Design Guidelines for Micro Information Radiators to increase Seniors' Safety in Urban Space

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Figure 1: Information radiator network applied in urban space. From left to right: micro light signals reacting to approaching passers-by, information display, vibrating park bench signaling approaching senior, information kiosk to help overcoming barriers and to inform about the area (from [14])

ABSTRACT

Senior citizens face challenges during activities in urban space. To help and motivate them pursuing outside activities, we propose a network of (micro and macro) information radiators to increase their feeling of safety. In this paper we first collect guidelines and relevant aspects for the design of micro information radiators. Then we summarize our own experiences from a project designing smart urban objects – particularly giving an overview of design guidelines for input and output interaction of micro information radiators.

CCS CONCEPTS

• **Human-centered computing** → **Interaction devices**; Accessibility; • **Social and professional topics** → *Seniors.*

KEYWORDS

Micro information radiators, information radiator, seniors, human computer interaction, HCI, design guidelines

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1 INTRODUCTION

For elderly people it is important to move around independently and pursue outdoor activities. As they often face various challenges outdoors, fear and loss of safety become an obstacle for them. An uneven ground may not be a problem for young people, but seniors may lose grip and start to feel unsafe while walking. Some may suffer from vision impairments and cannot see or read the street signs clearly. This impairment causes a loss of information and makes seniors feel unsafe, maybe even to such an extreme extent that they do not want to pursue outside activities anymore. To support seniors during such activities and motivate them to go outdoors, we propose a network of information displays in urban spaces, especially so-called *micro information radiators*. The aim of these radiators is to provide personalized information and hints for seniors in the urban space and thus, to improve their safety feeling during outdoor activities and expand their comfort zone [13, 14].

Micro information radiators are small devices that can be flexibly integrated into many objects in urban space (e.g. lamp posts or park benches). The radiators interact with the seniors through LED lights, sound or vibration [12]. Connecting several information radiators – micro and macro – enables guidance by navigation and support of activities over a wide area (see figure 1 for examples).

This paper aims to explore the design space and identify senior-friendly interaction possibilities for micro information radiators. We first look at other approaches, which conceptually resemble our understanding of the radiators. Then we define design guidelines on the basis of related work and the experiences we gained in the project *UrbanLife+*, that aimed to design smart urban objects to increase the participation of seniors in urban life [8].

2 RELATED WORK

The term "information radiator" was coined by Alistair Cockburn [6] in the context of agile software development. Cockburn uses the term to describe a class of displays (not necessarily digital) placed at high-visibility locations that continuously display contextually relevant information so that it can be perceived and understood by passers-by. This distinguishes information radiators from most conventional IT systems, which typically return information only after a specific request (selection, search query, etc.). Information radiators have the ambition to be passively usable. Within our research we distinguish between macro and micro information radiators. Macro information radiators are kiosk-like interactive large screens, micro information radiators are small devices – usually without a screen in the narrow sense.

A literature search identified some existing systems and concepts that are similar to micro information radiators. We only present systems that are networked in some way. In addition to these you can find lots of examples of simple light or audio notifications in urban objects – e.g. red and green lights at the entrance or exit of escalators to indicate if one should enter here, if the escalator is out of order or going in the opposite direction.

2.1 Navigation systems

With regard to navigation systems, there are some solutions that seek to modernize traditional wayfinding systems:

Boicesu et al. use ePaper technology and iBeacons to design an intelligent display and alarm system [3]. So far, this concept only considers the use inside buildings, but offers a good possibility to be used outside, because ePaper technology has a long battery life.

The project "Kommunen in neuem Licht" [4] has extensively researched lighting in urban environments. One solution promotes an LED light band for visually impaired pedestrians. It helps pedestrians to orientate themselves better by visual and tactile stimuli. Due to taking the *2-senses principle* into account – meaning that two of our five senses (sight, smell, hearing, taste, touch) are addressed – this research project is a good example for senior-friendly as well as urban design. The carried-out evaluation of the concept confirms the acceptance and usefulness of color and signs.

2.2 (Guidance in) Parking decks

With regard to parking decks and their guidance systems, the products "Sitraffic" [21] and "Sipark" [22] by Siemens AG are used for parking space search and navigation. Ultrasonic sensors are installed above parking spaces, which light up red (occupied) or green (available) and thus, help people looking for a parking space by using light signals. In addition to the signals above the parking spaces there are additional arrow signals pointing drivers to available parking spaces.

2.3 Traffic lights

Due to their important function in traffic control, many ideas exist for the interaction with and optimization of traffic lights.

The "Green Wave Copenhagen" [1] regulates the traffic flow of cyclists using LEDs at the edge of the cycle path and thus, increase the speed and safety of cyclists [5].

Ground traffic lights or "Smombies" (which stands for "Smartphone-Zombies") are LED lights along the curb at crossings, which flash red as soon as a tram approaches or the traffic light turns red [24]. The main purpose of the light signals on the ground is to increase the safety of smartphone users, as they mainly look down towards the road. Such light signals are in use or were tested in Augsburg [24], New Jersey [7], the Netherlands [18] and Tel Aviv [25].

