Creating Tactile Emotional Expressions Based on Breathing Patterns

Ning Zhang[1,2]
1. Nanjing University of Science & technology
2. Eindhoven University of Technology
n.zhang@tue.nl

Min Li[1,2]
1. NXP Semiconductors
2. Eindhoven University of Technology
min.li@nxp.com

Bin Yu
Eindhoven University of Technology
5612 AZ Eindhoven
b.yu@tue.nl

Yajun Li
Nanjing University of Science & technology
lyj5088@163.com

Pengcheng An
Eindhoven University of Technology
5612 AZ Eindhoven
P.An@tue.nl

Jun Hu
Eindhoven University of Technology
5612 AZ Eindhoven
J.Hu@tue.nl

ChineseCHI '18, April 21–22, 2018, Montreal, QC, Canada
© 2018 Copyright is held by the owner/author(s).
ACM ISBN 978-1-4503-6508-6/18/04.
https://doi.org/10.1145/3202667.3202697

Abstract
This paper presents an efficient and direct method to transform emotional signals into tactile signals. The tactile expressions were implemented with a triangle wave oscillator from an open-source library. To gather user experiences and design implications, one study was carried out to evaluate whether the tactile expressions could enhance the emotional experience with the visual emoji. Results indicate that the proposed vibration patterns can enhance the expressiveness of emoji icons and that they can also be used independently from the visual media.

Author Keywords
Tactile expression; Vibrotactile stimuli; Breathing emotions

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
Tactile emojis are often designed with a focus on mapping between emotions and tactile signals, as known as emotion-to-vibration mapping 2. Shin et al. 4 proposed a *TCON* (Touch Emoticon) compiler and created six emotional icons. Mathew 2 developed nine

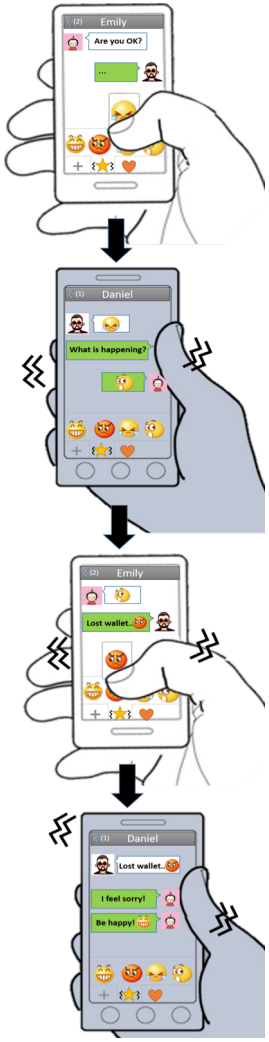

Figure 1: Tactile emojis for WeChat.

different kinds of *vSmileys* using the Immersion Studio 4.0. Tünnermann et al. 5 tuned the vibration intensity with the acceleration sensor. Park et al. 3 mapped six affective touch behaviors on tactile feedback signals using a multi-touch mobile device. Chang 1 investigated the relationship between touch pressure and vibration signals to complement voice communication with tactile feedback. These methods use compilers to generate or transform signals, which is however not directly based on or related to emotional signals. The vibration signals for different emotions have to be learned and remembered with practice by the users 2, which cannot directly convey the emotions and will cause additional burden for the users.

In this study, we propose to generate tactile emojis based on breathing patterns (TEB). Breathing pattern associates with emotional variations. And it is familiar to us. Therefore we assumed that the proposed tactile expressions derived from breathing patterns could be subtly and intuitively perceived by users and naturally associated with the emotions intended to express. A user study was carried out to investigate to what extent the proposed tactile expressions could enhance the emotional experience with the visual emojis.

1. Design concept

When using instant message applications there are different scenarios such as group chat, notifications when standing-by, and sending and receiving messages during a one-to-one chat. In this paper, only the one-to-one chatting with tactile expressions is explored. Fig.1 shows the use scenario of the tactile emojis in WeChat. Two individuals named Daniel and Emily are chatting, with the support of the TEB emojis. Each pair of braces, {}, represents a tactile emoji icon. For example, {sad} represents a sobbing tactile vibration. Emily asks Daniel *"Are you OK?"* Instead of sending text, Daniel chooses to reply with a single tactile emoji icon to continue this conversation. That icon {sad} can describe his emotion at this very moment. Emily not only sees the sad visual emoji but also feels a tiny force impulse when receiving Daniel's tactile emoji. The chat continues with texts as well as the tactile responses with various different modes for different emotions.

