Aito Sound

A proof of concept exploration for haptics and sound with piezoelectrics

What if?

What if your flat touchscreen would let you feel the visual movement of buttons? Well, this technology already exists and is being developed by Aito, a company specialised in giving haptic feedback with piezoelectric sensors. But what if we take this technology a bit further? What if this new technology could also create audio? Would this turn your whole screen into a speaker? These last questions were explored in this graduation project.
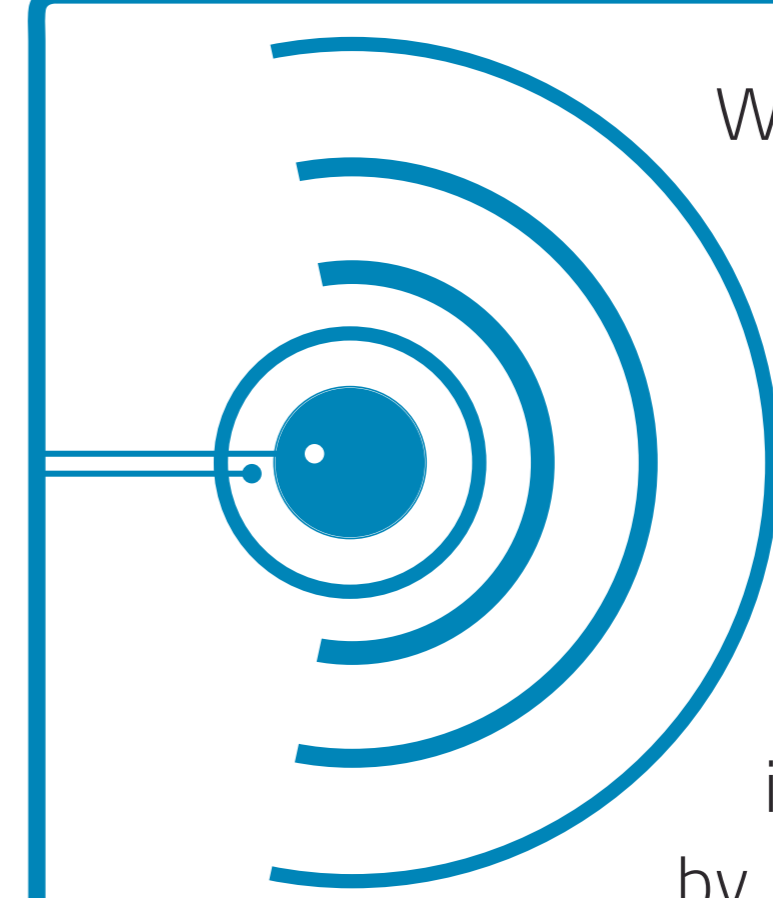
The Basic Principle

Aito has developed a technology that can be placed underneath surfaces to give haptic feedback. They make use of piezoelectric discs to sense a pressure difference and actuate a pulse if this difference reaches a certain level; the images on the right explain this principle. This system is possible because of the piezoelectric crystals in the discs. These crystals create current from movement for the sensing action, and create movement by adding current for actuation action. These properties, combined with the way Aito layers the structure to support the piezoelectric discs, allow for this type of haptic feedback which mimics the press of a button.

While the technology of Aito currently focuses on a single pulse to mimic the feeling of a button, it is possible to send a continuous stream of pulses through the piezoelectric discs. This stream could be a pulse that is being repeated over and over, or it could be a variation of pulses which creates music. With Aito's current structure, it seems possible to create a speaker in which the surface is vibrated to create audio. Their structure resembles distributed mode loudspeakers or multiactuator panels, these speakers use a vibration module (an exciter), to move the surface they are attached to which is illustrated in the right bottom image. The difference between these two speakers is the placement and number of exciters.

