Open Standards for 3D Immersive Virtual Exercise Environments

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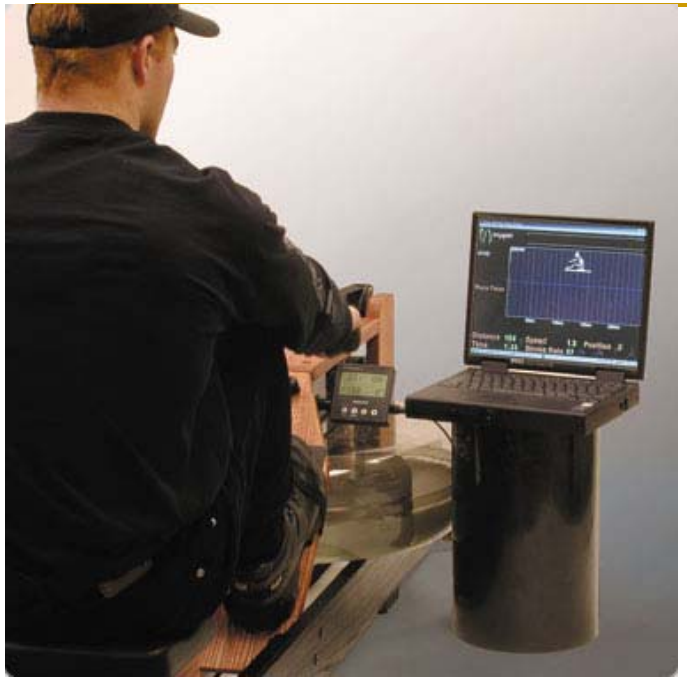


