

Scooter, 3 wheeled cobot

North Western University

A **cobot** is a robot for direct physical interaction with a human operator, within a shared workspace

PERCRO  
Exoskeleton





## Unicycle cobot

the simplest possible architecture

consists of a single wheel steered by a motor.

able to demonstrate the **two** essential control modes:

"free" mode in which the wheel is steered such as to transparently comply with the user's desired direction of motion

"virtual surface" mode in which the wheel is steered such as to confine the user's motion to a software-defined guiding surface.



## **"Rutgers Ankle" Rehabilitation Interface**

...robotic ankle rehabilitation device designed for at-home use and Internet-based remote monitoring by therapists

...its quantitative remote evaluation capabilities are designed to permit less-frequent visits to the therapist

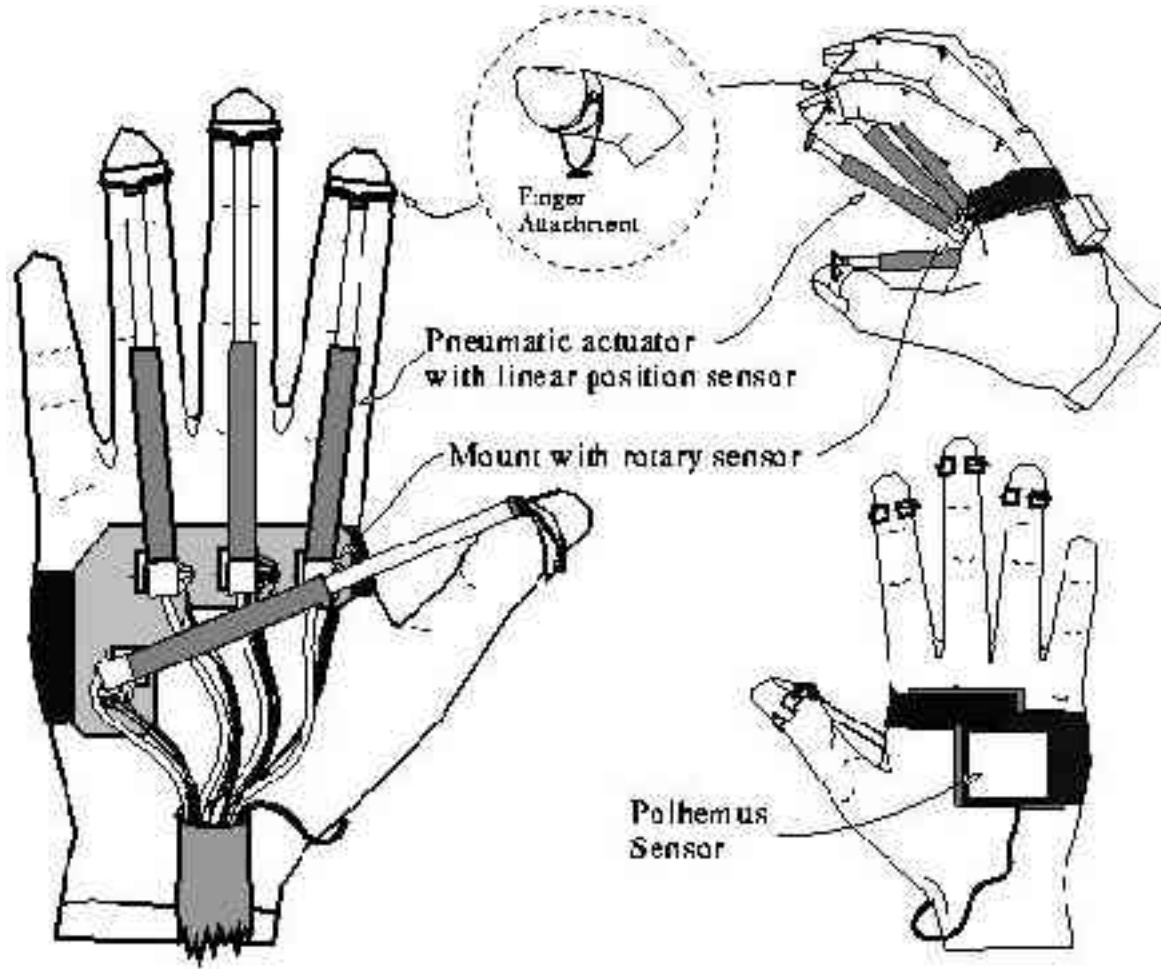
...as a virtual-reality haptic interface, it allows patients to interact with motivating virtual environments as they exercise



