# *Twech*: A Mobile Platform to Search and Share Visuo-tactile Experiences

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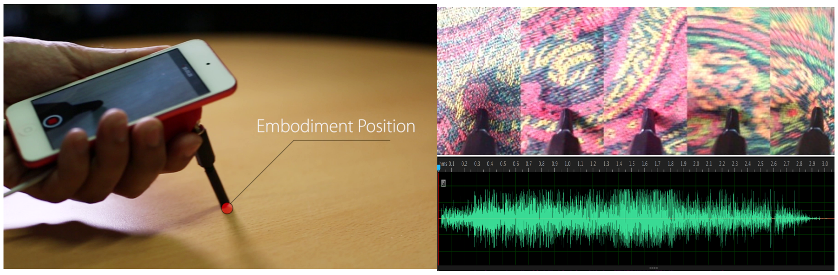


**Figure 1.1:** *Example of recorded experience data (a scratching cloth)*

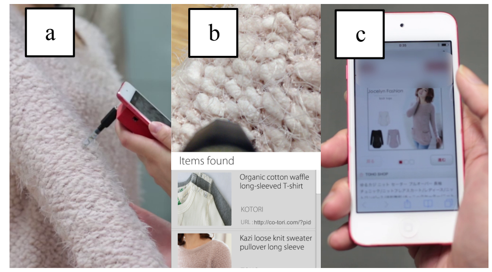


**Figure 1.2:** *(a)Record textile (b)Search textile (c)Present and Suggest*

## 1. Introduction

Using social networks in our daily life, users sometimes upload their experience; for example, foods, magnificent views, a gathering scene with friends etc. These events are taken by a camera, recorded by a microphone, or archived by a video camera. These data provide us with visual, sound or integrated audio-visual experiences through the Internet. However, up until now, the sharing of corresponding haptic experiences has not been possible. If this haptic experience can be shared, this sensory feedback will be compelling enough and is easy to understand what people are experiencing by a first-person perspective.

The TECHTILE toolkit [Minamizawa et al. 2012] is an easy-to-use device that can record and playback realistic haptic experiences. This device captures solid borne wave produced by friction-evoked sound using a microphone. As a haptic feedback actuator, they use a vibrator and directly input amplified audio signal that is captured by a microphone. Since recorded audio signal is highly associated with haptic event, we can enjoy high fidelity haptic experiences using this device.

In this works, we propose a mobile platform, called *Twech*, which enables users to collect and share visuo-tactile experiences. This platform also provides a function that enables to find materials that can provide similar haptic feeling. User can record and share visuo-tactile experiences by using a visuo-tactile recording and displaying attachment for smartphones. This system allows users to instantly share their experiences with social media, and re-experience shared data such as visuo-motor coupling.

Further, *Twech*'s search engine finds similar experiences, which were collected by scratching material surfaces, communicated with animals or other experiences. Tactile data is analyzed using deep learning algorithm that ware expanded for recognizing tactile materials. When this engine was included in web shopping store, user may find similar clothes based on analysis of recorded signals. In other words, user can search tactile data for textures instead of using explicit verbal expressions.

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## 2. System Description

*Twech* is consisting of two different components: one part is meant to capture video and audio signals that are associated with tactile experience. Another part is meant to provide haptic experience that is similar to recorded signals. Below, we will discuss how these captured images are analyzed in the developed signals.

### 2.1. Attachment for Record and Display

We proposed a smartphone extension for sharing visual and tactile experiences [Nakamura et al. 2015]. As shown in Figure 2 (left), the device consists of a tactile amplifier (AMP15W-8006), a tactile microphone (PRIMO MX-M4758) that is able to capture frequencies as low as approximately 10Hz, a voltage divider and a haptic actuator (Tactile Lab Haptuator Mark-II). This actuator is strong enough to provide haptic feedback with entire smartphone device. This configuration is also effective to make participants be aware to touching it. The microphone, which was embedded in the contact probe, helps users to pay their attentions to the contact point between the probe and materials. The captured data was recorded by audio signal. This audio signal is converted into tactile signals by presented with the Haptuator. Previous study showed that high fidelity tactile feedback was achieved with this method [Minamizawa et al. 2012]. To re-experience recorded by users, this system uses visuo-motor coupling situation and accordingly playbacks the recorded tactile data. In addition, this method is our previous research provides sufficient information to re-experience the scene by body motion using badminton racket [Mizushina et al. 2013]. These give us an alternative method to provide embodied experiences through shared experience, which were recorded by other person.

