Simulation of Hybrid Systems in Virtual Environments

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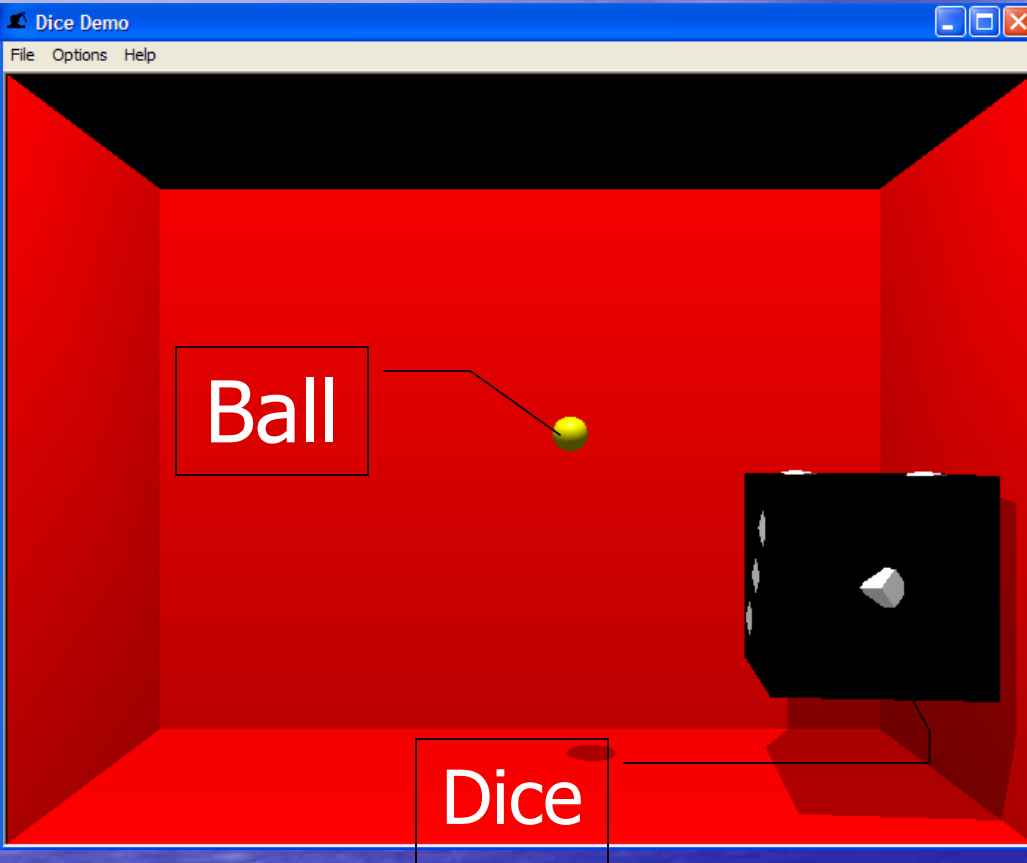**Department of Electrical Engineering and Computer Science**

Project Goals and objective

- Understand the programming and coding of the haptic examples.

- Create a virtual environment where I have a ball a wall.

Objective: Create a virtual environment where I have a bouncing ball on a moving paddle that I can move using the haptic device.

Dice Demo

Haptics

- What are haptics?
- Has six degrees of freedom and postion detection.
- Inkwell is design to calibrate the haptic device
- Maximum force 3.3 N