Singapore uses the "Green Man+" system at now over 1000 intersections, which allows over-60s and physically challenged people to extend the green phase of a traffic light up to 13 seconds by holding a concession card to a device at the traffic light [17]. Then, a LED indicator lights up red and during the next green phase the person in need can cross the road without time pressure. This concept is suitable for urban areas as well as for senior citizens.

3 BASIC CONDITIONS IN URBAN SPACE

After reviewing existing concepts in the previous section, we now present challenges of the urban space which we experienced during the development and deployment of smart urban objects in our project *UrbanLife+*. The aim of the project was to encourage the elderly to participate in urban life. Together with other partners we have developed, designed and evaluated different smart urban objects [2, 8, 10, 11, 23, 27].

External use: The environment of the installation is in urban space and thus, much less controllable compared to an indoor scenario. Interactions can take place at any time of the day or night. In addition to senior citizens, all other demographic groups in the urban space can be attracted by and interact with information radiators as well.

Technical requirements: Due to the reduced control, it may be difficult to adapt or enable technical requirements in urban space. As an example, if the micro information radiator needs WiFi, the design has to take into account that sometimes no WiFi is available or the connection is not stable. Also, battery life and power supply is a challenge for the design.

Environmental influences: Influences of weather and wildlife are part of the environmental conditions that need to be considered during the design phase. Weather influences, such as humidity, sunlight, extreme temperatures and wind, as well as vandalism or exposure to animals must be taken into account by hardware. Thus, components should be inexpensive. Also, software logic can be influenced by the environment, e.g. sudden rain may force seniors to return home quickly and require navigation that is well-considered and fast.

4 METHODOLOGY

The summary of design guidelines was made on the basis of a literature analysis, evaluation outcomes and our own experiences from the project *UrbanLife+*. For the literature analysis, various existing concepts were reviewed that propose technological innovations or concepts for seniors similar to our definition of micro information radiators. Also, literature regarding design recommendations was in the focus to identify important aspects in general and for seniors.

Some project evaluations were taken out as "Technology Cafe" to receive feedback for various technologies and its usage. For each of

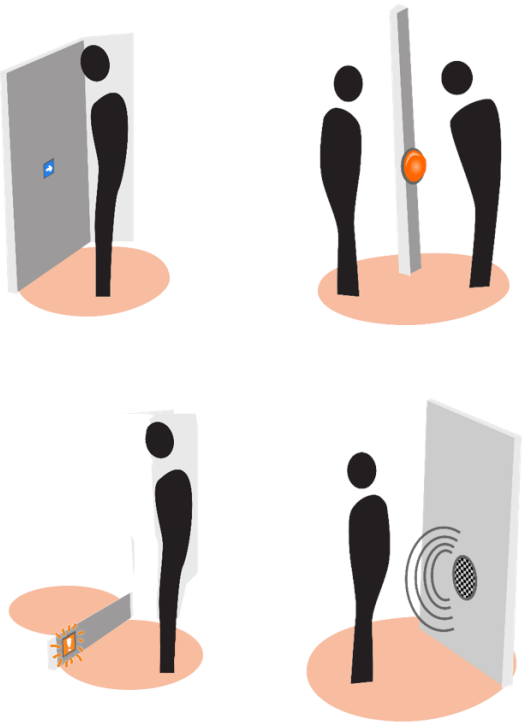

Figure 2: Four scenarios for micro information radiators involving different form factors and modalities. From left to right and top to bottom: navigation assistance, attention grabbing/signaling, visual warning of environmental danger, ambient audio information.

the four sessions we invited eight seniors from a retirement home for 90 minutes and focused on technical issues or experiments. Especially the outcome regarding smart home assistance is part of the auditory input and output design guideline. Other recommendations were results of our own thoughts about designing technology for seniors as we collected experiences from and with our project members.

5 DESIGN GUIDELINES

For micro information radiators many possibilities of design and interaction exist. In the following, some examples for input and output are summarized. Input is the term used to describe interactions that external persons or objects direct at a radiator, while output refers to interactions that are directed from the radiator to persons or other objects.

5.1 Input

Micro information radiators installed in an urban space wait for an input with information about the senior, who needs their support. One option for enabling implicit interaction is to detect the the user by Bluetooth signal. Therefore, the senior needs to carry a Bluetooth transmitter (e.g. smartphone, iBeacon, etc.). Using this input option, it is important to ensure that the Bluetooth transmitter is easy to use, lightweight, as inconspicuous as possible and has low configuration effort. Another input option is the direct interaction using touch or buttons (similar to [17]), gestures or speech of the micro information radiator. The design should be senior-friendly and consider that some options are more intuitive for seniors.

Apart from user interaction, a micro information radiator can also process environmental information or input from other smart urban objects and use it to provide helpful support for seniors. As an example, micro information radiators could detect rising humidity as a sign for impending rain. Then, nearby seniors could be informed about the change in weather and navigated on a short way home.

