Norsk Regnesentral
NORWEGIAN COMPUTING CENTER

Note

# Report on User Activities in UD-Robots Project – Are Social Robots Universally Designed?

## UD-Robots

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| Note no. | DART/23/12/22 |
| Authors | Diana Saplacan; Zada Pajalic; Trenton W. Schulz |
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## Authors

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## Norsk Regnesentral

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## University of Oslo

The University of Oslo is a public research university located in Oslo, Norway. It is the highest ranked and oldest university in Norway. It is consistently ranked among the top universities in the world and as one of the leading universities of Northern Europe; the Academic Ranking of World Universities ranked it the 58th best university in the world and the third best in the Nordic countries. In 2016, the Times Higher Education World University Rankings listed the university at 63rd, making it the highest ranked Norwegian university. The Department of Informatics at the University of Oslo is the oldest and largest department for informatics in Norway. The department was in 2017 ranked number 1 in Norway, 3rd in Europe, and 12th in the world in Computer Science and Engineering by Academic Ranking of World Universities. Famous researchers that have been associated with the department includes Turing Award winners such as Kristen Nygaard, Ole-Johan Dahl and Donald Knuth. The Robotics and Intelligent Systems Research Group (ROBIN) at Department of Informatics, University of Oslo covers research within various areas, including advanced and complex systems such as robots, but also smartphone. The research group has advanced knowledge within artificial intelligence and machine learning, from simulation to rapid prototyping of robots using 3D-printer and CN-milling machines. The work at ROBIN covers both fundamental and applied research. As part of the applied research, we conduct studies with users and robots within the field of Human-Robot Interaction. These studies are often inter, trans- and cross-disciplinary at the inter-, trans- and cross-section of design, user-experience, engineering and robotics, psychology, and health sciences, but also other fields (musicology, rhythm, time, and motion).

## VID Specialized University

VID Specialized University is an accredited, private higher education institution. With approximately 560 employees and 5590 students VID is the third largest private higher education institutions in Norway. VID Specialized University undertakes education and research in the fields of health and social sciences, educational science, management, diaconial studies, and theology. The University offers approximately 50 study programmes at bachelor's, master's and PhD levels, and their objective is to develop as a national institution through regional cooperation. The University has campuses in Oslo, Bergen, Stavanger, Sandnes and Tromsø. The research group Sustainable Healthcare and Welfare Technology (SHWT) conducts research that thematizes innovation, implementation and evaluation related to the development of health care in collaboration with health personnel and users of health care. This includes research on robotics, artificial intelligence, e-health, nutrition, Information and Communication Technology (ICT), welfare technology, and the quality of health care services in home nursing, hospitals, and nursing homes. Research areas also include ethics and value-related challenges related to eHealth, artificial intelligence, and welfare technology.

**Acknowledgment**

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D. Saplacan wishes also to thank her employer, University of Oslo, and to the Vulnerability in Robot Society (VIROS) research project funded by the Research Council of Norway (Grant Agreement No. 288285), for giving her the opportunity to work with the UD-Robots project.

