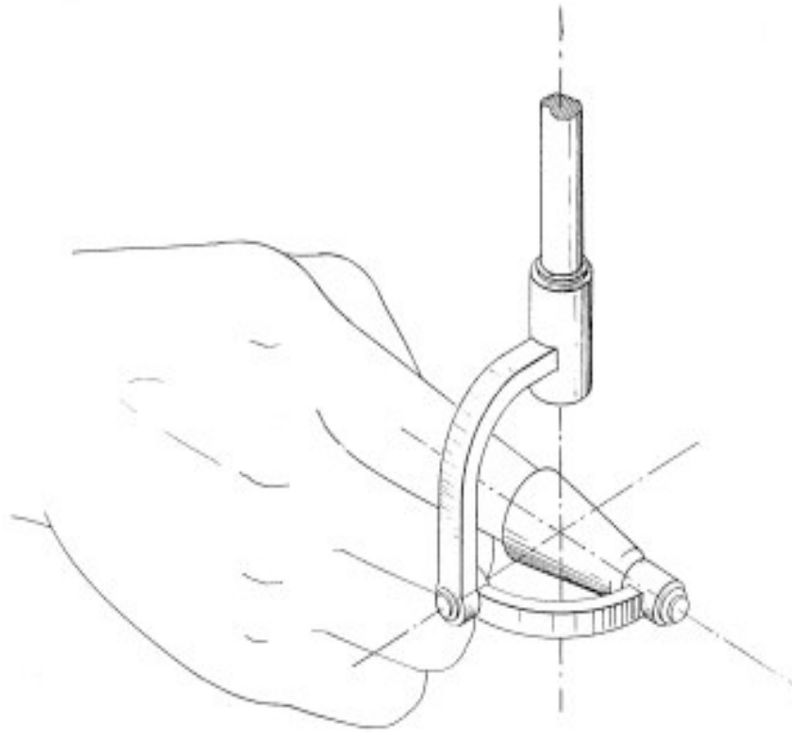
CS277 - Experimental Haptics
Lecture 1

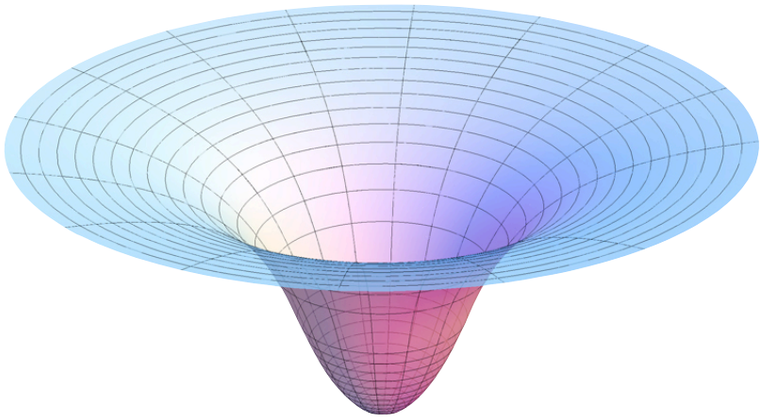
Introduction to Haptics

Haptic Interfaces

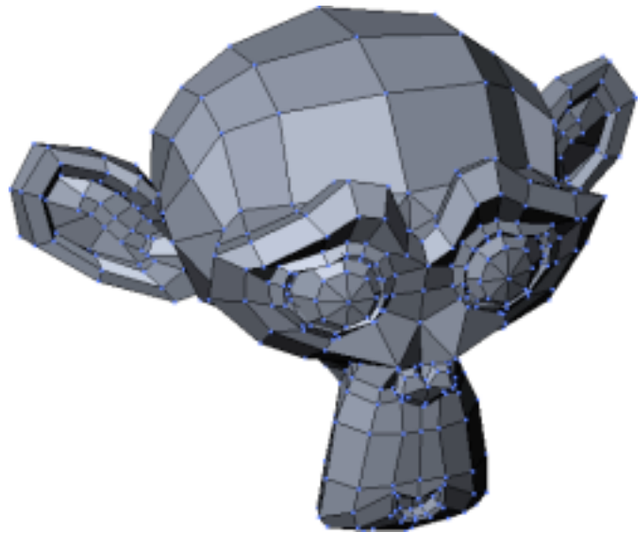


Enables physical interaction with virtual objects

Haptic Rendering

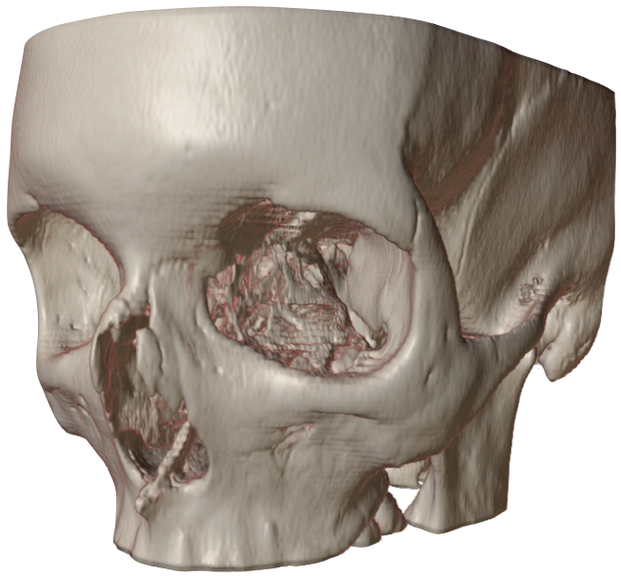


Potential Fields



Polygonal Meshes

Implicit Surfaces



Volumetric Data

Applications

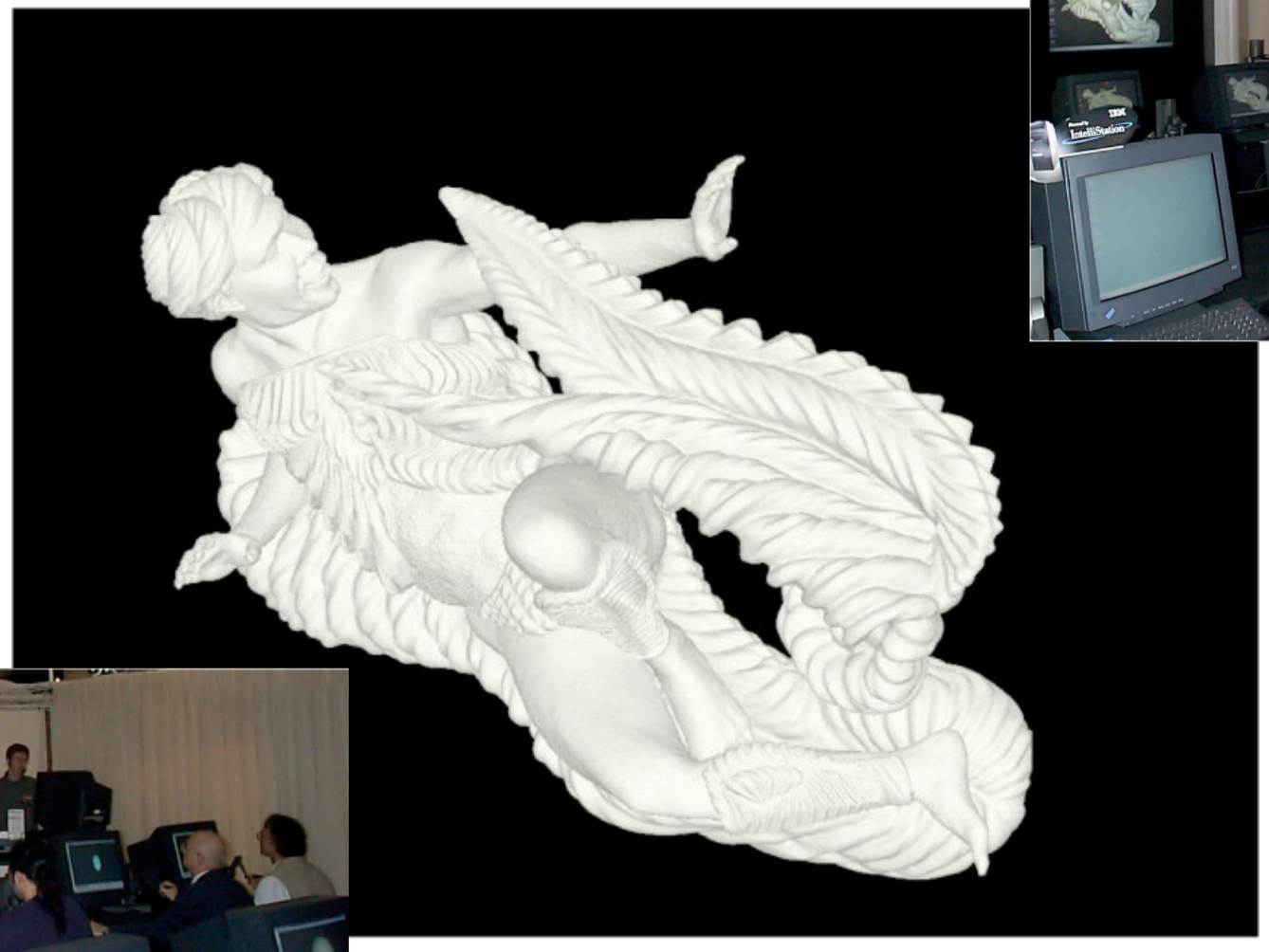
CAD (Geomagic / 3D Systems)

