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# Expand Your Comfort Zone! Smart Urban Objects to Promote Safety in Public Spaces for Older Adults

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**Abstract**

Urban areas and demography are changing, leading to an acceleration of life pace and an ageing population at the same time. In order to ensure safe mobility in urban areas for older adults, we aim to increase awareness for own abilities, potential assistance by peers and pedestrians, as well as awareness for emerging needs of older adults by implementing smart urban objects in public space. Based on research approaches on awareness in HCI, we present an example scenario of expanding older adult's comfort zones with smart urban objects and discuss potential challenges and future work in the funded project UrbanLife+.

**Author Keywords**

Urban areas; older adults; comfort zone; urban HCI; smart cities; smart urban objects.

**ACM Classification Keywords**

H.4.3 Communications Applications: Bulletin boards; H.5.2 User Interfaces: Ergonomics; J.4 Social and Behavioral Sciences: Sociology; K.4.1 Public Policy Issues: Human safety; K.4.2 Social Issues: Assistive technologies for persons with disabilities.

**Older adults:** We refer to older adults as people with age 65 and above. Since they strongly differ in their perception of age and their abilities, when talking about assistive technology for older adults, we focus on older adults with age-related cognition, sensor or motor impairments.

**Safety:** In this paper safety is composed of *objective safety*, which refers to parameters that determine the actual safety in a certain situation, and *subjective safety*, which describes the feeling of safety in the situation based on individual experience and personality.

**Comfort zone:** When referring to the comfort zone, we picture the set of spaces in which a person feels safe to move (not necessarily a radius). These zones are dependent on personal and environmental factors e.g. recent experiences, time of day, and weather. Thus, comfort zones are regarded as dynamic areas.

## Introduction

In urban areas the continuously speeding up pace of life is particularly demanding for older adults who might additionally encounter age-related physical or cognitive impairments. With an increasing percentage of older adults, communities are facing the challenge of encouraging participation in public activities for people with and without need of assistance [7]. In the living environment of older adults, social engagement and self-determination is mainly dependent on the ability to move safely within the environment outside of their home. Many factors affect the feeling of safety. For example, studies suggest, that neighborhood interaction is closely related to the feeling of safety. This factor is especially relevant for urban areas, in which older adults generally feel less safe compared to rural areas [14]. The field of safe movement and action varies depending on abilities and experiences. While some people feel uncomfortable when leaving the own apartment, others are willing to walk on known ways or use familiar transportation means. Thus, the prerequisites for social engagement are highly heterogeneous and depend on the individual comfort zone, which determines the field of action and activities. Therefore, attempts to motivate social participation from older adults should address expanding comfort zones.

Novel approaches in human computer interaction (HCI) show high potential in influencing social and spatial parameters. Ambient intelligence, ubiquitous computing and pervasive technology have the potential to gather and present information that is helpful for coordinating, structuring and orientating within. Additionally, these tools can open interaction channels that are useable and engaging for older adults. An increasing number of

approaches implement technology in urban space, allowing for shared and public interaction. The project UrbanLife+, funded by the German Federal Ministry of Education and Research, aims at fostering older adult's safety in urban settings by implementing smart urban objects into the public environment.<sup>1</sup> In order to promote safety, our approach is to design technology that creates awareness for the competences and support needs within the public social environment. In this paper we try to highlight the potential of technology in public urban areas to raise awareness. We discuss the application of smart urban objects in order to increase safety for older adults and thus, expand their comfort zone. In the next section we commence with an introduction of how HCI can affect safety and discuss examples of smart technology that has been implemented into urban areas. We then transfer the examples into a scenario of smart urban objects that foster safety for an urban setting and motivate older adults to expand their comfort zone.

