H3D API

An open source API for dexterous skills simulators

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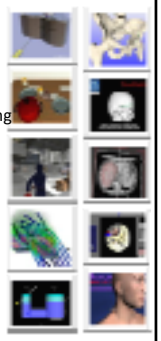
SenseGraphics

Outline

- What is haptics?
  - Concepts
  - Hardware devices
  - Software
- H3D
  - HAPI
  - H3DAPI
  - Toolkits
- Case studies
  - Simodont - Moog dental simulator
  - Cork University hospital - spinal anesthesia simulator

SenseGraphics technology

- SenseGraphics H3DAPI Software development platform (Open Source)
  - SenseGraphics H3DAPI is designed for users intending to write software applications in "multi-sensory" environments.
- SenseGraphics Immersive Workstations
  - Work with your data in Immersive environment.



What is haptics?

- Tactile vs kineastetic force feedback

Exploratory procedures

- Lateral motion (texture)
- Pressure (hardness)
- Static contact (temperature)
- Unsupported holding (weight)
- Enclosure (global shape)
- Contour following (local shape)

What is haptics?

- 3-DOF - 6-DOF

Haptic devices





Display systems




H3D platform

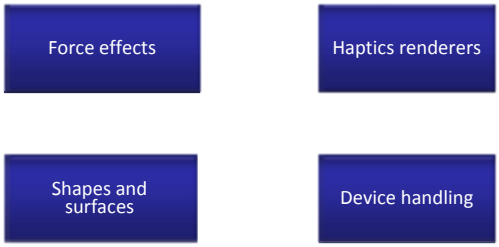
- H3DAPI
  - X3D-based scene-graph API
  - Graphics, haptics, sound
  - Scripting through Python
  - C++, OpenGL
- HAPI
  - Haptics SDK
  - C++
  - Cross-platform (Windows, Linux, OSX)
  - Device independent

www.h3d.org

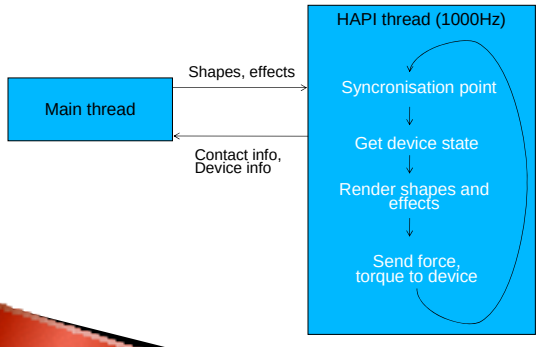
HAPI

- C++
- Haptics API
- Cross-platform
- Device independent
- Modular and easily extendable

HAPI - components



HAPI – program flow

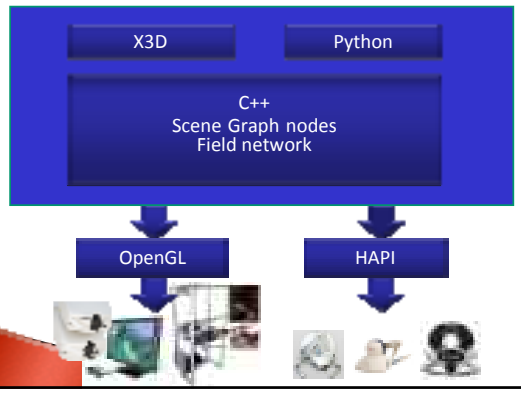


Code example (HAPI)

```
int main(int argc, char* argv[]) {
  AnyHapticsDevice hd;

  HAPISurfaceObject *my_surface = new FrictionSurface();
  HapticPrimitive *my_haptic_sphere =
      new HapticPrimitive( new Collision::Sphere( Vec3( 0, 0, 0 ),
                                                  0.05 ),
                           my_surface );

  hd.setHapticsRenderer( new GodObjectRenderer() );
  if( hd.initDevice() != HAPIHapticsDevice::SUCCESS ) {
    cerr << hd.getLastErrorMsg() << endl;
    return 0;
  }
  hd.enableDevice();
  hd.addShape( my_haptic_sphere );
  hd.transferObjects();

  string temp_string;
  cerr << "Press ENTER to exit" << endl;
  getline( cin, temp_string );

  hd.disableDevice();
  hd.releaseDevice();
}
```