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## Abstract

This report presents an overview of the findings related to social and assistive robots and Universal Design, as well as an overview of the dissemination activities. The data collection methods included two surveys and two workshops using the Story Dialogue Method (SDM). The surveys were distributed through social media networks, and through email to over 2000 users, and 33 participants were invited to the workshops. In total 62 participants took part in this study distributed in the following way: 8 participants took part in the two workshops, 19 in the first survey, and 35 participants in the second survey. This report presents the findings from each data collection method, in relation to Universal Design and Robots. The findings from the workshops indicated challenges related to Universal Design and robots that cover: ethical dilemmas, infrastructure considerations, user – and design considerations. Survey 1 indicates a set of guidelines for each of the 7 universal design principles that are applicable to robots. Survey 2 indicates what healthcare professionals think in relation to robots and universal design. In general, our findings show that there is no such robot that can n fulfil all the principles and guidelines of Universal Design, but rather is about how the aesthetic/design and functional features of a robot are balanced, but also how the robot may fit the context of use and the user's abilities. In terms of limitations of the study, we can say that the number of the respondents to the surveys and people participating in the workshops was limited. At the same time, if other participants with other physical, cognitive abilities or other experience would have participated, the findings could have been different. In addition, we only included six types of social and assistive robots with different appearance. These robots are by no means representative for all the robots available on the market. However, they are good representatives of several types of robots: companion robots, different types of telecommunication robots, humanoid and/or assistive robots used in research or in other settings, or robots used in therapy with children with autism. As future work, we suggest that these surveys are sent to more people, are reused in other settings to test our proposed guidelines for universal design of robots. The findings in the report provide a user perspective on the universal design of social and assistive robots while the evaluation method from DART/22/22 focus more on the technical perspective. Both have their place and can be useful until there is an integrated tool for both perspectives.



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|---|---|
| Keywords | Universal, design, social robots, users, evaluation |
| Target group | People working with Universal Design, Accessibility, Human-Robot Interaction and/or Robotics, but also health care professionals, and designers |
| Availability | Public |
| Project number | 320685 |
| Research field | Universal Design, User Studies, Human-Robot Interaction, Accessibility, Design, Health and care services |
| Number of pages | 73 |

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# Executive Summary

This report discusses the user activities that were done to gather information about universal design of robots. There were two workshops and two surveys that were run during the project. A total of 62 participants involved in all the activities: 8 for the workshops and 54 participants between the two surveys. All user activities were run following good data handling procedures and ethical evaluation from Sikt (tidligere NSD) and the Regional Committees for Medical and Health Research Ethics (REK). Some basic preliminary results are included in this report. a more thorough analysis will be part of future journal or conference articles.

The topic for the workshop was robots and vulnerable people. We recruited participants from our networks of clinical practice and research. The workshops used the story dialog method (SDM), which is a method where participants use stories to discuss themes around a topic. Participants often bring their own stories about a topic, but given many don't have much experience with robots in this context, we included several stories for the participants. Participants pointed out challenges with robots in healthcare in the area of ethical dillemmas (robots not able to replace personnel for everything), infrastructure considerations (how to include a robot in an environment), user considerations (how does the robot affect patients' trust in the healthcare system), and design considerations (universal design should be a minimum, with options to customize to the situation).

The two surveys focused on different topics. The first survey was about universal design of robots and the second survey was about the use of social and assistive robots in the home and healthcare settings. In the first survey, participants were presented with the seven principles of universal design and then were presented a selection of different robots that were currently available. The participants were then asked how they felt that each robot addressed these different principles. Each robot had different strengths and weaknesses in fulfilling the principles, but it shows that there is a need for further work in making robots accessible and beneficial to people with disabilities.

In the second survey, participants were presented with the robots, but asked how they felt the robots could be used in a home context or to help older people. Many participants had experience in this area and could find different tasks where a robot could be helpful such as providing information to a patient, managing schedules, being a personal assistant, or providing support by fetching objects. The participants answered a robot could not help in all situations, such as working with people with psychological issues, a personal appointment with a patient that involved a discussion or examination, or doing the creative work for coming up with new ideas. While participants indicated robots could be helpful for older people, they acknowledged there were ethical and personal issues that must be examined (and also the need to provide technical support). These robots would also need to handle a variety of household tasks and connect emotionally with the patient. This is information that can be used to aid in designing newer robots.

Finally, the project has been presented and talked about in different venues during the project period. This includes the web presentations at different university, and various venuse such as the Research Council of Norway, Standard Norway, and the National Committee in Research Ethics in Science and Technology. The topic has also been mentioned and discussed at several international research conferences. With the project end, we will continue to analyze the results and to publish these in upcoming journals or conferences about universal design and robotics.

