Reflections on a Versatile User Interface Framework for Older Persons Optimised for an Assistive Robot Providing Support in Daily Life

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Abstract

A versatile multimodal user interface (UI) framework was developed for persons with disability and for older persons to increase autonomy and quality of life. This UI framework covers use cases from single switch use in scanning mode, simplified telephone for older persons based on touchscreen terminal, integration of social media (e.g. Facebook, Twitter) and assistive robots. The evaluation activities carried out up to now demonstrate the usefulness while further improvements and extended functionality are planned.

1 Introduction

User interfaces for older persons are of significant importance for the Ambient Assisted Living (AAL) research area [1], [2]. In our group, the Centre for Applied Assistive Technologies, a long tradition exists concerning versatile UI frameworks. In the mid 90`s of last century a framework called Autonomy dedicated to severely and multiple impaired children and adults was developed [3]. It was evaluated with significant success in an institution for severely disabled children [4], [5] and later with motor disabled students [6]. The original focus was on single switch / two switches input devices and scanning mode [3].

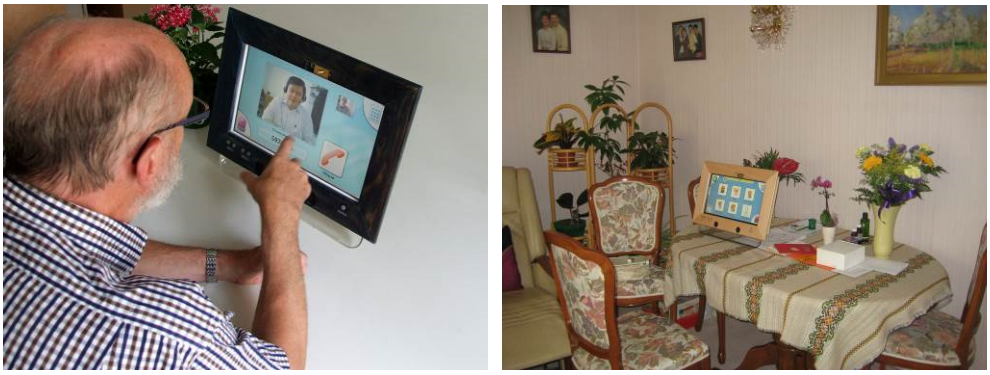

Fig. 1: Stationary Touchscreen UI during video call (left) and in a real life trial in a private flat (right).

Based on this knowledge a new framework, initially intended as UI for intelligent transportation systems [7] later dedicated telephone systems for older persons [8], was established from scratch. Furtheron, it was extended to a very general framework for older persons providing a multitude of functions including the command interface for the assistive robot HOBBIT [9].

2 Methods

2.1 Usability considerations and requirements for UI

Jakob Nielsen and Ben Shneiderman elaborated a framework of system acceptability, where usability as part of "usefulness" is composed of [10], [11] learnability, efficiency, memorability, error handling and satisfaction. Accessibility is an essential pre-condition of usability and especially important in the case of users with various limitations. In the case of a multi-modal user interface the interaction of various input and output channels makes things slightly more complicated but the same basic principles of any universal design apply [12]:

- GUI (Graphical UI) and button elements must be sufficiently big in size so they can be easily seen and used (> finger size (~20mm) in case of touch screen, buttons)
- GUI and button elements should have both easy to understand and big enough graphical and textual information about their meaning
- GUI and button elements should be arranged in a consistent and clearly spaced way
- Spoken messages should be clearly pronounced (volume and speed) and consistent with GUI display
- Spoken messages should be repeatable upon user request
- Every user input should be directly answered by a consistent UI response for acknowledgement (avoid impression of non-reaction)
- Buttons should provide tactile or other feedback on activation
- Any user input should be possible by different input channels, the GUI serving as fall back solution
- Any system response should be given consistently by several output channels

- Same or similar functions should always work the same way
- The user should be able to choose the UI properties (size, brightness, volume, speed …) to his/her liking
- No change in system state should be performed without notifying the user
- Errors and unclear situations for the user should be avoided by guiding the user to select from meaningful alternatives

Torun et al. [13] reported on results for complexity and depth of GUIs suitable for older users, concluding that the complexity of single prompts needs be kept limited to maximum 4 items as well as the hierarchical depth should be no more than 3 levels. Further recommendations are documented in [14], [15], [16], in the CEN-CENELEC Guide 6, "Guidelines for standards developers to address the needs of elderly persons and persons with disabilities" which lists many factors important for multi-modal interfaces for older persons, and in the information and design tools of the GUIDE project [17].

