Social Robots for Older Adults: Framework of Activities for Aging in Place with Robots

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Abstract. According to the United Nations World Population Prospects, the world's population is aging. Older adults constitute a fragile part of society, as aging is always accompanied by major psychological and physical challenges. A way to cope with those challenges is to strive for a good Quality of Life (QoL) and contribute to successful aging. Social robots can play an important role in the promotion of QoL by integrating activities with independent-living older adults. Using a qualitative design through a focus group method, this paper aims to present the activities in which independent-living older adults, *i.e.,* older adults that do not depend upon anyone to carry out their activities, require a robot. By understanding the activities where robots can positively influence and contribute to older adults' QoL, we set specific goals for the future research in the field of Human-Robot Interaction (HRI).

Keywords: Human-Robot Interaction · Quality of Life · Successful aging

1 Introduction

The world's population is growing and aging. Furthermore, the late adulthood stage (>65 years old) is faced with major psychological and physical challenges [6]. Those challenges are usually accompanied by multiple stressors, such as social isolation and incapacity for work independently [20]. However, many older adults face these challenges but have an independent lifestyle (*i.e.,* do not depend upon anyone to carry out their activities of daily living) [7]. It is the thin balance between aging and still having an independent living lifestyle that constitutes one of the gravest challenges for achieving good standards of QoL.

Successful aging is one of the ways to ensure the maintenance of QoL [1]. By being able to promote an independent lifestyle, technology becomes an important factor associated with successful aging and better standards of QoL. Social robots in particular, have been investigated as a type of technology that can positively influence successful aging. Studies have shown the role that robots can have in providing assistance with house keeping activities [2], or by providing support over the needs and difficulties of older adults [11]. However, the concept of QoL

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encompasses more contexts than the home environment and goes beyond needs and difficulties. In fact, QoL covers various components of life and is associated not only with functional aspects of life, but also with well-being [15]. The novelty of this study is to elicit the activities that older adults require a robot to integrate all of their possible real-world contexts, including activities that support their desired living style and QoL. As such, this study goal is twofold:

Goal 1 Elicit the *types of activities* in which older adults require the inclusion of a robot to sustain a good QoL and independent living.
Goal 2 Present the *robots that older adults chose* for the different activities.

2 Related Work

Different societal studies have all came to the same conclusion: humanity is facing a profound demographic change, moving from a society where the majority of the population was relatively young, to one that faces a significant portion of older adults [16]. In fact, according to the United Nations World Population Prospects of 2012 for 2100[1], the percentage of older adults will increase as part of the population density across Europe, America, and China [13]. Although these news are tough to prospect, anthropological studies can reassure us. According to this field of study, the ability to create tools (*e.g.,* technology) is one of the pivotal developments and adaptations of humanity to change. In this line, technological artifacts have been making their way into our lives, mirroring the human capacity to develop tools that adapt to our needs [19].

Moreover, technology has been defined as the capacity to apply scientific knowledge to practical tasks that respond to societal needs and so, impact on the QoL [5]. When looking at older adults research, it can be seen that QoL is among the most studied constructs. In fact, for older adults QoL is preferred over to longevity [9]. A paper review [15] defines QoL as a conscious cognitive judgment of satisfaction with one's life. In aging research, QoL is associated with two broad categories: functioning (*e.g.,* the ability to perform activities of daily living) and well-being (*e.g.,* emotional well-being) [15]. The present study aims to contribute for the research of older adults' QoL associated with social robots, by eliciting activities they can integrate to promote successful aging. By doing so, this study provides a contribution for the development of both service and entertainment robots for older adults that live independently.

