A Computer Cutting Game to Train Hand Function for Children

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Outline

- Introduction
- Related Work
- Design & Implementation
- Experimental Result
- Conclusion & Future Work
Motivation

- In the United States, 17% of children have a developmental or behavioral disability.
- Hand function is a key point of child development.
- Opportunities for treatment have been missed if children are not identified before starting school.
Problem

- Traditional therapy requires children to go to the hospital periodically.

- Disadvantages
  - Professional needed for
    - Supervising
    - Recording
    - Evaluation
  - Infrequency (once a week)
Proposed Solution

- A computer cutting game for child hand function training
  - Automatically supervises and records user’s hand activity
  - Easily deployable at home for frequent practice

- A game manual for parents.

- An evaluation system for therapist.
Related Work (1/4)

- Hand function training for children
- Frog Writing Fun
  - Holding and moving pen
  - Product
  - 牛津家族: http://www.newwis.com.tw/

- Shortage
  - No recording
  - No evaluation
Related Work

- Hand function training for adults
- Stroke Rehabilitation
  - range, speed, fractionation, strength
  - ACM conference on Assistive technologies
  - Dept of Comp. and Info. Sci. New Jersey Institute of Technology

- Detail but expensive
Other ability training for children
- Aurora
  - Social Behavior: eye-contact, joint-attention, approach, avoidance, following
- ICDVRAT (International Conference on Disability, Virtual Reality and Associated Technologies)
- Adaptive Systems Research Group, Department of Computer Science, University of Hertfordshire
Other ability training for children

- Playful Tray
  - Mealtime behavior: nutrition, time, parent-child interaction
- Ubicomp 2007
- NTU Ubicomp Lab
Design & Implementation
Training - Game

Bring to Home → Training → Recording

Evaluation → Bring to Hospital
Demo
Design & Implementation
Game - Choose
Design & Implementation
Game - Choose - Preview
Design & Implementation
Game - Choose - Preview
Design & Implementation
Game - Cut
Design & Implementation
Game - Cut – Cut then Draw
Design & Implementation
Game - Cut – Cut then Draw
Design & Implementation
Game - Cut – Cut then Draw
Design & Implementation
Game – Complete - Alert
Design & Implementation
Game – Complete - Alert

DONG

[Diagram of a game interface with a character and a palette of colors]
Design & Implementation
Game – Complete - Alert
Design & Implementation
Game – Complete - Alert

- Motivate child to control carefully
- Alert child in real time
- Lost information when done
Design & Implementation
Game – Complete - Area
Design & Implementation
Game – Complete - Area
Design & Implementation
Game – Complete - Area

- Motivate child to control carefully
  Really cut it

- Capture child’s performance *more accurate*
  than “Alert”

- Preserve information till the end
Design & Implementation
Game – Complete - Piece
Design & Implementation
Game – Complete - Piece
Design & Implementation
Game – Complete - Piece
Motivate child to control carefully
What you cut is what you get

Capture child’s performance accurately

Preserve information till the end
Design & Implementation
Training, Recording, Evaluation

Bring to Home → Training → Recording

Evaluation → Bring to Hospital
Design & Implementation
Training, Recording, Evaluation

Bring to Home → Training → Recording

Evaluation

Bring to Hospital
Design & Implementation
Training, Recording, Evaluation

Bring to Home → Training → Recording

Evaluation

Bring to Hospital
Design & Implementation Evaluation - Simulator
Design & Implementation Evaluation - Evaluator
Design & Implementation Evaluation - Evaluator
Design & Implementation Evaluation - Evaluator
Design & Implementation Evaluation - Evaluator
An automatic evaluator for therapist
- Solve more complex case
- Avoid human error and subjective judgment
- Save time for therapist
Design & Implementation
Training, Recording, Evaluation

Bring to Home → Training → Recording → Bring to Hospital

Evaluation
Design & Implementation
Training, Recording, Evaluation

Bring to Home → Training → Recording

Evaluation → Bring to Hospital
Limitation

- **Training**
  - Different operation from real paper cutting
  - *Imperfect* check method
- **Recording**
  Rough information about hand activity
- **Evaluation**
  *Imperfect* match between cut and contour in special case
Experiment

- **User**: seven children with autism
- **Flow**
  - pre-test
  - training
  - post-test
  - follow-up
  - one week
  - four weeks
  - four weeks

- **Test Procedure**
  - Two different clinical standard tests for hand function evaluation
  - Real paper cutting
  - *Cutting Game*
Results (1/2)
Results (1/2)
Results\textsubscript{(1/2)}

**Child G's error rate**

![Graph showing error rate over time]

- **Date**:
  - 2/22 2008
  - 2/29 2008
  - 3/7 2008
  - 3/14 2008
  - 3/28 2008
  - 4/4 2008
  - 4/11 2008
  - 4/18 2008
  - 4/25 2008

- **Error rate**:
  - 0.0
  - 0.2
  - 0.4
  - 0.6
  - 0.8
  - 1.0
  - 1.2
  - 1.4

- Lines represent:
  - L1
  - L2
  - L3
  - L4
Results

Child A's error rate

Error rate

12/25 1/1 1/8 1/15 1/22 1/29 2/5 2/12 2/19 2/26

L1 L2 L3 L4
Results\textsubscript{(2/2)}
Results (2/2)

Child E's error rate

- L1
- L2
- L3
- L4

Date
- 2/20 2008
- 2/27 2008
- 3/5 2008
- 3/12 2008
- 3/19 2008
- 3/26 2008
- 4/2 2008
- 4/9 2008
- 4/16 2008
- 4/23 2008
- 4/30 2008
Results

Child F's error rate

Error rate

Date


L1
L2
L3
L4
Finding

- Child
  - Distinguish difficulty between figures
    - 「這個太簡單了」
    - 「那個好難喔」
  - Ignore figures
Finding
Conclusion

- We build a complete system that provides training, recording, and evaluation.

- The system provides a feasible solution at home that supports frequent training without professionals.

- The results suggests that error rate decreased when children cut along the contour.
Future Work

- Large scale studies
- Online service
- Game
  - Real-time feedback
  - Utilizing (Control) Difficulty
- Evaluation
  - Standardized clinical test
Thanks