2.2 Considerations for UI of an Assistive Robot

The HOBBIT project develops a prototype of a social assistive service robot for older persons [9]. The HOBBIT robot features autonomous navigation, a manipulator with a gripper and a multi-modal user interface (UI) optimised for old users allowing interaction via speech, gesture and touch screen and wireless call buttons [18]. The UI provides easy and unified access to information in the web, videophone service, serious games, fitness or therapy instructions, control of robot functions and emergency calls in an accessible and consistent way. The UI also communicates the status of the robot and asks feedback from the user. A small display on top of the robot presents emotions by expression of eyes.

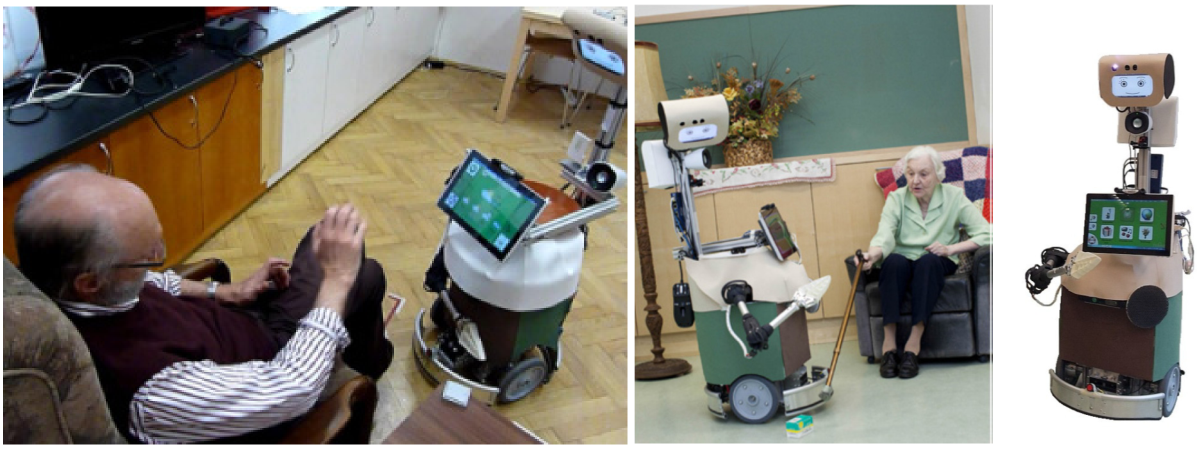

Fig. 2: Multimodal UI on the assistive robot Hobbit (Prototype 1) during user Interaction scene in lab (left) and during user trials (middle). Front view first prototype of Hobbit robot (right).

The Hobbit project aims at an affordable final prototype with limited resources which does not allow extensive development or use of costly components and substantial adaptations to the environment. Thus, gesture recognition and localisation/navigation are done with cheap Kinect sensors, automatic speech recognition (ASR) and text to speech (TTS) for the 3 user languages (German, Swedish, Greek) are based on commercial products and for the AAL components a very basic set of devices is optionally foreseen.

