Involving Older and Vulnerable Persons in the Design Process of an Enhanced Toilet System

Peter Mayer
HCI Group, Inst. for Design & Assessment of Technology, TU Wien
(Vienna Univ. of Technology)
Favoritenstraße 11/187-2,
A 1040, Vienna, Austria
mayer@fortec.tuwien.ac.at

Paul Panek
HCI Group, Inst. for Design & Assessment of Technology, TU Wien
(Vienna Univ. of Technology)
Favoritenstraße 11/187-2,
A 1040, Vienna, Austria
panek@fortec.tuwien.ac.at

CHI'17 Extended Abstracts, *May 06-11, 2017, Denver, CO, USA*
ACM 978-1-4503-4656-6/17/05.
http://dx.doi.org/10.1145/3027063.3053178

Abstract
Traditional water toilet systems of sitting style as mostly used in the Western countries do not fit all the needs some older persons or people with a disability may have in day to day life. To overcome this, the European Ambient Assisted Living (AAL) project iToilet elaborates a concept for an ICT enhanced toilet system which is able to adapt to individual preferences. The paper describes the involvement of users in the design process and discusses some first findings. Our experiences show that participation of vulnerable users is possible even in the challenging and taboo-related area of toileting. Supportive are a good information policy and a high level of mutual trust among the involved organizations and individuals. The initial findings from participatory design activities are being fed back into the development process of the upcoming first full system prototype which shall enter lab trial stage in 2017 and after a re-design the field trial stage in 2018.

Author Keywords
ADL; hygiene; toilet; AAL; smart home.

Figure 1: Height and tilt adjustable base module intended to be put on top of existing toilet bowl. Drawing: Santis Kft.

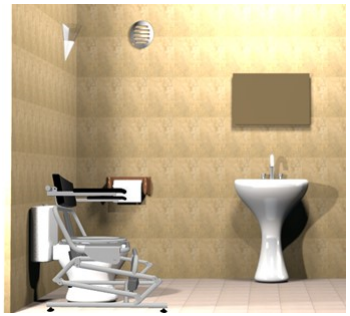

Figure 2: Illustration of the envisaged itoilet base module in a near to life toilet room.

ACM Classification Keywords

H.5.2 [Information interfaces and presentation (e.g., HCI)]: Prototyping; K.4.2 [Computers and society]: Social Issues - Assistive technologies.

Introduction

Toileting is an important aspect of the activities of daily living (ADL). It is remarkable that despite very varying user needs and technological pervasion of daily life the traditional Western sitting type water toilet has not changed much since its widespread introduction in the late 19th century [2]. Research indicates that there is a high need for more adaptable and configurable bathroom and toilet versions in order to make it easier or at least feasible to use the toilet for as many persons in our society as possible [1], [3], [4]. The current de-facto situation of "one size fits all" needs to be overcome in a more effective way than by the optional provision of a fixed height adaptation, the only current answer to needs. This endeavor is one of the objectives of the iToilet project [5]. iToilet aims at developing a flexible set of Information and Communication Technology (ICT) enhanced toilet modules, e.g. speech control, self-adaptation and emergency recognition. This envisaged set of modules can be tailored according to individual needs, wishes and preferences of the users. In this way well-tailored ICT may help to overcome barriers and to empower older and disabled persons to fully participate in the society. The project starts with elicitation of user needs [7], then undertakes participatory design (PD) activities involving older persons and persons with functional limitations and their carers, then it builds iterative prototypes and evaluates them in the field at two tests sites in Hungary and in Austria.

The paper at hand describes the initial involvement of users in the design process which aims at providing useful input for the technical development running in parallel. The paper is structured as follows: First the architecture of the iToilet system and the basic interaction between user and toilet is outlined. Secondly the user involvement and the structure for it is laid down and the project structure is described. Thirdly some examples of the first participatory design (PD) work are given and discussed.

Overview on the iToilet Architecture

The following hardware modules [6] are foreseen for the upcoming prototype system:

- A motorized height and tilt adjustable toilet from manufacturer Santis Kft, Hungary, forms the mechanical base (see Figure 1 and Figure 2). Two separate motors can change height and tilt of the seat. Sensors for measuring the actual position of the toilet and the passive or active load (e.g. by a person sitting on the toilet or standing up from the toilet) are integrated.
- A control unit connects the different (partly optional) modules of the toilet system and runs the inferences software unit, the dialogue manager and the network coordination of the different modules.
- Sensors in the environment measure activities (e.g. person presence, persons entering the toilet room).
- A Kinect type sensor aims at recognizing falls (manufacturer: CogVis GmbH).
- An Automatic Speech Recognition (ASR) module with microphone in the far field (without the need to be worn by the user) allows to use speech control as alternative to the tactile commands.

- Buttons (tactile commands) for controlling the toilet are available on a remote control connected to the system via cable and as buttons integrated in the grip bars.
- RFID reader at the entrance for user identification. Allows to automatically recall individual user preferences (e.g. height, tilt, language) and to move the toilet into the preferred position already when the user is entering the toilet room.
- Interface to care documentation systems, useful for storing preferences and for visualization usage data. This interface also is used for connecting mobile graphical devices (e.g. smart phones) to the system.
- The output is given by synthetic speech, sound or graphical devices like smart phones.

