

Novel Method for Notification from Interactive Smart Cover

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Abstract. Traditional interaction method on mobile device often causes notification stress. Several research projects based on the software approach were attempted but it is not always perfect solution. In this design work, we propose a new interaction method with Interactive Smart Cover. This mobile device accessory adds a new notification channel as well as protects device. We extend its potential to future devices such as smartwatch. Future applicability of the accessory and its limitation will be discussed as well.

Keywords: Notification · Interactive · Accessory · Appessory · Cover

1 Introduction

Current mobile device supports varieties of functions. People can use it to manage finance, view documents or design creative contents. However, its primary use is limited to lightweight activities [9, 29] such as checking E-mail, communicating on Facebook, or playing games. All these start from checking notifications. For instance, when you receive new E-mail from your friend, you would receive push message for the reply. This means that our mobile device is always ready for communicating with people, other software, or even with other devices.

Although the push notification system has contributed to the formation of application ecosystem, method of checking notifications is not heavily changed. People still head down to read texts displayed on the screen or prick up ears to hear ring tone. This lasting interaction method might stress out users while communicating with social network. Yoon et al. investigated [8] the causes of notification stress from mobile messenger and revealed that current method of notification does not properly express the importance and kind. In this regard, we have looked back on the notification system and devised the way to complement users.

We think device accessory will play greater role in the future. Surveys [1, 2] and potential growth of device accessory [10, 11] also backs up our vision. Academic community also recognized the infinite potential of mobile accessory and defined Appessory, [5] a smart accessory that can be integrated with mobile applications. Appessory is now widely distributed in commercial market and some research projects using accessory type device were presented [3, 4, 6, 7] as well.

Therefore, we revisit research on the interruption of notification system and improvement on that issue. We also briefly report on the current use of mobile accessory. Next, we propose our new notification method with simple magnetic cover, Interactive Smart Cover, the cover that we were inspired by the Apple Smart Cover [30]. The specific design and concept of the cover is proposed, and we extend its potential to flexible device like smartwatch. Functional integration on mobile device and limitation of the proposed item will be discussed as well.

2 Related Work

Although notifications provide valuable information, it often interrupts people in real life and even stresses people. Herein, we will focus on the notification system, its stress and interruption while using mobile devices. The disruptiveness of notification and proposed solution by other researchers will be presented as well.

2.1 Notification, Stress, and Interruption

People receive a lot of push messages every day but we do not know how frequently they get notifications and what the leading cause of stress is. In this regard, Pielot et al. reported the quantitative analysis on real-world notifications through logging user actions [15]. The objective data revealed that participant received about 65 notifications every day and messenger applications took the biggest portion. Czerwinski et al. and Iqbal et al. reported on the effects of Instant Messenger on the desktop environment [25, 26]. They showed two findings; one is that the relevance between notification and task is related to productivity [26] and the other is that the disruptiveness of notifications varies according to the phase of task [25].

In mobile environment, Fischer et al. [24] also found the result that timing of notification is important. It is known that opportune moment of notification is end of the task. Yoon et al. pointed out the problem of intrusive notification and surveyed the notification stress of mobile messenger [8]. They elicited from participants that tons of messages in multi-user chat room cause huge stress to users. From the in-depth interview, several interviewees said they felt like they had heard auditory hallucinations of notifications. On this issue, Fallman et al. put emphasis on the necessity of context aware notification [23] and discussed which modality could be important.

Several research projects attempted to mediate notification stress. To reduce the disruptiveness of notification, Horvitz et al. physically deferred the frequency of E-mail notification [14]. Iqbal et al. devised the concept of scheduling notification and developed the system [26], Oasis, which is able to defer notifications until interruptible moments. Scheduling notification was pretty effective [26] in that it yields faster reaction time compared to immediate notification. Another improved notification design within specific mobile application is done by Böhmer et al. [12]. Researchers pointed out the limitation of previous phone call user interface and developed the improved visual design of dialer application [12], which enables users to get out of full screen notification and helps them to prepare for incoming call. Perhaps disabling

notification for a while could be helpful to users. This extreme idea has also been discussed from Iqbal et al., who conducted an experiment [27] which compares E-mail client access rate in two conditions; with notifications and without notifications. Ironically, some of the participants said [27] they are willing to turn on notification and accept the potential disruption because they want to monitor whether new information arrived. This clearly indicates that mitigating stress with traditional interaction method is not always perfect solution for everybody.

