database
4. retrieve model prototype
5. Model prototype
6. matching & fitting
7. Patient specific model
- real time volume rendering
- mesh in same view
- Loop subdivision
- multi-resolution mesh editing
What's Left?

- Topology estimation
- DBMS with topology matching
- Model database
- System integration & UI
Topology Estimation

- Make binary image
- Skeltonize
- Trace edges
Making Binary Image

- accuracy is not very important
- speed is very important
Skeltonization

- make crude centerlines
- delete pixels from boundary
Edge Tracing

- determine connection between nodes
- trace each edges pixel by pixel
Model Database

Database of Images, Topology, Models and Pre-Computed Flows

DB(Results)
DB(Models)

Matching

Initial Condition

Rendered MRI  Centerlines  Basic Model  Modified Model

Physiological Flow Studies Laboratory
Centerline Based Grid Definition

- easy to modify by hands
- easy to generate a structured grid
System Integration and User Interface

- File
- Edit

- New
- Morph
- Properties
- Configurations

- display config

- blending operator:
  - over
  - attenuate
  - MIP with GL_LOGIC_OP
  - MIP with GL_MAX

- x: 5.000  y: -2.000  z: 0

- hide in 3D view
- hide in schematic view

- Recursive automatic schematic place children

- Center new
- Recursive center new

Template Volume:

filter:
Summary

- quick and accurate modeling
- using pre-constructed model database
- topology estimation
Future Works

- database management system with topology matching
- model database
- system integration and user interface
- validation