Study of the implementability of tactile feedback while operating touch panel device -From two directions of efficacy & feasibility-

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Abstract

In a few years, the number of apparatuses with touch panel displays like smartphones will increase. People who are visually impaired, hearing impaired and disabled can use tactile feedback for receiving incoming communications. However, opportunities for tactile feedback applications are limited.

Our hypotheses follow: as there are haptics patterns suitable for use cases, we will design haptics samples of tactile feedback and inspect their effectiveness. This study focuses on haptics patterns showing a relationship between the user's impression and various use situations. Previous studies have been insufficient, so our target subjects inspected a limited number of objects.

This study consists of two inspections:

1) We collected various haptics patterns that users had defined and analyzed the first inspection. For the next inspection, we manufactured a smartphone prototype. We matched the impression of eight haptics patterns types that we got from the subjects in the first analysis with different situations and tested various replies.

Tests were repeated and recorded for various situations. As different haptics vibrations were added to emails, we inspected whether subjects could distinguish a difference in their meanings. Thus, we added different haptics patterns that corresponded to various situations. We concluded the hypothesis was effective for subjects. We could inspect the hypotheses in relation to subjects' impressions of the haptics pattern.

2) Additionally, we obtained different results between elders and youths. Consequently, we suggested design guidelines for the new tactile feedback of the smartphone application. We suspect that haptics will be possible for a variety of interactive designs.

Keywords: Haptics, Emotion, Situation

1. Research background

In recent years, the number of devices equipped with a touch panel on a display typified by a smartphone has increased. Although it has made it possible to perform intuitive

operation, it has been conventionally pointed out that a user interface without a physical clue becomes a cause of erroneous operation. On the other hand, effective application of haptic feedback, which is "tactile (vibration) stimulus issued in line with investigation" is expected.

Tactile feedback is used today in incoming phone calls, games and other situations. Tactile feedback is also provided for inputs used in gestures such as touch, pinch, swipe, etc. in touch screen devices including smartphones. However, existing haptic feedback does not have many patterns, and opportunities to use are limited. However, in reality there should be suitable patterns according to the situation, and it is necessary to design a haptic feedback pattern according to the situation. In order to solve this problem, we focused on the "impression and situation" that the pattern of haptic feedback gives to the user in various situations.

2. About the experiment

In this research, we investigate what kind of impression the user receives for haptic feedback. Hypothesis: A specific image can be given by tactile sense.
In order to verify the above hypothesis, we set up surveys of ① and ②.
①: Collection and convergence of various haptic feedback patterns
②: Impression evaluation of haptic feedback pattern collected

2.1 Collection of haptic feedback patterns

Various patterns and their convergence are necessary to collect patterns according to the situation. So we asked 5 collaborators (students) to create.

We used Arduino IDE (Arduino) and library Adafruit DRV 2605 Library for pattern creation. Arduino is a microcomputer board and is used for prototyping etc. The equipment used is 1100 rpm at 5 V with the microcomputer board FLORA (made by Adafruit) and the DRV 2605 L vibration feedback module (the same manufacturer) and the coin type vibration motor Vibrating Mini Motor Disc (the same manufacturer). There are 116 kinds of commands available in the pattern, and up to seven commands can be combined in the pattern. Also, the patterns created by collaborators are four: joy, anger, fear, and relief. By this alone, the degree of difficulty to create is increased, so we chose expressible expressions to connect with 4 patterns using a book called emotion expression dictionary. The following is a description of the pattern created by collaborator A.

Table 2.1.1 Haptic feedback pattern created by collaborator A

Emotion	Creation intention	Combination
Joy	Jump	1, 4, 74, 4
Anger	Rampant	85, 84, 34, 88
Fear	Scared	4, 0, 0, 0, 0, 55, 78
Peace	Beating of heart	69, 9

Next, I show the software command table. In this table, 36 representative ones among a total

of 123 commands are selected and tabulated.