Entertainment (Novint)

Medical (Hansen)

Medical (Philips)

Collaborative Haptics



ACM SIGGRAPH 1999

Today's Outline

- Course objectives
- Organization, policies, logistics
- What is haptics?
- Haptic interfaces, past and present

Course Objectives

- Understand major topics in haptics
- Experience rendering virtual objects using a variety of techniques
- Improve your paper reading and presentation skills
- Have fun!

Course Content

- Haptic interfaces
- Haptic rendering
  - Basic algorithms
  - Collision detection
  - Dynamics simulation
  - Advanced methods
- Human haptics and psychophysics

Administrative Information

- Instructors
  - Ken Salisbury, Sonny Chan, François Conti
- Course Information
  - http://cs277.stanford.edu
  - https://piazza.com/stanford/spring2014/cs277
  - email: cs277-spr1314-staff@lists.stanford.edu

Grading

- Grading breakdown:
  - Programming assignments (4 x 15%)
  - Project proposal / milestone (10%)
  - Final course project (30%)
- Assignments to be completed individually
- Teams of two for final project

Class Enrollment

- ~20 students (as many as we have devices)
- Prerequisites:
  - Object-oriented programming in C++
  - CS148/248 or CS223 recommended
- Information form
  - To determine your level of interest and ability

Programming Assignments

- Four assignments in four weeks...
- And a course project!
- If your interest is in devices and control, please consider ME327 instead.

What is Haptics?

CS277 - Experimental Haptics, Stanford University, Spring 2014

What is Haptics?

- Physical interaction via touch
- Uniquely bi-lateral sensory modality
- Touching and interacting with real, virtual, and remote environments

Why is Haptics Interesting?

- Primal
- Intuitive
- Pervasive
- Expressive
- Unexplored...

Definition

hap•tic (*adjective*) \'hap-tik\

1. relating to or based on the sense of touch
2. characterized by a predilection for the sense of touch « a *haptic* person »

Etymology:

- International Scientific Vocabulary, from Greek *haptesthai* to touch
- First Known Use: ca.1890

[Merriam-Webster online dictionary: http://www.merriam-webster.com/dictionary]

Nomenclature

- haptic: an adjective, as in "a haptic interface"
- haptic interaction: the act of touching objects
- haptics: use as a noun, the study/practice of haptic interaction
- haptically: making use of touch interaction
- haptic interface: device permitting human to have touch interaction with real or virtual environments
- haptisize: bad English :-) but, like sensorize, found
- haptical: yikes, no, no.

Nomenclature

- Human Haptics
  - human touch perception and manipulation
- Machine Haptics
  - concerned with robot arms and hands
- Computer Haptics
  - concerned with computer-mediated haptics

Many Contexts

Human haptics

- every-day manipulation
- tools, controls
- music, art, etc.

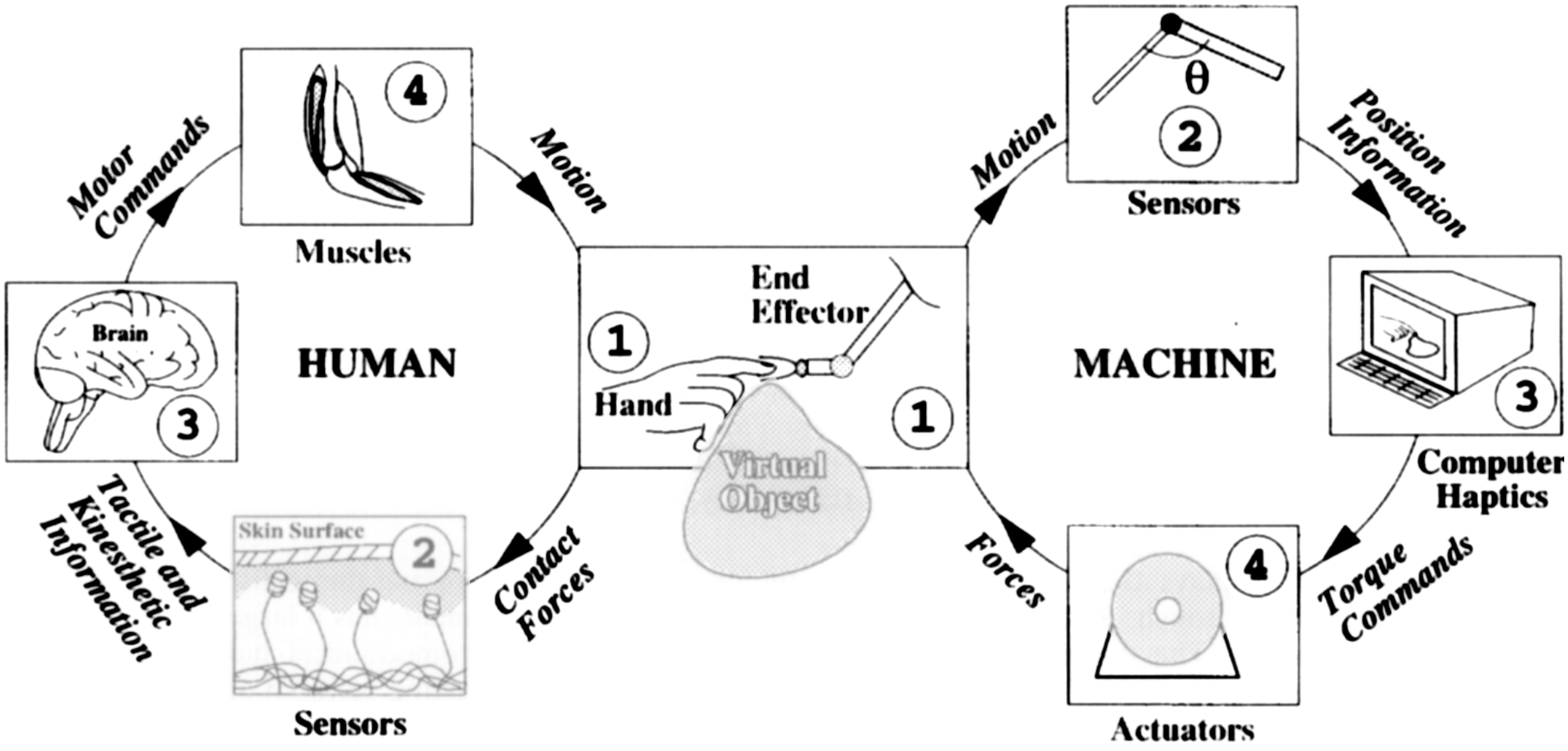
Machine Haptics

- autonomous robots
- remote manipulator systems
- surgical robots, etc.