## HCI to Promote Safety

Moving safely in urban settings is dependent on multiple factors at the individual and environmental level. For example, the tendency to walk is influenced by personal knowledge, expectations and perceived barriers of walking, while neighborhood factors including sidewalk conditions, lighting, traffic, as well as walking distances are strongly related to individual perceptions of outdoor safety, especially among older adults [9]. Thus, when investigating HCI design parameters to increase safety in urban areas, we look into factors that have shown to influence the subjective safety. In the course of gathering design ideas for

<sup>1</sup> Further information on UrbanLife+: [www.urbanlifepius.de](http://www.urbanlifepius.de)

**Awareness:** According to Dourish and Bly [4] the term awareness can be defined as "an understanding of the activities of others, which provides a context for your own activity". We use this definition, focusing on the process of becoming aware of others' activities.

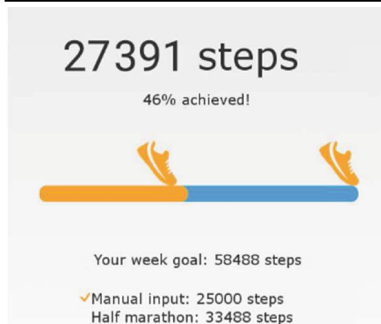


Figure 1: The persuasive pedometer app Move My Day raises awareness on physical activity [11]



Figure 2: The physical rehabilitation game SilverPromenade simulates a walk in the park [17]

increasing the comfort zone, we focus on approaches related to awareness that cope with perceived barriers for engaging in urban outdoor activities as well as motivating and encouraging factors.

#### *Motivating and Encouraging Activity*

When aiming to engage older adults in urban activities, motivation is a key factor. If there is no perceived benefit [15] or no destination [9], older adults are less likely to take part in any outdoor interaction. The awareness of people, familiar faces and neighbors as well as people engaging in outdoor activities and visitors have shown to be encouraging factors for walking in older adults [9]. Also, being aware of one's own actions and abilities is a promotional factor in cognitive and physical health related behavior change [19]. Thus, different attempts to increase awareness have been made in HCI e.g. through playful or persuasive technology.

For enhancing user satisfaction and motivating older adults to engage with technology, systems for older adults often apply scores, ranking lists, or awards to communicate progress in a certain task. The visualization of one's own activity is also a major matter in persuasive technology design. Within self-tracking applications and information systems, content is provided in a way to trigger behavior change or have an impact on lifestyle. For example, fitness tracking has shown to have a positive effect on physical activity for recreational as well as professional athletes. These techniques are also being implemented into technology for older adults, focusing on persuasive means for people with individual abilities and preferences [11]. By those means playful and persuasive technology increases the awareness for the own abilities and thus, can be implemented as means to increase safety.

Serious games for older adults extend the playful experience of using HCI in terms of content and design. Memory games showing pictures of relatives [20] and cooperative co-located and remote quiz games [10] were positively related with feelings of presence, awareness and well-being in older adults. Studies on playful approaches have shown to promote social interaction [16]. By increasing the awareness for people in the environment, serious games may increase safety in urban settings.

#### *Reducing Barriers*

The field of HCI has provided means to address the individual abilities of older adults, helping to reduce perceived barriers for urban engagement. Health problems are frequently reported barriers to physical outdoor activity [14]. Thus, attempts to help older adults overcome age related cognitive or physical impairments are focused by assistive technology. Novel technologies offer easy access to digital cognitive and motor training, e.g. games for older adults to autonomously train cognitive and psycho-motoric skills, or applications that provide just in time instructions in order to help older adults to accomplish tasks. Within assistive technology approaches, adaptation and user modelling play an increasingly important role. Individual abilities and preferences in addition to contextual information are incorporated in order to adapt context and system parameters. A detailed list of assistive technology to support individual users is provided in [13]. The potential of removing barriers for older adults in open spaces are demonstrated by HCI research, e.g. through adaptive navigation assistance in wheelchairs [21].