...users can steer a virtual airplane with their feet

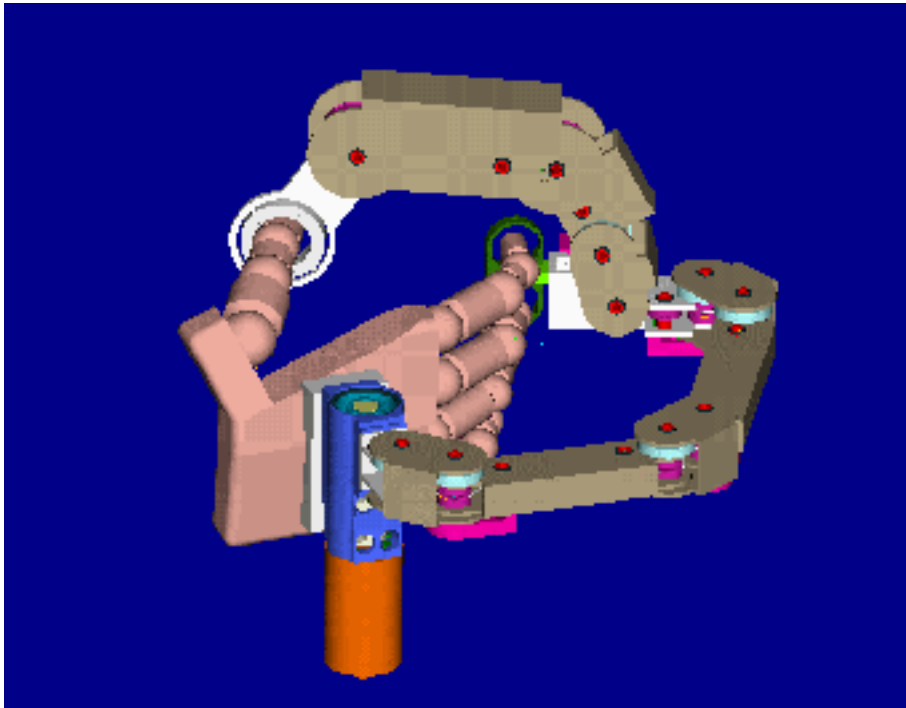
...feeling resistive forces increase with speed

...while users exercise, the system collects force and position data in all of the ankle's degrees of freedom



