User’s Expectation on the Feedback of Flexible Interaction

Jaemyung Lee, KAIST, Daejeon, Republic of Korea, nestleshurei@gmail.com
Hwal Kim, KAIST, Daejeon, Republic of Korea, kimhwal@kaist.ac.kr
Jiwon Jung, KAIST, Daejeon, Republic of Korea, glarajung@kaist.ac.kr **Kun-pyo Lee**, KAIST, Daejeon, Republic of Korea, kplee@kaist.ac.kr

Abstract

Flexible interaction technology became a one of key technology in nowadays. On the other hand, there are relatively little works has been done to understand how it should be designed especially for feedback of it. In this study, we investigate the guidelines for design feedback to flexible interaction systems through based on user’s expectation on them. We conducted user participated design workshop to collect user’s perspectives about feedback when they use flexible interactions. We gave 8 sets of actions which are generally used in flexible interaction and let 6 participants to generated ideas about visual, sound, and haptic feedback of them. From discussion session in the design workshop, we found out key factors about feedbacks. As a result of design workshop, we build guidelines of designing feedbacks for flexible interactions. This result will lead system designers to build flexible interaction to create flexible interaction which can improve the user experience.

Keywords: Feedback, Feedback Design, Flexible Interaction, Design Workshop, User-Centered Design

Introduction

Flexible interaction technology is a bright technology that is expected to change user experiences (UX) in future human-computer interaction (HCI) due to its novel characteristic of flexibility and tangibility. On account of its novel characteristic of flexibility and tangibility, many researchers have been finding a new possibility of UX in flexible
interaction. Also, many companies in HCI field tried to apply it to their new products.

Nevertheless, there is only few understanding about flexible interaction. Flexible interaction research studies in the HCI field mostly focused on developing an experimental prototype for interaction to find out novel interaction (Dijkstra et al., 2011; Girouard et al., 2015; Gomes et al., 2013; Kildal et al., 2012; Lahey et al., 2011; Ramakers et al., 2014; Schwesig et al., 2004). Most of them concentrate on building a novel input system with the flexible interaction. In contrast, there is the lack of understanding about how a computer should give feedback to a user when they use flexible interaction as an input signal. Although some researchers tried to understand flexible interaction in the point of view of users, they only focus only how user manipulate them (Lee et al., 2010; Warren et al., 2013).

The main purpose of this study is to explore how user expects feedback to their flexible interaction device. In this study, we conducted user participated design workshop to understand about their expectation. As a result of research, we provide some guidelines that will help to design a feedback in flexible interaction which is an essential part of building an interaction and interface of a system.

Background

Nowadays, the various applications of flexible interaction have been developed, starting with the Gummi, which is a bendable computer prototype (Schwesig et al., 2004). From the starting of the Gummi, many researchers constantly proposed about new concept of interactions based on flexible display technology (Dijkstra et al., 2011; Girouard et al., 2015; Gomes et al., 2013; Kildal et al., 2012; Lahey et al., 2011; Ramakers et al., 2014). However, most of them only concentrate on finding novel and specific methods of the flexible input system. In contrast to the thorough understanding of input situation, there is a lack of understanding about feedbacks of flexible interaction. Most of their system did not include about feedback itself (Dijkstra et al., 2011; Girouard et al., 2015; Gomes et al., 2013; Ramakers et al., 2014). Moreover, although they consider about feedbacks in their system, they just followed traditional feedbacks in desktop, smartphone, and tablet (Kildal et al., 2012; Lahey et al., 2011). Dimitriadis et al. developed notification system based on flexible interaction (Dimitriadis et al., 2014). However, in their new interaction system, they just use flexible interaction as an output of computer system.

Several researchers did studies about how user interact with a flexible device (Lee et al., 2010; Warren et al., 2013). They tried to figure out that what kind of action user prefer in flexible interaction. On the other hand, in their research, they did not consider about how computer system should react to the flexible input as a feedback.

Thus, in this research, we conducted an ideation workshop to explore the user’s expectation on the feedback of flexible interaction to draw a guideline of feedback styles in flexible interaction.

