

## Assistive Robotic Technology: A Review

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### ABSTRACT

Older people with chronic conditions even lead to some disabilities face many challenges in performing daily life. Assistive robot is considered as a tool to provide companionship and assist daily life of older people and disabled people. This paper presents a review of assistive robotic technology, particularly for older people and disabled people. The result of this review constitutes a step towards the development of assistive robots capable of helping some problems of older people and disabled people. Hence, they may remain in at home and live independently.

**Keywords:** Robot, Assistive Technology, Older People, Disabled People.

### 1. INTRODUCTION

Global ageing varies in its extent and speed. In most developed countries, the speedy transition of population ageing has progressed for many decades. In contrary, population ageing has taken place more recently in many developing countries, alongside the decrease in fertility and mortality levels [1]. The rapidly growing population of elderly people gives rise to important issues that need to be addressed and several works that must be implemented to anticipate the problems that come with old age. In several cases, the elderly are seen as a burden for family and communities who often neglect and abandon them. At the older age, the likelihood of disability increases and hence the increasing need for long-term care and facilities to assist elderly people who endure gradual loss of body function. Elderly people need assistances anywhere and anytime in performing their daily activities.

Deployment of assistive robotic technologies is considered as a tool to enhance the wellbeing of elderly. Such assistive robots can serve various tasks and purposes in performing daily life either social care or medical sectors. The use of assistive robots focused on humans' assistances. However, robots could not replace humans' role in environment. The demographic factor through increasing ageing population influences the growth of market robots. To reach desired level of deployment, assistive robots have to meet technological challenges. Besides they should follow the requirements of task they can do. Making an assistive robot which has socially competent service in all the daily life areas is very challenging.

The aim of this paper is to provide wide information to the reader about type and purpose of assistive robotic technology, challenges, impacts and implications on

technology. This paper is organized into four sections. Section II describes about assistive robots. Section III presents challenges. Section IV is about conclusion of this paper.

## **2. ASSISTIVE ROBOTS**

The ultimate goal of assistive robots is to enhance autonomy's level of older people as well as disabled people and increase efficiency through the use of variety of cheap sensors in gathering information [2]. However, some complex tasks require human assistance to guarantee safety. Assistive robots can be classified into three categories: robots that assist physically to user, robots that have functions in companionship, and robots that can function as health and safety monitoring [3]. Some robots have functionalities more than one of these categories. While some are more beneficially involved in healthcare, others are designed more to have more positive impacts in companionship. Some kinds of autonomously assistive robots [2]: teleoperation robot which has function as a complete and permanent control of the robot, safeguarded robot which the operator guides the robot and it evaluates its own conditions as well as the environment and could perform tasks to protect itself or the environment, and autonomous control robot which has ability in performing both the low-level control as well as the high level reasoning transmitting to the operator the measured environmental data giving him the opportunity to analyze them as well as to react with high-level commands in exceptional situations. Table 1 presents kinds of assistive robots.

Care-O-bot 3 is a future household robot that assists people in performing their everyday life at homes, such as cleaning table and clearing dish washer [4]. Though Care-O-bot 3 was designed for general household assistant, it was not limited only for assisting older people. The most important thing in robot-based assistance is be able to recognize the elderly's needs. However the developments of assistive robots have not been integrated yet with older people's perspectives and preferences. Utilization is needed in order to enhance the wellbeing of elderly as well as to penetrate companies entering older adult market.

The ROBADMOM project is a robot designed to provide verbal and non-verbal interactions in performing older people's daily activities and giving feedbacks to assist older people [5]. This project was conducted in Paris and intended for older people who have mild cognitive impairments. The needs and preferences of older people were gathered, thus the behaviors towards this type of robot were determined to provide specific implementation of an assistive robot.

The HOBBIT project in Sweden developed a social assistive robot to promote independent living among seniors [6]. To acquire knowledge in developing robots for assisting older people needs user trials at older people's homes. Feedbacks from older people are needed to increase reliability and safety of an assistive robot, such as reducing falls. Reliability for socially assistive robots can be increased using smaller sensors combined with an increased distance range.

