Agile Co-Creation for Robots and Aging (ACCRA) Project: new technological solutions for elderly

D'Onofrio Grazia, Fiorini Laura, de Mul Marleen, Fabbricotti Isabelle, Okabe Yasuo, Hoshino Hiroshi, Limosani Raffaele, Vitanza Alessandra, Greco Francesca, Giuliani Francesco, Guiot Denis, Senges Eloïse, Kung Antonio, Cavallo Filippo, Sancarlo Daniele, Greco Antonio

Correspondence:

Complex Unit of Geriatrics, Department of Medical Science,

IRCCS Casa Sollievo della Sofferenza,

Viale Cappuccini 1, 71013 San Giovanni Rotondo, Foggia, Italy

Tel. and Fax: +39 0882 410271

Email: g.donofrio@operapadrepio.it

Abstract

Introduction: Worldwide population is getting older. The elderly persons want to stay independent and wish to increase their engagement in social activities in order to tackle loneliness, depressions and isolation. The aim of ACCRA (Agile Co-Creation for Robots and Aging) is to enable the development of advanced ICT Robotics based solutions for extending active and healthy ageing in daily life by defining, developing and demonstrating an agile co-creation development process.

Methods: ACCRA robotics solutions will be designed and developed to be tested in three different domains: mobility, daily life, socialization support in four countries (i.e. France, Netherlands, Italy, and Japan). The proposed approach identifies four different phases: 1) Needs analysis, 2) Agile co-creation, 3) Experimentation, and 4) Sustainability analysis. Currently, the first two phases were completed. The elderly recruitment are the following. 1) The recruitment inclusion criteria for Mobility were: age ≥ 60 years, and presence of mobility issues assessed by Elderly Mobility Scale (EMS) with a score > 13; 2) the recruitment inclusion criteria for Daily Life were: age ≥ 60 years, and presence of difficulties engaging in housework assessed by Autonomie Gérontologie Groupes Iso-Ressources (AGGIR) with a GIR score ≥ 4; 3) the recruitment inclusion criteria for Socialization Support were: age ≥ 60 years, and absence or mild level of cognitive impairment assessed by Mini Mental State Examination (MMSE) with a score ≥ 24.

Results: The needs analysis and first co-creation sessions focus attention on the experience of elderly in the four countries. Preliminary results show how, in all the pilot sites, many expectations were raised from elderly, formal and informal caregivers about the application of the technology into their life. Minor concerns exist about privacy and real efficacy and modularity in a real world environment. Overall, it was recorded a good attitude towards the use of technologies to live an

independent life. Moreover, the elderly engaged in our studies showed a great interest to be involved actively in the developing phase of something built based on their needs.

Conclusions: The availability of new solution to increase independence and increase quality of life in a sustainable manner appear to be mandatory in the actual society considering the actual socio-economic situation over the industrial countries.

Introduction

In the next thirty years, the worldwide elderly population is expected to increase from 900 million to 2 billion people [1]. The probability of a parallel increment of diseases and subjects with a functional impairment will be incredibly high and the sustainability of the entire health care system will be a crucial argument of discussion in the near future.

Latest tendencies focus the design of acceptable and usable products on specific stakeholders needs. In general, elderly persons want to stay independent and in close contact with their families. They do not want to be considered as a burden for society and wish to increase their engagement in social activities in order to tackle loneliness, depressions and isolation.

Particularly, the compliance to the therapies have a crucial impact on subjects with chronic diseases and often, the consumption of multiple drugs per day and the use of different devices, make the process very difficult.

Potentially new technological approaches, also based on robotics, might be an effective answer to these growing needs and demands. Actually, some evidences begin to arising regarding their usefulness [2, 3].

In particular, several researches outlined remarkable reactions of interest from the elderly involved in experimentations with assistive robots, especially for the impact in support activities, cognitive stimulation, inclusion and reduction of loneliness [4, 5, 6].

Social robotics rises to the challenge of designing robots able to perceive the needs and feelings of users with adaptation intentions. It is plausible that, under this perspective, if robots were able to show these skills, they would be accepted as social companions without any doubts. With these assumptions in mind, the project called Agile Co-Creation for Robots and Aging project (ACCRA) was proposed. It involves four countries (i.e., France, Netherlands, Italy, and Japan) and it is funded

by European Union-Japan cooperation with the aim to enable the development of advanced ICT Robotics based solutions for extending active and healthy ageing through an agile co-creation development process. The peculiar aim is to define a specific standard in the development methodology to improve and maintain the level of autonomy, while simultaneously promoting the maintenance of social ties of the elderly people with loss of autonomy.

