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Haptic-Emoticon: Haptic Content Creation and Sharing System To Enhancing Text-Based Communication

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Abstract: In this paper, we introduce Haptic-Emoticon, which is used in a text message. It expresses a writer's emotion and/or decorates the message with physical stimulus on a reader's skin. We employ stroking motions for that purpose. The motions are represented as a 2D trajectory so that a writer can create the Haptic-Emoticon with a conventional pointing input device. The input line is recorded as an image data in an existing image format. The Haptic-Emoticon can be shared on Twitter network because it is an image file. By employing Twitter, a worldwide SNS network, as an infrastructure for sharing the Haptic-Emoticon, we expect that users (writers and readers) evaluate their creative works each other. Moreover, by combing it with a Twitter text message, the Haptic-Emoticon could be a context aware haptic content to enrich text-based communication.

Keywords: Haptic-Emoticon, haptic content, user generated content (UGC), physical communication.

1. INTRODUCTION

Text message is still the most common channel for a computer-mediated communication. Although we can access remote video communication service easily, we mainly use e-mails, text chats, short messaging services, and social network services (e.g. Twitter [1]) for daily computer-mediated conversation. However, we feel difficulty to convey our emotion to others with text-based messages compared to face-to-face communication. To transmit emotional expressions via text-based messages, we usually use emoticons.

An emoticon (emotion + icon) is a graphical character which is embedded in a text message. Here, in this paper, a term "emoticon" includes not only traditional plain text icons (e.g. ":-)", "(!o!)") but also graphical images embedded in text message such as HTML e-mails. We can use various emoticons including smile, angry, surprise, etc. to express current emotion. Not only transmitting our emotions, emoticons includes various signs to express some objects, life events, and animals, etc. These emoticons are used to decorate messages. In the field of Human-Computer Interface research, Rivera et al. have studied the effects of emotional communication by using emoticons in [2]. It was indicated that emoticons are effective for emotional communication via remote.

Meanwhile, physical contact (touch) is a fundamental channel to express emotion and indicate intimacy in face-to-face communication (e.g. hug, handshake, etc.). Hence, a lot of researchers have shared a motivation to establish a more enriched remote communication system by applying haptic feedback to computer-mediated communication. InTouch [3] applies haptic feedback technology for remote interpersonal communication. Shimizu et al. [4] and Sugiura et al. [5] have proposed physical interaction systems using robotic motions of plushie. Hashimoto et al. demonstrated Emotional Touch display [6, 7]. The system was designed to display emotional information on a user's palm. Furukawa et al. have developed Kusuguri [8] which realizes remote hand-to-hand tickling with the existing telecommunication infrastructure.

We propose emoticons accompanied by physical stimuli (hereafter we call them Haptic-Emoticons). We expect that combining text messages and haptic stimuli would appeal to lots of users. We emphasize not only to append haptic feeling to the conventional telecommunication but also to provide a system for diffusion and evaluation of Haptic-Emoticons while researches mentioned above are motivated by the importance of physical contact and provide various haptic feelings and experiences. For that purpose, we employ an existing social network service, Twitter, as an infrastructure of our system. The Haptic-Emoticon consists of two dimensional stroking motions. We expect that the Haptic-Emoticon is to be a haptic content. The stroking motion (trajectory) can be drawn with conventional pointing input devices such as a highly functional mobile device with a touch screen. This content is encoded in a standard image format (PNG format) and shared via Twitter. A vibrator array is our first and primitive prototype to display the Haptic-Emoticon on a users' body surface physically. Since the emoticon is recorded as an image file, users can also recognize its content visually.

In this paper, we introduce a framework of the Haptic-Emoticon system. The following section describes a brief overview of our proposed system. The haptic emotion system includes three components: creation, sharing, and displaying. We describe detailed information for each component. At the last section we conclude the paper and discuss future works.

