Haptic User Experience Based on User Preference

Hoon Sik Yoo[1]([⊠]), So Yon Jeong[2], and Da Young Ju[2]

[1] Techno and Design Research Center, Yonsei University, Incheon, South Korea
yoohs@yonsei.ac.kr
[2] Yonsei Institute of Convergence Technology, Yonsei University,
Incheon, South Korea
{sjeong3206,dyju}@yonsei.ac.kr

Abstract. As the mobile device and touch screen market grows continuously, the development of Haptic Technology is expected to give a boost to the touch screen market. The inertia based tactile reproduction technology applied to current device is contributing to the expansion of market. The purpose of this study is to analyze what kind of service and material is preferred for the tactile reproduction technology to be applied to mobile device. To carry out the research, 100 surveys were performed and priority based on the surveyed contents was analyzed as well as additional analysis for gender and age to subdivide the demand of the users. The user preference on which haptic technology should be applied first is on movie, reflecting the desire to sensual experience various contents provided by the movies. Users also preferred soft materials such as silk. They also preferred materials which are encountered in daily life such as hanji, plastic, or cotton. For the development of the study, further research on what situation and through what method should be applied for application of higher service is necessary.

Keywords: Haptic technology · Touch display · User experience · User research · User-centered design

1 Research Background and Purpose

As the mobile device and touch screen market grows continuously, the development of Haptic Technology is expected to give a boost to the touch screen market. The inertia based tactile reproduction technology applied to current device is contributing to the expansion of market. Global mobile device companies such as SSE, Apple, and HTC are releasing products with next generation high-precision haptic technology. As can be seen in Fig. 1 according to Lux Research Inc., the global haptic market is expected to grow up to 13.8 billion dollars by 2025.

Up to now, major cases with application of haptic technology provide vibration experience using Actuator. After the commercialization of touch screen, various studies to graft tactile production were in process and studies and cases about haptic technology to feel texture on surface of touch screen has been appearing for few years. Although technological research for the release of product is in progress, Killer
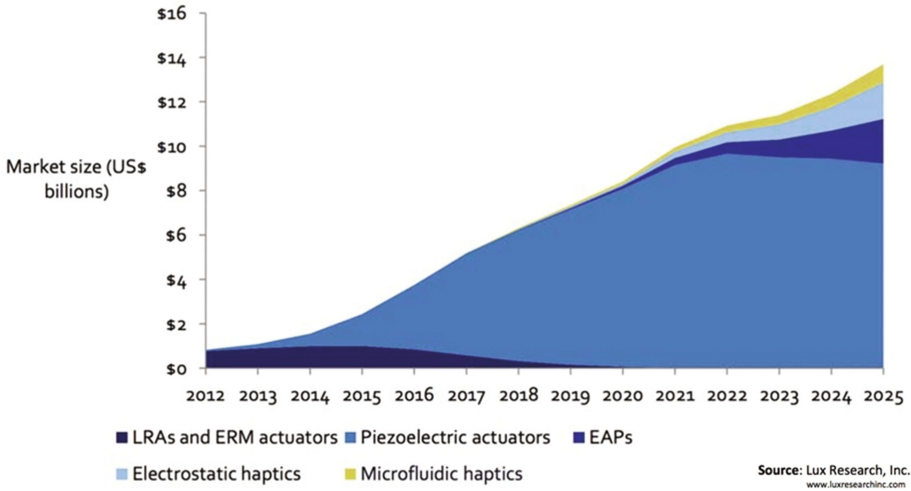
Fig. 1. Expected market size of haptic technology according to types of actuator

application which is applied from the perspective of user with the experience of Haptic is lacking. This is the time when the UX/UI study based on tactile reproduction technology is necessary.

The purpose of this study is to analyze what kind of service and material is preferred for the tactile reproduction technology to be applied to mobile device. If the preferred service is analyzed, the priority of what kinds of application that haptic technology should be applied to can be analyzed. Also, if the material preferred by the user is analyzed, what kind of tactile experience should be embodied first can be analyzed. To carry out the research, 100 surveys were performed and priority based on the surveyed contents was analyzed as well as additional analysis for gender and age to subdivide the demand of the users.