Past

Future

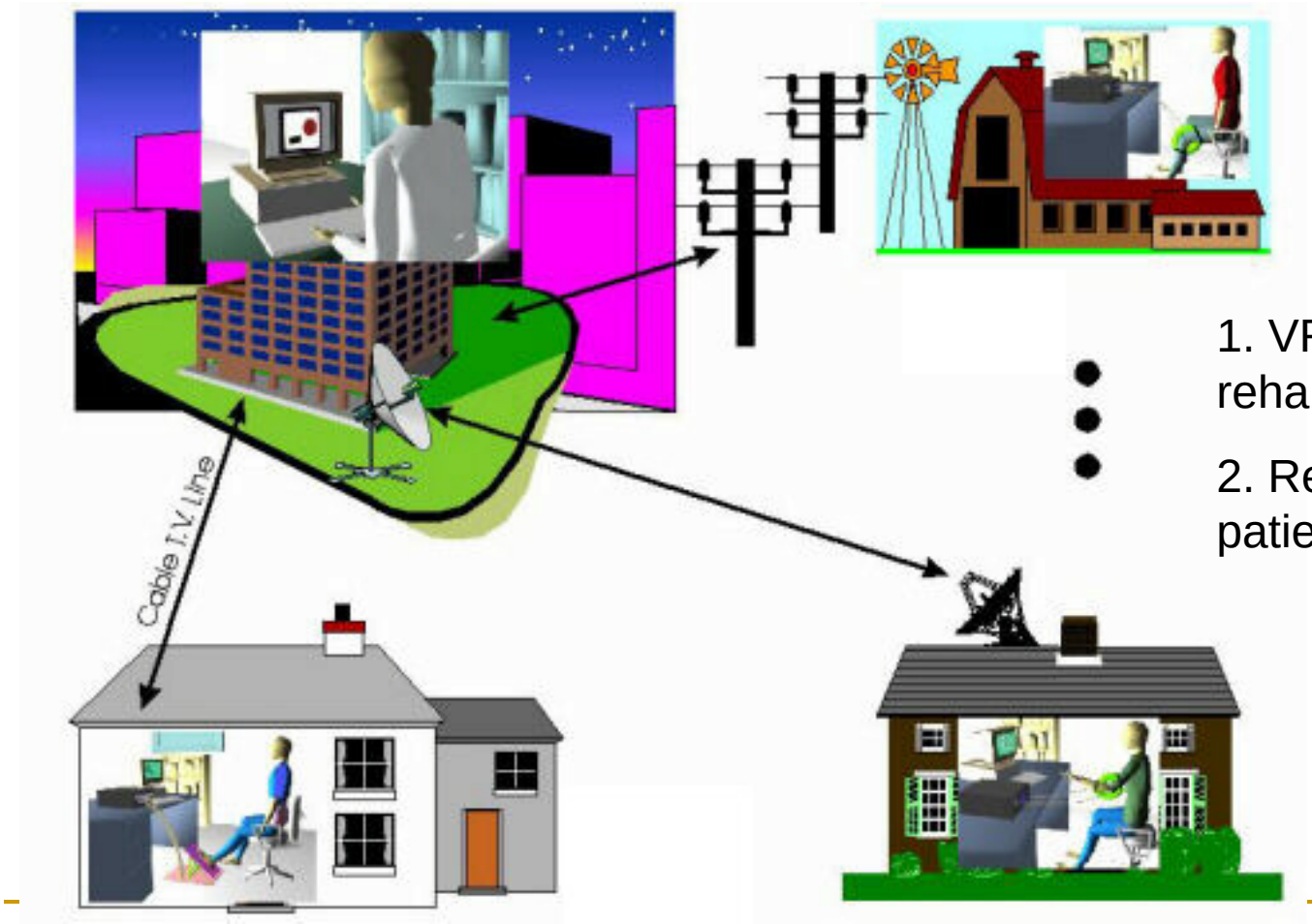
3D Immersive

Outline

- Non Immersive Virtual Exercise Environments
- Immersive Virtual Exercise Environments
- Proprietary Virtual Exercise Environments
- Open Standards for Immersive Virtual Exercise Environments

Non Immersive Virtual Exercise Environments

Virtual Reality (VR)-Based Exercise Program for Stroke Telerehabilitation



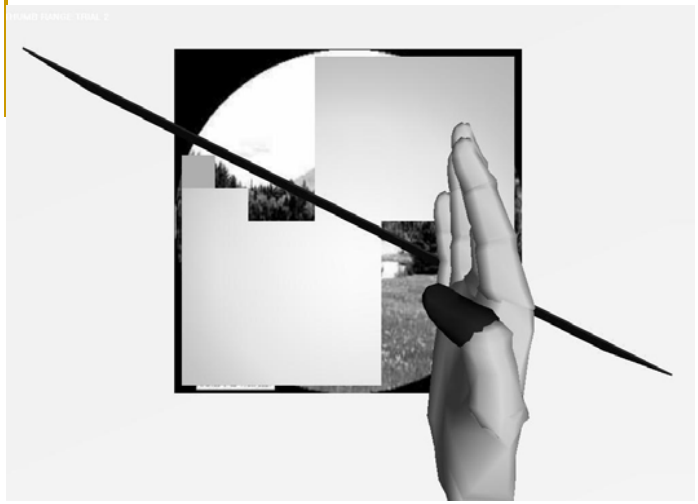
Rutgers/NJIT

1. VR haptic based rehabilitation at home

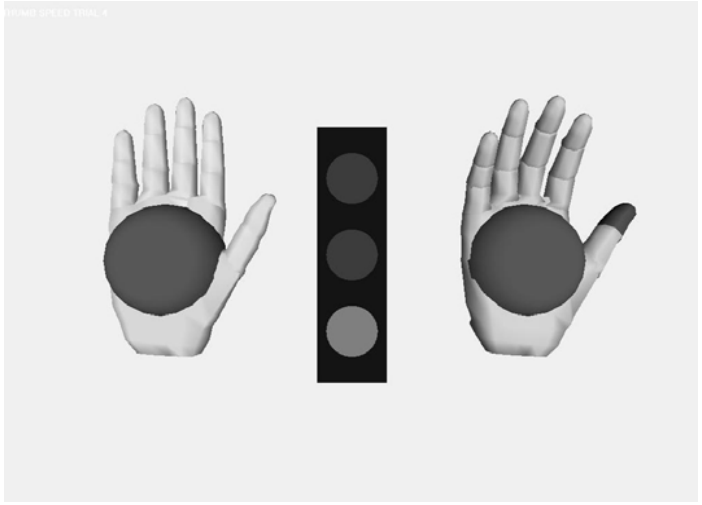
2. Remote monitoring of patients by therapists

