Investigating Real-World Mappings for Foot-based Gestures

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CS 352
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INTRODUCTION
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Reasons to study foot gestures?


**Introduction**

- Reasons to study foot gestures?
  - Hands are wet or dirty
Introduction

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  - hands are busy with other things
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INTRODUCTION
What gestures can feet perform?
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- Kicking
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- Ankle rotations (shaking)
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Scope of Work
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• Scope of Work

• Discrete Gesture Set Mapping
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- Scope of Work
- Discrete Gesture Set Mapping
- Validation of Gesture Recognizability
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- Continuous Gesture Set Mapping
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- Scope of Work
- Discrete Gesture Set Mapping
- Validation of Gesture Recognizability
- Continuous Gesture Set Mapping
- Advice for Future Development
**Discrete Mapping**

- UCD approach
- Experiment Design
  - Presented with scenario
  - Participant acts out gesture
  - Questionnaire at end of session
  - Video recording for offline coding
## Discrete Mapping

<table>
<thead>
<tr>
<th>Command</th>
<th>Generalised gesture</th>
<th>% part. Assigned gesture</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phone control</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Answer incoming call</td>
<td>Tap foot</td>
<td>58% Double tap</td>
</tr>
<tr>
<td>2. Ignore incoming call</td>
<td>Shake foot</td>
<td>42% Shake foot</td>
</tr>
<tr>
<td>3. End current call</td>
<td>Tap foot</td>
<td>68% Double tap</td>
</tr>
<tr>
<td><strong>Media control</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Play/pause</td>
<td>Tap</td>
<td>68% Double tap foot</td>
</tr>
<tr>
<td>15. Next track</td>
<td>Rightwards movement</td>
<td>74% Kick right</td>
</tr>
<tr>
<td>16. Previous track</td>
<td>Leftwards movement</td>
<td>68% Kick left</td>
</tr>
<tr>
<td>17. Shuffle</td>
<td>Shake foot</td>
<td>68% Shake foot</td>
</tr>
<tr>
<td>18. Volume up</td>
<td>Forwards movement</td>
<td>47% Kick forward</td>
</tr>
<tr>
<td>19. Volume down</td>
<td>Backwards movement</td>
<td>42% Kick backward</td>
</tr>
</tbody>
</table>

**Table 1: Gesture set for common mobile device commands.**
Discrete Mapping

- Participants
Discrete Mapping

Participants

19 total (7 F, 12 M)
Discrete Mapping

Participants

- 19 total (7 F, 12 M)
- 18–25 years of age
Participants

19 total (7 F, 12 M)

18–25 years of age

no prior foot gesture experience
Discrete Mapping

Participants

- 19 total (7 F, 12 M)
- 18–25 years of age
- no prior foot gesture experience
- many w/ hand gesture experience
Discrete Mapping
Discrete Mapping

Results
Discrete Mapping

Results

Analysis 1: not much participant agreement
Discrete Mapping

Results

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$\mu = 0.13, \sigma = 0.08$
Discrete Mapping

Results

Analysis 1: not much participant agreement

\[ \mu = 0.13, \sigma = 0.08 \]

Analysis 2: higher participant agreement
Results

- Analysis 1: not much participant agreement
  \[ \mu = 0.13, \sigma = 0.08 \]

- Analysis 2: higher participant agreement
  \[ \mu = 0.42, \sigma = 0.20 \]
Validation of Discrete Set
Validation of Discrete Set

Goal of experiment
Validation of Discrete Set

- Goal of experiment
- Experiment design
Validation of Discrete Set

- Goal of experiment
- Experiment design
  - 5 participants (1 F, 4 M)
Validation of Discrete Set

- Goal of experiment
- Experiment design
  - 5 participants (1 F, 4 M)
  - Avg. age 22.2 years
Validation of Discrete Set

Goal of experiment

Experiment design

- 5 participants (1 F, 4 M)
- Avg. age 22.2 years
- 5 times during learning period
Validation of Discrete Set

- Goal of experiment
- Experiment design
  - 5 participants (1 F, 4 M)
  - Avg. age 22.2 years
  - 5 times during learning period
  - 5 times during test
Results

$\mu = 0.87$

Figure 2: Gesture recognition accuracy
Continuous Mapping
Continuous Mapping

*Overview*
Continuous Mapping

Overview

4 kick-based methods
Continuous Mapping

- Overview
  - 4 kick-based methods
  - 3 experiments
Continuous Mapping

- Overview
  - 4 kick-based methods
  - 3 experiments
  - 1st directional navigation
Continuous Mapping

Overview

- 4 kick-based methods
- 3 experiments
  - 1st directional navigation
  - 2nd navigating over distance
Continuous Mapping

- Overview
  - 4 kick-based methods
  - 3 experiments
    - 1\textsuperscript{st} directional navigation
    - 2\textsuperscript{nd} navigating over distance
    - 3\textsuperscript{rd} distance & direction together
Continuous Mapping
Continuous Mapping

