

Selecting Services for a Service Robot

Evaluating the problematic activities threatening the independence of elderly persons

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Abstract—Sustaining independent living for the elderly is desirable both for the individual as well as for societies as a whole. Substantial care interventions are provided to citizens supporting their independent living. Currently, such interventions are primarily based on human care provision, but due to demographic changes the demand for such support is continuously increasing. Assistive Robotics has the potential to answer this growing demand. The notions research towards service robots that support the independence of elderly people has been given increased attention. The challenge is to develop robots that are able to adequately support with those activities that pose the greatest problems for elderly people seeking to remain independent. In order to develop the capabilities of the Care-O-bot 3 in the ACCOMPANY project, problematic activities that may threaten continued independent living of elderly people were studied. Focus groups were conducted in the Netherlands, UK, and France and included three separate user groups: (1) elderly (N=41), (2) formal caregivers (N=40), and (3) informal caregivers (N=32). This resulted in a top 3 of problematic activity domains that received the highest priority: (1) Mobility, (2) Self-care, and (3) Social isolation. The findings inform the further development of the Care-O-bot. In the ACCOMPANY project the Care-O-bot 3 will be developed further to enable it to support independently living older persons in one of these domains.

Keywords—elderly care; problematic activities; service robot; independent living; aging in place

I. INTRODUCTION

Populations in Western societies are ageing, due to increasing life-spans and longevity, and older citizens attempt to live independently in their own homes as long as possible. However, there are many everyday tasks a person needs to be able to perform in order to maintain their independence. Age-related changes and impairments to mental and physical abilities can make the performance of these everyday tasks

difficult, challenging, or even impossible without help. For those who are unable to remain completely independent, there are different solutions in place toward regaining/sustaining independence. In many cases, this results in a dependency on care. Traditionally, such care is provided either informally by the direct social environment (e.g. family) or more formally by professionals funded by public or private means. Nowadays, family members are less inclined and/or able to provide care due to changes in the social structures. Due to these changes and the increasing shortage of care staff [1] in Western societies, alternative solutions to maintain an acceptable level of care at home have been given increased attention.

Technology offers many such alternative solutions, some of which are already being used and have high potential. Assistive technologies (AT), such as wheelchairs, stair lifts, patient hoists, smart home technologies and in general accessibility adaptations of the home have come a long way in supporting individuals in their independence [2]. ICT technology and robotics in particular have the potential to support care and independence in several ways [3]. Nevertheless, there are still only limited robotic applications available in care. So far these developments and the type of tasks robots perform are primarily guided by technical feasibility developments, and less attention is given to the actual needs of the targeted users [4]. Examples of robotic technologies for this use are robots which are based on the functionality of an existing touchscreen combined with a mobile device. The main focus of these kinds of robots is to support communication. These tele-care robots raise the question if there is a need for these touchscreens applications to be mobile. Over the past decades several projects have been developed. Commercial success has been very disappointing and consequently the promised potential of robotic technologies has not been realized. Only a small number of robotic systems have actually been brought to the market and made available to support the care for individuals in their daily lives. This raises serious questions concerning the

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suitability of such systems to actually answer the needs of users. This study explores in depth the needs of the elderly struggling to remain independent in their own homes, and aims to use these needs to guide future development of service robots.

The FP7 European ACCOMPANY project aims to further develop the functionalities of an existing service robot to support older citizens in sustaining their independent living [5]. The existing robot adopted in ACCOMPANY is the Care-O-bot 3. This development is intended to support *activities* and is not aimed at replacing lost or declined human abilities as such (e.g. loss of eyesight is a loss of an ability, but as a consequence of loss of eyesight people may have difficulties with a wide range of activities from walking stairs to reading). In order to inform such development, it is essential to know which activities are critical to such a degree that their loss is a threat to the independent living of an older person, regardless the current availability of technological solutions.

This paper presents the findings of a literature exploration review combined with the results obtained from a series of focus group sessions. These sessions were conducted with elderly persons, professional caregivers, and informal caregivers in the Netherlands, the United Kingdom, and France, and surveying the problematic daily activities which results in elderly people becoming dependent on care provision.