2. SYSTEM OVERVIEW

In this section, we describe brief overview about the Haptic-Emoticon system.

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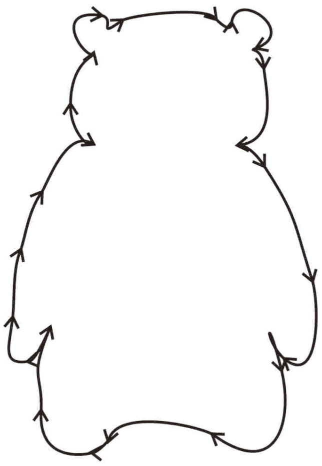

Fig. 1 2D stroking motion (trajectory) which is used as a haptic content for a Haptic-Emoticon. A stylus traces the line with the direction of each arrowhead.

The Haptic-Emoticon system employs two dimensional stroking motions to present a haptic content (Fig. 1). We assume that the Haptic-Emoticon is fingertip stroking on a palm. While a stroking motion (trajectory) is very restricted, it can represent a wide range of information from numerical and alphabet characters to abstract graphical shapes. Moreover, as with calligraphy, a stroking motion itself could be an art work because of its expressive trajectory and dynamic change of speed.

To create, share, and experience the Haptic-Emoticon, we design a framework consisting of three components: creation, sharing, and displaying. At a creation part, a user creates a Haptic-Emoticon. Because our haptic content consists of a stroking trajectory, the Haptic-Emoticon is easily drawn with conventional pointing input devices such as touch screens, mouse, graphic tablets, etc. The input trajectory is encoded in an existing image format (PNG format). Users can send, share, and view the Haptic-Emoticon via Twitter service. On Twitter, the Haptic-Emoticon is attached to a text message. A user expresses his/her emotion and decorates the message by using the Haptic-Emoticon. The following three sections describe these details.

3. HAPTIC-EMOTICON CREATION

To make it easy to create a Haptic-Emoticon, we developed a web-based application (Fig. 2). A user creates a Haptic-Emoticon by drawing a stroking trajectory in a white space. It is developed in HTML5 so that a user can access it from any device with pointing input such as a touch screen, a mouse, a graphic tablet, etc. It is also platform-independent. Currently we have confirmed that it is available on Windows OS, Mac OS, iOS, and google's Android. The web-based application is ready for public [9].

An input stroking motion is recorded as an image format. We utilize an existing image format to encode the haptic content. Currently there is no general standard for haptic information encoding and transmission. Since one of our purposes is to make a lot

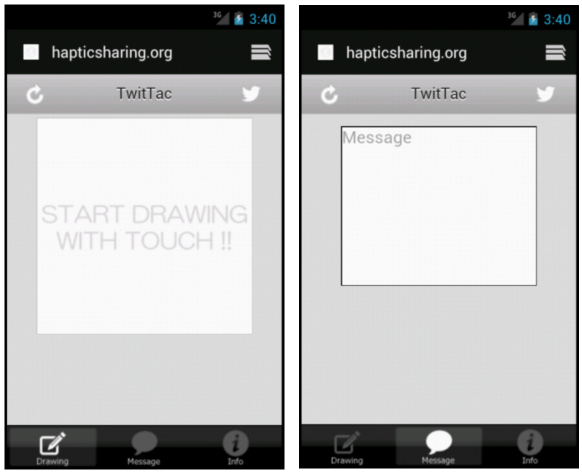

Fig. 2 A HTML5 web application to create the Haptic-Emoticon. The images shows its appearance when its web page is opened on a smartphone. A user draws a stroking trajectory in the white space displayed in the web page (Left).Then he/she inputs some text message for sharing the Haptic-Emoticon on Twitter (Right).