# 1 Introduction

Social robots are conquering the healthcare context at a high rate as the need to replace the shortage of healthcare professionals grows. With a shortfall of healthcare workers in different contexts, robots are being introduced into everyday life in homes of people of all all ages to support daily activities and replace human companionship if necessary. This introduction of robots is breaking new ground and is still in its infancy. Robots have been studied from different perspectives: such as design, engineering, and informatics. Broadly, robots can be divided into industrial, professional, service robots and personal service robots[1,2]. Social robots interact with people using social mechanisms such as speech and gestures[3]. Socially assistive robots can be used to teach or coach people in different areas, such as helping people with autism spectrum disorder understand social and emotional cues[4]. There is a need to co-design the robots technical functions so that they become user-friendly in cooperation with all potential users of robots. Furthermore, there are requirements that the universal design must follow a series of rules and guidelines.

This project aimed to examine existing guidelines to evaluate how they apply to robots, discuss different use cases with potential users of robots, propose methods for evaluating robots, and use them to evaluate more different social robots. Further, the goal of the project was to find out how one can design and evaluate if social robots are universally designed.

To get answers to the project's purpose, we have chosen to recruit study participants who are users and potential users of social robots. We also included experts who are software developers in robotics.

We collected qualitative and quantitative data to obtain detailed and varied descriptions from the study participants. Qualitative data were collected via the workshop, and quantitative data were collected via questionnaires.

Project partners recruited the study participants via their own national and international networks.

The respondents were informed that the project's aim was to investigate how we can create robots that are universally designed. We wanted to know the respondents' opinions about the use of robots and to what extent they are available. Specifically, the purpose of the project was to investigate whether a robot can be examined and evaluated through universal design principles. This aim was addressed through the surveys.

The respondents were then given information about what Universal Design means in the context of technology, i.e., the idea that technology can be used by as many people as possible regardless of their abilities. We explained that, for technology, so far, the focus is on guidelines such as for websites and mobile apps. We indicated that robots have a different profile and characteristics than a website or an app and possibly may

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[1] Thrun S. Toward a Framework for Human-robot Interaction. Hum-Comput Interact. 2004 Jun;19(1):9–24.

[2] Goodrich MA, Schultz AC. Human–Robot Interaction: A Survey. HCI. 2008 Jan 25;1(3):203–75.

[3] Breazeal C, Dautenhahn K, Kanda T. Social Robotics. In: Siciliano B, Khatib O, editors. Springer Handbook of Robotics [Internet]. Berlin, Germany: Springer Verlag Berlin Heidelberg; 2016 [cited 2016 Oct 18]. p. 1935–72. Available from: http://link.springer.com/chapter/10.1007/978-3-319-6.

[4] Matari MJ, Scassellati B. Socially Assistive Robotics. In: Siciliano B, Khatib O, editors. Springer Handbook of Robotics [Internet]. Springer Publishing; 2016 [cited 2016 Oct 18]. p. 1973–94. Available from: http://link.springer.com/chapter/10.1007/978-3-319-32552-1_73

need additional guidelines or new methods to investigate whether a robot is universally designed or not.

The participation in the study meant that the respondent was invited to share his or her experiences and opinions on various topics related to the UD-Robots project via Nettskjema. Nettskjema is an online tool for data collection, provided by University of Oslo.

# 2 Method

In this project, we have used a descriptive qualitative design.

## 2.1 Data collection methods

The data was collected through two data collection methods digital synchronous workshops using Zoom and two online surveys by using Nettskjema.

### 2.1.1 Workshops

We conducted two digital synchronous workshops using Zoom based on Story Dialogue Method (SDM). SDM is a method of both data collection and analysis coming from constructivism, feminism, critical pedagogy, and critical social sciences[5],[6] The method is based on a structured dialogue and builds on participants' own stories or experiences as triggers for dialogue and discussions related to a given theme. More about the data collection and analysis using the SDM method can be found in Section 3.

### 2.1.2 Surveys

Based on the literature review and the workshops, the two questionnaires were developed in the project and have been created in Nettskjema, which generated a link we sent to the participants who met the inclusion criteria.