Using other smart urban objects as input source, micro information radiators gain their full potential in flexible application, subtle interaction and especially in a connected IoT network [9, 14]. Several micro information radiators in a network create synergies and enable support for seniors during their whole outdoor stay. Using only one single radiator severely limits the scope of aid to one place. Thus, the usefulness only proves itself through the installation of several devices within at least one area of a city.

5.2 Output

The output of a micro information radiator can be either visual, auditory or tactile.

A visual display can send symbols, directional arrows, light, color changes (such as [1]) or flashing light signals. As an example, the third picture of figure 2 shows a flashing micro information radiator as a warning of an obstacle. Using colors and symbols in urban spaces, a number of things need to be considered. Regarding visual design, DIN EN ISO 7010 (graphic symbols – safety colors and signs) and DIN EN 12368 (traffic control systems) provide guidance.

With regard to signage, Wenzel [26] contributes a manual as a planning aid for the conception of pedestrian guidance systems. Künzer [16] is concerned with color interpretations in connection with danger and safety. Further design recommendations for the conception of a guidance and orientation system are given by Molloy et al. [19]. On the basis of this literature, the following aspects regarding visual design are important:

- use clear contrasts (brightness/contrast at least 70%)
- max. four colors
- consider association to color and perception disorders
- pictographs and symbols: clear associations, uniform, culture-independent, internationally readable

Auditory interaction possibilities with micro information radiators can be melodies, tones or spoken text, which pass on information to the senior. The fourth example of figure 2 depicts an audio-based interaction. In relation to this interaction possibility, there is an interesting study by Kukka et al. [15], which examines the effect of audio cues on an interactive screen. This study evaluated *"spoken cues"*, *"any melody"*, *"Auditory Icons"* and *"No-Audio"* as variants of interaction or attraction. The study draws the conclusion that audio cues are basically good interaction possibilities – in particular, spoken cues that are used to indicate a special feature. Another study examines the use of audio feedback in different

contexts and comes to the conclusion that sounds are mostly perceived as unobtrusive in work and leisure situations [20]. During one *"Technology Cafe"* session we identified some challenges regarding the suitability of auditory interaction for our target group using smart home assistants. The task of this evaluation was that e.g. seniors used voice commands to find out where the next Italian restaurant is located. The voice output was always rated as very good and clear by our evaluation participants, while voice input revealed challenges regarding recognition due to accents and unclear pronunciation. Further, we identified issues with regard to outside use. Thereby, sounds of the environment, like animals or traffic noise, increase the difficulty of recognition severely. Reflecting the study by [15] and our own evaluation and thoughts, auditory interaction as output of micro information radiators may be suitable, while voice commands as input still struggle with recognition.

Finally, the option of tactile interaction, vibration, also exists. As experience gained from working with seniors and senior experts, we identified that it is important to consider the vibrations' intensity and which information can be conveyed meaningfully. For example, triggered by a micro information radiator, seniors could receive a warning of a danger zone (at an intersection of a busy road) by vibration. The advantage of this design is the subtle interaction, as the senior is the only recipient of the message and cannot be exposed publicly.

5.2.1 Multi-user functionality. Technology applied in urban space must be usable by several people. Thus, micro information radiators need to provide a multi-user functionality. Figure 1 displays example scenarios for a connected and multi-user functional network [12]. Nevertheless, the usage of micro information radiators by several users is restricted as only one output can be displayed at the same time. One option to enable multi-user functionality is using different colors for each senior and thus, personalizing the information that is displayed on the output channel. Even if personalizing by colors is possible, the questions arise how to display information if two seniors require information at the same time and what happens if seniors choose the same personalized color for their output?

5.2.2 Personalization. To use micro information radiators to their full advantage, it is helpful for seniors to receive personalized information to ensure that the information is addressed for them and that the abilities of the senior are taken into account. As an example, if a senior is taking a walk and uses radiators for navigation, the micro information radiator can display an arrow to the left at an intersection and help its clarity by coloring the arrow in the senior's chosen color, e.g. blue. Switching the color indicates that the arrow is meant for another person. This small degree of personalization enables multi-user functionality of micro information radiators.

6 DISCUSSION AND OUTLOOK

The development of urban micro information radiators suitable for senior citizens is faced with challenges in public use, environmental influences, technical requirements and human perception. In the *UrbanLife+* project we are developing micro information radiators that meet these requirements and increase the subjective safety during outdoor activities through flexible use and diverse interaction possibilities. Since standalone micro information radiators cannot reach their full potential (e.g. personalization, contextual awareness), our usage scenario calls for a deployment of an information radiator network including various smart urban objects, which can then make use of central backend services such as adaptive routing, profile management, and a database of urban safety features. A detailed overview of the connection between smart urban objects and backend services is provided in [9]. Specific future work concerning micro information radiators for seniors could encompass empirical evaluations of visual and auditory cues. It would also be interesting to research differences in how seniors perceive micro information radiators in public contexts compared to younger adults.

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