VR- Haptic Interfaces

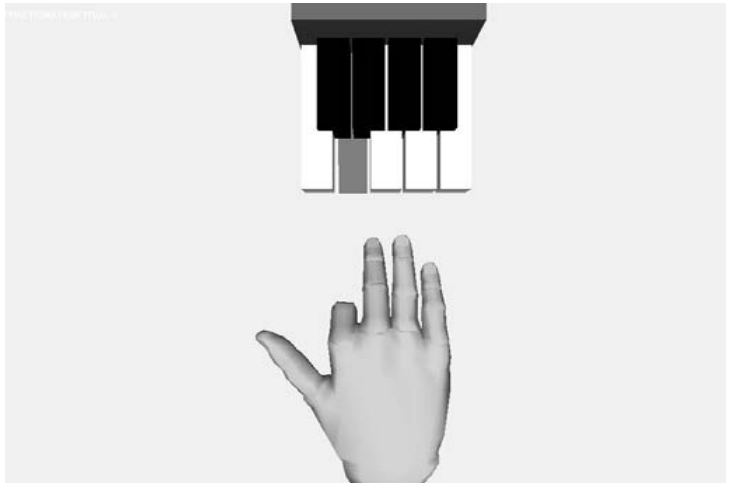
- CyberGlove - Virtual Technologies Inc.
- Rutgers RMII Master
- "Rutgers Ankle" Rehabilitation Interface



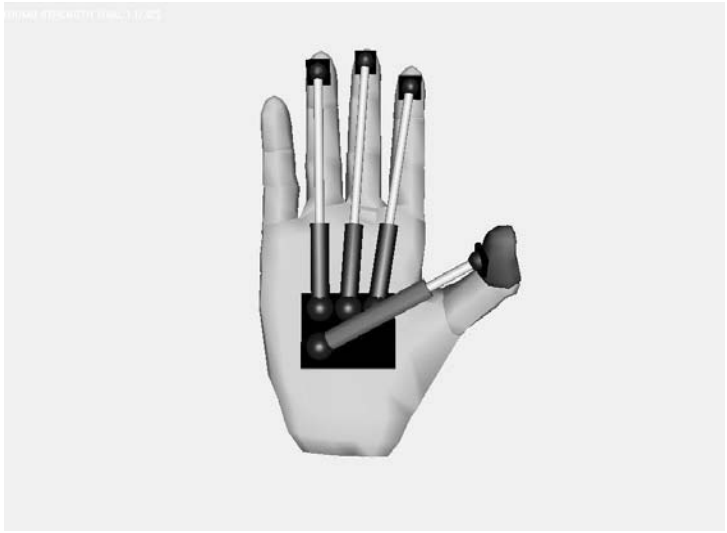
Range of Motion Task



Speed Task



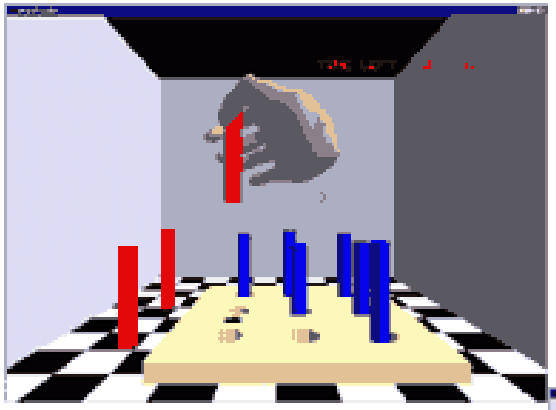
Fractionation Task

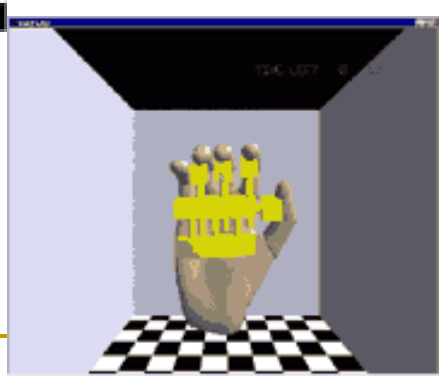


Strength Task

Tasks

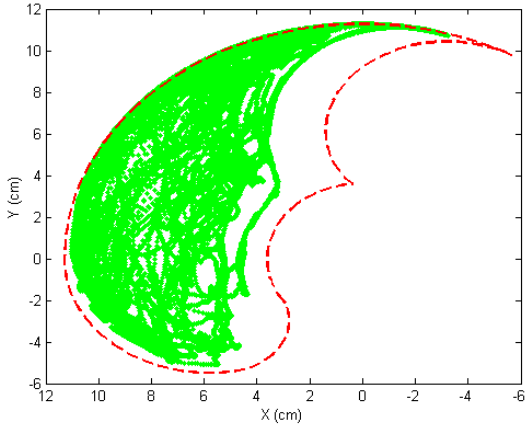
- Stanford & Rutgers
- PC-based
- Three physical therapy exercises
  - DigiKey
  - Ball
  - Power Putty
- Two functional rehabilitation exercises
  - Peg Board
  - Ball Game