2. Prototyping

The design goal of TEB was to explore a new approach to design tactile emojis based on human breathing patterns for facilitating user recognition and experience with the emotional information. As shown in Fig 2, for each emotion, we selected a set of typical breathing patterns associated with the specific emotional expressions. The tactile expressions of TEB were implemented by the triangle wave oscillator of the *Sound* library in *Processing* platform. As shown in Fig 3, the basic vibration pattern has a rectangular or trapezium shape of the envelope, which can be manipulated by four parameters: *Attack-time*, *Sustain-time*, *Sustain-level*, *Release-time*. We modulated the parameters of the basic vibration patterns and then combined them to represent the breathing pattern derived from the audio signal. Through an audio-to-haptics driver, the audio signal was then converted into the vibrotactile stimuli of a Linear Resonant Actuator (LRA) vibration motor. The LRA motor has an internal mass that oscillates back and forth along the X-axis at its resonant frequency. In this study, a rectangular LRA motor was attached on the back of a smartphone. Participants held the phone in one hand to feel vibrations, as shown in Fig 4.

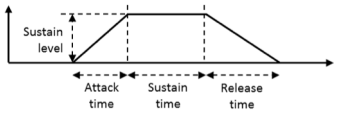

Fig 3: The basic vibration pattern with trapezium shape of the envelope.

Basic pattern	Attack time (s)	Sustain Time (s)	Sustain Level (s)	Release Time (s)
1	0.001	0.5	0.8	0.5
2	0.001	0.4	0.6	0.4
3	0.001	0.3	0.4	0.3
4	0.001	0.2	0.2	0.2
5	0.001	0.1	0.1	0.1
6	0.5	0.2	0.5	0.5
7	0.1	0.1	0.1	0.001
8	0.2	0.2	0.2	0.001
9	0.3	0.3	0.4	0.001
10	0.4	0.4	0.6	0.001
11	0.5	0.5	0.8	0.001
TEBemoji	**Structure of Composite Patterns**			
1. Happy	1-2-3-4-5			
2. Surprised	6			
3. Sad	4-5; 4-5; 4-5			
4. Angry	5-4-3-2-1			

Table 1: Basic and composite vibrotactile patterns

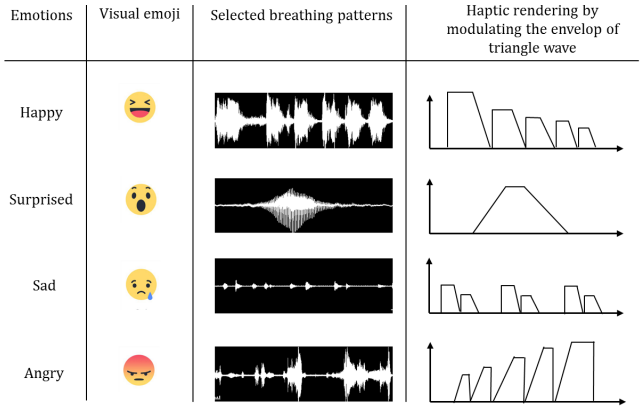

Fig 2: Envelop of Triangle wave for tactile rendering. Breathing patterns were selected from open-source sound recordings.

As shown in Fig 2, TEB is rendered by a combination of multiple basic vibration patterns of trapezium shapes. Table 1 shows the composite vibration patterns to encode four emotions. To express the emotion 'happy', five different patterns are combined to mimic the breathing pattern during laughing. The second TEB expresses 'surprised' feeling. Only one basic vibration pattern with a long Attack-time, a shot Sustain-time and a long Release-time to get a vibrotactile sense that mimics the sound *"Wow"*. The third TEB expresses the emotion of 'sad'. Two different vibration patterns with different Sustain-time, Sustain-level and Release-time are combined to mimic the breathing pattern during crying or sobbing. The fourth TEB expresses the emotion 'angry'. Five vibration patterns of increasing intensity are combined to mimic the sound of *"growl"*.

