Robots responding to care needs? Analyzing design strategies behind the new generation of care robots

Lina Van Aerschot & Jaana Parviainen, Faculty of Social Sciences and Humanities, University of Tampere

Session 09 - Technological innovation and social investment strategies in the care sector: challenges and opportunities

Abstract

The new generation of care robots is expected, in the near future, to enable opportunities for renewed ways of providing help and care, as well as significant reforms of service provision. Assistive robotics are expected to prolong the independent living of older people, enable autonomy for disabled people and remarkably assist in care giving in private homes and institutional settings. However, the development, acquisition and adoption of new technologies should always be based on the needs, wants and wishes of the users, and be shaped around the users' conditions. In this paper, we outline what kind of conceptions of care seem to prevail when robotic platforms are designed for human care.

We contribute by first taking a look at the essential aspects of care based on theories of care ethics and essential aspects of care. Second, we introduce the existing robot technology that has been designed and developed to assists in providing care. We take a look at the types of assistive, monitoring and social robots and discuss their potential in meeting the care needs of older or disabled people. Thirdly, we contemplate three different design approaches to the robotic technology: robots as instrumental particulars, robots for affectual bonding and technology assisted new care ecosystem.

Introduction

The new generation of care robots is expected, in the near future, to enable opportunities for renewed ways of providing help and care, as well as significant reforms of service provision. There is a lot of pressure and expectations on designing service robots that respond to the needs of elderly people (Sharkey & Sharkey 2012), the work practices of care givers (van Wynsberghe 2013) and the service infrastructure of elderly care including the current technological devices (Schulz et al. 2015). The ageing of the societies is expected to create an unforeseen demand for assistance, help and care. At the same time there is expected to be a shortage of professional care workers. Robots are seen to make meeting care needs and organizing care work in new, more efficient ways. The idea is that when part of the tasks could be delegated to robots, humans could concentrate on doing the things that they are best at.

By definition, a care robot is a machine which is able to either autonomously or semi-autonomously conduct tasks that are related to physical or emotional care (Goeldner et al. 2015). Care robots have been designed to provide assistance with daily living, cognitive support and training, assistance and support for care givers, collaboration within a smart-home environment, social interaction and remote medical triage

(Baer et al 2014). In short, care robots are expected to prolong the independent living of older people, enable autonomy for disabled people and remarkably assist in care giving in private homes and institutional settings (Decker & al 2011; Baer & al 2014).

A major concern regarding the introduction of novel care technology is whether it affects the lives of the care recipients in a positive or negative manner (Borenstein & Pearson 2012), with consideration also given to their family and close ones. This, essentially, depends on the abilities and features of the technological devices, as well as the ways in which the innovations are able to offer meaningful added value to their users. The development, acquisition and adoption of new technologies should always be based on the needs, wants and wishes of the users, and be shaped around the users' conditions taking into account also the social context in which the technology is to be used (Frennert & Östlund 2014; Smarr et al 2014).

The doubts related to the use of robots in caregiving settings are related mainly to the idea that the nature of care differs fundamentally from that of other services, not to mention the production of most commodities. Emotional and physical requirements, and the time invested in the relationship between the caregiver and the recipient, are integral to the quality and efficiency of care (Daly & Lewis 2000, 285). Care can be defined as a process of events and activities within which it is difficult to define a beginning and an end. Care is situational and entails reacting and responding "on the spot" to the needs of the person being cared for (Mol 2006, 18-20). Although it is obvious that humans cannot be replaced by machines in care giving, robots and other technologies may well be, and already are, used to assist with care-related tasks (e.g. Pols 2010).

