

interaction with their homes through adaptable IoT technologies. Besides studies with larger sample sizes and longer durations, we believe that it would be beneficial to also study other modalities of interaction in the smart home, especially concerning how can users appropriate smart home interaction through voice or gestures, or other physical interaction. Interaction with automation in the home is another venue that should be explored further. There is much published work on how automation can work from a technical standpoint, but there is also need for work on where, how and why automation could be used as part of a home ecology.

7. Conclusion

IoT technology is rapidly changing our lives, and the home is no exception to this change. Given the growth of smart home systems and the unique nature of the home as our most private space, we set out to explore user appropriation of smart home interactions through IoT enabled buttons in a smart home security system. Our findings show that our participant families welcomed the opportunity to make smart home systems their own. Our users leveraged configurability, placement and the physical nature of the buttons to create custom interaction points that helped them manage automation, create convenient shortcuts and fulfill the emerging needs of daily life. These findings contribute to the field of domestic computing by illustrating that supporting appropriation of interaction with smart home technology through user-configurable interaction points is an important element for the success of IoT systems in the home.

Acknowledgements

This work was partially funded by the Knowledge Foundation through the Internet of Things and People research profile.

References

- [1] Hutchinson, Hilary, Mackay, Wendy E, Westerlund, Bo, Bederson, Benjamin B., Druin, Allison Plaisant, Catherine, Beaudouin-Lafon, Michel, Conversy, Stéphane, Evans, Helen, Hansen, Heiko, Roussel, Nicolas, Eiderbäck, Björn, and others. 2003. Technology probes: inspiring design for and with families. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '03: 17–24. <https://doi.org/10.1145/642611.642616>
- [2] Logitech. 2019. The Logitech POP Button. Retrieved March 17, 2019 from <http://www.logitech.com/en-us/product/pop-smart-button>
- [3] 2019. The Flic Button. (www.flic.io) Webpage accessed 2019-03-17
- [4] 2019. Bttn. (www.bt.tn) Webpage accessed 2019-03-17
- [5] Michael, Mike and Gaver, William. 2009. Home Beyond Home: Dwelling With Threshold Devices. *Space and Culture* 12, 3: 359–370.
- [6] Poole, Erika Shehan, Chetty, Marshini, Grinter Rebecca E, and Edwards. W Keith 2008. More Than Meets the Eye: Transforming the User Experience of Home Network Management. 455–464.
- [7] Salovaara, Antti, Helfenstein, Sacha and Oulasvirta, Antti. 2011. Everyday appropriations of information technology: A study of creative uses of digital cameras. *Journal of the American Society for Information Science and Technology* 62, 12: 2347–2363.
- [8] Wilson, Charlie, Hargreaves, Tom, and Hauxwell-Baldwin, Richard. 2015. Smart homes and their users: a systematic analysis and key challenges. *Personal and Ubiquitous Computing* 19, 2: 463–476.
- [9] Chalmers, Matthew and Galani, Areti. 2004. Seamful Interweaving: Heterogeneity in the Theory and Design of Interactive Systems. In *DIS '04*, 243–252.
- [10] Yang, R and Newman, M.W.. 2013. Learning from a Learning Thermostat : Lessons for Intelligent Systems for the Home. Proceedings of the 2013 ACM international joint conference on Pervasive and ubiquitous computing (UbiComp 2013): 93–102
- [11] Bernheim Brush, A.J., Lee, Bongshin, Mahajan, Ratul, Agarwal, Sharad, Saroiu, Stefan and Dixon, Colin 2011. Home Automation in the Wild: Challenges and Opportunities. *CHI Conference on Human Factors in Computing Systems*: 2115–2124
- [12] Taylor, Alex S. ,Harper, Richard, Swan, Laurel Izadi, Shahram. Sellen, Abigail and Perry, Mark. 2007. Homes that make us smart. *Personal and Ubiquitous Computing* 11, 5: 383–393.
- [13] Harper, Richard and Shatwell, Brian. 2002. Paper mail in the home of the 21st century: An analysis of the future of paper mail and implications for the design of electronic alternatives. *Interactive Marketing* 3, 4: 311–323.
- [14] Chetty, Marshini, Sung, Jy and Grinter, R. 2007. How smart homes learn: The evolution of the networked home and household. *UbiComp 2007: Ubiquitous Computing*: 127–144
- [15] Grinter, Rebecca E, Edwards, W Keith, Chetty, Marshini, Poole, Erika S, Sung, Ja-Young Yang, Jeonghwa, Crabtree, Andy, Tolmie, Peter, Rodden, Tom, Greenhalgh, Chris and others. 2009. The ins and outs of home networking: The case for useful and usable domestic networking. *ACM Transactions on Computer-Human Interaction (TOCHI)* 16, 2: 8.the networked home and household. *UbiComp 2007: Ubiquitous Computing*: 127–144.
- [16] Taylor, Alex S. and Swan, Laurel. 2005. Artful systems in the home. *CHI '05 - Proceedings of the SIGCHI conference on Human factors in computing systems*: 641.
- [17] Vianello, Andrea, Florack, Yves , Bellucci, Andrea, and Jacucci, Giulio. 2016. T4Tags 2.0: A Tangible System for Supporting Users' Needs in the Domestic Environment. *Proceedings of the TEI '16: Tenth International Conference on Tangible, Embedded, and Embodied Interaction*: 38–43.
- [18] [Brush, Aj J Bernheim, Lee, Bongshin, Mahajan, Ratul, Agarwal, Sharad, Saroiu, Stefan and Dixon, Colin. 2011. Home Automation in the Wild: Challenges and Opportunities. *CHI Conference on Human Factors in Computing Systems*: 2115–2124.
- [19] Dourish, Paul. 2004. Where the Action Is: The Foundations of Embodied Interaction. <https://doi.org/10.1162/leon.2003.36.5.412>
- [20] Karapanos, Evangelos, Zimmerman, John, Forlizzi, Jodi and Martens, Jean-Bernard. 2009. User experience over time. In *Proceedings of the 27th international conference on Human factors in computing systems - CHI '09 (CHI '09)*, 729.