Computer Haptics

- training
- design
- entertainment

Information & Power Flows



[From M. Srinivasan and C. Basdogan, *Comput. & Graphics* 21(4), 1997.]

Haptic Interfaces

CS277 - Experimental Haptics, Stanford University, Spring 2014

Haptic Devices - Outline

- Haptic stimulation modalities
- Basic device characteristics
- Example devices: passive
- Example devices: active
- What makes a good haptic interface?

Haptic Stimulation

- Force and position
- Tactile
- Vibration
- Thermal
- Electrical

Device Characteristics

- Degrees of freedom: number of joints
- Active/passive: force reflecting or not
- Grounding: grounded vs. exo-skeletal
- Sensing quality: resolution, max, range
- Actuator quality: resolution, max, range
- Bandwidth

Passive Devices

- Grounded
  - Keyboards, knobs
  - Trackballs, mice, pens
  - Joysticks

MicroScribe 3D (Immersion)

Passive Devices

- Exo-skeletal

  - Gloves, etc.

5DT Data Glove

- Hand-held

  - Optical

  - Electromagnetic

  - Accelerometer

Nintento Wiimote

Active Devices

- Grounded, 1-DOF
  - Steering wheels
  - knobs, etc.

Atari Hard Drivin’

Ultimate Per4mer (SC&T)

(IntuiTek)

Active Devices

- Grounded, 2-DOF
  - Pens & mice
  - Joysticks

Pencat/Pro

WingMan Force
(Logitech)

Sidewinder Force
Feedback 2
(Microsoft)

Active Devices

Grounded, 3-DOF

Phantom Premium (SensAble)

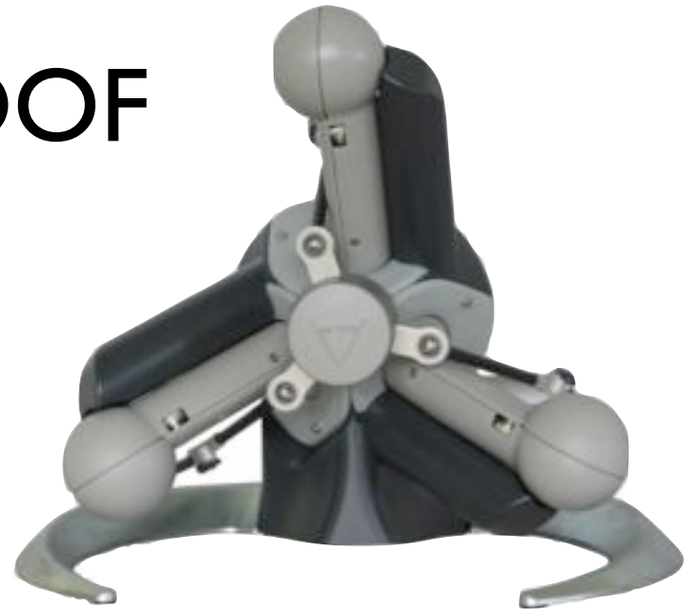
Xitact IHP

Delta (Force Dimension)

Active Devices

Grounded, 6+DOF

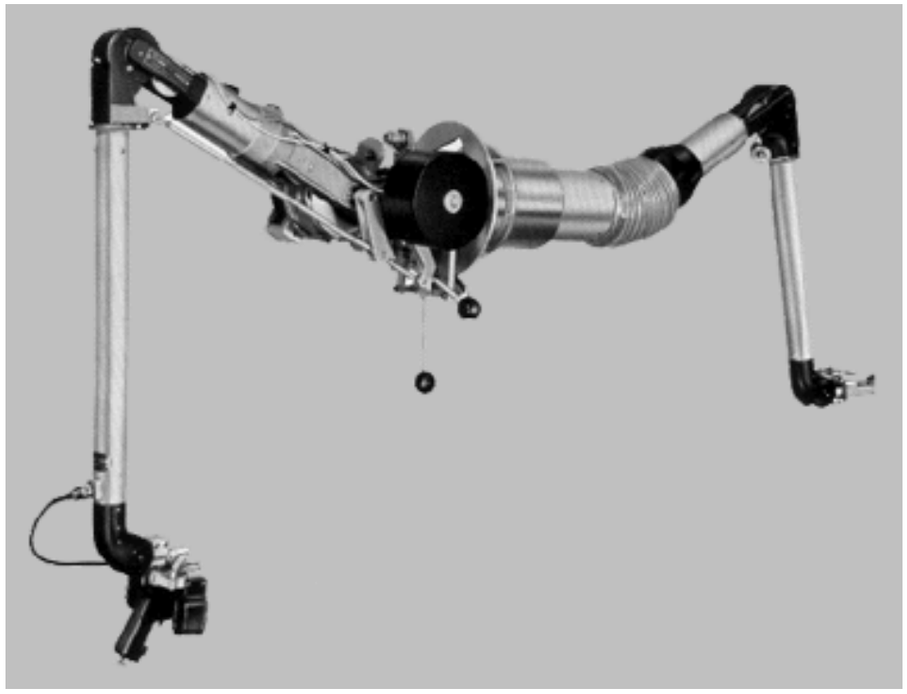
Freedom 6S (MPB)

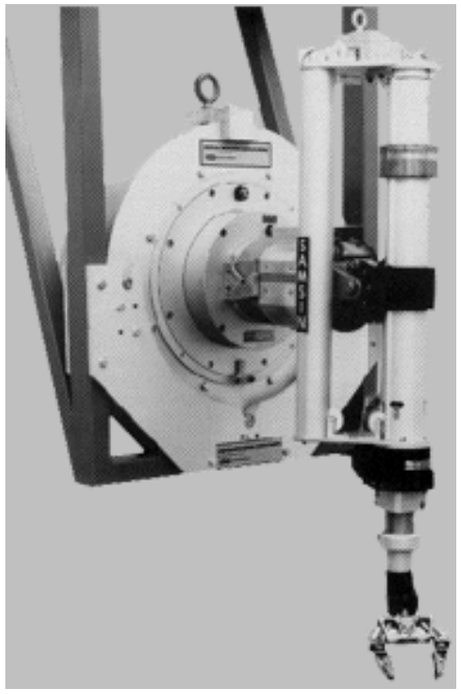


Virtuose (Haption)

Sigma.7 (Force Dimension)

Historically...





