Low-Cost Touch Screens for Large-Scale Interactions

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Abstract

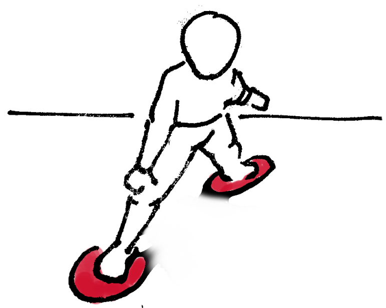

Figure 1: "Zooming in". Do paper-sized interactions work on large-scale screens?

1 Background

Capacitive touch screen are becoming a ubiquitous piece of technology, allowing for direct manipulation of digital icons with touch and on-screen hand gestures. While touch screens offer limited tangibility, clever sensing tokenizes tangible objects allowing them to be identifiable by the parent device [1, 2]. However, capacitive touch screens are prohibitively expensive - rarely seen larger than a tablet or laptop - and are notoriously fragile.

Vision-based touch screens promise low-cost, robust, large scale interaction. By not relying on capacitive sensing, a vision-based screen can transform most surfaces into a site for user interaction. These screens however are often limited by occlusion, unreliability, or the need for underside projection. Furthermore, processing and segmenting live camera input is computationally intensive. To circumvent these constraints, vision systems rely on high-contrast, colorful visual tokens such as pucks. However, these systems typically have a stateful architecture, limiting the amount of dynamic interaction and feedback.

How might we develop a scalable touch surface and what interactions exist in the space outside paper-sized tablets?

2 Proposed System

We propose a system consisting of a visual touch surface paired with a vision system to couple the responsiveness and reliability of capacitive touch screens with the scalability of vision-based touch screens.

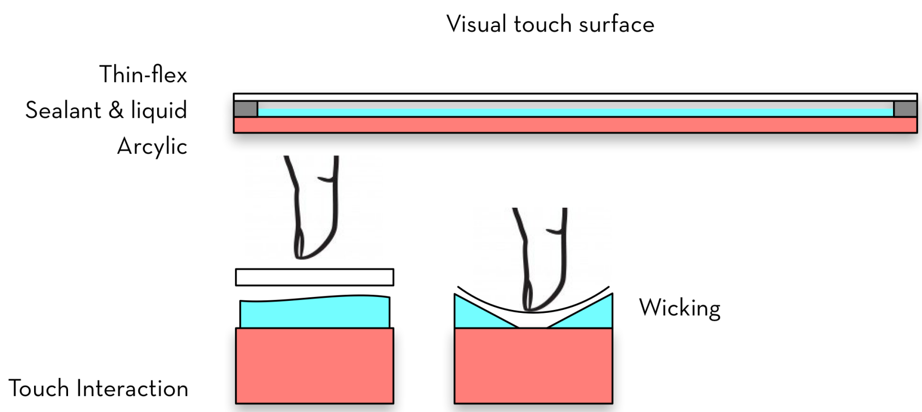

Figure 2: A mechanical visual touch screen that uses a liquid's wicking motion to create visual cues.

Touch Surface Liquids exhibit dynamic behaviors, such as wicking whereby a liquid can travel unassisted through a narrow space. We propose a liquid mediated surface consisting of an opaque liquid sandwiched between a semi-flexible surface and acrylic plate. Applying pressure to the surface causes the liquid to wick, displacing the liquid and revealing a visually salient cue. We anticipate that such a cue would aid in image processing, thereby reducing computation costs and increasing system robustness and response. By pressing or stepping on the surface, the device naturally creates a colored ellipse around the depression providing input-output coincidence. The size and shape of this ellipse depends on the direction and magnitude of force. Each object then potentially has an identifiable force signature. Our surface would be a low-cost modular design consisting of accessible materials like acrylic, an opaque fluid, and a webcam and CPU.

Computer-vision tracking We will use a standard overhead camera setup to filter and segment visual data. With color histogram back-projection, we can segment color cues, calculate connected components, and map these to surface to be used in our application framework.

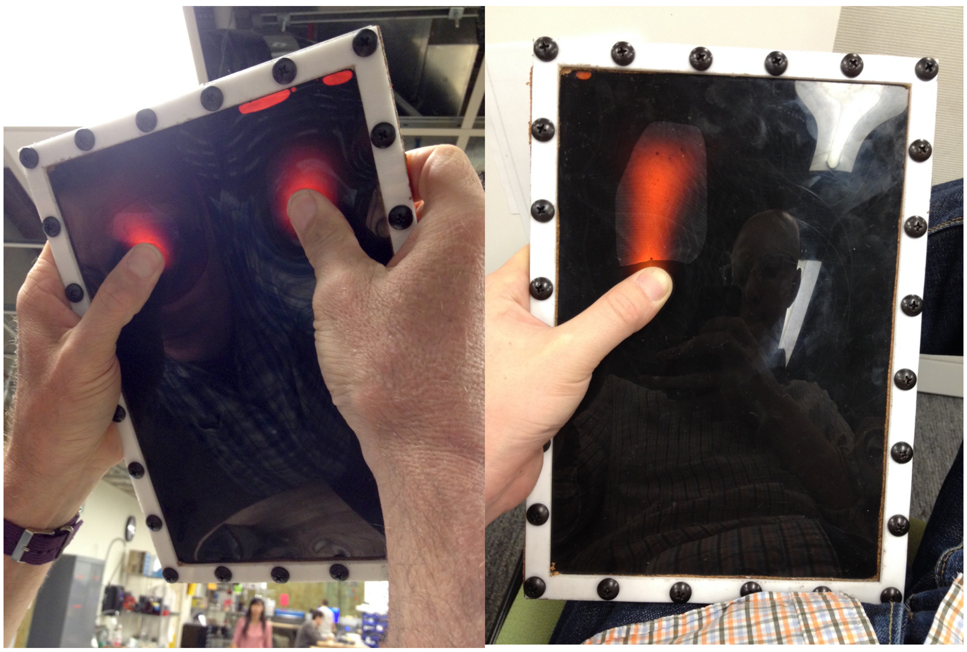

Figure 3: A prototype visual touch screen using orange acrylic, tempura solution, and clear plastic. (left) Multitouch. (right) Residual touch. Interaction points (orange) were post-process overexposed for clarity.

Initial prototypes

3 Proposed Tangible Interactions

We ensure the shortest feedback loop by enforcing input-output coincidence. Since the system is scalable, we imagine an integrated touch floor where actions like walking and running change the colors underneath. The system offers new sensing capabilities such as: occupancy, gait, presence, and collaboration detection [weight signatures of two people close by/apart]; also new media opportunities that explore the body as paintbrush [3] and augmented aural-visual syncopated environments.

4 References

[1] Pedersen, Esben Warming, and Kasper Hornbk. "Tangible bots: interaction with active tangibles in tabletop interfaces." Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. ACM, 2011.

[2] Taylor, Stuart, et al. "VideoPlay: Playful and Social Editing of Video using Tangible Objects and Multi-touch Interaction." In adjunct proceedings of IEEE Conference on Horizontal Interactive Human-Computer Systems. Tabletop 2007. Vol. 42. 2007.

[3] Utterback, Camille. Abundance. 2007. http://camilleutterback.com/projects/abundance/