Interaction method itself is obviously important factor of notification system. There are some unique research projects based on the technological advance. MorePhone [28] is the representative case of notification method using shape-changing flexible display. The actuated smartphone is able to describe both urgency and type of notification. This seems a bit different approach from previous projects because most have adopted software approach [12, 14, 25, 26]. On the other hand, Vibkinesis [6] is obviously unusual research project. Yamanaka et al. proposed a smartphone-attachable case [6] that can control its angle and directions of movement. The proposed hardware enables the smartphone to move and notice the alarm by tapping user's hand. The external accessory rotates with vibration motors, and the specific rotation angle can be used to notify the number of new E-mail.

In summary, majority of prior works have focused on reducing the stress within its device – software application, optimizing algorithm, or device integrated sensors. But there is little research which tried to mitigate notification stress in the perspective of accessory devices. From the following section, we revisit the current mobile accessories and propose futuristic notification method using them.

2.2 Revisiting the Mobile Accessory

In this section, we briefly look around the mobile accessory and interaction with it. It includes the following categories; Protective accessory, music receivers (Headphone and earphone), or chargers. Given the distribution of accessory [31], we will narrow down the subject to protective accessories.

Protective accessory is the most representative category among mobile accessories [31]. It can be categorized according to the protecting area. Cover-type accessory generally refers to the item which covers only the one side of the device (Reversely if the cover only protects backside of device, it is named back cover in the market.). On the other hand, case-type accessory protects rear and side of the device. Case cover accessory which protects all the face exists as well.

To improve interaction of using device, we have to know how people use their accessories on their devices. Following is the typical way people use protective cover to check notifications (Except for backside cover):

1. Device receives a push message.
2. Device notifies.
3. User recognizes, opens the cover.
4. Reads information.

From these steps, we found that manually opening the cover to read message might be cumbersome to whole accessory users. This comes from the contradiction that people want both safety and instant access. The contradiction gave rise to a number of unique commercial items that not only cover devices but also provide instant access. Samsung S View Flip Cover is an example [32] which displays summarized information through rectangular hole on the cover. The Flip Cover helps users not to open the cover for checking notification. However, the cover still has the limitation that users must open it by hand whenever they want to look detail information. The small size of notification area and its top-sided location is also regarded as weak point.

3 Interactive Smart Cover

Assuming most people use their own protective cover on their device, the key problem while using cover-type accessory is that visual feedback is blocked. When people receive a new message, text tone sounds but users cannot catch the information before they open the cover. In this respect, we introduce the futuristic notification method with Interactive Smart Cover, which does not require us to manually check the notifications.

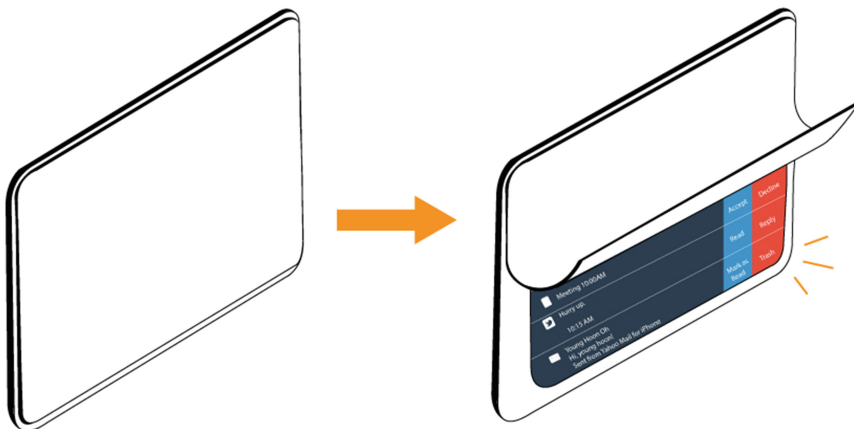


Fig. 1. (a) Before receiving notification (Left), (b) Example of notification list and buttons (Right).

