Asian Social Science; Vol. 13, No. 1; 2017
ISSN 1911-2017 E-ISSN 1911-2025
Published by Canadian Center of Science and Education

Personal Care Robots for Older Adults: An Overview

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Received: November 20, 2016 Accepted: December 1, 2016 Online Published: December 20, 2016

doi:10.5539/ass.v13n1p11 URL: http://dx.doi.org/10.5539/ass.v13n1p11

Abstract

In recent decades, the usages of robots in variety of industries have been increased. Self-directed robots have appeared in human lives, specifically, in the areas related to the lives of elderly. The population of old people is significantly growing worldwide. Therefore, there the demand for personal care robots is increasing. The aim of this demand is to enhance the opportunity of mobility and promote independence. In the future, robots care will be in very near contact with people lives. But, what caring roles will robots have at home in the future before old persons? It depends not only on the kinds of robots but also those facets of ageing which are discussed in the paper. This article probes the part and function of robots care in the lifecycle of older adults. It contemplates on the advantages and disadvantages of robots application in human life.

Keywords: Robots, Care robots, Elderly care, Human robot interaction

1. Introduction

Technological progress is a universal trend which effects on human life are considerable. Robots are among the greatest technological realizations. The application of robotics has led to notable improvement in human life and industry. Nowadays, robots are a permanent part of various fields including: manufacturing, medical and household services, military activities, and entertainment (Yampolskiy, 2013).

The older population is increasing world-wide which renders their needs an important matter to health providing authorities, agents of governments, caregivers, and families. These leads to the appearance of healthcare robots which have an authoritative role in assisting older adults to independently complete caring responsibilities. They also compensate the shortage in caretakers (WHO, 2016).

Should we be worried about the application of robots for elder care? The application of robotics and related technology is frequently suggested as one way of tackling the increasing number of elderly people in our society. Indeed, there is a rising industry which considers the application of robots for elder care. However, we should be cognizant of some ethical concerns that are being articulated about these progresses (Sharkey & Sharkey, 2010b). There is an anxiety, for instance, that trusting elder care to robots could intensify social isolation, resulting in deception and loss of dignity. At the same time, researchers have pointed to some evidence that confirm the profits of robot care for the elderly (Banks et al., 2008). Also, concerns, advantages and disadvantages of robot care in elderly life will be dealt in this paper.

In the papers related to Robot Care and Elderly, there are some general explanations. But, in this paper, we introduce types of robots and the roles they have in old people's life. We also consider the helpful points of the application of robots in elderly care. Yet, the negative effects, dangers and the anxieties that are resulted from the application are not ignored in this paper. It is followed by some recommendations that can reduce the communication problems between robots and old generations.

Tis paper follows this order: 1.We start the paper by Introduction. Then, we briefly explain the technological concepts and those related to care such as the definition of robot care and the Ethic related to it. 2, we clarify the elderly and robot care, kinds of robotic care and its advantages and disadvantages as well as the public concerns about elderly 3. We go through the Conclusion and recommend some points.

1.1 Technology and Care

The idea that because of its impact on the area of care, the technology which is applied in the field should be investigated supposes that care and technology are in conflict. On the one hand, there is a perspective that

assumes caring and technological knowledge as divergent concepts; that the two are the representation of different domains of meaning (also referred to as "gendered spheres") (Wilson, 2002). In this way, one domain embodies images of personal identity and feeling (care) and the other one produces that of objectivity and standard regulation (technology) (Wilson, 2002).

Therefore, care as in healthcare, is appreciated as a means of addressing the emotional needs related to physiology, physics, and psychology of old people and children in a way to be cognizant of personalized expectations. It demands the exercise of skill along with a sympathetic temperament. Regarding this explanation, it is possible to employ technologies as aids in the offering care in a way that affirms this outlook.

1.2 Definition of Robot

Because of the recent robotic progress, robots nowadays are capable of complex movements, are very skilful and flexible, not to forget the ability of mutual learning from and interacting with humans. According to these innovations, the potential application of robots has greatly expanded (Manyika et al., 2013). The service robotics business is affected by these developments in robotic technologies, which, in its turn, has resulted in numerous robotic applications. Under the influence of the current demographic variations, work restructuring, and the economic crisis, the concentration on the occasions provided by Information, Communication, and Robotics Technology (ICRT) as well as the exploration activities and projects which aim at finalising solutions for sustainable healthcare services has steadily increased (Moschetti et al., 2014). Between 2013-2016, the sales of robots as assistance of old and handicapped people has touched about the number of 6,400 units, and it is assumed to undergo a considerable increase within the next 20 years (IFR, 2014).

