

# Haptic Systems

## 530-655

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Lecture 1

9/1/06

# Outline

- Overview of the course
- Human Haptics
- Haptic Systems
- Applications of Haptic Systems

# Course Objectives

- Be able to implement an stable haptic system
- Understand selected topics in haptic rendering and force-feedback teleoperation
- Experience developing a control system
- Understand new research problems in Haptics.

# Administrative Details

- Class time: MTWThF 9.00-10.30
- Class Location: Latrobe 107
- My office: NEB-B26, Room 5
- Contact [mahvash@jhu.edu](mailto:mahvash@jhu.edu), Tel: (410) 516-5477
- Credits 2
- Grading Pass/Fail (No Exam)
- Lab Location: Haptic Exploration Laboratory, Latrobe 200
- References: for each lecture, I give you a list of papers

# Lab Assignments

- Group of two students
- You can select your assignments
- Haptic device: Phantom Omni or a device from your supervisor's lab (you need your supervisor's permission)
- Operating system: MS Windows, Linux, Real-time Linux, RTAI
- Topic: Haptic rendering or Teleoperation
- Contents: Kinematics, Real-time programming, Haptic Simulation and Stability
- You may not use some libraries of your device
- Programming Languages: C, C++

During lecture I explain how to use Phantom Omni under MS Windows.

# Syllabus

## Week1:

Introduction to haptic rendering and force-feedback teleoperation,  
Generate haptic feedback with a manipulator, Real-time programming  
You should be able to program a simple haptic system

## Week2:

Haptic rendering of rigid object, haptic rendering of friction and texture,  
Haptic rendering of deformable bodies, Virtual Fixture

## Week 3:

Stability of haptic systems, Effect of time-discretization on the  
Stability, Methods to stabilize haptic Systems

## Who am I?

2004- Present: Postdoctoral fellow: working on force-feedback teleoperation

2002 – 2004 President RealContact Inc: Working on force-feedback surgical Simulators

Ph.D. McGill University, Canada

Haptic Rendering of Tool contact and Cutting

## Who are you?

Your research interest?

Your background?

Any suggestion?

# What is haptics?

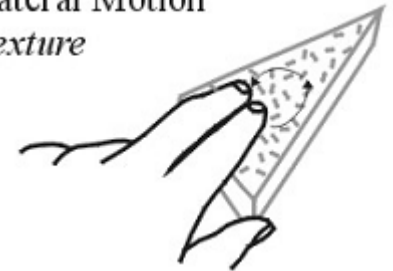
Comes from the Greek *haptesthai*, meaning *to touch*

Tactual sensory information conveyed to the brain:

## 1- Tactile information:

The responses of receptors of the skin  
in contact with an object  
(texture information about an object)

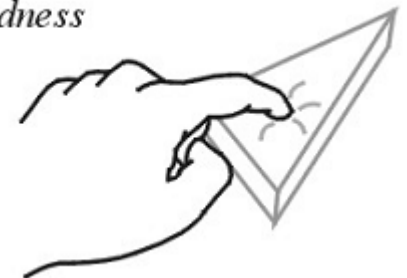
Lateral Motion  
Texture



## 2- Kinesthetic information:

Net forces applied to limbs  
(coarse information about an object)

Pressure  
Hardness



# Haptic Interfaces

## Kinesthetic/Force Displays



SensAble Phantom Omni



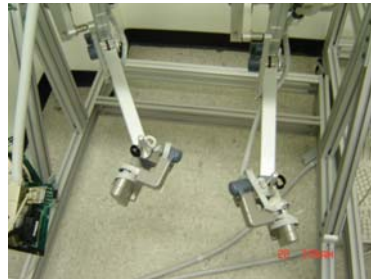
MPB Freedom 6S



Immersion Impulse engine

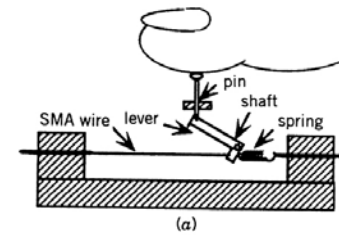


SensAble Phantom

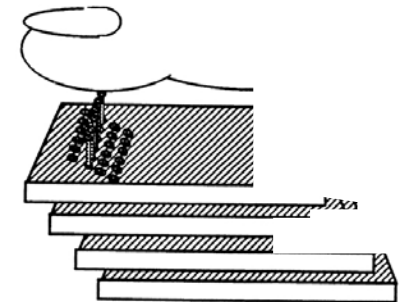


Da Vinci Master, Intuitive Inc.

