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# Assessing Emotional Sharing Using Air-Transmit Haptic Communication Device

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Abstract: Touch plays a crucial role in communication. In this study, our objective is to determine whether individuals can convey emotions via an Air-Transmit Haptic Communication Device that can transmit air pressure. The haptic device allows participants to communicate the opening and closing movements of their hands. Participants viewed videos and then expressed their emotions using the device. Our results suggest that people can successfully share feelings of excitement through the haptic device. We think that this result can contribute to richer online communication.

Keywords： Touch Communication, Haptic Device, Social Touch

## 1. Introduction

In our face-to-face communication, not only verbal communication but also nonverbal communication such as physical interaction plays an important role. For example, we touch the other person's back to encourage them or high-five them to share our joy. The perception of touch consists of the kinesthetic system, which is related to the movement and position of limbs, and the aneous system, which is related to stimuli from various receptors in the skin. Through touch, we can perceive different types of stimuli such as vibration, temperature, pressure, pain, and position [1]. Previous studies have shown that direct touch on the arm can convey emotions with the recognition performance far above the level of chance [2]. This has also been shown to be true for the Japanese [3]. An example based on this is the remote high-fives can be used to share joy. Remote high five is a haptic communication device to convey joy [4]. This remote touch has been shown to increase the sense of togetherness and share the feeling of watching together because of the sense of touch. Thus, it is shown that remote high touch gives a new experience. In this study, we experimented with a haptic device that can transmit hand movements pneumatically to share emotions.

## 2. Method

### 2.1 Participants

Ten men and ten women participated. The participants were informed prior to the experiment that their privacy was guaranteed and approval of the research protocols by Kyushu University was obtained. The participants ranged in age from 18 to 24 years; the mean age was 21.8 and the standard deviation was 0.98. All participants made a pair and each pair consisted of the same gender. 19 participants were right-handed, and 1 participant was left-handed. All participants claimed to be free of serious problems in vision and their hands. The present study was approved by the Institutional Review Board of Kyushu University.

### 2.2 Apparatus

An air-transmission haptic communication device as shown in Fig.1 was used to transmit the open-and-close hand movements. Watanabe et al. [5] developed this device and used for watching sports and sharing the excitement with visually impaired people. The haptic device was composed of two soft tennis balls (inside diameter 66mm) and a silicon tube (inside diameter 1mm, outer diameter 2mm length 500mm). This makes it possible to transmit air pressure. Therefore, they can convey not only conscious hand movements but also unconscious hand movements. This is simple, so it is not sensitive to language, culture, and disabilities.

**Fig.1: Air-transmission haptic communication device.**

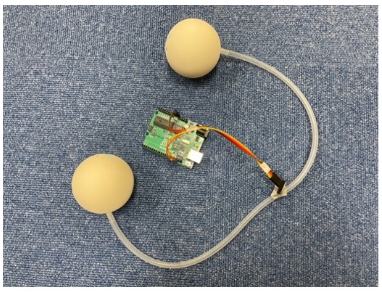

**Fig.2: Air-transmission haptic communication device and a measurement sensor**

### 2.3 Measurement

We measured air pressure with Adafruit MPRLS Ported Pressure Sensor Breakout (sampling rate 100Hz, the microcontroller is Arduino Uno R3, recorded by Mac). We made a small hole in the middle of the silicon tube and attached this sensor to that hole Fig.2. During the experiment, participants hands were recorded by a video camera.

### 2.4 Video dataset

We selected videos from the database, the Open Library for Affective Videos (OpenLAV) [6], which aimed at affective induction. The videos of OpenLAV consist of 188 videos and have a CC-BY license. Each video is given some value or label such as the value of valence and arousal, the emotion label by experimental participants. The value of valence and the value of arousal were continuously annotated on a 9-point Likert scale (1- " extremely unpleasant " to 9- " extremely pleasant " and 1- " extremely " and 1- " extremely calm " to 9- " extremely excited " ) by experiment. We selected 8 videos for the main session and 1 video for the practice session from OpenLAV, 2 videos are high valence and high arousal (high-V/high-A), 2 videos are low valence and high arousal (low-V/high-A), 2 videos are low valence and low arousal (low-V/low-A), and 2 videos are high valence and low arousal (high-V/low-A). These 8 videos were divided into group A and group B. Both 2 groups had a high-V/high-A video, a low-V/high-A video, a low-V/low-A video, and a high-V/low-A video. Group A ' s video codes were VID_408, VID_113, VID_1001,