Study Methods

As this user research was an imaginary future device, a flexible display device, we conducted design workshop (Chen et al., 2012; Mori et al., 2013) to determine what kind of value user wants on the feedback of flexible display. The objective of our design workshop was for participants to generate with design ideas about feedbacks of flexible interaction and unearth why they design in that way. To achieve that aim, we recruited 6 participants who have an experience with design interface and feedbacks of them. The average age was 23 (from 20 to 27, SD=2.46); 4 of them were men, and 2 were women. All participants have their own smartphone and tablet at least 1 year. For the first session of design workshop, we gave them 8 different flexible actions (figure 1) which are general actions in two different materials;

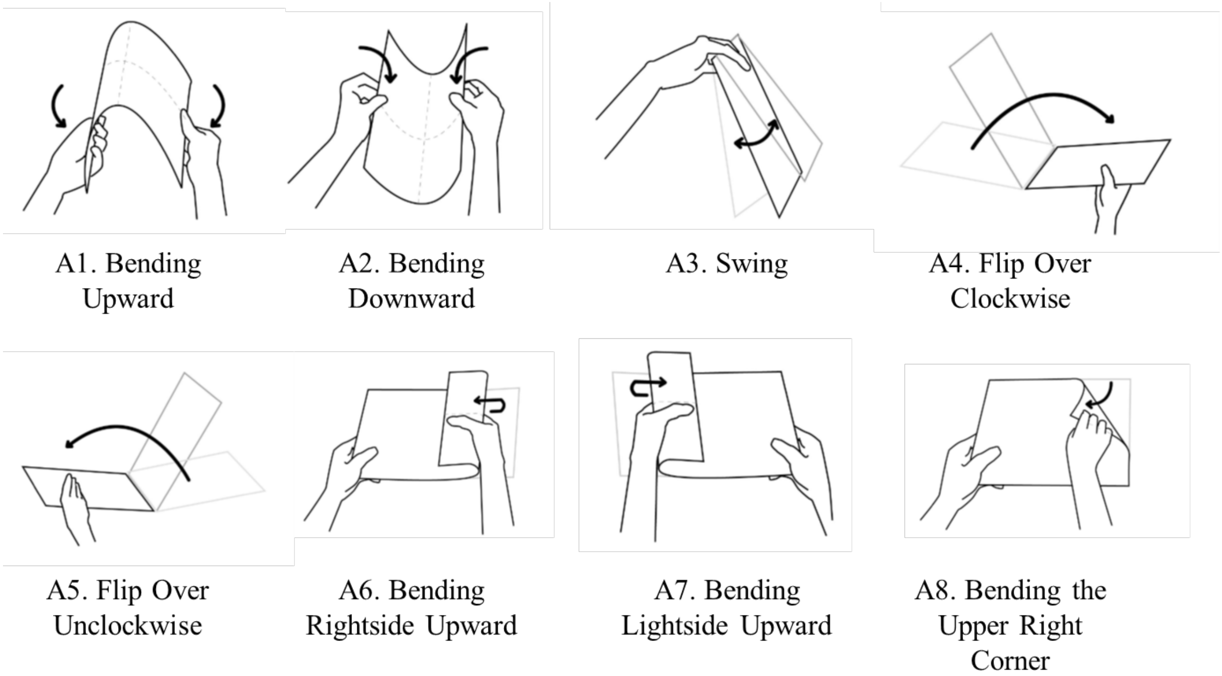

Figure 1. 8 Different Actions Lists in Flexbile Display (Lee et al., 2010)

paper and plastic sheet (Lee et al., 2010). For each action, we let participants generate visual, sound, and haptic feedback. We provide several sheets of A4 size paper and OHP films, pens, post-it, and marker. We gave 48minutes for the design workshop, which means 6 minutes for each action. Then, all participants shared their ideas and discussed why they designed feedback in that way.

Result

We conducted ground theory method (Pandit, 1996) to extract main keywords from participants' idea result and discussion points. Table 1 and 2 shows results of feedback design workshop. To analyze visual feedback, we focused on where the feedback starts. For sound, we considered the motivation of sound and the pattern of it. Finally, for the haptic feedback, we mainly focused on the duration of haptic feedback. The results are written in table 1.

When all participants show same comments, the table was colored gree; conflicted opinion was colored blue or red.