At the moment research, debate and discussions about care robots are vivid in Western societies. The technologies are developing rapidly and future robot-assisted care scenarios are largely presented in the media[1]. Nevertheless, at the moment we do not have very sophisticated care robots on the market. Currently a robotic vacuum cleaner is perhaps the most common assistive robot for households. So, by now the expectations towards care robots have not yet materialized (Wu & al 2011; Kyrki & al 2017). Rather, the technology developers and engineers are urgently searching for the most beneficial directions for their work. Therefore, now it is the time for care researchers from different disciplines to take part in the discussions and bring in essential questions related to the design and conditions for the possible use of care robots.

In this paper, our purpose is to outline what kind of strategies robot engineers in collaboration with care experts rely on when designing robotic platforms for human care. We contribute by taking a look on one

[1] E.g. "Robots could help solve social care crisis, say academics", BBC News 31.1.2017, "How a robot could be grandma's new carer", The Guardian 6.11.2016,

hand at the essential aspects of and on the other hand on how the existing robot technology assists in meeting these needs. First, we consider the essence and ethical principles of care on the basis of care research literature. We take into consideration both the care ethics and disability studies points of views. Second, we take a look at the types of robots that are being or have been developed for care giving and assisting the elderly or disabled people. This part of the article is based on the literature and research reports on care robots that are available at the moment or foreseen to be on the market in the near future. Third, drawing on the philosophy of technology and design of robotics (e.g. Sullins 2009; Vermaas et al. 2009) we formulate three design scenarios that can be found on service robotics industry for elderly people. We conclude by discussing the design strategies and the essential questions related to the foreseen increase of care robots: What could be the possible and most feasible scenarios of care robots: how does the development of these technologies alter care work and the conditions in which care is given?

To respond to a person's needs

Care is about interpreting, being attentive and responding to a person's physical, psychological and social needs (Sointu 2016, 43). It is about being available for a person who is in one way or another in need of assistance or attentiveness, a person who is not capable of managing independently, either in some aspects or at all, and whose well-being is therefore dependent on other people.

Care research in the fields of social sciences, gender studies and ethics have emphasized that care is essentially different from production of other goods and services (Mol 2006). It is both a relation and action implying that it takes place between at least two people of which one is concerned of the needs of the other and attends to meet them. (Waerness 1984, 188). Good care is built on patience, empathy, attentiveness, intimacy and willingness to fulfill also what may seem to be insignificant needs (Sevenhuijsen 1998, 1). Kari Waerness has used the concept of rationality of caring to suggest that good care can only be given when the person in need of care is seen, heard and encountered. The care giver needs enough quiet to grasp what is specific in each situation to be able to respond to the needs (Waerness 2005, 25).

According to well-known and often cited theory by Joan Tronto (1993, 105-107), care should be understood as a process with four different phases. The first one, caring about, is to notice and recognize a person's need that has to be met. The second one, taking care of, involves taking responsibility and defining a way to respond to the need. The third phase is care-giving which entails the actual responding to the need. The fourth aspect, care-receiving, is the end result from the point of view of the person whose need for care was to be met. The end result of care should be a state in which the care-receiver feels that his/her need for care has been met. Tronto's differentiation of phases of care help us to catch that care is not only about

somebody somewhere helping another person but about a process of different phases in which different people can take part.

When it comes to disability research, the focus is on the care-receivers' rights to autonomy, choice and control: this branch of research emphasizes older and disabled persons' rights to have control over their own life and to make choices regarding the assistance and help that they need (Kröger 2009; Fine 2007, 92-95). The disability researchers have pointed out that even when a person is not self-sufficient, i.e. needs assistance of other people, he or she should not have to give up the right to make decisions and be in control (Williams 2001). Disability movement has emphasized the role of the person being cared for as an essential part of the process and practice of caring. Care needs should not be defined and care giving organized as a top-down process in which the care receiver is left in a passive role. Thinking about Waerness'es rationality of caring the emphasis is put on the attentiveness to the particular needs of an individual who needs care in a certain situation. Or, considering Tronto's phases of care, the focus on is on the fourth phase which points out that receiving care is an essential part of the care process.

