ICT Services and Robotics: The SocialRobot Solution*

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Abstract— **Most elderly people prefer to live independently, for as long as possible, in their preferred environment. Nowadays, the predominant care model for supporting elders living alone at home is based on informal carers' assistance (i.e., relatives, friends, neighbours, etc.). Considering the shifting demography of the elderly population, this model is expected to pose major challenges both in the economy as well as the society. To address these challenges, there is growing attention for assistive technologies to support seniors stay active and independent for as long as possible in their preferred home environment. ICT and Robotic systems are among those initiatives. The work presented in this paper is based on the context of the Social Robot project and focuses on presenting the integration of ICT and Robotic technologies as a trigger towards 'Positive Ageing'. 'Positive Ageing' seeks to take a balance approach between addressing the opportunities and challenges of an ageing society rather than seeing the increase in longevity as a burden and a threat.**

I. Introduction

There is an important recognition of the ageing population in Europe with projections that, by 2050, the number of people in the EU aged 65 and above is expected to grow by 70% and the number of people aged over 80 by 170%. Moreover, improvements in welfare and medical care will allow life expectancy in Europe's population to increase, which is of course a positive result, however with the overall population to age. This will raise new challenges and opportunities for healthcare technologies of the 21st century:

- Meet the higher demand for health care,
- Adapt health systems to the needs of an ageing population while keeping them sustainable in societies with smaller workforce and
- Having an older but healthy workforce will become essential since younger people will have to work longer to relieve the financial burden on society.

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ICT and Robotics are among those technologies offering functionality related to the support of independent living, monitoring and maintaining safety or enhancement of health and psychological well-being of elders.

The work presented in this paper is based on the context of the Social Robot project, funded by the FP7 Marie Curie Programme IAAP, and focuses on presenting the integration of ICT and Robotic technologies as a trigger to towards 'Positive Ageing'. 'Positive Ageing' seeks to take a balance approach between addressing the opportunities and challenges of an ageing society rather than seeing the increase in longevity as a burden and a threat.

II. Robotics and ICT Technologies

Robotics and ICT technologies are being taken up by the market as health and social care profitable solutions in terms of deliverance and efficiency [1]. Robotics and ICT technologies can support older people (1) at work, by enabling them to stay active and productive for longer and experience better quality of work and work-life balance, (2) in the community, in overcoming isolation and loneliness, keeping up social networks and accessing public and private services, and (3) at home by offering them in a better quality of life for longer, and promoting their independence, autonomy and dignity. These technologies can address daily and independent living such as:

- **Social communication for overcoming social isolation**: easy access to phone and video conversation, group activities;
- **Daily shopping, travel, social life, public services**: easy access over the internet to order goods and services online, when reduced mobility makes these activities difficult;
- **Safety**: making sure that doors and windows are locked when leaving the house; checking for water or gas leaks;
- **Telecare and telemedicine** with new opportunities for providing medical care at home
- **Personal health systems** for monitoring and diagnosis, fall prevention, therapy;
- **Support for people with cognitive problems** to stay at home and remain active for as long as possible: cognitive training, r**eminders** (taking medication, fulfilling household tasks, attend to prescheduled activities), GPS tracking.

Using ICT and robotic technologies to improve monitoring and assistive services has been target of keen research by different groups and with a strong support of the European Commission. In fact, the EU funded different specific research programmes, such as the Ambient Assisted Living – Joint Programme, amongst others. One major research branch has been the development of mobile robotic platforms for assistance and monitoring. This study covers all the aspects of service provision, from the technological

*Research supported by the Social Robot project, (FP7 IAPP Marie Curie Programme 2011; Grant agreement no.: 285870)

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considerations to the end-user feedback, so as to define the requirements and measure the usability and acceptability of these systems.

Some examples of these projects are MOBISERV [2], which developed a robot to support the daily living of seniors focusing on health, nutrition, well-being and safety, including the capability to monitor vital signs or detecting falls. The KSERA [3] aimed assisting elderly with Chronic Obstructive Pulmonary Disease through monitoring their psychological, behavioural and environmental data and providing embedded entertainment. FLORENCE [4] aimed to improve the well-being of the elderly by providing connectivity, reminding, fall detection, encouraging activities, gamming and interface with some home devices. Other notable technological mentions on the field of assistive service robots are the Companionable [5], the Echord – Astromobile [6], the Care-O-Bot [7] and the Robot Maid [8].

The market of ICT and Robotics for ageing well, while growing fast, is still in a pre-mature phase and does not yet fully ensure the availability of the necessary solutions. Currently there are a number of research activities related to the development of robot systems to be used for elderly care at home. However, most of them are not yet addressing the important factors of user acceptability, usability and affordability, handicapping thus their adoption in the market.

