Reflections on Plants as Interaction Material

Tanja Döring

Digital Media Lab

University of Bremen

Bibliothekstr. 1

28359 Bremen, Germany

tanja.doering@uni-bremen.de

Abstract

This paper addresses plants as part of human-computer interaction. First, I discuss the role different qualities of ephemeral materials like plants can play for interaction. Second, I introduce the "physicality representation spectrum" using the example of plants as interaction material, a structural approach that includes direct and metaphorical applications of plants to HCI. Finally, the paper concludes with emerging themes for nature-based and nature-inspired user interfaces that evolve from this work.

Author Keywords

Human-plant interaction; materiality; material perspective; tangible user interface; ephemeral user interface; physicality representation spectrum; nature; metaphor.

ACM Classification Keywords

H.5.2 Information interfaces and presentation (e.g., HCI): User Interfaces – *Input devices and strategies, Interaction Styles.*

Introduction

Experiencing nature is important for human wellbeing and usually evokes joy and recreation, especially for people who live in urban environments (e.g., [3]). Thus, from a ubiquitous computing standpoint, which interweaves computing into all areas, it is desirable to explore unobtrusive ways to integrate technology into

nature environments. Furthermore, it is valuable to integrate natural elements into human-computer interaction (HCI) also in domestic or other contexts. In previous work, we have explored the use of natural materials and elements like water, plants, fire, or soap bubble as part of ephemeral user interfaces [6]. It is important to understand the different levels on which materials like these unfold, and how they can be used to shape interactions with technology [7]. Next to properties, form factors or the human senses a material addresses, the material meanings in certain use contexts and the users' emotional responses play important roles (e.g., see also [10]). In this workshop contribution, I focus on the use of plants as part of human-computer interaction (for an overview of human-plant interaction see e.g., [23] and [19]). First, I discuss the role different qualities of ephemeral materials like plants can play for interaction. Second, I introduce the "physicality representation spectrum" using the example of plants as interaction material, a structural approach that discusses direct and metaphorical applications of plants to HCI. Third, I conclude with emerging themes for nature-based and nature-inspired user interfaces that evolve from this work.

Using the Ephemeral Qualities of Plants for Interaction

Integrating ephemerality, e.g. in form of ephemeral interaction materials, into HCI has a number of potentials, which have to date not been explored sufficiently. The notion of the ephemeral (literally meaning "lasting only one day" or "daily") comes along with a number of meanings and associations. First of all, it refers to *transience*, to temporary phenomena that disappear after a while. Bringing this to HCI offers new ways to deal with the ever-growing amount of data and interfaces around

us. A circuit printed on a banana leaf presents an example for a design exploration of a plant-based decaying computational element [9]. Connected to this is the aspect of *changing-over-time*. Ephemeral materials naturally grow, age, get patina or traces, decay and disappear. These behaviors make them valuable and meaningful. Nevertheless, digital artifacts generally do not have these aspects integrated into their design in a meaningful way. In the case of plants, e.g., the reaction to light and water has been applied to use them as ambient displays (e.g., [11],[12],[17]). Third, natural ephemeral materials provide a certain and unique *aesthetics*, often naturally evoking a multi-sensual experience and a strong emotional response. Especially for plants it has been shown that people emotionally response to them, which has suggested human-plant interaction application contexts like the creation of companions for older adults [1] or social interaction for patients and their loved ones [22]. A fourth interesting aspect of the ephemeral is a natural "spirit of *vagueness*" [4] due transient states and limited controllability of the materials. In contrast to conventional computing approaches, this offers interesting and often beautiful approaches for novel input and output strategies. For example, the above mentioned ambient display plants (e.g., [10],[11],[16]) might not present the data very precisely but focus more on aspects of meaning and emotion. This ambient approach to present data through ephemeral materials also makes use of another aspect of ephemerality: its connotation of *triviality* of everyday life and the mundane, which makes ephemeral user interfaces so well suited to present information unobtrusively at the periphery. Human-plant interfaces are a very good example for this. In the following section, I will discuss strategies to directly or metaphori-
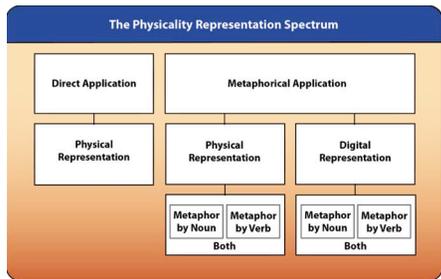
Figure 1. The Physicality Representation Spectrum. Starting from an interaction material, it structures different levels of representations within user interfaces: direct physical representation, metaphorical physical representation and metaphorical digital representation. In the scope of this paper, it is used to discuss nature-based and nature-inspired user interfaces using the example of plants.

