Francesca Tosi, Mattia Pistolesi

Home Care Design for Parkinson's Disease

Designing the Home Environment for People with Parkinson's Disease

HOME CARE DESIGN
FOR PARKINSON'S DISEASE

Serie di architettura e design
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Contents

Research contract between Fondazione Zoé and Department of Architecture DIDA, University of Florence, Laboratory of Ergonomics and LED Design.

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7. Design and disability: new enabling technologies

by *Claudia Becchimanzi*[1]

7.1 Robotic and wearable technologies: a powerful tool to support caregivers and PwP

Robotic and wearable digital technologies are making significant progress in a wide range of fields (Yang et al., 2018), including medicine and social-health care. They are currently playing, and will be able to play, a key role in the future, implementing human perception and skills and creating the right conditions for improving the quality of life of PwP (people with Parkinson's) and services addressed to them, improving their mobility, communication possibilities, increasing their sense of security and independence and promoting social inclusion (Ancona et al., 2021; Sapci & Sapci, 2019).

Assistive robotics has seen a strong development in recent decades: Japan has been the pioneer country, investing a lot of resources in developing but also experimenting with increasingly sophisticated and intelligent platforms. Europe is also pursuing the same objectives, through the most recent strategic research programmes such as the European Strategic Research Agenda for Robotics in Europe 2014-2020 (SPARC)[2]. Similarly, the RAS 2020 (Robotics and Autonomous Systems)[3] programme in the United Kingdom also pursues the objective of developing robotics aimed at social and health care. Advanced robotics is among the five revolutionary technologies that will transform private life, work and the global economy (Manyika et al., 2013) by actively cooperating with humans (Čaić et al., 2018; Alwardat & Etoom, 2019). Furthermore, with regard to the domestic robotics market alone, the number of adopted robotic systems increased by 31 million between 2016 and 2019 (IFR, 2020). The market value of robots for performing strenuous and/or risky household tasks has grown by 13 billion in this timeframe. In addition, the assistive robotics market is expected to increase from $4.1 billion in 2019 to $11.2 billion in 2024 with a Compound Annual Growth Rate (CAGR) of 22.3% (Markets and Markets, 2019). Wearable devices, compact and miniaturised, are worn directly by people, creating a constant interaction between computer and user. The wearable technology which

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2 Cf. www.eu-robotics.net/sparc/.

3 Cf. www.ukras.org.

includes a wide range of devices, services and systems developed with a view to incorporating technology into homes and everyday products, is opening new avenues for their application and major opportunities for research and design (Piwek et al., 2016; Møller & Kettley, 2017; Rinaldi et al. 2018). The network-connected devices (and among them the Internet of things - IoT), which in 2015 were more than 5 billion, will be about 28 billion by 2025 for a value of about 11.000 billion, or 11% of the entire world economy (Manyika et al., 2015). The integration of new technologies into interconnected systems can facilitate the activities of health workers (for example, health monitoring, drug control, environmental safety) and can prevent loneliness and isolation by supporting PwP in Activities of Daily Living (ADLs) and by facilkitating socialisation and an active emotional and cognitive stimulation. Wearable and robotic technologies can contribute to home autonomy, monitoring health and safety (Iecovich, 2014) to ensure a viable and less expensive alternative to institutionalised care (who, 2007), but also to support the diagnosis and treatment of Parkinson's disease (Rovini et al., 2017; Paff et al., 2020; Hubble et al. 2015; Pardoel et al., 2019).

This chapter investigates the research areas and the main areas of application of assistive technologies in relation to PwP, with a focus on the state of the art at the international level through the analysis of representative case studies and on ethical issues related to the dissemination of *Assistive Technologies* (ATs). In addition, this paper briefly questions the role and challenges of Design in relation to the Human-Robot interaction (HRI) and the subject of technology acceptability. They concern both design and research through Design: The Designer plays a key role not only as a professional able to identify people's needs and translate them into tangible solutions but also as responsible, from an ethical and social standpoint, for the use and dissemination of technologies designed to support and not replace human activities and relationships.

7.2 Assistive technologies and the Internet of Things: principles, taxonomies and research areas

Digital technologies are becoming increasingly widespread and developed, due both to the progress of software and hardware research and to the increase of functions and, therefore, of application fields. Assistive Technologies (ATs) are defined by the World Health Organization (WHO)[4] as "*any product, instrument, equipment or technology adapted or specially designed to enhance an individual's ability and independence to facilitate participation and improve overall well-being*". According to the Association for the advancement of Assistive Technology in Europe (AAATE)[5] "*assistive technology is a term for any technology-based product or service that can facilitate people with functional limitations of all ages in daily life, work, and leisure*".

