

Emotional Communication by Using a Tactual Communication Tool

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Abstract—The purpose of this study is the development of a tactual communication tool that conveys emotional communication during an oral conversation. In the present study, emotional communication using a tactual communication tool was examined, and the features of emotional communication were analyzed. As a result, the senders expressed surprise by unique strong and short one-time grip; joy and anger by strong multiple grips with constant short intervals; and sadness, disgust and fear by weak grips with constant short intervals. The coincidence ratios of surprise, anger joy were higher, and the total coincidence ratio was 48.3%. We categorized the emotions as three groups (surprise, joy and anger, and sadness, disgust and fear). The coincidence ratio of the emotion group was 87.5%. Therefore, the impressions of emotional expression by the senders were similar to those by the receivers.

Index Terms—Emotional communication, tactual communication, communication tool.

I. INTRODUCTION

Tactual communication (interpersonal touching) is the most primitive form of communication. Tactual communication between people familiar to each other can express various positive emotions. But a social distance exists between unfamiliar people, and we have a tendency to avoid the touch of these people. In recent years, some tactual communication systems have been developed. Ambe introduced a haptic communication system in interpersonal telecommunication and analyzed the change of structure of informal telecommunication using the tool [1]. The purpose of our study is the development of a tactual communication tool that conveys emotional communication during face-to-face oral conversation. In a previous study, we designed the tactual communication tool with the concept of "using tactual communication but keeping a social distance" [2]. The tool consists of two soft rubber balls and a hose (see Fig. 1). A hole was made on the surface of each ball (diameter: 60 mm) so that both balls could be connected by the hose (inner diameter: 6 mm, length: 1200 mm). The interfaces between the balls and the hose were sealed by adhesive bond. Two users each hold one ball during an oral conversation (see Fig. 2). When one ball is gripped, air is pumped out of that ball and into the other. Thus, a user can grip the ball in different ways, and the other user can recognize the different pressures of the ball.

In the previous studies, we analyzed the effectiveness of

this communication tool during oral communication [2] and the features of emotional expression by a person's grip on the tool [3]. The results showed that the subjects mainly used the tool to respond to the grip and talk by the other subject and intended to emphasize their talk when they expressed emotions; surprise and joy, and anger and sadness, were expressed by one and two common grip patterns, respectively; disgust and fear were expressed by different grip patterns.

In the present study, to analyze the features of emotional communication by using the tactual communication tool, the emotion expressed by the person's grip on the tool and the emotion recognized by the other person were examined.

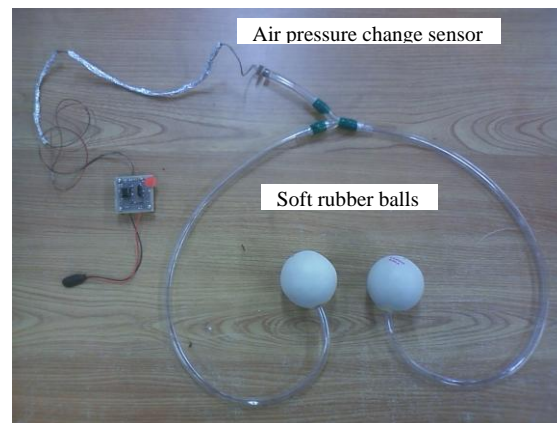


Fig. 1. Tactual communication tool.



Fig. 2. Oral communication using the tactual communication tool.

II. METHODS

The subjects were four male college students. All subjects gave their informed consent after hearing a description of the study.

The expressed emotions were the fundamental emotions of human beings: joy, anger, sadness, disgust, surprise and fear. We set the following six scenes for the subjects to express

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their emotions:

Joy: You are joyful because you received some presents on your birthday.

Anger: You are angry because someone has made fun of you.

Sadness: You are sad because a family member, a friend, or a dear pet has died.

Disgust: You are disgusted by a sweaty person standing next to you in a crowded train.

Surprise: You are surprised because someone shouted suddenly at you.

Fear: You find a cockroach in your room, and then it escapes. You fear cockroaches.

Two subjects became senders (senders 1 and 2) and the other subjects became receivers (receivers A and B). The senders had participated in the experiment of emotional expression by the person's grip on the tool [3] and the receivers had never participated in the experiment of emotional expression. The experiment consists of four pairs of the senders and receivers. A screen separated the receiver from the sender (see Fig. 3). The sender and receiver wore earplugs and did not speak during the experiment.

