

Game Concepts for Health, Therapeutic Robotics, and Performance Enhancement

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Overview

- Games for Health
- Game play devices with possible therapeutic applications
- Some sample game projects at UCI
- Games for sports and assisted performance training
- Game-based therapy/rehabilitation protocols
- Games and tele-rehabilitation
- Recommendations

Some findings on Games for Health/Therapeutic Applications

- The design and utility of a game to realize therapeutic value is not obvious.
- E. Flores, G. Tobon, et al., Improving Patient Motivation in Game Development for Motor Deficit Rehabilitation, *ACM 2008 Intern. Conf. Advances in Computer Entertainment*, 381-384.

Table 1. Gaming design criteria for stroke rehabilitation programs serving elderly users

Criteria for Stroke Rehabilitation	Criteria for Elderly Entertainment
<ul style="list-style-type: none"> Adaptability to motor skill level Meaningful tasks Appropriate feedback Therapy-Appropriate ROM Focus diverted from exercise 	<ul style="list-style-type: none"> Appropriate cognitive challenge Simple objective/interface Motivational Feedback Element of social activity Appropriateness of genre Creation of new learning following guidelines of experts Sensitivity to decreased sensory acuity and slower responses

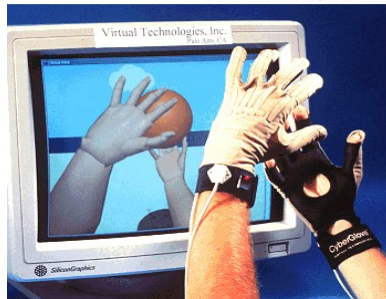
		Pong	Driver's SEAT	Whack-a-mouse	Tetris	Computer Chess	Trivial Pursuit
CRITERIA	Stroke Rehab	Adaptability to motor skill level	✓	✓	✓		
		Meaningful tasks	✓	✓			
		Appropriate feedback		✓	✓		
		Therapy-appropriate ROM		✓			
		Focus diverted from exercise	✓	✓	✓	✓	✓
	Elderly Entertainment	Appropriate cognitive challenge			✓	✓	✓
		Simple objective/interface	✓	✓	✓	✓	✓
		Motivational Feedback	✓	✓	✓	✓	✓
		Element of social activity	✓			✓	✓
		Appropriateness of genre	✓	✓	✓	✓	✓
		Creation of new learning				✓	✓
		Sensitivity to decreased sensory acuity	✓	✓	✓	✓	✓
		Sensitivity to slower responses	✓	✓	✓	✓	✓

Games for Health

- Four focus areas for enabling human behavior change for health
 - Increasing physical activity and performance
 - Mobility/dance exercise; overcoming obesity; increasing agility
 - Nintendo *Wii Sports* and *Wii Balance Board*
 - Improve self-care
 - Training or learning games for facilitating patient recovery or understanding purpose of care protocols
 - (Healthy) Lifestyle improvement
 - Diet; mitigating easily transmitted diseases/ailments
 - Facilitating therapy
 - Technology-mediated therapy (games often focus more on evaluating potential of new technology in therapy)
- New game play devices are expanding the possibilities for games for health

Game play devices with possible therapeutic applications

- Simulated devices
 - *Guitar Hero guitar; Rock Band drum set*
- Haptic wheels, trackballs, and joysticks
- Force-feedback play controllers (racing game wheels, pneumatic bladders)
- Multi-sensor play controllers (including video capture, infra-red, accelerometers, neurological sensors, electro-goniometers (SEMG), etc.)
 - *Wii Remote and nunchuk*
- Multi-jointed, body-worn sensors as play controllers
 - *Data gloves*



- *GypsyMIDI*



Game play devices with possible therapeutic applications

- Endoscopic surgery training “joysticks”

- Simball 4D joystick adapted to therapeutic game play for stroke rehabilitation
- <http://www.g-coder.com/content/view/7/6/>



- 3D, real-time video motion capture enabling *mixed reality game play* spanning physical and virtual worlds

- *Project Natal* at Microsoft
- In-game characters can interact with human players through gestures and body movements
- http://www.youtube.com/watch?v=g_txF7iETX0



Games for sports and assisted performance training

- **Wii Sports** (best selling game for Nintendo in 2007; 45M copies sold worldwide through 2009)

- Boxing
- Bowling
- Golf
- Tennis
- Baseball



What's next?



