Use of Virtual Exercise Environments for People with Disabilities

Jane Mulligan, Jaeheon Jeong, Wei Xu,
University of Colorado at Boulder

Objectives:

Virtual reality (VR) offers a unique approach to addressing the exercise needs of people with disabilities. The RecTech Virtual Exercise Environment (VEE) is an image-based immersive environment that plays back real recorded trails to make the user feel as though they are traveling through the natural environment. The VEE provides access to virtual trails regardless of weather and will allow users to meet or compete with a buddy over the Internet. The overall goal of this project is to create more motivational, visually-stimulating VEEs that will promote greater adherence to exercise among people with disabilities. The current prototype consists of a recording system to capture video, distance and incline data about trails, and a playback system which "displays" both video and terrain data in the form of video speed and machine resistance. We are currently improving and expanding the system to provide more compelling displays and greater availability to the home user..

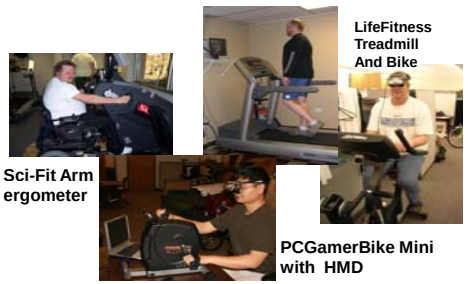
Progress to Date:

Updated Trail Capture System:

- Handheld GPS with onboard memory to save incline and distance measurements.
- 3 commodity HD camcorders with built in hard drives are used for panoramic trail capture.
- **Challenge:** spatially and temporally align independent image and GPS sequences.

Revised Playback technology:

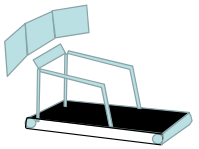
- Updated MPEG based playback system.
- Recorded trail distance and incline are “played back” on stationary exercise equipment, by controlling video playback speed and machine resistance.
  - Communications Specification for Fitness Equipment (CSAFE) allows us to control exercise machines using VEE software.
  - PCGamerBike offers inexpensive tabletop egrometer with USB interface.
- Virtual trail position computed by reading machine speed and calculating the distance from time elapsed.
  - User speed determines video playback speed.
  - Trail difficulty (incline) is emulated by controlling machine resistance or by reduced playback speed for steep trail segments (requiring greater effort for the same “motion”).
- Panoramic (surround) image sequences played back in a Head Mounted Display (HMD) or multiple large format flat monitors.



Panoramic Frames with 140° Field of View

Challenges:

- High resolution/high speed playback:
  - HD quality playback at variable speed for the VEE requires the latest media interfaces and codecs.
  - Large fromat 3 screen display requires multiple graphics cards and window interfaces that provide persistent video playback over multiple desktops.
- Panoramic Video:
  - Determining a single viable mapping to the panorama for all frames in a sequence
  - Blending and color normalization to generate smooth, visually natural panoramas
- Finding interactive exercise equipment: VEE/activity interface
  - CSAFE compatible machines are relatively expensive and rare in the home exercise machine market.
  - Commodity products such as the PCGamer Bike and Wii devices give us some inexpensive options for VEE platforms, but this does not allow people to use machines they already have.
  - Instrument the person: interface wireless wearable activity monitoring devices such as the Zephyr HxM or RT3 to the VEE to control playback using observed subject activity or effort.



Large format display consists of 3 HD flat panel TVs positioned to partially surround the user.

Use activity monitors with wireless interfaces to the VEE to drive playback.

Next Steps:

- Complete integration of updated trail capture and playback systems.
- Large scale panoramic display using commodity flat panel TVs.
- Instrument the user to increase availability of VEE to home users.
- Create gamelike network of intersecting trails allowing users to chose paths.
- Add online cooperative and competitive trail exercising with VOIP connection to other users.

This work is sponsored by the NIDRR RERC RecTech grant and the Coleman Institute for Cognitive Disabilities.