SocialRobot is a project aiming to provide solutions to key issues of relevance for improved independent living and Quality of Life (QoL) of elderly people and efficiency of care. The first objective, is to gain a good insight in the main problems that elderly are facing, related to their independent living and social interaction. Emphasis is given on the three key factors of user acceptability, usefulness and affordability of a robotic solution, aiming to promote its acceptance by the users, and eventually its adoption in the market. In order to reach its main goal in fulfilling the achievement of these three key factors, the SocialRobot project brings together the Robotic and Computer Science fields by integrating state-of-the-art Robotic, ICT and Virtual Social Care Communities technologies.

III. The SocialRobot System

The SocialRobot project focuses on providing solutions to key issues of relevance for improved independent living and Quality of Life (QoL) of elderly people and efficiency of care. It follows a user driven approach and considers the elder as an active collaborative agent able to make personal choices and adapt the care model to his/her lifestyle, personalized needs and capabilities changes over the ageing process. Emphasis is also given in supporting the elders to maintain their self-esteem in managing their daily routine at home, by addressing the elders' security, privacy, safety and autonomy.

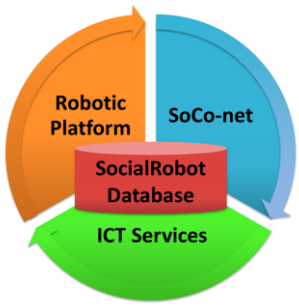

Figure 1. SocialRobot Integrated Components.

Figure 2. SocialRobot Robotic Platform Outshell

A. The SocialRobot Robotic Platform

The SocialRobot's Robotic platform consists of a 2-wheel robotic base, with a structure body and a robotic head and integrated sensors: cameras, a Kinect sensor and laser range finders. During the design of the platform the development of an appealing robot with the appropriate size, colour and sound (i.e,, speech, notification sounds, etc.) was considered, so as to be easily accepted by the elderly end users (see Figure 2). Also in order to reach affordability, during the design and development of the system, focus was given only to the functionality with the highest priority extracted based on the user requirement analysis. In Figure 2, the initial version of the outer shape of the robot is presented. The inclusion of some other devices, including for example a touch screen (i.e., a tablet) on the chest of the robot, can lead to some changes from this initial form. The SocialRobot's Robotic platform provides, for an end-user, adaptable multi-modal interface (text, voice, images, video, etc.) supporting an affective and empathetic user-robotic interaction. The design takes into account the capabilities and acceptance by elderly users, their needs in terms of functionality, as well as security and privacy issues. The main features provided by this platform are behaviour analysis, facial expression analysis, audio visual synthesis, speech and gesture recognition as well as tracking and navigation in indoor environments.

B. The SocialRobot ICT-based Services component

In SocialRobot, ICT-based services are developed to support rapid, low-cost composition of applications offering the functionality needed by the system, directly or indirectly, and allowing users to interact with it without focusing on underlying technicalities. The SocialRobot ICT-based services are grouped into cohesive physical units, which we call packages. Each package contains a set of services addressing the specific user requirement and performs functions, which can be anything from simple requests to complicated processes. The three major packages of SocialRobot services are the Care & Wellness, Guidance and Mobility Monitoring.

Provided Care & Wellness services are for example:

- Physical activity service which correlates/maps a challenging and realistic physical activity schedule for the elderly based on the individual's actual physical and psychological status.
- Group leisure activities service that assists the elderly to create meeting groups to share leisure group activities with the other members in his/her Virtual Care Team (VCT).

Provided Guidance services are for example:

- Daily Routine Monitoring and Assistance, that provides to the elderly explanations on how to perform different daily activity tasks.
- Cognitive failure assistance that provides memory help reminders to the elderly (i.e., take his/her mandatory accessories before leaving home like eye-glasses or medication, remind him/her about planned activities or appointments, etc.).

Provided Mobility Monitoring services are for example:

- Detection of immobility in order to assist the elderly in case he/she finds himself/herself in a situation where he/she is lost, not knowing what to do.
- Daily activity follow up service which allows a caregiver to follow up of the elder's activities to monitor and contact the elder at any time during the day and enquire variations in the schedule (e.g., delay or absence from a meeting, etc.).

C. The SocialRobot Virtual Social Care Community (SoCo-net) component

The SocialRobot's Virtual Social Care Community (SoCo-net), is an elderly centric, web-based virtual collaborative social community network that constitutes a core component of the solution. SoCo-net builds Virtual Care Teams (VCTs) around the elderly person consisting of people of different ages (young and old) and roles (relatives, friends, neighbours, care professionals, etc.) that can assist, collaborate and actively communicate with elders to improve their daily life in an ad-hoc and informal way through the use of assistive mobile wireless technologies. Moreover, it maintains unique personalized profiles for the elders composed of disabilities and abilities, special needs and preferences promoting thus personalized care provision.