CENTRAL RESEARCH LABORATORIES

A DOVER DIVERSIFIED COMPANY

History

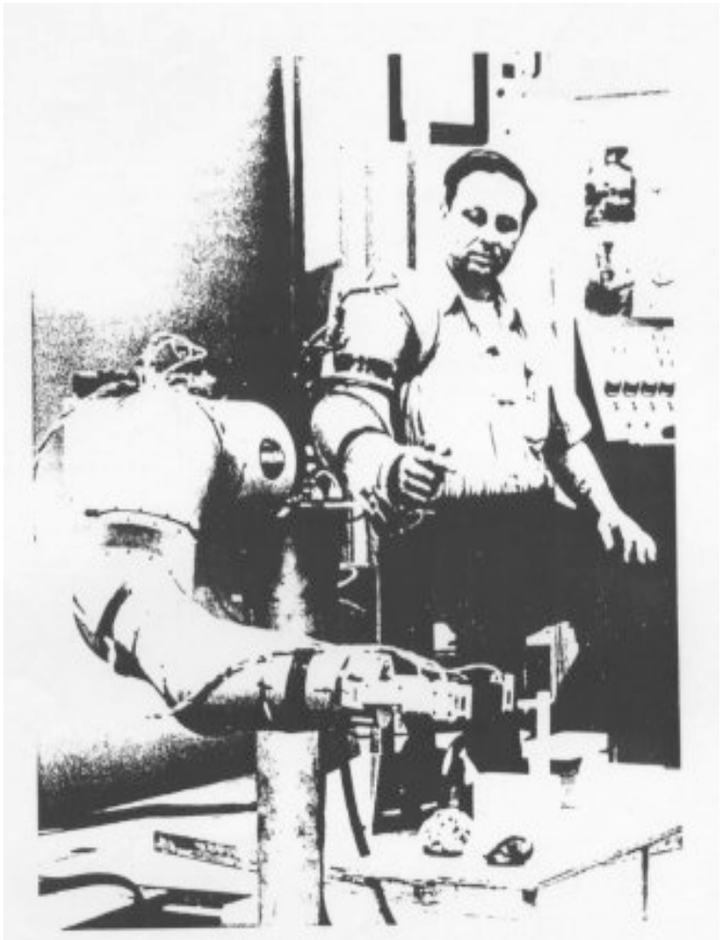
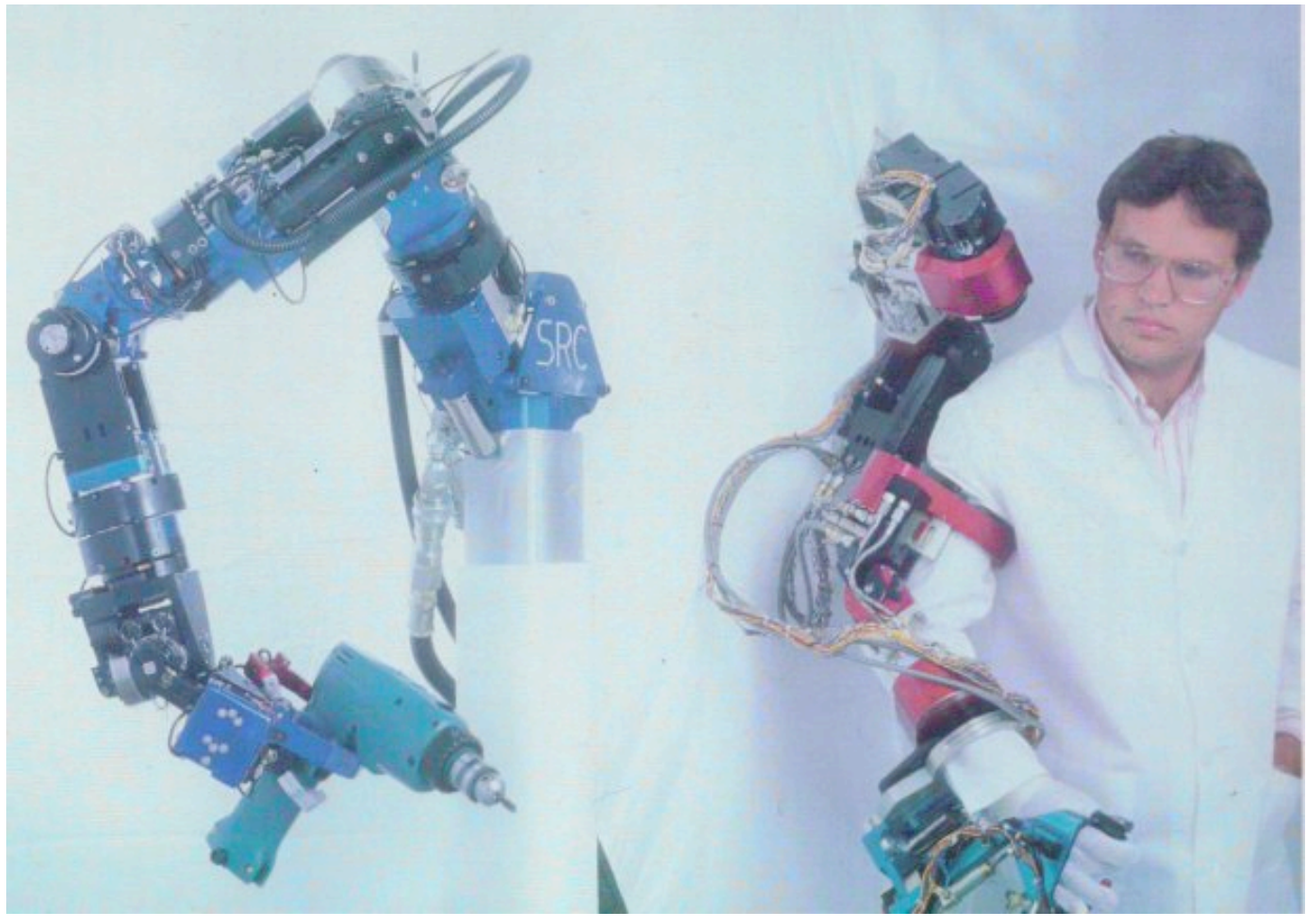


Figure 3-8. Ames Anthropomorphic Exoskeleton Controller and Geometrically Similar Slave [41]