Various types of tasks are made possible by making use of the services offered by autonomous service robots. Samples are taking care of old people at home(Kartal et al., 2016; Portugal et al., 2015; Veloso et al., 2012) or accompanying guests inn multi-level buildings(Veloso et al., 2012).

Robotic service solutions include the simplest telepresence to the most complex functions to back caregivers. Examples are the Giraff (www.giraff.org) advanced in the ExCITE project(Coradeschi et al., 2013) (, AVA (www.irobot.com/ava) and Luna (Ackerman, 2011), assisting needy persons in their everyday movements (www.aal-domeo.eu), self-management of long-lasting illness (Simonov et al., 2012), comfort and safety as in the cases of Florence (Frank et al., 2012) and Robo M.D (van de Ven et al., 2010), and unification in an environment controlled by smart applications (Cavallo et al., 2013). On the other hand, the number of robotic applications that are dedicated to social services in settings like smart office buildings is very few (Rosenthal & Veloso, 2012).

Considering the entity of a care robot, several definitions are recently offered: Carebots are robots that are designed to assist people, support them, or provide the patients, disabled, young, old or vulnerable people with needed care, in different places and situations like homes or hospitals (Vallor, 2011).

Others, define care robot as a robot which has some projected roles and has to accomplish them. Sharkey and Sharkey discuss the care robots that are designed for elderly people. They mention three main functions of such robots: to help old people in their everyday career; to provide aid in monitoring and controlling the elderly's deeds and health; and spend time with them as their companion. Alternately, care giving robots may be categorized between an "affective robot which is a robot that befriends a human being or works as his/her companion is the opposite of a utilitarian robot which describes a robot which has instrumental functions (Shaw-Garlock, 2009).

2. Ethic and Robot Care

The interest in the investigation of the ethics of employing robots for personal affairs is a matter of curiosity nowadays. This is partly because research in this field possibly will play a progressive role in our lives (Borenstein & Pearson, 2010).

It is believed that noble care (appreciated care) is a kind of care that corresponds to the shifting needs of individuals. This is one of the most significant points that the literature of ethics care is concerned with; care is just regarded as "good care" when it is personalized (Tronto, 2010; Vanlaere & Gastmans, 2011).

If we firstly consider the inventiveness in creating and using care robots based on the certainty that care robots employ a high standard of care, or even possibly improve the quality of care, then the key demand is how others understand care; what is care, what is good care, and how can we achieve this and/or evaluate it? Ambiguity of the nature of care, its structure, what does it involve, and what does it mean, is the cause of all the ethical matters that are spoken of up to date is,. This just complicates the explanations about the goodness of care, for whom is it good, and, most important, what elements render it good. As psychoanalyst Sherry Turkle persuasively argues in

her book (Turkle, 2012), the new generation of robots offers the new society the opportunity to rethink on the standards that are important for societal life and to also maintain their place or otherwise pave the ground for trade-o- between ideals. This chance is what Turkle (Turkle, 2012) terms as "the robotic moment" and embodies the situation we are experiencing at present. But Turkle (Turkle, 2012) believes that this is not just an opportunity, but a necessity. Care robots let us contemplate on care _ what it is, how it is attained _ and, therefore, help us to modify the scheme of the robot. For writers like Shannon Vallor (Vallor, 2011), this is to particularly pay attention to the critical things that are necessary for the care-giver when a robot is utilized. Sparrow and Sparrow regard this as acknowledging the significance of the presence of human element in caring (Sparrow & Sparrow, 2006). Sharkey and Sharkey recognize it as the rights of weak demographics and how such rights may impress a care robot (Sharkey & Sharkey, 2012).

3. Elderly-care Robots

Robotic technology has contributed to some new developments that could render the lives of the elderly more manageable. One of the essential reasons to seek the assistance of robots in taking care of the old people is the rapid increasing of the population of the elderly people compared to that of the young people who are able to offer such caring in a society.

From Jan 1, 2011, each day nearly 10,000 Americans have turned 65 and, automatically, become in need of Medicare(Cohn & Taylor, 2010). This increase will last for another 15 years with the same speed. It will enlarge the levels of Medicare and, consequently, multiply pressure on the workers of primary health care who, due to the shortage in number, cannot cover all the needs at present (Health & Services, 2013).Based on some demographic studies it is claimed that as the average life expectancy over the years increases, the European population is getting older (Europea, 2014). Recent data released by European authorities indicates that, at present, around 17.5% of the total population (88.5 million out of 505.7 million people in 2012) are aged 65+. Yet, it is estimated that this percentage will go up to 30% (164 million people) in 2050 (Conrad, 2015; Hendrich et al., 2015) The respective estimations of the increase for China are 6.9% (88 million people) and 23.9% (400 million people) (Hendrich et al., 2015).