cally include these qualities of plants into user interfaces along the physicality representation spectrum.

The Physicality Representation Spectrum: From Physical to Digital Representations

To use and apply certain properties, meanings and emotional connotations of a material in a user interface, interaction designers have a wide spectrum of options from directly applying material aspects physically by integrating the material itself to including only selected aspects metaphorically. It offers an interesting perspective to start thinking from a physical material and then explore different representations of the material aspects as part of a user interface. The physicality representation spectrum starts from a physical material, in this case plants, and incorporates different ways to apply material aspects directly or metaphorically within HCI. Inspired by the distinction between metaphor by verb and metaphor by noun as applied to tangible user interfaces by Fishkin [8] my spectrum includes metaphorical applications by verb and noun within physical as well as digital representations. Overall, the spectrum is subdivided into three categories of material application: direct application, metaphorical physical application and metaphorical digital application.

Direct Application: Physical Representation
The direct application of properties, meanings and evoked experiences of a physical material means that it directly becomes part of a user interface, be it for output, input or both. In the case of plants as interaction materials quite a number of works exist that have explored this design space, many presented in arts contexts. One of the first works using plants as input device is "Interactive Plant Growing" by Sommerer and

Mignonneau, realized in 1993 [21]. Here, approaching and touching plants triggered projected virtual plants to grow. Other works have explored touching plants to generate music (e.g., Akousmaflore [14], Botanicus Interacticus [18]). Using real plants for output primarily can be found in the form of ambient display applications, for example presenting the amount of communication (PlantDisplay [12]), trash disposal vs. recycling (Infotropism [11]) or stock market rates (Yucca Invest Trading Plant [17]). While these works use plants in indoor environments, the project "The singing trees of Tremough" [20] is an example for using trees for output in a nature outdoor environment. This installation realizes a real time sonification of environment data through distributed sensors and speakers in the trees. Using plants for input and output at the same time has been explored by Kuribayashi et al. who presented the I/O plant toolkit and discussed a number of patterns for using plants as sensors and actuators [13]. Angelini and colleagues focused on the emotional relationship between plants and older adults [1]. They sensed touch interactions and the plant's state and communicated this via emoticons on a display located at the plant.

Integrating real plants into interaction is an interesting direction in HCI that broaches issues such as expressiveness, emotional response and bringing joyful nature into the context of user interfaces. Nevertheless, starting from real plants as interaction material, there are further and more conventional ways to bring human associations and impressions about plants into HCI. In the scope of the physicality representation spectrum, we look at other physical instantiations representing plants as well as graphical representations.

Metaphorical Application: Physical Representation
Tangible user interfaces are often physical representations that apply aspects taken from other physical materials in a metaphorical way, e.g. by applying aspects of shape or typical manipulations for example. I call this category metaphorical application with physical representation. If aspects like properties, form factors, or meanings of an original material are metaphorically applied to another physical material, I speak about a metaphor by noun. In case a handling or manipulating a material that is physically represented or realized in an embodied way in a user interface without integrating the original material itself, I speak about a metaphor by verb. Of course, UIs can also integrate both kinds of metaphorical applications in one physical representation. This is for example done in the work of Wallbaum et al. [22], who designed an artificial flower plant as communication device for patients. It includes controllable LED lights for output and several direct interaction techniques for input (e.g., removing a blossom, touching a leaf). Three other prototypes, infotropism [11], LaughingLily [2] and Follow the Grass [16] focused on metaphor by noun and realized robotic plants that mimic the behavior of real plants in order to communicate information in an unobtrusive way.