Rutgers Master 2  
@ Rutgers University

...research on ball games  
and ball deformation



## **CAD model of the pinch HI**

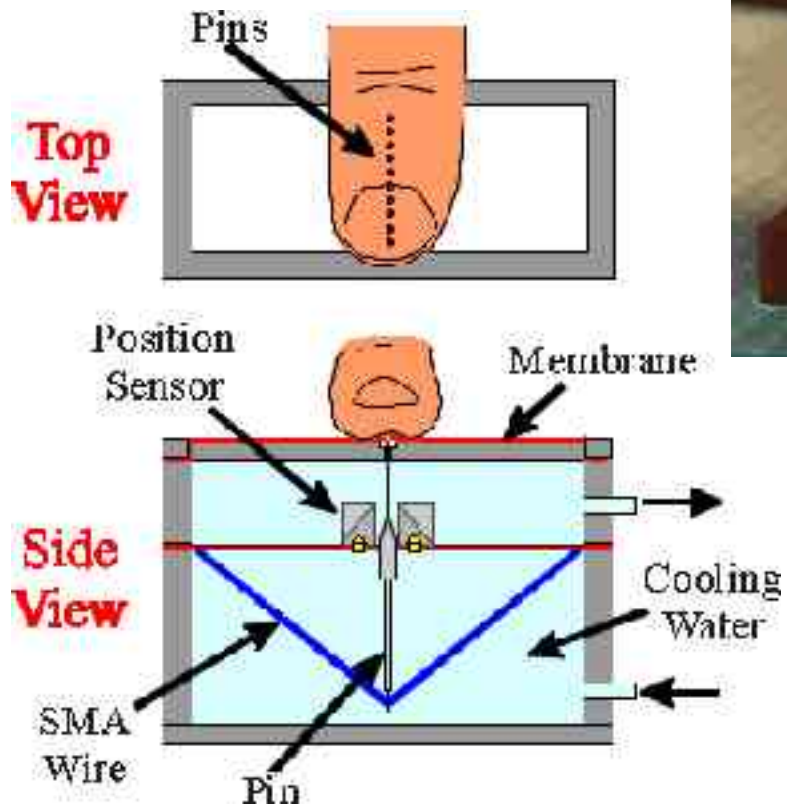
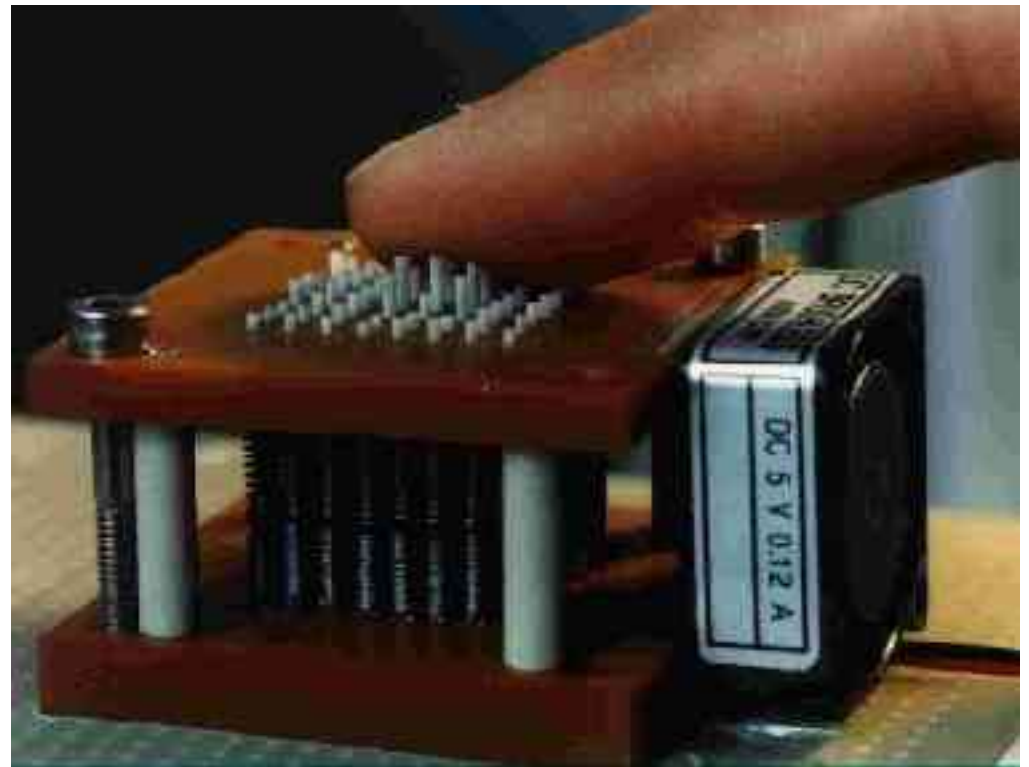
system has been designed  
according to ergonomics and  
functionality requirements