Five experimental sessions were conducted in each pair. In the experimental session, the sender expressed six emotions in a predetermined random order. Both sender and receiver held the tactual communication tool with their fingers and palm totally contacting the soft rubber ball, so that the main hose was positioned between the thumb and index finger (see Fig. 4). In the previous study, this was the most frequent holding form for subjects showing their emotions with the tool [2]. The sender expressed an emotion by gripping the soft rubber ball for 15 seconds or less, and the receiver responded to the emotion for 15 seconds or less after the sender gripped one time.

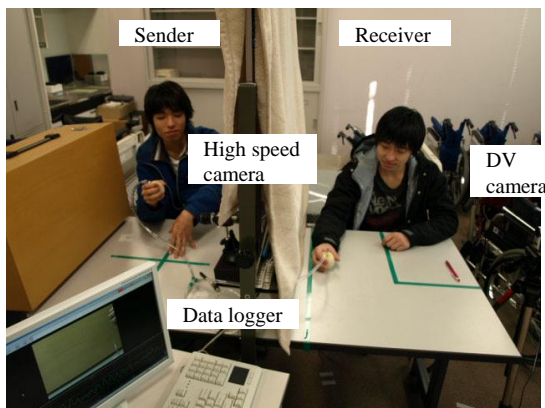


Fig. 3. An experiment.

The hose had a third branch in the center. This branch was connected to an air pressure change sensor (FKS-111, Fuji ceramics) (see Fig. 1). The air pressure change sensor and a high-speed video camera (DEWE-CAM, Dewetron) were connected to a data logger (DEWE-800, Dewetron). The data logger measured the air pressure change as a result of the grip and simultaneously recorded the image of the grip by the senders. The measurement range of the air pressure change was 1 Pa–133 kPa and the sampling frequency was 10 kHz. The image was 640×480 pixels and the sampling frequency was 70 Hz. Another digital video camera (DCR-HC62, Sony)

recorded the image of the pumping of the other ball that held by the receiver.



Fig. 4. Holding form of the tactual communication tool.

III. RESULTS

A. Results of Emotional Expression

Fig. 5 shows the air pressure changes as a result of the short one-time grip (grip one-time, then release). Fig. 6 shows the air pressure changes as a result of the long one-time grip (grip and hold 2 seconds, then release). Fig. 7 shows the air pressure changes as a result of the multiple grips with constant short intervals (grip 5 times for a total of 2 seconds).

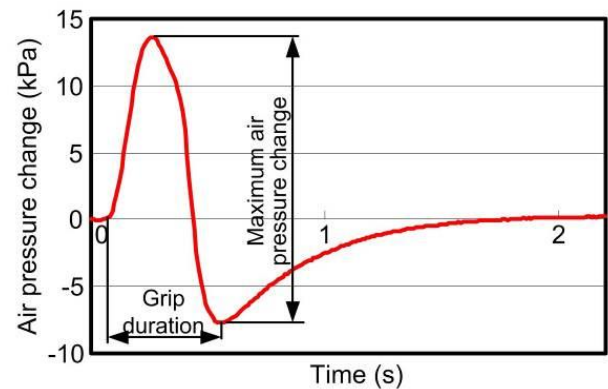


Fig. 5. Air pressure changes as a result of the short one-time grip (grip one-time, then release).

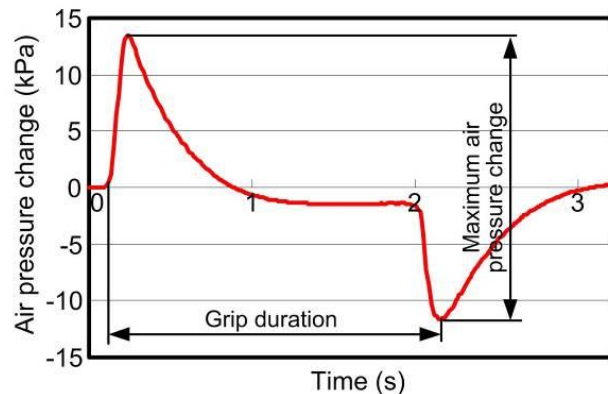


Fig. 6. Air pressure changes as a result of the long one-time grip (grip and hold 2 seconds, then release).

