Virtual Patient/Clinician Platform for Tele-Rehabilitation Application and Case Study

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Outline

- Introduction and Motivation
- Tele-Rehabilitation System
  - Exercise design
  - ACTIVE+: Peer-to-peer streaming platform
- Conclusions, Q&A

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Introduction and Motivation

- Healthcare costs are rising rapidly
- Delivering cost-effective healthcare is becoming increasingly important
- One possible area is home healthcare

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Introduction and Motivation

- Opportunities to deliver certain services online
- Facilitated by a number of technological trends
  - Pervasive availability of broadband connections, i.e., DSL and cable modems
  - Cost-effective hardware
  - Advances in virtual environments
  - More technologically savvy population
- Examples
  - Tele-rehabilitation
  - Training

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Introduction and Motivation

- Our project focus: tele-haptic rehabilitation for stroke patients
  - Patients traditionally receive therapy at neurorehabilitation centers
  - Task performance is observed by therapist

- Collaboration with
  - USC's Annenberg School of Communication
  - USC's Keck School of Medicine
  - USC-UT Consortium on Interdisciplinary Research

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Introduction and Motivation

- Multiple project components
  - Tele-haptic, virtual environment
  - Design of exercise tasks
  - Audio conferencing application

- Use of haptic devices such as the PHANToM

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System Features

- Therapy program of games and exercises
- ACTIVE+ streaming platform (Audio/video, RichText Data etc.)
- Local human-machine dialog system for intake and survey applications
- Online transcription and archiving of audio in mediated interactions with human therapist
- Real-time therapist viewing and monitoring of multiple patients as they perform their exercises
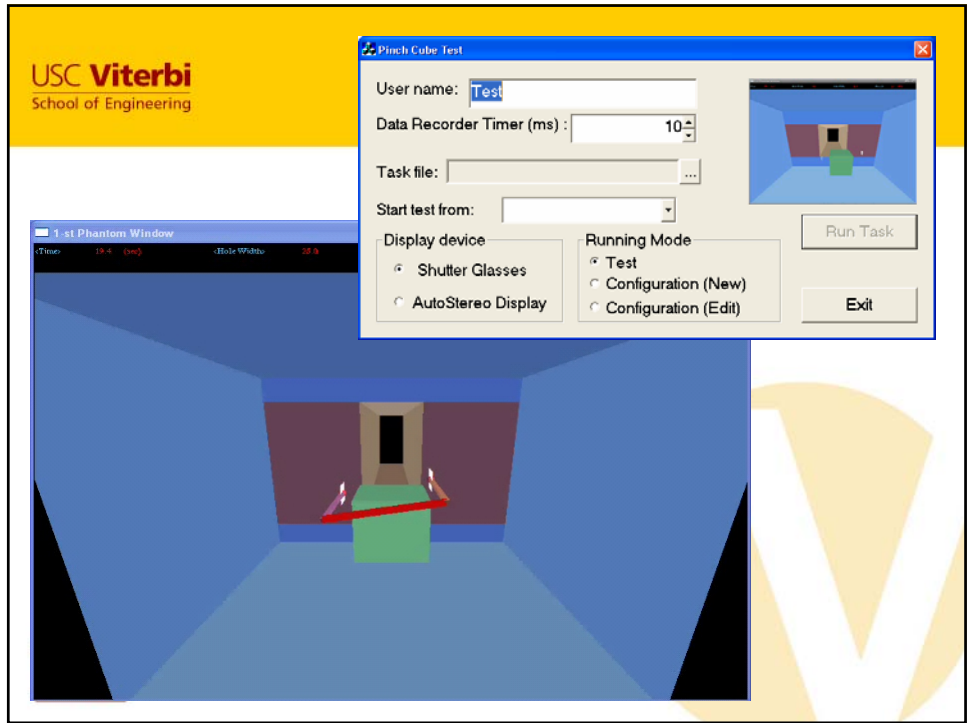- Hand-over-hand guidance of the patient by the therapist

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Exercise Tasks

Virtual rehabilitation exercises with the PHANToM:

(a). The 'Space Tube' exercise.   *(b)*. The 'Ball Array' exercise.

