

Rendering Tactile Features on Touchscreens

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s you read this, how many touch interfaces are within reach? We'd wager a few. After all, the touchscreen is the leading user interface of our time. Yet the appellation "touch" is really only a half-truth. Yes, it's by touch that we put information into these devices, but it's by sight that information returns to us. This is a shame because, with proper haptic feedback, our fingertips are capable of typing, adjusting knobs, and many other feats, all without constant visual attention.

Surface haptics aims to change this state of affairs by adding haptic feedback to touch interfaces. Our forthcoming article "Search Efficiency for Tactile Features Rendered by Surface Haptic Displays" (IEEE *Trans. Haptics*, vol. 7, no. 4, 2014) asks how well people can perform a basic perceptual task—detecting the presence or absence of a haptic effect—using surface haptic technology. It's well known that certain visual searches exhibit search-time invariance. For example, the time required to find the letter A in a field of Bs is roughly independent

of the number of *B*s. This invariance occurs because the letter *A* has slanted lines, a primitive component that isn't present in the letter *B*. Primitive components are extracted early on in the brain's processing with little to no cognitive effort. It's also known that search-time invariance can occur in haptics. For example, a rough surface presented to one fingertip can be recognized efficiently no matter how many smooth surfaces are presented to the remaining fingertips.

We wondered if surface haptic devices could support efficient search. To study this, we used a TPad, which varies the friction across a glass surface as it's explored by a fingertip. Haptic effects are created by controlling the friction level as a function of the finger's position. For example, a virtual edge is created by turning the friction from low to high when the finger slides beyond a certain point.

Using six TPads, we investigated the ability of participants to detect a target feature presented to one finger among a set of smooth surfaces distractors—presented to others. We found that detection of a material property such as slipperiness, or an illusory shape such as a virtual hole, was significantly impaired by distractors, whereas the search for an abrupt discontinuity as in a virtual edge was unaffected. The efficiency of search for edges suggests that they might engage primitive detectors in the haptic perceptual system.

While many other types of target features are yet to be investigated, the results are encouraging. Before long, we might all be able to use touchscreens a little more effectively—while fixing our eyes on them just a little less.

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