2 Related Work

2.1 Haptic Technology

Various next generation actuator technologies to provide detailed textile feedback from mobile device are in progress. The most representative technology is Electro Active Polymer (EAP). This is a technology that utilizes a polymer which changes its bonding structure based on the electric field; it uses the technique of producing vibration through contract-relax of the mass. It has advantages of good durability and free structure, and the response speed is 5 ms which is relatively fast. Figure 2 shows the structure of the polymer which is a EAP Actuator based Vivi Touch technology developed by the AMI (Artificial Muscle Inc.).

Pacinian Inc. of Fig. 3(left) developed Actuator to embody realistic sense of touch through vibration based on the initial attraction and repulsion produced using two glass
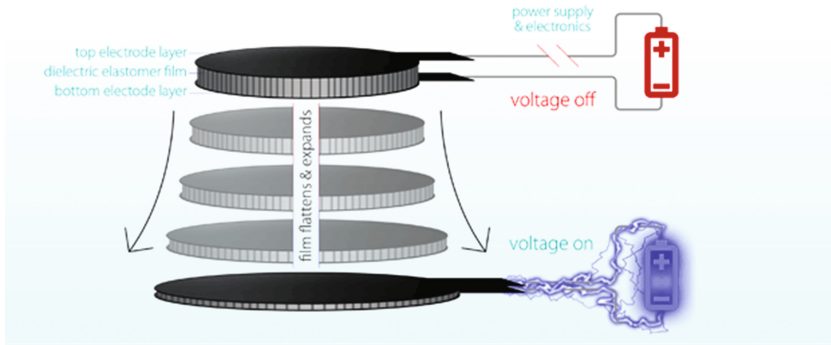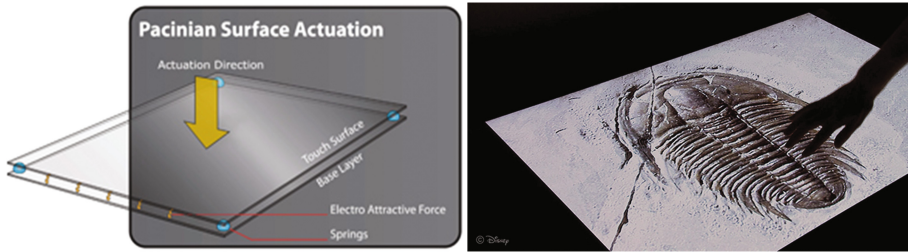
Fig. 2. Vivi touch of AMI

Fig. 3. Vivi touch of AMI

surface charged with different charges. Disney Research of Fig. 3(right) developed Tesla Touch composed of one glass board and insulation board to express the sense of friction through electrostatic force between finger and transparent electrode. [3] Toshiba developed Sensag through similar principles.

RWTH Aachen technical university developed Mudpad which can provide localized haptic feedback to the multi touch screen using Magnetorheological (MR) fluid. Mudpad changed parameters such as Magnet signal and research to provide tactile pattern was also executed; based on this tactile pattern, the User interface which gives impression of touching physical buttons on the touch screen was applied [5] (Fig. 4).
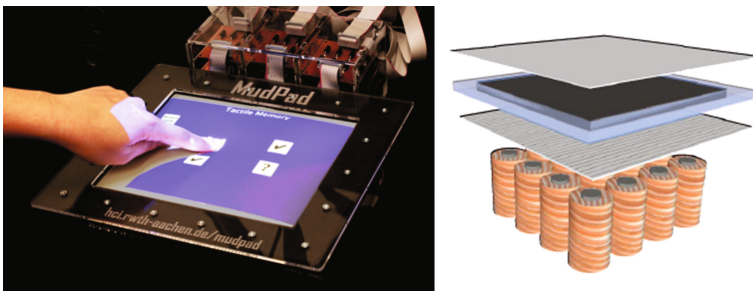

Fig. 4. MudPad's prototype and exploded view of system

2.2   Haptic Experience Study

There are various studies related to haptic; among those, studies related to actual subjects and human perception are important to provide texture on the surface of display. Tiest shows how actual roughness and perceived roughness differs and analyzed 96 samples on the difference of visual and sensual perception in the perspective of roughness. [4] Millette experimented on human capabilities to perceive periodic haptic stimulation by changing frequency and power. Millette experimented on human perception to differentiate between two textile stimulation with 30% power difference. [2] Hwang researched on the influence visual feedback has on textile feedback to embody haptic display. [1] When the visual feedback about texture is provided, users tend to exhibit positive response.

