Results of a Real World Trial with a Mobile Social Service Robot for Older Adults

Jürgen Pripfl[1*], Tobias Körtner[1*],
Daliah Batko-Klein[1,] Denise Hebesberger[1],
Markus Weninger[1], Christoph Gisinger[1,2]
[1]Akademie für Altersforschung am
Haus der Barmherzigkeit
Vienna, Austria
juergen.pripfl@altersforschung.ac.at

[2]Zentrum für Geriatrische Medizin und Geriatrische
Pflege Donau Universität Krems
Krems, Austria

* Equal contributions

Susanne Frennert, Hakan Eftring
Certec, Department of Design Sciences
Lund University
Lund, Sweden

Margarita Antona, Ilia Adami
Institute of Computer Science (ICS)
Foundation for Research and Technology - Hellas
(FORTH)
Heraklion, Greece

Astrid Weiss, Markus Bajones, Markus Vincze
Automation and Control Institute (ACIN)
Vienna University of Technology
Vienna, Austria

Abstract— **Robots are an increasingly discussed solution for assistance of seniors. Importance of testing natural interaction therefore becomes crucial. This paper presents first results of a study with an autonomous mobile social service robot prototype that was deployed in 18 private households of senior adults aged 75 years and older for a total of 371 days. Findings show that utility met the users' expectations. However, the robot was rather seen as a toy instead of being supportive for independent living. Furthermore, despite of an emergency function of the robot, perceived safety did not increase. Reasons for this might be the good health conditions of our users, a lack of technological robustness and slow performance of the prototype. However, users believed that a market ready version of the robot would be vital for supporting people who are more fragile and more socially isolated.**

Keywords—natural interaction; elderly users; HRI; social service robots; assistive robots

I. Introduction

The need of care for older adults is increasing, and supporting ways have to be found for human caregivers. One solution could be provided by robotics. So far, several research prototypes have been developed, e.g. [1-4]. Social robots, however, have hardly left living lab contexts and been introduced to real user homes. This paper presents first results of a long-term field trial in real private homes with prototype 2 (PT2) of an autonomous mobile social service robot called HOBBIT (see Fig. 1). Its main goal was to provide a feeling of safety (e.g. by fall detection) and to support the users in some tasks of daily living (e.g. pick-up objects from the floor/fall detection). We present answers to research questions on how seniors experienced the natural interaction with the autonomous robot in their private homes in terms of usability, utility, support of their independent living, and their feelings of safety.

II. Robot System

The platform used (max. height 125 cm, max. width 56 cm; for details, see [5]) had differential drive kinematics, a floor-parallel depth camera, a pan-tilt head with an RGB-D camera (ASUS Xtion mounted at a height of 120 cm above ground), a touch screen in front of the torso, and an arm with a gripper. Development of the system aimed to keep hardware costs as low as possible, i.e. below EUR 15,000.-. Autonomous navigation was based on a virtual laser scan. The robot interacted with the users via a multimodal user interface (MMUI) which consisted of a GUI (Graphical User Interface) with touch-input, ASR (Automatic Speech Recognition), TTS (Text to Speech) and GRI (Gesture Recognition Interface). It provided entertainment (radio, music, audio-books, games, pre-installed web services, fitness function), reminders, phone service, control of a manipulator, access to an Ambient Assisted Living (AAL) environment (e.g. call buttons), and emergency call features. The robot's functionalities included automatic emergency detection (e.g. patrolling and detecting persons lying on the floor), handling emergencies

Fig. 1 HOBBIT PT2

(communication with relatives), and supportive fall prevention measures (transporting small items, picking up objects from the floor, searching for objects the robot had been taught by the user).

III. Methods and Materials

All trials were carried out in private homes of single-living senior adults. Trials were carried out in Austria, Greece, and Sweden. Each trial with one user lasted three weeks. In total, the robot was deployed for 371 days. Assessment by means of qualitative interviews and questionnaires took place at four stages of each trial: pre-trial, mid-term, end of trial, and post-trial (i.e. one week after the trial had ended). Results of the qualitative interviews as well as perceived safety measured by the Falls Efficacy Scale (FES) [6] are reported here. 18 elderly users participated in this study, 16 (14 female) were included for statistical analysis (two participants had to be excluded because of missing data). The mean age was 80 years, ranging from 75 to 89 years. Qualitative data were organized using NVivo (QSR International). Quantitative data were analyzed using SPSS by means of descriptive statistics and non-parametric methods (Friedman ranking-test).