H3D API

H3DAPI Overview



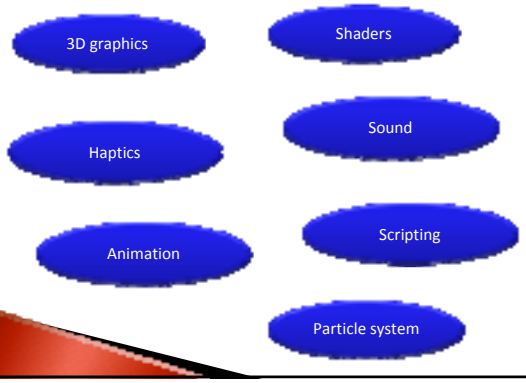
H3D API

- X3D – scene definition
- Python – scripting, scene updates, interaction
- C++ - nodes, scene building blocks

Simple X3D example (H3DAPI)

```
<Shape>
  <Appearance>
    <Material diffuseColor="1 0 0"/>
    <FrictionalSurface stiffness="0.3" />
  </Appearance>
  <Sphere radius="0.1" />
</Shape>
```

H3D API Components



More info

www.H3D.org

www.sensegraphics.org

www.web3d.org

Wiki

Documentation

Training

Consultancy

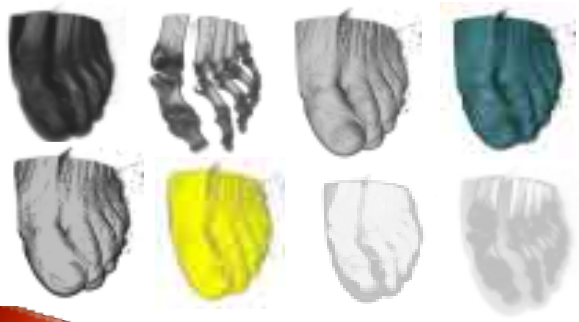
Toolkits

- MedX3D (volume rendering)
- VHTK (volume haptics toolkit)
- UI (3D user interface)
- RigidBodyPhysics(under development)

MedX3D

- Web3D Consortium – Medical working group
  - Create ISO standard for representation of human anatomy
  - First step: volume visualization
- MedX3D toolkit for H3D API
  - First implementation of standard draft
  - GPU based raycasting and slice based 3D texture rendering

Render styles



ComposedVolumeStyle

- Compose several styles into one

Opacity-Phong

Opacity-Phong-Edge enhancement

SegmentedVolumeData

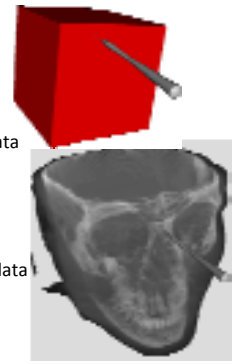
- Render different parts of data with different rendering styles.

Cerebral ventricular system: ToneMapped
Head: Opacity

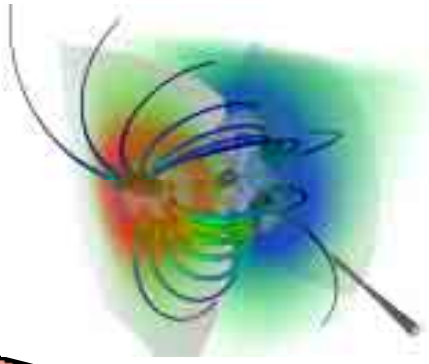
Blood vessels: Phong
Head: Opacity-Boundary

VHTK – Volume Haptics Toolkit

- Surface Haptics
  - interact with surfaces
- Volume Haptics
  - haptic algorithms using volumetric data
  - interaction with volumetric data
- Applications
  - surgery simulation on authentic data
  - scientific visualization of volumetric data



Dichloroethane Electro Potential



Femur Bone Drilling

Dynamics in Volume Haptics

RigidBodyPhysics

- Rigid bodies
  - Physics properties (mass, friction, etc)
  - Geometric shape
  - Joints
  - Haptic interaction
  - Currently ODE and Nvidia PhysX

