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Addressing ethical issues in the design of smart home technology for older adults and people with disabilities

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Abstract. Unique ethical, privacy and safety implications arise for people who are reliant on home-based smart technology due to health conditions or disabilities. In this paper we highlight a need for a reflective, inclusive ethical framework that encompasses the life cycle of smart home technology. We present key ethical considerations for smart home technology for older adults and people with disabilities and argue for ethical frameworks which combine these key considerations with existing models of design and development.

Keywords: Smart Home Technology, Pervasive Computing, Older Adults, People with Disabilities

1 Introduction

Smart home technology encourages independent living at home with the support of assistive technologies. Specialized assistive devices, smartphone or tablet based applications, on-body or passive sensing technology can be used to increase, maintain, or improve the functional capabilities of older adults or individuals with disabilities. Feedback from monitoring technology can be relayed to occupants or shared with informal caregivers to aid with decision making about health and wellbeing. Challenges in the ethical design and development of such technology include how to develop understandable and usable technologies so that they meet individual variations in needs and abilities so that they help to maintain autonomy, provide meaningful activities, address the emotional state of individuals and promote social inclusion (Nunes 2015). Moreover, there is great variety within user groups, such as differences in demographics (e.g., socioeconomics) and personality, but also due to the diversity of specific conditions, each with different behavioral, cognitive, and emotional consequences. We consider the following as pertinent ethical considerations when developing assistive smart home technologies.

Informed consent: The pervasive nature of some smart devices raises issues of technological understanding and consent. In addition, older adults or persons with specific disabilities might have a reduced or compromised ability to decide for themselves about the use of technology.

Privacy: Smart devices gather a broad spectrum of data about their users, ranging from in-application activity to communications to movement and location data. Combined with their pervasive nature, data can be collected and used in ways that are not always clear to end users.

Security: This involves physical security as well as security of the data and network from intrusion and cyber attacks (Karale 2021). Choosing the right technology to fit the requirements is crucial in avoiding over or unnecessary surveillance. For example a motion sensing device may be sufficient in place of a camera to determine activity.

Autonomy: Technology should be designed to accommodate existing living patterns and should offer users control and influence over their lives and well-being (FakhrHosseini 2019).

Safety: Ensuring the safety of older adults and persons with disabilities is crucial to their independence and quality of life. Safety and technological reliability are highly coupled and it is important that evaluations of smart technologies are not limited to laboratory settings rather than more complex real world environments (Pigini 2017).

Data Accuracy: The accuracy of data collected in smart spaces depends on a number of factors including device reliability, configuration or placement, misuse or misunderstanding. Smart sensors can also generate false positives and inferences and recommendations based on inaccurate data will contain errors (Aramendi 2019).

Data Sharing: Smart home data is often shared with manufacturers and third parties. This can be for varied purposes, to help improve the product or to aggregate data for analytics and insights. Older adults or persons with disabilities may wish to share data with formal or informal caregivers but they should have control over how and with whom their own data is shared. Data management policies should be available and accessible (Mocrii 2018).

Transparency: Transparency enables end users to understand the smart system. It incorporates previous factors such as privacy and data management and ensuring that these are well understood by those using the system. Transparency is important at both device and system levels (Yao 2019).

Trust: To trust decisions computed by smart systems, users need to know how that system arrives at its conclusions and recommendations. Trust is related to data accuracy and transparency above and explanation below (Cannizzaro 2020).

Explanation: Existing approaches to explanations for smart systems are tailored more towards interpretations that are more suitable for modelers and less for technically inexperienced users. The majority of smart systems do not incorporate explanation capabilities (Nikou 2019).

Acceptability: Pervasive technology requires data to understand the environment and individual. This means allowing technology access to our personal spaces. This can be intrusive if not done correctly and tailored for the cohort. Passive, low impact, low visibility, low maintenance and high reliability should be considered as high priority requirements when dealing with older adults and people with disabilities.

It is accepted that end users make trade-offs when using smart technology, for example, privacy for functionality or increased autonomy, security over privacy for better surveillance, increased

functionality or better displays for less explanations or usability for complexity. We argue that these trade-offs should not be inevitable, particularly for persons who are reliant on technology. We posit that an ethical, user driven framework incorporating a design-driven approach can reduce or eliminate these trade-offs by better understanding the requirements of end users.