Hersh & Johnson (2008) propose an explanation of the term in a broader sense, inclusive of products, environmental changes, services and processes that allow access to and use of ATs, in particular by people with disabilities and the elderly. So ATs help users overcome infrastructure barriers to enable their full participation in social activities, safely and easily.

4 Cf. www.who.int/disabilities/technology/en/.

5 Cf. www.aaate.net/about-aaate/.

Cook & Polgar (2014) proposed five principles for the effectiveness of ATs: Services must be person-centred; the objective is to allow the person to participate in the desired activities; the provision of assistance services must occur through a process based on evidence and information; assistive technologies must comply with ethical standards; ATs must be sustainable.

According to the latest report from SAPEA (Science advice for Policy by European Academics), the main areas of implementation of new assistive technologies are (Michel et al., 2019):

(i) physical health and applications for social and cognitive health, whereby m-health, based on smartphone use, plays an increasingly important role in health monitoring and in supporting the adoption of correct lifestyles, in a preventive prespective;

(ii) design according to the principles of Inclusive Design: this means that smart home technologies provide greater safety and support for daily activities and social connection (a fundamental contribution is also made by the rapid spread of social and assistive robots, wearable products and/or interconnected systems);

(iii) care technologies and wearables: they facilitate permanent follow-up of health, chronic clinical conditions and functional capabilities through remote monitoring, physical rehabilitation at home, brain training and drug intake/administration control;

(iv) applications of machine learning algorithms (AI) for diagnostic and surgical procedures, which offer enormous possibilities.

Part of the research concerns the integration of robotic or micro-robotic systems into the use of everyday products or furniture, such as smart cabinets capable of monitoring and/or remembering drug use (Ennis et al., 2017). Other projects concern the development of wearable devices to monitor and communicate any diagnosis directly to health professionals (German et al., 2017). McNaney et al. (2014) investigated the acceptability of Google Glass as PwP and caregiver assistive devices, both in the home and outdoors. Research has revealed generally positive trends toward the device, which instils confidence and security, even if it gives rise to concerns about the possible stigmatisation of users and the need to ensure as much as possible the independence of the others.

Moreover, the potential of digital assistants such as Alexa (developed by Amazon[6]) or Siri (developed by Apple[7]) in the health and care sector is very broad, though still limited in comparison to the state of the art in the robotic field (Wicklund, 2018; Reis et al., 2017). IoT (Yan et al., 2008) describes the connection of devices and products to the Internet, including household and sanitary appliances, motor vehicles, etc. Once connected, each product can store and process information on the network independently but also communicate with other devices in the network.

It is clear, therefore, that IoT technologies can be a valuable tool in support of the Ageing in Place and the diverse needs of PwP, in the smart home, in telemedicine and in remote monitoring. According to Asakawa et al., (2019) digital technologies, including virtual reality and interconnected wearable and robotic systems, can improve both the diagnosis and treatment of Parkinson's disease. The use of these technologies can support a safe, objective and real-time assessment. That is why their development can revolutionise the treatment of neurological diseases.

6 Cf. www.amazon.it.
7 Cf. www.apple.com/it/siri/.

However, there are several studies that highlight the problems of assistive technologies. Sometimes there is a lack of adaptation between people's daily lives, their needs and the available technologies (Greenhalgh et al., 2015; Sanders et al., 2012). In other cases, the low rate of ATs adoption may depend on inefficient interface design, privacy or security concerns (Yusif et al., 2016) or economic or socio-cultural barriers (Wang et al., 2016).

As many solutions are identified in the greater inclusion of users and of formal and/or informal caregivers in the design processes, for example through co-design sessions (Beringer et al., 2011), but also through an evaluation of such systems based on the real needs of the end users (PIETRZAK et al., 2014).

However, despite the obvious revolutionary scale of these new technologies, whose benefits have been demonstrated globally through a variety of research and experimentation programs, it is important to bear in mind that they must be integrated into domestic environments and people's daily routine, still without being invasive or incurring the risk of distorting environments and habits.

In order to avoid the risk of creating an incompatibility between technology and human activities, it is essential to ensure the effective adoption and management of these digital products, so that the interaction between people, social and domestic space and technological dimension can be pleasant and comfortable (Rodden & Benford, 2003), but also reliable and acceptable.