2.1 State of the Art on Social Robots for Older Adults

The development of robots that assist the activities of daily living of older adults contributes to the enrichment of Ambient Assisted Living (AAL), which is an emerging paradigm in information technology aimed at empowering peoples' capabilities by means of technology that is sensitive, adaptive, and responsive to the human needs [18]. Also, different projects concerning robots for older

[1] World Population Prospects: The 2012 Revision, http://esa.un.org/wpp/

adults have been emerging, such as GiraffPlus[2], Robot-Era[3], SILVER[4], CARE[5], ACCOMPANY[6], HOBBIT[7], ExCITE[8], ENRICHME[9], and RAMCIP[10]. The aforementioned projects have been developing prototypes of robots to interact with older adults, aiming to develop ways to assist on their needs. Yet, some of the applications and activities proposed are based on the need of the caregivers on one hand, and the older adults on the other. Still, there are unforeseen activities that can be developed for robots that will increase older adults' QoL and successful aging. This paper presents different activities that older adults require assistance not only from a basic and functional point of view, but also concerning entertainment and enhanced activities that contribute to their QoL.

3 Methodology

This study aimed to elicit the activities in which older adults require the presence of a robot to support their QoL. By doing so, we provide guidelines for the development of robots that co-exist with older adults, fostering successful aging and independent life style.

3.1 Participants

A focus group methodology was used (N = 16 participants), with each group comprised of 5 (except one of the groups that consisted of 6 participants) older adults with independent lifestyle (12 females, 4 males; M age = 78.69, SD = 12.20). Participants were recruited from a day-home care institution in Lisbon (Portugal). Most participants lived alone in their home (81.3%), or with their friends (12.5%), and relatives (6.3%). The focus group sessions were conducted at the recruitment facilities. Each session lasted 45min and was held by a psychologist and a computer scientist, both working in the field of HRI. The study followed the ethical norms of conduct for privacy, and all participants signed a consent form and assented participation. The cases in which participants were unable to read the consent form (due to their education level or physical impairment), the consent was read to them by a caregiver of the institution.

3.2 Procedure and Methods

Aiming to elicit the types of activities in which older adults envision robotic technology as an enhancement to their QoL, a qualitative study with focus group

[2] GiraffPlus project: http://giraffplus.eu/
[3] Robot-Era project: http://www.robot-era.eu/robotera/
[4] SILVER project: http://www.silverpcp.eu/
[5] CARE project: http://care-project.net/welcome/
[6] ACCOMPANY project: http://accompanyproject.eu/
[7] HOBBIT project: http://hobbit.acin.tuwien.ac.at/
[8] ExCITE project: http://www.aal-europe.eu/projects/excite/
[9] ENRICHME project: http://www.enrichme.eu/wordpress/
[10] RAMCIP project: http://www.ramcip-project.eu/ramcip/

methodology was used [3], designed of three phases: 1) *information and sensitizing phase*; 2) *brainstorm session*; 3) *choosing robots*.

Phase 1: Information and Sensitizing. This phase informed about what a certain emergent technology *is* and can *become* [21]. In this study, we aimed to inform and sensitize about social robots using a short-film documentary of 6min that consisted of five chapters:

1. **What is a robot?** Since our intention is to keep distance from sci-fi culture when eliciting activities that participants envision doing with a robot, different existing robots such as the industrial Kuka arm[11], the social robotic pet AIBO[12], and humanoids like the Geminoid robot[13], were introduced by showing robots interacting with humans or in their context of use.
2. **How does a robot function?** This chapter explained that robots perceive the world differently from humans. As an example, this chapter contrasted the way humans perceive the world (*e.g.,* through their *eyes*), while robots perceive the world through *cameras*. The emphasis was on the difference between human and robot perception without emphasizing the limited capabilities that robots have nowadays.
3. **Do robots for older adults exist?** This chapter presented robots and prototypes specially developed for the aged population. Examples of these robots were RIBA robot[14] and Paro[15].
4. **What are the limitations of robots?** This chapter aimed to show the current real limitations of robots in the wild. This was demonstrated by, *e.g.,* a video where Asimo robot[16] falls of the stairs.
5. **How will the future with robots be like?** In order to show what an emergent technology such as a robot can become, it was necessary to show a possible future of robots and older adults together. Therefore, segments of the commercialized movie *Robot and Frank* directed by Jake Schreier (2012) were shown.

