Adding Haptic Feedback to Mobile TV

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Introduction
The value and appeal of mobile TV broadcasts can be increased by the addition of a haptic-feedback channel to supplement the traditional video and audio streams.

We present the development of mobile haptic TV systems through a series of design constraints and the development of a prototype implementation, UltraTV. UltraTV is a mobile device that provides mid-air, multi-point, back-of-device ultrasonic haptic feedback to enhance the mobile TV experience.

Designing Mobile Haptic TV

Device Grasping
Common device grasping techniques are shown to the right. All are conducive to back-of-device feedback: The palms and fingers are behind the device to aid the grasping action.

Output Style
The sensations created using vibrotactile haptic feedback can be varied by controlling the frequency, pulse and length parameters.

Haptic feedback can be provided to the user in a continuous or pulsed manner.

Pulsed feedback provides very short bursts. Altering the length of burst and the time between bursts controls the texture of the output.

Testing UltraTV's Feedback

We asked participants to place their hand over the output array and indicate the location and number of points that they could feel.

The system generated permutations of four fixed position points of feedback: one in each quadrant of the square array resulting in a total of 16 permutations.

Eight participants took part in the study and each of them tested all 16 permutations. This resulted in a total of 128 tested permutations.

Results showed that the participants could correctly identify which of the feedback points were active with 87.3% accuracy (112/128).

Towards Mobile Haptic TV

UltraTV provides multi-point, contactless haptic feedback on a single side of a mobile device.

It uses ultrasonic air pressure waves that the user feels as vibrations on their hand.

By using low frequency ultrasound (~40kHz), >99% of the ultrasonic waves will reflect from human skin, producing a tactile sensation.

The UltraTV hardware consists of a 10x10 array of ultrasonic transmitters, with electronic circuitry to individually trigger each transmitter.

Each transmitter is driven at 40kHz by an 8-bit microcontroller and an amplifier based on a MOSFET driver IC.

Overall control of the phase differences between transducers is performed using an XMON XC-1A running at 400MHz.

Images at right show: (top) XMON micro-controller, (middle) control circuitry, (bottom) array of ultrasonic transducers.

1. Investigate users’ ability to differentiate different intensity output and textures produced by UltraTV.
2. Explore users’ ability to detect points that move across the back of the device.
3. Understand how haptic feedback should be correlated with visual and audio output from the TV stream.
4. Examine what types of content are best suited to mobile haptic TV presentation: e.g. sports, movies, etc.
5. Develop and field test sample applications and content.

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