2 Ethics and Smart Home Technologies

It is fair to say that software engineering has traditionally been driven by a utilitarian approach by focusing on outcomes in terms of the development of commercial products or services. However, virtue ethics, with its focus on choices that aim at the 'good life' is ideally suited for managing complex, novel, and unpredictable moral landscapes, just the kind of landscape that today's emerging technologies present (Vallor 2016). Value Sensitive Design (Friedman 2013), defined as "a theoretically grounded approach to the design of technology that accounts for human values in a principled and comprehensive manner throughout the design process" could be considered an example of Vallor's (2016) application of virtue ethics to technology.

The 'Human Factors & Ethics Canvas (HFEC)' introduced by (Cahill 2019) provides a bridge to integrating human factors and ethics issues with a particular focus on the collection of evidence using stakeholder evaluation methods. The HFEC allows non-ethicists such as Designers, Human Factors Researchers, Engineers, and Computer Scientists to engage in ethical issues pertaining to the emerging technology product. Frameworks such as that by (O'Keefe and O'Brien 2018) offer organizations a practical guide to implementing data ethics. Recent welcome developments have shifted the emphasis from outcomes to intentions to reduce blind spots in technology development. For example Consequence Scanning is an iterative approach that encourages organizations to consider potential consequences of products and services on people and communities (Brown 2019).

Projects involving human participants undergo ethical assessments and more recently data protection impact assessments but typically these occur at the end of the design phase. Ethical evaluation is usually late in technology development or research project and focus on the impact of the system as designed on the participants. At this point, it is arguably too late for researchers to consider questions such as "should this technology have been developed in the first place?". We argue that a framework is required that allows to reflect on ethical issues - those related to both intentions and outcomes - at challenge points throughout the technology life cycle.

3 A Framework for Inclusive Smart Home Technology

As part of the Ethics4EU project (Ethics4EU 2021), we are developing a new ethical framework - the 5D Framework - for the development of inclusive smart home technology by combining research presented above with aspects of the five-phase design thinking model proposed by the Hasso-Plattner Institute of Design (d.school), at Stanford, USA (Apiyanti 2019), as well as elements of the UK Design Council's Double Diamond Model (Howard 2008). Crucially, the framework emphasizes that the user is at the heart of the framework - they must be the co-designers of the system; in combination with HFEC, the O'Keefe and O'Brien ethics model

and the practical application of ethics in value-sensitive design (Friedman 2013). The full design team includes participants that are end-users, as well as experts in technology and relevant health domains i.e. general practitioners, occupational therapists, physiotherapists and other clinical specialists. An initial draft of the 5D framework in shown in Figure 1.

1. **Discover**
The full Design Team is trying to understand the needs of the end-user of the system. They, therefore, will speak to the end-user in a thoughtful and solicitous manner, as well as other parties that may provide useful insights. The end-user is also asking questions.
2. **Define**
The full Design Team are trying to encapsulate their findings from the Discover Stage into a series of models, noting key challenges (pinch points and pain points) as well as existing affordances. Again the end-user is a core member of the Design Team, and they are both the subject of the design, and the architect of the solutions.
3. **Develop**
The full Design Team are working on identifying a range of potential approaches to addressing the issues identified in the two previous stages. Again the end-user will be a vital force in the stage.
4. **Deliver**
The full Design Team is selecting a single potential solution from those developed in the previous stage, and it is vital that the end-user is asked and listened to.
5. **Determine**
The full Design Team is testing the effectiveness of their solution. The system is deployed and the team is determining what aspects of the system work well, and which are not fully serving their purpose. This section includes considerations relating to maintenance and sustainability.

Fig. 1. 5D framework

4. Conclusions

Older people and persons with disabilities are vulnerable groups and their dignity, rights and privacy must be safeguarded. The development of inclusive home-based smart technology presents many unique ethical challenges, and when this is allied with these systems being developed for older adults and people with disabilities, the ethical concerns and considerations grow significantly. Assessing the ethical implications of new technologies which may have impacts we cannot predict, is very difficult. Critically, design frameworks should consider protections concerning potential negative consequences, unintended consequences and unknown future implications. In this paper we have outlined a framework for navigating some of these ethical issues using a range of techniques from Software Engineering, Human Computer Interaction, Education, and Research Methods to produce a coherent new ethics driven approach that we have entitled “The 5D Framework” that puts the user at the heart of the process.

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