Using various channels such as LinkedIn, EU COST-action members' emails, and group emails to employees and students at the Faculty of Health Sciences at VID, our networks within clinical practice and research, the respondents were invited to respond two surveys named: 1) Survey - Universal Design of Robots 2) Survey on the use of social and assistive robots in home- and healthcare settings. More information can be found in Sections 4–6.

The first survey, Survey 1 - Universal Design of Robots, focused on assessing six different social and assistive robots in relation to Universal Design principles was divide onto two parts. Part 1 was focusing on demographic issues and part 2 focused on questions related to Universal Design principles.

[5] Labonte RN, Feather J. Handbook on Using Stories in Health Promotion Practice. Ottawa, Canada: Prairie Region Health Promotion Research 1996.

[6] Labonte R, Feather J, Hills M. A story/dialogue method for health promotion knowledge development and evaluation. Health Education Research. Feb 1;14(1):39–50.

Table 1 Examples of some of social and/or assistive robots

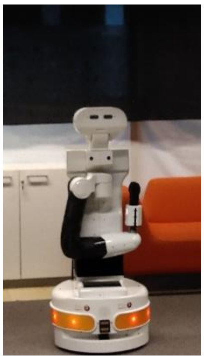
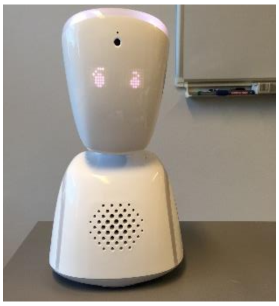
| Robot A – Robotic pets | Robot B – TIAGo | Robot C – NAO |
|---|---|---|
|  (Photo Diana Saplacan) |  (Photo Diana Saplacan) |  (Photo Diana Saplacan) |
| **Robot D – Pepper** | **Robot E – AV1** | **Robot F - Berntsen** |
|  (Photo Diana Saplacan) |  (Photo Trenton Schulz) |  (Photo Trenton Schulz) |

Table 2 Overview of data collection methods and participants

| Data collection methods | Details about the method and participants | | | |
|---|---|---|---|---|
| **Method #1** | **Story Dialogue Method Workshop** | | | |
| | Number of facilitators | Number of partici-pants invited | Number of partici-pants interested in participating | Total number of par-ticipants that actually took part in research activity |
| Workshop #1 | 2 (2 females: DS-main, ZP-observant) | 16 | 12 (2 males and 10 females) | 5 (1 male and 4 fema-les) |
| Workshop #2 | 4 (3 females: DS-main, ZP-observant, CB-master stu-dent, 1 male: TS) | 17 | 9 (all females) | 3 (all females) |
| Total | 4 different facilitators | 33 | 21 interested | 8 participated (1 male and 7 female) |
| **Method #2** | **Surveys** | | | |
| | Number of facilitators | Number of respond-ents invited to re-spond the survey | Number of respondents that actually an-swered the survey | |
| Survey 1 | 3 (2 females: SD, ZP and 1 male TS) | Over 2000 people (in-cluding social media channels,email, and | 19 (7 female, 10 male, and 2 other gender) | |

| | | | |
|---|---|---|---|
| | | other professional networks) | |
| Survey 2 | 3 (2 females:SD, ZP and 1 male TS) | Over 2000 people (including social media channels,email, and other professional networks) | 35 (22 female, 12 male, 1 other gender) |
| Total participants in the surveys | 3 different facilitators | Over 2000 people (including social media channels,email, and other professional networks) | 54 respondents in total (29 female, 22 male, and 3 other gender) |
| TOTAL participants in the study | | | 62 participants in total (36 female, 23 male and 3 of other gender) |

The second survey, Survey 2 focused on the use of social and assistive robots in home- and healthcare settings consisted of questions divided into part 1, focusing on demographic issues and part 2 Use of Robots in the Home- and Healthcare.

