On the Discrepancy between Present Service Robots and Older Persons' Needs

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***Abstract*—Service robots present many functionalities to assist older users. However, conclusive evidence on usefulness is missing. From overviews of robot functionalities and personal user needs taking into account ethical and therapeutic aspects, we conclude that user needs could be modelled with three layers: the safety and health layer portray today's service robots and a personal layer covers emotional, social and psychological needs. We conclude that work so far shows a gap to reach up to this level to directly address personal needs.**

I. Introduction

Today more and more companies and research teams present service robots to assist with Activities of Daily Living (ADL). The number of tele-presence robots increases steadily (e.g., Giraff) and research teams present advanced functionalities such as reminders and bringing drinks (e.g., Care-o-Bot), picking up objects from the floor with the aim to prevent falls (e.g., HOBBIT), etc. Furthermore, when looking at studies on what needs older adults express [1], the results indicate that they expect robots to help them with household chores such as cleaning the kitchen, bath, toilet, lifting heavy objects, reaching for and pick up of objects, delivering objects, and assist with personal tasks (e.g., medication and drinking reminders). As a first observation, the more detailed review below will indicate that most of these tasks cannot be performed in a user satisfying manner with state-of-the-art robotic platforms.

However, there is a second point we want to raise: the perspective of the user needs. While the ultimate goal of the European agencies is to keep people longer independent at home, the user-centred design approaches to service robots tune in on the aspects of usability and acceptance. A typical example is the goal to create a companion [2], [3]. However, touch screens, restricted voice interfaces and basic dialogue systems are not at the level of allowing easy and natural interaction. Already [4] questions what present short studies actually indicate about user liking and needs.

We put forward the proposal to take another perspective in the user-centered development of service robots for older adults, which is less technology-, task- and expectation-driven, but focuses on the changing basic needs older adults have. What are the factors that render older adults independent? When and how do we need to introduce robotic assistance? And at what level or in which form is interaction wanted such that a persons' life stays active? We argue that an outreach to research from gerontology on these aspects is required and that a reasonable transformation of this knowledge is needed to inform the behaviour design of future service robots for older adults.

In the following, we present a review on state-of-the-art service robots and which user needs they try to address. Next we present an overview on basic needs of older adults to stay active at home identified by gerontologists. Finally, we discuss the innovation potential of transferring the incorporation of basic needs into the behaviour design of a service robot.

II. Needs Addressed by Today's Robots

According to a study conducted by Georgia Tech's Healthcare Robotics Lab, people with motor impairment drop items on average 5.5 times a day. Their small tele-operated Dusty robots are developed for that purpose: picking up objects from the floor, which they achieve with a scoop-like manipulator. Cody, a robotic nurse assistant, can autonomously performs bed (sponge) baths. Current work focuses on GATSBII, a willow Garage PR2, as a generic aid for older adults at home. The Care-O-Bot research platforms developed at the Fraunhofer Institute (IPA) are designed as general purpose robotic butlers, with a repertoire from fetching items to detecting emergency situations, such as a fallen person. Also from Fraunhofer is Mobina, a small (vacuum-sized) robot specifically performing fallen person detection and video calls in emergency. Carnegie Mellon University's HERB is another general purpose robotic butler. It serves as the main research platform at the Personal Robotics Lab, which is part of the Quality of Life Technology (QoLT) Center. KAIST in Korea has been developing their Intelligent Sweet Home (ISH) smart home technology including intelligent wheelchairs, intelligent beds and robotic hoists. Their system also employs the bi-manual mobile robot Joy to act as an intermediary between these systems and the end user. RobotDalen, a Swedish public-private consortium has funded the development of needed robotic products such as Bestic, an eating device for those who cannot feed themselves; Giraff, a remote-controlled mobile robot with a camera and monitor providing remote assistance and security; or TrainiTest a rehabilitation robot that measures and evaluates the capacity of muscles and then sets the resistance in the robot to adapt to the users individual training needs. Remote presence robots have recently turned up in a variety of forms, from simple Skype video chats on a mobility platform (Double Robotics) to serious medical assistance remote presence robots such as provided by the partnership between iRobot and InTouch Health, Giraff, and VGo Communications' post-op pediatric at-home robots for communication with parents, nurses, doctors, and patients.