Methods

Definition of scenarios

The proposal is applied on three different scenarios: 1) Mobility, 2) Daily Life and 3) Socialization Support. During the project, some applications and services will be developed using two different robots: *(a)* ASTRO robot [7] to provide both physical and non-physical support and, *(b)* Buddy robot able to offer socialization and daily life support.

The *Mobility Application* (involved pilot sites: Netherland and Italy) essentially consists in support and coach for walking; in particular, the ASTRO robot should help users to stand up and walk (i.e., physically as a coach) contributing to maintain the walking capacity. These applications are focused on people with high risk of falls or post-stroke rehabilitation.

The *Daily life Application* (involved pilot sites: France and Netherland), instead, tries to promote well ageing in activities in daily life. The companion robot (i.e., Buddy robot) helps users on housework for promoting independence (e.g., taking decisions or reminding medications, cooking, eating, washing, monitoring hydration, improving social links, etc...) and for detecting potential risks of autonomy reduction.

Finally, the *Socialization Application* (involved pilot sites: Italy and Japan) enables rich and diversified Communication channels (e.g., remote video conferences, sharing photos, playing games, etc.) to induce conversation rehabilitation focused on creating interaction schemes with elderly people in a process similar to physical rehabilitation, where medical professionals give rehabilitative exercises to the patients.

Socializing and keeping conversations (also through a virtual community), maintaining a quality link with the caregivers despite the distance, conversation rehabilitation to engage people in conversational activities, besides the use of companion robots with verbal interaction capabilities

are some of the services goals of the project for promote a well independent living. Simultaneously, those activities may induce both entertainment and challenging interactions based on their intellectual curiosity (i.e., preferences and psychological profile) [8].

ACCRA Methodology

This section provides a more detailed description of the methodology used for the different ACCRA scenarios.

The ACCRA methodology for design and evaluation of technology in the context of ageing well brings together expertise from robotics, software development, marketing, health services research, and health economics, which is the peculiarity of the proposed approach.

It can be considered as a scientific approach, which aims to become a framework of conducting researches, taking into account and identifying the needs of the elderly people experiencing loss of autonomy, positioning them and their caregivers in the heart of the creation process. Specifically in the project, the methodology shall use a strategy to co-create robotic solutions that meet the users' needs to evaluate their daily use and to measure the sustainability of the built ACCRA solutions.

The proposed approach identifies four different phases (i.e., steps), as synthesized in Figure 1:

1. ***Needs analysis***: identifying needs and investigating the context for each applications uses.
2. ***Agile co-creation***: developing of the robotics solutions in conjunction with the elderly, the informal and formal caregivers, using agile programming tools.
3. ***Experimentation***: wide-scale testing the robotics solutions in a real context.
4. ***Sustainability analysis***: defining the potential market interest and assessing the impact of built robotics solutions on the health system.

Currently, the first two phases were completed.

The purpose of the needs analysis is the identification of desires and behaviors of the elderly in loss of autonomy based on a qualitative approach consisting of in-depth interviews. Indeed, their needs are essentially related to the physical and physiological disorders due to functional decline and chronic diseases. By placing all the figures involved in the center of the innovation process, the aim

of the entire project is to design robotic solutions and services offering that effectively meet needs, expectations and uses of elderly people with loss of autonomy and/or social isolation and their caregivers. The participation of all involved figures helps to improve the robotic solution and services by proposing concrete optimization solutions, perceived as operational by both the elderly people, family and professional caregivers and finally robotics technicians.

This approach is strategic and the introduction of working groups, named *co-creation groups*, which work together during common co-creation sessions, formalizes this social innovation [9, 10] in the ACCRA project. Indeed, researchers in social innovation show how involving the diversity of actors in the innovation process with an active participation of users are essential features in the creation and implementation of new solutions. This mechanism tries to provide a more complete representation of the problems, causes and possible solutions to better deal with the identification of individual issues by developing better solutions. This finally encourages the implementation of the identified solutions [11].

