The Hedonic Value of Sonnengarten – Touching Plants to Trigger Light

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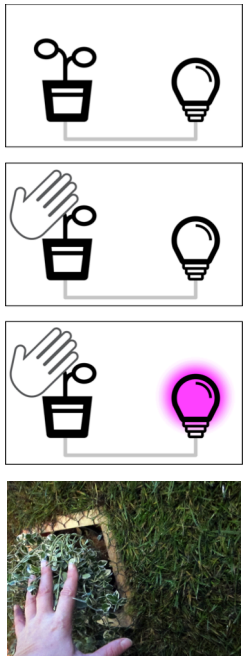

Figure 1: Overview of Human-Plant Interaction. When touching one of the interactive plants on the outside of the frame, the colored light emanated from underneath of the touched plant changes.

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Abstract
Sonnengarten is an interactive light installation, controlled by touching plants. It was developed for an urban festival, with the aim of increasing attractiveness of a courtyard and passageway. Light patterns were varied over the course of the festival. Requiring prolonged touch for a more complex light reaction increased interaction duration compared to the initial 1-step process and resulted in the installation being rated higher in hedonic quality in AttrakDiff questionnaires.

Author Keywords
Urban HCI; interactive lighting; media architecture.

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

Figure 2: People exploring the installation. Here a green base light, with middle section turned white after being touched.

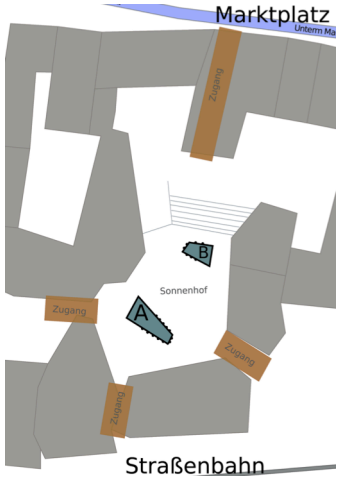

Figure 3: Map of courtyard (orange: passageways between courtyard and outside streets and market place, dark-green: installation, grey: buildings). The market place (Marktplatz) is on the top and access to the tramway (Straßenbahn) at the bottom of the map.

Introduction

Sonnengarten is an interactive light installation developed for an urban festival [2]. It is controlled by touching plants held in a large frame. Two main ideas motivated the project. Strategically, the installation was to increase the location's overall attractiveness and entice people to stay longer. Furthermore we aimed to raise visitor's awareness of nature by creating a symbolic communication channel between nature and user. In this project, we explored how light as a feedback medium could contribute to both aims. Over several days, the installation was deployed in a public courtyard, with different light patterns on each day. We describe findings from an AttrakDiff questionnaire evaluation.

Background

Light is a popular medium to increase attractiveness of the urban landscape, as it can create various types of atmospheres. A number of projects explored creative lightscapes that enable citizens to control and play with light [13]. Four main design elements in lighting design are intensity, color, distribution, and movement [11].

Since the 1960s, researchers have been investigating whether plants have any sort of consciousness (or some awareness and reactivity). While discussed in popular science literature, there is little reliable research. Often arts installations build on these ideas to enhance users' awareness of their relation and connection with nature. Various projects exploit conductive properties of plants, with resistance effected by touch [1], detecting sound and vibration via piezo elements, capacitive measurement [5, 10, 14, 16], electric field sensing [17], or bioelectric measurement [3, 12]. It is very difficult to measure plant biofeedback accurately, thus most projects simplify measurement and reaction.

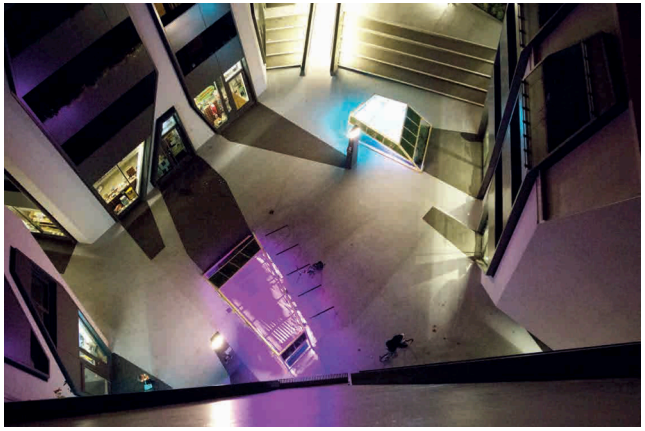

Figure 4: Birds-eye view of courtyard with the two structures

In everyday life, we cannot observe how plants react to environmental influences because of their slow movement. Most plant-based arts installations utilize sound reaction, symbolically lending plants a voice, e.g. Akousmaflore [10] or Pieces for Plants [12]. Only few arts installations provide visual feedback, e.g. Botanics Interacticus [14] highlights touching plants visually and auditory, and in 'Interactive Plant Growing' [17], proximity and touch trigger a virtual garden to grow. Plant-based interaction has also been found to trigger emotive connections, making interaction more enjoyable, suggesting a potential for plants as interaction medium [18], with contact to nature affecting health [4].