The KSERA (Knowledgeable Service Robots for Aging) project which is integration between socially assistive robot and smart home technology was developed to extend older people living independently, particularly those with COPD (Chronic Obstructive Pulmonary Disease) [7]. Sensors were installed at smart home to gather information which was used to determine robot's behavior. The KSERA was developed by considering user center design through older people

needs, treatment plans, and laboratories studies. Some factors for successful a social assistive robot include abilities of person and self-localization, context aware of personal navigation, speech recognition and generation, gestures of robots, emulated emotions, eye contact and joint attention, verbal and non-verbal interactions.

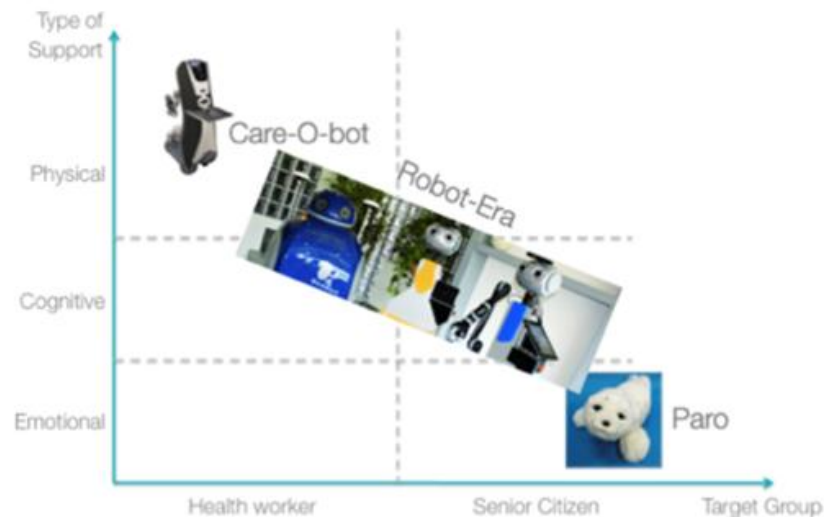


FIGURE 1. Classification of assistive robots [8]

Another type of robot is a telepresence robot which is designed to support daily activities of older people in order to enhance the well-being of older people. Additionally, it can also overcome a sense of loneliness and community isolation among older people through social interaction between older people and their professional caregivers. Telepresence is aimed to create virtually physical presence by professional caregivers to interact with older people at a remote place through the robot mobility, verbal and non-verbal communications [2].

According to [8], assistive robots are classified into six categories as depicted in Figure 1. Assistive robots can support both health workers and senior citizen (older people) physically, cognitively, and emotionally. Table 1 shows kinds of assistive robots that are developed currently.

TABLE 1.  
Kinds of assistive robots

Item	Font	Size
Care-O-bot 3/Germany [4]	To assist elderly had kinetic tremor in performing household tasks	Experiment scenarios were conducted by using the index finger to touch the screen test. The test elderly was asked to perform an “input” and they would visual feedback about what they already inputted
ROBADOM/France [5]	To provide interactions and feedbacks among	The design of study comprises qualitative and experimental

<p>elderly, which focus on context aware of robots socially and perceptions of robots for elderly</p>	<p>methods by identifying user's needs as well as robot's functionalities and behaviors to enhance personalization interaction. Thus, robot's adoption to show user's acceptances among elderly</p>
<p>HOBBIT/Sweden, Austria, Greece [6]</p>	<p>Preventing and detecting falls among elderly through low cost mobile robot</p>
<p>KSERA/Italy, Netherland, Israel [7]</p>	<p>Presenting KSERA system based on user needs, treatment plans, and lab studies</p>
	<p>User requirements were gathered through workshop, questionnaire, and interviews. Two prototypes of HOBBIT were designed. Second prototype use mobile platform, multiple sensors, an arm with 6 degrees of freedom with a gripper and a multimodal user interface. Robot had features a human detection, tracking, gesture recognition, gripping, and learning ability</p> <p>Integrating smart home technology and socially assistive robots by considering user-centered design framework to link the design with the needs and context aware. Some metrics used to measure HRI quality, usability, and user acceptance. Sensors used to gather information about robot's behavior. User studies and field trial were used to validate the approach</p>