The study of needs and the co-creation meetings were performed by some relevant care organizations. Specifically, the WVO Zorg in Vlissingen (Netherlands), the Complex Unit of Geriatrics of IRCCS "Casa Sollievo della Sofferenza" in San Giovanni Rotondo (Italy), CCAS in Antibes (France), at Fukuzuen (social welfare corporation, located in Aichi pref. Japan) and Kyoto lighthouse Suzaku dorm (elderly general welfare center, located Kyoto pref. Japan).

For what concerns the co-creation sessions, the participants (i.e., elderly people and formal/informal caregivers) are recruited by the different care organizations, explaining what the session's aims are through informational letters and brochures about the project. The elderly recruitment reflects some specific inclusion criteria for participation.

The recruitment inclusion criteria for Mobility were: 1) Age $\geq$ 60 years, and 2) Presence of mobility issues assessed by Elderly Mobility Scale (EMS) with a score > 13 [12]. The recruitment inclusion criteria for Daily Life were: Age $\geq$ 60 years, and 2) Presence of difficulties engaging in housework assessed by Autonomie Gérontologie Groupes Iso-Ressources (AGGIR) with a GIR score $\geq$ 4 [13].

The recruitment inclusion criteria for Socialization Support were: 1) Age ≥ 60 years, and 2) Absence or mild level of cognitive impairment assessed by Mini Mental State Examination (MMSE) with a score ≥ 24 [14].

The informal caregiver were recruited according to the relationship with the subjects involved in the study. The formal caregivers were recruited on the basis of their elderly caring experience.

Each sessions in general take several hours and are recorded either entirely or partially. All participants were required to sign three consent forms before participation: consent for participation, consent for sharing the recorded material with other consortium members and a consent form for using the recording material for public purposes (publications, dissemination goals). Moreover, the sessions are hosted in native language to ensure a total comprehension. The observation and annotation of the participants' ideas, inputs for robot improvements and any criticism are the key points for the service optimizations.

Results

All recruited participants are summarized in the Tables 1, 2 and 3 according to different scenarios.

Needs analysis

The needs analysis objective was to prioritize the needs and robot services of interest of the 3 types of respondents (elderlies, formal caregivers and informal caregivers).

The results achieved by the need analysis are described according to different ACCRA scenarios, as shown below.

1) Mobility: the results revealed four categories of needs from the perspective of the older persons: instrumental needs, rehabilitation needs, personal safety and activities of indoor daily life. Complementary, three categories of caregivers needs were also distinguished: instrumental needs, rehabilitation monitoring needs and check-up needs. The highest percentage of participants, both older persons and caregivers, showed a positive expectation towards service robotics. Additionally, from the robotics point of view, the robot abilities that should be developed in the next years deal with motion, interaction, manipulation, decision support and perception abilities.

2) Daily life: in Netherlands, the needs among the elderly were classified in three groups: daily life needs, technical and miscellaneous needs, and physical mobility needs.

In France, nine categories of needs are proposed, by order of priority: needs for companionship, safety needs, communication needs, well-being needs, entertainment needs, meal needs, forgetfulness and loss, buying needs, and dressing-up needs.

The general acceptance level and perception of the robot is decent among the elderly and caregivers samples. There is interest in the robots and they believe that the robot can be useful. Particularly,

the safety and reminding services are appreciated. In addition, the elderly people believe that the robot could be a nice companion in their daily life.

3) Socialization support: the common needs were categorized in three groups: Communication; Emotion detection and Safety. The Italian elderly participants have also reported as priority need the Cognitive stimulation, whereas, the Japanese participants have reported the travel, fashion/golf. In addition the Italian caregivers had expressed other needs: from the formal caregivers' perspective the robot could provide monitoring the patients, whereas from the informal caregivers' perspective the robot could offer reminders to take the medicine and eat/drink at specific times of the day and support in simple meal preparation, improving and optimizing the time care. The general robot acceptance level is good and the perception is positive among the participants in the pilot sites.

First co-cocreation

Starting from the evaluation of the needs through questionnaires, the first co-creation sessions focus attention on the experience of elderly in the four countries. Preliminary results show how, in all the pilot sites, many expectations were raised from elderly, formal and informal caregivers about the application of the technology into their life. Minor concerns exist about privacy and real efficacy and modularity in a real world environment. Overall, it was recorded a good attitude towards the use of technologies to live an independent life. Moreover, the elderly engaged in our studies showed a great interest to be involved actively in the developing phase of something built based on their needs.