The Installation

Sonnengarten is a light installation with human-plant interaction developed for the light and science festival CityVisions which took place on four days in October 2015 in Jena (Germany). The project was an interdisciplinary collaboration between MediaArchitecture and

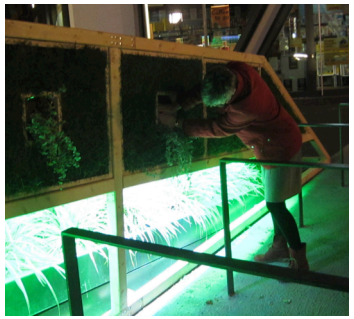

Figure 5: Woman exploring the light reactions.

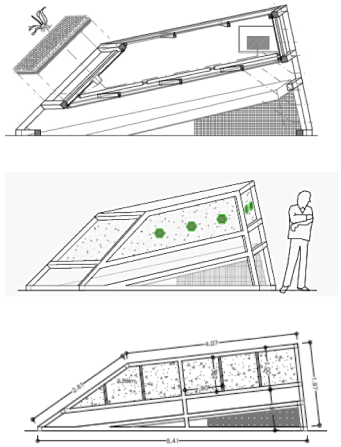

Figure 6a-c. Structure of the installation (technical drawings)

Human-Computer Interaction (see [2]). The installation was located in the courtyard of a modern-architecture building from concrete and steel, which mostly serves as a throughway to other roads and plazas (see figures 3 and 4), but is considered 'underused'. Sonnengarten aimed to attract people to the courtyard and to increase its general attractiveness as well as duration of stay within. In addition, passersby should be enticed to enter the area. To increase the duration of stay, the interaction was designed for shared encounters to occur.

As the brief for this location was to enhance quality of stay and its attractiveness, the idea emerged to use plants, since exposure to nature is known to be beneficial. The site owners also requested to make the courtyard more visible to highlight its function as a passageway between two destinations. From the decision to use plants as core element, the notion emerged to raise visitor's awareness of nature via Human-Plant Interaction by creating a symbolic communication channel between the plants and users of the courtyard.

Built upon existing architectonic elements in the courtyard (figure 9), the installation consisted of two separate structures. This created different vistas depending on how visitors passed through the yard. By using organic building materials (wood, grass, plants), which contrast to the originally dominating materials of concrete and steel, in combination with colorful illumination, we aimed to create a different mood and perceptual quality that invites and attracts people.

Bespoke wooden boxes extended existing architectural elements (air shafts of underground parking), whose outer wall panels were covered with grass and 'interactive' plants in the middle of each panel (figures 1, 5, 6).

Between the ground section and the new extension an open gap space remained. Inside this gap space, lights were distributed so that each interactive plant had a corresponding light. When touching a plant, the corresponding light changed (figures 1, 2, 5). With several plants inside each panel, we wanted to provide multiple interaction spaces that would enable strangers to explore the installation simultaneously. Moreover, having several interactive plants at different heights ensured the installation increased accessibility and chances of shared encounters. Furthermore, this was to provide variation in the interaction and invite exploration.

Illumination Patterns

Initially, we planned to illuminate the installation's gap space in white. On interacting, the light for a corresponding plant should fade out, to illustrate people's harmful effect on nature by symbolically taking away plants' energy of life – light. This was reconsidered, as 'negative' feedback was likely to reduce people's willingness to interact. Thus we chose a more colorful, inviting alternative for illuminating the entire installation. Moreover, since another installation was placed in an entry to the courtyard for the festival, attracting attention required a bold color scheme.

Illumination colors were changed every evening (see table 1 and figure 10), partially to experiment with aesthetic effects and on one day, in response to funders who requested the logo colors blue and orange to be used. On detecting touch, the color of the lamp belonging to the plant brightened until it was white. On release, it changed back to the default hue. This interaction concept points out the influence of human interaction on nature in a symbolic way and provides the plant with an allegorical possibility to communicate.