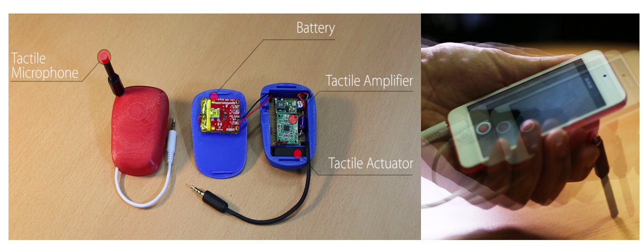


**Figure 2:** ***Attachment overview (left) and Visuo-tactile experience (right)***

## 2.2. Haptic search engine

To achieve what to search for tactile data, we develop haptic search algorithm, which finds similar tactile data. We employ a convolutional neural network algorithm for tactile recognition [Krizhevsky et al. 2012]. This architecture is capable of learning scale and translation invariances. Applying this learning algorithm in tactile search system, scale invariance of tactile data is equivalent to the amplitude of audio signal. Translation invariance is associated with frequency shift that is caused by the difference of touching speed. Those invariances successfully analyze our collected dataset; for example, the system can classify how users touch an object with slow or fast speed. The input data was also analyzed using spectrogram, and the data was divided into low frequency (0Hz-1000Hz) and high frequency (1000Hz-20kHz) components. Spatial configuration of contact surface is also classified based on the time structure of measured signal, suggesting whether the surface texture is rough or smooth (see Figure 3). Final output of analyzed data is shown in Figure 4, suggesting that collected signals were successfully classified into small number of categories. This network recognizes search results, which based on vibro-tactile map, as shown in Figure 5. This figure shown that X-axis is low frequency vector and Y-axis is high frequency vector. When network gets new material, our developed recognition system is capable of calculating the similarity of new input with known materials. As you can see in this figure, left bottom area's materials has roughness texture, for example washboard, shell and LEGO. On the other hand, right top area's materials have smooth textures and almost of them are textiles.

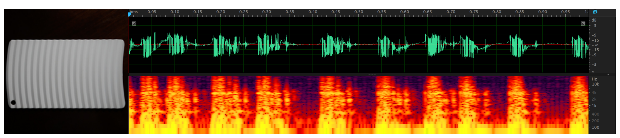

**Figure 3**: ***Washboard's photo and spectrum***

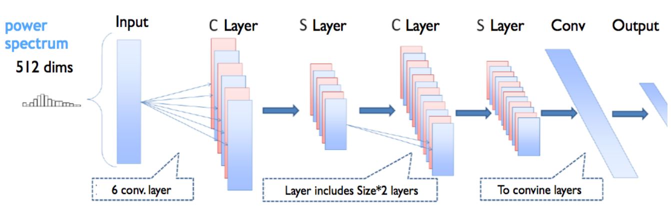


**Figure 4:** ***Machine Learning of tactile recognition***


**Figure 5:** ***Tactile map: Blue) shell and LEGO, Red) textiles***

## 3. Possible User Experience

*Twech* is a mobile platform that enables users to share visuo-tactile experience and search other experiences for tactile data. User can record and share subjective experiences using visuo-tactile information recorded and presented with developed attachment for smartphone. This setup allows the user to instantly such as tweet, and re-experience shared data.

Further, *Twech*'s search engine finds similar visuo-tactile experiences, which cam be the feelings of scratched material surfaces, communicated with animals or other experiences, from collected tactile data. This similarity is automatically calculated by using search engine is based on deep learning, *Twech* provides sharing and finding haptic experiences and users re-experience uploaded visual-tactile data from cloud server, as shown in Figure 1.2.

In addition to, this system also provide platform to share interactive experience with animals. The recorded data will be utilized recorded enhanced interacting with animals along visuo-audio-haptic feedback. Users who can't even touch them, may be able to have interactive experience with animals.

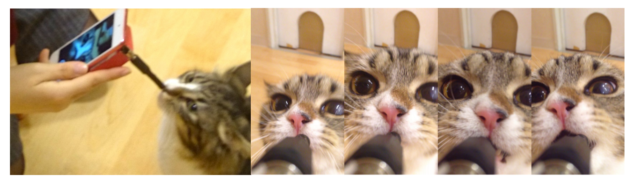

**Figure 6:** ***Record play with a cat***

## 4. Acknowledgements

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