7.3 Assistive robotics: application areas and representative cases

The scientific community provides different taxonomies and classifications of *assistive robotics*, dividing platforms according to the type of assistance provided (physical or non-physical), the ability to socialise or establish an effective interaction from the psycho-emotional standpoint (Feil-Seifer & Matarić, 2011) and formal and morphological characteristics (automata, zoomorphic or humanoid robots) (Dautenhahn, 2013).

Social and assistive robotics can counter solitude and social isolation, especially in facilitating a human-human interaction that is independent of direct contact. From this perspective, robotics can optimise the workload and services offered by healthcare workers and caregivers, while safeguarding collective health (Yang et al., 2020).

Social/assistive robots and *educational robots* have made considerable progress in recent years, both from regarding social recognition and linguistic expression. For this reason, robot-human interaction becomes more intuitive and fluid and robots are more effective from the standpoint of cognitive assistance, social interaction and user involvement in various activities (Lee & Davis, 2020). *Therapeutic robots*, very often zoomorphic, have shown benefits in the interaction with PwP, Alzheimer's or cognitive problems. Service robots, oriented to efficiency and functionality, guarantee the support to the performance of ADLs. *Companion robots*, combining artificial intelligence and learning skills, have considerable potential in mitigating the sense of solitude and maintaining psycho-emotional well-being (Odekerken-Schröder et al., 2020).

Medical robots can support doctors and surgeons during medical exams or surgery and support patients during rehabilitation, while prosthetic robots can replace limbs, muscles and perform analogous functions.

In relation to Parkinson's disease, research is investigating how robotic systems, connected in the cloud with wearable devices and sensors integrated into the home environment, can help PwP to be as independent as possible, but also support carers in their tasks (Asakawa et al., 2019; Valenti et al., 2020; Wilson et al., 2020).

In addition, many of the studies in literature focus on identifying frameworks for future developments in service and assistance robotics (McGinn et al., 2018) while others emphasise the importance of recognising and including in the design brief the specific and particular requirements and needs of PwP (Wilson et al., 2020), which are not generally comparable to those of other types of users.

Prescott & Caleb-Polly (2017), as part of the white paper of the UK Robotics and Autonomous Systems (UK-RAS) network, outline a real roadmap for the development of social and welfare robotics, identifying the necessary advances in physical capabilities, artificial intelligence and integration between technologies in order to generate a sustainable and ethical connected care ecosystem (connected care Ecosystem for independent living) to support the maintenance of an autonomous life in the home for as long as possible.

The Multi-Annual Roadmap (Robotics 2020, Multi-Annual Roadmap for Robotics in Europe)[8] identifies the main issues to be addressed for the application of robotics, especially in relation to healthcare:

(i) reliability (dependability): the ability of the system to perform assigned tasks without errors, so that end users depend on and rely on the proper functioning of the robotic service. In fact, assistance structures can delegate some activities to the robots only if they are reliable and, in order to guarantee the safety of the users, they should have qualified personnel as well as highly tested robotic systems;

(ii) ability of social interaction: the robot's ability to interact with humans, correctly interpreting social and subjective signals and reacting accordingly. In the field of assistance, robots are involved in the interaction with primary users but also with other actors (family members, caregivers, doctors, etc.), so that the interaction must be simple and intuitive for all;

(iii) human-robot interaction skills: today's robotic systems are not always able to perform predefined actions independently while interacting with humans. In order to be effective, a service robot should guarantee its own autonomy or in any case safety in case of remote control;

(iv) decision-making autonomy: The constant changes in real environments require a solid technology (robustness) able to handle uncertain data. It is therefore necessary to validate robotic systems in realistic environments and scenarios to verify their decision-making processes in critical situations.

The area of "socially Assisted Robotics (SAR)", consisting of the intersection between the two categories of *Socially Interactive Robotics* (SIR) and *Assistive Robotics* (AR), includes all robots that create an effective interaction with human beings but not with regard to the interaction itself (as is the case with SIR) or based solely on physical interaction (as in the case of AR) but in order to provide assistance or support to users.

The aim of SAR is to use social interaction to achieve insurable progress in the fields of rehabilitation, convalescence, education and treatment, etc. (Feil-Seifer & Matarić, 2005).