Figure 7: Implementation principle. Touch recognition via capacitive sensing controls the lights.

Figure 8: Lab test with different plants

On the last evening, the light reaction was adapted again to test if attendants' interaction duration could be increased. The previous one-step reaction was extended so that on touching a plant, the color changed first to another color and then turned white after longer contact. Analysis of data logs reveals that this approach was successful, as the average touch duration rose from 3s to 5s (see table 1).

Festival day	*Color scheme with base colors and effects*	*∅ Interaction duration*
Thursday	Magenta + cyan – turns white on touch	3 sec
Friday	Dark blue + orange – turns white on touch	3 sec
Saturday	Green + red – turns white on touch	3 sec
Sunday	Both blue – magenta on touch, white after 5 seconds	5 sec

Table 1: Color schemes and average duration of interaction with plants. On Sunday, when the light reaction was extended, interaction duration almost doubled.

Implementation

During development, different approaches were tried to recognize if plants are touched. Measuring a plant's reaction to the environment (biofeedback) [3] provided useful insights into plant-signal response, but proofed too complex, as every environmental impact on a plant changes signals (e.g. weather). The advanced capacitive sensing technology of Swept Frequency Capacitive Sensing [15] seemed to provide a solution for explicit touch recognition, and had already been utilized with plants [14]. But testing revealed that enhanced touch recognition was not necessary for our task, so we eventually used simple capacitive sensing.

The final system worked as follows. As part of the touch recognition circuit, the plant acts as an extended electrode, using the MPR121 sensor connected to an Arduino Uno Rev. 3 (cf. figure 7). On interacting with the plant, a change in state is measured and processed. A laptop receives the Arduino signal when a plant is touched or released and controls the lights. Status changes are visualized in a shifting of light color with lamps using DMX attributes that enable addressing specific light devices and their attributes.

Deployment and Evaluation

Over the course of four evenings during the festival, the installation was activated between 7pm at dusk and midnight. During the festival we witnessed different approaches to interaction. Some visitors briefly interacted with the plants and continued their way after figuring out what happened. Others stayed considerably longer and tried out different ways of interaction and various positions. Also, the technical implementation attracted considerable interest. Because of the festival context, information material such as leaflets, web presence and other kinds of announcements, provided most visitors with some indication of the interactivity of exhibits. It would have been interesting to see how visitors approach and understand the installation without any background knowledge. Further indication of the attractiveness of the installation comes from the observation that in the week after the festival, there were frequent visitors to the courtyard who wanted to try out the installation (which then was deactivated).

During the festival, various data was gathered for evaluation. Log files were recorded of duration and other details of the plant interaction. On the three final days, visitors that had been seen interacting with Sonnen-

Figure 9. Courtyard without and with the installation (built on top of existing air shafts of underground parking)

Figure 10: Courtyard setup, with visitors exploring the installation and several observers. The second structure is visible at the back behind the other structure. View on two different days with different color illumination.

garten were asked to fill out the AttrakDiff 2 questionnaire which evaluates pragmatic and hedonic qualities of a system and its attractiveness [6, 7] and has been utilized to evaluate arts installation before [9, 19]. Overall, 132 questionnaires were collected (49, 44 and 38 for Friday, Saturday, Sunday), with mostly local visitors, and more female (72) than male respondents (57). 2/3ds of respondents were between 20 and 40 years old. The number of respondents younger than 20 increased over the weekend from 2 to 22% and the number of older attendants varied between 4 and 15%.

The art installation was rated as having neutral pragmatic quality (unsurprisingly, given pragmatic quality is not predictive of appeal when participants are having fun [8]). Furthermore, it was rated attractive. The resulting 'portfolio' representation (figure 11), which integrates responses for pragmatic and hedonic qualities, reveals that responses were fairly similar, with little variability (small confidence squares) and shows the installation was perceived as having positive hedonic quality. The portfolio analysis shows that the installation is 'self-oriented', supporting personal aims [6]. The final day was rated as slightly higher in hedonic quality (for both sub-categories of stimulation and identity).

Analysis of semantic differentials (figure 12) shows that the Sunday (green line) fared slightly better on most categories for hedonic dimensions (in particular: professional, stylish, premium value, presentable, challenging, and novel). In addition, it was rated as more unpredictable (bad as a pragmatic category, but potentially of value for an arts installation), and, interestingly, as more 'technical'. These ratings (in particular for 'challenging) might be due to the more complex interaction scheme with colors changing twice, but could also be influenced from having a higher percentage of younger attendees on this day. In addition, Saturday's green and red color scheme appeared to be perceived as less attractive.

