FUTURE Privacy Control in the Smart Home: Fair, User-centric, Transparent, Usable, Responsible, Educational

ALBRECHT KURZE, Chemnitz University of Technology, Faculty of Computer Sciences, Germany

CCS Concepts: • **Human-centered computing → Human computer interaction (HCI)**.

Additional Key Words and Phrases: HCI, Privacy, Human-Computer Interaction, Home, Smart Home, Internet of Things, IoT, Sensor Data

1 Motivation

More and more smart devices enter our homes. Often these devices include sensors, mostly simple sensors, e.g., for light, temperature, humidity or motion. These sensors, when critically reflected, are often only "simple" in a technical sense but not in terms of consequences, i.e. for home dwellers privacy.

The data of these sensors is “thin” but “big” data [5], needing contextualization for sensemaking - in timeseries itself but also about the data capture. Not only algorithms can make sense of this data (e.g. [14]) but also people are actually able to make sense of simple sensor data [4, 16] – an ability that lay people fundamentally have [10] using "situated knowledge" about domestic life. This data reveals a lot about the people in a home - capturing their presence, arrival and departure, typical domestic activities [4, 16] but also bad habits and health status [10]. However, it may not even need a Big Brother, Big Tech or AI and often not even bad intend to make the data of these sensors sensitive, e.g., if used for lateral surveillance within families [15]. Often unintended but wicked implications [7, 8] emerge despite good intentions, such as improving efficiency or energy saving through collecting sensor data [1–3, 10].

2 Privacy Challenges

Over the last years we have conducted participatory research for privacy by co-design on possible implications of using seemingly simple but networked sensors in the home. We not only want to understand the WHY of implications, but also HOW we can address them in design and in actual use.

We developed suitable tools and methods for this purpose: Our Sensorkit is a self-contained system with simple sensors for data collection, visualization and annotation. We deploy it in field studies in real homes and let real people interact with it. “Guess the Data”, a data-driven group discussion format, lets participant collectively make sense of anonymised excerpts of the collected sensor data what stimulates discussion about possible implications and unintended consequences.

This way we were able to prove the relevance of the following quite prominent and ever repeating challenges for privacy and consent in the smart home.

Shared space and multitude of stakeholders: Effectively a home is often a shared space, forming a small community of household / family members that include besides a primary user in a traditional sense but also secondary users (e.g., partners, children, elderly) as well as bystanders (e.g., guest, care persons, craftsmen).

Power imbalances: Exclusive right to install sensors, access to data, higher data literacy and the ability to use the data for own purposes can consolidate or reinforce existing power imbalances in household communities. Often it is

Author’s Contact Information: Albrecht Kurze, albrecht.kurze@informatik.tu-chemnitz.de, Chemnitz University of Technology, Faculty of Computer Sciences, Chemnitz, Saxony, Germany.

the man in a partnership that is a bit more tech savvy, interested and thus the person that installs and manages the smart device. Thus, it is typically a single person that easily becomes a data dictator in the home.

Mighty 3rd party stakeholders: While a holistic picture of stakeholders is not only relevant in the home - it is of extraordinary importance there - caused by complexity of context. This might include the creators of smart technology, often big tech, that might hold some exclusive rights of handling in their clouds the data of and by the people from home. It might also include the landlord, since a rented flat is still his property and he might have a plausible interest to have data of the building / flat but without having data of the dwellers' life. And in the end it might be "the government" or its authorities (e.g., intelligence services and police), using the data from the home for their purposes, e.g. to check compliant behavior, law-abidance or to solve crimes.

3 FUTURE Privacy Control Opportunities

All these aspects together result in still unresolved challenges for consent about collection and processing of sensor data in the smart home. To address these challenges, it needs not only suitable approaches to management of these data but also solutions and practices in action which offer FUTURE privacy controls that we work currently on:

Fair: Not a single user or stakeholder should be in a solely privileged position that allows them to know, monitor and control everything and everybody what creates power differences or reinforces existing ones. Instead it needs shared decisions that involve different stakeholders. This requires negotiations on equal terms – without advantages or disadvantages – through access or knowledge.

User-centric: The system has to be built around these multi-user centric perspectives and preferences, not only the vendor's or other third parties' (landlords) data-collection goals, despite it still respects them as stakeholders. Primary as well as secondary users and even bystanders must be able to express or revoke their consent in a flexible and fine-granular way.

Transparent: The system has to be transparency about data collecting, processing, storage and use. This might start with labels that already inform a potential buyer, clear data processing and privacy statements as well as clear indication of operation and status of devices.

Usable: The best in theory privacy control system is worthless if it is not understandable and usable. This requires means and tools, that address also users who are not experts, without smart homes as their hobby and even not tech savvy one. Nevertheless, usable interfaces and assistive (AI) functions, whether digital or tangible, support all users to orchestrate the system in their intended way.

Responsible and rights-based: The framework respects legal and ethical rights (e.g., GDPR) and gives users the ability to exercise them (access, correction, deletion).

Educational: The system allows users to build up privacy literacy, understanding not only controls but also consequences. This is a necessity for consent, an ability that is ultimately granted to humans.

4 FUTURE Personas

When it comes to FUTURE it is not only important to have a look at the users but also on the side of FUTURE's designers, creators, developers and vendors. These are our current students. We shape them.

We picked this up by integrating FUTURE privacy aspects in our teaching. We use ideation and reflection tools in existing courses [6, 13], use our Sensorkit in multiple ways - form integration in courses up to use in student projects [12], conceptualized an interdisciplinary human-data/computer interaction course that focuses not only on skills but also on attitudes [11], and embed ourselves in a community of responsible researchers and practioneers [9].

5 About me

I am a post-doctoral researcher and senior lecturer at the chair Media Informatics at Chemnitz University of Technology. With a background in computer science my research interests are on the intersection of Ubiquitous HCI and human centered IoT, i.e. in the home. My research is funded by the German BMFTR grant *Simplications* FKZ 16KIS1868K.

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