Phase 2: Brainstorm Session. *Brainstorm* is a well-established technique, usually used in groups, for generating a large number of new ideas quickly, enabling the transformation of abstract concepts into practical experiences [14]. Thus, the brainstorm session aimed to register in a whiteboard the different activities that participants envisioned to do with a robot. In the middle of the same whiteboard was written "robots for older adults" so that participants could easily situate their ideas. The researchers' role in the room was to clarify questions that emerged along the session, to facilitate the interaction and to write down on the whiteboard the activities mentioned by participants.

[11] KUKA Arm from KUKA Robotics: http://www.kuka-robotics.com/en/products/
[12] AIBO robot from SONY: http://www.sony-aibo.com/
[13] Geminoid robots from IHL: http://www.geminoid.jp/en/robots.html
[14] RIBA robot from RIKEN-TRI: http://rtc.nagoya.riken.jp/RIBA/index-e.html
[15] PARO robot from AIST: http://www.parorobots.com/
[16] ASIMO robot from HONDA: http://asimo.honda.com/

Fig. 1. Companion Robots *(from left to right)*: Paro, Pleo, Emys; **Service robots**: Pearl, Care-O-bot, PR2. Categorization of assistive robots for older adults [4].

Phase 3: Choosing Robots. Six images of robots were shown to the participants, whose task was to assign a robot to the activities they had previously brainstormed about. The robots were chosen according to the categorization of assistive robots for elderly, *i.e.,* robots designed for social interaction that can play an important role with respect to the health and psychological well-being of the elderly. The selection of robots tried to met different contexts of aging, such as therapy, entertainment, and service-related [4]. Therefore, three *companion robots* were shown: Paro, Pleo, and Emys; and three *service robots* were shown: Pearl, Care-O-bot, and PR2 (see Fig. 1). The groups discussed what robot would better fit a specific activity and the researchers added this information to the whiteboard. It is important to note that participants did not specify a robot for all the activities, neither they were instructed to do so. In addition, they could choose more than one robot for the same activity. The open-endedness style of this phase was adopted to avoid pressure participants on a decision.

4 Results

The activities that participants yield were analysed by the two psychologists of this study. The elicited activities came from two different sources: activities written on the whiteboard, and audio recording of the sessions. All group sessions were transcribed and coupled with the activities present on the whiteboard. Participants generated a total of 75 activities in which a minority was repeated. As this study aims to provide visibility to a broad range of activities instead of analyzing their prevalence, the repeated activities were excluded. Thus, data was re-arranged and coded only with 65 non-repeated activities. The yield activities were coded according to the framework for aging in place with the objective of categorizing and organizing them according to their primary goal and context [10,12]:

- **Basic Activities of Daily Living (BADL)** This dimension represents the basic activities that people living independently should be able to perform (*e.g.,* bathing);
- **Instrumental Activities of Daily Living (IADL)** Successful independent living requires the capability to carry out instrumental activities (*e.g.,* managing a medication regimen);

- **Enhanced Activities of Daily Living (EADL)** Independent living also requires activities related with the outside world communication that are beyond what is considered to be instrumental. These activities are connected with major and holistic responsibilities (*e.g.*, buying groceries);
- **Social Activities (SA)** These activities are meant to entertain and sustain social closeness, such as communicating with others as a way to establish relationships. According to the generated ideas of participants, this dimension was added to the framework for aging in place with robots.

4.1 Coding Procedure

Data was coded according to the required functions that a robot should have to perform each activity. Each coder coded the totality of the material (65 different activities). According to Cohen's Kappa test, the level of agreement between the coders was K = .91, α = .000, indicating an almost perfect agreement [8].

4.2 Activities for Aging in Place with Robots

Results suggest that older adults refer more different IADL (24 different activities), followed by BADL (17), and finally both EADL and SA (12 activities each) with a robot (see Fig. 2). Some of the referred activities are described in Table 1.