## **The pinch Haptic Interface (HI)**

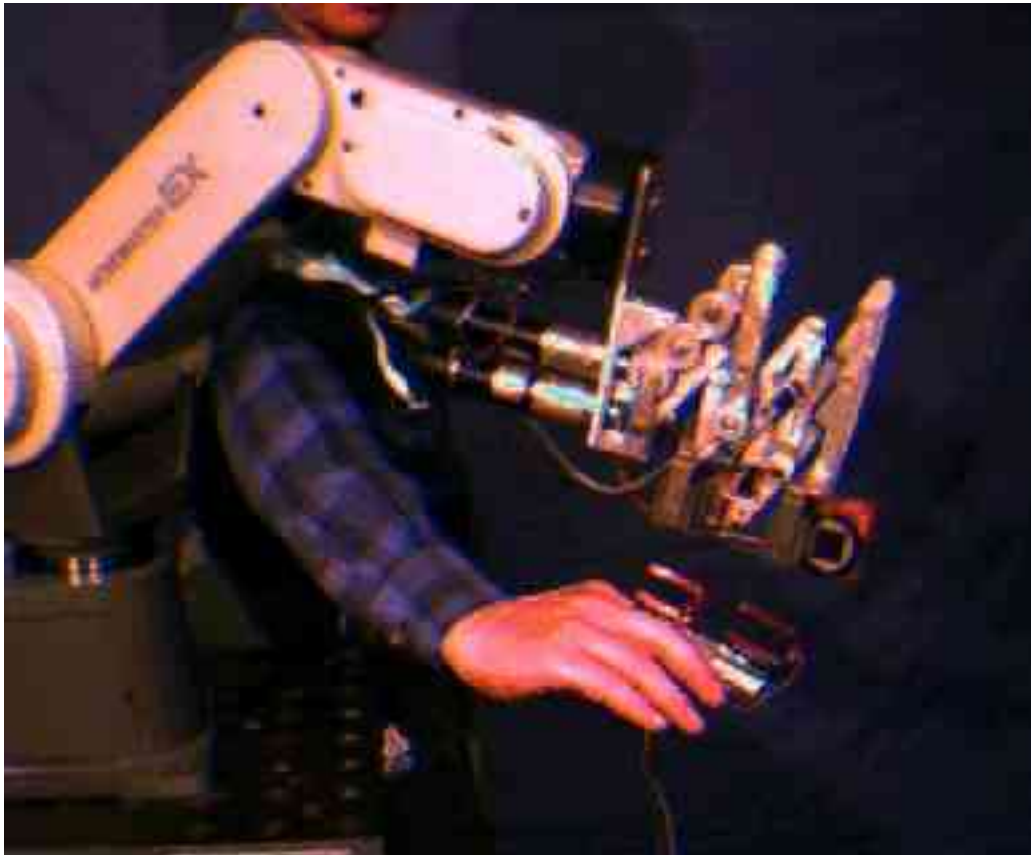
...the pinch Haptic Interface(HI) is a force-feedback device with 5 degree of freedom

...the operator can wear it on the hand fingers (thumb, index and medium)

...the HI can exert a force directed along the joining line of the thumb and index-medium fingertips