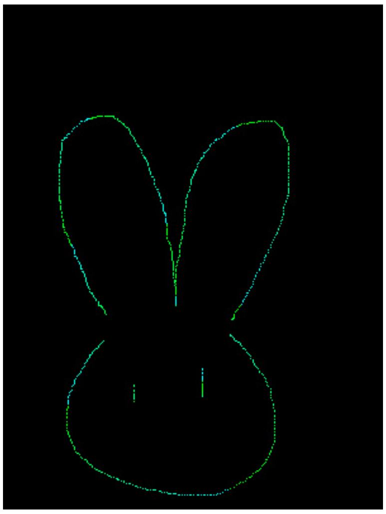

Fig. 3 A Haptic-Emoticon encoded in an image file (PNG format). Temporal information is encoded by using color channels as well as the trajectory is represented with the pixel position.

of users available to access the Haptic-Emoticon framework, our strategy is to utilize conventional and existing infrastructures or services as much as possible.

In Fig. 3, we show a Haptic-Emoticon image file. Our algorithm is quite simple. Stroking trajectory is represented with the pixel position which has any colour. Each pixel on the trajectory has RGB or CMYK colour channels which are used to encode temporal information. In other words, the pixel on the trajectory has sequence numbers. By tracing the pixels in the sequence, the input stroking trajectory is able to be decoded. Our web application uses PNG (Portable Network Graphics) format. It provides lossless data compression and so the temporal data is unchanged.

We consider that the Haptic-Emoticon format is easily expanded to express enriched haptic information. Especially, supporting pressure is the easiest one because it is realized by encoding both of temporal and pressure information in colour channels. For example, UnMousePad [10] is a multi-touch sensing technology which detects not only touch position but also pressure. These technical developments would provide a new environment to create enriched Haptic-Emoticons.

4. HAPTIC-EMOTICON SHARING

As described in Section 3, the proposed Haptic-Emoticon is represented as a 2D stroking motion trajectory and is encoded in a PNG format image. Since it is an ordinary image file, sharing the Haptic-Emoticon is available by using existing image sharing services. For example, the Haptic-Emoticon is inserted in HTML e-mail. For our original web-based application, we employ the Twitter network to share the Haptic-Emoticon.

Twitter is a social networking service (SNS) in which users can send and read text messages within 140 characters. The service is estimated that there are more than five hundred million users over the world. While Twitter is a text-based service, there are a lot of related services to send and view image data by inserting text links related to the images. In this way, we can put the Haptic-Emoticons in Twitter text messages. We utilize an existing image sharing service Twitpic [11] for the Haptic-Emoticon framework. We have confirmed that Twitpic does not modify uploaded image data.

Users can input short text messages after they create their original Haptic-Emoticons on the web application shown in Fig. 2. The system acquires Twitpic links of the Haptic-Emoticons and sends the text messages with that links.

There are two main reasons why we employ Twitter as an infrastructure for the Haptic-Emoticon. The first one is that users can share the Haptic-Emoticons with others on Twitter. When a user posts (tweets) a message, multiple users who follow him/her read it. If they have interested in the message, they can distribute (retweet) it to their follower. In this way, a message could spread beyond one individual user's relationship. This is a merit for our framework to become a common service. Moreover, we expect that the service would evolve through a huge number of users' evaluations and feedbacks of the Haptic-Emoticon. In other words, a recent trend of user generated content (UGC) is applied to the Haptic-Emoticon framework by employing Twitter as an infrastructure for distribution.

The second reason is that we consider that the Haptic-Emoticon should be context-aware haptic contents. Even with the traditional graphical emoticon, the emoticon itself is not suitable for transmitting any message. In the case of haptics, it is much more difficult to explain anything properly with physical stimuli on the body surface. Therefore, we argue that the haptic content should be a context aware representation. By using the Haptic-Emoticon accompanied by the Twitter message, users can guess its meaning or emotional expression from not only its physical (haptic) and visual appearance but also the attached text.

