ExerLink:
Enabling Pervasive Social Exergames with Heterogeneous Exercise Devices

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Previous work: Exertainer and Swan Boat

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Toward ‘Pervasive’ Social Exergames...

Key features of Pervasive Social Exergames:

- Remotely playing social exergames with diverse exercise devices

**Pervasive social exergames supporting diverse exercising contexts**

- Personal preferences and capability differences
  - Preferred exercise type
  - Goal of exercising (fat burning, waist shaping, ...)
- Surrounding situations
  - Exercising location (gym, home, office, ...)
  - Exercise devices available
Repetitive-Individual-Aerobic (RIA) exercises

- Running, cycling, rope jumping, hula hooping, ...
  - Incorporating stationary and portable exercise devices

- Suitable for use in exergames:
  - Popular, easy to access, long-lasting, monotonous
  - Possible to freely change exercising speed
    ➔ We can control game characters by changing speed!

Key features of ExerLink:
Support remote exergame play with diverse RIA exercise devices... you may imagine similar exercises as well
Research Questions

RQ1. How to convert RIA exercise devices into exergame controllers?

RQ2. Cyclists always win the game!! How to provide ‘fair’ gameplay?

RQ3. Is it really fun to play in distance? Are people willing to play?
Converting Exercise Devices into Game Controllers

- Four representative RIA exercise devices
  - Two (near-)portable, two stationary devices
- Iterative design process
  - Prototyping and gameplay test
- Major design considerations
  - Sufficient controller sensitivity to play interactive games
    - Off-the-shelf exercise devices: 1Hz or lower rate
  - Speed changes should be directly applied
    - Direct sensors (e.g., mechanical sensors) rather than indirect ones (e.g., accelerometers)
  - Should not disturb natural exercising activities
Converting Exercise Devices into Game Controllers (Cont’d)

- Design of the final prototypes

**Hula hoop**
(contact sensor-based)

**Jump rope**
(rotary encoder-based)
Converting Exercise Devices into Game Controllers (Cont’d)

- Design of the final prototypes (cont’d)

**Stationary Cycle**  
(magnetic sensor-based)

**Pedal shaft**  
(we placed sensors here)

**Flywheel**  
(some cycles have sensors here)

**Good**  
**Bad**

**Interactive Treadmill**  
(ultrasonic sensor-based)

**Speed Controller**  
Ultrasonic distance sensor
Speed-Game Input Mapping

- Preferred range
  - Minimum and maximum speed for game control

by mapping exercising speed into game input values

7-11kph  80-160rpm  30-45rpm  30-80rpm
Providing fair gameplay

RQ2. Cyclists always win the game!! How to provide ‘fair’ gameplay?

Unfairness of traditional games comes from:
- Network latency, imbalance between game characters, ...

Unfairness of pervasive exergames also comes from:
- Diversity of game controllers!!
Providing fair gameplay: Identifying sources of unfairness

Why do the cyclists win the game so easily?

• Observation:
  • Teams with cyclists can **quickly change the boats’ direction**
  • Example game: Swan Boat
    • Two players collaborate to steer one boat
      • e.g., left-side player exercises faster → a boat turns left
  • **Rapidness of speed change** decides **rapidity of steering**
Providing fair gameplay: Analyzing characteristics

- Fitt’s law pointing test (1-dimensional version)
  - Move a cursor and click two targets alternately
- Results
  - Treadmill, hula hoop have longer movement time (Slower speed change)
  - Cycle, jump rope have shorter movement time (Faster speed change)
Providing fair gameplay: Counterbalancing imbalances

- Movement time (MT) balancing
- Key idea: movement time normalization
  - 1. Short-MT controller players: Penalize to change their speed slowly
  - 2. Long-MT controller players: Assist to change their speed quickly

Game input value

Make all controllers to have similar movement time

short MT controllers

target MT

long MT controllers

time
Case Study 1: Balancing and Fairness

• Key question: Does our balancing mechanism provide fair gameplay?

• Method
  • 20 participants
  • Carefully mixed exercise types
  • Data collection
    • Game statistics, questionnaire and comments from interviews

• Results
  • Participants’ responses did not explicitly demonstrate fairness issues
    • 70% did not report the unfairness issues
    • 30% reported the issues, but the unfairness depends on personal skills more
  • Game statistics (lap time, score) did not show any imbalance between exercise type combinations
Analyzing social interaction

RQ3. Is it really fun to play in distance? Are people willing to play?

- Case study analyzing social interaction
  - Analyzing patterns of social interactions in remote gameplay
  - Evaluating feasibility of ExerLink as a social medium
Case Study 2:
Patterns of Social Interaction

• Method
  • 16 participants (4 groups)
  • Co-located vs. remote play
    • Provided voice channel for remote gameplay
  • Data collection
    • Conversations (recorded), questionnaire and comments from interviews

• Result
  • ExerLink facilitates social interactions even in remote gameplay
    • “I didn’t feel any inconvenience…” [P8]
    • “… I could control the boat as if we were in a same room…” [P4]
  • Remote play increased the number of interactions between players
  • Participants tend to focus more on the game in a remote environment
Case Study 2: Patterns of Social Interaction (cont’d)

- Potential of ExerLink as a social medium
  - Participants appreciated the system as an excellent conduit for social experiences
    - 14 out of 16 participants (strongly) agreed to ‘I am willing to use this system to socialize with acquaintances and friends’
  - They liked the socializing feature of the system
    - Strongly agreed that the game play improved forming bonds between players
    - “before the game play, we were not so familiar with each other ... after playing two games, we were chatting together as if we were close friends” [P8]
  - Gameplay with strangers is acceptable
    - 8 out of 16 participants agreed to ‘I will virtually meet and play the game with strangers online’
    - “.. If none of my friends are available to play, I’ll find my teammates online” [P13]
Conclusion

• **ExerLink** – a pervasive exergaming platform
  - Supports diverse multiplayer exergames
  - Remote gameplay
  - Incorporates multiple exercise devices (both portable and stationary)

• **Our contributions**
  - First step to a **general pervasive game platform**
  - Provided **practical experiences from prototyping and revision process**
  - Dealt with a case of **unfairness from multiple game controllers**
    - Will be an important problem in other pervasive games and apps
  - Observed **rich social interaction between remote exergamers**

• **Thank you! Questions?**