Connecting Realities for Fluid Computer-Mediated Communication

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User Interface
The image shows a playful kitten lying on its back, with its legs stretched outwards, resting on a person's lap. The person is wearing blue shorts and is seated, with their legs forming a triangle shape on which the kitten is comfortably sprawled. The kitten has a grey coat with darker grey spots and stripes, typical of a tabby pattern, and is looking directly at the camera with a relaxed yet alert expression. The background suggests a home environment, with a red cushion and blue fabric, possibly part of a sofa or chair, complementing the casual and cozy setting.
Virtualize Physical World

Physicalize Virtual World
Virtualizing Physical World for Fluid Remote Communication
ThingShare: Ad-Hoc Digital Copies of Physical Objects for Sharing Things in Video Meetings

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University of Virginia¹, Aarhus University², Google Research³
How to point?
Objects Blurred By background!
Formative Study

Survey with 124 Mturk users

How often do you show physical objects in video meetings?

At least Occasionally: 58.0%
Work-Related: 57.2%
Never: 15.70%
Rare: 27.27%
Occasionally: 37.19%
Frequent: 19.01%
Always: 12.40%
Leisure-Related: 12.40%
Work-Related: 29.75%

### How do you show objects?

<table>
<thead>
<tr>
<th>How do you show objects</th>
<th>Leisure-Related</th>
<th>Work-Related</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Holding the object up to the camera”</td>
<td>5.20%</td>
<td>6.21%</td>
</tr>
<tr>
<td>Using dedicated instrument to capture object or documents</td>
<td>45.09%</td>
<td>50.28%</td>
</tr>
<tr>
<td>Holding the object up to the camera</td>
<td>20.23%</td>
<td>13.56%</td>
</tr>
<tr>
<td>Holding the external camera to capture the object</td>
<td>17.34%</td>
<td>21.47%</td>
</tr>
<tr>
<td>Taking a picture or video of the physical object and then send it via text chat or email</td>
<td>12.14%</td>
<td>8.47%</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Challenges of Showing Physical Objects

- **Details**: Difficult to show the fine detail of an object.
- **Perspectives**: Unable to show multiple pages of a document or different perspectives.
- **Remote Referencing**: Limited view to reference and understand remote user’s attention.
- **Framing**: Laborious to repeatedly frame, coordinate, and adjust the position and angle.
- **Privacy**: Virtual background obscures the object.
Challenges of Showing Physical Objects

- Details: Difficult to show the fine detail of an object.
- Perspectives: Unable to show multiple pages of a document or different perspectives.
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- Framing: Laborious to repeatedly frame, coordinate, and adjust the position and angle.
- Privacy: Virtual background obscures the object.

Not Difficult for Virtual Objects
Use of Digital Copies
Use of Digital Copies

- Blending digital copies and video can support casual and playful conversations
- Remote access to digital copies enables parallel exploration
- Maintaining privacy while sharing physical objects
Constructing Shared Perspectives

- For Asymmetric Tasks, digital copies enable a shared perspective.
Constructing Shared Perspectives

- For **Symmetric Tasks**, digital copies help **gauge attention**.
Physicalizing Virtual Interaction for Accessibility
Take My Hand
Automated Hand-Based Spatial Guidance for the Visually Impaired

Adil Rahman, Md Aashikur Rahman Azim, and Seongkook Heo
University of Virginia
Microsoft HoloLens 2

Ruofei Du et al. Opportunistic Interfaces for Augmented Reality: Transforming Everyday Objects into Tangible 6DoF Interfaces Using Ad hoc UI. CHI Demo ’22
Motor input
Visual output
Audio output
Body position input
Sensing environment
Haptic output
Finally, the StateLens iOS application provides interactive guidance for blind users to access the interfaces.
Anhong Guo, Junhan Kong, Michael Rivera, Frank Xu, Jeffrey Bigham
StateLens: A Reverse Engineering Solution for Making Existing Dynamic Touchscreens Accessible, UIST ’19

Jonggi Hong, Alisha Pradhan, Jon E. Froehlich, Leah Findlater
Evaluating Wrist-Based Haptic Feedback for Non-Visual Target Finding and Path Tracing on a 2D Surface, ASSETS ’07
Motor input
Visual output
Audio output
Body position input
Haptic output
Sensing environment
Automated Hand-based Spatial Guidance

1. Sensing environment
2. Motor input
3. Body position input
4. Visual output
5. Audio output
6. Haptic output
There are several ways of actuating the user’s hand.
In this work, we achieve this using **FingerRover**, an *on-finger* miniature robot.
Demonstration of Automated Hand-Based Spatial Guidance using *FingerRover*

**Step 1: Intent**
Where are my headphones?

**Step 2: Spatial Guidance**
Follow *FingerRover*

**Step 3: Task Complete**
Grab Headphones
Locating Objects
Operating Touchscreen
Assembling Objects
Shape
Sensemaking
We conducted an exploratory user study with 7 visually impaired participants to test the effectiveness of automated hand-based spatial guidance in supporting interactions for BVI individuals.
Participants were able to easily adapt to spatial guidance, and found it to be effective in guiding their hands.
Task 1: Locating Objects
Task 1: Locating Objects

“I feel [the robot] is a little safer because it will navigate around objects, as opposed to just the audio where I could knock something over to get to something else” (P5)

“A couple of objects were next to each other, so I could’ve certainly picked up the wrong thing [using audio guidance]. I think the robot was better than the audio. I was able to find everything that you asked me to instantly. I didn’t pick up the wrong things” (P3)
Task 2: Operating Touchscreen
Task 2: Operating Touchscreen

“I liked that the robot gives you haptic and auditory feedback. So you actually have something that you can touch as it moves across the screen” (P2)

“[The interaction] was very simplistic, which is good. There was a natural flow, because the menu can change, but your actions remain the same.” (P6)
Task 3: Assembling Objects
Task 3: Assembling an Object

“It’s easier to pick things up [using the robot] if they’re in a jangled mess.” (P3)

P1 commented that unclear verbal instructions could also lead to potential misunderstandings between the user and the guide, which could be avoided by using the robot, as the guide would have explicit spatial controls.
**Task 4: Shape Sensemaking**

Shape 1: Triangle (7/7)

Shape 2: Square (5/7)
- Trapezoid (1)
- Hexagon (1)

Shape 3: Rhombus (0/7)
- Off-Angled Square (1)
- Square (2)
- Parallelogram (1)
- Rectangle (3)
User Agency
While the idea of automated hand-based spatial guidance may be promising, the susceptibility of this technique to possible risks must not be overlooked.
Since this technique takes the task of controlling the user’s hands off the user, the user may relax their agency. And this can be particularly dangerous if the system gets compromised.
Safety must be carefully considered when designing automated hand-based spatial guidance systems.
In our study, users unanimously agreed that they felt completely in control over FingerRover, and that they could stop following the guidance at any point by simply lifting their fingers.

FingerRover, as a device, is not strong enough to override the user’s agency – it moves ONLY if the user wants it to move.
Capabilities and Limitations of the Two Worlds are different
Ultimate User Interface Group
https://ultimateinterface.com/

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