Ambient Notifications with Shape Changing Circuits in Peripheral Locations

Lee Jones
Carleton University
Ottawa, Ontario, Canada
Lee.Jones@carleton.ca

John McClelland
Carleton University
Ottawa, Ontario, Canada
John.McClelland@carleton.ca

Phonesavanh Thongsouksanoumane
Carleton University
Ottawa, Ontario, Canada
Phonesavanh.Thongsouk@carleton.ca

Audrey Girouard
Carleton University
Ottawa, Ontario, Canada
Audrey.Girouard@carleton.ca

ISS '17, October 17–20, 2017, Brighton, United Kingdom

ACM ISBN 978-1-4503-4691-7/17/10.
https://doi.org/10.1145/3132272.3132291

Abstract
Calm technologies help us avoid distraction by embedding notifications in our surroundings with peripheral updates. However, users also lose out on the passive awareness that comes from more overt notifications. In our paper, we present an initial study setup on shape changing circuits as notifications. We compare near and far peripheral locations to determine the optimal location for these notifications by assigning a primary task of arithmetic questions, and a secondary task of responding to bend notifications. Our demonstration will show the set-up of our study to encourage discussion on possible applications of shape changing notifications in peripheral locations.

Author Keywords
Notifications; Shape Changing Interfaces, Peripheral Display; Ambient Notifications; Deformation

ACM Classification Keywords
H5.2 [Information Interfaces and Presentation]: User Interfaces—Graphical User Interfaces, Interaction Styles

Introduction
The perceived value of notifications is providing passive awareness and information to users [4]. Contrary to

the belief notifications lead to less task switching [4], studies show they are distracting and often make tasks take longer [3]. In one study on desktop notifications participants took an average of over 16 minutes to return to their original task after an email alert, and almost 11 minutes after an instant messaging alert [3]. There is a clear impact on productivity when one considers the possible compounding effect of receiving these types of notifications throughout the day.

Attention-grabbing notifications are useful for urgent matters [9], but notifications of non-urgent information should not distract us [8]. One proposed solution is calm technology. Calm technology through ubiquitous computing is the idea that technologies are less distracting when they inform us on the periphery [9]. Yet with calm technology the user must actively decide to pay attention or risk missing information [9].

Given these two approaches, an identifiable gap in research is to provide passive awareness to users without creating distractions or causing task switching. Notifications in the near periphery, close to but not overlapping one's area of focus, could be a way to notify users passively without the distraction of on-screen pop-up notifications. To test this concept, we utilized shape change as near and far peripheral notifications.

Shape changing notifications also show potential for remaining noticeable without becoming a distraction, and are least distracting when they move slowly and quietly [5, 6]. Kobayashi et al. [5] made a motorized device that changed shape to signal a notification. They

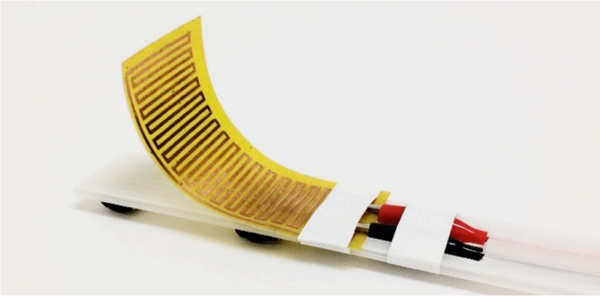

Figure 1. Shape changing notifications bend slowly and silently when electrical current is applied.

determined that for a shape changing notification the device needed to be slow moving and quiet to avoid distracting users. Another example, Wrigglo [6], is a smartphone addition with shape changing notifications. Their team discussed how shape-changing devices can provide effective and subtle notifications, and specifically focused on the benefits of a small design and the quiet aspects of shape change.

Prototype

Using Park et al.'s [6] design guidelines, that suggest shape changing notifications work best when they are small and quiet, we made the shape changing notification prototype for our study into a small 2"x5" device. We then replicated the fabrication process in UniMorph [2] by adhering three flexible layers (Kapton, UHMW polyurethane, and a copper circuit together (Figure 1)). When heated, these materials silently bend due to the differences in their thermal expansion coefficients.

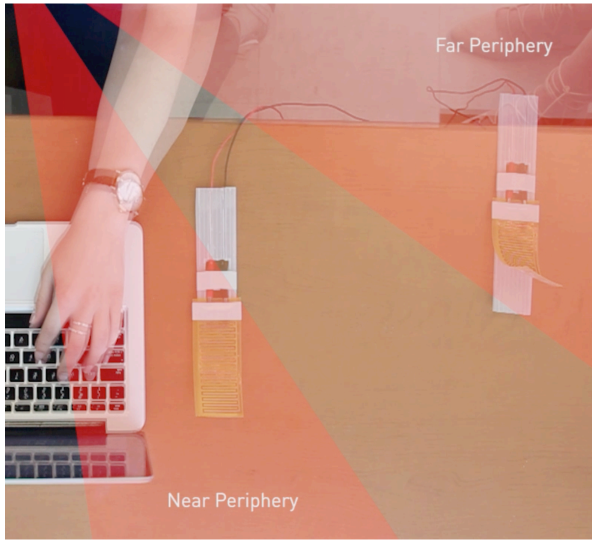

Figure 2. Device location compared to primary task.