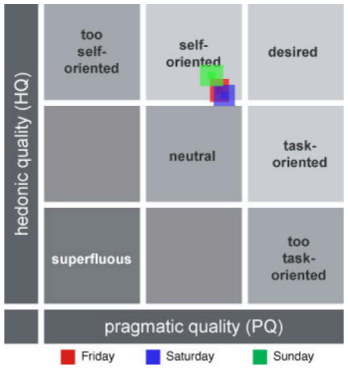

Figure 11. Results of AttrakDiff questionnaire: Portfolio of pragmatic and hedonic quality.

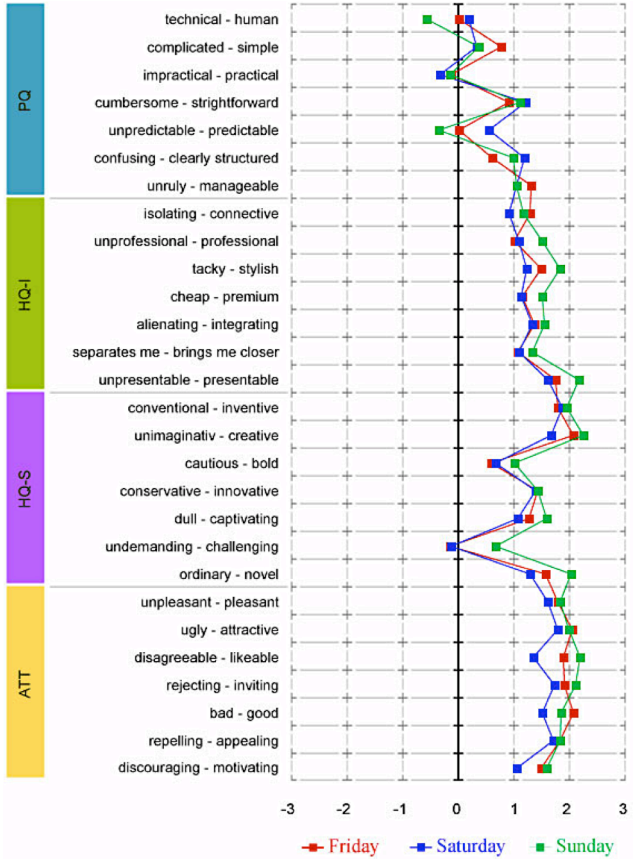

Figure 12. Semantic differentiale analysis (PG: Pragmatic, HG-I: Hedonic-Identity, HG-S: Hedonic stimulation, ATT: Attractiveness)

Logfile data reveals that the adapted interaction and light scheme on Sunday resulted in prolonged touch interaction. The majority of interactions happened on Friday and Saturday, the busiest festival days. This is a factor that might have influenced perceptions of the installation, a less busy courtyard resulting in visitors feeling less observed and more relaxed, rating the installation higher. Inspection of footage taken from the roof (one snapshot per hour) revealed that the majority of people present in the courtyard congregated around the Sonnengarten structure. This indicates that we achieved our aim of increasing the attractiveness of the courtyard and people's duration of stay therein.

Moreover, for both structures, one side was interacted with more, likely due to the spatial setup. For one installation, which was close to another bright installation in an adjacent passageway, the far side (where the light reaction was better visible) was used more. For the other installation, the side that visitors entering via another passage encountered first was utilized more.

Conclusion

Overall, evaluation indicated that the installation did increase attraction of the courtyard and made people linger. We further found that a more complex interaction process resulted in higher hedonic ratings. Unfortunately, we could not investigate whether visitors understood the deeper meaning of the installation. Our observation and questionnaires do however reveal that people enjoyed the interaction and perceived it as hedonic, thus contributing to changing the perception of the (previously barely used) courtyard. A limitation of our work is that evaluation was run during a festival (the installation was switched off by site owners afterwards) so that we could not assess 'normal' use of the courtyard.