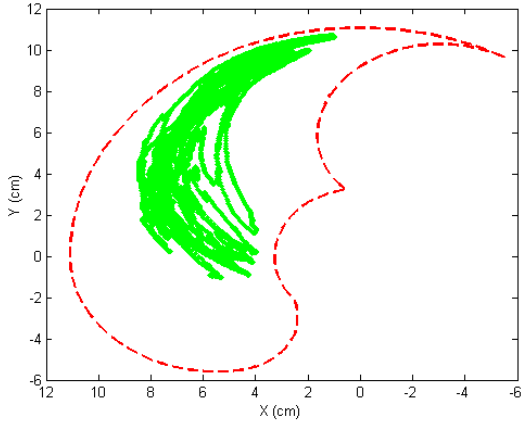


Sample Results

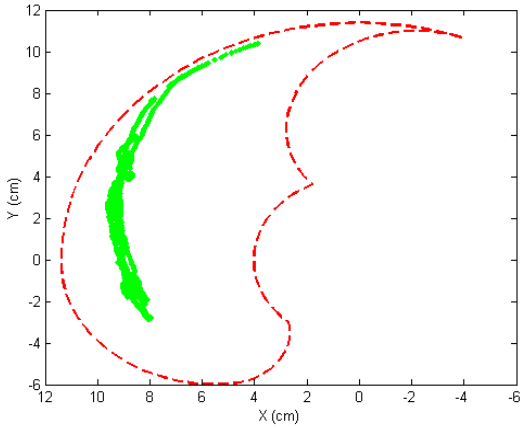
- Northwestern/Rehabilitation Institute of Chicago
- CyberGlove - pattern of finger motion during grasp, & portion of attainable workspace



attainable workspace of index finger for a control subject



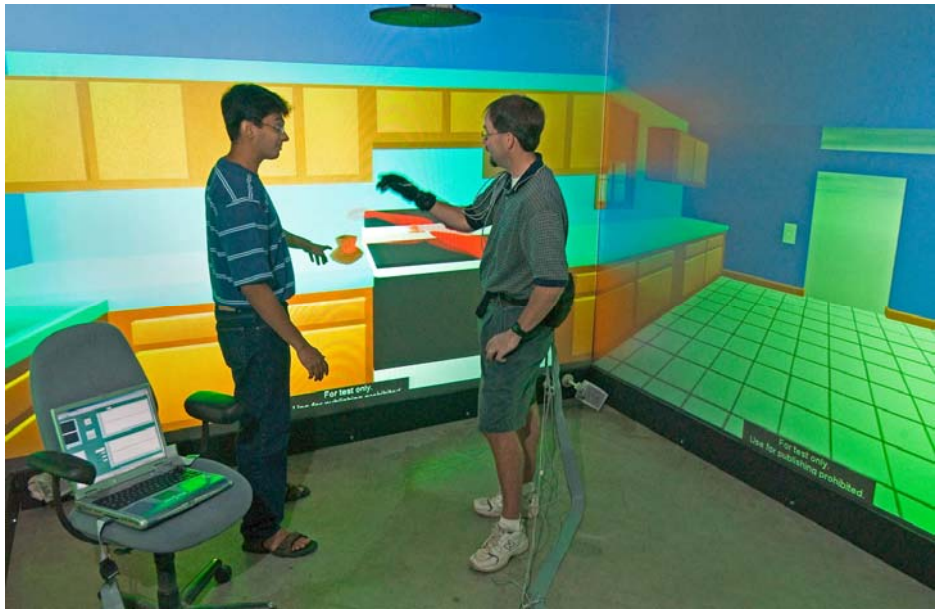
mildly impaired subject who is post-stroke.



