Demo of a Smart Plant System as an Exemplary Smart Home Application Supporting Non-Urgent Notifications

Alexandra Voit
University of Stuttgart
Stuttgart, Germany
alexandra.voit@vis.uni-stuttgart.de

Stefan Kohn
Deutsche Telekom AG
Bonn, Germany
stefan.kohn@telekom.de

Marie Olivia Salm
University of Stuttgart
Stuttgart, Germany
st107363@stud.uni-stuttgart.de

Stefan Schneegass
paluno - The Ruhr Institute for Software Technology
University of Duisburg-Essen
stefan.schneegass@uni-due.de

Miriam Beljaars
Deutsche Telekom AG
Bonn, Germany
M.Beljaars@external.telekom.de

NordiCHI'18, September 29-October 3, 2018, Oslo, Norway.

ACM ISBN 978-1-4503-6437-9/18/09.
https://doi.org/10.1145/3240167.3240231

Abstract
The present work is a demonstration of a smart plant system that monitors the current water level of a plant. Since related work showed that users are already overwhelmed by notifications in their daily lives, how to design smart home applications that use notifications is an important research question. To study how users experience non-urgent smart home notifications in their daily lives, we decided to use a smart plant system that notifies the users when the plant needs water as an exemplary smart home application. We developed a fully functional smart plant system for the usage in in-situ studies. Our smart plant system can notify the users either using an integrated ambient display in the plant pot or by sending notifications to the users' smartphones. Using these prototypes, we study the user experience of different strategies and locations to display non-urgent smart home notifications.

Author Keywords
Attention management; notifications; smart home; internet of things.

ACM Classification Keywords
H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous

Introduction

Today, many apps inform their users proactively on their smartphone using mobile notifications. Related work showed that users receive many notifications in their daily lives on their smartphones that inform them mainly about messages, emails and appointments [5, 6]. Users value notifications that are related to their current context or to other people [6]. However, former work investigated the effect of notifications on the users and found that notifications can cause negative effects such as distractions, interruptions or even stress [2, 3].

In the era of the Internet of Things (IoT) and the smart home, traditional home appliances are replaced with their smart counterparts. Therefore, all these kinds of smart home appliances will connect to the users to inform them proactively regarding current device states. Currently available smart home products inform their users also on their mobile phones using notifications. Thus, notifications generated by smart home appliances will compete with current mobile notifications for the user's attention [1]. As a result, the negative effects of notifications will further increase.

We assume that most of the provided notifications of smart home appliances will inform the users about home tasks that are important for the users but non-urgent, such as unloading the washing machine or changing the robotic vacuum cleaner bags. To limit the additional negative effects created by smart home notifications, future research has to investigate the design of smart home notifications; especially the design of non-urgent notifications.

However, studying non-urgent smart home notifications is challenging as few users nowadays own smart home appliances that support notifications. Even if users own such those devices, these appliances are too heterogeneous to conduct a systematic assessment. To be able to study non-urgent smart home notifications with a systematic assessment, we decided to use a single representative source for the generated notifications. We chose a smart plant system that notifies the users about watering the plant as watering plants is a lightweight daily home task that limits the burden that is put on the user in a study.

Concept and Implementation

To investigate how non-urgent smart home notifications should be displayed in home environments, we developed a research probe of a smart plant system as watering plants is a familiar, simple, and non-urgent daily home task.

Our prototype monitors the plant's current state and informs the users about the current water level state using an Android application and an integrated ambient lighting display within the plant pot. The system measures the plant's water level through a moisture sensor and differentiates between three different kinds of plant states: (1) The system informs the user if the water level is sufficient for the plant, (2) it notifies the user if the water level falls too low soon, and (3) the system informs the user if the water level is too low.

Furthermore, the system supports the two strategies to notify the users about the plant's state. In case of the event-based strategy, the system only notifies the user when it is necessary to water the plant. The persistent strategy displays the current water level of the plant permanently.

Thus, the smart plant system supports in total four notification types. (1) The plant pot can either persistently show the current water level (cf. Figure 3a) or (2) use the event-based strategy to only notify the user when the plant needs water (cf. Figure 3c). (3) The current water level can be shown through a persistent notification (cf. Figure 3b), or (4) the user can be notified by an event-based push notification in case the plant needs water (cf. Figure 3d).