II. LITERATURE

A manual search of Online sources led to the identification of a limited collection of literature concerning activity of daily living (ADL) needs for independent living. This led to three clarifying publications. These insights were further extended by reviewing recent EU service robot projects to review the argumentation behind the developed functionalities.

According to the statistics of the U.S. Department of Health & Human Services, the most commonly reported problematic activities for the elderly population, out of the six ADLs (i.e. bathing/showering, dressing, eating, getting in/out of bed/chairs, walking, and using the toilet), are mostly limitations with walking, bathing/showering and getting in/out of bed/chair [6]. Apart from these six ADLs, there are many everyday tasks persons need to be able to perform in order to remain independent. The European Multi-Role Shadow Robotic System for Independent Living (SRS) project [7], together with the Dutch study into *The most recurrent problems of the independently living elderly: recommended assistive devices and solutions* [8] both produced a list of activities that make independent living challenging for elderly persons. Although the SRS project is a project utilizing robotic interventions, the list produced was created without the interference of robotics or technologies and therefore suitable for this paper. Facal et al. [7] included elderly people, family caregivers, professional caregivers, and health professionals, and used qualitative and quantitative methodologies throughout their investigation. This study included direct questions about difficulties of daily living as well as their causes, in focus group sessions in Germany, Italy, and Spain. Crützen et al. [8] conducted a purely qualitative study in the Netherlands. This

resulted in a list of the 10 most mentioned problems of independent living elderly.

The *International Classification of Functioning* (ICF) of the World Health Organization (WHO) was adopted to group the activities humans perform and to label and deal with the variety of relevant activities. The ICF provides a structured taxonomy for the description of human functioning [9]. Within the ICF the particular subgroups of section d, *Activities and Participation*, was especially considered to be relevant as the focus here is on the activities people perform and not on their ability. The prioritized difficulties with daily tasks mentioned in the studies of both the SRS project and the and the Crützen et al. study can be defined as follows: reading – d166, mobility-related ones (walking – d450, climbing up stairs – d4551, reaching for objects – d4452, sitting & getting up – d410, carrying heavy objects – d430, and bending – d4105), self-care-related (washing oneself – d510, caring for body parts – d520, toileting – d530, dressing – d540, feeding – d550/d560, taking medication – d570), household-related (doing housework – d640, shopping – d620, preparing meals – d630), and loneliness – d7. The three difficult ADLs mentioned in the statistics of the U.S. Department of Health & Human Services (i.e. walking – d450, bathing/showering – d510, and getting in/out of bed – d410) also fit this list as they are mobility- and self-care-related.

III. METHOD

Different focus group meetings were conducted in the Netherlands, UK, and France to find answers to the question: *Which problematic activities in daily life are most threatening for the independence of elderly persons?* The metaplan method was used for the data collection [10], as this would allow for both individual viewpoints as well as the group consensus to be taken into account. Within the ACCOMPANY project three groups of users were targeted: (1) elderly persons, (2) professional caregivers, and (3) informal caregivers. Separate focus groups were held for each group of users, so that the perspectives of the different groups could be captured.

A. Participants

Elderly persons and professional caregivers were both contacted through local care organizations. The informal caregivers were contacted through local care organizations and personal networks. Elderly persons were selected based on three criteria: (1) aged 60+, (2) living at home, and (3) receiving home care. Professional caregivers' selection was based on their work activities/profession. Informal caregivers had to take care of an independently living elderly person on at least a weekly basis in the last year. During the recruitment process, the term robotics was mentioned, as well as the goal of the ACCOMPANY project. However it was clearly stated that the particular emphasis of this focus group would not be on the use of robots or technology.

In total 113 persons participated in the study:

- Forty-one elderly persons (12 male, 29 female) with a mean age of 78.0 years (60 to 95) participated in focus group meetings in the Netherlands (11), UK (5) and France (25). All elderly persons were still living at

home and receiving some form of care assistance (e.g. home care, Care TV).