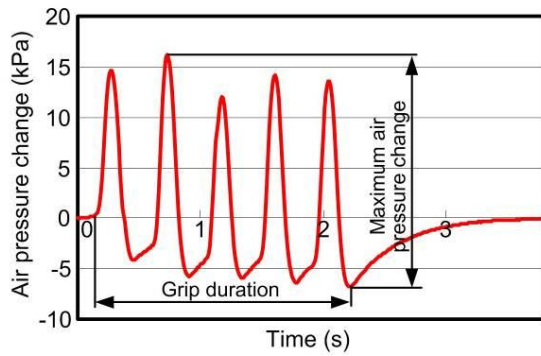


Fig. 7. Air pressure changes as a result of the multiple grips with constant short intervals (grip 5 times for a total of 2 seconds).

We calculated the grip duration and the maximum air pressure change and counted the number of grips. The mean of the grip duration as a function of emotions is shown in Fig. 8. An analysis of variance (ANOVA) revealed the significant main effects of emotion ($F(5,114)=66.6$, $p<.001$). Scheffe tests on the emotion factor revealed that the grip durations of surprise, anger and joy were significantly shorter than the grip durations of sadness, fear and disgust ($p<.001$).

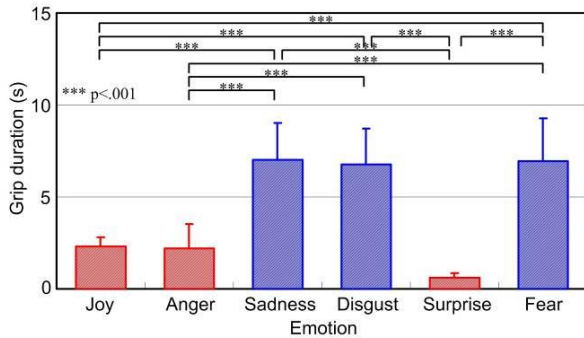


Fig. 8. The mean of the grip duration as a function of emotions.

The mean of the maximum air pressure change as a function of emotions is shown in Fig. 9, and the ANOVA revealed the significant main effects of emotion ($F(5,114)=43.3$, $p<.001$). Scheffe tests on the emotion factor revealed that the maximum air pressure changes of surprise, anger and joy were significantly larger than the maximum air pressure changes of sadness, fear and disgust ($p<.001$).

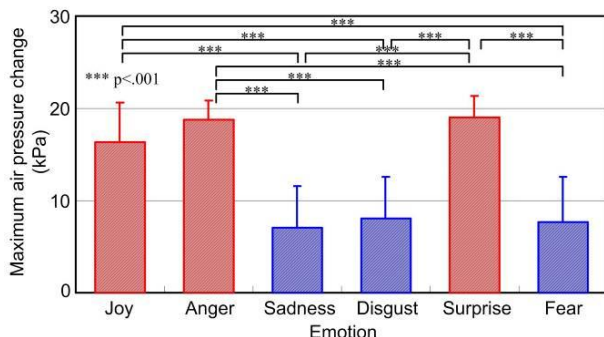


Fig. 9. The mean of the maximum air pressure change as a function of emotions.

The mean of the number of grips as a function of emotions is shown in Fig. 10. Again, the ANOVA revealed the significant main effects of emotion ($F(5,114)=32.3$, $p<.001$). Scheffe tests on the emotion factor revealed that the number of grips of fear was significantly larger than the numbers of

grips of the other emotions ($p<.05$); the numbers of grips of surprise and anger were significantly smaller than the numbers of grips of sadness and disgust ($p<.05$); the number of grips of joy was significantly larger than the number of grips of sadness ($p<.01$).

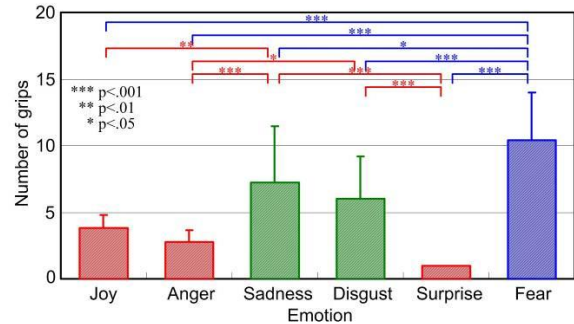


Fig. 10. The mean of the number of grips as a function of emotions.

