Surround Haptics: Sending Shivers Down Your Spine

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1. What is Surround Haptics?

Surround Haptics is a new tactile technology that uses a *low-resolution* grid of *inexpensive* vibrating actuators to generate high-resolution, continuous, moving tactile strokes on human skin [1]. The user would not feel the discrete tactile pulses and buzzes that are so common today, but rather a *smooth tactile motion*, akin to what we feel when someone drags a finger across our skin.

Surround Haptics is based on a carefully designed and thoroughly evaluated algorithm that uses *tactile illusions* to create and move *virtual actuators* anywhere on a grid. A virtual actuator can be created using any pair of physical actuators (Figure 1.1): the user would feel only a single vibrating point, not two separate physical ones. The algorithm is *recursive*. This allows for the generation of virtual actuators using *physical-virtual* and *virtual-virtual* actuator pairs (Figure 1.2, 1.3). This permits the creation of complex trajectories on skin using low-resolution actuator grids (Figure 1.4).

The entire algorithm is based on rigorous psychophysical experiments and new models of tactile perception that we have formulated. It allows us to control *speed*, *location*, *direction*, *length* and *intensity* of the moving tactile strokes. The details can be found in supplementary materials as well as in an upcoming publication [1].

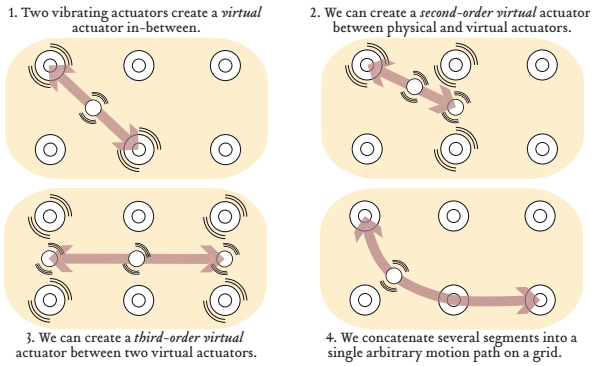


Figure 1. Basic approach behind the Surround Haptics algorithm.

2. Why it is important and relevant?

Designing tactile technologies that enhance the vocabulary of tactile "expressions" is one of the most important research directions in haptics and HCI today. Most of the available tactile technologies are not able to create *detailed tactile sensations* on *large areas* of human skin. For example, most tactile apparatus (e.g. chairs, controllers, mobile devices) provide either global vibration or discrete pulses in several locations. There have been few attempts to integrate them into complex, continuous tactile stimuli.

Surround Haptics, on the other hand, can draw "tactile strokes" on a user's skin, similar to drawing strokes with a brush on paper. The resulting display can be used to create new experiences and to communicate information by controlling stroke parameters.

3. Next-Generation Home Gaming with Surround Haptics.

We use Surround Haptics to design and explore immersive, video-tactile-audio home gaming environments. We wanted to replace common vibrating tactile game controllers with a technology that delivers highly detailed, dynamic and spatial tactile experiences tightly synchronized with game events and interaction.

We designed a modular home tactile system including (Figure 2): 1) a custom plywood chair that can be used in daily life, 2) soft pads for the seat and backrest with an embedded tactile grid, and 3) a wireless controller implementing our algorithm.

The user controls the game with Microsoft Kinect (Figure 3). To provide the user with a physical device and make tracking more reliable, we designed a physical prop resembling a steering wheel. A high-intensity driving simulator game ("Split/Second" by Black Rock Studio) was enhanced with a wireless protocol sending the required tactile sequences to a control board in the chair.

A broad range of game events have been enhanced with spatial tactile strokes. These include *collisions*, road *imperfections*, tire *traction*, *skidding*, ripples of *forces when landing*, *acceleration, braking*, objects *falling on the car*, *damage,* etc.

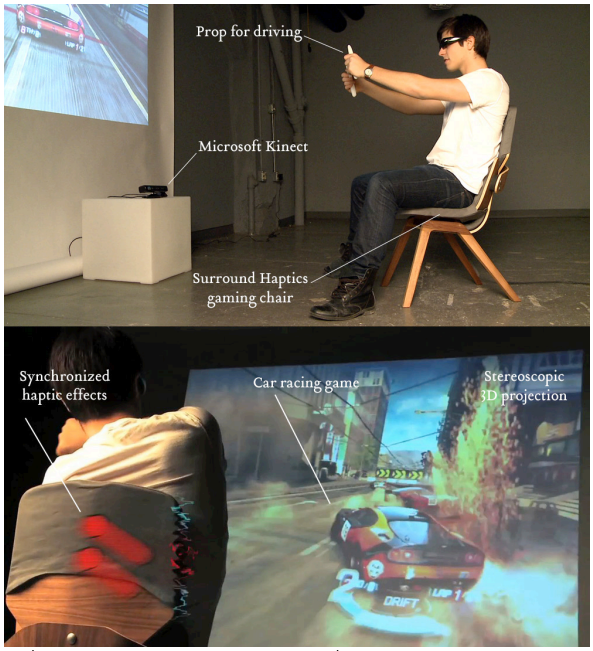
4. A Wide Range of Applications

Although we have only implemented Surround Haptics with a gaming chair to date, the technology can be easily embedded into clothing, gloves, sports equipment and mobile computing devices.

References

1. Israr, A., Poupyrev, I. *Tactile Brush: Drawing on skin with a tactile grid Display*. To appear in ACM CHI 2011, May: Vancouver, Canada.

Figure 2. Modular tactile gaming platform (a) pad with tactile actuator grid (b) assembling gaming chair (c) home tactile gaming setup.



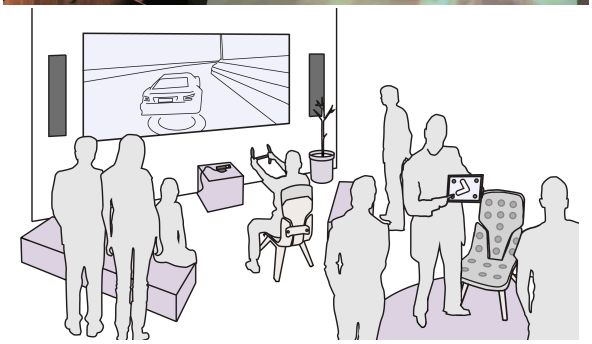


Figure 3. Surround Haptics game experience and exhibition proposal

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