Can Your Smartphone Touch You Back? Rendering Haptic Textures from Friction on Android OS

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Smartphone and tablet technology receive touch, but most devices don't give tactile feedback. We worked with a device that utilizes haptic technology, the Senseg "Feelscreen", to investigate its use for virtual textures. Our idea was that texture gradients could help people find their direction of movement without having to look at a screen.

Overview

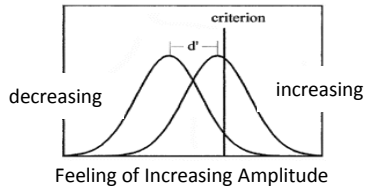
The Senseg tablet supports 4 pre-defined textures: grainy, bumpy even and smooth. They result from variations in spatial pattern (chosen by Senseg) and amplitude (from 0 to 1.0). Using these parameters, six gradients were chosen for experimentation.

Gradient	Min	Max	Delta
1	0.2	0.6	0.4
2	0.2	0.8	0.6
3	0.2	1.0	0.8
4	0.4	0.8	0.4
5	0.4	1.0	0.6
6	0.6	1.0	0.4

We asked:
How well can amplitude gradients be discriminated in virtual textures rendered on a touch screen device?

Signal Detection

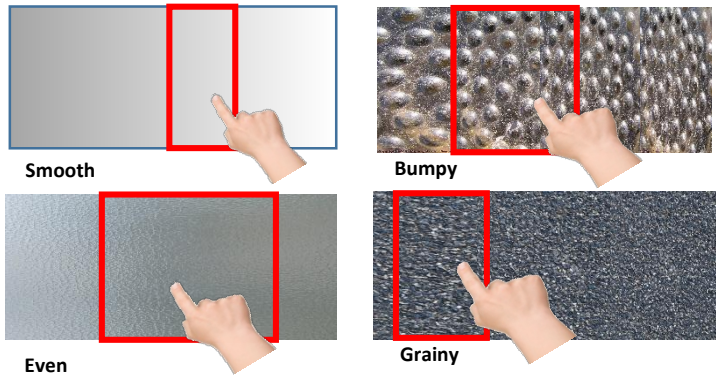
Data were analyzed with signal detection theory, which measures a subject's discrimination of 2 stimuli with d'. d' is in standard deviation units, so a value of 3 is a really good discrimination.

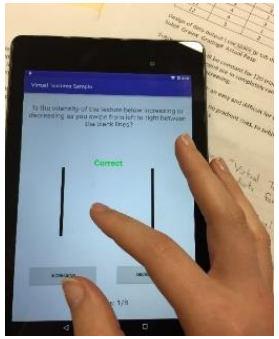


Experiments

Subjects swipe across a small area of the tablet to feel a gradient texture. Then they report whether the texture is increasing or decreasing in intensity as they swiped left to right.

Visualization of Gradients



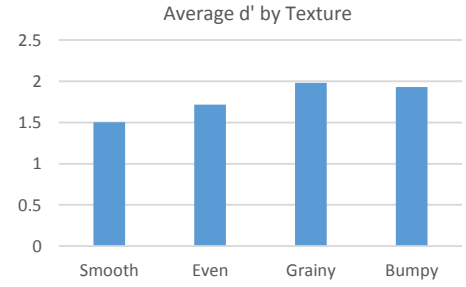


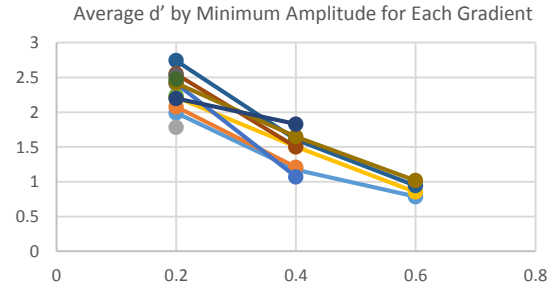
Experiment 1
24 subjects, each given 2 textures and 20 swipes of each gradient (10 increasing and 10 decreasing). Swipes within each texture were completely randomized. Gradients spanned a 2 inch window.

Left: subject interacting with Android application from Experiment 1.

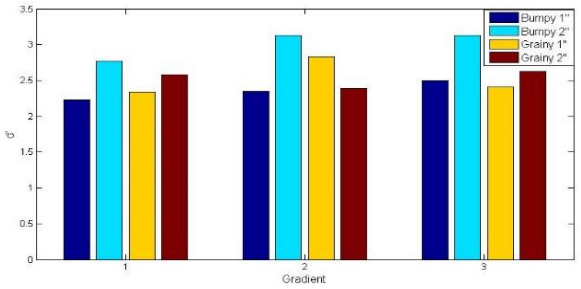
Experiment 2
Best performing 3 gradients and 2 textures were taken from Experiment 1. Gradients now presented in both one inch and two inch windows.

Results





Left: Mean d' by texture in Experiment 1. Discrimination generally excellent (d' = 1.5 to 2), nonsignificant trend favoring bumpier textures, which were used in Experiment 2.
Right: Mean d' by minimum amplitude in gradient. Textures starting at low amplitudes (gradient #s 1, 2 and 3) performed the best. This is consistent with "Weber's Law": greater sensitivity to differences at lower levels of a variable. These top 3 gradients were used in Experiment 2.



Left: Mean d' for each gradient, texture, and window size from Experiment 2. Subjects were able to discriminate all gradients with high accuracy, even at 1 inch width(all d' values were greater than 2)

These findings support the feasibility of using haptics to find direction of movement in mobile applications!

"App"lications

Spatial Awareness: Know where your finger is from how the tablet feels.
Virtual Tactile Keyboards: The screen is an array of different textures and amplitudes that correspond to numbers, letters, and symbols.
Try our app: The keyboard consists of three columns, each with a unique texture: grainy, even, bumpy. Moving downward makes textures more intense (higher amplitude in 4 steps).