IV. Results

Qualitative data: Users highly appreciated the functions picking up objects from the floor, transporting objects, emergency recognition, fitness program, and giving reminders. Concerning usability, they stated that the prototype was intuitive to handle, but that errors in the actions of the robot led to frustration. The pick-up function for example, was fully operational only for about 18% out of a total of 371 days. And, if available, only about one out of ten attempts was successful on the first grasp. Furthermore, processing speed of the whole system was criticized as being too slow. Neither voice commands nor gestures worked satisfactorily, which is why the touch screen ultimately was used most. In summary, usability was negatively influenced by a lack of robustness. Quantitative data: Perceived safety as measured by the FES did not change in the course of the trial ($p = 0.265$).

V. Discussion and Conclusions

In one of the first studies of its kind, a low-cost mobile social service robot with an arm that was intended to interact fully autonomously [7] over weeks was deployed in seniors' private homes to support them with tasks and make them feel safe. Our study thus marks a major step in evaluating assistive robotic systems in domestic environments under real world conditions. Utility of the robot's functions was appreciated very much. However, neither did users believe that the robot had been able to increase their own independence, nor did the robot increase their feeling of being safe at home. Nevertheless, users thought that such a robot might be vital for supporting more fragile or socially isolated people. This somewhat ambivalent result has probably two reasons. First, although 81% of the sample reported moderate mobility impairments, most users were able to do the tasks offered by the robot (e.g. pick up) by themselves, and even more efficiently than PT2. Furthermore, pre-trial assessment revealed no, or minor concerns about falling for the majority (88%) making it difficult to further reduce this concern by any intervention. Consequently, the robot was seen as a toy but not as a solution for solving real world problems. It might be speculated that users with severe mobility problems and moderate to high fear of falling would have appreciated the robot's contribution to personal safety and independent living much more. Second, and probably even more importantly, the prototype of the robot lacked robustness and reliability undermining usability and trustworthiness which are prerequisites for systems affecting one's own health.

The results from this study show that our prototype is intuitive to handle, and that the functions offered met elderly users' needs. However, further research should increase technology readiness and include even more fragile users, who might benefit more from such a device.

Acknowledgment

This research has received funding from the European Community's Seventh Framework Programme under grant agreement No. 288146.

References

[1] FLORENCE. (05.01.2016). Available: http://www.florence-project.eu/

[2] DOMEO. (21.12.2015). Available: http://www.aal-domeo.org

[3] K. Werner, J. Oberzaucher, and F. Werner, "Evaluation of Human Robot Interaction Factors of a Socially Assistive Robot Together with Older People," in *Sixth International Conference on Complex, Intelligent and Software Intensive Systems (CISIS)*, 2012, pp. 455-460.

[4] F. Amirabdollahian, R. Op Den Akker, S. Bedaf, R. Bormann, H. Draper, V. Evers*, et al.*, "Accompany: Acceptable roboticS COMPanions for AgeiNG Years - Multidimensional aspects of human-system interactions," in *6th International Conference on Human System Interactions (HSI)*, 2013, pp. 570-577.

[5] HOBBIT. (07.01.2016). Available: http://hobbit.acin.tuwien.ac.at/publications.html

[6] L. Yardley, N. Beyer, K. Hauer, G. Kempen, C. Piot-Ziegler, and C. Todd, "Development and initial validation of the Falls Efficacy Scale-International (FES-I)," *Age and ageing,* vol. 34, pp. 614-619, 2005.

[7] J. M. Beer, C.-A. Smarr, T. L. Chen, A. Prakash, T. L. Mitzner, C. C. Kemp*, et al.*, "The domesticated robot: design guidelines for assisting older adults to age in place," in *Proceedings of the seventh annual ACM/IEEE international conference on Human-Robot Interaction*, 2012, pp. 335-342.