Also, by 2015, the number of the people who were above the age of 65 was 25.0% of the total population in Japan. This renders Japan an already and rapidly aging society (Sumiya et al., 2015).The accidental fall is one of the serious risks for the elderly people at home. 25.3% of the people who have more than 85 years, have similar experiences of accidental fall within a year. 62.5% of elder people’s fall leads to their injury (Office, 2013). Moreover, the number of the elderly people who live alone has also been expanding (Health, 2012).

Another important matter is that World Health Organization and Alzheimer's International affirm that by 2050 the total of people who are afflicted with dementia will increase by three times worldwide, affecting the life of 115.4 million people (Canada, 2010; Organization). In Canada, the essential cause of disability of Canadians who are 65 years old or more is dementia. It imposes big economic costs on families and is anticipated to rise to $153 billion dollars by 2038 (Dudgeon, 2010). The other countries such as Japan and the United States have same issues. In these countries, the increase in the aging demographic together with a decline in the traditional caregiver demographic have motivated search for the strategies of advanced dementia care (Broekens et al., 2009; Canada, 2010; Kimura et al., 2010; Kramer et al., 2009; Organization)

Whether or not the role of robots as the best solution to provide help for the weak elderly citizens is accepted, yet these people are certainly in need of care. There are some strong and determined persons who manage to preserve their mind and body active until an old age. Still there are many who are in need of aid in their routine life as well as those people who totally depend on others.

The immobility problems of older people also means that they totally depend on others to manage their daily life at home, and that they are incapable of going out shopping, or visiting people. In addition, some forms of memory loss are expected with growing age, not to forget dementia as a present challenge.

Beside the physical weakness in performing personal affairs, elderly people usually need someone to remind them of the necessity to complete various actions, or tell them about the positions for, and elements of those activities (Sharkey & Sharkey, 2012). Elderly people are permanently exposed to the risk of falling over or getting sick, or getting confused or lost. They should not be left alone, but be attended and be offered companionship, affection and care.

Technological care giving is already realized in most of Western European counties, but the technology that is usually used in this case is not robotic. On the opposite, some of it is no doubt low-tech. The aiding technology that is mostly available for old people in the UK ranges from portable alarms for requesting help; smoke, CO2

and flood sensors; pillboxes or containers that are designed in a way that let older people take their drug on time; fall sensors are another samples as well (Sorell & Draper, 2014).

Two-way visual contact is also a way of communication and connection through webcams and television monitors, though it is not widely used despite its rather cheap price. This allows family members or employed carers to 'look in' on older persons and their homes with no need to commute (Shaw-Garlock, 2009). If older people feel at ease in working with computers, virtual visiting and communication is reasonable and easily established. It is not more difficult than installing and making a Skype account. Even there are virtual visiting systems which are more user-friendly than Skype and operate by connecting to local broadband networks.

Variety of probable positive and innovative aid that automatons and automaton technology could offer to enhance or preserve the bodily and emotional well-being of the aged people are stressed. Aid giver robots and robotic technology are helpful in overcoming the hardships of movement and reducing elderly people's reliance on busy and, sometimes, careless care givers (Banks et al., 2008).

The physical form, emotion and behaviour of small domestic pets are simulated by a number of robots. These can embody some existential features of real pets, reproducing companionship and a space for isolated elders to realize their affection (Sorell & Draper, 2014). This kind of robots is rather cheap, and its therapeutic function not only benefits the older people, but also those younger people who suffer from impaired cogitation, including children with autism. The multi-functioning humanoid robots are more expensive. They can move around in an apartment or bungalow, cooperating with old persons or their nurses, or both(Banks et al., 2008). All of these are despite the lists of benefits of such technological caring for elderly, particularly, in the case of human interaction with robot (Banks et al., 2008).

Care-O-bot is a sample of such technology. Care-O-bot platforms are designed with abilities of speaking to communicate the older person, carrying and lift things, and acting as an audio-visual portal connecting the outside world to the older person's home. Principally, the Care-O-bot could help an older person to be stable when changing position from sitting to a standing one or as they walk. They also have the capability of being encoded to learn and to recall an older person's day-to-day routine life, remind them of things, and transform signals of help when the person falls or any other pre-defined accident happens (Sorell & Draper, 2014).

Clearly, human health is the most pertinent and vital human value for robot care. Recognizing collective human anxieties about the mental and physical health of the elderly is quite logical. If the negative effect of robots on old persons' wellbeing was approved, in itself it was a convincing reason to oppose their usage (Sharkey & Sharkey, 2012).