Table 2.1.2 Arduino programing command

Comand Table(Vibration)

No.	Command name	Program number	Types of vibration intensity(%)
1	Strong Click	1	30, 60, 80, 100
2	Sharp Click	4	30, 60, 100
3	Soft Bump	7	30, 60, 100
4	Double Click	10	60, 100
5	Triple Click	2	60
6	Medium Click	21	60, 80, 100
7	Sharp Tick	24	60, 80, 100
8	Short Double Click Strong	27	30, 60, 80, 100
9	Short Double Click Medium	31	60 , 80, 100
10	Short Double Sharp Tick	34	60 , 80, 100
11	Long Double Sharp Click Strong	37	30, 60, 80, 100
12	Long Double Sharp Click Medium	41	60, 80, 100
13	Long Double Sharp Tick	44	60, 80, 100
14	Soft Fuzz	13	100
15	Strong Buzz	14	100
16	750ms Alert	15	100
17	Long buzz for programmatic stoping	118	100
18	Smooth Hum	119	10, 20, 30, 40, 50
19	Buzz	47	20 , 40, 60, 80, 100
20	Transition Click	58	10, 20, 40, 60, 80, 100
21	Transition Hum	64	10, 20, 40, 60, 80, 100
22	Pulsing Strong	52	60, 100
23	Pulsing Medium	54	60, 100
24	Pulsing Sharp	56	60, 100
25	Transition Ramp Down Long Smooth	70, 94	100 to 0, 50 to 0
26	Transition Ramp Down Medium Smooth	72, 96	100 to 0, 50 to 0
27	Transition Ramp Down Short Smooth	74, 98	100 to 0, 50 to 0
28	Transition Ramp Down Long Sharp	76, 100	100 to 0, 50 to 0
29	Transition Ramp Down Medium Sharp	78, 102	100 to 0, 50 to 0
30	Transition Ramp Down Short Sharp	80, 104	100 to 0, 50 to 0
31	Transition Ramp Up Long Smooth	82, 106	100 to 0, 50 to 0
32	Transition Ramp Up Medium Smooth	84, 108	100 to 0, 50 to 0
33	Transition Ramp Up Short Smooth	86, 110	100 to 0, 50 to 0
34	Transition Ramp Up Long Sharp	88, 112	100 to 0, 50 to 0
35	Transition Ramp Up Medium Sharp	90, 114	100 to 0, 50 to 0
36	Transition Ramp Up Short Sharp	92, 116	100 to 0, 50 to 0

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http://userdisk.webry.biglobe.ne.jp/030/734/88/N000/000/000/14500990502495521017 9_123. png

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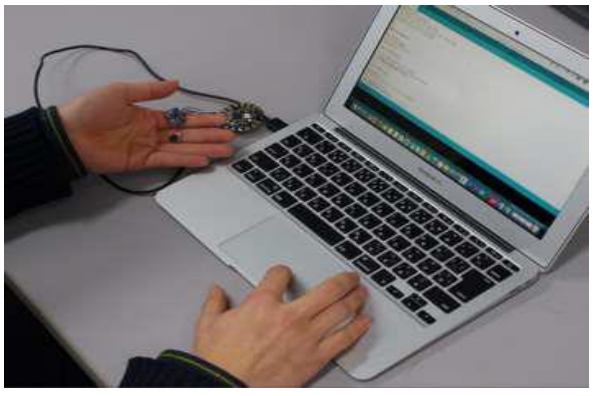

Fig. 2.1.1 Collaborators(students) making a vibration program

2.2 Impression evaluation experiment of haptic feedback pattern

In order to investigate the impression of the created pattern, various opinions were collected. We conducted an investigation using impression words for impression evaluation. Regarding impression words, we refer to past studies [1], [3]. The outline of the experiment is shown below.

2.3 Outline of experiment

Implementation Period: December 12 - 27, 2016
Experiment subjects: 21 elderly (11 males, 10 females), 12 healthy young people (8 men, 4 women)
Experimental place: Kyoto Institute of Technology 15th Building, Building 1
Experimental tool: Equipment used in pattern collection, experiment model ([138×66×10] mm)
Survey item: Investigate the impression of user-defined feedback pattern

Implementation method: Impression evaluation experiment was conducted by giving information of 5 steps of Semantic Differential (SD method) and situation of 1-5 using 8 collected patterns and impression word pair.