more impaired subject who is post-stroke

Immersive Virtual Exercise Environments

VR for Recovery of Stroke and People With Disabilities

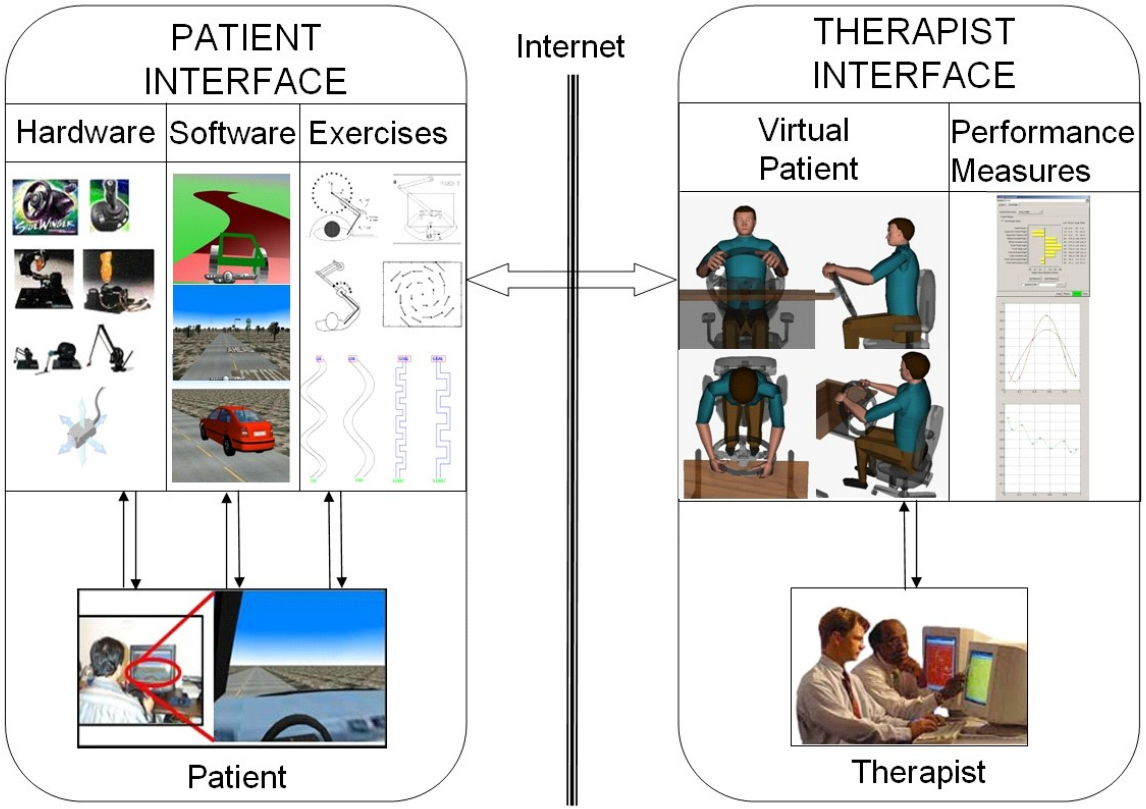


- Clarkson University
- Avatar of arm movement in VE (e.g goal - coffee on a kitchen counter) by moving own arm
- Wearing
  - electromagnetic sensors to measure arm position/ orientation
  - electromyography sensors to measure muscle activity
- Patient working to recover range of arm or grip motion

Goal Directed Arm Movement

- Université Grenoble, France
- Verify proposition for movement executed in VE
  - effect of immersion on visuomotor control of goal-directed arm movement