8 Cf. www.eu-robotics.net/cms/upload/downloads/ppp-documents/Multi-Annual_Roadmap2020_ICT-24_Rev_B_full.pdf.

Lee & Riek (2018) propose a further subdivision of SARs, highlighting that social and welfare robots have been conceived primarily as "compensation" technologies, that is, to compensate for a physical, cognitive and/or psychosocial decline:

- Physical compensation: some robots aim at alleviating physical decline by supporting people in carrying out daily activities (cooking, eating, washing, etc.) or to prevent falls. Examples in this field are Care-O-Bot or Hobbit, able to perform various activities and provided with semi-humanoid bodies (with robotic arms) which allow them to manipulate objects and perform various services.
- Cognitive compensation: some robots aim at compensating for some cognitive deficits, from mild memory loss to severe dementia. In these cases, service robots support drug management, act as reminders for appointments, or enhance cognitive well-being through daily interactions. An excellent example is represented by Paro, zoomorphic robot with validated therapeutic abilities.
- Psycho-social compensation: solitude and social isolation are frequent problems in the elderly population that can lead to serious physical and psycho-cognitive problems. In this field there are two types of robots: company and conversation robots (such as Paro or iCat) and telepresence robots.

In short, social and service robots can offer assistance at different levels (Rich & Sidner, 2009):

(a) to support the cognitive or functional capabilities of the user (e.g., reminder and monitoring of activities, navigation aid);

(b) to offer the user the opportunity to improve social participation and psychological well-being (e.g. communication and social applications, telepresence, company);

(c) provide remote and continuous monitoring of the user's health status (for example, blood pressure or fall detection sensors);

(d) instruct the user to facilitate the promotion of healthy behaviour and the achievement of health-related objectives (for example, improvement of nutrition, physical activity).

In addition, attention to the therapeutic use of social and assistive robots is increasing in recent years, especially for people with dementia or specific diseases such as Alzheimer's (Libin & Cohen-Mansfield, 2004).

Regarding the benefits of SARs in the specific area of mental health and cognitive abilities, Rabbitt et al. (2015) have identified the main roles of robots: companion (e.g. SAR working in a similar way to trained therapy animals); therapeutic gaming partners (e.g. SAR used to help children develop clinically relevant skills); coach or trainer (e.g. SAR providing instructions, encouragement and supervision to users in activities such as weight loss or exercise).

7.3.1 Socially assisted robotics: users, activities, and types of interaction

The area of the Socially Assistive Robotics (SAR), based on a human-robot interaction without physical contact, is safer, proven to be more effective in testing and experimentation and promotes the learning of skills and models of behaviour more useful and valid in the long term (Feil-Seifer & Mataric, 2005).

Therefore, starting from the taxonomy proposed by Fong (2003), Feil-Seifer & Mataric (2005) identify the properties that characterise a SAR, in terms of users, activities and sophistication of interaction (vadi Tables 7.1, 7.2, and 7.3).

Based on the above properties, it is clear that SAR, by establishing social rather than physical interactions with people, has the potential to improve the quality of life of many types of users, including PwP, the elderly, persons with specific physical and/or cognitive needs and/or in rehabilitation.

For these reasons, the investigation and research of Human-Robot-interaction (HRI) in SAR are rapidly spreading and require transdisciplinary efforts in countless areas (medicine, robotics, social sciences, neuroscience, design, etc.).

Users (SARs may assist one or more types of users.)	Elderly and non-autonomous people: Robots can provide care to elderly or fragile people, provide company to relieve stress and depression, or support information management such as nursing home schedules.
	Individuals with different levels of physical ability: Robots can act as mobile prosthetic devices, with features traditionally associated with wheelchairs or other mobility support systems.
	Convalescent individuals: Robots can provide care in hospitals or nursing homes.
	Individuals with different cognitive needs: Robots can effectively assist people with autism, with particular cognitive or behavioural needs.

Tab. 7.1 The main types of users that SARs can assist and support.

Activity (SARs can perform a variety of tasks, according to the nees of users they interact with).	Tutors: Robots can be good assistants to support teaching, especially practical. Although they cannot replace human teaching, they allow the teacher to focus on individual interactions, supporting them in the course of personal exercises or tutoring for small groups of students.
	Therapy and rehabilitation: SARs are widely used for therapies related to specific diseases (Parkinson's, Alzheimer's), for cognitive and/or physical stimulation. They find great application in the field of rehabilitation activities or similar exercises, supporting the operators in the achievement of rehabilitation objectives.
	Daily care: Robots can assist individuals both from a cognitive and physical perspective, in carrying out common and frequent daily tasks.
	Emotional expression: SARs can be an important incentive to express emotions, as is the case, for example, in children with autism or with serious diseases. Moreover, by stimulating the communication of emotions, they can facilitate socialisation and interaction between humans.