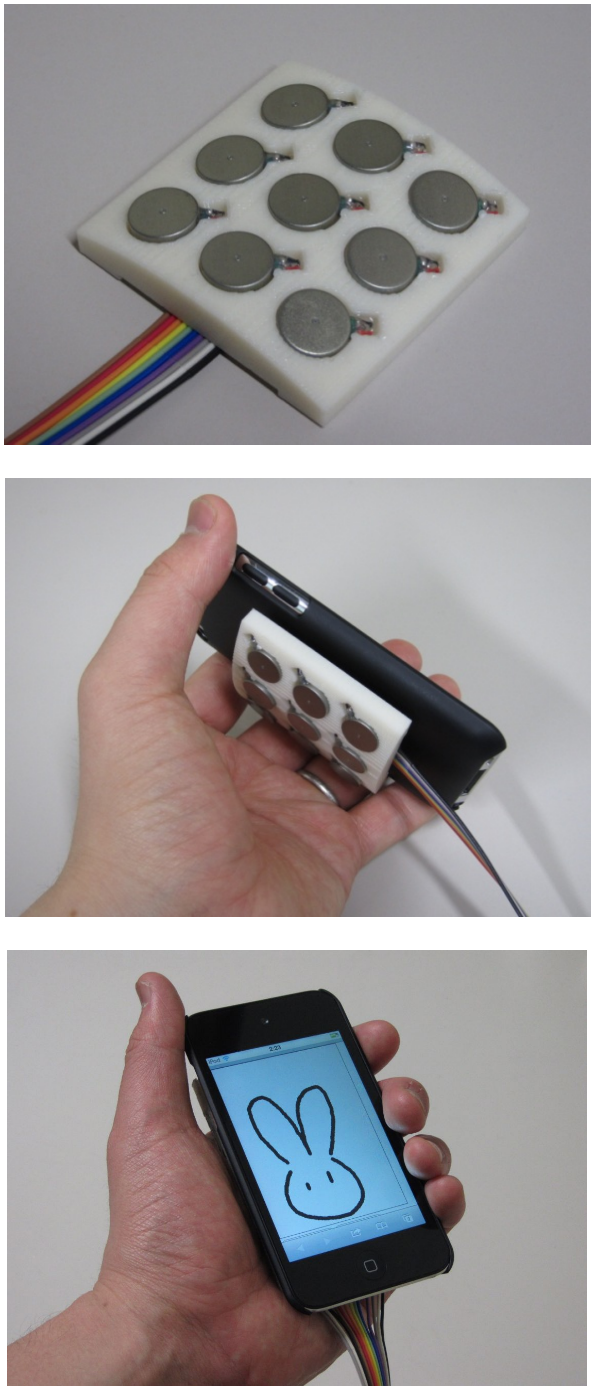

Fig. 4 A vibrator array for displaying the Haptic-Emoticon on a user's palm. It can be attached behind a touch screen device (in the above image, we use iPod touch.) so that the Haptic-Emoticon is represented visually and haptically simultaneously. In the bottom image, a Haptic-Emoticon shown in Fig. 3 is shown on the screen and displayed physically on a user's palm simultaneously.

5. HAPTIC-EMOTICON DISPLAY

In the former two sections, we show our major argument and describe how to realize it. In this section, we introduce our first primitive device to display the

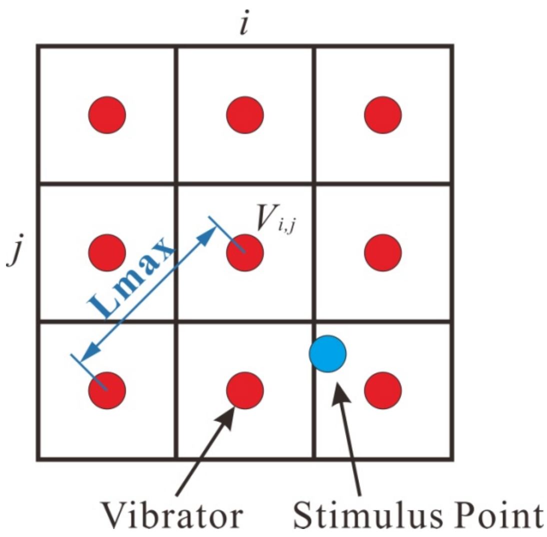

Fig. 5 An algorithm to design the vibration strength of the vibrator array shown in Fig. 4.