UI toolkit

- 3D/haptic UI nodes
  - Menus
  - Sliders
  - Buttons

Case study 1

Simodont - dental simulator

Moog

HapticMASTER

Conventional Dental Training Equipment

ACTA

ACTA

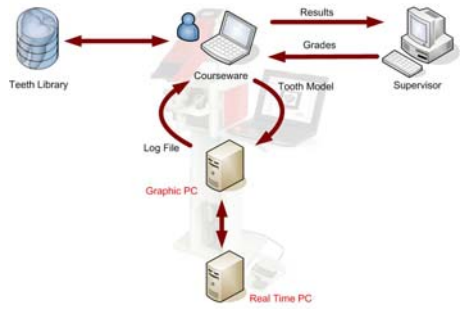
Visual Display

- Sharp, true size collocated visual display
- Full resolution, full stereo image projection and mirror technology

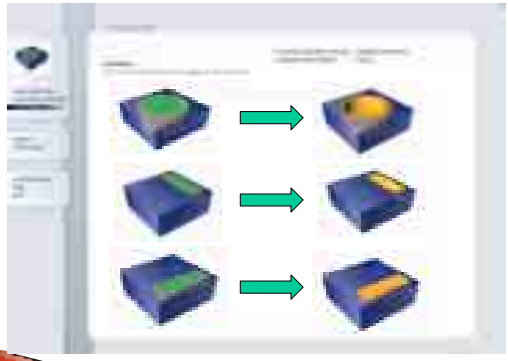
ACTA

Dental tools

Simulator and Courseware Interaction



ACTA

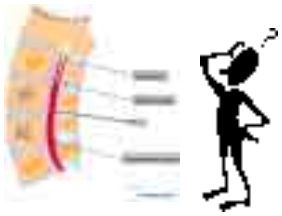


ACTA

Case study 2

Spinal anesthesia simulator

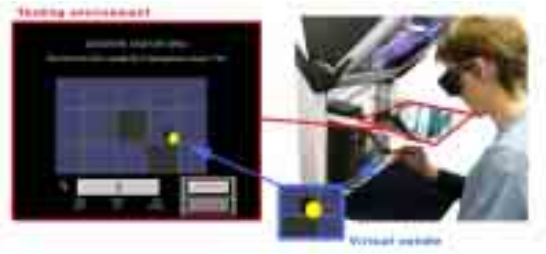
Spinal anesthesia – Can we improve how it is taught?



Determinant study – to understand the problem and the domain

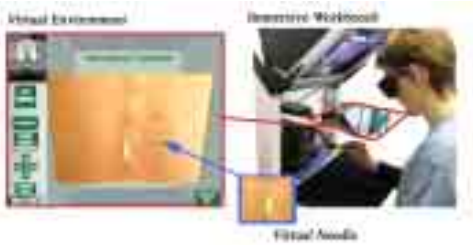
- Learning related:
  - Recognition of certain characteristic *sensations* as spinal anesthesia is performed
  - Ability to *visualise* the relevant anatomy
- Teaching related:
  - An explicit knowledge program for the procedure
  - A case-based learning program
  - A valid, reliable competence assessment procedure

Modeling of sensations



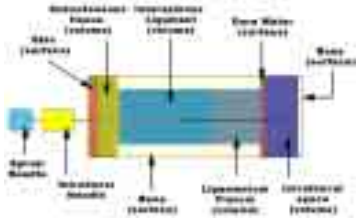
- Medical experts were recruited to rate sensations associated with spinal anaesthesia

Using the initial model



- The haptic arm controls the needles
- Each layer of tissue have different resistance
- The anatomy can be rotated for enhanced learning

Human tissue modeling



- A human tisssue model was developed to reproduce the actual sensations of performing spinal anaesthesia
- The model has been verified with medical experts and is believed to be very accurate

Visualisations

- Real-time 2D and 3D visualisations are used
- The learner can place the needles and then view how the needle was placed and from that create a mental model of the procedure

Simulator-supported assessment procedure

Thanks for listening!

See us in the exhibition hall for questions and demos