Shape Changing Device for Notification

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ABSTRACT
In this paper, we describe a notificatio method with peripheral cognition technology that uses a human cognitive characteristic. The method achieves notificatio without interrupting users' primary tasks. We developed a shape changing device that change its shape to notify the arrival of information. Such behavior enables a user to easily fin and accept notification without interruption when their attention on the primary task decreases. The result of an experiment showed that the successful notificatio rate was 45.5%.

Author Keywords
Peripheral Cognition Technologies; notification

ACM Classificatio Keywords
H.5.2. [Information Interfaces and Presentation]: User Interfaces - Theory and methods;

INTRODUCTION
There are many digital devices such as smart phones and tablet PCs that notify us of fresh information. However, frequent notificatio often breaks users' attention and interrupts their work. Various studies have been done for this problem. One approach with a user model [1] collects sensor data and estimates the user's interruptibility, and another approach without a user model develops effective visual notification that adjust the levels of interruption by using a transitional illustration [2] and an animated picture [3].

We propose a notificatio method with peripheral cognition technology (PCT) [5] that uses a human cognitive characteristic called *visual fiel narrowing*[4]. The method achieves notificatio without interrupting the task that a user is engaging in. We developed a shape changing device based on PCT that slowly changes its shape to notify of the arrival of information. The behavior of the device enables a user to maintain attention on his or her work and to accept notification without interruption when his or her attention on a task decreases because the device can move itself quietly and without causing a distraction. Furthermore we conduct preliminary experiment to evaluate the effectiveness of the notificatio method with the shape changing device.

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Figure 1. Shape changing behavior.

SHAPE CHANGING DEVICE
We propose a shape changing device that notifie users of the arrival of new information as an application of PCT. The device slowly and quietly changes its shape. The basic idea of the method is based on the human cognitive characteristics of narrowing the peripheral vision fiel when concentrating on a certain target (*visual fiel narrowing*) and having difficult with detecting subtle changes in a target (*change blindness*). The designed changing behavior is too slow and quiet for users to notice the movements. Information notifica tion is achieved when users happen to see that the device has changed its shape when their concentration level on a target naturally decreases.

In our research, smart phones are assumed as the notificatio device. We developed a device that notifie users of delivered information without interrupting them. The developed shape changing device un-intrusively alters its shape by making the smart phone stand up, making it is easy for users to notice the change.

Figure 1 shows the shape changing behavior. The device changes its shape when it obtains information from e-mail clients, Twitter, Facebook, RSS, etc. First, it softly opens the upper cover and then slowly raises the smart phone ((2)-(4) in Figure 1). Designing the behavior of this shape changing requires setting motor control parameters such as the moving speed and intervals so that users do not notice the changing actually taking place. The device needs to be located in the

side area to a display as a user's peripheral area when he or she does desk work with a PC.

SIMPLE USER STUDY AND DISCUSSION

We conducted a simple user study for two weeks. It was completely exploratory research done by one person who used the device for about two weeks in a real situation at his office Figure 2 shows the experimental environment. He spent most of his time at his desk but often left the desk. The device informed him of the arrival of information we sent that was designed to be like the typical information sent to smart phones by changing its shape to raise the smart phone within random intervals (between one to thirty minutes). He answered a brief questionnaire whenever he noticed a notification The questionnaire was displayed on the smart phone (Figure 3), and he directly selected the items by touch.

We evaluated the proposed method on the basis of the questionnaire results. The evaluation indexes consisted of the successful notificatio rate, the semi-successful notificatio rate, the intrusive notificatio rate, the neglected notificatio rate, and the notificatio received rate.

The results of the questionnaire are shown in Figure 4. In total, he answered the questionnaire 97 times within a certain time frame. The successful notificatio rate, selected with "I noticed it just now for no special reason," was 45.5% (44/97). The semi-successful notificatio rate, selected with "I noticed when I returned to my desk," was 29% (28/97). The intrusive notificatio rate, selected with "I suspended my work," was 19.6% (19/97). The neglected notificatio rate, selected with "I noticed it before," was 6.2% (6/97). The notificatio received rate was 37.9%.

The experimental results showed that the number of successful notification was 44 times, which exceeded that of the intrusive notification However, there is still room for improvement because the success rate was less than 50%. The reason for this result was that the participant answered that he noticed the sound of the motor in the device. Decreasing the motor sound is one problem to solve because he delayed responding to the device only six times when hearing the sound. The participant noticed the notificatio when he returned from being away from his desk 28 times. This suggests that the shape changing device is useful for work in which the worker leaves and returns to his desk multiple times throughout the day.

The notificatio received rate was less than 40%. This result is not surprising because the proposed method contributed

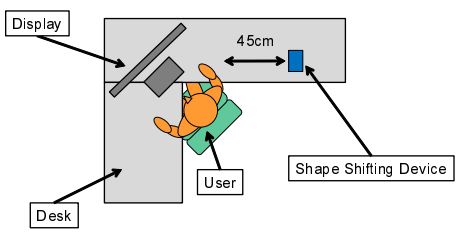

Figure 2. Experimental environment.

Figure 3. Questionnaire page on a smart phone.

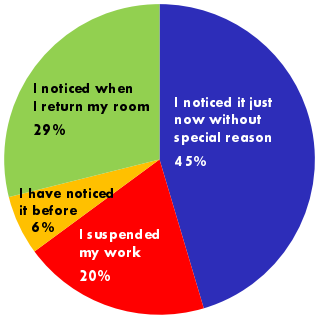

Figure 4. Results of questionnaires.

kept the number of times the user was interrupted from being excessive. However, since we used notification we created, the user's behavior might have been influence as a result. It is preferable to increase the received rate and to investigate realistic phenomenon more in depth.

Although there are many alternatives for the notification the proposed method changed the position of the smart phone. Notificatio can be achieved without raising the smart phone, but the advantage of raising it is to make it easier to operate the phone by picking it up. It is common for users to use their phone after they have accepted a notification

CONCLUSION

In this paper, we proposed a notificatio method with PCT that uses the human cognitive characteristic of visual fiel narrowing. The proposed method can achieve notificatio without interrupting the user's primary task that he or she is engaging in. We developed a shape changing device that changes its shape to notify of the arrival of information. Such behavior enables a user to easily fin and accept notification without interruption when their attention on a primary task decreases. We conducted a simple user study in a realistic offic environment. The experimental results support the effectiveness of our method with the promising successful notificatio rate.

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