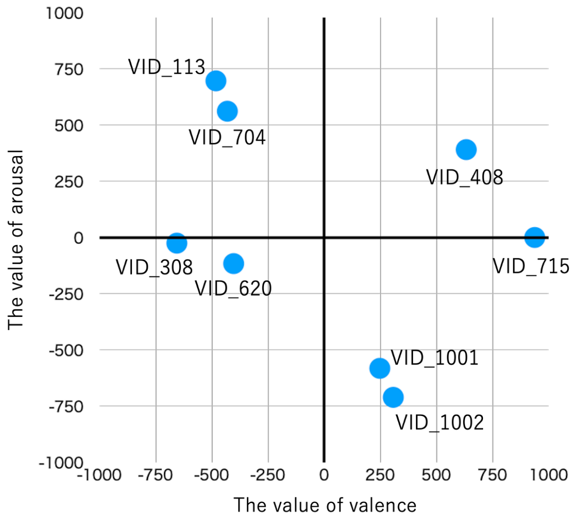


**Fig.3: The values of valence and arousal of selected videos**

and VID_308. Group B ' s video codes were VID_715, VID_704, VID_620, and VID_1002. The video code for the practice session was VID_721. The values of valence and arousal for each video are shown in Fig. 3. Four impressive scenes were determined for each video. We investigated participants' emotions in more detail by asking them about their feelings about four impressive scenes in the video.

### 2.5 Procedure

On arrival, participants sat at a table and were separated by an opaque white curtain. Participants could neither see nor talk to each other during their experiments, and they could not provide nontactile clues to the emotion being communicated. During the experiment, the room was dark to concentrate on watching videos. Participants got an explanation about the air-pressure ball, but they didn ' t specify how to grasp and use that device. Before watching the videos, each participant held a ball lightly and we measured air pressure for one minute to measure baseline air pressure. Participants watched a video and answer the questionnaire for practice. After the practice session, they did the main session. In the main session, they repeatedly watched a video and answered a questionnaire four times. Half of the participants watched Group A videos and the other half watched Group B videos. After watching each video, participants answered valence on a 9-point Likert-scale (1- " extremely unpleasant " to 9- " extremely pleasant" ) as shown in Fig.4 and arousal on a 9-point Likert-scale (1- "extremely calm " to 9- "extremely excited" ) as shown in Fig.5 with the Self-Assessment Manikin (SAM) scale [7] about what they felt from the 4 pre-selectd scenes and what they received from their partner through air-

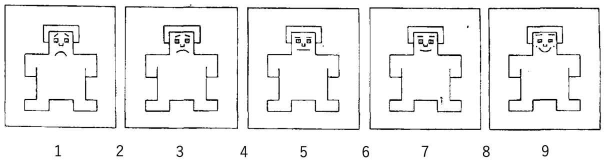


**Fig.4: The Self-Assessment Manikin (SAM) used to rate the affective dimensions of valence**

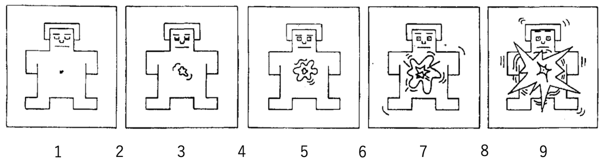


**Fig.5: The Self-Assessment Manikin (SAM) used to rate the affective dimensions of arousal**

pressure ball. After participants watched all videos, they answered whether they get a new experience through communicating with the air-pressure ball and comment on the experiments.

## 3. Result

### 3.1 Valence and arousal ratings

To assess whether the haptic device was able to convey emotion, we conducted correlation analyses. We calculated the correlation between the value of valence participants felt from videos (Self-report valence) and the value of valence felt from the partner via the device (decoded valence) (pearson ' s r = 0.636, p ¡ 0.001), and between the value of arousal participants felt from videos (Self-report arousal) and the value of arousal felt from the partner via the device (decoded arousal) (pearson ' s r = 0.518 p ¡ 0.001). Both valence and arousal had a significant and positive correlation between self-reported and decoded values. Fig.6 shows the value of valence felt from videos and felt from the haptic device, and Fig.7 shows the value of arousal felt from videos and felt from the haptic device. The density of each point of these figures indicates the overlap of the data. The darker the density, the more data overlap.