The robots included in both surveys were:

Robot A: Companion robots pet cat and dog robots from JoyForAll,

Robot B: TIAGo robot from Pal Robotics,

Robot C: NAO robot from Softbank Robotics,

Robot D: Pepper Robot from Softbank Robotics,

Robot E: AV1 from No Isolation, and

Robot F: Bernsten Robot from Innocom.

These robots are also shown in Table 1. The data collection followed convenience sampling, i.e., all the researchers in this project distributed the surveys to their own networks through social media platforms and/or by taking direct contact with their own academic network. Those who were contacted were kindly asked to distribute the survey further to their own networks.

## 2.2 Overview of all the participants in relation to each data collection method

The overview of participants and data collection methods is illustrated in Table 2.

## 2.3 Data analysis methods

The SDM method, as specified earlier, is both a data collection and data analysis method. In order to enable an accurate analysis of the data collected through this method. A short summary of the results of the data collected through this method are currently reported in Section 3. However, the researchers in the project plan also to go through the data when writing the scientific articles.

The data collected through surveys was analyzed by Nettskjema automatically to generate descriptive statistics. Open responses will be analyzed using qualitative content analysis. A summary overview of preliminary results is presented in Section 4 and Section 5. The researchers went through the data manually and compiled the results described in these sections.

## 2.4 Ethical considerations

The study was prospectively registered to the Norwegian Center for Research Data (NSD) for ethical assessment (NSD number 972068) ant to the Regional Committee for Medical and Health Research Ethics (REK) (REK number 494243). All participants received written and oral information about the project and what their participation in the study entails. Before beginning their involvement, they signed an informed consent form. Participation in the project was voluntary, and participants could end their participation without explanation.

The respondents of the surveys were informed about the project before starting the survey. They were then asked to confirm their consent to participate in the study by clicking on a button that will take them further in the survey. In case the participants did not agree to participate in the study, they were unable to continue further with the survey. Only demographic data was collected about the participants in the survey, such as gender, age range, highest education, profession, experience with working with vulnerable groups. The participants were not asked to give their name, telephone number of email address. Their response was completely anonymous.

We treated all the information about the participants anonymously and in accordance with the NSD, REK, and privacy regulations and the General Data Protection Regulation (GDPR). All the data was stored on a dedicated secured area in Teams, provided by the Norwegian Computing Center.

Preliminary results from the project are presented anonymously and at a group level so that nothing can be traced to any specific person. It shall not be possible for the participants to be recognized in any publications or other media that come out of the project unless specifically agreed.

Further, all the participants taking part in the workshops signed informed consent. They were also informed that they could withdraw from the project at any time and without any consequence for them.

# 3 Workshops

We have used Story Dialogue Method (SDM)[7] for the data collection during workshops. The method is often used when a change within an organization is desired, and/or when it is wished that the participants taking part in the workshop based on SDM shall come to insights related to a specific theme.

SDM was used so far within the healthcare domain and within education, but also more recently within Human-Computer Interaction[8,9]. Both Zada Pajalic and Diana Saplacan had experience with this method before. They agreed to use this method since it is an

[7] Labonte, Ronald, and Joan Feather. 1996. Handbok in Using Stories in Health Promotion Practice. Ontario, Canada.

[8] Saplacan, D. 2020. "Cross-Use of Digital Learning Environments in Higher Education: A Conceptual Analysis Grounded in Common Information Spaces." In Proceedings of the The Thirteenth International Conference on Advances in Computer-Human Interactions ACHI 2020, 10. Valencia, Spain: Technische Informationsbibliothek (TIB) - German National Library of Science and Technology.

