Analysis of Elderly Users' Preferences and Expectations on Service Robot's Personality, Appearance and Interaction

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Abstract. Fortunately, improvements in welfare and medical care will allow life expectancy in Europe's population to increase by the year 2050. However, it is not always the case that living longer implies a healthier, more active and independent life. In this context, technologies and products that will act as assistive companions to elderly, who are living alone at their home, are attracting a growing interest from both a research and commercial perspective. Literature reports contradictory results on the preferences of elderly towards assistive technologies and more specifically, service robots. In this paper, we are called to present an empirical study, conducted in the scope of an EU – Horizon 2020 project, in order to explore people's perceptions, attitudes and requirements towards the idea of a future service robot for the home.

Keywords: Aging well · Service robots · User-centred requirements analysis

1 Motivation

During the last decade mainly due to the increase of life expectancy, researchers are looking into solutions that will improve elderly quality of life (QoL), keep elderly active for longer and help them socialise more. Robotic assistive partners are becoming the trend in elderly care, in an attempt to keep the elderly at home for longer and to reduce consumption of care resources. This move into the edge of the technological innovation called robotics, forced researchers in the academia but also in the care sectors to investigate the potentials and benefits that might arise from exploiting care provision through service robots.

A service robot can be defined as a special kind of robot that is specifically designed for personal use at home and is expected to communicate with its users in a natural and intuitive way. Service robots have been around in the care area for some time now and although many studies proven the positive impact of robots to older adults' everyday life and well-being [1], there are still unanswered questions [2] on what end-users really want from a robotic partner. More specifically, the infancy of this area [3], generates questions on, (i) how a service or social robot should look like on its outer appearance; (ii) what type of personality the robot is expected to demonstrate when interacting with the user and (iii) in what ways the user would like to interact with the robot?

In this paper, we are called to provide evidence to answer the abovementioned questions through an empirical study conducted in the scope of the GrowMeUp project, in order to explore people's perceptions, attitudes and requirements towards the idea of a future service robot for the home. A human-centered approach was adopted and a systematic human-centered methodology was developed using questionnaires to derive data from 16 older adults and 16 caregivers. In this paper priority is given to the replies provided by the elderly participants of the study who are, after all, the primary end-users of the technology under development.

In the coming sections a discussion is provided on similar studies and related literature report, followed by the methodology that guided us in conducting this study. A report on the answers we received from the elderly participants is given along with conclusions.

2   Related Work

Service robots studies usually end or have a stage where there is a trial with end users for evaluating, the technology developed and its effect and acceptance by, the end users. A great obstacle in the adoption of this kind of technology is its acceptance by the end users and integration into their everyday routine, which is actually the purpose for service robots development [3]. Broadbent et al., in their article, stress the importance of studies that will focus on the preferences of older persons related to the required features that a service robot might have (appearance) [3] and to the aspects of the personality [4] that should demonstrate and preferred interaction with end users. Currently, literature reports contradictory results in these areas, that usually occur due to the methodology selection for studies that investigate the adoption of technology by older adults [1, 5–8], or even due to the selection of user groups that is involved in the evaluation of the developed technology. For example in Roy et al. [5], a service robot that was developed particularly for elderly care, it was evaluated by a group of students whom, the needs, expectations and requirements differ greatly from those of elderly users. Similarly the service robot developed at [6], evaluated by a number of older adults at a serviced apartments for the duration of only 30 min. The results from such studies can create misunderstanding in the research community of ambient assisted living and misguide the development and design of relevant technologies. Thus a more active involvement of the end users is paramount and a user-centred methodology

needs to be followed for understanding user needs and requirements and increase acceptance of service robots by elderly [9].

In this line, recent studies showed that the elderly are more willing to accept a robotic support partner that does not act as an "all knowing" superior being, especially when robots cannot achieve what is expected of them, due to technological limitations [3, 10, 11]. A robot in the elderly care might needs to demonstrate different roles and personalities, for example, to adopt the role of a friend, personal assistant, personal carer and should thus demonstrate a friendly or professional personality accordingly [12]. In addition, the interaction and support provided should demonstrate a non-invasive intervention of the robot to the older person's everyday life [2] and use a suitable and usable medium of input and output interaction (e.g., voice, touch, gesturing). Moreover, there are evidences [4] that support the argument that matching the personality of the end-user to the robot's behavior and personality can help the end user to accept the technology more easily.