Sample of Games Developed at UCI GameLab

- Collaborative science learning game (SLG) environment at Discovery Science Center
 - *DinoQuest* and *DinoQuest Online* (DQO)
- Collaborative game world for semiconductor or nanotechnology fabrication
 - *FabLab training simulator for Intel* (highlighting “gowning process”)
- Collaborative virtual world for envisioning possible cultural and technological opportunities with avatars and virtual (computer controlled) bots
 - *Intel Research (w/ Linden Labs)*

W. Scacchi, *Game-Based Virtual Worlds as Decentralized Virtual Activity Systems*, to appear in W.S. Bainbridge (Ed.), *Online Worlds: Convergence of the Real and the Virtual*, Springer, New York (2010).

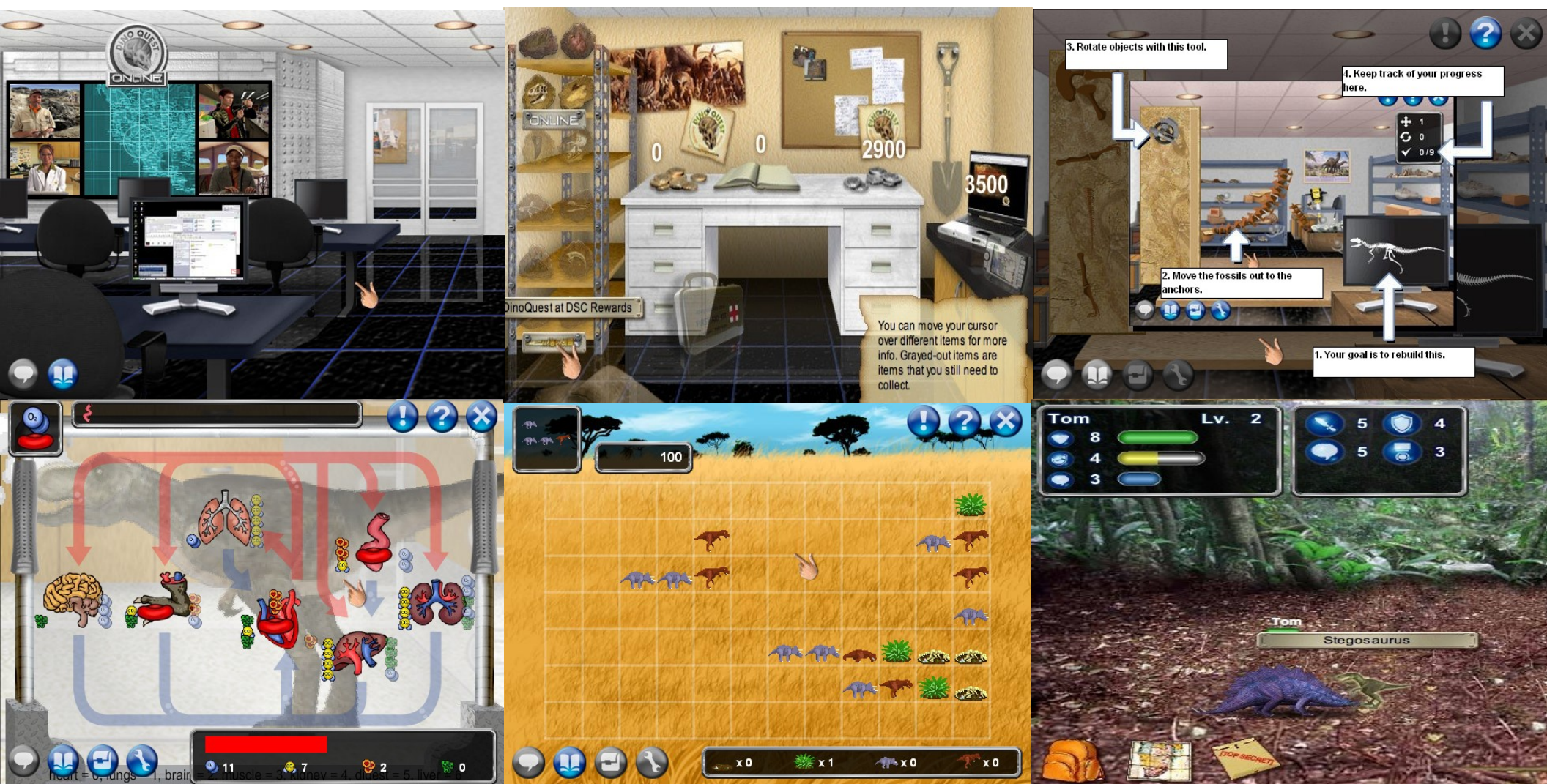
W. Scacchi, R. Nideffer, and J. Adams, *A Collaborative Science Learning Game Environment for Informal Science Education: DinoQuest Online*, in IFIP International Federation for Information Processing, Volume 279; *New Frontiers for Entertainment Computing*; P. Ciancarini, R. Nakatsu, M. Rauterberg, M. Roccetti (Eds.); Boston: Springer, 71–82 (2008).