Another class of robots aims more specifically at well being of older adults. The recently completed FP7 project

Mobiserv aimed to develop solutions to support independent living of older adults as long as possible, in their home or in various degrees of institutionalization, with a focus on health, nutrition, well-being, and safety. These solutions encompass smart clothes for monitoring vital signs, a smart home environment to monitor behavioural patterns (e.g., eating) and detect dangerous events, and a companion robot. The robot's main role is to generally activate, stimulate and to offer structure during the day. It also reminds its user of meals, medication and appointments and encourages social contacts via video calls. The US NSF is currently running the Socially Assistive Robotics project with partners Yale, University of Southern California, MIT, Stanford, Tufts and Willow Garage. Their focus is on robots that encourage social, emotional, and cognitive growth in children, including those with social or cognitive deficits. The elder care robot Sil-Bot developed at the Center for Intelligent Robotics (CIR) in Korea, is devised mainly as an entertainment robot to offer interactive games that have been co-developed with Seoul National University Medical Center specifically to help prevent Alzheimer's and dementia. Sil-Bot is meant to be a companion that helps to encourage an active, healthy body and mind. Its short flipper-like arms do not allow for actual manipulation.Another public-private partnership is the EC-funded CompanionAble Project, which created a robotic assistant for the elderly called Hector. The project integrates Hector to work collaboratively with a smart home and remote control center to provide the most comprehensive and cost efficient support for older people living at home.

Hoaloha Robotics in the United States is planning to bring their elder care robot to market soon. Based on a fairly standard mobile platform offering safety and entertainment, they focus on an application framework that will provide integration of discrete technological solutions like biometric devices, remote doctor visits, monitoring and emergency call services, medication dispensers, on-line services, and the increasing number of other products and applications already emerging for the assistive care market. Japan started a national initiative in 2013 to foster development of nursing care robots and to spread their use. The program supports 24 companies in developing and marketing their elder care technologies, such as the 40-centimeter tall Palro conversation robot that offers recreation services by playing games, singing and dancing together with residents of a care facility. Another example is the helper robot by Toyota, which is mostly remote controlled from a tablet PC. Going specifically beyond entertainment capabilities, Waseda University's Twendy One is a sophisticated bi-manual robot that provides human safety assistance, dexterous manipulation and human friendly communication. It can also support a human to lift from her/his bed or a chair. Going even further the RIBA-II robot by RIKEN-TRI Collaboration Center for Human-Interactive Robot Research (RTC) can lift patients of up to 80 kg from a bed to a wheelchair and back. Some ADL tasks are directly addressed by walking aids, e.g., [5] and cognitive manipulation training for example using exoskeletons [6], [7].

The short overview indicates that individually many ADL tasks are approached. However, they all require different types of robots. Besides tele-presence robots and combined functionality from an ambient living environment, ADL user needs are only partially fulfilled.

III. Personal Needs of Users

The theory of activation indicates that older persons, being more active have a lower risk to suffer from depression, dementia and frailty. In the following we will present therapeutic findings from gerontology which could be beneficial for service robot development.

A. *Therapeutic Findings*

Finding enjoyment in life and staying active is a challenge for seniors living alone and goes beyond pure technical aspects. Similarly, loss of motivation is frequently observed in aged persons [8]. Two thirds of persons over 65, for instance, were found to not exercise regularly [9], even though aware of the benefits of physical activity, and up to 75 percent of older Americans are insufficiently active [10]. It follows that reminding and informing the target group alone will not necessarily lead to prolonged motivation.