The proposed item differs from existing Smart Cover by Apple [30] because our cover has interactive feature. This means that the cover automatically opens/closes itself and alerts new notifications. When the cover is automatically opened, it shows the list of notifications and extended buttons for users to take action. Figure 1 illustrates what happens when users receive users receive a new mail.

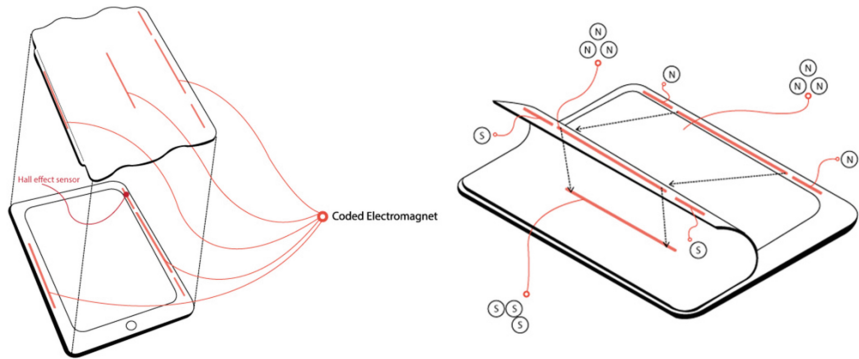


Fig. 2. (a) Arrangement of electromagnets (Left), (b) Disclosure of screen using repulsive force (Right).

3.1 Method

Interactive Smart Cover is operated by arrays of coded electromagnet which is placed both on the cover and device (Please note the Fig. 2(a)). Coded magnets or programmable magnets refer to the magnetic structures which can be programmed dynamically by using multiple correlated patterns of magnets. For example, when current is applied to the electromagnetic elements they will produce the magnetic field. Thus, we have designed the magnets on device to exert repulsive forces to the magnets on the cover. This results in the disclosure of screen as shown in Fig. 2(b).

Figure 2(a) describes the blueprint of the proposed accessory. All red lines on Fig. 2 describe the sets of coded electromagnets. There are four separate sets of magnets on the device – Two sets of long magnets and two sets of short magnets. Interactive Smart Cover has three long magnets and two short magnets. One of the long size magnets on device is for clamping the Interactive Smart cover and another one is limited to exert repulsive force only if the device receives message. Both have same magnetic polarity such as north polar (Also noted in Fig. 2(b)). Two short-sized magnets is also North pole and they are used to cover touchscreen same as previous Apple Smart Cover. Among five separate magnets of the cover, all are South pole except for the long-sized one which is used to make repulsive force. Therefore, two separate long-sized magnets are used to uncover touchscreen as shown in Fig. 1(b).

3.2 Benefit

Here are some following benefits of the *Interactive Smart Cover*. Uncoordinated notification has been important issue [8, 15]. One of the leading causes might be repetitive visual/auditory notification which occurs all at once. *Interactive Smart Cover* not only provides physical convenience but also gives peace of mind from the rush. The proposed cover does not repeat opening and closing every time device receives notification but it is gradually opened according to the number of push messages. This

means that the more messages it receives the more area it exposes (Compare Fig. 1(b) and Fig. 3(a)).

Unlike previous cover products, the proposed cover does not intrusively distract users. Imagine a situation that an office worker's phone sounds 'Marimba' during an important meeting. If it happens, you may feel embarrassed. This interruption comes from the fact that sound is originally "designed to attract maximum attention" [13]. The proposed item, however, is able to silently notice when the device is within the range of one's vision. It could reduce the notification stress from sound and even save some time to prepare for the interruption [12].