Immersive VE for Individualized Progressive Telerehabilitation

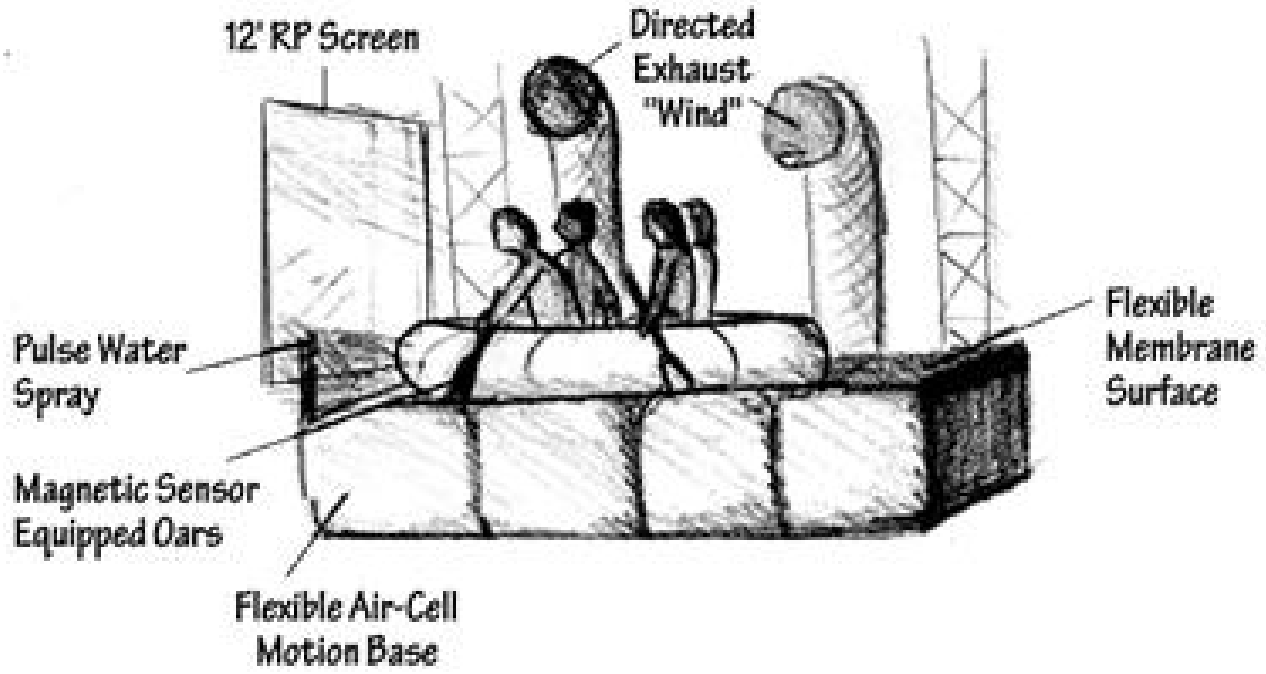


- SUNY Buffalo
- Virtual driving simulator with haptic feedback for rehabilitation of lost motor coordination skills in stroke patients

Proprietary Virtual Exercise Environments

Walt Disney Imagineering R&D

Virtual Rowing / Raft Dynamics System



Current Proprietary System

- Commercially available solutions
  - **Netathalon**- VR training and racing system
  - **Ultracoach**- Training Software
  - **RowH2O**- software monitoring and analysing of exercise performance
- Not suitable for R&D
  - Architecture not open, for third party content development

FitCentric's NetAthlon

- Rule-based artificial intelligence (AI) functions for training plans from workout data
- Input from a heart-rate monitor
- 3D graphics, LAN and Internet connectivity
- Graphics
  - "first person mode“: user/rider's head bobs up and down
  - “third person mode”: camera follows user
  - TV mode: system changes camera shots like a TV director during a live race
- Fast "rower" leading the pack to add competitive realism
- Microsoft's DirectX API
- Distance culling for swift frame rate

Open Standards for Immersive Virtual Exercise Environments

Need for Open System

- CSAFE (Communications Specification for Fitness Equipment) like standard needed
- Opportunity for multiple entities to build VR content
- Research based on analyzing current technological components
  - VR exercise software
    - E.g. NetAthlon http://www.fitcentric.com/html/netathlon_2_0.html
  - 3D courses
    - E.g. http://www.fitcentric.com/html/na_1_0_courses.htm
  - Rowing machine
    - E.g. http://www.waterrower.co.uk/
  - Advanced graphics
    - Open Inventor API, Microsoft's DirectX API
  - Serial and/or wireless communication between exercise equipment and virtual exercise environment
  - Interface standards to projectors, big screen, polarized glasses