### 3.2 Air pressure change

We analyzed the air pressure change during watching videos. While they watched videos, they can transmit the information the strength of the hand grip and the frequency of the hand grip through the device. There was a particularly large air pressure change during VID_408 and Fig.8 shows it. The x-axis shows the viewing time, and y-axis shows the difference between the standard of air pressure that was measured for 1 minute before watching videos and the air pressure during watching the video. The dashed lines on the vertical axis indicate the timing

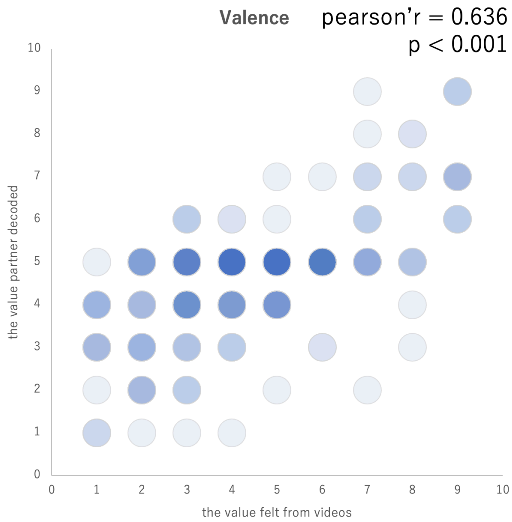


**Fig.6: The value of valence. The density of each point indicates the overlap of the data. The darker the density, the more data overlap.**

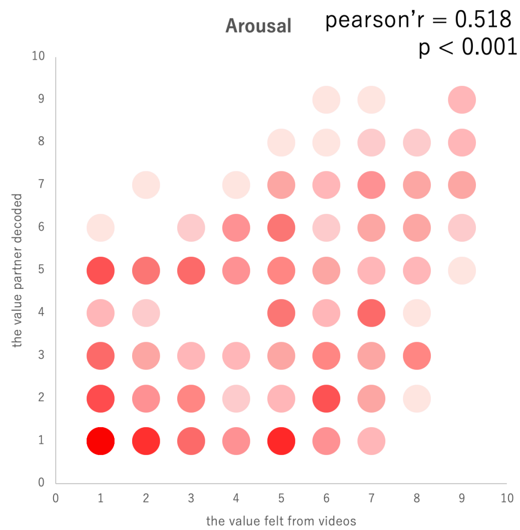


**Fig.7: The value of arousal. The density of each point indicates the overlap of the data. The darker the density, the more data overlap.**

of the four impressive scenes presented in the questionnaire. VID_408 was a video of an astronaut landing on Earth from space. From this graph, there were air pressure changes in some pairs especially from 1:19 to 3:18. This was a very tense scene.

### 3.3 Comments

We assessed the questionnaire to see whether participants were able to have new experiences through communicating with the haptic device. From this questionnaire, 65% of participants answered they had new experiences. Table. 1 is some of the participants ' thoughts. Some participants said that they can share the emotion to some extent, but some emotion was difficult to share, such as sadness or relief.

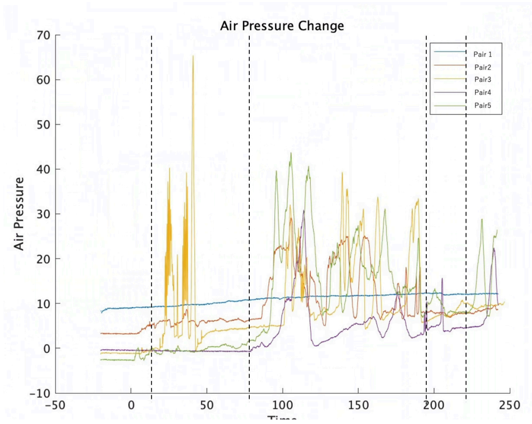


**Fig.8: Air pressure change during watching VID_408, a video of an astronaut landing on Earth from space.**

**Table.1: Some comments from participants**

| Comments |
|---|
| 驚きや喜びの感情は伝えやすいが、悲しみや安心などの起伏が緩やかな感情については伝えるのが難しいと思った。 |
| 相手がどういうときに感情が変化しているかが分かったし、それが自分の感情の変化を誘発することもあった。 |
| 感情を共有できて同じタイミングで感情の変化が起きていたことに安心感が生まれた。 |
| コンテンツを見ている際は観ることに集中しており、他人と気持ちを共有することまで思考が回りにくいと感じた。また、受け取る感情は自分の感情と引き付けて考えてしまいがちだと思った。 |

## 4. Discussion

In this experiment, we found that there was a significant positive correlation in the sharing of emotions for values of valence and arousal. This indicates that people can share the degree of excitement and calm and the degree of pleasure or unpleasure when they watch the same videos using an air-transmission tactile communication device. The two types of information are presumably transmitted through the device are the strength of the hand grip and the frequency of the hand grip. Thus, the valence and the arousal may be expressed by the combination of the strength and frequency of the ball movement. Since an air-transmission haptic communication device could convey emotions to some extent and provide new experiences, this finding should contribute to the development of haptic interfaces for richer online communication.

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