Sensing

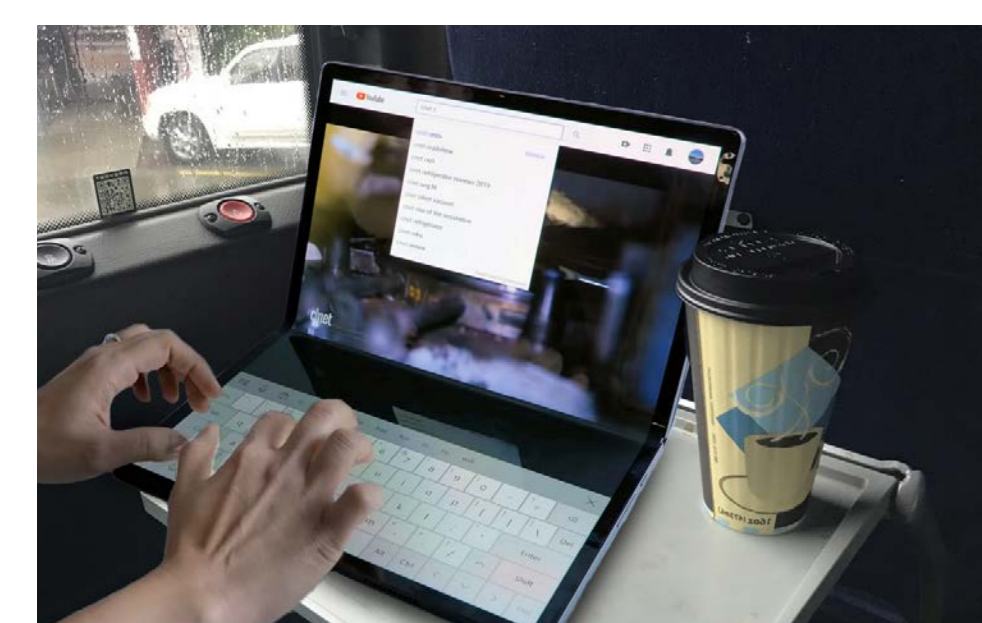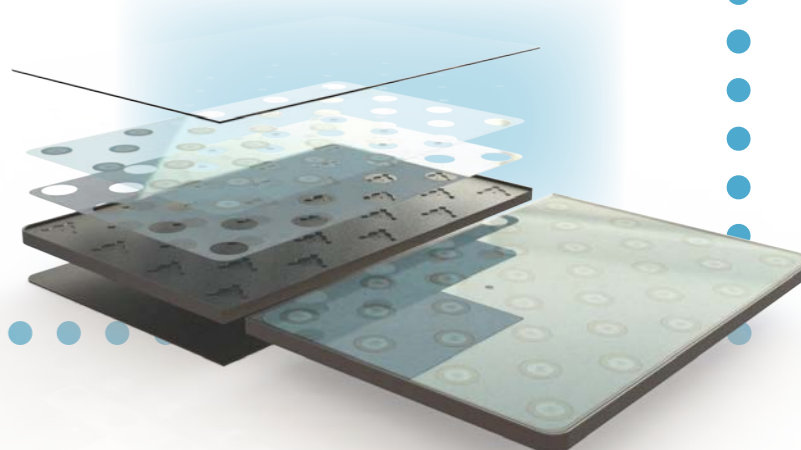*Actuating*

The System performance

Various tests were done based on the approach of audio engineers to define how Aito's structure performs for audio functionalities. This approach was chosen to compare the results to the requirements of the industry; these take volume levels and frequency range of the audio into account. When these requirements are combined, a grading system is created to help in selecting the correct speaker for specific experiences. The tests were done with simplified models of a foldable tablet because this product group is the best fit for a haptic and audio combination. How these models were created is explained in the box on the right.