3   Methodology

3.1   Trial Sites Involved

Two trial-sites, one in Portugal and one in the Netherlands, were involved in the overall process of extracting user needs and requirements for the GrowMeUp system. Each site has its own particular arrangements for providing services to the elderly in need and these are described below.

ZUYDERLAND: The target group members of ZUYDERLAND lives in two different care facilities in the Netherlands named Hoogstaete and Aldenhof. Both care facilities are part of the ZUYDERLAND care organization and are located on the north edge of Sittard and nearby a village called Born. Hoogstaete and Aldenhof are combined elderly houses with the following departments: (i) Small scale living for people with dementia (note: not in the scope for this study), (ii) Elderly home for people with dementia, mental and/or physical problems (the average size of these apartments is 30 m^2), and (iii) Care apartments for people with physical, mental and/or physical problems (these apartments are like normal apartments only adjusted for elderly like the presence of an alarm, adjusted bathroom, etc.). Elderly living in this department are (semi) independent but can make use of all the facilities from the attached care facility including care, meal service etc. All departments have a care staff consisted of Care Coordinators, Nurses with different education levels, Care Assistants and Activity Staff (occupational therapist).

CARITAS: The target group members of CARITAS live in three different home care services located in urban and suburban areas in Portugal. One of these services, Centro Rainha Santa Isabel, provides support mainly for the elderly that live in Coimbra city and that are still living in their own houses, many of which traditional houses in friendly neighbourhoods. The second is a social centre S. Pedro which is located in the outskirts of the city and congregates different types of elderly – either people retired from public services, with good cultural and economic conditions as well as

beneficiaries of social housing, with some financial difficulties. The third service, Centro N.ª Sr-ª dos Milagres, is in a suburban area, about 11 km from Coimbra. All of these centres also have day care services and ensure to their clients a range of services including meals, house cleaning and laundry, leisure activities, transportation to the hairdresser, bank and doctor appointments, among others.

The elderly group that was selected to participate in the requirement gathering process is supported by these centres.

3.2   Participants' Selection Process

The target group of GrowMeUp is the big group of healthy older persons or with light physical or mental health problems who live alone at home and can find pleasure and relief in getting help or stimulation to carry out their daily activities.

Groups of elderly and caregivers (both formal and informal), from ZUYDELAND and CARITAS, were involved throughout the process of establishing and analysing the requirements in order to contribute their needs and ideas. During the requirement gathering process three different groups, with different target group members have been involved: Group 1: Elderly supported CARITAS; Group 2: Elderly Residents of ZUYDERLAND; Group 3: Formal and Informal Caregivers (from CARITAS and ZUYDERLAND).

The first group includes 8 elderly (4 men and 4 women) from CARITAS with ages between 69 and 85, the second group includes 8 elderly (5 women and 3 men) from ZUYDERLAND with ages between 65 and 85 and the third group includes 16 formal and Informal caregivers from both test beds. More specifically 13 formal (8 from ZUYDERLAND and 5 from CARITAS; including Care Coordinators, Nurses, Psychologists, Sociologists, Policy Advisors, Older Person Care Specialists, ADL Trainers, etc.) and 3 informal caregivers (1 from ZUYDERLAND and 2 from CARITAS; including family members, that is 2 Sons/Daughters and 1 Grandchild, of the elderly).

The selection of the elderly participants of ZUYDERLAND and CARITAS, was based on inclusion criteria considering profile variations within the target audience that the study aims to reach (gender, daily habits, capabilities, preferences, technological skills, social status, etc.). Other inclusion criteria take into account: expression of interest from elderly in the project and elderly at the age of 65 + with none or only light physical or mental health problems at the time of the study. Elderly that have severe physical or mental health problems at the beginning of the study or start showing signs of heavy degradation during the trials and elderly with no autonomy in their daily activities are excluded from participation in the study.

