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

Peter Mayer & Paul Panek (peter.mayer@tuwien.ac.at, paul.panek@tuwien.ac.at)
HCI Group, Institute for Design & Assessment of Technology, TU Wien (Vienna Univ. of Technology), Austria

Introduction: Traditional water toilets of sitting style as mostly used in the Western countries are difficult to use for some older persons or people with a disability. 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 based on a chair-like construction of which the first prototype currently is tested with users in laboratory settings.

Despite the taboo area there is the ambition to include older users' day-to-day expertise and the knowledge of care experts into the project as early and deeply as possible. This motivated the participatory design (PD) sessions described below. The outcome of the PD is valuable input for the engineering part, informing and guiding it.

iToilet Architecture: A motorized height and tilt adjustable toilet seat forms the base (see Fig. 1).
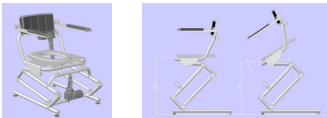

Fig.1: Toilet Base module with two independent motors for adjusting height and tilt of seat.

It is equipped with sensors for measuring the actual position of the toilet and the static or dynamic load:

- A **control unit** runs the inferences software, the dialogue manager, and a broker coordinating the different modules (connected via WLAN or LAN).
- **Sensors** capture user activities in the environment. A 3D depth sensor with analysis module recognises **falls**.
- An ASR module allows **speech control** alternatively to manual commands via buttons.
- **Buttons** (tactile commands): (a) on a remote control (via cable) or (b) integrated in armrests.
- An **RFID reader** (to identify users in institutions) 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: storing preferences, visualization of usage data.
- **Output**: by synthetic speech, sound or graphical devices like smart phones. Provides information on status, actions and instructions for use.

A **typical user interaction between** an elderly person and the iToilet system would be as follows:

- A user enters the toilet room. The RFID module recalls the preferences and the toilet automatically moves to the preferred height and tilt.
- The system may greet the user and inform about its current status and give instructions.
- Before transferring to the toilet the user may use physical buttons or the speech input for further adjusting the toilet position for sitting down.
- After having used the toilet the automatic flushing can be triggered via button press or voice command. Optional a bidet (shower WC) module for personal hygiene may be integrated.
- 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 change of height and tilt.
- During the toilet use the dialogue system can provide feedback to the user, give instructions or ask for confirmation.

Fig. 2: Users interacting with paper dispensers, remote controls, different buttons and grip bars. Photos: CS Caritas Socialis.

User involvement: Several Participatory Design (PD) sessions with typically 5 to 8 users were held. Potential users with Multiple sclerosis (MS) and experts together tried different solutions, discussed ideas for improvements and alternative concepts (Fig.2).

Early samples of some of the toilet modules were provided to get concrete feedback and to trigger the sharing of thoughts and ideas for potentially new or even totally different approaches.

Findings from Participatory Design Sessions:
Theme A: Paper Holder & Dispenser
The participants proposed that the paper should be made available on both sides and the dispenser might be mounted on the armrests. They proposed solutions where the paper is easy to grab and tear off.

Theme B: Speech Control
Eventually the participants came up with their own proposals for a small but sufficient set of commands they think would be easy to re-call for them. The tested speech recognition system was found to work fine 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 liked the hand held control with buttons which have a clear shape (recognizable just by touching) and a clear pressure point for feedback. They preferred it compared to the membrane keyboard technology which lacks easily perceivable shapes and pressure points. Also sizes and symbols were commented which has

led to a concept for a new hand control with clear big symbols and tactile feedback.

Theme D: Grip bars (also known as hand rails)
The grip bars should be on both sides, foldable, and usable to carry the remote control. More feedback is expected from lab testing.

Discussion: The findings from participatory design meetings were very rich. The participants not only outlined and discussed the current problems but developed solutions themselves. E.g. they took up the idea of an automatic dispenser device and 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 PD activities.

In any 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 PD groups is also 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.

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.

Fig.3: Toilet room for upcoming laboratory trials.

In the upcoming months the PD activities will be continued by involving more users and by providing additional and/or improved hands-on material. Currently the first prototype system has been installed for laboratory tests at a rehabilitation clinic in Budapest, Hungary, and at a day care center in Vienna, Austria (Fig.3). Based on the results a redesigned prototype will be built and tested in the field.