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References

1. John Baichtal. Cristian Martinez's Circuit-Bent Musical Instruments. http://makezine.com/2013/01/17/cristian-martinezs-circuit-bent-musical-instruments/. Jan. 2013. (Retrieved 21. 03. 2016).
2. Till Fastnacht, Abraham Ornelas Aispuro, Johannes Marschall, Patrick Tobias Fischer, Sabine Zierold, and Eva Hornecker. 2016. Sonnengarten: urban light installation with human-plant interaction. In Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct (UbiComp '16). ACM, NY, USA, 53-56. DOI: http://dx.doi.org/10.1145/2968219.2971423
3. Leslie Garcia. Pulsu(m) Plantae. Retrieved June 8, 2016 from http://lessnullvoid.cc/pulsum/
4. Bjørn Grinde and Grete Grindal Patil. Biophilia: Does visual contact with nature impact on health and well-being? *Int. J. Environ. Res. Publ. Health. 6*, 9 (2009), 2332–2343. doi: 10.3390/ijerph6092332
5. Tobias Grosse-Puppendahl, Sebastian Herber, Raphael Wimmer, Frank Englert, Sebastian Beck, Julian von Wilmsdorff, Reiner Wichert, and Arjan Kuijper: Capacitive Near-Field Communication for Ubiquitous Interaction and Perception. In *Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing* (UbiComp '14). ACM, NY, USA, 231-242. DOI: https://doi.org/10.1145/2632048.2632053
6. Mark Hassenzahl, Michael Burmester, and Franz Koller. 2008. AttrakDiff: Ein Fragebogen zur Messung wahrgenommener hedonischer und pragmatischer Qualität". In: Mensch & Computer 2003. Vieweg+Teubner Verlag, 2003, 187–196. doi: 10.1007/978-3-322-80058-9_19.
7. Mark Hassenzahl, Michael Burmester and Franz Koller. „Der User Experience Auf der Spur: Zum Einsatz von www.attrakdiff.de. In: IRB: Ethics & Human Research (2008).
8. Marc Hassenzahl and Daniel Ullrich. 2007. To do or not to do: Differences in user experience and retrospective judgments depending on the presence or absence of instrumental goals. Interacting with Computers 19, 4 (2007), 429-437 https://doi.org/10.1016/j.intcom.2007.05.001
9. Jun Hu and Duy Le. Attractiveness of an Interactive Public Art Installation. In: Norbert Streitz, Constantine Stephanidis (eds.) Proceedings of Distributed, Ambient, and Pervasive Interactions, DAPI 2013, Held as Part of HCI International 2013. Springer Berlin, Heidelberg, 2013. LNCS Vol. 8028, 430-438 doi=10.1007/978-3-642-39351-8_47
10. Grégory Lasserre, Anaïs met den Ancxt. 2007. Akousmaflore. Retrieved June 8, 2016 from http://www.scenocosme.com/akousmaflore_en.htm
11. Jason Livingston Designing with light: the art, science, and practice of architectural lighting design; Wiley 2014
12. Miya Masaoka. 2002. Pieces for Plants. Retrieved June 8, 2016 from http://www.miyamasaoka.com/interdisciplinary/brainwaves_plants/pieces_for_plants.html
13. Henrika Pihlajaniemi, Anna Luusua, Minna Teirilä, Toni Österlund, and Tuulikki Tanska. 2012. Experiencing participatory and communicative urban lighting through LightStories. In *Proceedings of the 4th Media Architecture Biennale Conference: Participation* (MAB '12). ACM, NY, USA, 65-74. DOI=http://dx.doi.org/10.1145/2421076.2421087
14. 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

15. Munehiko Sato, Ivan Poupyrev, and Chris Harrison. 2012. Touché: enhancing touch interaction on humans, screens, liquids, and everyday objects. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '12). ACM, NY, USA, 483-492. DOI=http://dx.doi.org/10.1145/2207676.2207743
16. Joshua R. Smith. „Field mice: Extracting hand geometry from electric field measurements". In: IBM systems journal 35.3.4 (1996), S. 587–608.
17. Christa Sommerer and Laurent Mignonneau. Interactice Plant Growing. In Ars Electronica - Facing the Future, 393-394. Cambridge, MA: The MIT Press, 1999.
18. Cameron Steer, Simon Robinson, and Matt Jones. 2015. Growth, Change and Decay: Plants and Interaction Possibilities. In *Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems* (CHI EA '15). ACM, New York, NY, USA, 2037-2042. DOI: https://doi.org/10.1145/2702613.2732765
19. Alexander Wiethoff, Jana Gerstberger, and Sven Gehring. 2015. StarLight: Exploring Embodied Interactions with Media Architecture and Public Audiences. In Proceedings of the 4th International Symposium on Pervasive Displays (PerDis '15). ACM, New York, NY, USA, 83-89. DOI=http://dx.doi.org/10.1145/2757710.2757726