Tab. 7.2 The main activities SARs can perform in relation to the different types of users with which they interact. Some activities are included as examples only.

Interaction sophistication (interactions established by SARs may vary by type but also by refinement and are different from the personality shown by robots).	Verbal communication: Conversation is a natural mode of interaction between people and, therefore, it would be appropriate with robots as well. A robot, in this case, can use a pre-recorded human voice or generate a synthetic voice.
	Gestures: Body language is a fundamental component of human communication, especially when it completes those meanings expressed only partially with a speech. For this reason, this type of interaction is very useful to increase the effectiveness of communication between humans and robots. For example, in a real environment, it can be very important for a robot to point an object or even just use gestures to focus attention in an interaction.
	Direct input: The ability to provide direct guidance or information to a robot can help in situations where voice or gesture commands are redundant or too tedious. It may be useful, for example, to provide direct input to the robot via a touch screen or a mouse, so as to make the human-robot interaction effective, albeit less natural. Moreover, for some users this type of interaction may be the only suitable form, due to physical and/or cognitive problems or disabilities.

Tab. 7.3 The most common types of interactions established by SARs. The interaction can vary both in type and in refinement.

7.3.2 Assisted robotics for Parkinson's disease: representative cases

In the literature, several scholars have categorised and divided SARs according to different criteria, based on the level of sociality and the type of interaction and/or assistance provided and the activities carried out. From the morphological standpoint they can be subdivided into (Dautenhahn, 2013): Automata or mechanoid (with a mechanical aspect), zoomorphic (animal-like) and humanoid (human-like). This latter category includes android robots, i.e. those designed starting from basic human characteristics but not realised in such a way as to be aesthetically identical and almost indistinguishable from a true human being (as in the case of humanoids).

The category of automata robots includes both mobile and non-mobile platforms, without appendices (for example, arms or manipulators of any kind). This category includes: VGO[9], a telepresence robot primarily dedicated to doctors and healthcare professionals for remote patient monitoring; Hobbit[10], a robot for prevention and detection of falls; Kompai[11], an assistant for the communication and management of physiological parameters by carers; Giraff (and the subsequent GiraffPlus)[12], a robot for company and telepresence.

9 Cf. www.vgocom.com.
10 Cf. www.hobbit.acin.tuwien.ac.at.
11 Cf. www.kompairobotics.com/robot-kompai/.
12 Cf. www.giraff.org/?lang=en.

One of the most exemplary zoomorphic robots is PARO[13], with the appearance of a seal, produced in 1993 by Takanori Shibata, developed in Japan by the National Institute of Advanced Industrial Science and Technology (AIST) and marketed in 2004 by Shibata Intelligent System Co. PARO has been designed to provide all the benefits of pet therapy in hospitals or care facilities, environments where the use of real animals can be difficult or complicated from a logistical standpoint. It is equipped with five types of sensors through which it perceives the environment and interacts with people: tactile, temperature, light and sound sensors, posture sensors. PARO is able to distinguish light and darkness, to respond to voice commands and also to "learn" how to behave based on previous experiences. The robot seal reduces the stress of patients and caregivers, stimulates interaction, improves motivation of people, and supports socialisation between patients and health workers. One of the main limitations, however, is that it can only be used in specialised nursing facilities.

Older and functional systems of zoomorphic robots are JustoCat[14] and Joyforall[15], similar to dogs or cats with soft fur that react to contact. The robot with a dog-like appearance, Miro[16], is dedicated to the safety of the house and the owners. It is entirely programmable and has been developed for researchers, educators, developers and professionals in the health sector.

Another example of a zoomorphic robot is AIBO[17]. This robotic dog was developed by Sony from 1999 until the release of the latest model in 2017. AIBO can hear sounds and noises, see what surrounds it, so it can move on its own. Interaction with people mainly occurs through voice commands but the robot is able to react to external stimuli, coming not only from people but also from the surrounding environment. It has artificial intelligence (AI) connected to a proprietary cloud, which allows it to evolve from a puppy to adulthood, but also to configure its own personality, behaviour and knowledge based on experiences and interactions with humans.