Besides having the potential to enable older adults to move within neighborhoods by helping to keep physical and cognitive abilities, the feeling of being able to cope



Figure 3: Assistance by lighting that indicates the correct box to pick from for an assembly task, which is useful for people with severe cognitive decline, but too boring for people with just minor cognitive impairments [8]

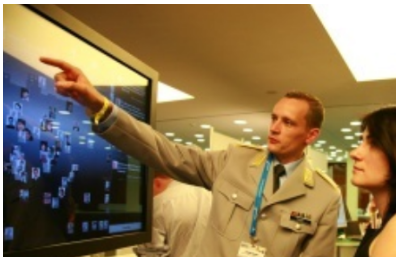


Figure 4: People interacting with CommunityMirrors, a multi-touch application to raise awareness on competences of people [12]

with challenges arising in public space may also remove barriers of outdoor activities. In order to promote the creation of coping strategies for people with cognitive and motor impairments, information systems provide insights into outdoor settings, e.g. the position of barriers along a way. The type of presented information and the interaction design vary across approaches and user groups, ranging from systems that provide additional information on an area of interest to the simulation of a specific task. Thereby, HCI shows the potential to raise awareness to one's own abilities as well as the abilities or competences of the spatial and social environment. Examples for applications that raise awareness for one's own abilities and the spatial environment include the simulation of sports for rehabilitation [18] and virtual walks that engage older adults in social and physical activities [17]. Studies also show higher work motivation and lower frustration levels for people with cognitive impairments when tasks are adequately simulated by assistive technology [8]. Awareness on the social environment is the key aspect in social community and network systems. By the integration of community information in a socio-technical environment and the design of user interaction, community platforms enable users to establish new contacts and to collaboratively use knowledge. Public shared displays that show information on community members and allow for multi-user interaction have been implemented to support awareness in communities [12]. These technologies help to remove barriers by fostering social support.

Urban safety is strongly related to activity in public spaces. Especially for older adults, a lack of perceived safety when moving in urban areas results in less

motivation to go out and engage in physical activity, which in turn may lead to physical and cognitive decline as well as less social interaction [15]. Moreover, objective safety decreases with less people being present in the streets [15]. At the same time, bad conditions of sidewalks, high traffic and unpleasant neighborhood surroundings are among the discouraging factors for outdoor activity in older adults [9]. Thus, the built environment as well as social structures are relevant for the perceived safety when moving in urban areas. While HCI cannot change these discouraging factors directly, we can try to make these factors less relevant for the decision to go outdoor and thus, remove barriers to urban engagement – by showing safe alternatives, by arranging for help and company.

Within the scope of UrbanLife+ we argue, that in order to enable older adults to move safely within urban environments, awareness should be raised related to own abilities, people in the area which are potentially able to provide assistance if needed, as well as people in the area who might need assistance.

### Smart Urban Objects

Even though an increasing number of older adults becomes technology-savvy and the stereotype of anxiety and helplessness when using technology does not apply for many older adults [5], technology needs to be non-intrusive and easy to use as well as easy to access in order to include people with cognitive and motor impairments. Therefore, we aim to create technology that is accessible for everyone, even when not owning or carrying personal electronic devices.

Existing approaches to help people with impairments in urban space often are related to the field of smart





Figure 5: location-based inDago HelpMe application connecting people in need with voluntary helpers [2]



Figure 6: InstaBooth, a design idea for enhancing local community interaction [3]

cities. For example, responsive street furniture aims to help blind people by combining personal technology and public urban technology into an in situ responsive system, which provides information as well as adjusts environmental features, like lighting [1]. Sensors attached to lamp posts already collect masses of data in pioneer areas in order to analyze movement in cities, contextual information, as well as social interaction. This processed and filtered information may then be used to create added value for target groups in the city, including information on how to find accessible public transport by tracking locations of busses and passengers [2], connect urban neighborhoods and online communities via public interaction booths [3], or encourage safe behavior by engaging pedestrians in activities while waiting at traffic lights [6].

In UrbanLife+ we focus on smart urban objects to improve safety. Smart urban objects are elements of the urban environment, e.g. posts, bulletin boards, and benches, which are connected to a digital information space and allow for implicit or explicit interaction in public spaces. Those objects range from interactive information billboards, and sidewalks that can be lowered for people in wheelchairs, to benches that indicate potential occupation by an older adult with a wheeled walker.