Employing the robots that are remotely controlled, to screen and virtually check elderly people provides the old people with the opportunity to live self-dependently for a longer time. Robots are there to remind the elderly of the medicines that they should take and attentively observe the health problems and security dangers. Companion robots are used to simplify the social well-being of old people. They function as interesting gadget that old people can refer to share their ideas. Monitoring robots can manage same social interaction by facilitating virtual visits from relatives, friends, and family.

3.1 Types of Robot Care

In the discussions about the next generation of robots, elderly care is a prevalent theme. Many countries encounter the phenomenon of an ageing population for taking care of which there are fewer young people(WHO, 2007). A group of countries, probably Japan and Germany the most notable among them, have referred to robotics as an option to tackle this problem. Old age care has three main areas in which robots are looked at as useful or even necessary: assisting elderly and/or carers to fulfil their works and duties, monitoring health and function, providing companionship (Sharkey & Sharkey, 2010b).

Assistance: Different types of robots can offered variety of ways to actualize their help.. Responsibilities can be simple, short, and restricted, achieved by professionally programmed robots such as cleaner robots like the Roomba or Navi Bot, or feeding-aids such as Bestic or My Spoon that serve users in eating and nursing. More For more sophisticated actions such as personal hygiene, high-tech robots would be necessary.

Health and behaviour monitoring Robots are used in s homes to record user's those behaviours that matter for keeping oneself healthy and safe. Examples of these behaviours are not leaving bed, falling and not standing afterwards, or spending much time in the bathroom. In such states, robots immediately send alerting signals to health services. Other types of behaviour such as habits of eating or treatment are also among the cases of monitoring and the information related to them will be sent to doctors or members of family.

Companionship Robots do not have any assisting role. They are designed to offer companionship and interfere

whenever necessary. In general, this type of robots are programmed to be socially cooperation. Now it is more than a decade that these robots have been in commercial use. They come in different form: the robotic domesticated animals such as the Sony AIBO robot dog, the Pleo dinosaur, and the Paro Seal. A topic that is not much argued about and yet is related to robot carers is child care (Lin et al.; Sharkey & Sharkey, 2010a)

3.2 Disadvantages of Caring with Robot Care

One of the anxieties expressed about the concept of future reliance on robots in caring is that carering robot would isolate the elderly from the rest of society (Sparrow & Sparrow, 2006). Borenstein & Pearson (2010) argue that robot carers will take the place of human ones. They argue that if the robots that are designed for future succeed in accomplishing higher level tasks that demand professional skills in care taking, they, no doubt, will banish human carers from the scene notably because of economic interests. Even if users prefer robots for simple and apparently unsophisticated unsocial tasks in human caring, it will influence the social life of elders. Taking care of elders is not separated from routine household activities such as cleaning. If robots are preferred on human carers in fulfilling some jobs, there will remain no justification for human carers to come.

Accordingly, it is argued that, in such cases, elders will lose the rare opportunities of human contact. Such a thing is observable in cases when robots assume to role of cleaning staff. They emphasize that considering successful robots as true support for human carers, being able to simulate original human interaction is very superficial. Promoting robots to professional fields of elderly care they will reduce human carers. Such a situation will automatically lead to the isolation of elders. Sharkey & Sharkey (2010) point to the fact that replacing humans with robots in caring responsibilities such as lifting or carrying things or dusting might reduce the chance for natural and essential need of human contact (Sharkey & Sharkey, 2010a). They explain that for establishing human relationships, regular, simple care duties such as changing diapers or clothes etc. are of significance. Consequently, leaving robots with these responsibilities will limit the chance of care recipients for improving necessary human contacts. If robot carers bear the responsibility of everyday routines, elders will confront an unwanted, imposed loneliness for long periods of time.

Another case that reduces human contact is the recruitment of robots as means of surveillance and sensing. The reason is that detailed surveillance will reduce the intention of carers and members of the family to visit elders and check their situation (Sharkey & Sharkey, 2011b). Park (2010) notes that the elders who live at home or the places that offer nursing are already isolated. However, s/he stresses that robots would render the situation worse. Because of this isolation, elders don't easily accept to have robots. To receive human carers as visitors creates such a humanitarian atmosphere that having their help in activities such as taking shower or other personal hygiene affairs is somehow approved. Though there are many people who consider these affairs as highly personal and are reluctant to have another person do them.

Despite these claims, having human carer is usually the only available social communication and human interaction for old people. For us the issue is not merely about the replacing of human carers by robot carers; a cause that increases the isolation of care recipients. There are debates about the role of robot carers in improving the self-reliance of care recipients and reducing their dependence on human carers (Borenstein & Pearson, 2010).