Existing studies focused on the perception and technological perspective. In this study, unlike previous ones, the preferred service and material to apply haptic technology is studies in the perspective of user experience.

3   Research

For this study, surveys targeting 100 users were performed. The information of participants is shown in Table 1.

Table 1. Profile

Item	Contents
Participated people	100 (Male 55/Female 45)
Average age (20s–6s)	Average of 42
Number of smart device owned	Average of 2.9

Through the survey, two following questions were proposed to analyze preference of users related to haptic UX.

Question 1. What is the content that can be utilized the most when texture is provided in display?

Game	Movies	Finance	Education	Weather	Navigation	News	Books
Photo/video	Shopping	Medicine	Food	Traveling	Music	Health	Video call

Question 2. From the texture provided below, what are the ones that are expected to give positive feeling?

Sand	A4 paper	Photographic paper	Hanji	Sandpaper	Bubble wrap	Brush
Stockings	Natural leather	Artificial Leather	Cotton	Silk	Wool	Morning bread
Rice	Plastic	Wood	Leaves	Rubber	Skin	✕

4 Results

4.1 Preferred Contents

The user preference on which haptic technology should be applied first is shown in Table 2. Preference on movie is the highest, reflecting the desire to sensual experience various contents provided by the movies. It also showed high preference on shopping service; this is determined to experience the texture of the product prior to purchase. For the navigation, the driver must focus on the front. When the texture feedback is provided, it will be useful.

When the difference between male and female regarding contents preference was compared, both group preferred movie as top priority. For male, the second priority

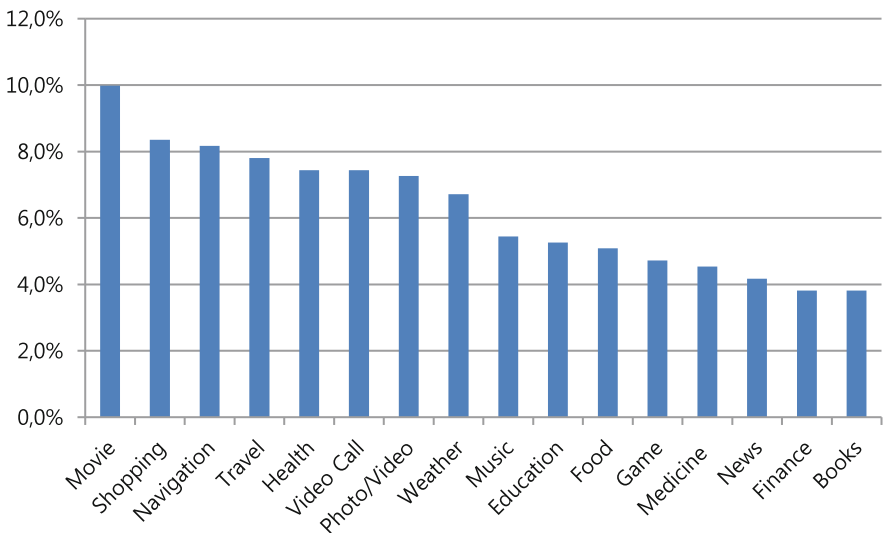**Table 2.** Preferred contents for the application of haptic technology

Table 3. Comparison between male and female on contents of haptic technology application

Gender	Male Frequency	Male (%)	Female Frequency	Female (%)
Game	18	5.9	8	3.3
Movie	31	10.2	24	9.8
Finance	9	3	12	4.9
Education	15	4.9	14	5.7
Weather	23	7.5	14	5.7
Navigation	25	8.2	20	8.1
News	11	3.6	12	4.9
Books	10	3.3	11	4.5
Photo/video	23	7.5	17	6.9
Shopping	23	7.5	23	9.3
Medicine	12	3.9	13	5.3
Food	15	4.9	13	5.3
Travel	27	8.9	16	6.5
Music	17	5.6	13	5.3
Health	23	7.5	18	7.3
Video Call	23	7.5	18	7.3
Total	305	100	246	100

was navigation while it was shopping for female. This reflects that male has great interest in automobile while female has in shopping (Table 3).