Androids also include platforms very similar to real desktop digital assistants, such as ElliQ[18], Mabu[19] and Matilda[20], specifically designed for company and assistance in the domestic environment and nursing homes. To promote social interaction and connection and emotional care of PwP and the elderly in general. Their contribution is also addressed to carers, as these robots can facilitate control and assistance operations.

Matilda is a service robot for communication, assistance and company, developed in collaboration between NEC Corporation - Japan and RECCSI[21] at the University La Trobe in Melbourne. The small robot has human similarities terms of appearance and behaviour (interacts with voice, gestures, expressions and emotions), is able to trace and recognize faces and react to touch thanks to sensors. The wireless connection allows it to be connected to the cloud so as to build a network integrated with other ICT technologies. It has been tested mainly with PwP and the elderly, revealing a high level of acceptance by

13 Cf. www.parorobots.com.
14 Cf. www.justocat.com/.
15 Cf. www.joyforall.hasbro.com/en-us.
16 Cf. www.consequentialrobotics.com/miro/.
17 Cf. www.us.aibo.com.
18 Cf. www.intuitionrobotics.com/elliq/.
19 Cf. www.cataliahealth.com/introducing-the-mabu-personal-healthcare-companion/.
20 Cf. www.latrobe.edu.au/reccsi.
21 Cf. www.latrobe.edu.au/reccsi.

users and, above all, effectiveness in involving them in individual and/or group activities, to improve the personalisation of care and overall well-being (Khosla et al., 2012). The people involved in the study used Matilda to play games, send mail to relatives, know the calendar of the day's activities both through voice and touch commands, according to their needs.

The different interaction modes allow the robot to customise its assistance for the various participants. Games with Matilda had a positive impact on the cognitive activity and on the sense of usefulness among the participants.

Experiments carried out with Matilda show that the synergy of artificial intelligence with techniques measuring emotion (and generating emotional emotions in users) can support and increase the psychological well-being of people, involve them positively, and making them productive and resilient (Khosla et al., 2013).

The ElliQ[22] robot was developed by Intuition robotics and presented at CES in Las Vegas in 2019. Designed specifically for the elderly, ElliQ aims at supporting them in autonomous, active and connected conditions while staying at home.

Fig. 7.1 the ElliQ robot, with artificial intelligence, designed by Intuition Robotics. Image: Intuition Robotics, source: www.intuitionrobotics.com.

Thanks to the artificial intelligence and the possibility to connect with other smart objects in the house, ElliQ is both a companion and social robot and a full assistant.

It can initiate video calls, play music and videos, or simply show photos. Reminds of appointments and when it's time to take any drugs It suggests initiatives to keep active,

22 Cf. www.elliq.com.

such as courses, lectures and other digital content, learning more and more about the owner's behaviour and personality over time. It can calm the person and call emergency relief and offer cognitive support and stimulation. ElliQ responds to the individual's voice, touch, and gaze and reacts with movement and voice; interaction is facilitated by the presence of a tablet. Its appearance is not humanoid or zoomorphic but recalls a kind of table lamp with minimal design. It is likely that the designers have chosen a clear reference to objects common and familiar to the reference users, so as to increase the acceptability of the robot. ElliQ is an innovative project not only for its functionality but also from the standpoint of the Design and the formal elements that characterise it (see Fig. 7.1). There are also mobile and non-mobile robots that are more commercial and, in addition to being excellent companions for the elderly, are real assistants for the whole family.

The main examples are Jibo[23], Kuri[24], Zenbo[25], Aido[26] and Buddy[27]: they can perform many functions, from support to communication and home security.

Finally, there are manipulative robots, of which Pepper[28] is the most representative. In addition to providing emotional support, it has two arms that allow it to grip and move light objects.

In the same category are Care-O-Bot IV[29] and Personal Robot 2[30], mobile robotic assistants able to support people in the home with the activities of Daily Life (ADL).

Riba II[31] (Robobear) is dedicated to healthcare, it can lift weights and help patients in walking.

The humanoid robot NAO[32] (see Fig. 7.2), by Softbank Robotics and totally programmable, is widely used in educational, health and research fields in various sectors. From the experiment of Torta et al. (2014), it can be seen that NAO has improved human-robot interaction and user confidence acceptance. NAO has been used by Briggs et al. (2015) in a study on facial masking of Parkinson's disease. Such a symptom, in fact, can be interpreted as apathy or dishonesty by carers and adversely affect social relations.