In ZUYDERLAND the elderly and the caregivers (both formal and informal) participants were invited in group sessions where they have been firstly informed about the overall scope of GrowMeUp. There were two sessions; one for the elderly and one for the caregivers. After understanding the main aim and objectives of the project, both the elderly and the caregiver were provided the questionnaire in a digital form (on-line) that they filled in and the data collected were analysed and processed. It is worth also indicating that during the time the elderly were filling in the questionnaires, caregivers

were always there to provide them help and clarifications to the different questions included in the questionnaire.

For CARITAS, due to the delay in obtaining ethical clearance from national authorities to the implementation of the user requirements, the solution was to implement an anonymized questionnaire distributed online to all CARITAS elderly and caregivers. The online questionnaire included information about the overall objectives of the project.

3.3 Process of Understanding User Needs and Establishing Requirements

The general methodology for understanding user needs followed in GrowMeUp (see Fig. 1) is adapted from the Miraculous Life[1] project methodology presented and emphasised in continues user involvement in the whole process. In this paper we are focusing only in the process prior to the development of the prototype system.
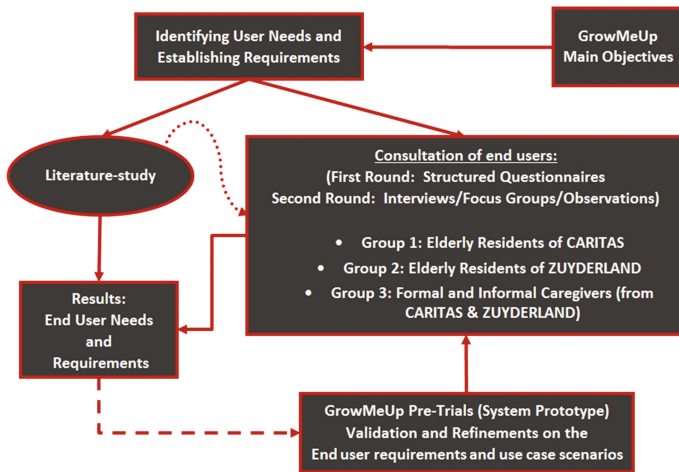

Fig. 1. End user needs and requirements extraction process flow-chart. The user is involved in the process at each stage.

More specifically, during the first round of the requirements gathering process, a literature study was performed that provided useful information from related research studies, particularly on the preferences of elderly users when interacting with robots and graphical interfaces. This information was considered as a starting and guiding point for discovering the link between the elderly and the use of ICT-based services and robotic technology. Furthermore, the results of this literature study provided understanding of the field and the theoretical background for the development of the

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[1] Miraculous-Life project, funded by the European Commission under the 7th Framework Programme (Grant Agreement: 611421).

two extended requirement analysis questionnaires (the one distributed to the group of the elderly and the other one distributed to the formal and informal caregivers). Through these questionnaires end-users were requested to reflect on their daily life habits and patterns, their skills, their expectations and their ideas of being supported by a service robotic system. The data collected were considered for guiding the initial design of the overall GrowMeUp system.

The first questionnaire concerned the elderly and how they perceived certain issues and expectations when interacting with the GrowMeUp system. The second questionnaire was provided to the formal and informal caregivers in order to get their point of view of what the system should provide to the elderly and their perception of certain issues. Formal (i.e., Care Professionals) and informal (i.e., Family members of the elderly) caregivers, of the elders' care team were involved in the analysis as their point of view was essential for two reasons. Firstly for gathering more realistic requirements and secondly for identifying requirements that will assist in improving the efficiency and continuity of integrated care provision to the older person, leading thus in a reduction of demand of care resources, of the workload burden of care and of the associated stress of the caregivers, improving thus the QoL of the caregivers community, as well.

An English version of the questionnaires was initially developed. The final questionnaires were translated into Portuguese and Dutch in order to propose the questionnaire in the native language of respondents and transformed in a digital form (online questionnaires). The questionnaires included questions in 4 categories:

- Part A - Demographic, Social and General Information about your Daily Routines
- Part B - Health and Memory Status
- Part C - Questions related to the GrowMeUp System Functionality
- Part D - Questions related to the GrowMeUp Robot Appearance/Personality/ Interaction

The data collected through the questionnaires have been analysed. Since the focus of this paper is the preferences and requirements of users in terms of the Robot appearance, personality and interaction, in the next section the results of Part D are presented and discussed.