When the difference between age was compared, young people at the age of 20–40s focused on application on entertainment area such as movie, photo and shopping while older people preferred such technology to be applied to necessary information such as health, news, and navigation (Tables 4 and 5).

Table 4. Comparison between ages on contents of haptic technology application

| Age	20s	20s (%)	30s	30s (%)	40s	40s (%)	50s	50s (%)	60s	60s (%)
Gender	3	6.4	9	5.2	11	4.9	3	3.5	0	0
Game	4	8.5	17	9.8	23	10.2	8	9.4	3	15
Movie	2	4.3	4	2.3	9	4	4	4.7	2	10
Finance	2	4.3	12	6.9	10	4.4	4	4.7	1	5
Education	4	8.5	11	6.4	15	6.6	7	8.2	0	0
Weather	3	6.4	13	7.5	18	8	9	10.6	2	10
Navigation	1	2.1	6	3.5	10	4.4	3	3.5	3	15
News	1	2.1	9	5.2	8	3.5	3	3.5	0	0
Books	5	10.6	15	8.7	13	5.8	6	7.1	1	5
Photo/video	5	10.6	15	8.7	21	9.3	5	5.9	0	0
Shopping	1	2.1	8	4.6	12	5.3	3	3.5	1	5
Medicine	3	6.4	9	5.2	12	5.3	3	3.5	1	5
Food	3	6.4	13	7.5	19	8.4	6	7.1	2	10
Travel	3	6.4	6	3.5	15	6.6	6	7.1	0	0
Music	4	8.5	11	6.4	14	6.2	10	11.8	2	10
Health	3	6.4	15	8.7	16	7.1	5	5.9	2	10
Total	47	100	173	100	226	100	85	100	20	100

Table 5. Comparison between male and female on preferred material

Gender	Male Frequency	Male (%)	Female Frequency	Female (%)
Sand	3	1.4	1	0.6
A4 Paper	6	2.8	4	2.3
Photographic paper	2	0.9	6	3.4
Hanji	20	9.4	14	8
Sand Paper	0	0	1	0.6
Bubble Wrap	10	4.7	4	2.3
Brush	2	0.9	6	3.4
Stocking	9	4.2	5	2.9
Nature Leather	30	14.2	24	13.8
Artificial Leather	3	1.4	10	5.7
Cotton	11	5.2	9	5.2
Silk	34	16	28	16.1
Wool	7	3.3	9	5.2
Morning Bread	9	4.2	7	4
Rice	0	0	1	0.6
Plastic	16	7.5	13	7.5
Wood	10	4.7	6	3.4
Leaves	5	2.4	1	0.6
Rubber	11	5.2	8	4.6
Skin	24	11.3	17	9.8
Total	212	100	174	100