The study aims at the development of future "robotic mediators", which could alleviate any tension in the caregiver-patient relationship, intervening in the event of ambiguity or misunderstanding. The research also investigates the level of acceptance of a robot within health processes by PwP. Participants reacted positively to the robot, despite preference for interaction with a human being. A similar study was conducted by Valenti et al. (2020) as part of a project for the development of a prototype of social welfare robots for people with Parkinson's disease. The aim of the research is to implement the robot's ability to detect and express emotions through different modes (for example, it can detect emotions from a speech and return them in the form of gestures or images). The results of the study are particularly relevant in the perspective of the use of technologies and support to the expression of emotions through digital communication systems, which do

23 Cf. www.jibo.com.
24 Cf. www.heykuri.com.
25 Cf. www.zenbo.asus.com/.
26 Cf. www.tuvie.com/aidoadvancedsocialrobotforsmarthomeinspiredbydolphins/.
27 Cf. www.bluefrogrobotics.com.
28 Cf. www.softbankrobotics.com/emea/en/pepper.
29 Cf. www.care-o-bot.de/en/care-o-bot-4.html.
30 Cf. www.willowgarage.com/pages/pr2/overview.
31 Cf. www.riken.jp/en/news_pubs/researCH_news/PR/2015/20150223_2/.
32 Cf. www.softbankrobotics.com/emea/en/nao.

not always provide for the possibility of expressing emotions through all possible channels (facial expressions, gestures, posture, tone of voice, etc.).

Wilson et al. (2020) on the other hand, apply NAO in the context of research into the development of robotic and/or artificial intelligence systems that are actually useful, acceptable and capable of supporting PwP. Scholars, therefore, develop and evaluate the architecture for a fully autonomous robot designed to assist older people with Parkinson's disease in sorting out their drugs. The robot's main objective is to help PwP maintain independence for as long as possible, by providing cognitive and social support at different levels, depending on user needs. The results of the research highlight a number of challenges for HRI in relation to Parkinson's disease: To design a robot capable of adapting to the different routines of PwP; to design systems based on the unique needs of PwP; to involve PwP in the design and development process.

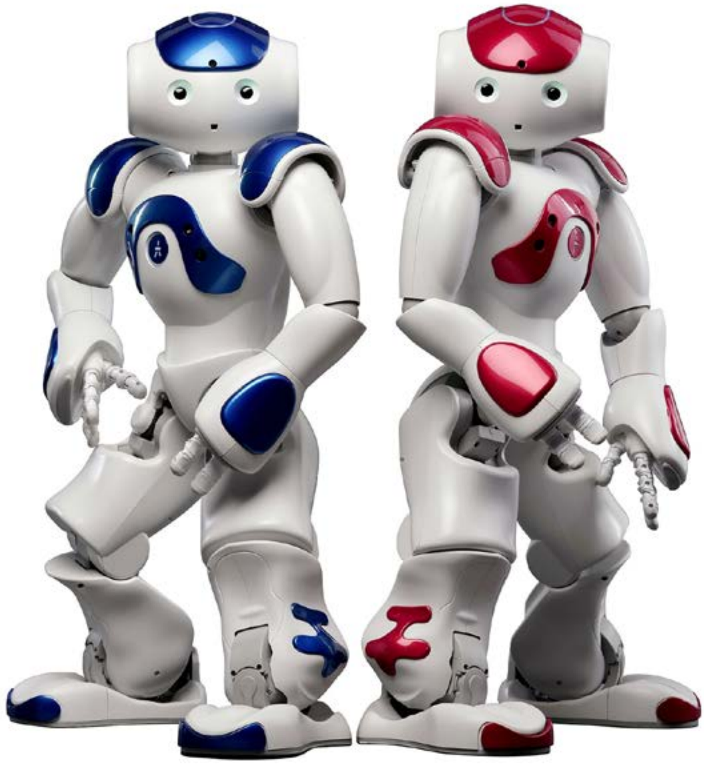

Fig. 7.2 the humanoid robot NAO by Softbank Robotics. Image of Softbank Robotics Europe - own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=62202564.