Mixed reality games for informal science education for K-6 students and families



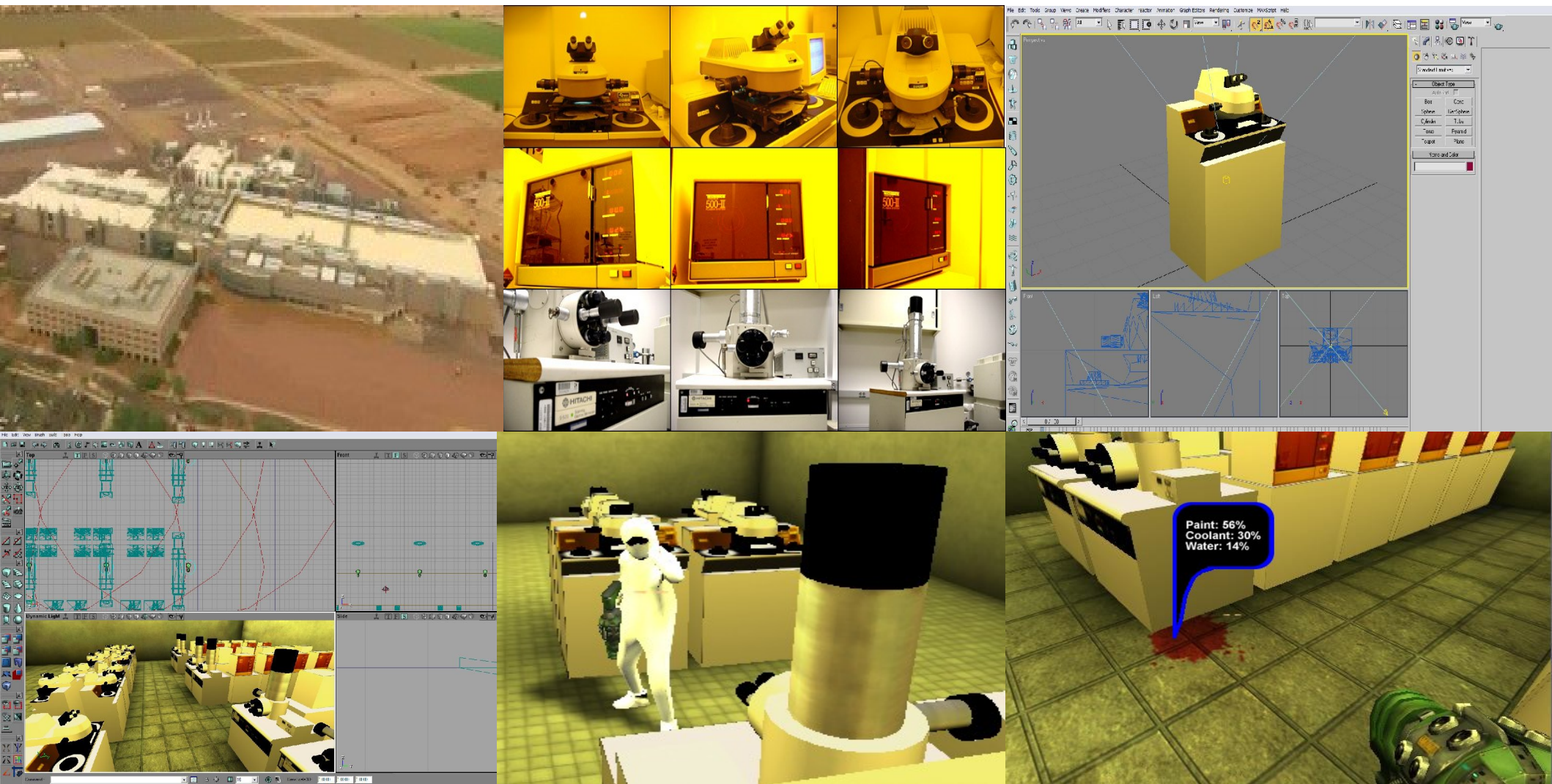
<http://www.DiscoveryCube.org/>

Web-based science learning games for informal life science education for K-6 students and families



<http://www.DQOnline.org/>