- [21] Howard, Steve, Kjeldskov, Jesper and Skov, Mikael B. 2007. Pervasive computing in the domestic space. *Personal and Ubiquitous Computing* 11, 5: 329–333.
- [22] 2019. If This Then That. (www.IFTTT.com) Webpage accessed 2019-03-17
- [23] 2019. Zapier. (www.zapier.com) Webpage accessed 2019-03-17
- [24] Kientz, Julie A., S. Patel, hwetak N, Jones, Brian Ed Price, Elizabeth D. Mynatt, and Gregory D. Abowd. 2008. The Georgia Tech aware home. *Proceeding of the twenty-sixth annual CHI conference extended abstracts on Human factors in computing systems - CHI '08*: 3675.
- [25] Dodier, Robert. 2004. Lessons From An Adaptive House. University of Colorado.
- [26] Intille, Stephen S.. 2002. Designing a home of the future. *IEEE Pervasive Computing* 1, 2: 76–82.
- [27] Mennicken, Sarah, Vermeulen, Jo and Huang, Elaine M. 2014. From Today ' s Augmented Houses to Tomorrow ' s Smart Homes : New Directions for Home Automation Research. *UbiComp '14 Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing*: 105–115.
- [28] Hassenzahl, Marc. 2010. Experience Design: Technology for All the Right Reasons. *Synthesis Lectures on Human-Centered Informatics* 3, 1: 1–95.
- [29] Merriam, Sharan B. 2009. *Qualitative research: A guide to design and implementation*. <https://doi.org/10.1097/NCI.0b013e3181edd9b1>
- [30] Chatting, David. Wilkinson, Gerard, Marshall, Kevin, Desjardins Audrey,, Green, David, Kirk, David and Boucher, Andy. 2017. Making Home: Asserting Agency in the Age of IoT. *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems*: 526–533.
- [31] Despouys, Robin, Sharrock, Rémi, and Demeure, Isabelle. 2014. Sensemaking in the autonomic smart-home. *the 2014 ACM International Joint Conference*: 887–894.
- [32] Liu, Yoga, Lee, Ya-Han, Chuang, Yaliang , Liang, Rung-Huei, and Chen, Lin-Lin. 2017. Designing the Expressive Point Lights to Enhance User's Situated Awareness of Smart Systems. *Proceedings of the 2017 ACM Conference Companion Publication on Designing Interactive Systems*: 333–336.
- [33] Desjardins, A., Wakkary, R., & Odom, W. (2015). Investigating genres and perspectives in HCI research on the home. *Conference on Human Factors in Computing Systems - Proceedings, 2015-April*, 3073–3082. <https://doi.org/10.1145/2702123.2702540>
- [34] Holtzblatt, K., & Jones, S. (1995). Conducting and Analyzing a Contextual Interview (Excerpt). In *Readings in Human-Computer Interaction* (pp. 241–253). <https://doi.org/10.1016/B978-0-08-051574-8.50028-5>