History

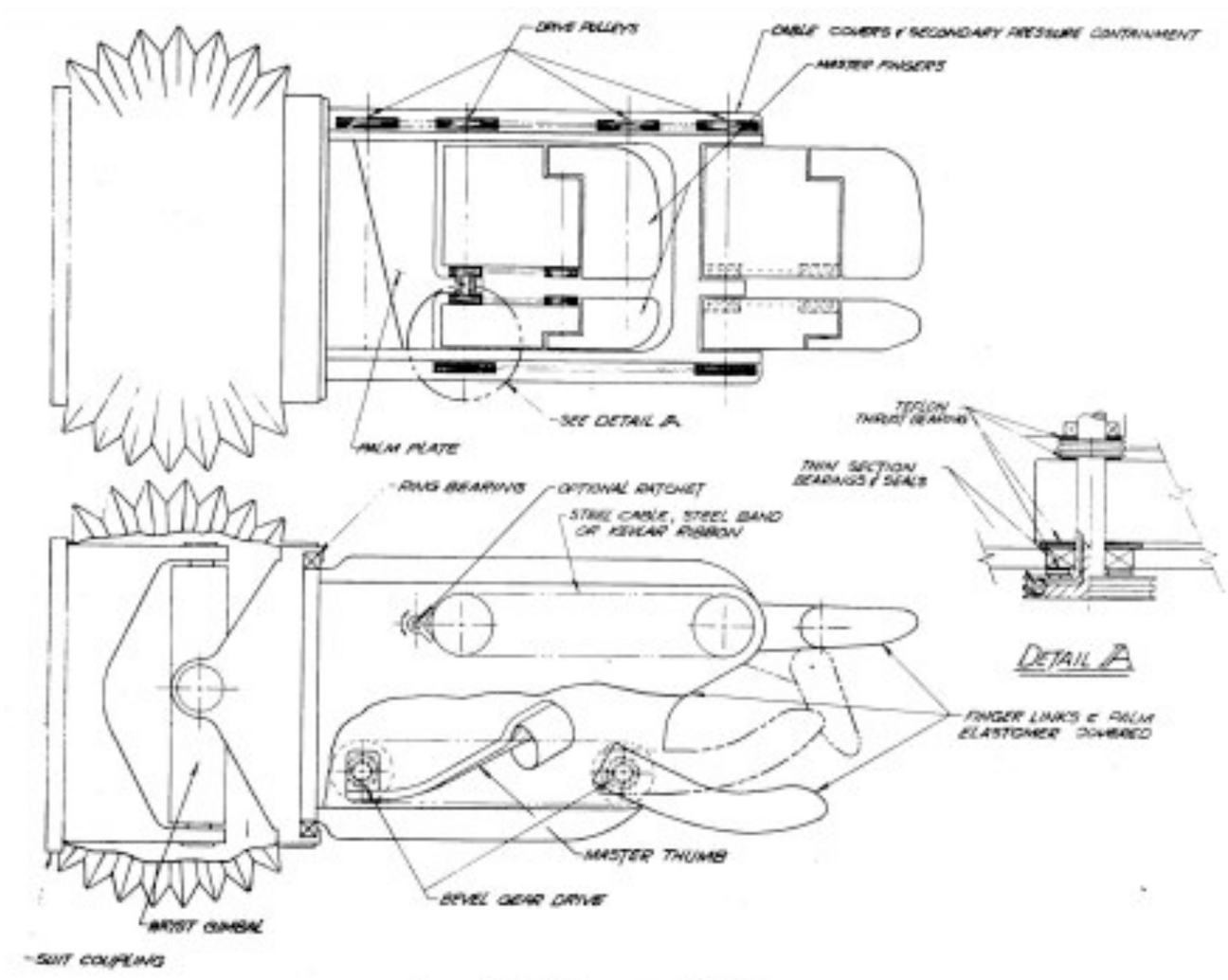
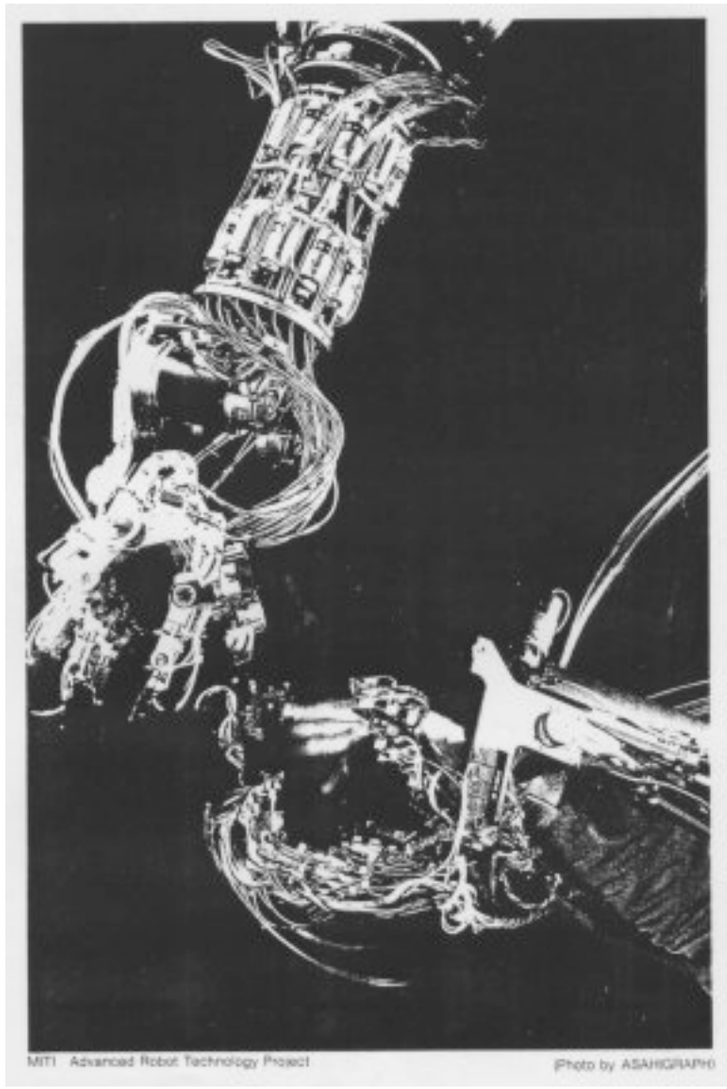
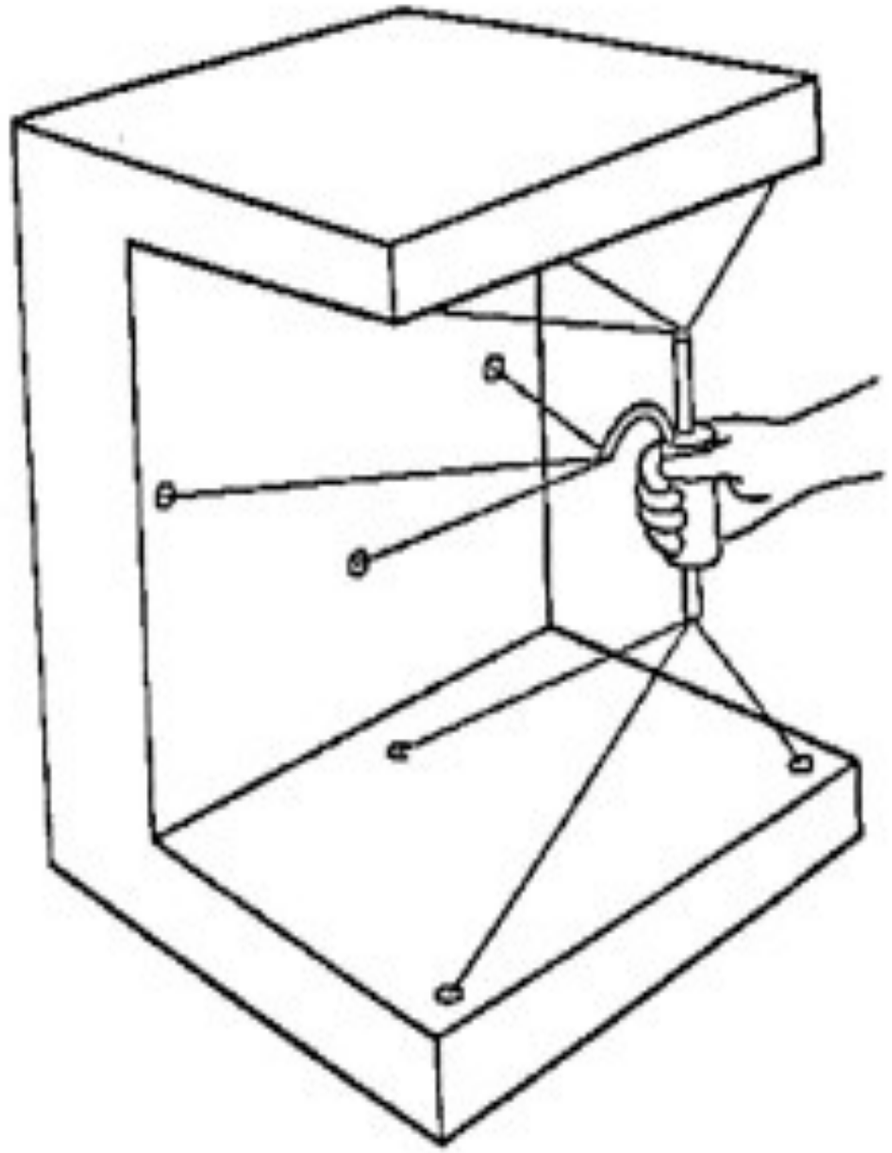
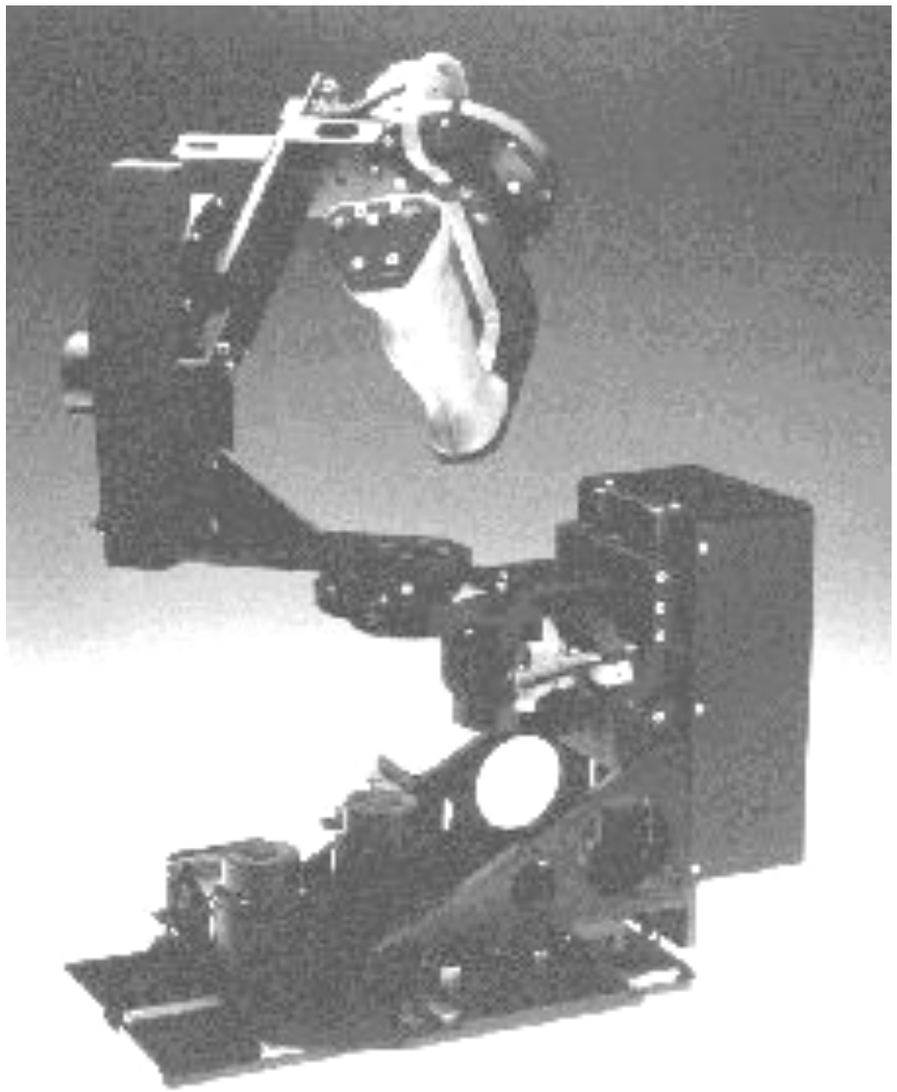


