Combining and Measuring the Benefits of Bimanual Pen and Direct-Touch Interaction on Horizontal Interfaces

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Background
Real World Requirements

- Touch tabletops have been gaining business grounds
- User requests of fine-granularity pen drawing and writing in addition to barehand direct touch
Simultaneous pen and multi-touch interaction?
Technology

- Experiments of overlaying a transparent dotted pattern from Anoto onto the multi-touch DiamondTouch
Technology – Touch Tracking

- **Mitsubishi DiamondTouch**
  - front-projected
  - array of antennas embedded in the touch surface
  - each antenna transmits a unique signal
  - users are connected capacitively
  - antennas near the touch point couple an extremely small amount of signal through the user's body to the receiver
Technology – Pen Tracking

- Anoto Pen captures
  - Pen ID
  - Page ID
  - position (x, y)
  - time (t)
  - pressure (256 levels)
Technology – Pen Tracking

Anoto pattern

Absolute coordinate addresses

Basic pattern

1.5mm

0.3mm

Above

Below

Left

Right
Technology – Pen & Touch

DiamondTouch Layer

Anoto Layer

Anoto Bluetooth Streaming

Pen ID
Page ID
x,y Position
Intensity

Bluetooth Server
Technology – Pen & Touch

- Anoto Pattern layer on top of DiamondTouch
- Pen does not interfere with touch input and vice versa
- Simultaneous touch and pen interaction
- Distinct touch and pen identification
Prototype
Bimanual Sketching
Bimanual Selection
Cut, Copy & Paste

Copy
Cut
Move
Position
Precise Position
Self Revealing Gestures

- How can the interaction possibilities of a bimanual pen and touch system be communicated?
- Top of the screen panel features Mechanism/Consequence feedback
Self Revealing Gestures

- Pen and Touch can invoke an action with different gestures (*Mechanism*)
- **Consequence** of each action always visible
Self Revealing Gestures

- **Consequence** of each action always visible
  - passive tooltip
  - active tooltip
Is the combination of *pen and touch* superior to *touch/touch* and *pen/pen* input for bimanual tasks?
Formal Experiment

- comparing the performance of *pen/pen*, *pen/touch* and *touch/touch* for performing a representative bimanual task
- Navigate through a maze
Formal Experiment

- Input Device Assignment
  - touch / touch
  - pen / touch
  - pen / pen
- DRAW with the dominant hand
- ZOOM / MOVE with the non-dominant hand

<table>
<thead>
<tr>
<th></th>
<th>touch/touch</th>
<th>pen / touch</th>
<th>pen / pen</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRAW</td>
<td>1 finger drag</td>
<td>pen</td>
<td>pen 1</td>
</tr>
<tr>
<td>ZOOM</td>
<td>2 finger stretch</td>
<td>2 finger stretch</td>
<td>pen 2</td>
</tr>
<tr>
<td>MOVE</td>
<td>1 finger drag</td>
<td>1 finger drag</td>
<td>pen 2</td>
</tr>
</tbody>
</table>
Formal Experiment

- each subject completing 10 mazes using each of the 3 input techniques
- Primary data collected
  - Time
  - Errors
Evaluation

Time Analysis

Error Rate Analysis
Evaluation

- Analysis of Zoom, Pan and Lift operations
Questions

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