Inkwell

Stylo

Phantom Omni

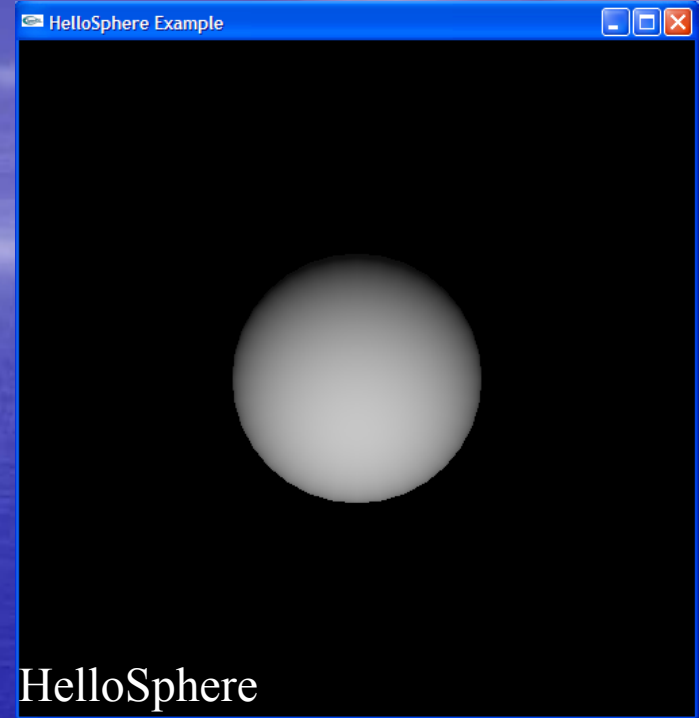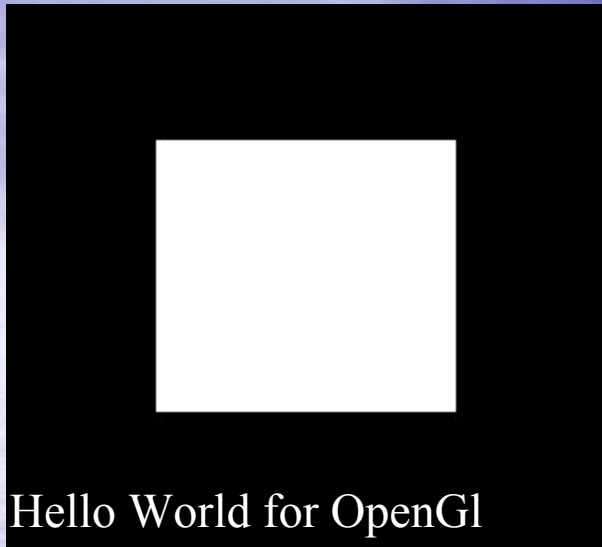- Workspace is appr. 6.4w ×4.8h ×2.8d in.

World Application

- Surgical Simulation and medical training.

- Painting, sculpting and Computer Aided drafting(CAD).

- Military Applications and Simulations.

http://www.crs4.it/vic/activities/surgical-simulation/

OpenGl

Hello World for OpenGl

HelloSphere Example

HelloSphere

- Creating graphics.
- Can build model using small geometric primitives. (e.g line, points)
- Implement Motion using Opengl.

Haptic Device

http://www.sensable.com/index.asp

Phantom Omni by SensAble technologies.

Haptic Library

HLAPI= Higher level of programming

HDAPI= lower level of programming

HLAPI VS. HDAPI

- Designed for programmers who are less familiar with haptic programming.
- Allows the user to add haptics to a graphic application.

- Developed for programmers who are interested in sending forces directly to the haptic device.

- Can be used to improve stability and responsiveness.

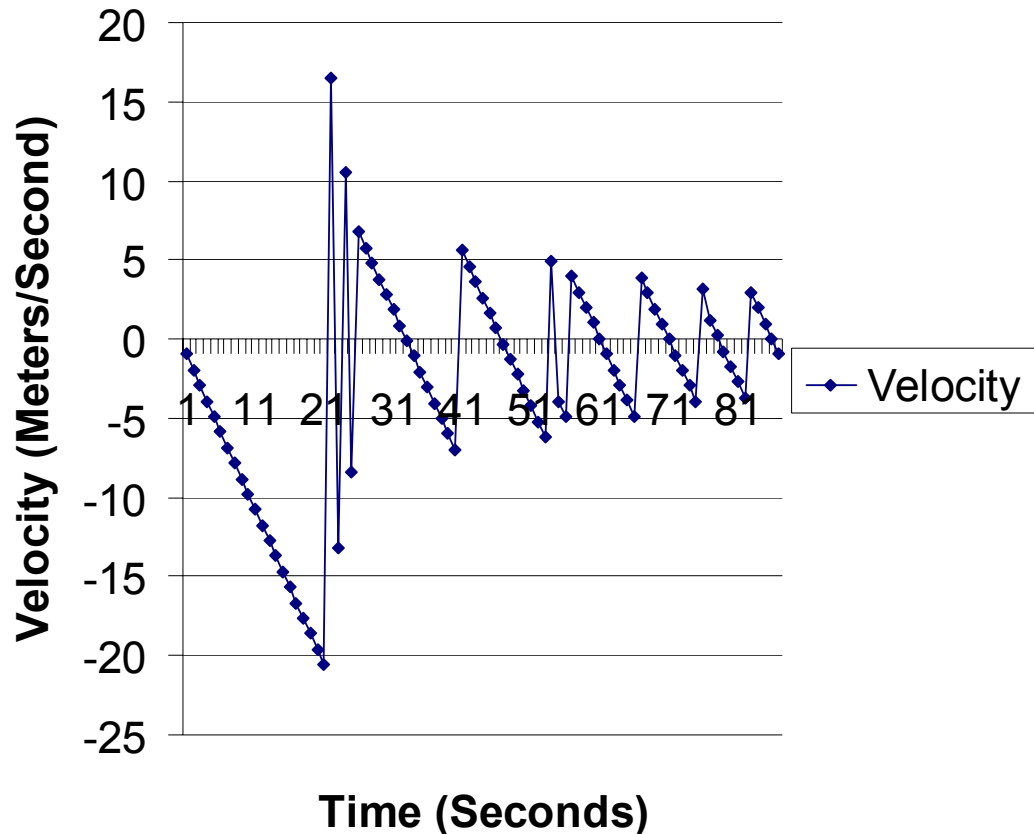HLAPI is built on top of the HDAPI, both libraries can be used together