Table 2.3.1 Impression Words and Nuances Used in the SD Method

1	Sad --- Cheerful
2	Unclearly --- Clearly
3	Dark --- Bright
4	Boring --- Fun
5	Uncomfortable --- Comfortable
6	feeble --- Powerful
7	Heavy---Light
8	Gentle --- Active
9	Cold --- Warm
10	Narrow --- Wide
11	Weak --- Strong
12	Negative - - Positive

Table 2.3.2 Conditions used in the experiment

Request	Please do it.
Reminder	Please hurry.
Report	I will report it.

Fig. 2.3.1 Prototype

Fig. 2.3.2Subjects participating in the experiment

3. Experiment results

In this experiment, patterns created for subjects were experienced randomly in each of the three situations (request, reminder, report). Subjects are divided between young and elderly groups. And among them are young healthy people and elderly groups in request situation. This also applies to reminder and report. Among them, there was a significant difference between the impression received by the subject and the elements constituting the vibration such as the magnitude and length of the vibration.

Request Elderly	Unclearly Clearly	Dark Bright	Uncomfortable Comfortable	Feeble Powerful	Heavly Light	Narrow Wide
Max	.714*	.717*	.767*	.737*	-.832*	.779*
Request Young	Heavly Light	Weak Strong				
Max	-.802*	.740*				
Report Elderly	Uncomfortable Comfortable	Cold Warm				
No vibration	-.730*	-.740*				
Report Elderly	Uncomfortable Comfortable					
ms	-.725*					
Report Elderly	Heavly Light					
max	-.740*					
Report young	Narrow Wide					
ms	.752*					

Table 3.1.1 Correlation table of feedback pattern elements and impression words

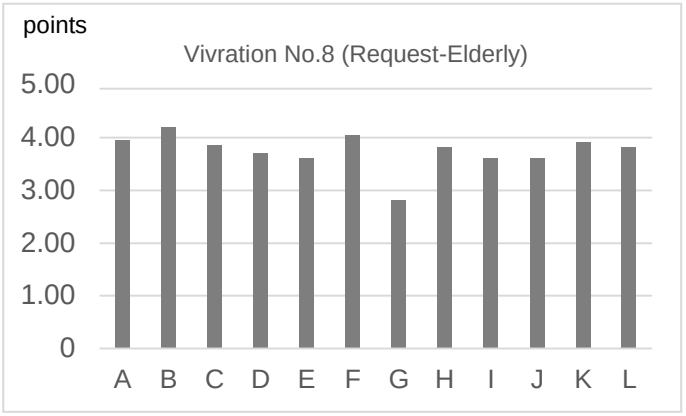

Fig. 3.1.1 Vibration No. 8 Evaluation of anger (Elderly)

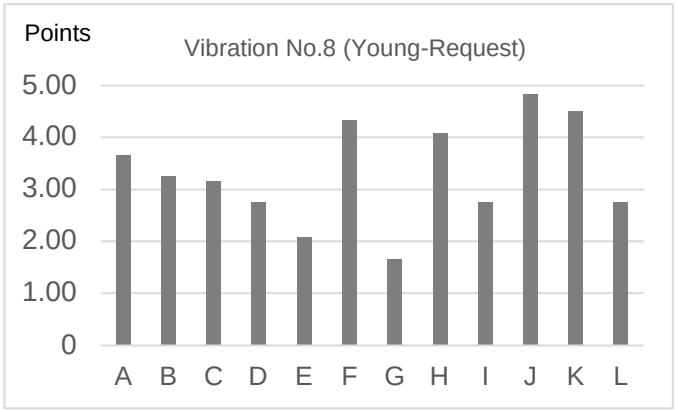

Fig. 3.1.2 Vibration No. 8 Evaluation of anger (Young)

(A: Sad - Cheerful, B: Unclearly - Clearly, C: Dark-Bright, E: Uncomfortable - Comfortable, F: feeble - Powerful, G: Heavy - Light, H: Gentle - Active, I: Cold - Warm, J: Narrow - Wide, K: Weak - Strong, L: Negative - Positive)

The way of viewing this graph is as follows. For example, when the score of C (dark - bright) score is high, the subjects have a bright impression.