We compared the device position between near and far periphery locations (Figure 2). For the first location, we placed the apparatus on the participant's desk at a 20° angle from their center of focus (a computer screen) and 20 cm away from them, and for the second we placed it on a wall 90° and 40 cm to the left of the participants. Each notification change (from flat to fully lifted) took less than 20 seconds, and varied slightly based on the device's temperature at the start of a notification.

Study

Our goal for this study was to find out where a quiet, slow moving shape changing notification should be placed in relation to someone's main task (their central area of focus). For example, when someone is working on a computer, what is the best way to notify them of a non-urgent matter without distracting them from their work? Past studies on shape changing notifications looked at this question through near peripheral locations [7] and far peripheral locations [5] separately, but none compared the two. To fill this gap, we conducted a user study that compared shape changing notifications in the near and far periphery to assess the impact of location on calm technology.

We hypothesized that users would find the near periphery device more distracting than the far periphery, resulting in a lower quality of work during near periphery sessions, and that the near periphery notifications will be more noticeable than those in the far periphery. Our user study utilizes a primary and secondary task, emulating Bodnar et al.'s study [1]. Participants answered simple mathematical questions, and either had to *Respond* to notifications by leaving the primary task and entering the time into a text box, or *Ignore* the notifications, and continue the primary task without interruption. Our approach tested two bend notification locations, resulting in a 2 (Near, Far) x 2 (Respond, Ignore) within-subjects model.

Results and Discussion

Our study found recognition accuracy to be significantly higher for the near periphery notification. When comparing the respond and ignore conditions in each location we saw no significant difference in work efficiency for the near periphery. In contrast, responding to far periphery notifications led to a significant decrease in the number of math questions completed. The results suggest shape changing notifications in the near periphery can provide passive awareness without distracting users from their primary task.

We outlined earlier that current approaches to notifications can result in two less than desirable outcomes. Attention-grabbing notifications succeed in communicating urgent information, but reduce productivity through distraction. Ambient notifications, such as those described by calm technology, do not distract users, but fail to provide the benefit of passive awareness. The gap between these two requires a notification method that does not disrupt productivity but is still easily observable.

Our results point to the near periphery as a location with a high potential to satisfy both these requirements. The near periphery device saw no significant change in primary task performance between ignore and respond conditions, and all but two near notifications received correct responses.

Conclusion

We evaluated the effectiveness of a shape changing notifications in two peripheral locations, as well as their impact on quality of work in terms of work completed and error rates. Overall, we found that it was easier to accurately recognize state changes at near peripheral devices. At the conference, we will show the set-up of our study to provoke discussion on applications for these shape changing periphery notifications.

Acknowledgements

This work was supported and funded by the National Sciences and Engineering Research Council of Canada (NSERC) through a Discovery grant (402494-2011) and by the Ministry of Ontario through an Early Researcher Award (ER15-11-101). The views expressed in the publication are the views of the Institution and do not necessarily reflect those of the Province.

References

[1] Bodnar, A., Corbett, R. and Nekrasovski, D. 2004. AROMA: ambient awareness through olfaction in a messaging application. *Proceedings of the International Conference on Multimodal Interfaces*, 183–190.

[2] Heibeck, F., Tome, B., Della Silva, C. and Ishii, H. 2015. uniMorph: fabricating thin film composites for shape-changing interfaces. *Proceedings of the ACM Symposium on User Interface Software & Technology*, 233–242.

[3] Iqbal, S.T. and Horvitz, E. 2007. Disruption and recovery of computing tasks: field study, analysis, and directions. *Proceedings of the SIGCHI Conference of Human Factors in Computing Systems*, 677–686.

[4] Iqbal, S.T. and Horvitz, E. 2010. Notifications and awareness: a field study of alert usage and preferences. *Proceedings of the ACM Conference on Computer Supported Cooperative Work*, 27–30.

[5] Kobayashi, K. 2013. Shape changing device for notification. *Proceedings of the ACM Symposium on User Interface Software and Technology*, 71–72.

[6] Park, J., Park, Y.-W. and Nam, T.-J. 2014. Wrigglo: shape-changing peripheral for interpersonal mobile communication. *Proceedings of the ACM Conference on Human Factors in Computing Systems*, 3973–3976.

[7] Probst, K., Haller, M., Yasu, K., Sugimoto, M. and Inami, M. 2014. Move-it sticky notes providing active physical feedback through motion. *Proceedings of the International Conference on Tangible, Embedded and Embodied Interaction*. 3, 29–36.

[8] Vastenburg, M.H., Keyson, D. V and Ridder, H. 2008. Considerate home notification systems: a field study of acceptability of notifications in the home. *Personal and Ubiquitous Computing*. 12, 8, 555–566.

[9] Weiser, M. and Brown, J.S. 1997. The coming age of calm technology. *Beyond Calculation*. Springer. 75–85.