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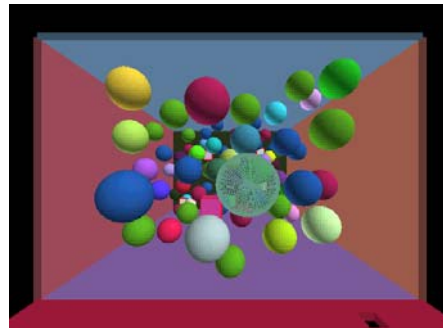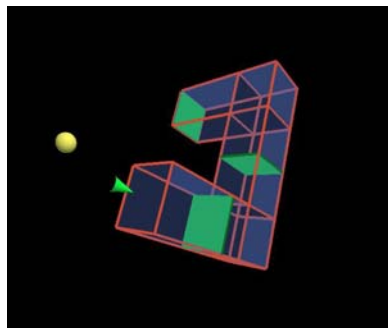
ACTIVE+ – P2P Streaming

- **Motivation:**
  - Current distance communication infrastructure allows excellent delivery of multimedia streams from **therapists** to **patients**.

  - Channel from **patients** to **therapists** only via face-to-face communication (e.g., site visits) or telephone (one-to-one).

  - Participatory learning can be enhanced through interactive communication among **patients** and between **patients** and **therapists**.

  There is a need for a collaborative, interactive tool that supports group voice communication.
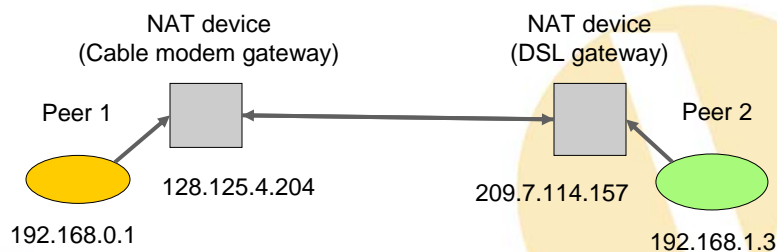
ACTIVE+: Design Challenges (1)
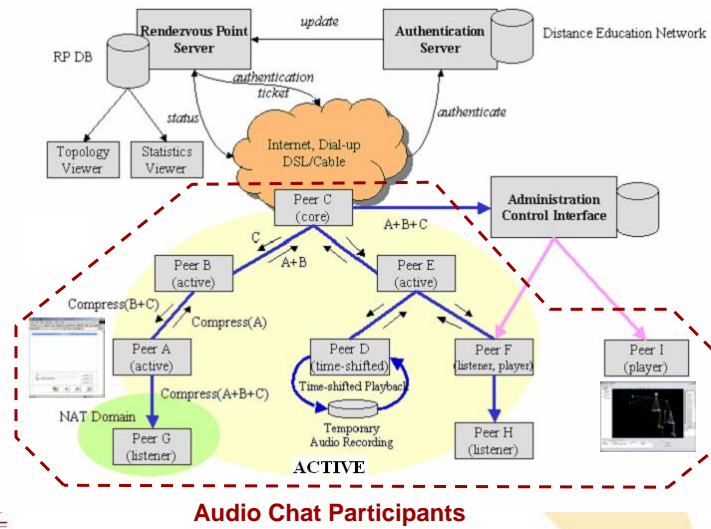
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- Dynamic environment
  - Nodes join and leave unpredictably
- Heterogeneous networks
  - Cable modems, DSL, FTTH
  - Packet loss on IP networks
  - Network Address Translation (NAT)
- Latency: Processing delay in each node is up to 50 ms
  - Latency for voice transfer should be less than 250-300 ms
  - A path within the p2p tree structure with many intermediate nodes presents a problem

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ACTIVE+: Design Challenges (2)

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- "NATmare" (© Nan Chen, Atrica)
  - Many peers use network address translation
  - Peers cannot directly connect (without gateway re-configuration)

NAT device
(Cable modem gateway)

NAT device
(DSL gateway)

Peer 1

Peer 2

128.125.4.204

209.7.114.157

192.168.0.1

192.168.1.3

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ACTIVE+ Architecture

Audio Chat Participants

Case study

We conducted a preliminary trial of our ACTIVE+ prototype starting in 2005

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Summay

- Tele-haptic rehabilitation system for remote therapy
- Real-time peer-to-peer communication platform introduced
  – Low cost
  – Low latency
- Platform currently supports audio and virtual enviroments, but will support generic streams in the future
- Future support for wireless communication

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Thank You!   Questions ?

DMRL Lab Website   IMSC Website

http://dmrl.usc.edu   http://imsc.usc.edu

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