FIGURE 6.7 DISPLACED FINGERS

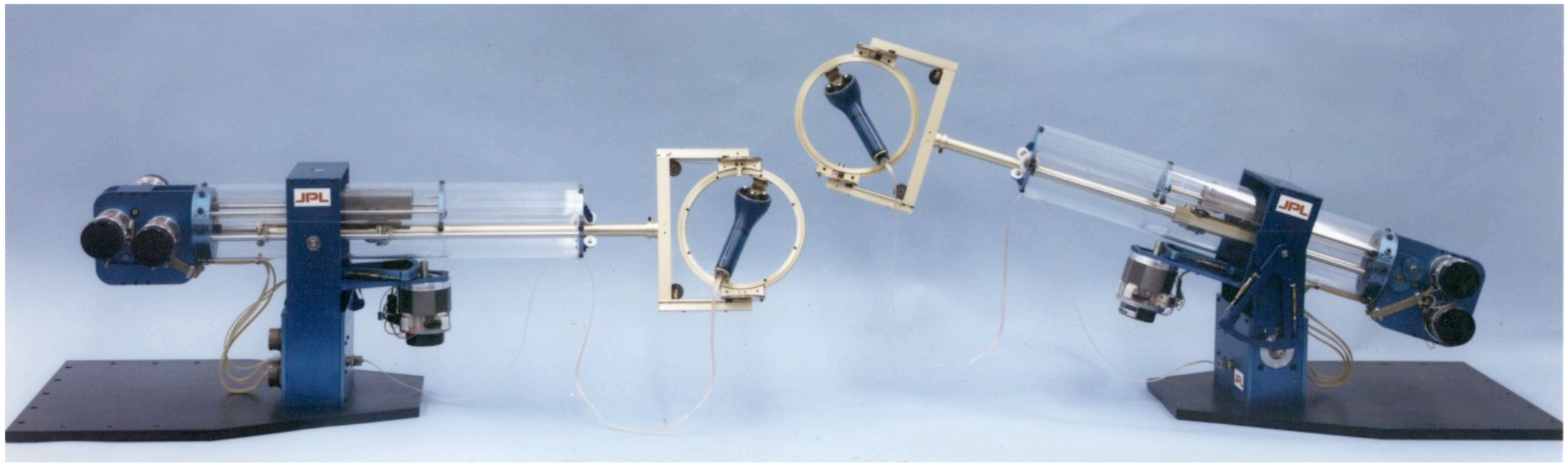


History

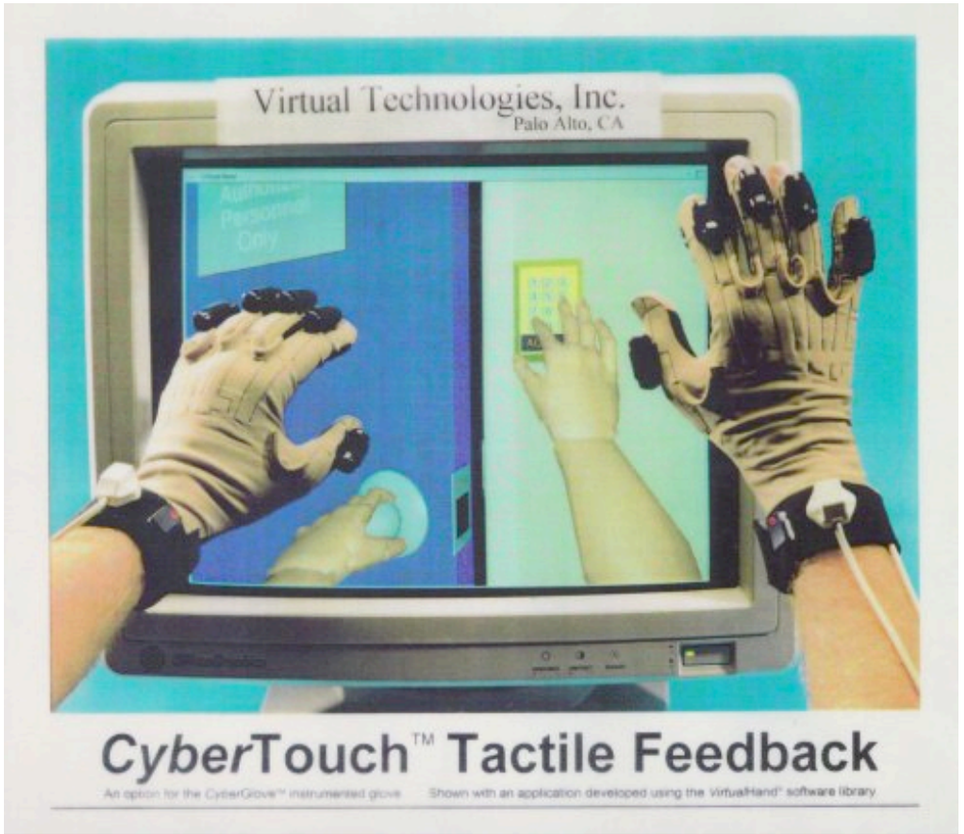


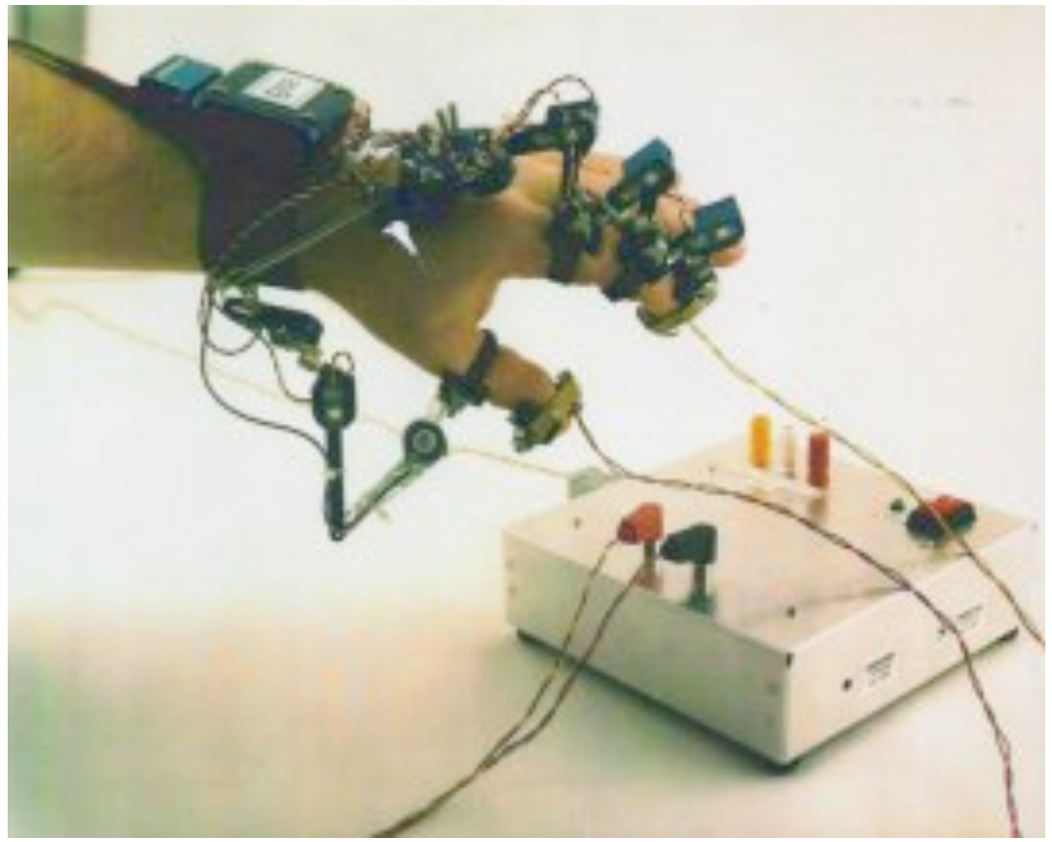


History

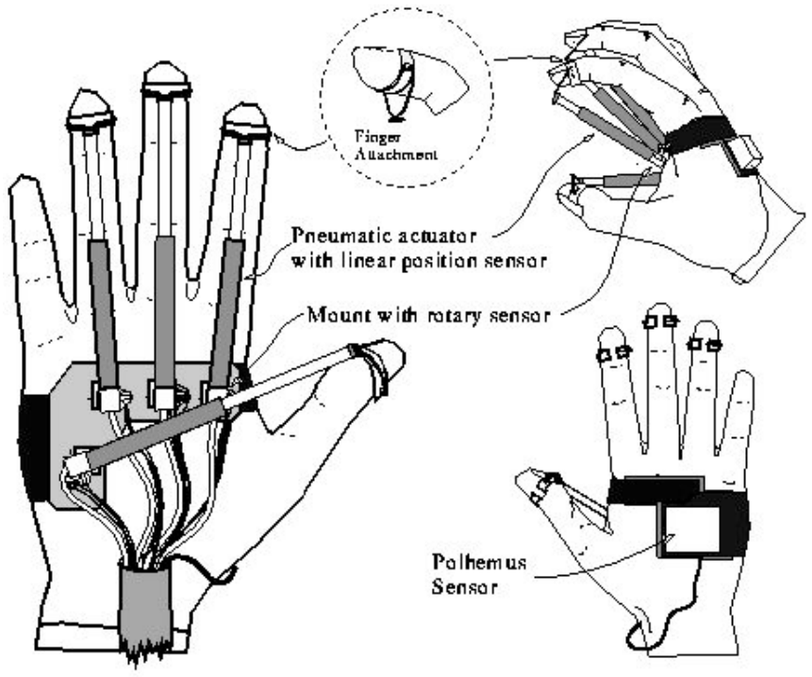


History


Virtual Technologies, Inc.