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### 3. CHALLENGE

The assistive robots can either enhance or degrade the older people depends on the aim of robot's design itself, the use of robots, cultural habits and older people's skills and knowledge [6]. Many researchers have developed robots to assist older people or disabled people in performing their daily activities. However, most did not feel an increased feeling of safety due to the robot but its presence made them feel less lonely. Acceptances of new technology as well as impacts and implications are discussed in this section as challenges.

#### 3.1 OLDER PEOPLE ACCEPTANCE

Acceptance of technology in the individual's home is a critical component and becomes an important discussion in the implementation of the technologies. Hence, user acceptance is important in the assessment of wellbeing of the elderly population who use the technology. Robots are considered as a tool to assist older people living independently at homes. However, despite the need for assisting humans, they have poor responses and some limitations in their abilities. To match user's expectations and robots' abilities is a challenging thing in order to increase user acceptances.

Some factors that influence older people in adopting new technologies are as follows:

- Needs: The elderly's needs have high impacts on their feelings towards assistive robots, such as the need for assistance in performing their daily life [9], the need for hearing or vision assistance, the need for personally treated such as reminder alerts in performing their tasks such as taking medication [10], and the need for escalating function in emergency conditions, such as fall [11]. Elderly have been suggested to be ready to accept assistive technologies in order to assist them in maintaining their independence [12].

- Reliability issue: Reliability becomes an important issue for complex technology, such as robots. Communication has to be able to deal with extreme, especially when older people are transported in a care professional's car [13]. Power supply and battery capacity become sensitive stuffs regarding caring for older people whom are very dependent on the availability of vital information for professionals healthcare [13] [14]. Fault tolerance free such as error handling should be available since elderly people have limitation in knowledge of products and also decrease in motoric function so the possibilities of mistakes are higher. A good technology has low energy consumption, which does not require too much energy in its operation.

- Experiences in using technologies/robots: Lack of familiarity with robots can result in having feeling uncertain about robots [3]. Most of older people have lacks of knowledge in using assistive technology. They felt complex assistive technologies would be complicated in operating [13]. They also have feared that using assistive technologies would be reduced caregiver's visit.

- Economical factor: Economical factor is associated with buying power of user, which is cost. Is the cost spent for assistive technologies comparable to the benefit or value received by elderly? If the assistive cost over the economic ability of elderly, will the elderly buy the assistive technology? Cost is the most important concern of deciding whether older people or disabled people would like to use the assistive technology [14, 15]. Currently, there is no private insurance or public policy program will cover the entire cost of using assistive technology, particularly robots. Since the older people are in retire age, they do not have enough income to buy. For those are far more important of having assistive technology because of its benefits.

Older people' acceptances have important roles in making assistive robots being successfully adopted by being incorporated into the individual's life. Older people' acceptances have important roles in making assistive robots being successfully adopted by being incorporated into the individual's life. Basic requirements in adopting robots as assistive technologies for older people: motivation in using robots, ease of use, and convenience in using robots cognitively, physically, and emotionally [3].

### 3.2 IMPACT AND IMPLICATION ON TECHNOLOGY

Is there any impact of using assistive technology on the environment? One of important aspects need to be considered to increase pervasiveness is the impact of assistive technology for the environment. The more positive impact the more easily these technologies being adopted. If the use of assistive technology can decrease the activity level of elderly thereby affecting the physical and psychological health of elderly, the system will not be easily adopted socially for longer term even though the elderly people feel convenience. The impact from use of this technology should be acceptable.

Some people wondering how assistive technologies and their services would be available at home. Who will provide such technologies and services? Is the implementation of assistive technology supported by manufactures and other stakeholders such as hospital, pharmacies, and IT services?