Kari Waerness (2005), as many other care researchers, has recently called for better understanding and consideration of feminist care research in planning, administration and organization of care services. The focus is most often on efficiency and productivity which leave no space for care ethics and rationality of caring. This creates a conflict for care workers who are not able to provide care of the quality that they are qualified for and would want to. Those who are able may choose to seek different jobs (Waerness 2005, 26).

Considering the theories on care ethics and good quality of care, the most essential aspects of care are related to human characteristics and emotional capabilities. From this point of view a robot giving care seems inhuman, deceptive and wrong. But robot as an assistive device helping either the care giver or the person who needs care in certain tasks doesn't mean that humans would be replaced by machines. However, seen from the perspective of a person who needs assistance but is fully capable of both control and choice, a robot might be a warmly welcomed means for maintaining autonomy. Sometimes people in need for care may not at all want to be dependent on other people but, on the contrary, rather prefer assistive devices.

Interest in the development of care robots is seen to be driven by the demand-pull created by the aging population. However, the current robotic solutions for elderly people are more technology-push innovations (Nourbakshs 2013; Taipale & al. 2015a). As Selma Sabanovich (2010) suggests, when social issues are invoked to motivate robotics research, they are quickly subsumed by discussions of technological possibilities and concerns. The research on care robots relies largely on somewhat stereotypical views of older people as lonely, frail and not fully capable of many things (Frennert & Östlund 2014; Parviainen &

Pirhonen 2017). Yet, older or disabled people should not be seen as inactive recipients of robotic technology but as active co-designers and conscious consumers who know what they want (Taipale & al 2015b) –just like the disability movement has been claimed. As a consequence, designing new technologies should always depart from the needs, wants and wishes of the users and they should fit to the users' conditions (Frennert & Östlund 2014; Smarr & al 2014). The above mentioned theories on the essential aspects of good quality care and the principles of respecting the autonomy of the care receiver provide excellent starting points for designing care robots.

Robots for care?

Even though the conversations about robots as care assistants are lively in the media, it seems that there is a need for further knowledge on what is meant by care robots, what are these technologies capable of at the moment, what are the main streams of development and what are the questions and topics related to care robots that people should pay attention to. There is already plenty of scientific research available but seen from the point of view of social sciences or philosophy, for example, this line of research has remained somewhat marginal. Thus it is important to include care researchers to the discussions.

A care robot is a machine which is able to conduct tasks that are useful for humans in the context of care (Goeldner et al. 2015). Care robots are service robots that are used for care-related tasks. The main distinction is made between industrial robots and services robots the latter being robotic devices used by people in normal life environments, not in industrial units. A care robot may either run tasks that are part of care practices, assist professional or informal care givers or support the person who needs care. The robots may be used to assist in physical labor or used for social purposes, like companionship (Santoni de Sio & van Wynsberghe 2015).

Glenda Shaw-Garlock (2009) divides care robots in two categories according to the purpose of their use: utilitarian and affective sociable robots. Care robots may also be typed in three groups out of which the first two are utilitarian and the last one sociable robots. A *monitoring* robot can help observing behavior and health. It may follow and register factors related to a person's state of health and safety related issues and, for example, call for help when necessary (Sharkey & Sharkey 2012). These robots can remind about eating, taking medication etc. and facilitate, for example, interaction with health care personnel. They are also developed to check for signs of stroke or fall. It has been suggested that the monitoring robots could be used to offer the human carers some time off as the robot could surveil and also perform certain tasks with remote control. Secondly, *assistive* care robots support people in everyday needs as butlers or assistants offering help with eating, dressing, toileting or moving from bed to bathroom (Sparrow & Sparrow 2006). The third type of robots are *social* robots that provide companionship and can be used as therapeutic tools, for physical

or social activity and entertainment. A social robot could remind of and instruct physical or cognitive exercises, for instance (Sharkey & Sharkey 2012; Shin and Choo 2011; Wu 2012; Pino et al. 2015).