Tactile display



## Force Feedback Exoskeleton

### Robotic and Magnetic Interface for VR Force Interactions

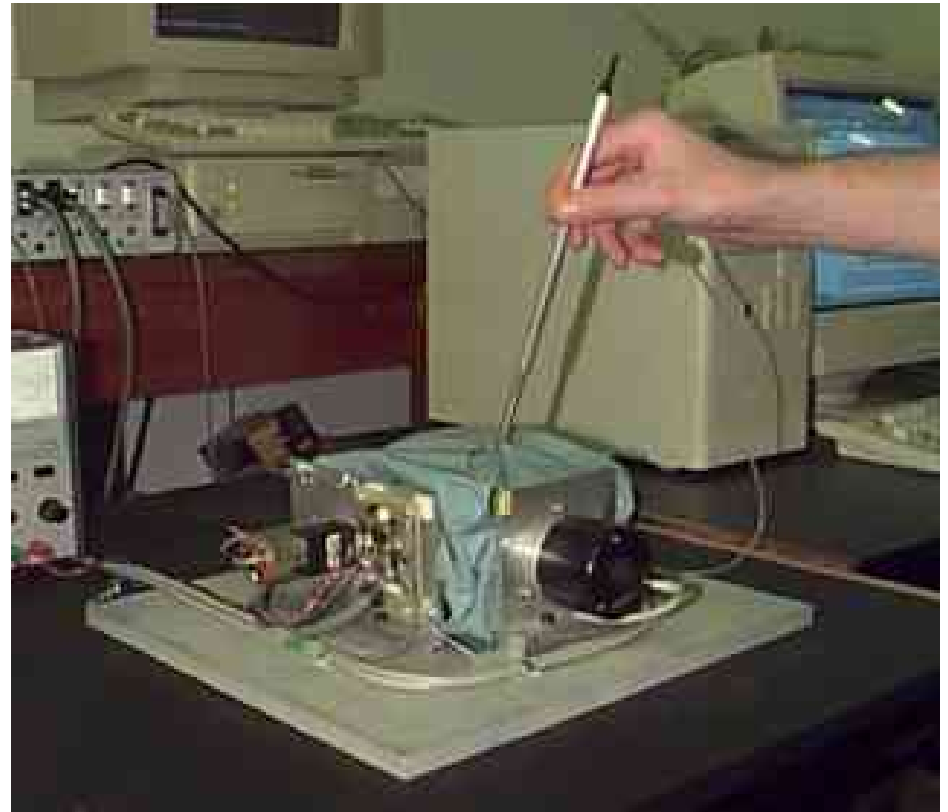
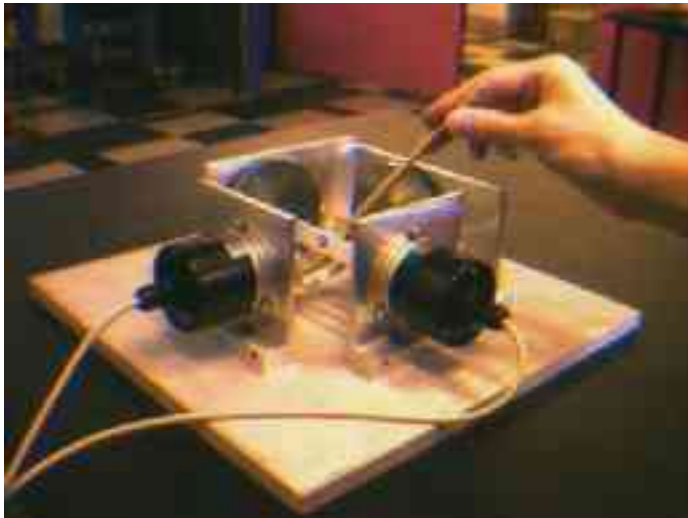
development of a haptic interface system allowing force interactions with computer-generated virtual reality graphical displays

system is based on the application of electromagnetic principles to couple the human hand with a robotic manipulator