Figure 7 shows a summary of how we envision future interaction with smart urban objects. Technology is either implemented into existing urban interior by attaching kiosk systems, lighting, and sensors (left side of Figure 7), or new interior and machinery is being installed, already integrating electronic components (right side of Figure 7). Via optical fiber cables and wireless networks, the technology is connected to

servers, which facilitate the connection to digital communities and information systems. Each smart urban object provides different functionality and information to increase awareness. As soon as a person approaches these objects in a viewable distance, the object exits standby and triggers a reaction in order to attract attention, e.g. blinking lights or moving mechanical elements. Information that is gathered and presented in order to provide an added value for older adults includes information on the users, the immediate (built) environment, (social) activities, events taking place in an area, distances, transportation means, and available services, products, and vendors. Furthermore, environmental conditions like weather and time of day are included through sensor and online data. The interaction itself can consist of implicit interaction with a personal device, like sending a status update, up to complex interaction of browsing through data notes, depending on the awareness goal that the object is designed for.

By implementing these objects into urban spaces, different scenarios of raising awareness can be applied, based on the presented approaches in HCI. Within UrbanLife+ we discuss different scenarios for smart urban objects in teams of interdisciplinary stakeholders with the aim of creating accessible, meaningful, and easy to use technology for the user group. Our scenarios are inspired by HCI work including playful approaches, social communities, visualization of own abilities, and adaptive information presentation, that have shown to reduce barriers and motivate activities for older adults. In the following, we present our scenario of how smart urban objects can help to expand the comfort zone of older adults.

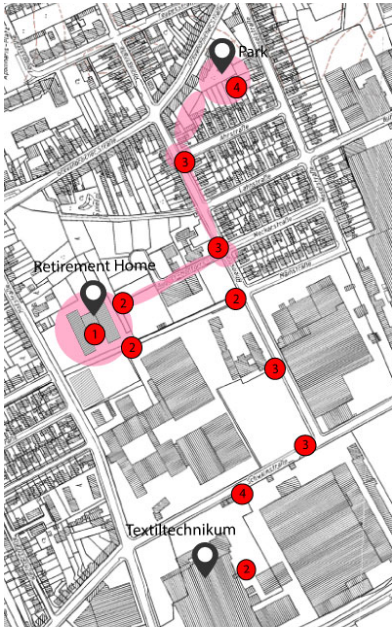


Figure 8: Locations of smart urban objects (1-4) that are implemented along the way and already established comfort zone around the assisted living home and park (map of the district Mönchengladbach Hardterbroich)