## Tactile Displays



(a)

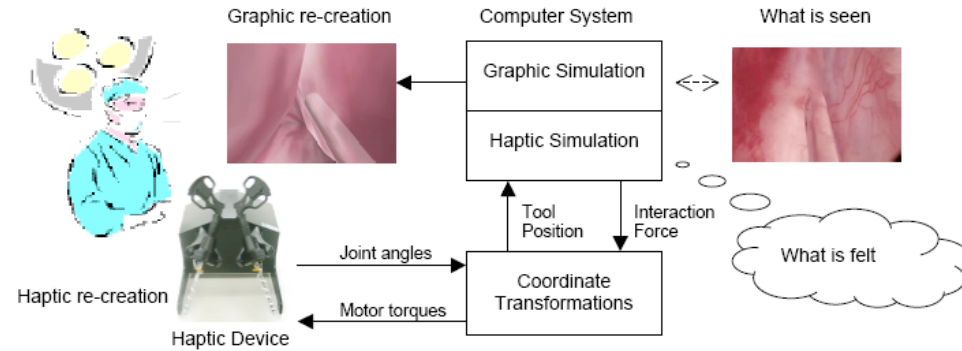


(b)



# Haptic Systems

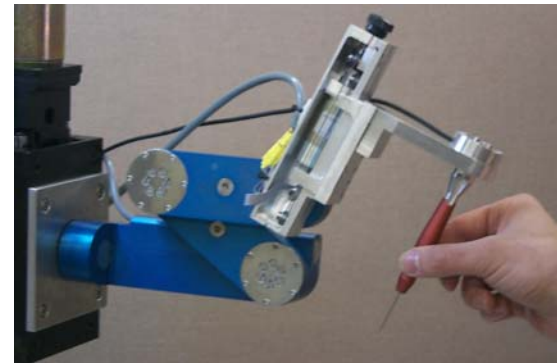
Force-Feedback Virtual Environment:



Force-Feedback Teleoperation:



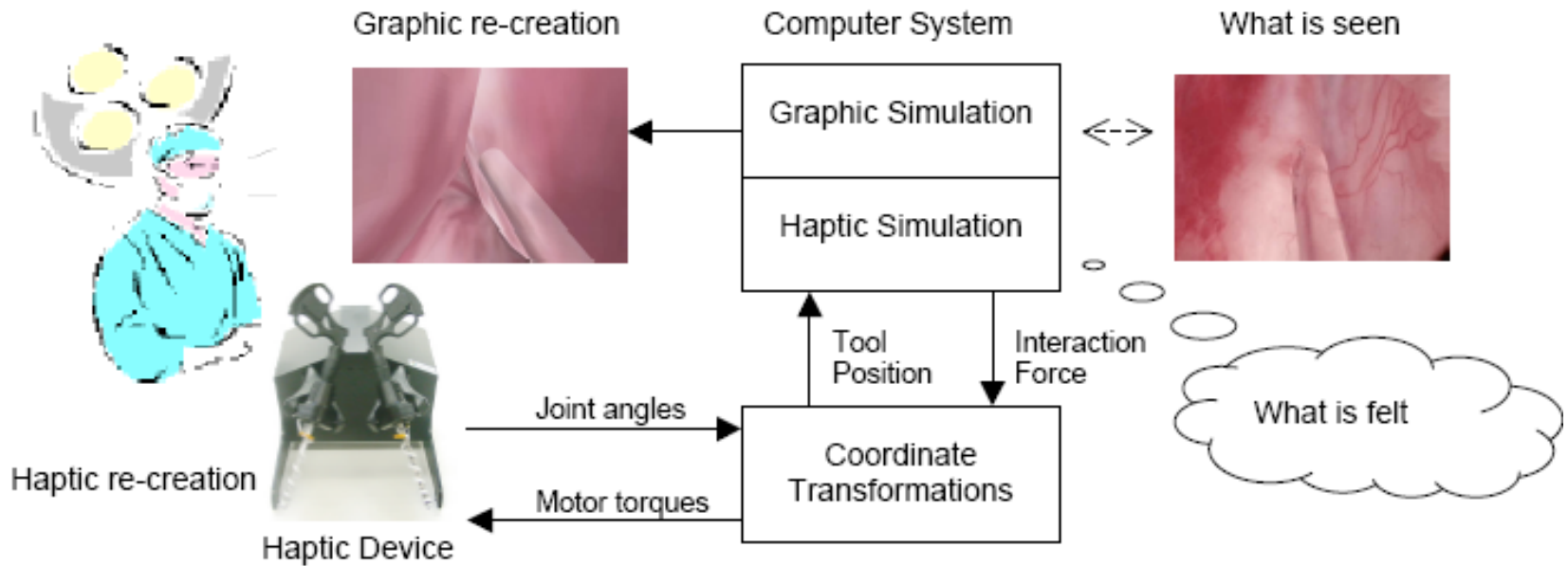
Force-Feedback Cooperative Environment:



# Applications:

- Education and training, surgery training
- Telemanipulation, robot-assisted surgery and telesurgery
- Computer-aided design
- Entertainment, games
- Manufacturing, rapid prototyping
- Displaying scientific data, molecule docking, data mining in geology, display of physical fields
- Arts

# Surgery Training



# Force-Feedback Robot-Assisted Surgery



Da Vinci Surgical System, Intuitive Surgical Inc.