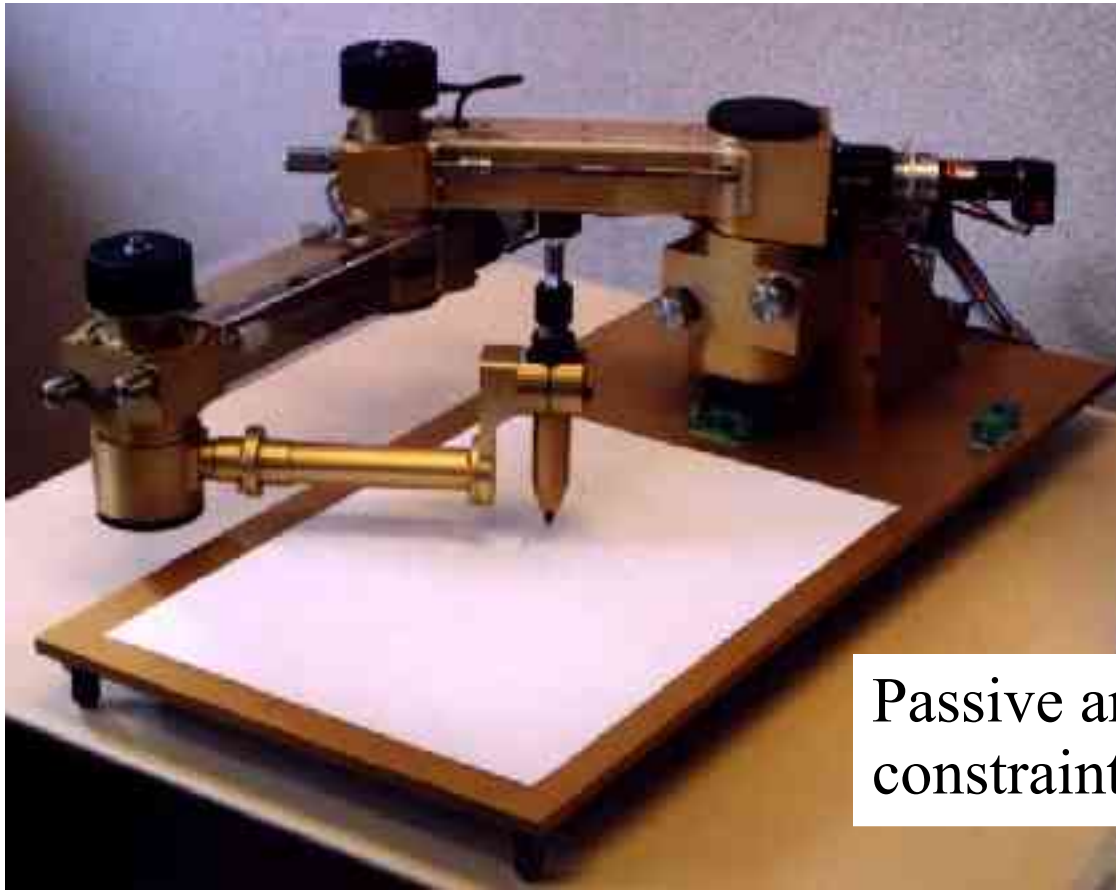
forces are transmitted between the robot exoskeleton and the human **without** using mechanical attachments to the robot