[9] Saplacan, D., Jo Herstad, Nikoline Marthe Elsrud, and Zada Pajalic. 2018. "Reflections on Using Story-Dialogue Method in a Workshop with Interaction Design Students." In Proceedings of Fifth International Workshop on Cultures of Participation in the Digital Age - CoPDA 2018, International Conference on Advanced Visual Interfaces (AVI 2018), 2101:33–43. CoPDA. Castiglione della Pescaia, Grosetto, Italy: CEUR Workshop Proceedings. http://ceur-ws.org/Vol-2101/paper5.pdf.

efficient to arrive to different insights related to a given theme, based on a structured dialogue, even when the participants do not know each other since before, and/or do not have experience since before with robots.

The theme of the workshops was **Robots and Vulnerable People**.

The aim of the workshops was knowledge development around the given theme and Universal Design and accessibility related to social and assistive robots.

Since the participants did not know each other from before, and experience with robots was not a requirement for participation in the workshop, we adjusted the SDM-method in the following way. We created four different stories based on previous or ongoing research. Schulz and Saplacan have discussed several cases, before choosing four of them.

Each of the participants were asked to choose a story that they can relate best with, prior to the workshop. The participants were also offered the possibility to bring their own story related to the given theme "Robots and Vulnerable people" if they previously had experience with robots. The stories were provided both in English and Norwegian. Each of the stories provided are shown below (in English).

The motivation behind the stories is given below, along with the description of each of the stories.

## 3.1 Story 1: Eve –an 85-year old lady using a robot monitoring her health

*Motivation.* This story was based on previous and current research conducted by the Vulnerability in Robot Society (VIROS)[10] research project, where the focus is on safety, privacy and security aspects related to robots to be used within home- and healthcare. The case was based on previous interviews conducted by the researcher D. Saplacan, and presented in a book chapter on «*Should Social and Assistive Robots Integrated within Home- and Healthcare Services Be Universally Designed?»,* as part of Cambridge Handbook on Law, Policy, and Regulations for Human-Robot Interaction[11]. The same case lies as a foundation for ongoing studies with an elderly facility at a Care+ activity center for independent living elderly, where Saplacan is conducting research together with TIAGo robot from Pal Robotics. The case was used since it presents different ethical dilemmas that can be interesting for both potentially vulnerable users of social and assistive robots, home- and healthcare professionals, as well as researchers and academics within the fields of design, engineering, and healthcare, but also within Universal Design.

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[10] VIROS – Vulnerability in Robot Society, University of Oslo, Norway. https://www.jus.uio.no/ifp/english/research/projects/nrccl/viros/

[11] Saplacan, Pajalic, and Tørresen 2022, (in press). *Should Social and Assistive Robots Integrated within Home- and Healthcare Services Be Universally Designed?»,* as part of Cambridge Handbook on Law, Policy, and Regulations for Human-Robot Interaction.

*Story description.* Eve is an 85-year old lady who lives on her own. Her vision has deteriorated over the years, and she needs text that is large and has good contrast to read things without her magnifying glass. She has two adult children who visit her sometimes. She has also the privilege of being a grandmother to Lisa (4 years old) and John (15 years old). She received as part of her care services, TIAGo, a service assistant robot. TIAGo helps her with chores in the home: picking up stuff for her, bringing her a glass of water when she forgot it in another room, reminding her to take her medication, and asking her how she is doing when TIAGo notices that she expresses some signs of sadness, depression, or loneliness. TIAGo is equipped with cameras and various types of sensors that can monitor Eve's health over time. This enables TIAGo to provide better personalized service to Eve and show her graphs and statistics about her health. Some examples of these are: her heart rate, how much she moves, when she should move, what she can do to improve her health, and telling her when she should get up and move a bit around the home. Eve finds TIAGo helpful, but she is sometimes unhappy that TIAGo shows some of the information on the screen. She would prefer TIAGo to interact with her through speech, in her mother tongue, and without using technical language. But TIAGo is still in the learning process, so it needs to collect more data about Eve to improve its services. Eve is also concerned about whether the robot collects data about her visitors (her adult children, and her underage grandchildren), what it does with that data, where it stores the data (on the robot itself, or if it goes in her health journal), and who is responsible for that data. Eve is concerned that the care service provider will not take responsibility if something happens to the robot when her grandchildren are visiting her. Finally, she is worried that if she is left alone with a robot, she will miss out on the care services she has the right to receive. TIAGo also seems to be a bit of a hassle for the healthcare professionals, since they are concerned about how to use it, and who is responsible for it. The care professionals do not exactly know how to deal with the issue of informed consent from Eve as a patient, since the robot collects health (and other sensitive) data about Eve and her visitors. The visitors are also concerned about whether their data is also collected, and they are not sure how to handle this.