Next, we observed the images of the grip and classified the grip technique and the pattern of the grip cycle into five types each. The grip technique was classified as a quick or a slow clench (the index, middle, ring and little fingers curling into the palm), a quick or a slow grasp (the index, middle, ring and little fingers do not touch the palm), and a combination of the two. Fig. 11 shows the percent distribution of the grip techniques as a function of emotions.

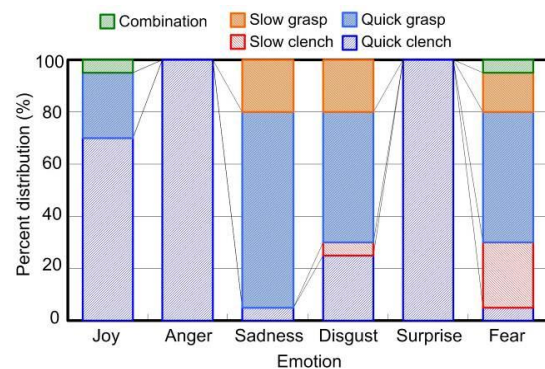


Fig. 11. The percent distribution of the grip technique as a function of emotions.

The pattern of the grip cycle was classified into multiple grips with constant long or short intervals, a long one-time or a short one-time grip, and a combination. Fig. 12 shows the percent distribution of the patterns of the grip cycle as a function of emotions.

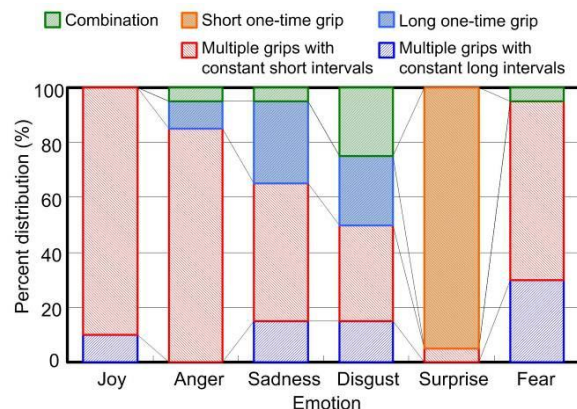


Fig. 12. The percent distribution of the pattern of the grip cycle as a function of emotions.

B. Results of Emotional Communication

As a result, the relationship between expressed emotions by the senders, recognized emotions by the receivers are presented in Table I. Anger and joy were frequently misrecognized between each other. Sadness, fear and disgust were frequently misrecognized among each other.

TABLE I: RELATIONSHIP BETWEEN EXPRESSED EMOTIONS BY THE SENDERS AND RECOGNIZED EMOTIONS BY THE RECEIVERS.

Expressed emotion	Recognized emotion					
	Joy	Anger	Sadness	Disgust	Surprise	Fear
Joy	11	7	0	0	1	1
Anger	3	12	0	3	0	2
Sadness	3	0	7	7	0	3
Disgust	1	1	3	5	0	10
Surprise	1	0	0	0	19	0
Fear	1	1	9	5	0	4

The coincidence ratios are presented in Table II. The coincidence ratio of surprise was the highest (95%), the coincidence ratio of anger was second (60%), and the coincidence ratio of joy was third (55%). The total coincidence ratio was 48.3%.

TABLE II: COINCIDENCE RATIOS OF EMOTION.

Expressed emotion	Coincidence ratio
Joy	55 %
Anger	60 %
Sadness	35 %
Disgust	25 %
Surprise	95 %
Fear	20 %
Total	48.3 %

C. Questionnaire Results

After the experiment, the senders were asked how they expressed these emotions and the receivers were asked how they recognized these emotions. The responses of the senders 1 and 2 are listed in Table III, and the responses of the receivers A and B are listed in Table IV.

The senders also answered that the easiest expressing emotion was surprise, and the most difficult expressing emotion was disgust. The receivers also answered that the easiest recognizing emotion was surprise, and the most difficult recognizing emotion was disgust.

TABLE III: RESPONSES OF THE SENDERS 1 AND 2 TO QUESTIONNAIRE ON EXPRESSING EMOTIONS.

Expressed emotion	Answer
Joy	(1) Strongly and rhythmically, for 5 sec (2) Strongly and rhythmically, for 3 sec
Anger	(1) Strongly and quickly, for 4 sec (2) Strongly and quickly, for 2 sec
Sadness	(1) Weakly and slowly, for 10 sec (2) Weakly and slowly, for 5 sec
Disgust	(1) Weakly and slowly, for 8 sec (2) Weakly and slowly, for 4 sec
Surprise	(1) Strongly and one-time, for 2 sec (2) Strongly and one-time, for 1 sec
Fear	(1) Weakly, for 8 sec (2) Weakly, for 5 sec

TABLE IV: RESPONSES OF THE RECEIVERS A AND B TO QUESTIONNAIRE ON RECOGNIZING EMOTIONS.