- Forty professional caregivers (2 male, 38 female) participated in focus group meetings in the Netherlands (14), UK (4) and France (22). Caregivers' professions varied from care workers, nurses, psychologists to managers. All professional caregivers worked closely with the elderly.
- Thirty-two informal caregivers (2 male and 30 female) participated in focus group meetings in the Netherlands (7), UK (5) and France (20). Informal caregivers took care of (one of), their spouses, neighbors, parents, or other relatives. In two cases the elderly person taken care of was recently institutionalized and in one case the elderly person had recently passed away.

B. Procedure

The focus groups were carried out in separate groups of 4-10 participants. After the introduction and signing of the informed consent, participants were given the following questions: *Which problematic activities in the daily life of elderly people are threatening their independent living?*

Firstly, participants were asked to write down as many activities they could think of on sticky notes (one activity per sticky note). When finished writing, participants were asked to put all their notes (randomly) on one surface. Secondly, participants were asked, as a group, to cluster all the gathered materials by topic. During this clustering phase, discussion among participants was encouraged and more clarification was elicited as needed. After this clustering process, all subgroups/topics were again discussed in the group. Finally, participants were asked which activity cluster/topic they believed to be the most important for independent living. The duration of the focus groups varied between 1.5 and 2 hours.

C. Data analysis

Pictures were taken of the final clustered notes and all activities written on the notes were copied per group/topic. A short summary of every group/topic was compiled, as well as a general description of the whole session. A final list was composed for every focus group of those activities participants felt needed solving first.

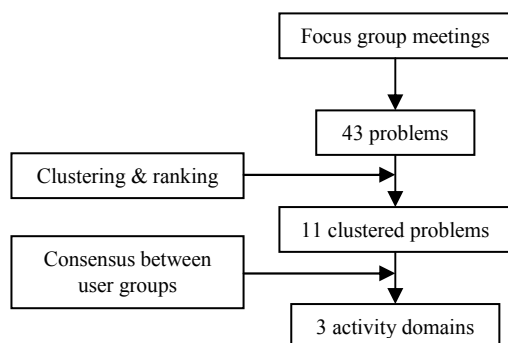


Fig. 1. Steps taken for the analysis of the results of the focus groups.

IV. RESULTS

In the focus group meetings a total of 43 different problems were mentioned (see Fig. 1). The majority of these problems could be grouped into section d, *Activities and Participation*, of the ICF. The other problems mentioned were not specifically activities of individuals but more of the environment (e.g. being looked after). Most of the problems raised had more than one dimension and were threatening the independence of the elderly for several reasons. When completing the problem assessment sessions in the focus group meetings, participants were asked to cluster and rank the problems. Several problems were mentioned repeatedly in the focus group meetings, but were not subsequently ranked as being experienced as threatening. An example of this is preparing meals, which was mentioned multiple times in the focus group meetings. However, there are easily accessible current solutions (e.g. meal delivery services, microwave meals) meaning that this problem was no longer perceived as a severe threat for the independence of elderly persons. The clustering and ranking resulted in a total of 11 problems (see Table I). The majority of these 11 problems have, similar to the most of the 43 problems, more than one dimension and are a threat for several reasons; e.g. opening the front door poses, beside it being a mobility issue, the additional problem that it is difficult for the elderly to know if it is safe to open the door.

Table I also provides an overview of the consensus between the 3 different groups of users. The following three activity domains were all seen as the most threatening for the independence of elderly people and were given the highest priority from all the three groups of users across all three countries:

- Self-care activities: When an elderly person is not able to take care of their personal hygiene, then he or she becomes dependent on care, especially when getting up

TABLE I. OVERVIEW OF THE HIGHLIGHTED (SHADED) CLUSTERED PROBLEMS EXPRESSED IN THE FOCUS GROUP MEETINGS IN THE NETHERLANDS, UK AND FRANCE.

Clustered problems	Groups of users		
	Elderly	Professional caregivers	Informal caregivers
Communication support for the hearing impaired			
Costs (e.g. poverty)			
Housing adaptations			
Social isolation			
Lack of hobbies			
Mobility			
Monitoring			
Opening the front door			
Self-care activities			
Shopping			
Specific information about health problems			

in the morning or going to bed in the evening. Consequently, people have to adapt their daily schedule to the schedule of their caregiver. In terms of ICF classifications, these self-care activities include washing oneself – d510, caring for body parts – d520, toileting – d530, dressing – d540, eating – d550, drinking – d560, and taking medication – d570.