Semiconductor/nanotechnology fabrication training game



FabLab Demo Reel

Semiconductor/nanotechnology fabrication training game

working in a cleanroom

Suit made of
ultra clean material

Battery pack for
air filter system

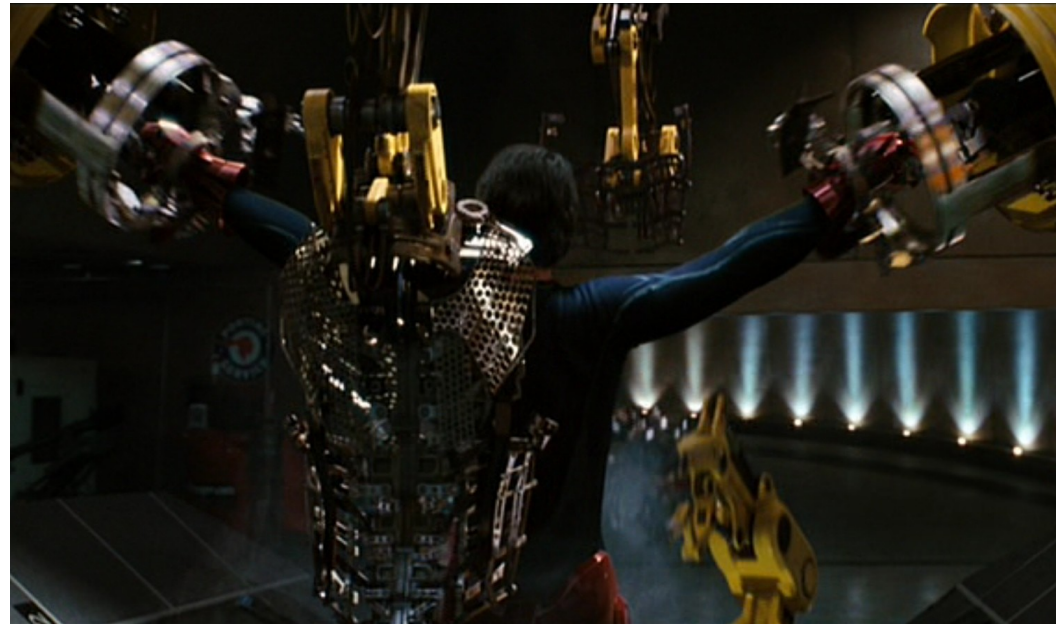
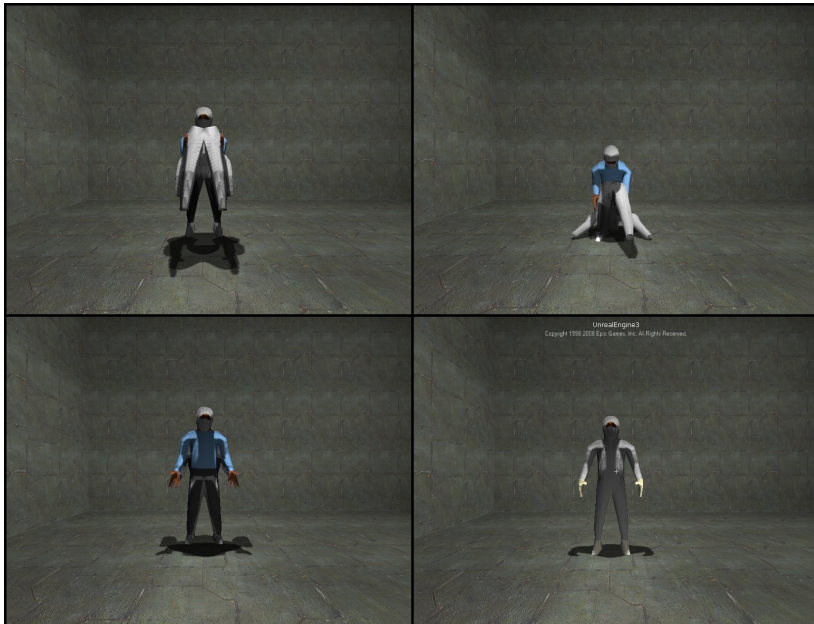
2 pairs of gloves
nylon & latex