Data

Bouncing Ball Position
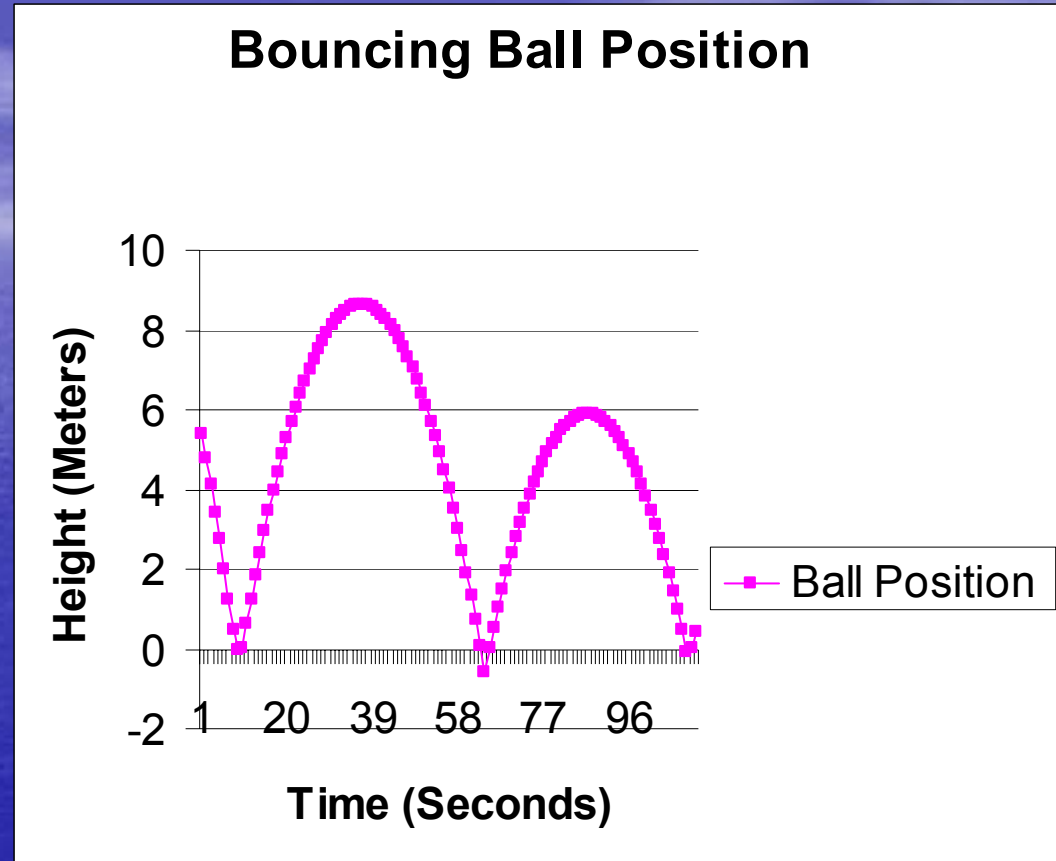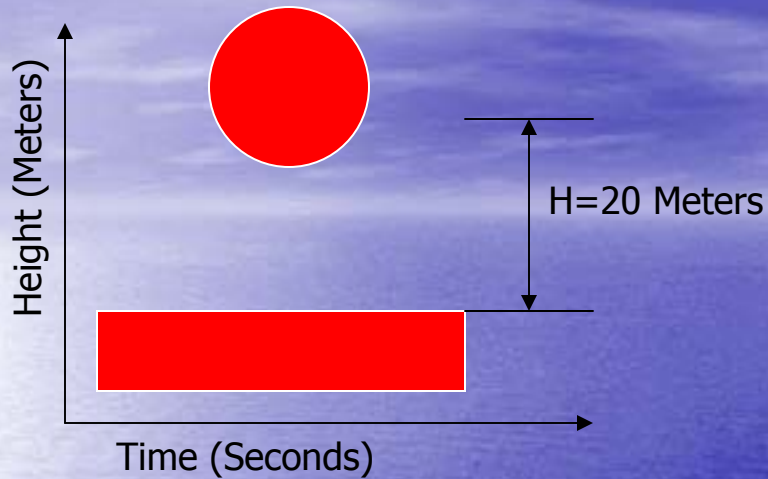
Position : Y=yinitial +vinitial×time +
1/2×acceleration ×time^2