Staying active in older age has been found to contribute to physical, psychological and also cognitive well-being in older persons. In therapeutic settings, the use of group activities involving simple games, turned out to have a positive effect on perceived well-being of persons with mild to moderate dementia [11]. Other studies looked into the fact that participation in leisure activities among older persons improves life conditions, compensates for social and physical deficits in later life [12], and contributes to subjective well-being [13]. Beneficial effects of exercise on various physiological and psychological parameters in healthy elderly have been well established, too [14]. Happiness of a person in general has a strong effect on longevity in healthy populations [15], and thus should also be fostered in older age groups.

It could be shown that joyful physical activities, such as dancing [3], increase the perceived health status and quality of life of senior citizens [16], [17]. In general, physical activity is regarded a determinant of mobility performance in older age [18]. It seems to contribute to well-being of older adults because it helps people to maintain a busy and active life, mental activity, positive attitude toward life and, in turn, also avoidance of stress, negative function, and isolation [19].

Apart from physical and cognitive activities, social activities of older people have been observed to be associated with lower mortality [20]. Thus, a robotic assistant motivating the user to engage in social contacts and activities could enhance quality of life. In a study by Zuckerman et al. [21] happiness was identified as a psychosocial predictor of mortality among older adults. It is therefore not surprising that entertaining activities such as listening to music [22], visiting friends and participation in crafts [23] are positively related to greater psychological well-being in older adults. Additionally, the risk of incident frailty among senior citizens participating in physical activities or in group cultural activities was found to be significantly lower than in those who did not participate in such activities [24].

B. *Ethical Aspects of Human Robot Interaction*

For many older adults, who have slightly to none cognitive or physical impairments, functionality is not a crucial reason to use technology, especially if they have spent most part of their lives without such technical devices. Given that their health is all right, most older adults want to be socially active, help others and enjoy their time. Certainly, they do not want to depend on others nor a robot.

To overcome acceptance problems that older users may have, contemporary research focuses on psychological mechanisms to develop robot companions. A meta-study shows that there is a positive effect of service robots, however the effect is not conclusive and a large-scale studies is needed [25]. One reason about this uncertainty is that design approaches mistake social mechanisms to trigger emotional attachment for a kind of extended usability. However, usability is related to the adaptation of needs of persons, while sociability describes the capability of interacting with other people. This means that emotional attachment raised by social mechanisms cannot be equated with acceptance by usability.

Following the Ethics of Care [26] and the Autonomy concept used in bio-ethical systems [27], the employment of such social mechanisms in robot products can have a serious impact on the moral autonomy of a person [28]. They stand in conflict with two basic moral principles on which the autonomy of the person is based:

- Substantial knowledge: usually provided using the professional practice standards.
- Substantial freedom: usually affected by such aspects as persuasion, coercion, and manipulation.

Socially assistive robots using strategies that confuse emotional attachment with product acceptance stand in conflict with both of these moral principles of personal autonomy. The end-users lack substantial knowledge about the social mechanisms establishing an attachment, something which is usually experienced between persons and not towards objects. Freedom is compromised due to the effect of these social mechanisms. The end-user may experience difficulties to escape the unconscious social mechanisms and to decide against the robot. Socially assistive robots should neither be built to replace human caregivers nor to delude their owners with unconscious emotional mechanisms in order to become indispensable.

IV. A Three-Layer Model of User Needs

The review indicates that there is a wealth of robotic solution that address specific user needs while aspects of therapeutic and ethical findings indicate that there is more to learn. In order to enable active independent living at home for older adults we argue that a robot first needs to have an eye on the safety and health status of the user to then activate the user to live an active life. This activation should be achieved by motivating the user and addressing the basic physiological and social needs listed in the following.