4.3 Chosen Robots

Results show that older adults have chosen different robots to serve different activities (see Fig. 3). It can be seen that Care-O-bot (18%) is the robot that most of the participants have chosen for BADL, followed by PR2 (17%) and Pearl (12%). When looking at IADL, it can be seen that Care-O-bot is the most chosen robot as 21% of participants have chosen this robot to integrate such activities. Then, PR2 (17%) is also referred in the context of IADL, followed by Peal (4%) and Pleo (4%). Considering the EADL, results show that half of the participants chose PR2 (50%), followed by Pearl (25%), Emys (25%), and

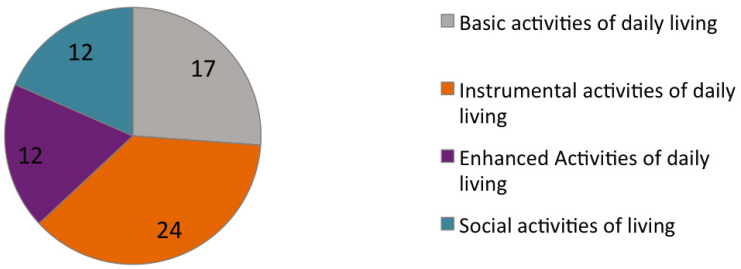

Fig. 2. Number of activities yield by older adults.

Table 1. Framework of activities for aging in place with robots, adapted from [12].

Basic Activities of Daily Living
"Help bathing, specially washing the feet and the back."
"Help open taps, like bath taps because it's hard for me to open them."
"Help put on the socks, and then the shoes. Then help to take them off."
"Help shaving because I do not see well and help cutting the nails."
"Help dressing, I don't mean every day but there are cloths that seem harder to dress."
Instrumental Activities of Daily Living
"Memorize what I eat. I do not always remember when to eat or what I eat, so I end up having a bad diet."
"Make the bed and change the bed sheets. Also, do the laundry and then hang it on a clothesline. Oh yes, and then iron it!"
"[The robot] should know my medical history and adapt the food it cooks. I cannot eat cakes and the robot should know this information."
"Help with the electricity and construction works like painting a wall that needs painting, repairing a water pipe, or just changing a light bulb, this is very useful."
"Clean the floor and sweep the kitchen and all that stuff. Oh, and wash the bathroom and clean the dust."
Enhanced Activities of Daily Living
"I would gave a list of what I need and the robot could go buy groceries and to the pharmacy."
"Make emergency calls to the police, ambulance, or family."
"Have an informative dialogue, by providing meteorological, time and news information. [The robot could also help us by] answering the door when we are lying in bed."
"[The robot should] be able to communicate with doctors and nurses."
[The robot should] warn us regarding appointments or obligations, like visits to the doctor, or when to take the right pills at the right times of the day."
Social Activities
"Read stories. I like novels very much, but my eyes are not able to see the words now. I would be so happy if the robot could read me stories at night."
"Accompany when walking outside to the park and to the cinema. I would never do such activities alone now."
"Cheer people, communicate or talk. The robot should be able to share its own ideas, even when they are different from ours."
"Pray with us". Some said the robot should also *"have a religion"*, others disagreed. In the cases where they claimed it should have a religion, two opinions were expressed: *"[the robot] should adapt to theirs religion by having the same one"*, or *"could choose its own belief."*
"Play games in general, and cards and domino particularly. It would be wonderful if the robot could just talk with us and be a company in our daily life."

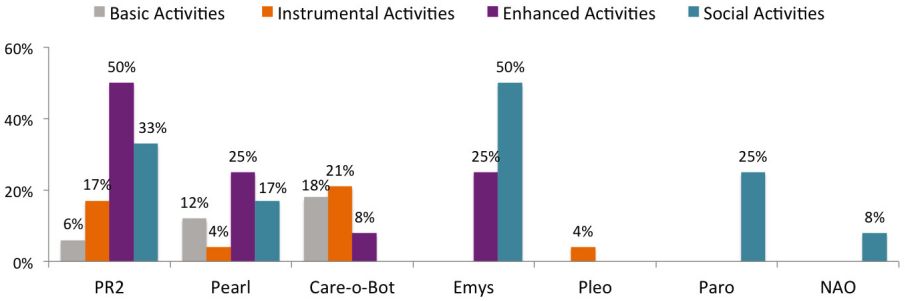

Fig. 3. Chosen robots according to the different types of activities.