During the meetings, the participants were asked for their initial impression on first glance about generic topics, for example, on the ergonomics and the general qualities of robots.

The first co-creation sessions shown some mixed feelings about robots. Even if it was not asked explicitly, from impressions arises that all participants believe the use of robots useful to support elderly and their caregivers. Sometimes, these expectations are beyond the actual capabilities and the aims of the robots and some suggested services would require more capabilities at higher-level.

In particular, the specific results were shown in the different scenarios:

1) Mobility: in Dutch and Italian pilot sites, 4 robot services were explored by the participants (walking and guidance, exercise, safety and reminders and monitoring). For the first co-creation session there were some mixed feelings about ASTRO. It was not asked explicitly, but the parcipants do believe that the robot could be useful to support elderly and the caregivers. However, they had larger expectations for the robot. However, these expections are beyond the actual capabilities and the aims of the robot. Some services would require the robot to have hands, e.g. handing over medications, performing injections.

2) Daily life: in French pilot site, the tested services are company, protection/security (falls, medication and appointment reminders, good practice reminders), communication (telephone and video calls, reception and sending photos, videos and drawings), and collective animations. The completeness of the offer is a strong vector of positive evaluation. Very high demand was for voice commands (without this, low added value compared to the services available on the internet and on tablet / phone). This is all the more important since the robot is considered too low for tactile controls (difficulty for older people to bend over) and the screen is too small to ensure good visibility. At the Dutch pilot site, the tested services are were divided into 4 themes (companion robot, protection/security, online communication, and entertainment. The participants were more interested in what the robot could do instead of what it should be able to do to fulfill their needs.

3) Socialization support: in Italian pilot site, 7 robot services were explored by the participants (Communication assistance, Protection-Assistance, Protection-Prevention, Protection-Reminder, Entertainment, Collective animation, Companionship). In Japanese pilot site, 3 robot services were explored (Travel & Fashion/Golf support needs, Promote conversation, Emotion detection). All themes were viewed as important and therefore for the next co-creation session improvements should be made in each of the themes. Overall, all the services were viewed as useful, but optimizations are required in order to improve the perception of the robot's performance. For many of the participants the added value was still difficult to determine.

Conclusion

The capability of the robotic technology to improve the life of an elderly appears an objective to reach as soon as possible, considering the demographic shift, the economic constraint and societal changing. The era of AI exploited for socially useful tasks is arriving, since these needs have lead to the development of the emerging interest in the use of Robotics and Artificial Intelligence in Health care. Working in this direction, many are the questions to be addressed as: privacy, the human-robot interaction, the robot acceptability, the economic implications and security. These are not to be considered as barriers but, interesting challenges in which all figures are called to participate in order to promote a sustainable and ethical scientific progress. The use of the robot could be considered from a new care perspective to be an opportunity to release more time to care.

Moreover, including cognitive supports in the design of technological products for domestic assistive services, can be more useful in terms of living independently both at home and in the community. Clearly, it is really difficult to imagine how could an entire society change by the introduction of robots (e.g., humanoid robots) capable to accomplish any work but, up to now, we are focusing our attention on robotic tools that represent something of really different from that idea and which might improve the life of many subjects affected of disabilities.

Figure 1. ACCRA Methodology plan.

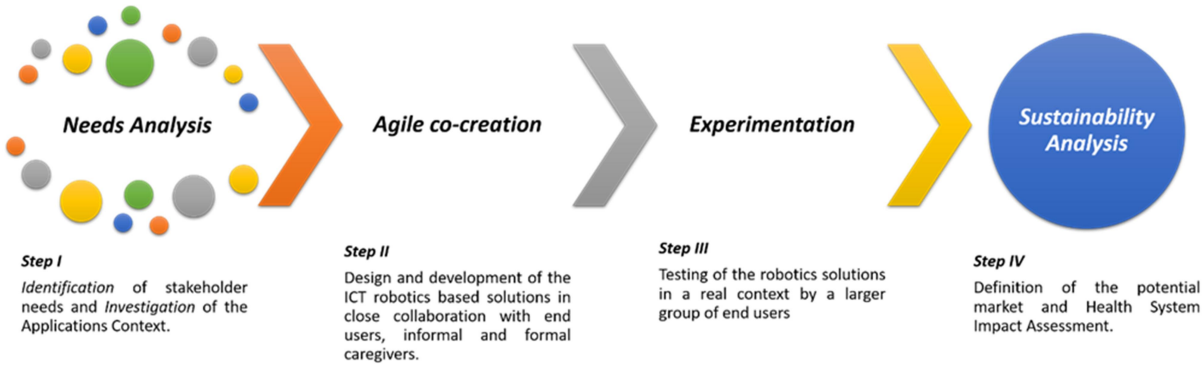

Table 1. Mobility application – Recruited participants.