- **Mobility:** Living independently at home becomes extremely difficult as one is not mobile any more. Mobility concerns the following ICF activities: walking inside – d450, climbing stairs – d4551, sitting & getting up – d410, lifting and carrying objects – d430, and bending – d4105. Mobility problems can also make other activities problematic (e.g. opening the front door or shopping).
- **Social isolation:** Social isolation is caused by the decrease or even lack of activities concerning interpersonal interaction and relationships – d7.

A combination of the results from the focus group meetings and the two studies mentioned in the Section II is shown in Table II. The numbers in the fourth column refer to the ranking in the top 10 of the most problematic activities of elderly

TABLE II. OVERVIEW OF THE ACTIVITIES IDENTIFIED (SHADED) IN THE LITERATURE AND FOCUS GROUP MEETINGS THREATENING THE INDEPENDENT LIVING OF ELDERLY PERSONS IN ORDER OF ICF NUMBER.

Problematic activities	ICF	Literature		Focus groups
		SRS [7]	Crützen et al. [8] ^a	
Reading	d166			
Changing basic body position	d410		6	
Bending	d4105		7	
Lifting and carrying objects	d430			
Reaching	d4452		10	
Walking	d450		1	
Climbing stairs	d4551		2	
Washing oneself	d510		4	
Caring for body parts	d520			
Toileting	d530			
Dressing	d540		5	
Eating	d550			
Drinking	d560			
Taking medication	d570			
Shopping	d620		8	
Preparing meals	d630		9	
Doing household	d640		3	
Interpersonal interaction and relationships	d7			

^a. The numbers in this column refer to the ranking place within the top 10.

people of this study. The results of the focus group meetings show great overlap with both of these studies concerning activities within the domain of mobility– d4, self-care – d5, and also for interpersonal interaction and relationships – d7. The activities shopping – d620, preparing meals – d630, and doing household – d640, were mentioned in the literature, but were not ranked as being a high priority in the focus group meetings as current solutions were sufficient. An example is the activity preparing meals – d630, which is discussed above.

V. DISCUSSION

There is no single activity that can be singled out as the main activity causing elderly people to lose their independence. The focus group meetings identified activities concerning mobility – d4, self-care – d5, and social isolation – d7 as the problematic activities with the highest priority. These activities were also found in the literature, however only problems concerning mobility – d4 and self-care – d5 were found in both the SRS [7] and Crützen et al. [8] studies.

These studies also found that domestic activities (shopping – d620, preparing meals – d630, and doing household – d640) were problematic. While these activities were also mentioned during the first phase of the focus group meetings, nevertheless none of these were assigned a high priority at the later stage of the meetings. Problematic activities concerning social isolation (d7) were found in both the focus group meetings and in the SRS study [7]. However, it is unclear if the focus of the Crützen et al. study [8] was only on physical individual activities and therefore would not consider problematic social activities.

The focus group meetings provided valuable insights into those problematic activities in the daily life of the elderly which threaten their independence the most. The ranking of the most problematic activities turned out to be difficult for some participants. This was often caused by the inherent multidimensional nature of these problems. Participants who were unable to pick one problem at the end of the meeting were asked to answer the following question: *If we are going to create something to solve one of these problems, which problem should we solve first?* The prioritization of the activities in the focus group meetings was based on the input of elderly people, formal caregivers, and informal caregivers. This was also the case in the study of the SRS project [7], but in the case of the Dutch study [8] only elderly people were consulted.