Robots are expected to support those older people who are able and willing to continue living at home as long as possible, to offer help and relief or possible apprehension for informal care givers and to reform the field of care services. Indeed, the new generation of care robots is expected in the near future to open opportunities to develop renewed ways of providing help and care and enable significant reforms of service provision (Decker & al 2011; Pratt 2015). However, until now, such expectations have not materialised (Wu et al 2011) and the current household robots are rather low-tech artefacts (Fortunati et al 2015). The research on care robots has not led to their wider industrialisation, nor have significant markets for such devices emerged. The market of service robots is, however, increasing steadily at the moment. For medical service robotics a growth of about 15 percent is expected between 2014 and 2022 the market size increasing from USD 2.1 billion to over USD 6 billion (Global Market Insights 2016). Care robots that are either used by care workers or in private homes are part of the medical service robotics but form only a minor share of the market.

Already now robots can be used for routine tasks like cleaning or lawn mowing (Katz & Halpern 2014) which may partly enable independent living. Also monitoring devices and robots are already available. They are seen to be useful for supporting independent living because they may guarantee that the person's condition is followed and help is being called in a case of emergency. In the future especially robot assistance in daily routines could offer an important support for autonomy and independence for those disabled or older people who want that and offer possibilities to organize care work or informal care in new ways.

However, the ideas of technologies supporting independent living may turn into coercive measures (Mort, Roberts & Callén 2013) when combined with current austerity policies, the discourses on economic burden due to the ageing population or "silver tsunami". Also the social changes in family formation and behavior play an important role in the ways in which informal care is available or possible. The demands for efficiency and cutting costs in care services might mean that technology is introduced to care work to legitimize cuttings in personnel costs and providing care with less workers. Or, that a person's home is furnished with monitoring and assistive technology and that leads to a situation in which human contacts are minimal and the social and emotional needs for care are forgotten. Therefore, we need to be attentive when designing, planning, adopting and implementing new technologies.

Goal-directed and practice-oriented care activities

Aimee van Wynsberghe (2011) has developed a framework for the ethical evaluation of care robots: *a care centered value sensitive design*. She calls for recognition of the specific context of use of a care robot, the needs of users, the tasks that the robot is used for and the technical capabilities of the robot. The aim should be, according to Wynsberghe, to design robots that support and promote the fundamental values of care (i.e. patient safety, dignity and well-being) which are emphasized to different extents depending on the particular context in which care takes place. More recently Filippo Santoni de Sio and van Wynsberghe (2015) have proposed *a nature of activities approach* for analyzing when care robots should be used or not be used. Accordingly, when we understand the points of different care activities we are able to identify which values are involved in those activities. Hence, we are able to decide whether or not care robots are suitable and acceptable for different care tasks when we can tell whether the initial points of the care tasks are endangered or fostered.

The nature of activities approach makes a distinction between goal-directed activities and practice-oriented activities. The point of goal-directed activities is to reach an end which is external to the activity whereas in practice-oriented activities the main point is on the performance of the activity itself (Santoni de Sio & van Wynsberghe 2015). As care can be defined to be responding to a person's physical and emotional needs and well-being, goal-directed care activity could be, for example, fetching a glass of water for a person who is not capable of getting out of the bed. A practice-oriented activity could be talking to or holding the hand of a person who is waiting to be transferred to a theatre for a major surgery operation.

Thinking about care work more concretely, the different tasks that it includes can be divided into those of direct patient care, indirect patient care and other activities such as documentation, administration and planning medication (Ballermann & al. 2011). Reflected against the nature of activities approach, direct patient care is most often practice-oriented activity where the activity might be as important as the end result and thus the goal is internal to the activity. Indirect patient care and other activities of care work could, on the contrary, be considered as goal-directed tasks which aim to reach a goal external to the activity itself.