Country	Activity	Elderly	Informal caregiver	Formal caregiver	Total
Italy	Needs Interview	10	15	15	40
	1° Co-creation	6	3	6	15
Netherlands	Needs Interview	10	-	4	14
	1° Co-creation	4	2	5	11
	Total	30	20	30	80

Table 2. Daily life application – Recruited participants.

Country	Activity	Elderly	Informal caregiver	Formal caregiver	Total
France	Needs Interview	10	1	10	21

	1° Co-creation	8	2	2	12
Netherlands	Needs Interview	10	3	6	19
	1° Co-creation	5	1	5	11
	Total	33	7	23	63

Table 3. Socialization support application – Recruited participants.

Country	Activity	Elderly	Informal caregiver	Formal caregiver	Total
Italy	Needs Interview	10	15	15	40
	1° Co-creation	7	2	1	10
Japan	Needs Interview	7	3	3	13
	1° Co-creation	3	-	6	9
	Total	27	20	25	72

References

[1] World Health Organization. “Mental health of older adults”. Posted December 2017. http://www.who.int/mediacentre/factsheets/fs381/en/. Accessed May 27, 2018.

[2] J. Broekens, M. Heerink, H. Rosendal. “Assistive social robots in elderly care: a review”. Gerontechnology 2009; 8(2):94-103.

[3] A. Sharkey and N. Sharkey. “Granny and the robots: Ethical issues in robot care for the elderly”. Ethics and Information Technology, 14(1):27–40, 2012.

[4] I. Iancu and B. Iancu. “Elderly in the Digital Era. Theoretical Perspectives on Assistive Technologies”. 5, 2017.

[5] Y. Lin, H. Chu, C. Y. Yang, Ch. H. Chen, S. G. Chen, H. J. Chang, C. J. Hsieh, and K. R. Chou. Effectiveness of group music intervention against agitated behavior in elderly persons with dementia. International Journal of Geriatric Psychiatry, 26(7):670–678, 7 2011.

[6] J. Broekens, M. Heerink, and H. Rosendal. Assistive social robots in elderly care: a review. Gerontechnology, pages 94–103, 2009.

[7] F. Cavallo, M. Aquilano, M. Bonaccorsi, R. Limosani, A. Manzi, M. C. Carrozza, and P. Dario. “On the design, development and experimentation of the ASTRO assistive robot integrated in smart environments”. In 2013 IEEE International Conference on Robotics and Automation, pages 4310–4315, May 2013.

[8] G. D'Onofrio, D. Sancarlo, D. Seripa, F. Ricciardi, F. Giuliani, F. Panza, and A. Greco. Non-pharmacological approaches in the treatment of dementia. In Davide Vito Moretti, editor, Update on Dementia, chapter 18. InTech, Rijeka, 2016.

[9] Taylor, J. B. (1970), 'Introducing Social Innovation', The Journal of Applied Behavioral Science. Vol.6:1, pp. 69–77

[10] Harrisson, D., et Vézina, M. (2006). "L'innovation sociale : une introduction". *Annals of Public and Cooperative Economics*, 77, 2, 129-138.

[11] Cloutier, J., et CRISES. (2003). Qu'est-ce que l'innovation sociale ?, Crises.

[12] YU , M.S.W., CHAN, C.C.H. & TSIM, R.K.M. (2007) Usefulness of the Elderly Mobility Scale forclassifying residential placements Clinical Rehabilitation; 21;1114–1120.

[13] Aguilova L, Sauzéon H, Balland É, Consel C, N'Kaoua B. [AGGIR scale: a contribution to specifying the needs of disabled elders]. Rev Neurol (Paris). 2014 Mar;170(3):216-21.

[14] Folstein M, Folstein S, McHugh PR. Mini-mental state: a practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12:189–198.