4   Analysis of Results and Establishing User Preferences

4.1   Demographics and General Information of Participants

In total the study involved 32 participants, 16 of which were elderly and 16 caregivers. As illustrated in Table 1, the majority of the elderly that participated in this study are female. The mean age of the elderly is 78.9 years while the mean age of the caregivers is 39 years old. The group of the thirteen (13) formal caregivers consisted of mostly Care Coordinators, Psychologists, Sociologists, Nurses and Policy Advisors. The three (3) informal caregivers were mainly family members of the elderly (Son/Daughter (or in-law) and a Grandchild). A summary is provided in Table 2.

Table 1. Summary of demographic information of elderly participants in the study

Elderly population	ZUYDERLAND	CARITAS	Total elderly
Amount of participants	8	8	16
Gender	3 male	4 male	7 male
	5 female	4 female	9 female
Average age	78.4	79.4	78.9
Range of age	65–85	69–85	65–85

Table 2. Information on caregivers that participated in the study

Caregivers population	ZUYDERLAND	CARITAS	Total caregivers
Amount of participants	9	7	16
Type of caregivers	8 formal	5 formal	13 formal
	1 informal	2 informal	3 informal
Profession of formal caregivers	1 Care coordinator	2 Care coordinators	3 Care coordinators
	1 Nurse	1 Nurse	2 Nurses
	2 Psychologist	1 Psychologist	3 Psychologists
	2 Policy advisors	1 Sociologist/SST	2 Policy advisors
	1 ADL trainer		1 Sociologist/SST
	1 Specialist older persons care		1 ADL trainer
			1 Specialist older persons care
Relationship of informal caregivers	1 Son/Daughter (or in-law)	1 Son/Daughter (or in-law)	2 Son/Daughter (or in-law)
		1 Grandchild (or in-laws)	1 Grandchild (or in-laws)

Although the goal of this paper is to highlight the needs and requirements of elderly and their caregivers when interacting with robotic technologies, it was interesting to understand also their familiarity with technologies during their everyday life. The results show that 62.5 % of the elderly of ZUYDERLAND use a tablet every day. The smart phone, laptop and the application Facebook are also used every day, by 37.5 % of the elderly. A desktop computer and the applications Skype and Viber are used the least by the elderly; the majority of the elderly participants never or rarely used these applications. As for CARITAS' elderly, only one of the elderly participants uses a smartphone on a daily basis and a laptop some times. All the other elderly don't use any of the technologies or applications specified.

The above information provides an insight on the potential users of the overall system under development. What follows will focus on the end users' preferences on (i) how a service or social robot should look like on its outer appearance; (ii) what type of personality the robot is expected to demonstrate when interacting with the user and (iii) in what ways the user would like to interact with the robot?

Prior to asking the elderly about their preferences, we asked CARITAS and ZUYDERLAND caregivers their opinion regarding the acceptance of this kind of technology by the elderly. CARITAS caregivers are convinced that the elderly would not have any issues having a Robot in their household. Most of the caregivers (13 out of 16) believe that the elderly would like to be with a robot on a daily basis. In ZUYDERLAND 2 caregivers replied negatively implying that the elderly will not accept the Robotic service provider in their daily life, mentioning also that *"elderly would prefer actual people delivering care, not a robot"*. Similarly in a question whether the elderly would feel comfortable with a robot inside their house 12 out of 16 caregivers replied positively while there was also a concern from ZUYDERLAND caregivers: *"I think they might be suspicious at the beginning (about the Robot), or maybe a bit ashamed. It might seem strange at the beginning."*

4.2   Users' Preferences on Robot's Appearance, Personality, Interaction

Appearance: One of the most important outer features of a device, hence a robot is the colour of its shell. In our study elderly participants provided mixed opinions on their preferences. Specifically, elderly in ZUYDERLAND equally (25 % of elderly respondents) selected pink, red, blue and grey. On the other hand CARITAS elderly in their majority (37.5 %) selected the red colour for the robot's shell. The results in this case show that possibly elderly are just concerned with the aesthetics and that colour will not affect their interaction with the robot.