Typical User Interaction Scenario

A typical interaction [6] between an elderly person and the envisaged iToilet system could be as follows:

- The user enters the toilet room. The RFID module reads the preferences and the toilet system automatically moves to the preferred setting (e.g. height and tilt for sitting down) of the specific user.
- While approaching the system may greet the user and inform about its current status (if wished by the user). Before transferring to the toilet the user may use physical buttons (on remote control or integrated in the grip bars) or may use the speech input for further adjusting the toilet. The same is possible after the transfer to the toilet seat has been done in order to move to a position which is convenient for the user for sitting. This depends on various factors, among others the preferred sitting height of the user (influenced by popliteal height), the type of transfer (e.g. from wheelchair to toilet or from walker to toilet seat).
- After having used the toilet the automatic flushing can be triggered via button press or voice command. Optional a bidet (shower WC) module may be available for personal hygiene. This also can be controlled via voice or via tactile input.
- Despite the various possibilities to pre-select and adapt the toilet position in any stage, the system can also dynamically support sitting down or standing up by automatic changes of height and tilt.
- During the toilet use the dialogue system can provide feedback to the user, give instructions or ask for confirmation.

User Involvement – Some Challenges

Users already have participated heavily in the requirement gathering phase of the project (corresponding findings are documented in [7]). The technical development and design of a first working prototype system mature enough for lab trials should also benefit from early and ongoing user involvement. This was planned as an ambitious transdisciplinary approach together with different user classes (older persons, care persons, nursing experts, etc.) aiming at defining certain parts of the future system where (a) very early samples for hand-on testing could be provided and where (b) a need for early user feedback could be expected.

From experience with similar projects [4] the importance of providing early demonstrators to make the technological solutions catchable for users in order to get rich input was already known.

Figure 3: Interaction with a toilet paper holder. Photo: CS Caritas Socialis.

Figure 4: Interaction with an automatic paper dispenser. Photo: CS Caritas Socialis.

In discussions between technical partners and user representatives the following topics were identified as a starting point: Toilet paper dispenser, speech control, various mechanical buttons and remote controls and grip bars.

Focus groups and open discussions groups were chosen as appropriate methods and the clients (also called "guests") of a day care centre were invited to participate in meetings lasting approx. 1 hour. Number of participants in the group sessions varied between 5 and 8 persons. The meetings were moderated by nurses from the day care centre who also were involved in the iToilet project. The timing of the meetings was chosen in such a way that it fit well into the daily routine of the day care centre. Technical partners provided various hands-on material for the group meetings.

In order to cope well with the challenging taboo area of toileting and personal hygiene the information given to the participants in advance was carefully selected. Additionally, each group was moderated by a well experienced member of the local nursing team having also long term relationship to the participants (guests of the day care centre). Close contact was established between technical partners and the user partner to provide quick and detailed support whenever necessary.

As with the requirement gathering process the participatory design (PD) activities were conducted after informed consent was given by the participants including permission to use photos taken to illustrate the findings.

Initial Findings from Participatory Design Sessions

Theme A: Paper Holder & Dispenser

The participants consistently reported that paper dispensers in usual toilets most often are mounted in inappropriate positions, are partly occupying space which would be needed for other purpose (e.g. transfer to toilet) or cannot be reached easily when needed. Additionally, the task of taking of the paper from the dispenser poses difficulties, e.g. in case of functional limitations of arm/hand and even more in case of inappropriate positioning. Also the problem of paper often unrolling in an uncontrolled way has been mentioned (see Figure 3).

While most of the users are familiar with a manual paper dispenser (or paper holder) there was also possibility to test an automatic paper dispenser (see Figure 4). The original dispenser device was triggered by a proximity sensor and automatically dispenses and cuts a certain length of the toilet paper. In the ideal condition the user triggers the device by approaching his/her hand to the device and then catches the paper before it is cut (and consequently falls down). Due to limited mobility of hands and arms this turns out not to be appropriate from point of view of the users as there is too little time between triggering the device and having to catch the paper. Also, in case of manual assisting the transfer from/to the toilet (provided by a second person) the dispenser accidentally would be triggered. After hands-on trying of different set-ups and group discussions the users came up with an alternative proposal by sketching a device which is triggered by speech (instead of proximity) and is not fully cutting the paper (which would make it to fall down) but to cut it also incompletely so that the user

has unlimited time to tear the paper from the dispenser.

The participants also proposed that the paper should be made available on both sides and the dispenser might be mounted on the armrests.

Theme B: Speech Control
An early version of the Automatic Speech Recognition (ASR) software for iToilet running on a laptop (to ease the testing process) was provided to the participants for hands-on tests. The speaker-independent ASR works from a distance of up to some meters (depending on room characteristics and speaker) without having to use a head-set microphone. The users commented on the draft set of commands (for controlling the toilet system including triggering an alarm call, 7 base phrases in total plus some variations where it seemed appropriate) and assessed the reliability and performance. Finally they came up with their own proposals for a small but sufficient set of commands they think would be easy to re-call for them. A main result was that the system was found to work fine when tested in a real toilet room but it failed to recognize well the voices of users with speech limitations.