Velocity Data

Velocity : V=Vinitial + acceleration×time

Accomplishments
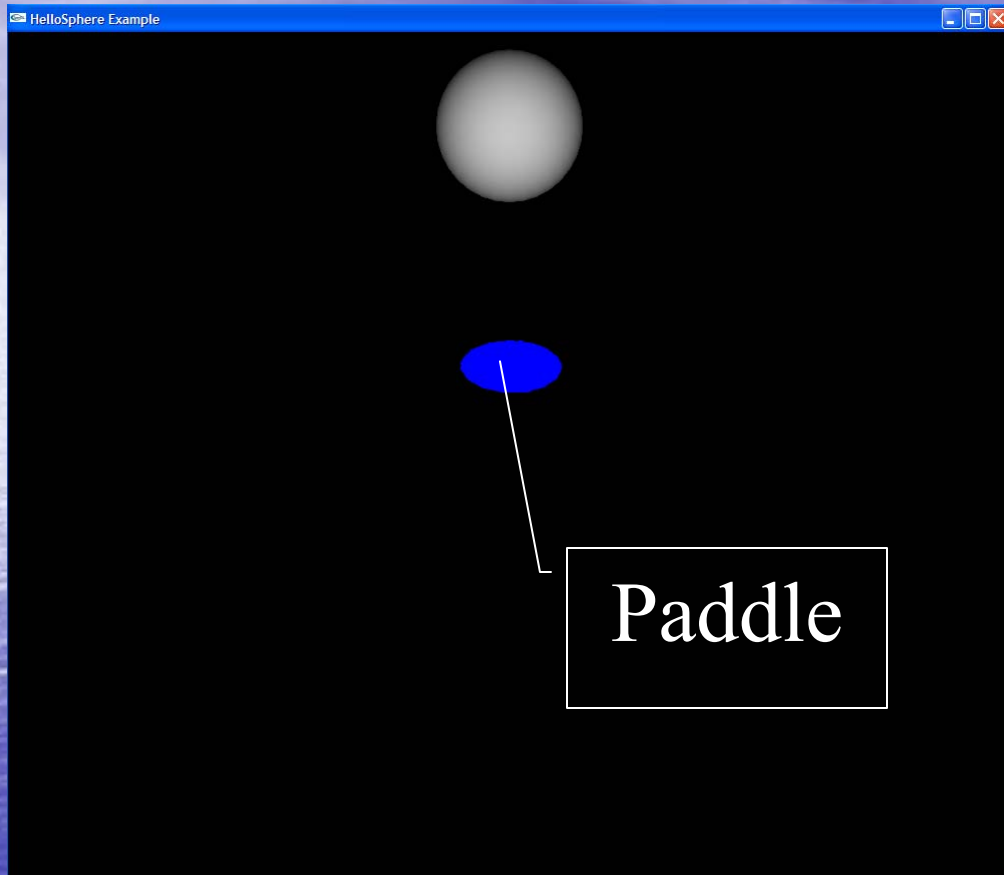
Paddle

Three-Dimensional Sphere with haptic interaction

Continuing Research

- I plan to create a better offset function
- Create a paddle surface that is made of different materials.
- I expect that this will affect the way that the ball will bounce.