Haptic-Emoticon physically on a user's skin.

We fabricated a vibrator array as an initial prototype. Although there have been a lot of technologies which can display 2D trajectory stimulus on our skin, we choose the current hardware because of it can be easily fabricated with off-the-shelf parts. As shown in Fig. 4, the prototype has nine vibrators (FM34, Tokyo Parts.) with an interval of 17 mm. The vibrator array is arranged on a curved structure which was three-dimensionally printed by using a plastic material. A user's palm fit to the structure's curve. Each vibrator is driven via motor driver ICs (SN75441) and a microcontroller board Arduino [12] controls them. The total size of the vibrator array is designed to be used with a mobile computing device iPod touch. Its size is suitable for most people to use it on their palm.

Although the vibrators are arranged discretely, we can provide an apparent stroking motion by designing the driving time and force of each vibrator appropriately. For the initial prototype, we developed a simple vibrator driving algorithm. There is a diagram in Fig. 4 representing the algorithm. In our framework, there is always a single stimulus point on the skin. Driving force $S_{i,j}$ of each vibrator $V_{i,j}$ is decided from the distance between the vibrator and the stimulus point $L_{i,j}$ using the following formula.

$$S_{i,j} = 255 \times \left(1 - \frac{L_{i,j}}{L_{max}}\right) \quad (S_{i,j} \geq 0)$$

In the actual calculation, $S_{i,j}$ is a integer number from 0 to 255 and L_{max} is the distance as is shown in Fig. 5. L_{max} is an important element to dominate how many vibrators are driven simultaneously. With the design shown in Fig. 5, a number of vibrators which are driven simultaneously is 3 or 4.

We conducted a pilot study to evaluate the prototype display. One subject volunteered for the study. We displayed several trajectories on a subject's hand. The represented trajectories consist of circle, triangle, star, and rectangle. We displayed the trajectory visually on a PC screen simultaneously. The subject gave an impression that the stimulus on the palm surely traced the trajectory displayed on the visual screen. However, when the subject closed his eye, it was difficult to guess the displayed trajectory accurately.

Through the pilot study, we found that there is variability of vibrating force depending on the stimulus position. Additionally, the current prototype cannot provide a smooth apparent motion on a palm. The design of vibrator driving force has been studied by Borst et al. [13]. We are planning to improve the vibrator driving method through using these related studies.

6. CONCLUSION

In the former two sections, we show our major argument and describe how to realize it. In this section, we introduce our first primitive device to display the Haptic-Emoticon physically on a user's skin.

In this paper, we introduced the Haptic-Emoticon framework. The Haptic-Emoticon is a haptic icon which is embedded or inserted in a text message to express emotion and decorate the message.

We described the system overview and details of three components of the framework: creating, sharing, and displaying. To achieve a prevailing haptic technology, we employ a 2D stroking trajectory as a haptic content. The stroking trajectory is drawn with a conventional touch screen device and encoded in an existing image format. The Haptic-Emoticon image data is shared on Twitter by using an image sharing service, Twitpic. A user posts a message with Haptic-Emoticons on Twitter by using our web-based application. To display the Haptic-Emoticon physically on a user's palm, we fabricated the primitive prototype of a two dimensional vibrator array. The pilot study indicated that the prototype could display an intended line, while we need to improve it for more natural and smooth trajectory representation.

For future works, we improve the Haptic-Emoticon display. Additionally we are planning to release all information about our framework and evaluate how the Haptic-Emoticon will be used by users.

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