Three design strategies behind care robots

According to the technologically optimistic perspective, technological innovations make older and disabled people's lives more autonomous helping them to live longer in their own homes and maintain their independence. The technological innovations of current service robotics industry can be seen to have two distinct design paradigms, *effective* and *affective* (Sullins 2009). American and European robotics companies have largely focused on the effective, or, utilitarian robotic technologies such as robotic vacuum cleaners, robotic feeding devices, or autonomous mobile delivery robots. Japanese and Korean companies,

on the contrary, have focused on building affective, social robots like robotic pets, dolls and humanoid companions. They have delivered playful robots that are meant to trigger positive affections and emotions in their users. Asian companies like Sony, Toyota and Honda have, for example, launched several companion robots that can chat and dance to entertain their users.

By effective design Sullins (2009, 146) refers to the interpretation of robots as tools or appliances that are meant to automate human activities or certain parts of activities. Applying Sullins's notion of effective design in the context of human care, we suggest that one of the design strategies of care robotics is to seek to delegate some tasks related to care from humans to robots. The aim is to develop robots to be as autonomous as possible and conduct the tasks with little or no human direction. We call this type of approach to technological innovations as design of *instrumental particulars* that are focused on automating activities. This kind of design considers care as a series of activities out of which some can be replaced by a technological solution or robotic device to cut costs and save human labor or to be more effective and save time.

The feeding robot Obi for home care or autonomous mobile delivery robots TUG and Awabot that are designed for hospital logistics are examples of designing instrumental particulars. The idea is, for example, that a disabled person doesn't need a human assistant for eating when s/he can eat with the help of the robot. The logistic robots are developed to increase productivity by performing the delivery and transportation tasks in order to enable clinical and service staff to focus on patient care. Designing robots to deal with instrumental particulars aims at producing robots that effectively take over tasks that do not require, for instance, multi-tasking that combines social and practical skills that only humans have.

Seen from the point of view of care ethics a human assistant in eating can either be an important increase of autonomy for those who need help with eating but do not wish to be dependent on other people. Yet, eating is not only about taking food from the plate with a fork and bringing it to the mouth. First of all, a meal has to be prepared and served somehow. Secondly, eating may be an important daily event deeply connected to the well-being of a person. It may have social connotations and when a person is frail, ill or disabled it may be of essential importance that another person has time to sit down and help with eating. Thus, when personal assistive robots are introduced, it is crucial that they are only used by the people who are able to make an informed decision on the use of the technology.

When it comes to logistic robots, the idea of a robot taking care of tasks that are only indirectly related to patients sounds ideal. This would save time care workers' time and allow them to use it with the patients. However, a person taking care of the logistics and walking on the corridors of a hospital to bring sheets or clean instruments may have also other meanings than solely doing the job. The assistive personnel might have an important social role just by being a person who walks by, says hello and possibly asks how it is

today and chats about the weather. The fear is that the use of logistic robots does not mean more time for care givers with the patients but economic savings and decreasing number of nurses –and no increase in time with patients.

Affective design, the second design paradigm defined by Sullins (2009), aims to introduce robots deeply into the lifeworld of the humans. The objective is first and foremost to develop interactive robots. We call this second design strategy of care robotics *affectional bonding.* These types of robots are built to elicit human emotion and "perform" emotional reactions in order to bond more fully with their human users. Examples of social robots that are meant to be used in care of older people are the pet-like Paro and a small humanoid NAO. The interactive seal Paro is especially used as a therapeutic tool with people with memory disorders to ease anxiety, depression and agitation (Mordoch & al 2013). NAO communicates on a simple level with people and is capable of directing simple physical exercises or playing games. These kind of robot are designed for affectual bonding, entertainment and socializing. They do not conduct physical and concrete care tasks but they may be used as interactive tools that the care workers or informal care givers may use with the carees. The design strategy of affectual bonding does not see care work as solely a series of tasks that a robot could manage. This strategy sees humans as inherently social beings and they can be used in care as parts of a flexible network in which relationships are knitted together by emotional bonding.