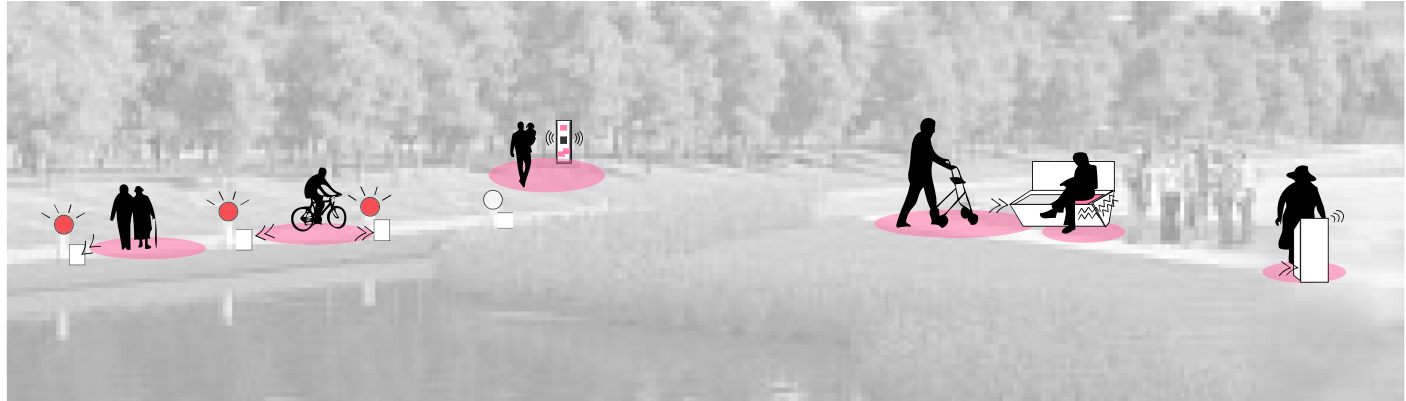


Figure 7: Envisioned smart urban objects – lights reacting to people approaching (left), augmented reality information system on a tree (mid left), vibrating bench that reacts to upcoming older adults by vibrating (mid right), kiosk system that shows how to overcome barriers along the way and gives information on the ducks living on the lake (right)

### Expanding the Comfort Zone

We introduce a persona of an older adult in an assisted living situation in the German city of Mönchengladbach in order to clarify the potential technology usage:

*Margot Nowak is 82 years old and lives with her husband in an assisted living home, where they do not receive constant care, but can request supporting services depending on their needs. Ever since her husband sits in a wheelchair, the shared zone, in which Margot can move safely with her husband, decreased. Although she has a pushing aid for the wheelchair, she does not feel comfortable in going long distances with her husband. Ever since they moved to the assisted living home, Margot wanted to take her husband on a day trip to the Textiltechnikum, a local museum, which introduces the fabrication history of her home town. However, she only feels safe to move with her husband within the immediate neighborhood. Her children registered Margot and her husband on the urban*

*neighborhood platform of Mönchengladbach, where movement data for her and her husband during different times are stored in a personal profile. This data is processed into a digital representation of their (shared) comfort zone. In the common room a digital information board (a large multi-touch screen) shows information on events and recommended activities in the neighborhood. Whenever Margot approaches the board, it suggests a trip to the Textiltechnikum, according to her interest to go there as well as a calculated safety parameter. She can see information on the trip, ways to get there, and activities along the way. She can also see a visualization of her comfort zone and recommendations on activities to expand it.*

*Today, she will go for a walk with her husband. She is excited to show her husband a part of the park he has not seen before. There are a lot of people outside, which makes Margot feel less alone and helpless in case she is not able to push the wheelchair back home.*

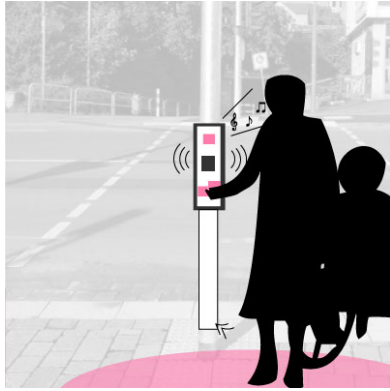


Figure 9: Interaction with the digital information board suggesting safe and engaging outdoor activities (object 1)

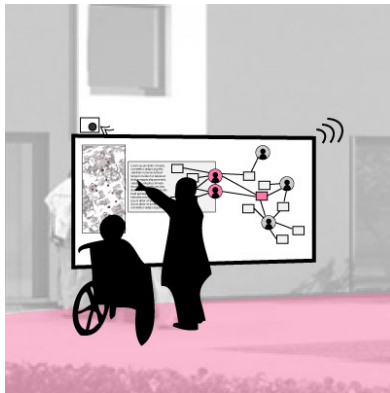


Figure 10: Interaction with a traffic lights kiosk system providing information on how to overcome obstacles (object 3)

Thus, she starts walking. Right outside, there is a small kiosk on the traffic light she needs to pass. It attracts her attention by playing an audio file of a bird chirping. As she approaches, the display shows a location where it is easier to cross the street with a wheelchair due to longer green light periods and lowered sidewalks. She is happy with this information and goes to the indicated location. Meanwhile, her comfort zone is updated, showing an expansion of the way she has just mastered in spite of obstacles for the wheelchair.

