A Survey on Serious Games for Rehabilitation

Paula Rego\textsuperscript{1,2}, Pedro Moreira\textsuperscript{1}, Luís Paulo Reis\textsuperscript{2}

\textsuperscript{1}Instituto Politécnico de Viana do Castelo
\textsuperscript{2}Faculdade de Engenharia da Universidade do Porto
A Survey on Serious Games For Rehabilitation

- Overview
- Serious Games
- Serious Games for Rehabilitation
- Proposed Classification
  - Criteria
  - Comparison
- RehaCom - A Case Study
- Conclusions and Future Work
Motivation

- Rehabilitation results in high social costs
- Effective rehabilitation must be *early, intensive* and *repetitive*
- It is difficult to maintain patient motivation and interest
- High rehabilitation costs at hospitals/clinics

Approach

- Computer assisted Rehabilitation
- Use of Game Design and Technologies can be effective in augmenting motivation

Our Research

- Focus on rehabilitation
- Identify features relevant to design more effective rehabilitation games
- Develop a classification framework
Serious Games (SG) : definitions

- Zyda (2005):
  - “a mental contest, played with a computer in accordance with specific rules, which uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives. “

- Michael and Chen (2006):
  - games that do not have entertainment, enjoyment or fun as their primary purpose

- Our definition:
  - games that engage the user, and contribute to the achievement of a defined purpose other than pure entertainment (whether or not the user is consciously aware of it)
SG: A Recent and Active Research Topic

- In 2002 was formed the Serious Games Initiative

- In 2009 was organized the first Conference specialized in SG: VS-GAMES’09 - First IEEE Int. Conf. in Games and Virtual Worlds for Serious Applications

- Recent Advances in game platforms

- High availability of new forms of interaction
• SG: Surveys

• Zyda (2005): SG technology can be applied to domains as diverse as healthcare, public policy, strategic communication, defense, training, and education

• Michael and Chen (2006): SG can have a number of markets: military games, government games, educational games, corporate games, healthcare games, and political, religious and art games

• Sawyer and Smith (2008) introduced a Serious Games taxonomy
  ▪ Start point to further contributions
SG for Rehabilitation: Problems

- Impairments:
  - attention and concentration deficiencies, balance loss, pain, weakness and paralysis

- Tasks often repetitive and boring
- Can cause depression and fatigue

- Rehabilitation can require patients to travel to specialised units
  - High healthcare costs

- Early and intensive practice of functional tasks in an enriched environment show more positive outcomes for motor and cognitive rehabilitation
SG for Rehabilitation: Related Works

- Classifications:
  - Flores et al. (2008): classification for elderly rehabilitation
    - Criteria: entertainment for elderly + stroke rehabilitation
    - Subjective comparison
  - Burke et al. (2009): classification for upper limb stroke rehabilitation
    - Game design principles: meaningful play and challenge
    - Developed games based on the criteria
    - Evaluation using questionnaires
    - Small number of participants

- Applications:
  - Balance rehabilitation
  - Upper limb stroke rehabilitation
  - Behavioral and addictive disorders
  - Traumatic brain injury (TBI)
Application Area

- **Two main areas:** Cognitive Rehabilitation and Motor Rehabilitation

- Cognitive Rehabilitation
  - Goal: to achieve most independent/highest level of functioning
  - How: individualized goals according to strengths and weaknesses
  - Examples: brain injury, cognitive impairments from chronically illness

- Motor Rehabilitation
  - Stroke rehabilitation
  - Balance training
  - Acquired brain injury
  - Wheelchair mobility
  - Parkinson’s disease
  - Orthopaedic rehabilitation
  - Functional activities of daily living training
  - Telerehabilitation
Interaction Technology

- Body Weight Movement
- WiiMote and Wii Balance Board
- Motion Tracking
- HMD
- Speech + Touch + Motion Tracking + Biosensors
- Special Keyboard
- Joystick
- Web cam
● Game Genre
● Game Interface

● 2D

● 3D
Proposed Classification ➔ Criteria

- **Adaptability**
  - Capacity to adapt dynamically game difficulty/challenge according to patient performance and abilities
  - Speed and position of game elements adjusted according to player’s successive hits or misses
  - Speed, position and size of game elements can set level of challenge
  - Many games use levels to structure difficulty
- Progress Monitoring

- Performance Feedback

Congratulations! You scored: **90%**

Play again?

Yes  No

Your Previous Scores:

- 70%
- 90%
- 50%
- 44%
- 55%
- 88%
- 63%
- 90%
● Portability

- The capacity of the game to be played in a clinic or at home
- In a clinic it requires hardware that cannot be used at home
- At home the therapist can analyse data remotely
### Classification and Comparison of Rehabilitation Serious Games

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<tbody>
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<td>Body Weight Movement</td>
<td>Body Weight Movement</td>
<td>Motion Tracking + HMD</td>
<td>Speech + Touch+ Motion Tracking + Biosensors</td>
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<td>WiiMote Wii Balance</td>
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<td>2D</td>
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<td>Competitive / Collaborative</td>
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<td>Strategy</td>
<td>Simulation</td>
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<td>Simulation</td>
<td>Maze</td>
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<td>Yes</td>
<td>No</td>
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<td>Clinic/Home</td>
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<td>--</td>
<td>Clinic</td>
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RehaCom: Importance

- Modular computer system
- Widely used and tested in cognitive rehabilitation
- Installed in many clinics
- Effectiveness has been demonstrated in a number of studies all very well referenced
- It has many types of games
### Training Procedures of System RehaCom by Application Area

<table>
<thead>
<tr>
<th>Attention Training</th>
<th>Memory Training</th>
<th>Executive Functions</th>
<th>Field of View Training</th>
<th>Visuomotor skills</th>
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<tr>
<td>Alertness</td>
<td>Topological Memory</td>
<td>Shopping</td>
<td>Saccadic Training</td>
<td>Visuomotor Coordination</td>
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<td>Vigilance</td>
<td>Physiognomic Memory</td>
<td>Plan a Day</td>
<td>Exploration</td>
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<td>Memory of Words</td>
<td>Logical Reasoning</td>
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<td>Verbal Memory</td>
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<td>Divided Attention</td>
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</tbody>
</table>
RehaCom: Game Examples

Attention and Concentration

Plan a Day
Conclusions

- When compared to popular games:
  - Current therapeutic games lack qualities to be entertaining
  - Less motivating for patients

- Most applications are:
  - Prototypes
  - For a single-user player

- The evaluations made included a small number of participants
  - Effectiveness in rehabilitation is not well validated

- Most applications used only at clinics or hospitals

- Neither of the applications reviewed included the collaboration or competitiveness functionality
• Conclusions
  ▪ A review of the most important literature was made
  ▪ Relevant games characteristics were identified
  ▪ To distinguish different systems, a classification proposal was made
  ▪ The limitations and advantages of the systems were identified
  ▪ New opportunities for research were identified
• Future Research:

- Identify and measure the impact of more relevant aspects
- Explore automatic systems for monitoring patient performance
- Explore tele-rehabilitation
- Study the effectiveness of incorporating a social dimension: competitiveness or collaboration
- Competitiveness can be a positive feature
- Explore the use of artificial agents to simulate users' presence
- In the later, study how we can put those agents in the same level of abilities as real players and further problems
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Questions?

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