There are five essential subjects which should be considered before any decision for the full application of robot technology in elder care is made (Sharkey & Sharkey, 2011a, 2012; Sharkey & Sharkey, 2010a, 2010b).

i. The reduction of human social exchange. In such occasions, elderly people will be subjected to more neglection by society and their families compared to earlier times (Shaw-Garlock, 2009). If other humans simply assume that the old generation' physical and emotional needs are addressed by machines; the role of robots in such a neglection is not as much as that of human.

ii. Loading the robots with numerous tasks to increase the convenience of human carers, which consequence is increased conflict with elderly people who come to see themselves as objectified and, in such a situation, loss lose their self-control. This incident is possible, for instance, when robots are used to relocate people around without informing them in advance.

iii. The limitations imposed on personal freedom are another side-effect of resorting to robots for elder care. The extent of the manageability of the limitation imposed on humans' behaviours by robots is a difficult question. It has a wide range of implications.

iv. Cheating and infantilising mature people: it happens when old people are encouraged to refer to robots as their companions, (although as it is discussed, the elderly maybe personally undergo such a deception that complicates the matter); and finally

v. If the control of robots is given to elderly people, there is the possibility that things will go wrong. But this raises an argument on other controversial issues such as the extent of agreement with the elderly person's desires, and the relationship of the control recognized for elderly person and their mental status (Parks, 2010; Sharkey & Sharkey, 2011a, 2012; Sharkey & Sharkey, 2010a, 2010b).

3.3 Ethical Concerns Robots for Elder Care

The industry of robotic technology for elder care is a growing one. Nevertheless, there are some ethical concerns about the developments in this field (Sharkey & Sharkey, 2010b).

For example, suppose a scenario in which robot X assists an elder person Z who has passed a very bad night and suffers of it. Since X is expected to eliminate Z's pain, it is concerned with the best position of Z in bed to help relieve his pain, but Z asks for pain-killer medication. Yet, X is programmed to refer to Z's remote human supervisor before giving Z any medication. The conflict continues because the attempts of the robot to contact the supervisor fail. What options do X have? Ignore Z's in pain or give Z the pain medication (e.g., it is aware that, in Z's case, taking pain medication is insignificant). What would a human health-carer do in such a situation? This is one of the possible scenarios where future autonomous robots with executive capabilities might face proper impasses in handling social situations; no difference what is their decision, they even cause pain and suffering for humans. The matter then is the reaction of such robots. Should human allow the robots to act beyond the rules, humanize them with moral emotions (such as empathy) and some general ethical understanding (based on some ethical theory) that can guide them in their cognitive calculations, policymaking and, on the whole, evaluation of their choices and actions.

Furthermore, there is a consideration, for instance, of the appropriateness of using robots for elder care one of which results is intensified social isolation together with deception and loss of dignity. Obviously, human mental and physical sanity is the most critical and vital human value in robotic care. Recognizing the common human concerns related to the physical and mental wellbeing of the elderly is of priority. If the harmful effects of the application of robots in old persons' life were approved, in itself, it had the capacity to question their usage (Sharkey & Sharkey, 2012).

The most important ethical anxieties resulted from making use of robots as carers of the elderly as well as their influence on these people's security are classified in two notions (Sharkey & Sharkey, 2012).

- Firstly, it susceptibly will diminish the already limited human contact of the elderly.
- Secondly, in the case of insensitive use, it could intensify a sensitivity about self-objectification and absence or loose of control over personal lives in senior citizens (Sharkey & Sharkey, 2012).

One of the serious difficulties of aging is the reduction or disappearance of social life and human connections. The fear rises from the anxiety that relying on robots in elder care for household tasks such as "lifting," "carrying," or even "cleaning" might result in a reduced human social contact for an elderly person (Sharkey & Sharkey, 2012). In their argument about the utilization of robots for the elderly care Sparrow and Sparrow (2006), decided that if robots were used, for example, to replace a human cleaner in tasks such as cleaning floors, this would eliminate the senior citizen's rare chance for improving minimum social interaction and, as such, it is better to be avoided.

4. Conclusion and Recommendations

In the last decades, robots have widely been used in various industrial fields. Self-governing robots have been employed in human lives, particularly in managing the lives of the old and very young people. The population of the old generation is significantly rising worldwide; therefore, there is an amplified need for the robots that offer personal care. It is for improving movement and facilitate independence. It is expected that in the approaching years, human being will have a very close collaboration with personal care robots. This article focused on the concepts that consider the daily tasks of robots in the life of both children and adults. In addition to the positive points of the application of robots in the daily life of children that is for enhancing their living conditions, – it was explained in this article – the shortcomings and resulted anxieties were also stressed. It is something that people should consider. Elderly are in need of for social contact, yet old group may not be familiar with that knowledge of the technology which underlies the apparent approachability of interactive robots. Scholars have investigated both of these factors to enhance the propensity to be anthropomorphic in recent accounts (Epley et al., 2007). Elderly people are permanently exposed to the risk of falling over or getting sick, or getting confused or lost. They should not be left alone. So, it is not recommended to leave elderly for long ours with a robot. It is recommended that elderly need to be encouraged to obtain robotic literacy. Such 'literacy' will let them learn about these facts:

- The mechanism of producing, maintaining and operating robots, highlighting their man-made properties;
- What are the limits and potentials of different types of robotic technological knowledge.