VE for studying real-time interactions

## 2 DOF surgical simulator



...simulation of a knee operation to train surgeons



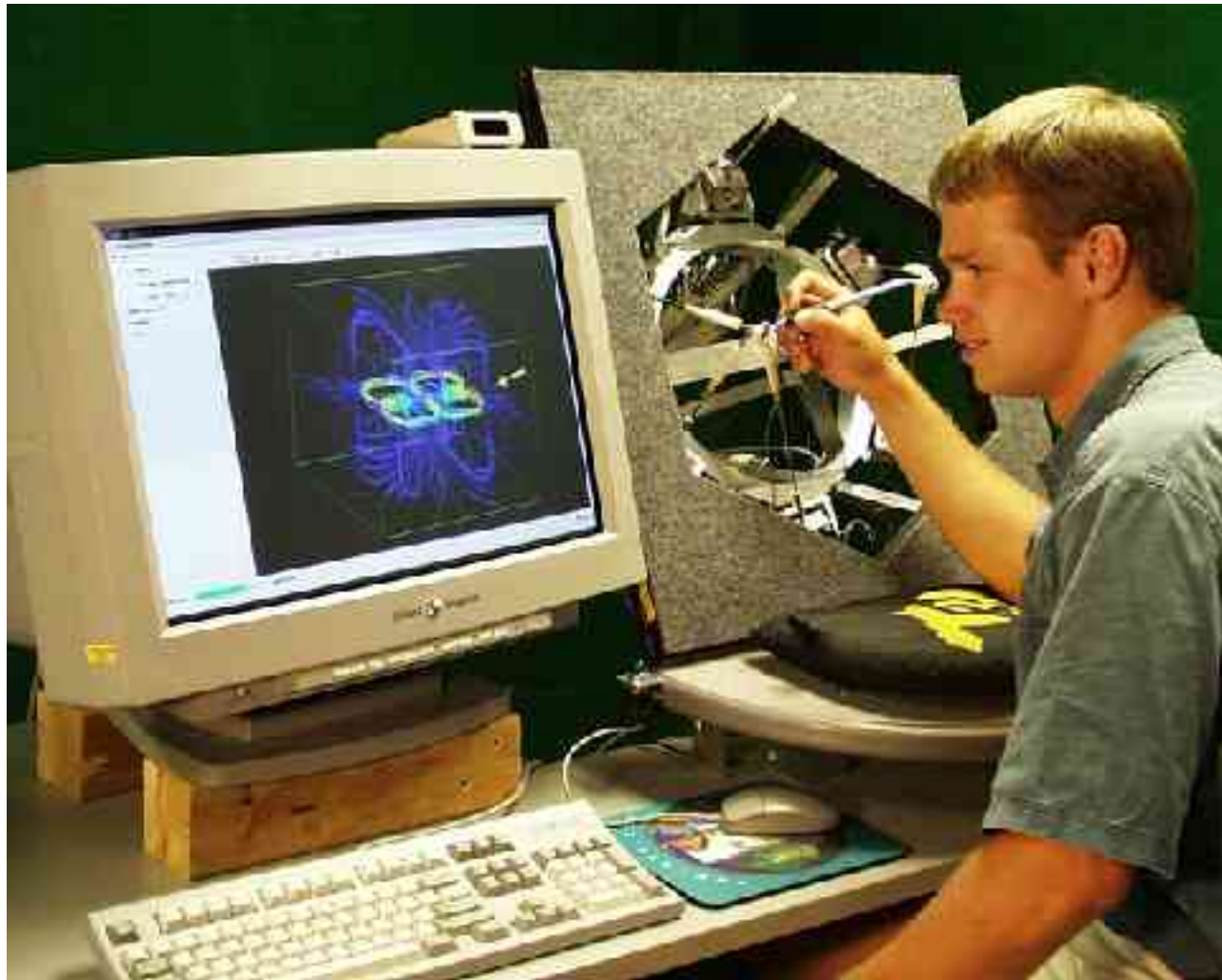
Passive arm with dynamic constraints PADyC

from 3-D image processing, surgical simulation to surgical robots

"passive robot" (that means, the robot itself never moves unless the assistance of surgeons)



**Cybergrasp force**



Five DOF haptic interface

research test bed for exploring data rendering techniques in scientific visualization

user operates the haptic interface by grasping the stylus in a precision (pencil) grip, with the elbow resting on a padded surface

as the user moves the stylus, a yellow arrow (glyph) on the screen moves accordingly

similar to the common mouse and screen pointer, except three degrees of freedom in translation (x,y,z) and two degrees of freedom in orientation (pitch z and yaw y) are provided



three actuator rods connect at the left end of the stylus and two rods connect at the right

grip of the stylus contains buttons for selecting functions during interaction with data

approximately spherical workspace of diameter 0.3 m, determined from rod length, measurements to a resolution of  $7\mu\text{m}$



## Freedom 6S Haptic Device

a six degree of freedom hand controller

which permits an operator to interact either with a real telemanipulator or with objects in a virtual world

operator feels forces in translation and rotation

gives an uncanny sense of "being there"