		Action 1	Action 2	Action 3	Action 4
		Bending Upward	**Bending Downward**	**Swing**	**Flip over clockwise**
P1	**Visual**	Highlight Center	Obumbrate Center	Highlight End Part	Highlight End Part
	Sound	Getting High Tone	Getting Low Tone	Sound of Shaking Paper	Sound of Shrinking Paper
	Haptic	Continuous Vibrating while Action	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating Until Action
P2	**Visual**	Highlight Center	Obumbrate Center	Highlight End Part	Highlight End Part
	Sound	Getting High Tone	Getting Low Tone	Sound of Shaking Paper	Sound of Shrinking Paper
	Haptic	Continuous Vibrating while Action	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating Until Action
P3	**Visual**	Obumbrate Side	Highlight Side	Obumbrate Hand Part	Obumbrate from Hand Part
	Sound	Getting High Tone	Getting Low Tone	Sound of Shaking Paper	Sound of Shrinking Paper
	Haptic	Continuous Vibrating while Action	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating Until Action
P4	**Visual**	Obumbrate Side	Highlight Side	Highlight End Part	Highlight End Part
	Sound	Getting High Tone	Getting Low Tone	Sound of Shaking Paper	Sound of Shrinking Paper
	Haptic	Continuous Vibrating while Action	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating Until Action
P5	**Visual**	Obumbrate Side	Obumbrate Center	Obumbrate Hand Part	Obumbrate from Hand Part
	Sound	Getting High Tone	Getting Low Tone	Sound of Shaking Paper	Sound of Shrinking Paper
	Haptic	Continuous Vibrating while Action	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating Until Action
P6	**Visual**	Obumbrate Side	Obumbrate Center	Obumbrate Hand Part	Obumbrate from Hand Part
	Sound	Getting High Tone	Getting Low Tone	Sound of Shaking Paper	Sound of Shrinking Paper
	Haptic	Continuous Vibrating while Action	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating - Big Vibrating at Task End

Table 1. Result of design workshop (Participants 6 / Action 1-4)

		Action 5	Action 6	Action 7	Action 8
		Flip over unclockwise	**Bending right-side upward**	**Bending left-side upward**	**Bending the upper right corner**
P1	**Visual**	Highlight End Part	Highlight from Left Side	Highlight from Right Side	Highlight Upper Right Corner
	Sound	Sound of Shrinking Paper	Getting High Tone	Getting High Tone	Sound of Brush
	Haptic	Small Vibrating Until Action	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating - Big Vibrating at Task Occur
P2	**Visual**	Highlight End Part	Highlight from Left Side	Highlight from Right Side	Highlight Upper Right Corner
	Sound	Sound of Shrinking Paper	Getting High Tone	Getting High Tone	Sound of Brush
	Haptic	Small Vibrating Until Action	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating - Big Vibrating at Task Occur
P3	**Visual**	Obumbrate from Hand Part	Obumbrate from Right Side	Oburbrate from Left Side	Highlight Upper Right Corner
	Sound	Sound of Shrinking Paper	Getting High Tone	Getting High Tone	Sound of Brush
	Haptic	Small Vibrating Until Action	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating - Big Vibrating at Task Occur
P4	**Visual**	Highlight End Part	Highlight from Left Side	Highlight from Right Side	Highlight Upper Right Corner
	Sound	Sound of Shrinking Paper	Getting High Tone	Getting High Tone	Sound of Shrinking Paper
	Haptic	Small Vibrating Until Action	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating - Big Vibrating at Task Occur
P5	**Visual**	Obumbrate from Hand Part	Obumbrate from Right Side	Oburbrate from Left Side	Highlight Upper Right Corner
	Sound	Sound of Shrinking Paper	Getting High Tone	Getting High Tone	Sound of Brush
	Haptic	Small Vibrating Until Action	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating - Big Vibrating at Task Occur
P6	**Visual**	Obumbrate from Hand Part	Obumbrate from Right Side	Oburbrate from Left Side	Highlight Upper Right Corner
	Sound	Sound of Shrinking Paper	Getting High Tone	Getting High Tone	Sound of Shrinking Paper
	Haptic	Small Vibrating - Big Vibrating at Task End	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating - Big Vibrating at Task Occur

Table 2. Result of design workshop (Participants 6 / Action 5-8)

Discussion

Visual Feedback

For visual feedback, there are two tendencies among users. The first tendency is to make starting point of action as a starting point of visual feedback. For the action 1 (Bending Upward), participants 3,4,5,6 make feedback which obumbrating side part where user held and flex. On the other hand, participants 1 and 2 make feedback which highlighting center part where the actual task occurs. These results show another tendency that makes task part as a starting point of visual feedback. This tendency is also shown in another action except action 8 (Bending the right upper corner). In the case of action 8, because the task point is equal to action point, all the participants agree with highlighting that position. In general computer systems like desktop, smartphone, and tablet, the task point is always identical with an action point. For that reason, in a traditional system. However, in the flexible interaction system, disconnection between the task point and the action point frequently happen. When designer design visual feedback, they should pay close attention to decided where should be a starting point of visual feedback.

Sound Feedback

In the case of sound feedback, use tends to use the natural sound of that action. For action 3,4,5 and 8, participants build sound feedbacks based on the sound when the materials move in that way. Participants 3 mentioned, “Because it sounds like it if the system gives me that sound, I will feel more natural interaction for it.”. Users want to feel more naturalness while they interact with their flexible device by sound feedbacks from a real world.