Metaphorical Application: Digital Representation
Similarly, and with a longer tradition in HCI, plants, or aspects of plants have been applied metaphorically within graphical user interfaces, i.e., in digital representations. Similar to using real plants or mimicking them through other physical representations, unobtrusiveness, visual appeal and handling information overload were reasons to apply plant or flower metaphors in the digital. In People Garden [25], for example, the authors applied a flower metaphor to present a user's data

portrait based on his or her past activities on an online message board. E.g., for posted messages the digital flower representation gets novel petals and thus grows and changes over time. A further example that explored plant and garden metaphors to represent data is Wilkens' Mail Garden [24], a tree visualization representing mails in an inbox (e.g., the height of a tree reflects the length of an email). A further email visualization tool for email is Bloom [15]. It applies metaphor by noun and verb and explores, next to the presentation of emails by blooms of a flower, also interactions like plucking flowers (which removes items from a task list) via touch interactions.

Discussion and Conclusion
Designing for unobtrusiveness is a major theme throughout all different instances of representations of plants in UIs (i.e., by integrating plants directly or metaphorically). Especially *plants as ambient displays* can be found in all categories of the physicality representation spectrum, generally bringing aspects of nature into domestic or artistic indoor environments and presenting information in the periphery. One emergent theme in the interaction between humans and real or robotic plants explores *the emotional relationship between humans and plants*, e.g., by encouraging touch interactions, an aspect that is less likely to be as strong and expressive in digital presentations. A further theme when taking real plants as interaction material focuses on an *amplified sensory experience of plants*, especially by giving the plants a voice and creating sound. In future, further sensory experiences could be explored. In HCI, most examples of human-plant interactions have taken place in indoor environments, yet not so much embedded in real nature environments, whilst there is much potential of applying it outdoor as well.

References

1. Leonardo Angelini, Stefania Caparrotta, Omar Abou Khaled, and Elena Mugellini. 2016. EmotiPlant: Human-Plant Interaction for Older Adults. In Proceedings of the TEI '16: Tenth International Conference on Tangible, Embedded, and Embodied Interaction (TEI '16). ACM, New York, NY, USA, 373-379.
DOI=http://dx.doi.org/10.1145/2839462.2856548

2. Stavros Antifakos and Bernt Schiele. 2003. LughingLily: Using a Flower as a Real World Information Display. In: Proc. of UbiComp 2003.

3. Agnes E. Van den Berg, Terry Hartig, and Henk Staats. 2007. Preference for nature in urbanized societies: Stress, restoration, and the pursuit of sustainability. Journal of social issues 63, 1, 79--96.

4. Christine Buci-Glucksmann. 2003. Esthétique de l'éphémère. Galilée.

5. Jaewon Cho, Sanghoo Park, Been Jeon, Byung-Chull Bae, and Jun-Dong Cho. 2015. People's Emotional Responses to a Plant's Emotional Expression. In Proceedings of the Ninth International Conference on Tangible, Embedded, and Embodied Interaction (TEI '15). ACM, New York, NY, USA, 545-550.
DOI=http://dx.doi.org/10.1145/2677199.2687899

6. Tanja Döring, Axel Sylvester, and Albrecht Schmidt. 2013. A design space for ephemeral user interfaces. In Proceedings of the 7th International Conference on Tangible, Embedded and Embodied Interaction (TEI '13). ACM, New York, NY, USA, 75-82.
DOI=http://dx.doi.org/10.1145/2460625.2460637

7. Tanja Döring. 2016. The Interaction Material Profile. Understanding and Inspiring how Physical Materials Shape Interactions. To appear in: *CHI Extended Abstracts 2016*.

8. Kenneth P. Fishkin. 2004. A taxonomy for and analysis of tangible interfaces. *Personal Ubiquitous Comput.* 8, 5 (September 2004), 347-358.
DOI=http://dx.doi.org/10.1007/s00779-004-0297

9. Luke Franzke. 2013. Decay. Designing Ephemeral Interactive Devices. Master Thesis. Zürich University of the Arts (ZHdK).