7.4 A brief outline of ethical issues for new digital technologies

While the benefits and potential of robotics leave room for countless research directions, they also point to ethical and social issues that experts have been debating for years and pose additional, increasingly complex, and broad ones. Indeed, the growing use

of robotic and wearable technologies also brings with it an increase in the ethical issues related to them, both in the scientific and humanistic fields. This topic is so debated that it has generated a vast area of research, Roboethics (Veruggio et al., 2016), with the aim of developing scientific and cultural instruments for the analysis of the ethical implications of assisted robotics, with a view to preventing any abuse against mankind. Ethical issues, especially in relation to the theme of Health Design and technologies for PwP or fragile persons, are extremely sensitive and require detailed guidelines regarding all legal, moral and social aspects. They also concern the reduction of human contact, the loss of personal freedom, the loss of privacy, issues concerning responsibility, infantilisation, emotional deception and attachment (Sharkey & Sharkey, 2012; Veruggio et al., 2016).
However, it is also possible to say that these problems are only one side of the coin. In any negative aspect, in fact, it is possible to find positive feedback, which makes these issues even more complex (Van Maris, 2020).

According to Casey et al. (2016), the most urgent issues, particularly in the case of technology for persons with neurological diseases, include: change or modification in the nature of care; replacement of human care; autonomy of human beings with a view to possible restrictions by the robot concerning safety; negative impact on dignity; emotional attachment of the user and/or excessive dependence on the robot; safety and privacy-related concerns.

Feil-Seifer & Mataric (2011) apply a consolidated medical ethical model to identify some fundamental ethical principles in the field of assistive robotics: They should act in the best interest of the patient; they respond to the principle "first of all, do not harm", so robots should not harm a patient; they should give the patient the opportunity to make a decision based on informed, non-forced care; fair distribution of scarce health resources.

7.5 The role of Design

Based on what has emerged from the previous paragraphs, the key role of Designers and their design approaches in the development of truly human-centred technologies, which should be built with respect for fundamental human rights and then be adapted flexibly, depending on the different situations, the values, beliefs, expectations and desires of the individual users, supporting their independence and assisting them in improving their well-being and quality of life.

The vision of a Designer can give an important push to inspire new technological advances and translate them into new categories of emerging products, offering unique perspectives both in problem solving, and in problem setting. Indeed, it is no coincidence that the Commission Staff Working Document on "Design as a driver of user-centred innovation" analyses the Design's contribution to innovation and competitiveness and strongly claims that, although Design is often associated only with the aesthetics of the products, its application is in fact much wider. User needs, aspirations and skills are the starting points and focus of Design activities, with a potential to integrate environmental, safety and accessibility considerations into products, services and systems (Rinaldi, Becchimanzi, Tosi 2018).

Digital technologies are therefore a resource to support caregivers and PwP and present Design and designers with new challenges, different needs and expectations.

From this perspective, the Human-centred Design/HCD approach and the ergonomics for Design (Tosi, 2018) can make an important contribution to identifying and analysing needs that are often silenced, in order to create products centred on people. Moreover, the acceptability of technology is a delicate matter, whose parameters of evaluation offer many challenges to research in Design. PwP want products that can satisfy their aesthetic desires and functional needs but, above all, respect the values of personal identity, dignity and independence.

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This volume collects the results of the research programme *Home Care Design for Parkinson's Disease*, aimed at defining good design practices to enhance the autonomy and quality of life of people with Parkinson's disease within the home environment.

The programme, promoted and financed by the Fondazione Zoé, was realised by a multidisciplinary work group – which involved the University of Florence for the area of design, the University of Turin for the area of neurology, the Catholic University of Milan for the area of sociology, the Universidade Federal de Minas Gerais (Brazil) for the area of industrial production engineering – in collaboration with the Confederazione Parkinson Italia and the Accademia Limpe-Dismov.

The book proposes an introductory overview of Parkinson's disease from a medical and sociological point of view, analysing the main and most frequent areas of discomfort and/or difficulty experienced by people with Parkinson's disease during activities of daily living and relationships.

The project approach is based on the principles of Design for Inclusion and on the theoretical and methodological approach of Human-Centred Design which, through the direct involvement of users, have made it possible to focus attention on the specific needs and expectations of people with Parkinson's disease and their families and to define the different design solutions.

Specific insights are devoted to the emotional effects of interaction with the environments and products of everyday life, and to the opportunities offered by the use of enabling technologies, which, from robotics to wearable devices to environmental monitoring technologies, can offer concrete solutions for enhancing independence.

The second part of the book is dedicated to the design guidelines that provide solutions and operational indications to ensure maximum usability, safety and pleasantness of use of the home's interior, its furnishings and equipment.

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La passione per le conoscenze