Physiological needs To remain healthy and fit in old age is an important factor for well-being. This includes physical activities such as

- Progressive Muscle Relaxation: Yoga, Pilates or Tai Chi can be shown by the robot in a funny and motivating way.
- Swimming: Swimming allows the swimmer to become weightless and reduces impact on the body so you can have a good aerobic workout without feeling too much pressure on your body. So a robot motivating to go swimming will have a positive influence on the physical situation but also improve social connectedness.
- Dancing will take a person back to her your youth and is a good social activity. Dancing is a good aerobic activity and a person could even try to organise a dance with friends and family and relive old times. Dancing can help to feel connected with the community and can enable a person to make more friends. The robot could help to show dancing steps but also plays the music. It may take a film of the person to motivate to continue.
- Walking to the shops, walking the dog or walking around the park: Make walking a social activity and invite family or friends along to walk with you. Walking is great aerobic exercise and it does not even have to feel like exercise.
- Chores and Housework: Even though chores and housework do not seem a great deal of fun, activities like these will help you maintain body strength. Even participating in a small amount of housework every day or most days will prevent your body from seizing up or lacking energy. In this way, you will not become sedentary and you will be able to enjoy life. The robot could motivate to change the surrounding with pictures, plants and light.

Social needs Similarly also social activities should be strengthened such as:

- Meeting friends, calling them by phone, playing games, having e-mail contact, going out for a coffee or dinner etc.
- Emotional functions can be trained by watching funny films, doing funny things, going to cabaret or funny social activities (parties, laugh yoga)
- Cognitive functions can be training in everyday activities (shopping), social interaction (talking to friends about news), playing games, reading newspapers, planning a journey etc.

One possible way to express these different user needs is to group them in three-levels as proposed in Fig. 1. Starting from the basic safety needs over needs related to health, we place on top the personal needs. What we think the reviews above indicate is that service robots need to address the personal needs with higher priority as developed so far.

Certainly, this approach needs a more thorough interaction of disciplines (as raised and intended by this workshop) ranging from therapists and geriatrics, over psychologists and sociologists to the computer scientists and robotics researchers. However, the challenge is to overcome traditional thinking of service robots performing household chores and come closer to the core needs of users to enable an active life style while ageing in place. We argue for exploring in a systematic way how these needs on the personal level can be transferred to HRI scenarios and that long-term studies with robotic systems in actual user homes will be required to provide insights.

V. Conclusion

In summary, we put forward the observation that there is a discrepancy between research for accepting robots versus building robots that address basic needs of older adults. We try to exemplify the discrepancy in terms of user needs. A typical

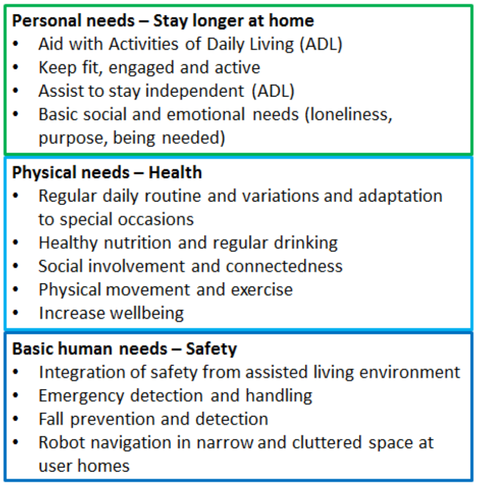

Fig. 1. Three layers of needs: *Needs related to safety* encompass issues such as fall prevention and detection and reliable navigation in narrow homes, *needs to stay healthy* are often reduced to reminders and tele-presence, and the final goal to fulfil *personal needs* that are most important to indeed reach the level of independence for staying longer independent.

examples is that an older person observes after short time with the robot, "reminders will not make me drink but annoy me". Long-term interaction would only increase annoyance.

We presented the needs in a three-layer concept to make it more clear what needs should be addressed. And we emphasised the point that work should start with the top-most layer — the personal needs. Personal needs such as factors motivating a person will be more difficult to reach, however, the hypothesis is that reaching the person at this level is much more effective. If we can achieve this, service robots will finally enter homes and will be joyfully received.

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