Prototype using iC3D/GeoWall

Computer: Intel® Xeon™ Processor 3.60GHz, 2MB

NVIDIA Forceware 3D Stereo Driver

Circular polarized glasses

iC3D/GeoWall

Two DLP projectors , stacked on top of each other so that the images overlap

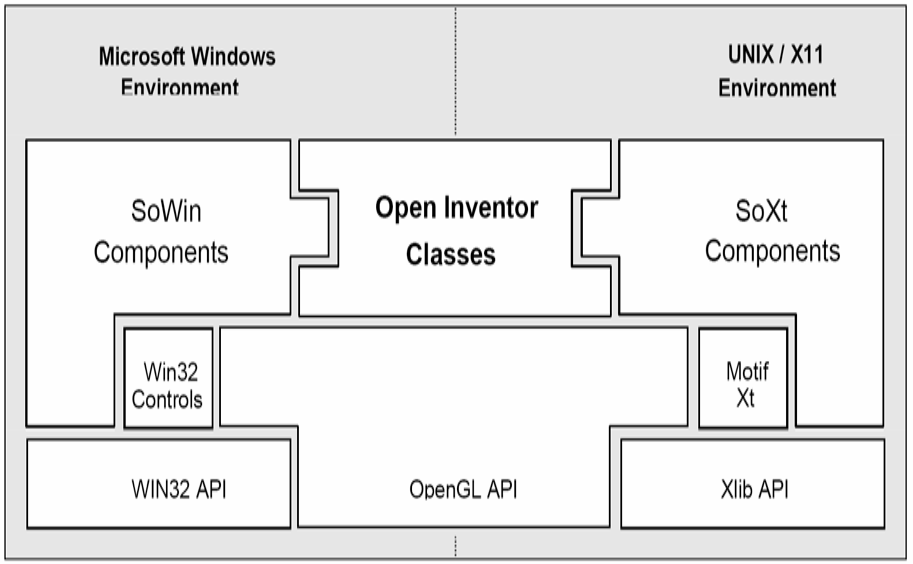
Circular Polarizers

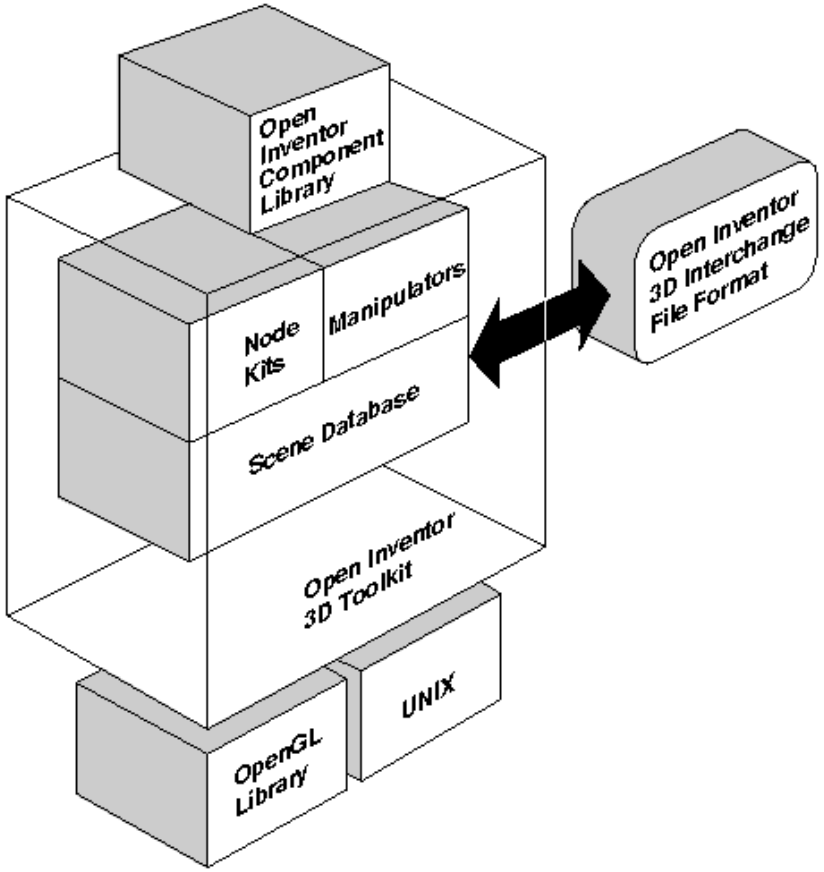
60" x 80" rear-projection screen

ForceWare NVIDIA 3D Stereo Driver

- Full-screen stereo viewing of many Direct3D® or OpenGL® based applications.
  - driver enables conversion of image to 3D stereo
- Good Stereo Viewing
  - Meaningful range of depth, or distance between the nearest and farthest objects
  - Nearest objects which are not too close for comfortable viewing
  - Heads up displays (HUDs) which are positioned so as not to interfere with the stereo experience
  - Ideally, HUDs should be at screen depth

Open Architecture





Realistic Water Using Bump Mapping and Refraction

- Every frame rendered to three textures
  - reflection, refraction & depth
- Reflection is flipping environment upside down, & clipping it to surface that we want to show the reflection.
  - e.g. reflect scene into water surface
- Refraction gives appearance of photorealism, reflection moves as if there are waves moving it around
- Replace original water texture with its reflection of the world onto the water