Overall, elderly persons experience similar physical and mental decline everywhere. Differences in both the way care is provided and the range of activities that is supported by public care provision in the three different countries made the recruitment of groups in all three countries necessary. It was expected that these differences would influence the problems experienced and reported by the participants. This expectation was not met by the results; in general, there was a high degree of consensus between the focus groups in the different countries. There were, however, some minor differences between the countries. The focus in the UK was somewhat more on disabilities (e.g. physical and psychological limitations) rather than activities. In France the problem concerning the coordination of care was quite prominent, while this was not mentioned in the Netherlands or the UK. Further,

the focus group meetings in three countries were all moderated by different facilitators, resulting in some variations in the adopted method. This introduced some difficulty in performing the final step in prioritizing the activities between the countries. Nevertheless, the results between the three countries were in line with each other and therefore one list of problems could be created.

The group sizes between the countries varied considerably. The majority of the participants participated in the focus group meetings in France. However, because the results between the countries showed sufficient overlap, the underrepresentation of the UK and the Netherlands was not a serious threat to the validity of the data analysis. Further, the inclusion criteria selection for the participants of the three different user groups was intentionally rather broad. This allowed for a diverse group of participants whose combined insights are more representative for the general population than if more narrow inclusion criteria were applied. The results of this study can be seen as representative for a wide range of elderly persons. The only group excluded were elderly people with cognitive impairments, who do form a large and growing group. For this group a different set of activities will prove to be a threat to independent living.

The results of the focus group meetings show great overlap with the earlier studies. This overlap strengthens the results, indicating what the most important areas for the application of robots supporting independent living are. However, this identification of problematic activities for elderly does not necessarily imply that these problems can or, even should, be solved by robotic solutions. For some of the problems in these areas, robots can offer advanced solutions not available through less advanced technologies, but for other problems, less advanced technologies may well be sufficient to provide adequate solutions. It may be more obvious to support mobility problems (e.g. transfers) and self-care activities (e.g. dressing, washing, toileting) than activities with the social isolation domain when considering the possible advantages of robotics (e.g. its ability to move, the possibility to physical support activities). If a specific activity related problem requires none of the advantages of a robot, other technological solutions should be preferred in seeking a solution (e.g. ICT technology). However, findings from the application of social robotics (e.g. Paro [11]) demonstrate that there are successful robot applications possible focusing on social isolation.

If we want to improve the home care situation in the future, we need to start from the current care situation, and not limit our focus to the current technical possibilities/limitations of today's robotic technologies. Approaching the development of a service robot from a care perspective, and not a technical one, results in different priorities. Besides, the added value of the use of a robot, when considered against the expected market potential would also play a role in the final selection.

VI. CONCLUSION

These findings have made it apparent that it is impossible to find **the** single activity that threatens the independent living of the elderly and leads to institutionalization, when it becomes problematic. The decision to enter an elderly person into residential care is often the result of a combination of problems

and also influenced by the wishes, and social environment of the elderly person. From both the literature and the focus group meetings we think activities within the activity domains mobility – d4, self-care – d5, and social isolation – d7 can be seen as those most threatening the independent living of elderly people. It is important to note that not all activities within these three domains are necessarily best solved by robotics.

Most service robots developed so far, seem to have been guided by technical feasibility, resulting in many cases of robots in the role of information or provider or cognitive prosthetic. However, information or reminders do not resolve the problematic activities identified by the elderly people and their carers these focus groups. The development of future service robots for the elderly based only on technical feasibility is not sufficient. Instead, the focus should be on the care and user need perspective. Developing robotic solutions to address problematic activities of elderly persons (e.g. washing, toileting, dressing, transfers), presents major (technical) challenges as the population represented by our sample would mainly benefit from robots supporting physical tasks. In addition, the needs of the end-user is only one variable to consider in the development of a robot for elderly people. In order to create a successful robot, the influence of the current care support available for elderly persons (e.g. home care support, the supply of institutional services) must be considered too.

In terms of achieving robotic solutions in the indicated domains, it seems that focusing on solutions with narrow functionalities is a strategy that may lead to faster success rather than looking for an all-encompassing service robot solution capable of many tasks. The ACCOMPANY project has selected a basic fetch and carry task as functionality (related to the activity domains mobility – d4 and self-care – d5) and will develop robot behavior, both functional and social to effectively deliver this functionality. We hope that this list of activities that the elderly themselves and their carers consider the most vital, will serve both as an inspiration and a wish list for future robot development.

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