10. Elisa Giaccardi and Elvin Karana. 2015. Foundations of Materials Experience: An Approach for HCI. In Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15). ACM, New York, NY, USA, 2447-2456.
DOI=http://dx.doi.org/10.1145/2702123.270233

11. David Holstius, John Kembel, Amy Hurst, Peng-Hui Wan, and Jodi Forlizzi. 2004. Infotropism: living and robotic plants as interactive displays. In Proceedings of the 5th conference on Designing interactive systems: processes, practices, methods, and techniques (DIS '04). ACM, New York, NY, USA, 215-221.
DOI=http://dx.doi.org/10.1145/1013115.1013145

12. Satoshi Kuribayashi and Akira Wakita. 2006. PlantDisplay: turning houseplants into ambient display. In Proceedings of the 2006 ACM SIGCHI international conference on Advances in computer entertainment technology (ACE '06). ACM, New York, NY, USA, , Article 40 .
DOI=http://dx.doi.org/10.1145/1178823.1178871

13. Satoshi Kuribayashi, Yusuke Sakamoto, and Hiroya Tanaka. 2007. I/O plant: a tool kit for designing augmented human-plant interactions. In CHI '07 Extended Abstracts on Human Factors in Computing Systems (CHI EA '07). ACM, New York, NY, USA, 2537-2542.
DOI=http://dx.doi.org/10.1145/1240866.1241037

14. Lasserre, G. & met den Ancxt, A. (2007), Akousmaflore: Sensitive and interactive musical plants. http://www.scenocosme.com/akousmaflore.htm.

15. Amy Martin and Wendy Ju. 2010. Bloom: an inter-active, organic visualization of starred emails. In *ACM SIGGRAPH 2010 Posters* (SIGGRAPH '10). ACM, New York, NY, USA, , Article 33 , 1 pages. DOI=http://dx.doi.org/10.1145/1836845.1836881

16. Andrea Minuto, Gijs Huisman, Anton Nijholt. 2012. Follow the Grass: A Smart Material Interactive Pervasive Display. Proc. of ICEC 2012. 144-157.

17. Ola Pehrson. 1999. Yucca Invest Trading Plant. Art Work. http://www.olapehrson.com/work_yucca.html (last access: 20th January 2016).

18. Ivan Poupyrev, Philipp Schoessler, Jonas Loh, and Munehiko Sato. 2012. Botanicus Interacticus: interactive plants technology. In ACM SIGGRAPH 2012 Emerging Technologies(SIGGRAPH '12). ACM, New York, NY, USA, , Article 4 , 1 pages. DOI=http://dx.doi.org/10.1145/2343456.2343460

19. Christa Sommerer, Laurent Mignonneau and Florian Weil. 2015. The Art of Human to Plant Interaction. In: Patrícia Vieira, Monica Gagliano, John Ryan (Eds). 2015. The Green Read: Dialogues with the Vegetal World. Lexington Books.

20. Stanza. The Singing Trees of Tremough. 2013. Art Work. http://www.stanza.co.uk/tree/ (last access: 20th January 2016).

21. Gerfried Stocker, Christa Sommerer and Laurent Mignonneau (Eds). 2009. Christa Sommerer and Laurent Mignonneau - Interactive Art Research. Springer.

22. Torben Wallbaum, Janko Timmermann, Wilko Heuten, and Susanne Boll. 2015. Forget Me Not: Connecting Palliative Patients and Their Loved Ones. In *Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems* (CHI EA '15). ACM, New York, NY, USA, 1403-1408. DOI=http://dx.doi.org/10.1145/2702613.2732772

23. Florian Weil. 2014. Artistic Human Plant Interfaces. Master Thesis Kunstuniversität Linz.

24. Kjen Wilkens. 2008. Mail Garden. http://human-centered-visualizations.com/.

25. Rebecca Xiong and Judith Donath. 1999. PeopleGarden: creating data portraits for users. In Proceedings of the 12th annual ACM symposium on User interface software and technology (UIST '99). ACM, New York, NY, USA, 37-44. DOI=http://dx.doi.org/10.1145/320719.322581