Another interesting point is that user wants continuous sound feedback during the action, not the task. Participants 5 commented “I am not sure that my input is ongoing or not. So, I want to know it when I manipulate the system.”. Moreover, for action 1,2,6, and 7, participants designed volume or pitch is proportional to the degree of flexed area for their sound feedback. For action 6, Every participant agrees that while bending right side more, the pitch of sound feedback should be high. This shows the continuous and tangible characteristic of flexible interaction (Warren et al., 2014). In flexible interaction system, the degree and the angle of action can be changed. For this reason, users want to system reacts to their degree and angle of action while they use flexible devices.

Haptic Feedback

For the haptic feedback, as same with sound feedback case, users want to continuous feedback on their action. One different point is that they want to know when the task actually done by the bigger vibration. In case of action 4,5 and 8, participants build feedbacks small vibrating during action, and finished with bigger vibration when task actually happened.

Conclusion and Future Work

In this study, we aimed to understand user’s expectation on the feedback of flexible interaction system by user participated design workshop. By doing this, we could extract design guidelines which designer should consider. For designing visual feedback, designers should consider where will be the starting point of visual feedback between action point and task point. In the case of designing sound feedback, designers should consider about continuity and degree of action. As the last, for haptic feedback, designers should consider about both action and task.

It is true that our study has a limitation on adapting real flexible interaction prototypes. However, we hope that this study will provide both designers and engineers helpful implications and reference for developing interaction system which increases the user experiences.

Reference

Chen, P. C., & Wang, X. (2012, August). Design for well-being in China: lessons learned from exploratory workshops. In Proceedings of the 12th Participatory Design Conference: Exploratory Papers, Workshop Descriptions, Industry Cases-Volume 2 (pp. 81-84). ACM.

Dijkstra, R., Perez, C., & Vertegaal, R. (2011, May). Evaluating effects of structural holds on pointing and dragging performance with flexible displays. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 1293-1302). ACM.

Dimitriadis, P., & Alexander, J. (2014, April). Evaluating the effectiveness of physical shape-change for in-pocket mobile device notifications. In Proceedings of the 32nd annual ACM conference on Human factors in computing systems (pp. 2589-2592). ACM.

Girouard, A., Lo, J., Riyadh, M., Daliri, F., Eady, A. K., & Pasquero, J. (2015, April). One-handed bend interactions with deformable smartphones. In Proceedings of the 33rd annual ACM conference on human factors in computing systems (pp. 1509-1518). ACM.

Gomes, A., Nesbitt, A., & Vertegaal, R. (2013, April). MorePhone: a study of actuated shape deformations for flexible thin-film smartphone notifications. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 583-592). ACM.

Kildal, J., Paasovaara, S., & Aaltonen, V. (2012, May). Kinetic device: designing interactions with a deformable mobile interface. In CHI'12 Extended Abstracts on Human Factors in Computing Systems (pp. 1871-1876). ACM.

Lahey, B., Girouard, A., Burleson, W., & Vertegaal, R. (2011, May). PaperPhone: understanding the use of bend gestures in mobile devices with flexible electronic paper displays. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 1303-1312). ACM.

Lee, S. S., Kim, S., Jin, B., Choi, E., Kim, B., Jia, X., ... & Lee, K. P. (2010, April). How users manipulate deformable displays as input devices. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 1647-1656). ACM.

Mori, J., Howard, S., & Gibbs, M. (2013, September). Designing in sensitive settings: Workshops to design a technology to commemorate Black Saturday. In Proceedings of The 9th Australasian Conference on Interactive Entertainment: Matters of Life and Death (p. 13). ACM.

Pandit, N. R. (1996). The creation of theory: A recent application of the grounded theory method. The qualitative report, 2(4), 1-15.

Schwesig, C., Poupyrev, I., & Mori, E. (2004, April). Gummi: a bendable computer. In Proceedings of the SIGCHI conference on Human factors in computing systems (pp. 263-270). ACM.

Ramakers, R., Schöning, J., & Luyten, K. (2014, April). Paddle: highly deformable mobile devices with physical controls. In Proceedings of the 32nd annual ACM conference on Human factors in computing systems (pp. 2569-2578). ACM.

Warren, K., Lo, J., Vadgama, V., & Girouard, A. (2013, April). Bending the rules: bend gesture classification for flexible displays. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 607-610). ACM.

Author Biography

Jaemyung Lee

PhD Candidate, Department of Industrial Design, Korean Advanced Instituted of Science and Technology

Hwal Kim

Master Degree, Department of Industrial Design, Korean Advanced Instituted of Science and Technology

Jiwon Jung

Master Degree, Department of Industrial Design, Korean Advanced Instituted of Science and Technology

Kun-pyo Lee

Professor, Department of Industrial Design, Korean Advanced Instituted of Science and Technology