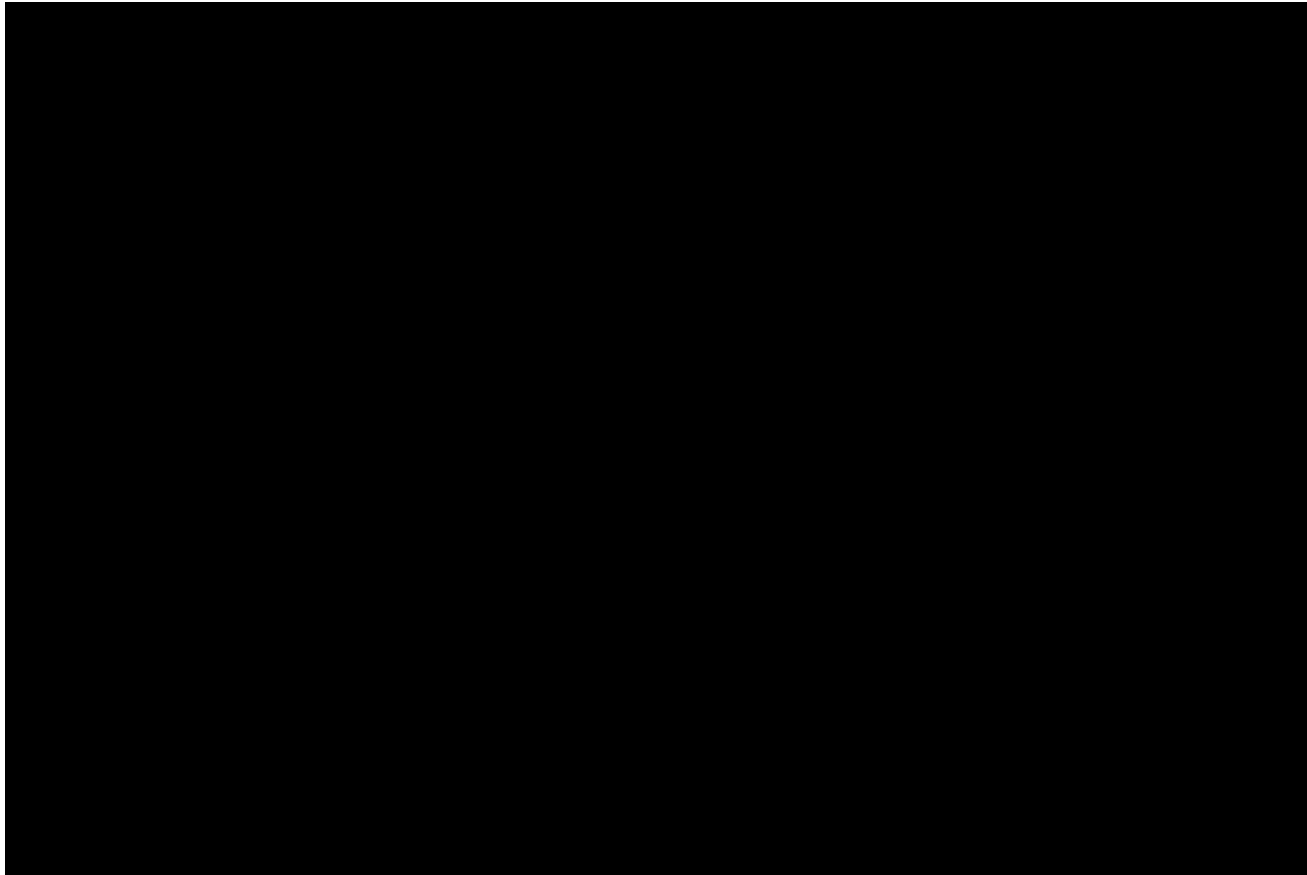
Da Vinci Instruments, Intuitive Surgical Inc.

## Why force Feedback?

Improving clinical outcomes

Example: force feedback knot tying during suturing

# A Video of a Medical Application



➤ [http://www.sensable.com/popup\\_haptic\\_application\\_videos.asp](http://www.sensable.com/popup_haptic_application_videos.asp)

## A Video of an Educational Application

**Solar System Demo**

## A Video of a CAD Application

# Haptics in Manufacturing: Boeing Voxmap PointShell (VPS) Software Library

Voxmap PointShell (VPS)  
is Copyright © 2003  
The Boeing Company

# Tomorrow

How to generate force feedback with a manipulator