Towards surgeon-authored VR training: the scene-development cycle

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Outline

- Authoring by Surgeon-Educators
- Distributing the work
- Surgeon-educator interface
- Modeling artist interface
Teaching Minimally Invasive Procedures

Practicing on animals

VR trainer

Box trainer
Advantages of Virtual Reality Simulators

- Practice decision-making
- Objective measurement of performance
- Low-cost, portable
- customizable
Customizable?

➢ Rare procedures need more training, but are **low volume**
➢ Anatomical **variation**
➢ Master surgeons teach their **unique approach**
➢ **Non standard** anatomy (tumor)
Example Authored Simulation: Nissen Fundoplication
Toolkit for Illustration of procedures in Surgery (TIPS):

Cycle
Toolkit for Illustration of procedures in Surgery (TIPS):

Creation-Validation Cycle
Modeling and testing a Stomach model using Blender2SOFA
Toolkit for Illustration of procedures in Surgery (TIPS):

Cycle

Creation-Validation
Authoring by Surgeons

➢ **Surgeon-author level**
  ○ Create and share teaching modules
  ○ Automatically instantiate a simulation

➢ **Modeling-artist level**
  ○ Design the anatomical structures
  ○ Specify physical behavior
  ○ Quickly test the designs

➢ **Trainee level**
  ○ VR simulation
  ○ Haptic interaction with the soft-tissue

➢ **Developer level (sofa)**
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Old workflow

Blender 3D modeling

SOFA simulation framework
NEW: Modeling-Artist Interface

➢ Blender interface: model geometry (anatomy)
➢ Blender2SOFA plug-in: define soft-tissue physics
➢ Test: auto-instantiated simulation
Auto-generation of Visual, Physical and Collision Models
Specifying Physical behavior
Volumetric Object Creation

- Extrude in normal direction to create **thick shells**
- Fill the space between two models to create **connecting tissue**
- Create volumetric models embedding organs in **fat**
- Convert curves into volumetric clamp & cut **vessel models**
Blender2SOFA features

- Specify Physical Behavior
  - Assign physical behaviors to geometry objects
  - Adjust parameters for physical behaviors
- Generate volumetric objects from surface geometry
- Generate visual, collision and physical models from geometry
- Generate attachments between objects
- Generate fixed constraints on deformable objects
- Define surgical instruments with haptic force

THANK YOU - QUESTIONS?
Source Code

- Modifications to SOFA simulation software:
  - Source code: bitbucket.org/surflab/sofa

- Blender2SOFA plugin:
  - Source code: bitbucket.org/surflab/blender2sofa

- TIPS-Author
  - Published: tips-author.appspot.com
  - Source code: bitbucket.org/surflab/tips-author
Surgeon-Educator Interface

● Enable surgeons to deconstruct a surgical procedure
  ○ Stage: a series of tasks to complete an objective
  ○ Task: a single action involving
    ■ Verb
    ■ Organ
    ■ Instrument

● Review lists of available organs and tools to use

● Auto-instantiate the simulation from a description
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