How big research contribution and support to the development of assistive technology? As an assistive system which is new for elderly, community and society, the adoption of assistive technology relies on the support and contribution of the research conducted by research institutions or researchers, both private institutions and industries that usually conduct the same research. Sustainable and scalable research is needed to make this technology more widely adopted.

Implementations of assistive robots have several impacts on the reducing number of individuals or units involved, including reducing caregiver's visit. Another area that becomes an important concern is impact of increasingly complex of technologies involved. Home is not only a place to stay, but is also many relationships that linked to personal identity, safety, and privacy. Since health technologies move from hospital to home, the assistive technologies become more prominent. Such technologies should be able to integrate with surrounding house appliances, residents, other supporting technologies, community and social life. Elderly people have lack of knowledge and decreasing functional ability. Hence, system designer has to develop assistive technologies/robots that can be understood for older people in operating such technologies safely. User acceptance and user competence are two prominent components in adopting new technologies. The more complex new assistive technologies, the more cognitive learning required.

In term of adaptation, assistive robots have to be able to make some changes without intervention of human in planning by themselves and implementation. These changes may affect different levels of the system. Some technological challenges such as cognitive decision making, changing the operational parameters of the software or adjusting hardware depending on the environment would be involved in this adaptation process [16]. The manufactures have to involve in deployment of assistive robots and should aware of environmental and social impact. The physical makeup of robots has to meet to environmental requirements on sustainability with respect to their manufacture, utilization and ultimate recycling [16]. The design of assistive robots must include some aspects that ensure the minimum energy consumption during their lifecycles.

Ethical considerations such as privacy and trust remain concern by elderly people, family member, and healthcare provider. Privacy is usually defined as a private condition of an individual which is not disturbed by others. Some information could be considered as private by elderly people. However, each elderly people have different sense of privacy. Privacy could be a subjective issue depends on many factors, such as the closeness of the monitored elderly people and the stakeholders (family member, care giver, doctor and wellbeing expert) and type of information [17]. Who can have rights to access health information? Health

information about personal has to be processed with clear respect. With massively health condition information of elderly people generated from the use of pervasive assistive technology, they worried that the data might be used for intrusive marketing purpose such as healthcare insurances.

Assistive robots bring some implications in older people's life. The understanding that elderly is a part of social structure is necessary for elderly people in order to adapt the integration of assistive technology with surrounding technology. Moreover, the services related to their surrounding environment which is shared with others should not be intrusive. The awareness of life sharing should be developed continuously, so that elderly people will have good understanding that the operation of its services must not interfere with others, even it should be shared with others.

Older people are in the environment in which there are also several other individuals who may not be connected directly to the system, as well as other communities are related to older people in their daily lives to be part of those. An interaction between the older people with the existing system does not become something that is considered as 'foreigner' by them. It will give convenience for older people in performing their daily life. The awareness for local community and social will be reasonable implications that should be tolerated by the older people.

The success of older people acceptances will bring the enhancement of wellbeing of older people. Wellbeing is an important thing in medical research for elderly people, which its interpretation is related to age and illness. Main dimensions of quality of life according to Gabriel and Bowling are social relationship, home and neighborhood, social capital, psychological wellbeing and outlooks, activities and hobbies, health and functional ability, social roles and activities. Wellbeing is also an important aspect of quality of life, besides health status, social relations, functional ability, and activities. Wellbeing is often related to health, which is the process of improving people's health. Using assistive technology, elderly people can remain their independence at home and enhance their wellbeing [18].

#### 4. CONCLUSION

Assistive robots present huge potential to assist older people to remain independent at home of their choice as they age. Assistive robots that deliver services based on older people's particular needs and preferences can enhance the wellbeing of independent ageing. Perceptions and acceptances of technologies about the positive benefits of technologies need to be emphasized to motivate older people to use and continue using assistive technologies. Through high acceptance of the assistive technology will result in easier to adopt and adapt the assistive technologies, so that older people can feel as a part of their daily life. Finally, it should be noted that this contribution constitutes only a step towards the development of assistive robots capable of helping some problems of older people and disabled people, so that they may remain in at home.

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