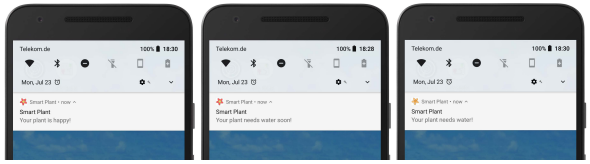
Design space of ambient notifications at the plant pot
To explore the design space of ambient notifications in the home, our prototype supports different notification settings and notification levels. We support two color-schemes for the ambient lighting to display the states (1) displaying the current state using the traffic light metaphor (green, yellow, red) [4] and (2) illuminating the plant more brown to increase the visibility of the plant's unhealthy state. Additionally, we can manipulate the brightness and saturation of the light feedback to communicate the state of the plants.

Functional prototype
For the implementation of our fully functional prototype, we used a microcontroller (ESP8266), a moisture sensor, a LED stripe, and implemented an Android app. The microcontroller is added next to the plant pot in a waterproofed case and is powered by a wall socket. Further, the microcontroller powers and connects to the moisture sensor in the soil of the plant and the LED stripe inside the plant pot. Changes of the plant' s water level detected by the moisture sensor are sent with an additional unique ID using Wi-Fi to a central server (Thingspeak). The server controls the state of the LED stripe and forwards the current water level to a connected smartphone (Firebase Cloud Messaging service). The smartphone app triggers or updates a notification if the water level of the plant decreased.

Demonstration prototype
For the demonstration of our smart plant systems in an environment with no access to water or draining possibility, such as a meeting room or a fair, we decided to use a variety of the magnetic field to simulate the watering of a plant. Therefore, we integrated a magnet into a watering can and replaced the moisture sensor with a hall sensor and integrated a magnet into a watering pot.

(a) persistent display: on the plant pot

(b) event-based display: on the plant pot



(c) persistent notifications: on the smartphone

(d) event-based notifications: on the smartphone

Figure 1: Images for the four supported notification types including their behavior in all three plant's states. The persistent notification strategies display always the current state of the plant's water level, while notifications in the the event-based strategy are only displayed when the plants need to be watered.

Demo setup

Our demonstration prototype will be available for demonstration. Participants will be given an introduction into the design of smart home notifications. Afterward, participants can experience notifications generated by our smart plant system and water the plant using a water can with an integrated magnet.

Acknowledgments:
This work is supported by the BMBF within the project DAAN (13N13481).

REFERENCES

1. Mary Czerwinski, Ran Gilad-Bachrach, Shamsi Iqbal, and Gloria Mark. 2016. Challenges for Designing Notifications for Affective Computing Systems. In *Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct (UbiComp '16)*. ACM, New York, NY, USA, 1554–1559. DOI: http://dx.doi.org/10.1145/2968219.2968548
2. Mary Czerwinski, Eric Horvitz, and Susan Wilhite. 2004. A Diary Study of Task Switching and Interruptions. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '04)*. ACM, New York, NY, USA, 175–182. DOI: http://dx.doi.org/10.1145/985692.985715
3. Gloria Mark, Stephen Voida, and Armand Cardello. 2012. "A Pace Not Dictated by Electrons": An Empirical Study of Work Without Email. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '12)*. ACM, New York, NY, USA, 555–564. DOI: http://dx.doi.org/10.1145/2207676.2207754
4. Andrii Matviienko, Vanessa Cobus, Heiko Müller, Jutta Fortmann, Andreas Löcken, Susanne Boll, Maria Rauschenberger, Janko Timmermann, Christoph Trappe, and Wilko Heuten. 2015. Deriving Design Guidelines for Ambient Light Systems. In *Proceedings of the 14th International Conference on Mobile and Ubiquitous Multimedia (MUM '15)*. ACM, New York, NY, USA, 267–277. DOI: http://dx.doi.org/10.1145/2836041.2836069
5. Martin Pielot, Rodrigo de Oliveira, Haewoon Kwak, and Nuria Oliver. 2014. Didn'T You See My Message?: Predicting Attentiveness to Mobile Instant Messages. In *Proceedings of the 32Nd Annual ACM Conference on Human Factors in Computing Systems (CHI '14)*. ACM, New York, NY, USA, 3319–3328. DOI: http://dx.doi.org/10.1145/2556288.2556973
6. Alireza Sahami Shirazi, Niels Henze, Tilman Dingler, Martin Pielot, Dominik Weber, and Albrecht Schmidt. 2014. Large-scale Assessment of Mobile Notifications. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '14)*. ACM, New York, NY, USA, 3055–3064. DOI: http://dx.doi.org/10.1145/2556288.2557189