Palo Alto, CA
CyberTouch™ Tactile Feedback



History


Finger
Attachment
Pneumatic actuator
with linear position sensor
Mount with rotary sensor
Polhemus
Sensor

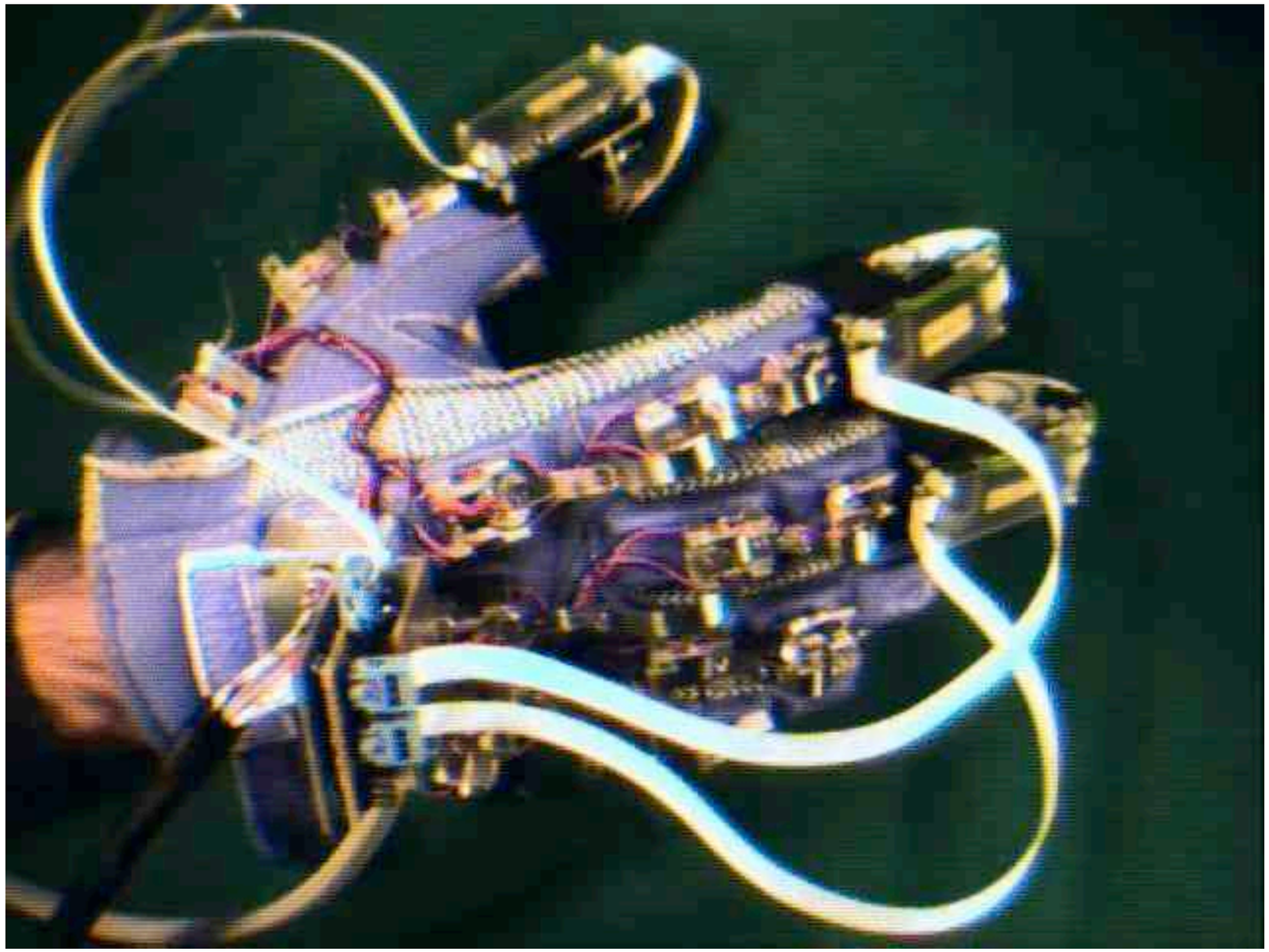

VIRTUAL TECHNOLOGIES INC.