References

Ackerman, E. (2011). Nevada Bill Would Provide Tentative Roadmap for Autonomous Vehicles. *IEEE Spectrum*. Retrieved from http://spectrum.ieee.org/automaton/robotics/artificial-intelligence/nevada-bill-would-provide-tentative-roadmap-for-autonomous-vehicles.s

Banks, M. R., Willoughby, L. M., & Banks, W. A. (2008). Animal-assisted therapy and loneliness in nursing homes: use of robotic versus living dogs. *Journal of the American Medical Directors Association, 9*(3), 173-177. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/18294600

Borenstein, J., & Pearson, Y. (2010). Robot caregivers: harbingers of expanded freedom for all? *Ethics and Information Technology, 12*(3), 277-288. Retrieved from http://link.springer.com/article/10.1007/s10676-010-9236-4

Broekens, J., Heerink, M., & Rosendal, H. (2009). Assistive social robots in elderly care: a review. *Gerontechnology, 8*(2), 94-103. Retrieved from https://pdfs.semanticscholar.org/049e/c0283895a5c5eda0ee6d2946d9ff35beeb46.pdf

Canada, A. S. o., &. (2010). *Rising tide: The impact of dementia on Canadian society*: Author Toronto,, ON, Canada.

Cavallo, E., Galiani, S., Noy, I., & Pantano, J. (2013). Catastrophic natural disasters and economic growth. *Review of Economics and Statistics, 95*(5), 1549-1561. Retrieved from http://services.iadb.org/wmsfiles/products/Publications/35220118.pdf

Cohn, D., & Taylor, P. (2010). Baby boomers approach 65—glumly. *Pew Research Social & Demographic Trends*. Retrieved from http://www.pewsocialtrends.org/2010/12/20/baby-boomers-approach-65-glumly/

Conrad, S. G., L. Krezdorn, L. Trieste, G. Turchetti. (2015). Second report on services, business and marketing models for Robot-Era services. *project report*. Retrieved from www.robot-era.euss

Coradeschi, S., Cesta, A., Cortellessa, G., Coraci, L., Gonzalez, J., Karlsson, L., . . . Palumbo, F. (2013). Giraffplus: Combining social interaction and long term monitoring for promoting independent living*IEEE.* Symposium conducted at the meeting of the 2013 6th International Conference on Human System Interactions (HSI). Retrieved from http://ieeexplore.ieee.org/document/6577883/

Dudgeon, S. (2010). *Rising Tide: The Impact of Dementia on Canadian Society: a Study*: Alzheimer Society of Canada. Retrieved from http://www.alzheimer.ca/~/media/Files/national/Advocacy/ASC_Rising_Tide_Full_Report_e.pdf

Epley, N., Waytz, A., & Cacioppo, J. T. (2007). On seeing human: a three-factor theory of anthropomorphism. *Psychological review, 114*(4), 864. Retrieved from https://static1.squarespace.com/static/51e3f4ede4b053e5f0062efd/t/51f7e119e4b0021e844852cc/1375199513450/on-seeing-human.pdf

Europea, C., &. (2014). *The 2015 Ageing Report: Underlying Assumptions and Projection Methodologies*: Joint Report prepared by the European Commission (DG ECFIN) and the Economic Policy Committee (AWG)"European Economy.

Frank, A. W., Labas, M. C., Johnston, J. D., & Kontulainen, S. A. (2012). Site-specific variance in radius and tibia bone strength as determined by muscle size and body mass. *Physiotherapy Canada, 64*(3), 292-301. Retrieved from http://ec.europa.eu/FC01D391-099B-4C31-9251-8C67A6DE2EA3/FinalDownload/DownloadId-AAE5A2C2FE105F341B175B0FE9E3B496/FC01D391-099B-4C31-9251-8C67A6DE2EA3/economy_finance/publications/european_economy/2014/pdf/ee8_en.pdf

Health, M. o. (2012). *Labour and Welfare: Comprehensive Survey of Living Conditions.* Retrieved from http://www.mhlw.go.jp/english/database/db-hss/cslc-index.html

Health, U. D. o., & Services, H., &. (2013). *Projecting the supply and demand for primary care practitioners through 2020: Rockville, MD: Author.*