The User expectations

Traditional methods to define audio quality perception were adapted to involve the users from the very beginning into the design process. This newly created method focussed on expectations for audio quality in foldable laptops and tablets rather than concentration on perception, which is measured at the end of the process. By letting user participate earlier on in the process, the audio quality experience can be changed efficiently. The perceptions could improve the experience at the end of the process while the expectations change it in the beginning

The Model Design

In total, there were eight individual models used during the system performance testing. All these model originated from one basic model, which was a simplified foldable tablet structure; this model can be seen below. Its structure is separated into two identical halves to be able to create stereo audio when both halves are used. In the individual models, changes were made to test the effects of different surface materials, surface edge fixtures, piezoelectric disc layouts and uses of the space behind the system. These changes were mainly based on the design principles of distributed mode loudspeakers and multiactuator panels but were combined with some design principles dictated by Aito and the speaker industry.

The Viability

This research was a first step in the direction of audio with Aito's current setup. From the performance of eight models in combination with the user expectations on foldable laptops and tablets can be concluded that the technology is not yet there. However, for less demanding products, such as intercoms, the audio quality might be deemed good enough as is. There is also the possibility to use the system only for higher frequencies and haptics and add another speaker to generate lower frequencies. If this project is continued, an amplifier specific for Aito's system has to be created, and the testing should be done with a real product rather than a simplified version.

1 Frank is on his way to work and already answers some emails on his device by folding it in laptop modus. The lower part of the tablet is the keyboard, and the top portion displays his programs.

2 When Frank gets to his desk, he unfolds his device to use it as a monitor when it is placed in its dock. In full-screen mode, both halves can function as a speaker, which creates a stereo effect.

3 When he arrives home, his daughter Lily can play a hide and seek game on the tablet. This game is based on touch and sound location to find her favourite game characters.

4 Because of the lockdown, Frank has to Skype with his friends to have a game night and drinks. In the laptop position, he can simultaneously see his friends and the game.
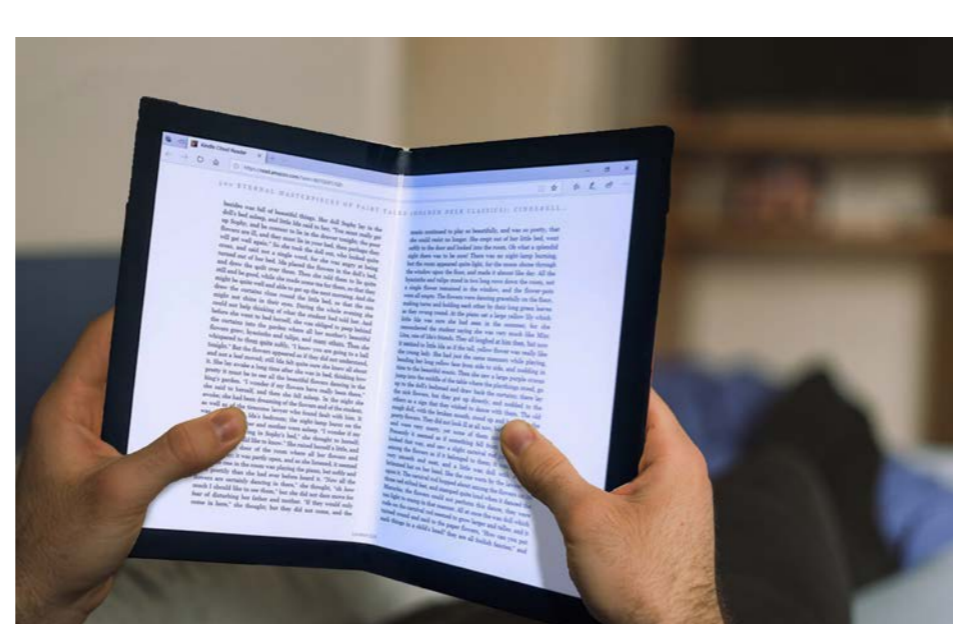
5 Before he goes to sleep, Frank reads some chapters of a book in bed. He folds the device in half so he can hold it as a book and turns the night-time setting on to filter blue light.

6 When the tablet has reached the end of its life, it will be disposed of. Because of the elimination of speakers and a keyboard, less plastic and critical materials will be thrown away.

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