History

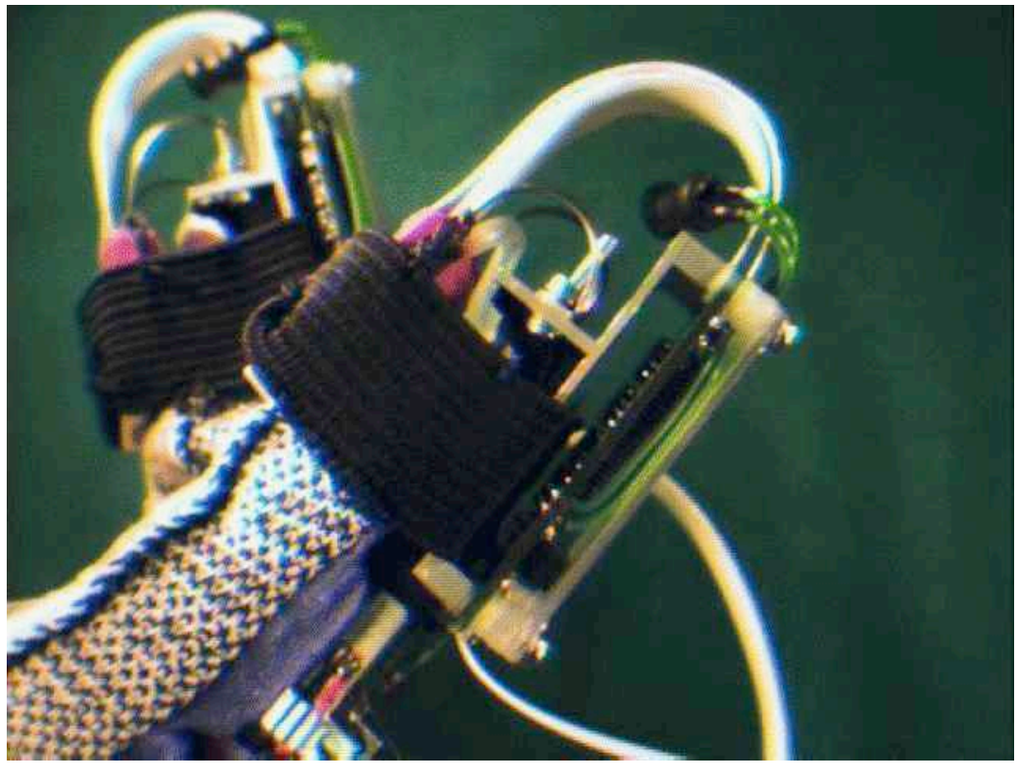
Other Stimulation Modalities

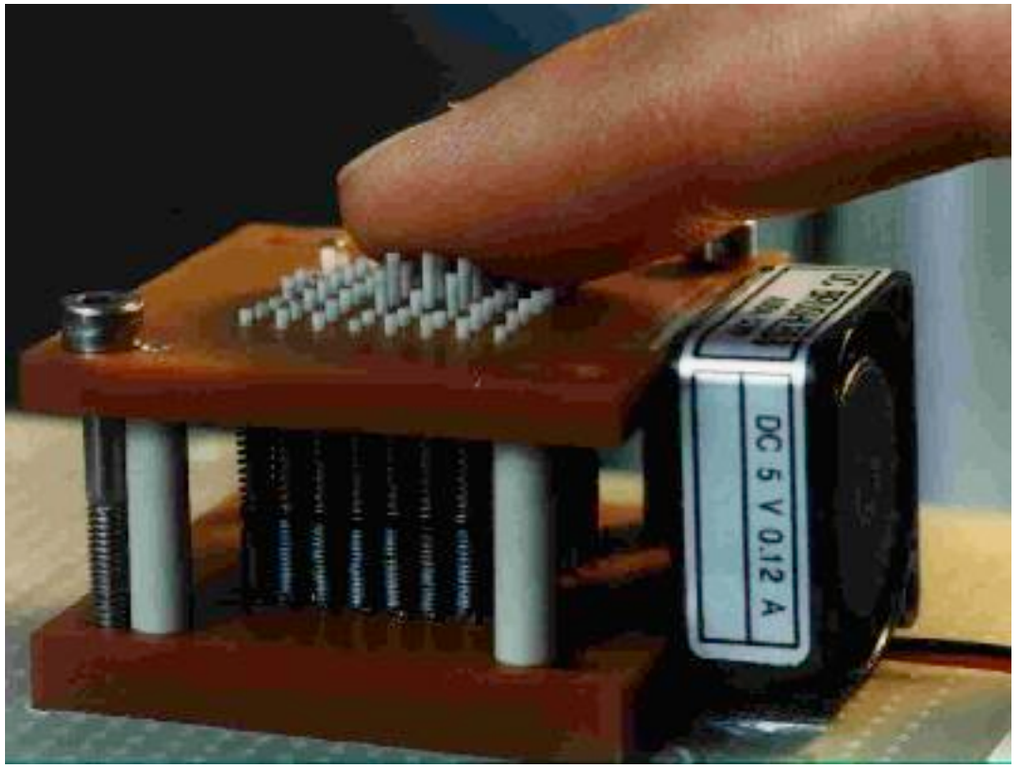
- Vibration and tactile arrays (Howe)
- Thermal stimulation (Ottensmeyer)
- Tactile/thermal glove (Scuola Superiore)
- Electrical (Bach-y-Rita)
- Tangential, haptic flow (Hayward, Bicchi)

Other Modalities



Other Modalities





Don’t Forget! - Survey Form

STUDENT INFORMATION FORM

CS277 - Experimental Haptics
Spring 2013-2014
Stanford University

Name: **Email:**

Background

Department ☐ Comp. Science ☐ Mechanical Eng. ☐ Electrical Eng. ☐ Other: _____

Program ☐ Undergraduate ☐ Masters ☐ Ph.D. Year: _____

Courses taken ☐ cs148 or equiv. ☐ cs248 or equiv. ☐ cs223 or equiv.

Other relevant courses: _____

Experience	**What?**	**Passable**	**Got Skillz**	**1337**
Object-oriented programming in C++	☐	☐	☐	☐
3D graphics programming and OpenGL	☐	☐	☐	☐
Linear algebra and vector geometry	☐	☐	☐	☐
Mechatronic systems design and implementation	☐	☐	☐	☐

Environment

Please describe your preferred software development platform and environment.

Platform ☐ Linux ☐ Mac OS X ☐ Windows ☐ Other: _____

Development tool ☐ Emacs / vi ☐ Xcode ☐ Visual Studio ☐ Other: _____

Motivation

My level of interest and motivation for taking this course is most appropriately described by

☐ I've got all the time and energy for it! ☐ This is my first choice for my major or research.

☐ I'm interested, but have alternatives. ☐ Just curious / mainly course shopping.

In the panel on the right, please describe in brief why you elected to enroll in CS277, and a few things you hope to gain from it.

Notes:

Please indicate if you have access to your own haptic device