In the park, Margot and her husband encounter several posts that light up, play sounds, or move as soon as they get into their field of view. As they approach one of the posts, a challenge is pushed to an app on Margot's phone, suggesting to ask a stranger to help her with an upcoming step in the park, that she wouldn't be able to overcome by herself when pushing the wheelchair. At that step, she asks two joggers for their help. Within seconds, Margot and her husband can continue along the way. As the next post recognizes their approach, the digital comfort zone is expanded. Throughout several occasions, they interact with different smart urban objects and receive information on how to overcome obstacles along the way. Finally, they both want to rest at the lake on the other side of the park. When they approach a fully occupied bench, one place on the bench, where a young adult sits, begins to vibrate, indicating that someone who might want to sit is approaching. He offers his seat to Margot and she can sit a while with her husband and enjoy the view. Since it becomes quite late on their way back, the posts and benches along the way show them a shorter way to get back home and Margot feels safe to know that this information and potential help is available.

In the assisted living home, Margot can view her digital represented comfort zone and reflect on how safe she felt along the way. By engaging in trips like the one described above, Margot and her husband expand their shared comfort zone and after a few months, are finally able to visit the Textiltechnikum on a sunny day, along with a group of people from their assisted living home.

The concept of these digitally represented comfort zones is a dynamic idea, changing with knowledge about the time of day, weather conditions, as well as physical and cognitive abilities of the user. Figures 8 to 12 represent the interaction with smart urban objects that aim to enlarge the comfort zone. As presented, smart urban objects, like envisioned in this scenario, have the potential to provide additional value in urban areas and engage older adults in urban areas.

## Challenges and Future Work

Although HCI approaches have shown how technology can raise awareness in socio-technological settings, little work has been done on how to increase awareness on the divergent needs of people as well as potential sources of assistance in public urban areas. While our scenarios on the implementation of smart urban objects are derived from promising HCI research, there are still many aspects to be discussed and challenges to overcome in our future research.

First of all, privacy is an emerging issue in many ubiquitous systems. Through implementing sensors and analytical processing in personal and public devices, personal data is collected. Thus, there is a need to ensure privacy, transparency and self-determination for users. We aim to include an extensive privacy concept in our design decisions, which allows for easy

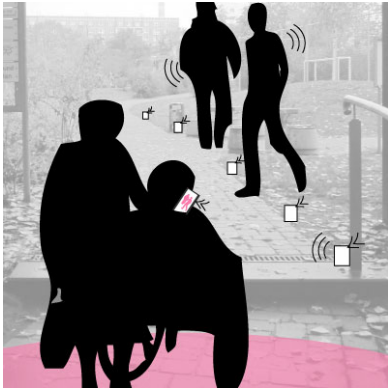


Figure 11: Interaction with a smartphone-based application that is connected to urban environment information and connects people in need with helpers (object 4)



Figure 12: Bench that creates awareness about people approaching who are potentially in need for a place to sit (object 2)

customization of all gathered and evaluated data. Furthermore, we ensure anonymous data collection, where applicable, and secure gathered data by encoding databases in order to protect information from third parties. However, more research needs to be conducted on how to implement these privacy reflections into actual system design in public space.

Most smart urban objects are designed to be open to public or semi-public spaces, meaning that most interaction will happen in walk-up-and-use (WUAU) scenarios. There is still a major challenge for research to determine how to design HCI for WUAU in public spaces. We also need to evaluate how multi-user applications may be designed in order to address individual needs and abilities. Our future work in UrbanLife+ will draw a focus on selected scenarios based on analyzed requirements, using a participatory design including older adults living in assisted living or retirement homes. By those means, we aim at the design of meaningful contents and interaction concepts.

Finally, in order to make statements on the success of raising awareness and potentially expanding comfort zones by implementing smart urban objects, experiments and (long-term) field studies need to be conducted with implemented prototypes. By raising awareness through smart urban objects we aim to increase social engagement and thus, ensure safe mobility for older adults beyond limited comfort zones.

### Acknowledgements

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