Hendrich, N., Bistry, H., & Zhang, J. (2015). Architecture and Software Design for a Service Robot in an Elderly-Care Scenario. *Engineering, 1*(1), 027-035. Retrieved from http://fulltext.study/FC01D391-099B-4C31-9251-8C67A6DE2EA3/FinalDownload/DownloadId-C5742F87F28ECF54D8F0C062BFF88681/FC01D391-099B-4C31-9251-8C67A6DE2EA3/download/480105.pdf

IFR. (2014). World Robotics 2014 Industrial Robots. *International Federation of Robotics*. Retrieved from http://www.ifr.org/news/ifr-press-release/global-robotics-industry-record-beats-record-621/s

Kartal, B., Nunes, E., Godoy, J., & Gini, M. (2016). Monte Carlo Tree Search with Branch and Bound for Multi-Robot Task Allocation Symposium conducted at the meeting of the The IJCAI-16 Workshop on Autonomous Mobile Service Robots doi:http://www-users.cs.umn.edu/~bilal/papers/AAAI16_MCTS.pdf

Kimura, R., Miura, K., Murata, H., Yokoyama, A., & Naganuma, M. (2010). Consideration of physiological effect of robot assisted activity on dementia elderly by electroencephalogram (EEG): Estimation of positive effect of RAA by neuroactivity diagram*IEEE*. Symposium conducted at the meeting of the SICE Annual Conference 2010, Proceedings of doi:http://ieeexplore.ieee.org/document/5602358/

Kramer, S. C., Friedmann, E., & Bernstein, P. L. (2009). Comparison of the effect of human interaction, animal-assisted therapy, and AIBO-assisted therapy on long-term care residents with dementia. *Anthrozoös, 22*(1), 43-57. Retrieved from http://www.tandfonline.com/doi/abs/10.2752/175303708X390464

Lin, P., Abney, K., & Bekey, G. A. Robot Caregivers: Ethical Issues across the Human Lifespan. Retrieved from http://ieeexplore.ieee.org/xpl/articleDetails.jsp?reload=true&arnumber=6733851

Manyika, J., Chui, M., Bughin, J., Dobbs, R., Bisson, P., & Marrs, A. (2013). *Disruptive technologies: Advances that will transform life, business, and the global economy* (Vol. 12): McKinsey Global Institute San Francisco, CA. Retrieved from https://www.sommetinter.coop/sites/default/files/etude/files/report_mckinsey_technology_0.pdf

Moschetti, K., Favre, D., Pinget, C., Pilz, G., Petersen, S. E., Wagner, A., . . . Schwitter, J. (2014). Comparative cost-effectiveness analyses of cardiovascular magnetic resonance and coronary angiography combined with fractional flow reserve for the diagnosis of coronary artery disease. *Journal of Cardiovascular Magnetic Resonance, 16*(1), 1. Retrieved from https://jcmr-online.biomedcentral.com/articles/10.1186/1532-429X-16-13

Office, C. (2013). The Aging Society: Current Situation and Implementation Measures. *Annual Reports*. Retrieved from http://www8.cao.go.jp/kourei/english/annualreport/2014/2014pdf_e.html

Organization, W. H., &. *Alzheimer's Disease International. Dementia: A Public Health Priority. Geneva: World Health Organization; 2012*.

Parks, J. A. (2010). Lifting the Burden of Women's Care Work: Should Robots Replace the "Human Touch"? *Hypatia, 25*(1), 100-120. http://onlinelibrary.wiley.com/doi/10.1111/j.1527-2001.2009.01086.x/abstract

Portugal, D., Alvito, P., Dias, J., Samaras, G., & Christodoulou, E. (2015). SocialRobot: An interactive mobile robot for elderly home care*IEEE*. Symposium conducted at the meeting of the 2015 IEEE/SICE International Symposium on System Integration (SII). Retrieved from http://ieeexplore.ieee.org/Xplore/login.jsp?url=http%3A%2F%2Fieeexplore.ieee.org%2Fiel7%2F7397479%2F7404874%2F07405084.pdf&authDecision=-203

Rosenthal, S., & Veloso, M. M. (2012). Mobile Robot Planning to Seek Help with Spatially-Situated Tasks Symposium conducted at the meeting of the AAAI Retrieved from http://www.cs.cmu.edu/~mmv/papers/12aaai-RosenthalVeloso.pdf

Sharkey, A., & Sharkey, N. (2011a). Children, the elderly, and interactive robots. *IEEE Robotics & Automation Magazine, 18*(1), 32-38. Retrieved from http://ieeexplore.ieee.org/abstract/document/5751987/

Sharkey, A., & Sharkey, N. (2012). Granny and the robots: ethical issues in robot care for the elderly. *Ethics and Information Technology, 14*(1), 27-40. http://link.springer.com/article/10.1007/s10676-010-9234-6

