

## Strategic Business Relevance:

Ultrasonic haptic feedback (UltraHaptics) is a promising new technique for providing mid-air tactile sensations. Ultrasonic feedback uses the phenomenon of acoustic radiation pressure – where an air pressure field is exerted on an interfering object – to produce tactile feelings on a user's hand. We present a mid-air, multi-point haptic feedback system.

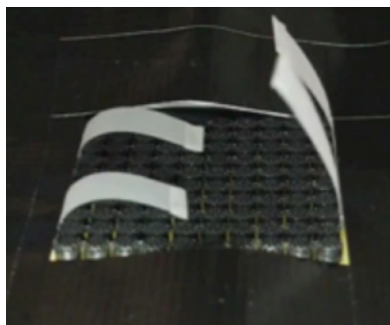
UltraHaptics opens a realm of new opportunities for providing users with haptic feedback

One of the most promising possibilities for use of this feedback is its incorporation into mobile devices. For example, a multi-point ultrasonic haptic array mounted on the rear of a mobile device would allow haptic TV presentation, as well as possibilities for combining multiple feedback devices and group sharing of haptic feedback.

Other applications could include mounting these ultrasonic arrays in seats for entertainment purposes (cinemas, etc.) as well as on game controllers to enhance the interactive experience for users.



A user sees, hears and feels a haptic video stream on a mobile device.



The multi-point haptic feedback system is powerful enough to displace pieces of tape placed over the array.

## Core Research: User Interactions for Breakthrough Services

This research addresses the ways in which users interact with portable and mobile devices (and other devices in their physical and logical environments) in order to enable new types of personalized and highly contextualized services.

The ultrasonic haptic feedback research forms part of the low-level research for this programme, with the aim of developing novel interaction techniques for mobile devices.

Virtual Centre of Excellence in mobile and personal communications



For more information see:  
[www.mobilevce.com](http://www.mobilevce.com)

## Evaluation Summary

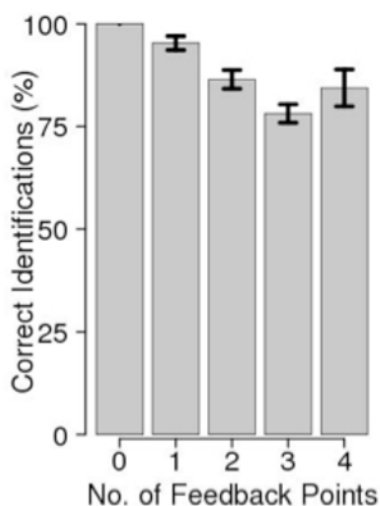
To validate our multi-point haptic feedback system, we conducted a simple user evaluation. We asked participants to place their hand over the output array and indicate the location and number of points that they could feel.

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. Each permutation was 'displayed' for three seconds; participants were then asked to circle the areas of activity on a diagram.

In order to calculate how well participants could identify and locate active feedback points, we counted the number of regions whose activity was correctly indicated on the diagrams on the paper. This means that for each permutation, participants were scored out of a maximum of four regions.

Results showed that the participants could correctly identify which of the feedback points were active with 87.3% accuracy (112 out of 128). The figure below shows the percentage of correct identifications of active feedback points.

Looking at those instances when participants were unable to correctly identify the active feedback points, we found that 75% of the errors (12 out of 16) were due to active points that were missed by the participants. The remaining 25% (4 out of 16) of errors came from the participants incorrectly identifying a region as being active when it was not.



Accuracy of user detection of multiple feedback points from the ultrasonic haptic feedback device.

## Key Points

- UltraHaptics is a new technique for multi-point, contactless, vibrotactile sensations to mobile users.
- The research is developing this system for inclusion in applications such as mobile haptic TV.
- An initial user evaluation has shown that users can always detect the presence or absence of haptic feedback but as the number of feedback points increases, identification accuracy decreases.
- A range of further studies is needed to fully understand how users perceive ultrasonic haptic feedback. This research will investigate issues such as the ability to differentiate textures and intensities of feedback, and how accurately a user can detect a moving point.