The third strategy for designing care robotics is one of *care ecosystem*. This is combines the effective instrumentally particular robots that take care of pre-defined tasks related to care and robots designed for affectual bonding with human embodied care. The technologies of a care ecosystem follows Latour's Actor-Network-Theory (ANT). According to Latour (1999), actions are not properties of individual agents, but of chains linking human and non-human actants, combining each other together towards an ensemble that form hybrid actors and collectives. Seen from the perspective of ANT, technology is not about solutions, tools or robots that serve for certain purposes and are used to conduct tasks operated, tele-operated or without human control. Rather, technology is a part of a network in which humans and technological solutions are linked together in multiple ways.

If we interpret care work practices through ANT, embodied dimension of care work – feeding, lifting and bathing – cannot be separated from non-human actants like cutlery, beds and showers. Different tools, appliances and assistive devices are an inseparable part of care as a whole if we apply ANT to interpret it. From this point of view, ICTs and robotics play a role in a more general development of material things, devices and tools becoming increasingly important and larger parts of the action chains in care work and caregiving. If care work has traditionally been considered as strongly based on human touch and presence, the increasing role of technology makes care more of a hybrid ecosystem of actions combining human and

technology.

In the future, also software and AI become presumably more tightly intertwined with care practices. Software, algorithms and AI go deeper into care practices than material tools or "classic" technology, with the result that many of care practices are being modified partly because of hidden logical machinery. Among other things, algorithms filter, structure, interpret and visualize information in an automatic fashion, performing task previously reserved for humans. In this sense, software is responsible for extending, both quantitatively and qualitatively, the role that technology plays in the everyday practices that make up modern life. If care work and robotics are intertwined at the micro-level, even the analytical separation of the two can become highly problematic. Software, algorithms and AI are not neutral but they integrate and propagate human values (Friedman 1997; Rieder & Schäfer 2008). This implies that the way how we see human care and its practices now can be changed radically with the consequences that human care can be a quite different phenomenon in the future.

Conclusions

In this paper, we have had a look at theories on care ethics and essential aspects of care, the types of care robots currently being developed and the design strategies that can be traced behind care robots at the moment. We wish to increase interest among care researchers and to have more social scientists to take part in the discussion about robots as future care assistants.

Seen purely from the point of view of care ethics the idea of robots as care givers is not fitting at all since the most essential aspects of care –attentiveness, empathy, encountering a person and responding to possibly changing needs according to a situational consideration– call for human presence. Yet, more sophisticated and capable assistive devices would be welcome in many situations. The disability movement and related research have emphasized that people who need care and assistance must have rights to decide and be in control of their own lives. The robotic technologies may bring interesting and important possibilities of increased autonomy for those care receivers who want it.

When considering what kind of care tasks could be completely conducted or assisted by robots the distinction between goal-directed and practice-oriented tasks (Santoni de Sio & van Wynsberghe 2015) is useful. Robots are easier to welcome to assist in tasks of indirect care, such as logistics or cleaning. For person-oriented tasks which include bodily care or being available, robots are not as easily accepted.

We have outlined what kind of conceptions of care seem to prevail when robotic platforms are designed for human care. In analyzing the new generation of care robots, we come to the conclusion that innovators and engineers have relied on three typical design strategies, called here instrumental particulars, affectional bonding and care ecosystem. We think that if robots are to make remarkable changes in the

processes and practices of meeting care needs in private and public sphere they need to become a part of a care ecosystem and find a place in the network of actors. Care robots may become ethically acceptable and socially welcome only if they succeed in meeting people's needs in ways that fit in the social networks and the context in which the person, his close ones and care givers act.

This research is part of the multi-disciplinary project Robotics and the Future of Welfare Services (ROSE) 2015-2020 funded by the Academy of Finland.

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