Teleoperation - for driving a manipulator

Games - For that "touch" sense

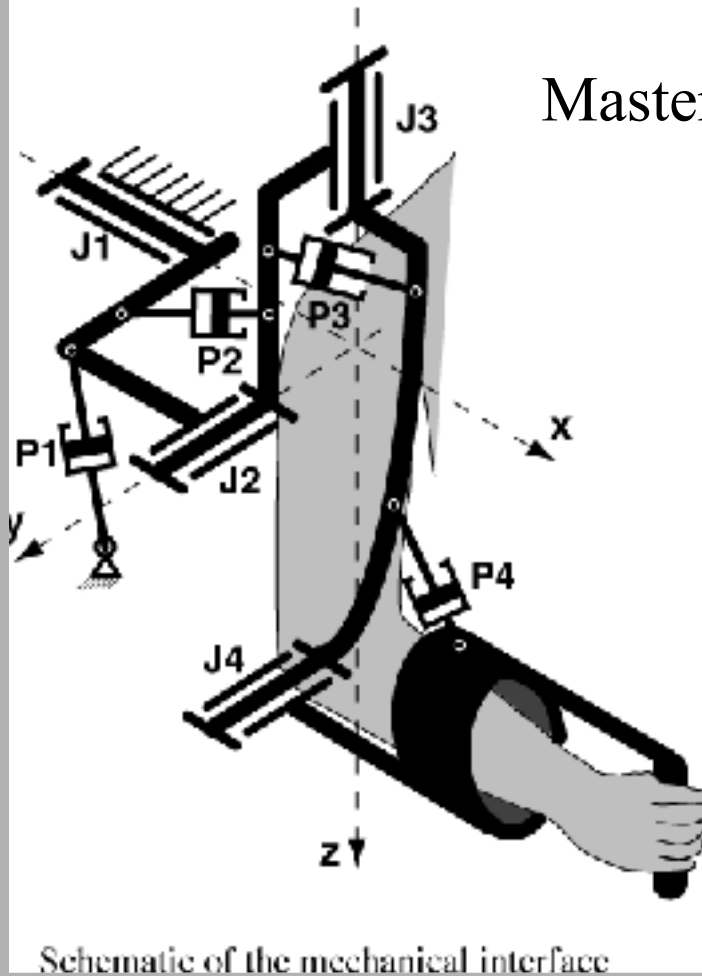
Medical - For surgeons, to wield a virtual scalpel

Animation - For artist, to form and place objects



Pneumatic Haptic Interface

(PHI)



Master arm:

unilateral aluminium manipulator with four revolute joints

tracks the shoulder-elbow motions of the right arm of the human operator

manipulator is fixed at one end to the chair that PHI is mounted on

other end of the manipulator is a handle that is grasped by the operator

Force feedback is realized by actuating the joints of the master manipulator by the pneumatic cylinders (*P1*, *P2*, *P3*, and *P4*)

spherical joint of the shoulder is implemented by three cylindrical joints *J1*, *J2*, and *J3*, with orthogonal axes intersecting at the centre of the shoulder  
 elbow joint is implemented by the cylindrical joint *J4*



Pantograph

...measures position and velocity of a manipulated knob and displays forces in two dimensions



Desktop  
Pantograph



Haptic Master is a Desktop Force Display

...force sensation plays important roles in the recognition of virtual objects

...in this display, users can feel the rigidity or weight of virtual objects with a compact force-feedback device(force display) for desktop use

...a six-degree-of-freedom manipulator employs a parallel mechanism to apply reaction forces to the fingers of the operator

...the manipulator's handle is supported with three sets of pantographs

**IWATA Lab's Haptic Master**



## "GaitMaster"

core elements of the device are two 3 DOF motion-bases mounted on a turntable

walker stands on top of the plate on the motion-base, each motion-base is controlled so that it can trace positions of the foot

turntable traces the orientation of the walker

walker can walk on uneven surfaces

semi-voluntary walking training systems, tele-rehabilitation



High Bandwidth  
Force Display

HBFD

University of  
Washington

2 degree-of-freedom, planar

large workspace and high force output make the device well suited for full arm manipulation in virtual environments



medium-index fingers  
can be moved with any  
degree of freedom with  
respect to the thumb,  
tracked by the pinch HI  
kinematics

HI is equipped with  
one motor only that  
constrains the pinching  
degree of freedom by  
means of a tendon  
transmission

...the pinch HI can be suitably employed in all tasks of virtual assembling with force feedback

...the HI can simulate the feeling of either grasping an object or manipulating it between fingertips.