Table 1: Typical UI modalities of an assistive robot (modified according to [12])

Interface	Modality	Remarks
GUI (Graphical User Interface) with touch	System shows visible information and offers input ("buttons") user can select by simple touching	Familiar also from stationary solutions; needs appropriate distance and position between robot and user
ASR (Automatic Speech Recognition)	Allows to use natural language for input	Recognition rate depends heavily on distance and on background noise; might not be reliable enough as only input channel; cognitive load as commands need to be memorized by user
TTS (Text to Speech)	System uses synthetic speech as (additional) output	Often in combination with visual representation
GRI (Gesture Recognition Interface)	Gestures to select commands	Appropriate distance and orientation of the robot needed, cognitive load

With the current state of the art the home environment is a difficult area for human-robot interaction by affordable voice and vision channels (Tab.1). The Hobbit robot can detect with some probability if a user is present and where by camera (if the user is within vision range) and AAL sensors (per room). The ASR and gesture recognition are not always working perfectly over the widely varying interaction distance [19], [20], [21]. As the touch, speech and gesture input is limited to close to medium range wireless call buttons have been added to be able to call the robot to fixed places throughout the house.
The multimodal UI shall offer a highly predictable interface to the task execution modules of the HOBBIT robot which are responsible for the navigation and grasping and for general user interaction for entertainment and information. This requires some autonomy of the UI including independent fusion of modalities and own capabilities for performing sub-dialogues with the user. All commands and responses to prompts can be given via the touch screen and the ASR, some selected input is possible via the gesture module (external to UI). As the UI processes all the input, a fusion of the different channels is achieved. The call button signals are forwarded to the system as request to navigate to the pre-defined locations.

3 Results

3.1 UI on Stationary touch screen

Results from testing the stationary prototype version of the UI framework supported our hypothesis that the audio/video telephony technology is actually able to connect different user groups, in particular to support older persons in maintaining their social contacts and to support formal and informal care persons to deliver expertise and support via audio/video links. In this case not only proprietary protocols like Skype but also open and interoperable protocols like SIP are used to support better care at home and in the community [8], [22].
The stationary touch screen device was also evaluated successfully as part of the eHome ambient monitoring system [23], [24] with 11 old users in their own flats over a period of totally 18 months. All users were satisfied with the touch screen user interface (which was provided with different wooden frames, see Fig.1) and named in particular the easy and clear way of using the UI. „*Man stellt sich's am Anfang kompliziert vor, aber das ist es dann gar nicht*" („*You think it is complicated at first, but it actually isn't at all*.") „*Wenn ich falsch drücke, dann drücke ich halt noch einmal*" („*If I press wrong, then I just simply press once again*.") [22]. The phone function was found to be a popular feature despite some technical problems with broadband connection partly reducing the audio quality. Also the information pages, in particular the weather forecast, were used very often [22].
The touch screen device is also connected with popular social networks which allow the target group of computer illiterate older users to benefit from social networks (e.g. Facebook, Twitter, Picasa) which are usually accessed via PC/Laptop or handheld devices. Friends and family members can easily share photographs and text messages via different social networks with users of one versatile AAL touch screen device.

3.2 UI on assistive robot HOBBIT

The multimodal UI version for the assistive robot was tested as part of the first HOBBIT robot user trials which took place in Sweden, Greece and Austria (N=49). The trials were carried out in controlled laboratory settings (Fig.2) and were based on six representative interaction scenarios that should demonstrate the core tasks. One of the aim or the study [9], [25] was to deriving implications for improvement of the prototype with respect to usability, acceptance, and affordability. 96% of the test persons considered the UI as useful with preferences for speech and touch input over gestures. Based on these results a 2nd prototype was developed and will be tested in 2015 in the home environment of old users. Part of the second prototype is also an innovative fitness motivation and training module which supports also some basic self-management of fitness and rehabilitation therapy

4 Conclusion

The versatile UI framework was developed targeting at computer illiterate older persons and persons with impairments. During the past years it was applied very successfully in various AAL projects including the long term evaluation of the eHome monitoring system. The UI framework also serves as multimodal UI for the assistive robot HOBBIT. Despite the limitations due to the HOBBIT project's vision of an affordable (low cost) assistive robot the UI approach so far seems promising. The consortium is working towards improvements for the upcoming final HOBBIT prototype and the final trials in users' homes.
Future research with the UI framework is planned to be done in the area of pro-activity of the UI and in creating a kind of personality of the UI to explore the matching between user's and UI's personality.

Acknowledgments
The research leading to these results has received partial funding from the European Community's FP7 under grant agreement No. 288146 (http://hobbit.acin.tuwien.ac.at/).

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