2 pieces
of foot gear
disposable
shoe covers &
outer booties

Helmet
includes
air filter
unit

Will also
wear
hairnet
& safety
glasses

Belt



Envisioning collaborative virtual worlds 2010-2012



Virtual Life Demo Reel

Game-based therapy/rehabilitation protocols

- From an outsider's perspective, therapeutic or rehabilitation protocols denote *specifications* for how to achieve some outcome state(s), given inputs, constraints, and set of operations.
 - Such protocols can be represented computationally, when formalized, and thus the protocols can be treated as “software processes”
 - Software processes can be enacted through interactive (Web) applications, and empirically measured, assessed and replayed.
 - Medical protocols can thus be viewed as software, and such software can be designed to operate within other software, such as a computer game, or game-based virtual world
 - Thus, we can investigate, design, and refine such protocols with online games!
 - Similarly, we have the potential to design and refine (sports) performance improvement protocols in ways that can be integrated within computer games and associated game play devices

Games and tele-rehabilitation

- Virtual worlds (like *Second Life*) can be used to support various kinds of tele-medicine and tele-robotics applications/tasks



- “Rehabilitation” tasks supported can include:
 - Remote observation, tele-consultation, role-playing and identity switching through avatars, device data collection, device software updates, collaborative product/prototype development, and more

Recommendations for Therapeutic Robotics Games

- **Prototype and refine multi-skill, multi-level games that can be rapidly tailored for individual capabilities, supported by therapeutic robotics**
 - **Via games that are pre-programmed to support diversity of play**
 - **Games whose user controls are integrated with therapeutic devices**
 - **Alternatively, assess existing games to determine their potential usage**
 - **Nintendo *Wii Sports*?**
- **Develop game-based virtual worlds that provide life-situation tasks for personal accomplishment and improved socialization opportunities**
 - **Exoskeleton gowning and user-device service tasks**
 - **Multi-player games for that mix players/avatars with varying physical capabilities (including those that may be virtually induced)**

Recommendations for Therapeutic Robotics Games

- Investigate, design, and refine alternative therapeutic rehabilitation schemes using assistive robotics integrated with online game environments
 - Specify medical protocols as computational specifications
 - Collect empirical measurements/observations to show performance change
- Design, prototype, and refine an online virtual world for collaborative engineering of therapeutic robotics devices, games, rehabilitation protocols, and performance data collection
 - Such an virtual world can be used to facilitate on-going collaborative R&D between Panasonic and UCI
 - Such effort can leverage new UCI Computer Games and Virtual Worlds research projects (current funding >\$3M), research center, and its research infrastructure
- Massively multi-player online robotics learning game (MMO-RLG) world
 - A virtual world that provides different support services and learning opportunities for all parties involved in facilitating use of assistive robotics applications.