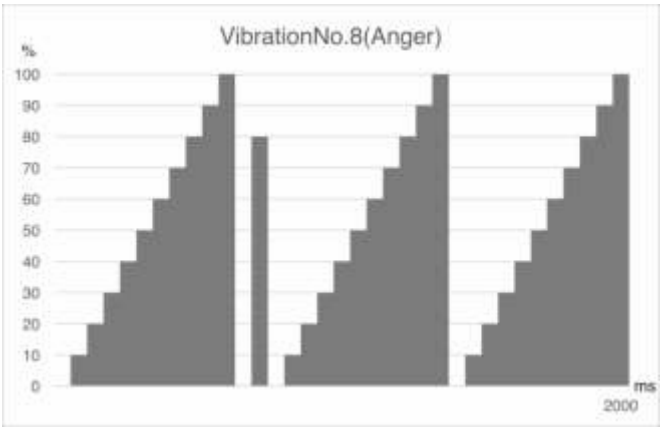

Fig. 3.1.3 Vibration No. 8 anger

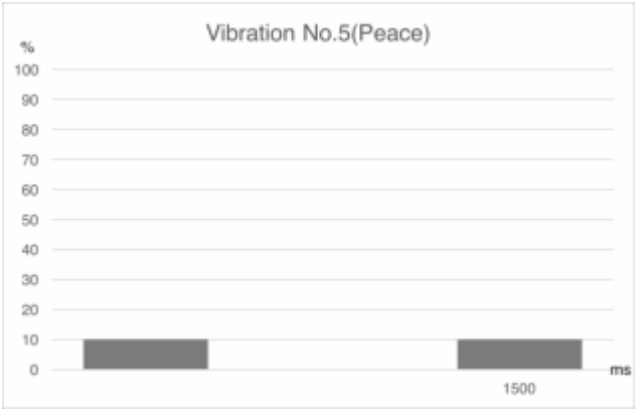

Fig. 3.1.4 Vibration No. 5 Peace

Both the elderly and the young people highly rated No. 8 and rated No. 5 low. The difference between the two vibrations is that the magnitude and vibration interval are different.

4. Summary of Experiment

From the research of this research, I found the necessary elements for the haptic feedback pattern suitable for the situation. First, although a significant difference appeared between the request and the report, it did not appear in the reminder. Because this was not so familiar with prompting, I think that it was because Nuance 's way of catching was limited compared to the other two. As for the request, it became clear that the elderly person can give the impression of clear impression, brightness, comfort, strength, by enlarging the vibration. During the experiment, we considered that favorable evaluation gathered in a large pattern that was easy to judge because it was difficult to distinguish weak patterns. Pattern No. 8 was created by imaging anger, but many elderly people had a positive impression (Table 3.1.2). There seemed to be few people feeling discomfort to large vibrations. In the case of young people the maximum and heaviness - a light correlation, a weak - strong positive correlation was seen. As for young people, there were many subjects who received impressions similar to those of preparers for pattern No. 8 (Table 3.1.3).

5. Discussion

As for the reason why the way of capturing the impression of young people and senior citizens differs in terms of requests and reports, it is thought that many elderly people are not so familiar with equipment equipped with haptic feedback such as smart phones and game machines compared to young people. As a result, older people tended to receive large vibrations positively. Or because the collected patterns were created for young people, it is thought that the opinion of the elderly is not reflected, which is considered as a factor.

6. Conclusion

The following conclusions are summarized from these analyzes.
Ⅰ.The impression that the magnitude of haptic feedback gives to users is different.
Ⅱ.Depending on the situation the user's impression on haptic feedback is different.
Although it was partial, I could prove the hypothesis "can give a specific image by tactile sense".

7. Future Challenges

Although we gathered diverse patterns, there are biases in the creators, and there are problems such as difficulty of cooperators for pattern creation being not visual. Also, since feedback constituent elements are also uniquely defined, it is necessary to examine the experiment and consider the correct setting.

References

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