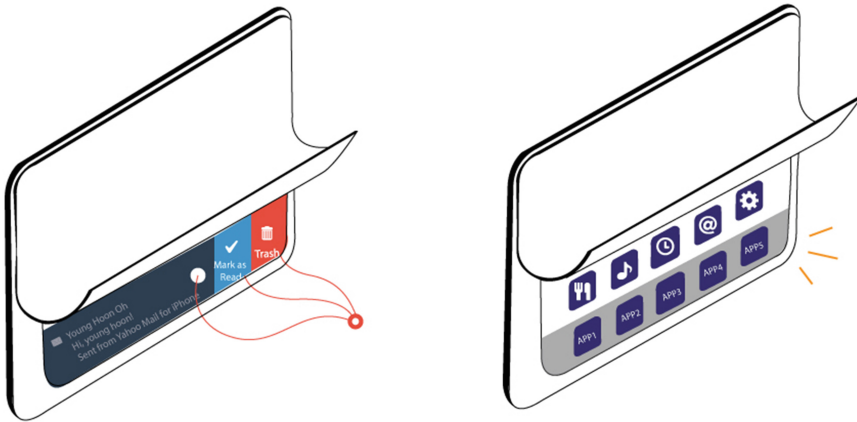


Fig. 3. (a) Uncovered screen with Interactive Smart Cover (Left), (b) Uncovered home screen with previous cover (Right).

There has been no option for people using non-interactive smart cover [30] to check notification instantly since existing products display the last screen when cover is opened (Assume device is unlocked). However, when Interactive Smart Cover exposes the touchscreen, the mobile device displays notification first (See Fig. 3(a)). The touchless notification enables users to use their mobile devices as if they are not using accessories. If user manually uncovers the device himself/herself, it shows the home screen or last app screen as previous products (Also in Fig. 3(b)). Therefore, the cover improves adaptability as well as usability.

From the perspective of Accessory, Interactive Smart Cover adds a new personalized notification channel. It can be configured to response only when the device receives important notification. For instance, if users receive phone call from starred contact which is personally set on the phone, the phone would be uncovered and incoming call screen will be displayed. It makes sense because the cover does not block visual feedback and it does not make sound even the device is mute mode. Third party applications might provide detail preference such as combining notification channel – sound notification and cover movement for important phone call, vibration and cover movement for important new E-mail. This will help people who are worried about

missing important notification [8] or who want to minimize daily interruptions [14]. With further integration with mobile application, proposed cover will be able to provide context-aware notification in the future.

4 Interactive Smart Cover on Watch-Type Device

Interaction with wearable computing devices has attracted HCI Community’s attention. Large amount of previous works have focused on the supporting input modality [33] but little work is gone into integrating notification system on smartwatch with accessories. Since steady growth of smartwatch is reported [20], accessory design supporting its own nature would be required. In this section we propose the notification method of Interactive Smart Cover for watch-type devices and account for the reason why its interaction design is suitable for them and other future devices.

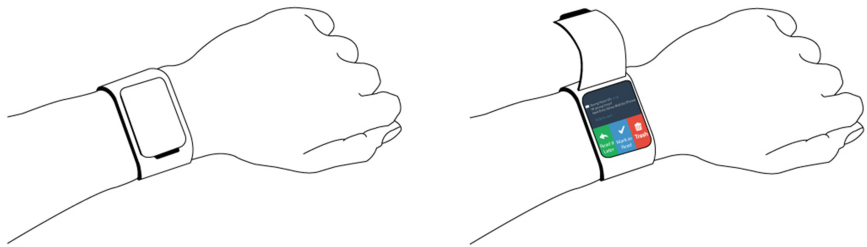


Fig. 4. Example of Interactive Smart Cover’s notification for watch-type device – closed (Left), opened (Right).

The question on how to deal with the integration of accessory and device has heavily led us to devise various designs. Figure 4 is an example of application for flexible device (or current non-flexible device). The flexible watch is on the wrist and the cover is uncovered to show notifications. However, the watch might lose its natural feature if the cover is closed all the time. In this regard Interactive Smart Cover not only protects the flexible device but also improve the noticeability of watch device with its interactive feature.