Care-O-bot (8%). Finally, for the SA, Emys (50%) is the most chosen robot, followed by PR2 (33%), Paro (25%), Pearl (17%), and Nao (8%).

When clustering the service robots (Pearl, Care-O-bot, PR2) and the companion/entertainment robots (Paro, Pleo, Emys), and comparing them with the type of activities they were assigned to, results show the majority of participants assigned companion/entertainment robots with SA (65%), less than half of the participants assigned these robots with EADL (35%), and only 9% have assigned with IADL. On the other hand, service robots were assigned by the participants to all types of activities (see Fig. 4). We emphasize that participants have not chosen a robot for all the activities, existing activities without an assigned robot. On the other hand, participants assigned more than one robot to some of the activities.

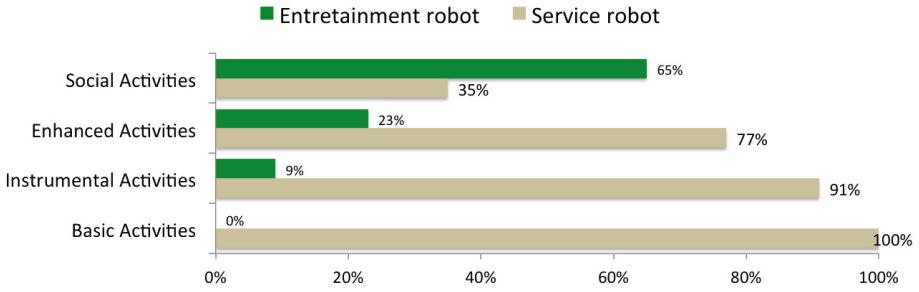

Fig. 4. Chosen robots according to the different types of activities.

5 Conclusions and Discussion

This study aimed to elicit activities from older adults in which the presence of a robot helps enhancing their QoL and contribute for their successful and independent aging. The novelty of this study concerns the presentation of activities that are part of all the real-world contexts of older adults: from the home, to the pharmacy, to a park, or even to be able to see a movie at the cinema.

Therefore, the majority of different activities refers to IADL, related with activities that are beyond personal and basic activities of daily living, but are essential to live independently in a society and community. In their perspective, it seems essential to have a robot that assists managing a medication regimen, maintain the household, and prepare meals of adequate nutrition [12]. Moreover, older adults referred that although they were able to perform some activities, they would prefer having a robot as an extra help (*e.g., "help putting and taking off the shoes"*). This seems to indicate that the participants are still in shape to independently manage their daily activities, but would benefit from additional assistance. A large number of different activities concerns BADL related with personal hygiene (*e.g.,* toileting and bathing) [12], in which participants claimed for help to *e.g., "get in and out of the tub"*. Finally, EADL and SA emerged as the activities in which older adults require the robot for communicating with the outside world due to the need to satisfy a basic activity (*e.g., "[the robot] could go buy groceries"*), translating an EADL; or due to a need to overcome social isolation by *"playing games"*, *"accompany to the cinema"*, or even *"pray"*, related with SA. Furthermore, service robots were chosen to perform all types of activities, showing this type of social robots are fit for different activities with this population. The participants referred that their choice for a robot was strongly motivated by its physicality. Thereafter, showing an interest for robots that are perceived as able to accomplish multiple tasks, instead of robots whose primary goal is more limited (*e.g.,* Pleo and Nao which are low height robots).

Although there are concerns about the accomplishments of some activities due to technical development and ethical aspects, this paper shows there is space for technology developments with views to enhance the QoL of older adults. By having a deeper understanding about the activities that older adults require a robot, HRI researchers detain key-information about where and how to dedicate their efforts and resources to fulfill a societal need and contribute to the QoL and successful aging among this population [17].

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