The opinions about the height of the robot also vary between respondents. Some of them chose a small to a medium sized robot (smaller than 100 cm). However, according to the majority (50 % of the elderly at ZUYDERLAND and CARITAS) the preferable height for the robot is medium (between 100 cm and 120 cm).

Furthermore, the elderly in our study requested for an extra feature in the robot's shell that they can use to help them get up if needed. Specifically, 75 % of ZUY-DERLAND elderly would like to be helped getting up and sitting down and 37.5 % of the elderly from CARITAS believe they would appreciate this aid. These results show the elderlies' confidence and trust in using the robot for an important everyday activity that also devises a threat of injury. In addition, 87.50 % of all the elderly also think that it would be useful if the robot would be able to carry some products.

Personality: As mentioned above an important aspect of a companion robot is the personality that it demonstrates while interacting with humans [4]. It is proven that in the elderly assistive care it is important that the robot does not show behaviour of a superior being or to dictate the elderly on its every day needs and activities. In this respect the majority of the elderly participants mentioned that they would like the robot to adopt the role of a personal assistant (43.5 % of the respondents) rather than act as a friend or a caregiver. However, with respect to the robot's behaviour if they had to choose one, they want it to be friendly and informal (62.5 % of the elderly respondents), mentioning also that it would be good if they could choose between personalities of the robot according to their preferences. More than half (53.5 %) of the elderly in the two participating organisations would appreciate to have this feature available on their assistive robot.

Interestingly with respect to the voice of the robot, at ZUYDERLAND half of the elderly would prefer a female voice to talk to them and half would prefer a male's voice, while in Caritas 75 % would prefer a female voice.

Another aspect of the robot's personality is the behaviour of the Robot. Two options are examined: a guiding behaviour which means that the robot helps the elderly to decide what they should do by giving them advice and a directive behaviour which means that the robot "just tells them what they should do". For the elderly in ZUYDERLAND, 50 % would like a guiding robot, while the other half of the group would like a directive robot. In CARITAS, 73.33 % of the elderly selected the "guiding" answers.

The following extra suggestions about the personality of the robot were made by the elderly of ZUYDERLAND and CARITAS:

> *'The robot is like a friend. Personal bonding is important. It would be fun if the robot will take initiative to tell something from the news for example.'*
> *'It must not be too directive and talk softly with the elderly.'*

Interaction: With respect to the way (e.g. vocal, touch screen, etc.) the elderly prefer to interact with the robot, voice is preferred (87.5 % of the ZUYDERLAND elderly, all of CARITAS' elderly) and vocal calling using the robot's name is the most desirable option. Similarly, the elderly participants in the study (88 % of ZUYDERLAND elderly and 75 % of CARITAS elderly) prefer the robot to call them by their first name, consistently with the informal/friendly behaviour that they want the robot to demonstrate. Similarly, the majority of the elderly would like to have a proactive rather than a passive robot (75 % of CARITAS elderly and 50 % of ZUYDERLAND elderly); meaning that it will 'take the initiative' to remind them about certain events in their calendars, provide advice regarding current states or activities even if the elderly has not initiated a discussion. Having said that, when the elderly asked, they mentioned that the robot should be switched off if required and get activated accordingly: "Switch on-off as I choose" (37.50 %). It is not surprising that most of the elderly want to be in control of the activity level of the robot.

5   Conclusions

In conclusion, it is apparent that a service robot seems to be an appreciated technological solution for the home care services and the elderly that live alone at home. In order though for end-users to accept and integrate this technology in their everyday life and exploit the benefits of a service robot, the technology has to meet user requirements and preferences. One size does not fit all and thus, special design considerations need to be made while designing and developing robots that are meant to have specific purposes e.g. service robots for elderly care. According to the above results, a service robot needs to interact as a friendly assistant, with a pleasant and sensitive voice, allow the elderly to feel they can control its behaviour, so it doesn't intrude in their lives and preferences, and act in an informal and personal way. It is important to mention that this solution must always be integrated with human provided services, either formal or informal, and that it does not aim to replace human contact. However, robotic systems have the potential to get accepted by the elderly as long as they understand the benefits and their ability to improve the elderly QoL.

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