Methods of continuous input via kicking
Continuous Mapping

- Methods of continuous input via kicking
- Displacement based (D)
Continuous Mapping

- Methods of continuous input via kicking
  - Displacement based (D)
  - Rate-based hold (RH)
Continuous Mapping

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  - Displacement based (D)
  - Rate-based hold (RH)
  - Rate-based continuous (RC)
Continuous Mapping

- Methods of continuous input via kicking
  - Displacement based (D)
  - Rate-based hold (RH)
  - Rate-based continuous (RC)
  - Flick (F)
Kick: Investigating the Use of Kick Gestures for Mobile Interactions

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Continuous Mapping

Figure 3: Experimental interface: (left) At the beginning of a task (right) At the end of a task.
Continuous Mapping

* Experiment Design

Figure 3: Experimental interface: (left) At the beginning of a task (right) At the end of a task.
Continuous Mapping

- Experiment Design
- Use kick to move position

Figure 3: Experimental interface: (left) At the beginning of a task (right) At the end of a task.
Continuous Mapping

- Experiment Design
  - Use kick to move position
  - Follow concentric circles towards center

Figure 3: Experimental interface: (left) At the beginning of a task (right) At the end of a task.
Continuous Mapping

- Experiment Design
- Use kick to move position
- Follow concentric circles towards center
- Stop inside green rectangle

Figure 3: Experimental interface: (left) At the beginning of a task (right) At the end of a task.
Continuous Mapping

Figure 4: (left) Target acquisition times (sec) for different directions (right) Mean num. of crossings for target selection
Continuous Mapping

Experiment 1: Direction

Figure 4: (left) Target acquisition times (sec) for different directions (right) Mean num. of crossings for target selection
Continuous Mapping

- Experiment 1: Direction

- Design: 8 directions: \{N, NE,\ldots, W, NW\}

Figure 4: (left) Target acquisition times (sec) for different directions (right) Mean num. of crossings for target selection.
**Continuous Mapping**

- **Experiment 1: Direction**
  - **Design:** 8 directions: \{N, NE, ..., W, NW\}
  - **Participants:** 10 total (2F, 8M), 18–27 years

![Figure 4: (left) Target acquisition times (sec) for different directions (right) Mean num. of crossings for target selection](image-url)
**Continuous Mapping**

🌟 Experiment 1: Direction

🌟 Design: 8 directions: {N, NE, ..., W, NW}

🌟 Participants: 10 total (2F, 8M), 18–27 years

🌟 Results:

![Figure 4: (left) Target acquisition times (sec) for different directions (right) Mean num. of crossings for target selection](image-url)
Continuous Mapping

- Experiment 1: Direction
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- Results:
  - Fastest method: RH

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Continuous Mapping

- Experiment 1: Direction
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  - Fastest method: RH
  - Slowest method: RC

Figure 4: (left) Target acquisition times (sec) for different directions (right) Mean num. of crossings for target selection
Continuous Mapping
Continuous Mapping

Experiment 2: Distance
Continuous Mapping

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- Design: 5 distances: \{150, 450, ..., 1350px\}
Continuous Mapping

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  - Design: 5 distances: \{150, 450, ..., 1350px\}
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Results:

Fastest method: RC
Continuous Mapping

- Experiment 2: Distance
  - Design: 5 distances: \( \{150, 450, \ldots, 1350\text{px}\} \)
  - Participants: 10 total (2F, 8M), 23–26 years

Results:
- Fastest method: RC
- Slowest method: Flick
Continuous Mapping
Continuous Mapping

Experiment 3: Direction & Distance
Experiment 3: Direction & Distance

Design: 8 directions & 3 distances
Continuous Mapping

- Experiment 3: Direction & Distance
- Design: 8 directions & 3 distances
- Participants: 10 participants
Continuous Mapping

- Experiment 3: Direction & Distance
  - Design: 8 directions & 3 distances
  - Participants: 10 participants

- Results:
Continuous Mapping

- Experiment 3: Direction & Distance
  - Design: 8 directions & 3 distances
  - Participants: 10 participants
- Results:
  - RH & RC tied for time
Continuous Mapping

- Experiment 3: Direction & Distance
  - Design: 8 directions & 3 distances
  - Participants: 10 participants

- Results:
  - RH & RC tied for time
  - User preference: RC
Contributions

- Determined a set of discrete gestures
- Validated the recognizability of discrete set
- Investigated continuous gesture mappings, Rate-based continuous determined the best
Discussion
Discussion

Concerns/Issues
Discussion

- Concerns/Issues
  - Social suitability
Discussion

- Concerns/Issues
  - Social suitability
  - Physical environment
**Discussion**

- Concerns/Issues
  - Social suitability
  - Physical environment
  - Mobile device must be held
Discussion

- Take away message for HCI

- Q/A
Citations


- http://www.iar.com/About/Partner-pages/Texas-Instruments/