3. Study

3.1 Participants

The proposed TEB were evaluated with 20 participants including ten males and ten females. Their ages ranged from 22 to 36 with an average of 24.8. All the participants were informed in advance about the purpose of the experiment.

3.2 Procedure

The IM chatting task was simulated by the experimenter and the participant with smartphones in their hands, using WeChat. The test setting is shown in Fig. 4. When receiving IM emojis, users would experience vibration patterns from their smartphones. The participants were asked to comment on whether the TEB patterns match with visual emojis and enhance their emotional experiences. We interviewed the participant for their opinions about the tactile emojis, and further describe their feelings about them.

3.3 Results

The users were asked to describe feelings about the vibration patterns and provide comments.

Happy. Sixteen participants stated that they could feel the emotion of the 'happy'. Thirteen of them felt that the pattern was similar to giggles, which fit the design based on. Four of them stated that the designed pattern was similar to the exaggerated laughter in traditional Chinese operas. Three of them stated that they felt a cheerful and informal way of laughter. Some of their responses are shown below. *"I am not sure if people from other cultural backgrounds could feel it, but I get a traditional Chinese 'Hehe'."* (P3) Three participants chose neutral and stated that the vibration of 'happy' is quite abstract and hard to understand.

Figure 4: Test setting.

Some participants also suggested that they could feel the design while they did not prefer. *"Laughter of 'Ha~Ha~Hahaha' is separated. I can feel the pattern is designed this way, but I do not really like it."* (P7)

Sad. Twelve participants stated that the vibration pattern matched well with the expression. They could feel the short and repeated vibrations. Nine of them thought that it was similar to constant and soft sobbing. Two of them stated that the vibration pattern was like the feeling of having aggrieved. *"I quite agree. It feels like sobbing."* (P6) Five participants provided suggestions for improving the design. Some believed that the vibration should be stronger for crying. Two of them said that the pattern last too short.

Surprise. Eight participants stated that the pattern matched well with the emotion. Five of them thought that the pattern contained a feeling of being astonished like *"Hah? Really?" "I believe it is saying 'Hah?' The vibration is good for the emotion."* (P7) Five Participants suggested a higher frequency before the pattern ends. A pattern of deep breathing could be added to the end.

Angry. Nineteen participants agreed that the selected pattern could be used to represent the emotion of anger. The vibration frequency is high, which express a strong, urgent atmosphere. Four of them believed that the situation was urgent and pushing when using this pattern. Three of them thought that it was similar to an angry snort with strong emotion. The following shows some comments from the participants. *"It feels like an urgent thing to do. With two of it, the situation becomes very urgent. I am being pushed."* (P3) Three participants suggested that the vibration could still be improved. It should be lighter at the beginning while stronger at the end, with a break added in the middle.

4. Discussions and Conclusions

The results of study one show that in the context of chatting with IM, the majority of the users agree that the tactile patterns can to a certain extent enhance the emotional communication in addition to the visual emojis, although it may work better for some emotions ('happy', 'sad', 'angry') than other ones ('surprised'). The proposed tactile emojis based on the breathing patterns can be applied directly to existing IM applications such as WeChat, QQ, and WhatsApp. Our succeeding work will focus on exploring more tactile expressions and different application scenarios.

REFERENCES

1 Angela Chang. 2002. ComTouch: A vibrotactile mobile communication device. Massachusetts Institute of Technology.

2 Deepa Mathew. 2005. vSmileys: Imaging emotions through vibration patterns. *Altern. Access Feel. Games* (2005).

3 Young-Woo Park, Chang-Young Lim, and Tek-Jin Nam. 2010. CheekTouch: an affective interaction technique while speaking on the mobile phone. In *CHI'10 Extended Abstracts on Human Factors in Computing Systems*, 3241–3246.

4 Heesook Shin, Junyoung Lee, Junseok Park, Youngjae Kim, Hyunjoo Oh, and Taehwa Lee. 2007. A tactile emotional interface for instant messenger chat. In *Symposium on Human Interface and the Management of Information*, 166–175.

5 René Tünnermann, Christian Leichsenring, and Thomas Hermann. 2010. Direct tactile coupling of mobile phones with the FEELABUZZ system. In *International Workshop on Mobile Social Signal Processing*, 74–83.