Theme C: Buttons and remote control
The users were presented some variations of buttons for control of toilet functions as already used for similar devices. There were cable-based controls which are normally put sideways (on some hooks) and others integrated into the grip bars.

The users liked the hand held control with buttons which have a clear shape (recognizable just by touching) and a clear pressure point for feedback (see Figure 5). They preferred it compared to the membrane keyboard technology (Figure 6) which lacks easily perceivable shapes and pressure points.

Figure 5: Two button remote control (with perceivable pressure point for each button) connected by cable.

Figure 6: Six button remote control (membrane keyboard).

The participants envisioned problems with fetching the control from the hook and the danger of dropping the hand control.

Figure 7: Buttons (membrane foil) integrated in a grip bar.

The provided buttons integrated in the grip bar (see Figure 7) were not the users' first choice. As disadvantages the missing pressure point of the buttons was named as well as a possible accidental triggering of buttons during use of the grip bars for transferring from/to the toilet.

Theme D: Grip bars (also known as hand rails)
Also clearly expressed was the need to provide the controls on both left and right side. This test will be continued during the upcoming lab tests of the first prototype. The options include single arm rests and double bars.

Discussion

The findings from the first participatory design meetings were already very rich. Some of the results confirm what already was expected (e.g. the preferences for buttons showing clearly perceivable pressure points), some other issues, e.g. the theme around the toilet paper dispenser was developed very deeply by the users. They not only outlined and discussed the current problems but also took up the idea of an automatic dispenser device but designed it themselves in a way which is now much more tailored to their needs. The developed design proposal of a speech controlled dispenser with a sensitive hand over of the toilet paper suitable also for slowly moving users is an impressive outcome of the participatory design activities.

In this case the provision of hands-on material (e.g. the automatic paper dispenser) was very useful for triggering intensive and focused discussions among participants which eventually led to a jointly elaborated and useful design proposal as very concrete result.

Generally, the high engagement of the users in the participatory design groups is very relevant as it can be considered also to be an indicator of the sound link which could be established between the users' individual life worlds and the expectations towards the contributions of the iToilet project. This of course will be of high importance also for the successful lab testing and field testing of full prototypes in realistic settings.

Conclusion and Outlook

Despite the taboo-related topic of toileting and related routines of intimacy and personal hygiene the involvement of older and vulnerable users in the design and development activities could be set up successfully. First initial results are promising and will influence directly the technical development. In the upcoming months the participatory design activities will be continued by involving more users and by providing additional and/or improved hands-on material. In spring 2017 first complete prototypes of the height and tilt adjustable seat module for lab testing are planned to be available. In 2018 improved prototypes of the iToilet system are planned to be available for real life evaluation.

Acknowledgements

We are thankful for the high engagement and acknowledge the contributions of the different user groups at a Viennese Day Care centre. Special thanks to R. Rosenthal, T. Lüftenegger and F. Sonntag.

The project iToilet is co-funded by the AAL Joint Programme (AAL-2015) and the National Authorities and R&D programmes in Austria, Hungary, Italy and Slovenia. More information: http://itoilet-project.eu

References

1. Paul Chamberlain, Heath Reed, Maria Burton, Gail Mountain. 2011. 'Future Bathroom', What to make? Or How to Make? Challenges in meeting sustainable needs. In: *Sustainable Intelligent manufacturing. Portugal*, IST Press, 777-784.
2. Alexander Kira. 1976. *The Bathroom*. Viking Press, New York.
3. Barbara R Klein, Holger Roßberg, Stephanie Hollmann. 2016. Independently living, autonomy and dignity with an I-Support shower robot, poster at *10th World Conf of Gerontechnology (ISG2016)*, 28-30 Sept 2016, Nice, France.
4. Johan FM Molenbroek, John Mantas, Renate de Bruin (eds.). 2011. *A Friendly Rest Room: Developing toilets of the future for disabled and elderly people*. IOS press, Amsterdam.
5. Paul Panek, Peter Mayer. 2016. Applying ICT to ease the toilet usage, *Gerontechnology* 2016, 15(suppl): 22s. doi:10.4017/gt.2016.15.s.928.00
6. Paul Panek, Peter Mayer. 2017. Initial Interaction Concept for a Robotic Toilet System, accepted for *Proc of ACM/IEEE International Conference on Human-Robot Interaction (HRI 2017)*, March 6-9, 2017, Vienna, Austria.
7. Anna Sobják, Tamás Pilissy, Gábor Fazekas, András Tóth, Ramona Rosenthal, Theresa Lüftenegger, Peter Mayer, Paul Panek. 2016. iToilet project deliverable D1.1 (public version). User Requirements Analysis showing three priority levels. Retrieved January 10, 2017 from http://www.itoilet-project.eu