Fig. 5. Example of using watch-type device with flexible cover (Before > Shaking > after)

Although small screen of watch-type device causes discomfort for users to check notification, current smartwatch users actively check notification/information from the mobile devices [16]. In accordance with the activity trend, we have added one more way to check notifications; shaking devices. Figure 5 shows another method to check notifications. It presents three simple steps. When people shake their own device, it senses the direction of motion. For example, if the flexible watch is shaken twice to the right, the OS forces the coded magnet to be opened. Users can trigger opening of the cover with motion sensor, which is widely packed in the watch device. This enables users to check notifications as if they are not using accessories. Of course, they can close it by shaking or by hand.

The proposed interaction for watch-type is applicable to most mobile devices. Past research on the utility of motion sensing [17, 18] supports that shaking accessory can be adapted to users naturally. Chernbumroong et al. had experiment on detecting five daily activities with single wrist-worn sensor [22] and Partidge et al. developed the TiltType technique [19], a text entry complementing system which is designed for small mobile devices such as current watch-type devices. Motion sensor is already distributed in the commercial market. For instance, Moto 360 which was the most popular in 2014 [21] has accelerometer sensor and gyro sensor (Fig. 6).

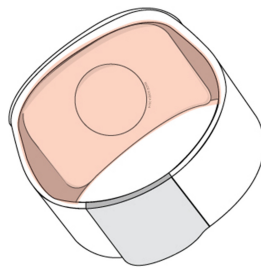


Fig. 6. Rear side of typical watch-type device

The original nature of smartwatch also supports the necessity of our interaction technique. Assuming most users need protective accessories for watches, front screen is vulnerable to be damaged in practice. On the other hand, the rear surface of the watch has lower chance of getting damaged. This means that cover-type accessory is suitable for watches. In addition, given that the most-used feature of smartwatch is checking notification [16], frequent notification might be stressful to watch users. Regarding this inconvenience, Interactive Smart Cover would be used as helpful customized notification channel.

5 Discussion

Noticeability varies depending on the context. In public spaces people usually set their phone to mute mode. This means that sound notification is not available at specific location. In case of time modality, “Do Not Disturb” or “Quiet time” feature in mobile OS blocks auditory notification during scheduled time [8]. In this regard, Interactive Smart Cover has obvious advantage that it does not explicitly make noise. Since we only proposed the interaction method and design of the cover from this paper, comparison of actual noticeability should be explored from the further research.

The proposed cover has some limitations as well. As we have previously mentioned, the cover’s movement is visible only within the user’s vision. This means that if s/he is distant from devices, the cover loses immediate notification. In this case, maintaining uncovering of the cover, it is able to notify arrival of new message just like the dying message [6]. Dark place might be problematic as well, but light from touchscreen and illumination sensor would be helpful to deal with the situation. We can find another weak point from the proposed interaction method (See Fig. 5). In respect of wearable device, whole user activities should be concerned. For instance, if table tennis player wears watch-type device with Interactive Smart Cover, their stroke could trigger the disclosure of the cover. To cope with extreme situations, further integration with mobile device is required. If motion sensor packed in the smartphone detects the exercising state, the phone would inhibit the trigger of paired device for a while. In addition to the case of small devices, strength of magnetic force should be tested for the feasibility.

For our future work, we will develop the hardware and compare the noticeability with traditional notifications. Significance of the cover would be the following. Based on the development of Interactive Smart Cover, we plan to apply some specific functions to the mobile device. Since our cover could expose private information publicly, we also devised how to avoid unwanted cases. One possible option is detecting user with front camera on tablet PC. If face of user is not detected, display would be turned off earlier. Other detail algorithm and steps will be addressed in the future work.

6 Conclusion

In this paper we review current notification system and several improvements on its problem. We also suggest new notification method using mobile device accessory which has been little focused. The design of Interactive Smart Cover is presented and it extends its potential to provide customized notification channel. We also propose a new interaction method for wrist-worn device. Further development and noticeability will be discussed in the future work.

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