Recognized emotion	Answer
Joy	(A) Strong and rhythmical grip (B) Strong, constant rhythm and long grip
Anger	(A) Strong and quick grip (B) Strong and short grip
Sadness	(A) Weak, slow and long grip (B) Weak and long grip
Disgust	(A) Weak, slow and long grip (B) Weak, slow and short grip
Surprise	(A) Strong and short one-time grip (B) Strong and short one-time grip
Fear	(A) Weak and long grip (B) Weak and long grip

IV. DISCUSSION

A. Features of Emotional Expression

According to the experimental results, the subjects expressed surprise, joy, anger and sadness by one grip patterns, disgust and fear by different grip patterns. The features of emotional expression are as follows.

Surprise was characterized by a quick clench technique, and the pattern was a strong and short one-time grip for an average of 1 second.

Joy was characterized by a quick clench or grasp, and multiple grips with constant short intervals.

Anger was characterized by a quick clench, and multiple grips with constant short intervals.

Sadness was characterized by a quick or slow grasp, and weak grips with constant short intervals.

Disgust was characterized by weak grips with constant short intervals, or some other patterns.

Fear was characterized by a quick grasp, weak grips with constant short intervals, or some other patterns.

Surprise was characterized by unique strong and short one-time grip. Both joy and anger were characterized by strong multiple grips with constant short intervals. Sadness, disgust and fear were characterized by weak grips with constant short intervals and similar to each other.

These features were similar to the features of emotional expression in the previous experiment [3], because the senders had participated in the previous experiment. Thus, it was considered that the senders expressed the emotions by the same way as the previous experiment.

B. Features of Emotional Communication

Because the senders expressed surprise by unique strong and short one-time grip, the receivers recognized the grips of surprise correctly. The senders expressed joy and anger by strong multiple grips with constant short intervals, then the receivers frequently misrecognized between each other. The senders expressed sadness, disgust and fear by weak grips with constant short intervals, then the receivers frequently misrecognized among each other.

We categorize the emotions as three groups (surprise, joy and anger, and sadness, disgust and fear). Table 3 presents the relationship between expressed emotion groups by the senders, recognized emotion groups by the receivers. The coincidence ratio of the emotion group is 87.5%. Therefore,

the receivers recognized the emotion group correctly.

TABLE V: RELATIONSHIP BETWEEN EXPRESSED EMOTION GROUPS BY THE SENDERS AND RECOGNIZED EMOTION GROUPS BY THE RECEIVERS (THE EMOTIONS ARE CATEGORIZED AS THREE GROUPS).

Expressed emotion group	Recognized emotion group			Coincidence ratio of emotion group
	Surprise	Joy and anger	Sadness, disgust and fear	
Surprise	19	1	0	95 %
Joy and anger	1	33	6	83 %
Sadness, disgust and fear	0	7	53	88 %

Even though the receivers had never participated in the previous experiment of emotional expression, the receivers could recognize the strong short one-time grip as surprise, the strong multiple grips as joy or anger, and the weak grips as sadness, disgust or fear. Therefore, the impressions of emotional expression by the senders were similar to those by the receivers.

When the sender grips weakly, the receiver recognizes the small pump of the ball. Then the receiver frequently misrecognizes sadness, disgust and fear that expressed by weak grip.

V. CONCLUSION

In the present study, emotional communication using a tactual communication tool was examined, and the features of emotional communication were analyzed. As a result, the senders expressed surprise by unique strong and short one-time grip; joy and anger by strong multiple grips with constant short intervals; and sadness, disgust and fear by weak grips with constant short intervals. The coincidence ratios of surprise, anger joy were higher, and the total

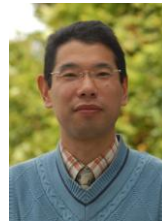
coincidence ratio was 48.3%. We categorize the emotions as three groups (surprise, joy and anger, and sadness, disgust and fear). The coincidence ratio of the emotion group is 87.5%. Therefore, the receivers recognized the emotion group correctly and the impressions of emotional expression by the senders were similar to those by the receivers.

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