Sharkey, N., & Sharkey, A. (2010a). The crying shame of robot nannies: an ethical appraisal. *Interaction Studies, 11*(2), 161-190. Retrieved from https://www.lucs.lu.se/wp-content/uploads/2016/01/KKEG16_sem2_the-crying-shame-of-robot-nannies.pdf

Sharkey, N., & Sharkey, A. (2010b). Living with robots: Ethical tradeoffs in eldercare. *Close engagements with artificial companions: Key psychological, social, ethical and design issues*, 245-256. Retrieved from https://benjamins.com/#catalog/books/nlp.8.29shaS

Sharkey, N., & Sharkey, A. (2011b). 17The Rights and Wrongs of Robot Care. *Robot ethics: The ethical and social implications of robotics*, 267. Retrieved from http://ofutures cholar.com/paperpage?docid=2403889

Shaw-Garlock, G. (2009). Looking forward to sociable robots. *International Journal of Social Robotics, 1*(3), 249-260. Retrieved from http://link.springer.com/article/10.1007/s12369-009-0021-7

Simonov, M., Bazzani, M., & Frisiello, A. (2012). Ubiquitous monitoring & service robots for care Symposium conducted at the meeting of the 35th German conference on artificial intelligence September, Saarbrucken, Germany Retrieved from http://www.dfki.de/KI2012/PosterDemoTrack/ki2012pd20.pdf

Sorell, T., & Draper, H. (2014). Robot carers, ethics, and older people. *Ethics and Information Technology, 16*(3), 183-195. Retrieved from http://link.springer.com/article/10.1007/s10676-014-9344-7

Sparrow, R., & Sparrow, L. (2006). In the hands of machines? The future of aged care. *Minds and Machines, 16*(2), 141-161. Retrieved from http://link.springer.com/article/10.1007/s11023-006-9030-6

Sumiya, T., Matsubara, Y., Nakano, M., & Sugaya, M. (2015). A mobile robot for fall detection for elderly-care. *Procedia Computer Science, 60*, 870-880. Retrieved from http://www.sciencedirect.com/science/article/pii/S1877050915023777

Tronto, J. C. (2010). Creating caring institutions: Politics, plurality, and purpose. *Ethics and social welfare, 4*(2), 158-171. Retrieved from http://www.tandfonline.com/doi/full/10.1080/17496535.2010.484259

Turkle, S. (2012). *Alone together: Why we expect more from technology and less from each other*: Basic books. Retrieved from http://escholarship.org/uc/item/35k2p4b6#page-3

Vallor, S. (2011). Carebots and caregivers: Sustaining the ethical ideal of care in the twenty-first century. *Philosophy & Technology, 24*(3), 251-268. Retrieved from http://link.springer.com/article/10.1007/s13347-011-0015-x

van de Ven, A. A., Sponselee, A.-m. A., & Schouten, B. A. (2010). Robo MD: a home care robot for monitoring and detection of critical situations*ACM.* Symposium conducted at the meeting of the Proceedings of the 28th Annual European Conference on Cognitive Ergonomics Retrieved from https://www.researchgate.net/publication/220956463_Robo_MD_a_home_care_robot_for_monitoring_and_detection_of_critical_situations

Vanlaere, L., & Gastmans, C. (2011). A personalist approach to care ethics. *Nursing Ethics, 18*(2), 161-173. Retrieved from http://nej.sagepub.com/content/18/2/161.full.pdf

Veloso, M., Biswas, J., Coltin, B., Rosenthal, S., Kollar, T., Mericli, C., . . . Ventura, R. (2012). Cobots: Collaborative robots servicing multi-floor buildings*IEEE.* Symposium conducted at the meeting of the 2012 IEEE/RSJ International Conference on Intelligent Robots and Systems Retrieved from http://www.cs.cmu.edu/~mmv/papers/12irosvideo-VelosoEtAl.pdf

WHO. (2007). Investing in the health workforce enables stronger health systems.

WHO. (2016). Health topics : Ageing. Retrieved from http://www.who.int/topics/ageing/en/

Wilson, M. (2002). Making nursing visible? Gender, technology and the care plan as script. *Information Technology & People, 15*(2), 139-158. Retrieved from http://wenku.baidu.com/view/8367bdb8fd0a79563c1e72a2.html

Yampolskiy, R. V. (2013). Artificial intelligence safety engineering: Why machine ethics is a wrong approach. In *Philosophy and Theory of Artificial Intelligence* (pp. 389-396): Springer. Retrieved from http://link.springer.com/chapter/10.1007%2F978-3-642-31674-6_29#page-1