Table 6. Comparison between ages on preferred materials

Age	20s	20s (%)	30s	30s (%)	40s	40s (%)	50s	50s (%)	60s	60s (%)
Sand	0	0	2	1.5	1	0.7	1	1.6	0	0
A4 Paper	0	0	3	2.3	3	2	4	6.6	0	0
Photographic paper	1	2.9	3	2.3	4	2.7	0	0	0	0
Hanji	3	8.8	8	6.1	14	9.5	7	11.5	2	15.4
Sand Paper	0	0	0	0	0	0	0	0	1	7.7
Bubble Wrap	3	8.8	4	3.1	6	4.1	1	1.6	0	0
Brush	2	5.9	3	2.3	1	0.7	2	3.3	0	0
Stocking	2	5.9	6	4.6	3	2	2	3.3	1	7.7
Nature Leather	4	11.8	21	16	21	14.3	7	11.5	1	7.7
Artificial Leather	1	2.9	3	2.3	6	4.1	1	1.6	2	15.4
Cotton	1	2.9	8	6.1	6	4.1	5	8.2	0	0
Silk	4	11.8	25	19.1	20	13.6	10	16.4	3	23.1
Wool	3	8.8	8	6.1	2	1.4	2	3.3	1	7.7
Morning Bread	2	5.9	5	3.8	6	4.1	3	4.9	0	0
Rice	0	0	0	0	0	0	1	1.6	0	0
Plastic	2	5.9	8	6.1	15	10.2	4	6.6	0	0
Wood	0	0	5	3.8	9	6.1	2	3.3	0	0
Leaves	0	0	2	1.5	4	2.7	0	0	0	0
Rubber	3	8.8	5	3.8	8	5.4	2	3.3	1	7.7
Skin	3	8.8	12	9.2	18	12.2	7	11.5	1	7.7
Total	34	100	131	100	147	100	61	100	13	100

Table 7. Priority of material preferred by user
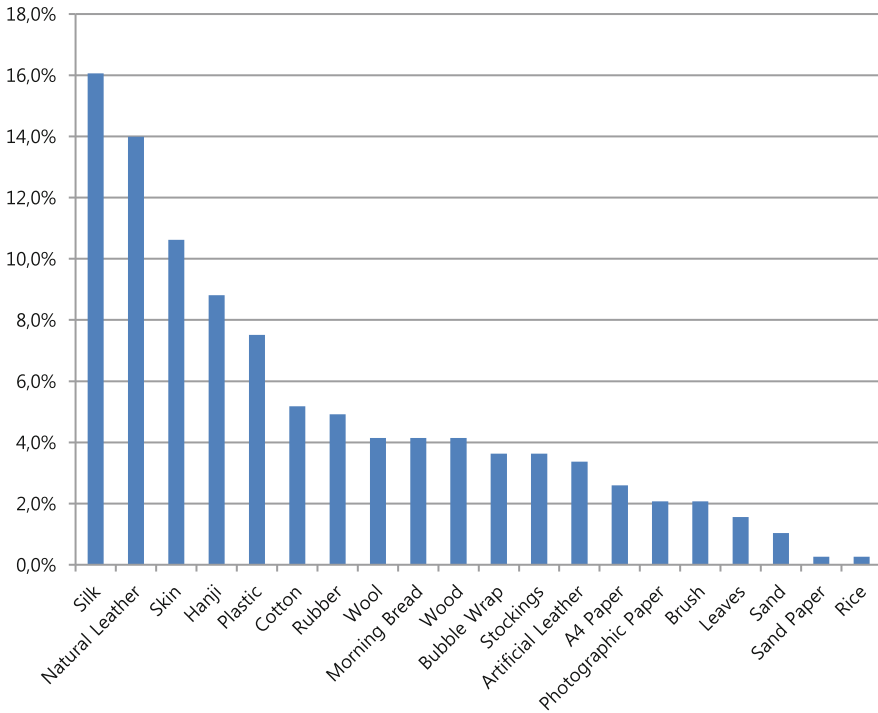
4.2   Preferred Materials

The priority of preferred material is shown in Table 7. Users preferred soft materials such as silk. They also preferred materials which are encountered in daily life such as hanji, plastic, or cotton. Rough materials such as sand or sandpaper or those related to food such as rice aren't preferred.

There weren't any difference between genders regarding preferred material. 1st–3rd of priority were identical and showed similar trend of avoiding rough materials.

There weren't also any difference between ages regarding preferred materials. Overall ranking was similar with high preference toward silk, natural leather, and skin (Table 6).

5   Conclusion and Future Work

This study analyzed the preference of the contents and materials of the users when the haptic technology is applied to the touch display to discover applicable user experience. As a result, uses wanted it to be applied to contents such as movies or shopping and it differs from gender to age. For material, soft materials such as silk, natural leather or

skin is preferred and did not show specific difference from gender to age. Based on the results of this study, factors related to the service and materials that must be applied to future haptic display could be defined. For the development of the study, further research on what situation and through what method should be applied for application of higher service is necessary.

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