D. The SocialRobot solution Innovation

SocialRobot targets to achieve technical innovation related the following areas: (1) Navigating indoors and in unstructured environments, (2) Human-robot interaction (emotion recognition, intelligent dialogue), (3) Monitoring and behaviour modelling considering the related context of daily routine occurrences of the elderly as they age, (4) Robot-human learning and understanding, (5) An innovative end-user personalized and adaptable multi-modal contact-less channel of communication between the user and the robot which enables facial expression and gesture analysis capable of understanding pointing gestures by hand, processing of basic vocal commands and confirmations and analysis of emotions.

IV. A USE CASE SCENARIO

To better illustrate the capabilities and functionality offered by the SocialRobot solution, we present a use case scenario from the many developed within the scope of the project. The scenario takes place in the facilities of a care centre, where elderly live in individual apartments and share common spaces.

Scenario Description	***Required Component***	***Service Requirements***
(…) Now with the presence of the Social Robot, half an hour before the meal, Social Robot considers the menu and the meal preferences of each elder. By comparing the menu and the meal preferences of Andreas, Marios and Antonis, Social Robot noticed that Andreas does not like the menu but Antonis and Marios love it.	***ICT & SoCo-net***	***1 Daily Routine monitoring and assistance*** ***2. Preference Assessment*** ***3. Task Guidance***
SocialRobot goes to the room of Andreas, Antonis and Marios	***SoCo-net & Robotic***	***1. Profile Information*** ***2. Localization*** ***3. Navigation***
SocialRobot informs them about the menu, and save Andreas from walking in the eating room and also reminds Antonis and Marios not to skip the dinner because the food today is their favourite. The three men were discussing that the care staff is so overloaded with the more severe	***Robotic***	***Human-Robot Interaction:*** ***1. Face Recognition*** ***2. Speech Analysis*** ***3. Speech Synthesis***

sick people in the centre, that they always ignore them thinking that they can still do most of the things alone and that only Social Robot looks for them. (...)		

V. SocialRobot and Positive Ageing

SocialRobot solution embraces and adopts the 'Positive Ageing' approach which seeks to take a balanced approach between addressing the opportunities and challenges of an ageing society rather than seeing the increase in longevity as a burden and a threat. It seeks to focus on the ways in which lifestyle, attitude, and skills can be supported and changed to create a better quality of life for all older people. The benefits of a positive ageing approach are clear and could include good health, independence, intellectual stimulation, self-fulfilment and friendship.

It encompasses the various concepts of 'active ageing', 'successful ageing', 'healthy ageing', and 'productive ageing' which in turn are linked to good health, financial security, having a positive attitude to life, engagement with an activity or with society, feeling connected to and supported by families and friends, and living in a place with which they are familiar.

SocialRobot solution rejects the 'disengagement' theory of ageing, which suggests that adjusting to old age requires a withdrawal by the individual from society and instead promotes the older person to remain actively engaged in society in order to adapt successfully to older age.

VI. Results

The SocialRobot project is still in progress and two pilots for testing the technology are scheduled to be carried out in the Netherlands and Cyprus. Up to fifty elderly people and their caregivers will use the SocialRobot system, both in homes and care centres, over a six month period where it will be investigated up to which point the SocialRobot services improve the self-management of daily routine at home, and how the services can leverage economic opportunities. Initial involvement of the selected end-user groups in system development and prototype testing have shown positive end-user acceptance related to the increase of the elders' motivation and reduction of their hesitations in carrying out their daily routine with the support and company of the SocialRobot.

VII. Conclusion

The work presented in this paper is based on the context of the Social Robot project and focuses on presenting the integration of ICT and Robotic technologies as a trigger to the 'Positive Ageing'. 'Positive Ageing' seeks to take a balance approach between addressing the opportunities and challenges of an ageing society rather than seeing the increase in longevity as a burden and a threat.

In the context of an ageing Europe, the opportunity to invest in innovative services built around new technologies that can provide cost effective solutions, addressing the aforesaid challenges and supporting seniors to stay independent and active and more important to increase their healthy life years for as long as possible, is a safe bet for the future. This will be a triple win for Europe in terms of: (1) enabling the EU citizens to lead healthy, active and independent lives until old age, (2) improving the sustainability and efficiency of social and health care systems and (3) developing and deploying technological innovative solutions to overcome the aforesaid challenges, fostering also competitiveness and market growth.

The Social Robot system will be introduced early enough in the life of the elderly when the first signs of physical and cognitive disabilities appear providing thus initially simple essential personalized functionality covering daily care needs. This will ensure that the elderly will be given enough time to become acquainted and increase acceptance of more complex robot care functionality introduced gradually to address further ageing capabilities degradation.

SocialRobot is expected to launch the final product onto the market two years after the project end; in 2017.

Acknowledgment

This work is supported by the Social Robot project, funded by the European Commission within the FP7, by People Programme, Industry-Academia Partnerships and Pathways (IAPP), under grant agreement 285870.

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