Acknowledgments

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Maxim Subbotin
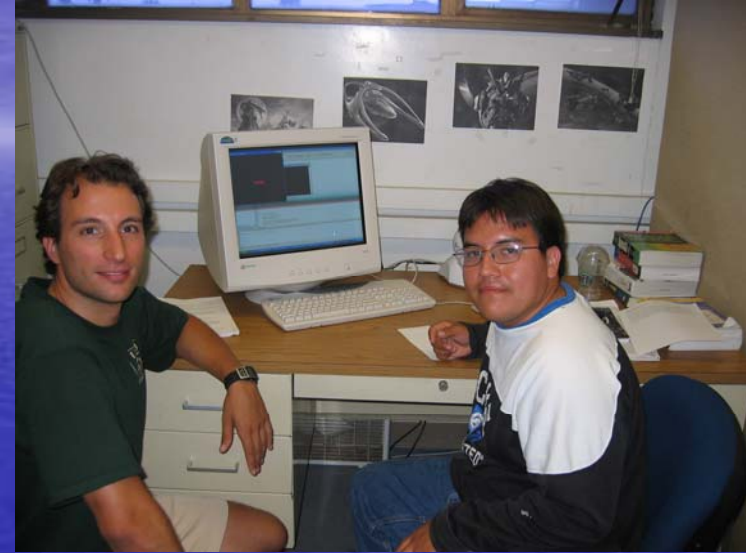
HDAPI and HLAPI

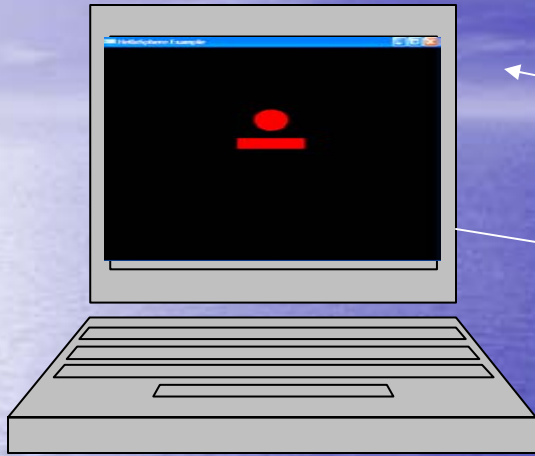- hlMaterialf(HL_FRONT_AND_BACK, HL_STATIC_FRICTION, 0.2f)

The 0.2 is between 0.0-1.0 Newton force.

HDAPI

Hooke's Law: $F = k \times X$; K= constant,

X= distance

Force Equation $F = kx + Bx + g(x,y)$

OpenGl and Haptics Interaction

Code

Phantom Omni by SensAble technologies.

1. **Create frame using hl**

2. **Add color**

3. **create the object and end the frame**

hlBeginFrame()
glPushMatrix();
   glTranslatef()
   glColor3f()
GlutSolidSphere();
glPopMatrix()

hlEndFrame()

Haptics in Nanotechnology

- A nanometer is very small it is about 1/80,000 of the diameter of a human hair.

- tool to save time. based on simulations can be used to test several hypothesis and select the optimal one for further experimental testing.

- Could save money by running test before expensive test can be made
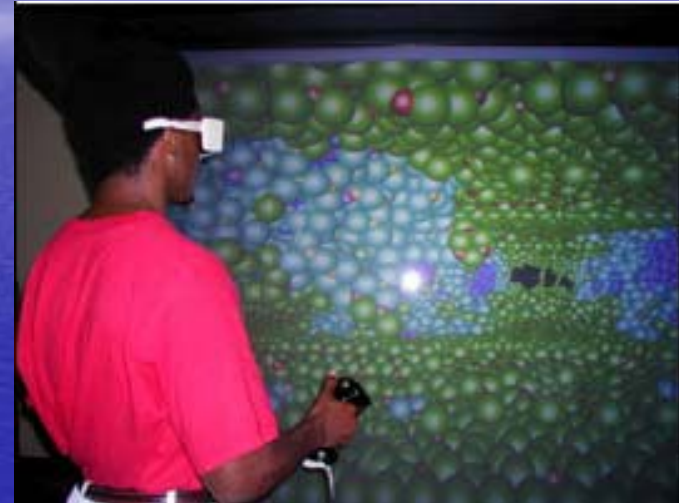
Courtesy of the University of Southern California