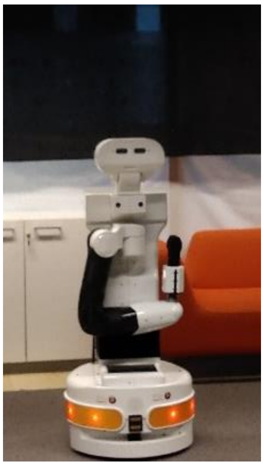

Figure 1 TIAGo robot from PAL Robotics (Photo by Diana Saplacan)

## 3.2 Story 2: Romibo robot, a toy used as a medical device with autistic children in therapy sessions

*Motivation.* The second case was carefully chosen based on two main motivations. The case was described in previous research conducted by Saplacan as part of the Vulnerability in Robot Society (VIROS) research project[12]. The case was based on previous

[12] University of Oslo. 2019. "Vulnerability in the Robot Society (VIROS) - Department of Private Law." 2019. https://www.jus.uio.no/ifp/english/research/projects/nrccl/viros/index.html.

interviews conducted by the researcher D. Saplacan, and presente d in a book chapter on «*Should Social and Assistive Robots Integrated within Home- and Healthcare Services Be Universally Designed?»,* as part of the Cambridge Handbook on Law, Policy, and Regulations for Human-Robot Interaction[13]. Second, the case was discussed in the Norwegian media[14], addressing the issue of using inappropriate robot design with children with autism in therapy sessions. Therefore, this case was chosen.


Figure 2 Photo of ROMIBO. Foto by SYKEHUSET I VESTFOLD / NRK. Photo source: https://www.nrk.no/vestfoldogtelemark/_-sprakrobot-_romibo_-er-ikke-bra-nok-1.14005371

Story description. Romibo was manufactured with the intention to be sold as a toy, a little static robot for children. Romibo has a static body with fur, and an iPhone used as the eyes of the robot. Although the robot was marketed as a toy, and indeed conforms with the European Toy Directive, i.e., it means that it fulfills the requirements for being sold as a toy, it turned out that the robot started to be used together with children with autism in therapy sessions. However, the manufacturer of the robot did not apply or comply with the Medical Device Directive, i.e., meaning that the robot was not assessed as fulfilling the requirements of being used as a medical device in therapy sessions, or in healthcare settings. Despite this, the robot was used in therapy sessions with autistic children.  Children with autism spectrum disorder often require extra training to develop their communication and social skills. Some children reacted fine to the robot in therapy sessions. They would repeat the words that the robot was saying and interact with the robot through speech. Other children did not understand where the sound came from. One reason for this could be that the robot does not have a "mouth". The sound came from the iPhone that is used as the eyes of the robot.ibid

## 3.3 Story 3: Robotic pets used with elderly people with cognitive decline

Motivation. The third case was chosen based on the same motivation as case 1. The same case lies as a foundation for ongoing studies with an elderly facility at a Care+ activity center for independent living elderly, where Saplacan is conducting research together with the companion robots from JoyForAll. The case presents ethical dilemmas between potentially vulnerable users of social and assistive robots, their family members, and home- and healthcare professionals. These issues for also interesting for researchers within the fields of universal design, engineering, and healthcare.

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[13] Saplacan, Pajalic, and Tørresen 2022, (in press). *Should Social and Assistive Robots Integrated within Home- and Healthcare Services Be Universally Designed?»,* as part of Cambridge Handbook on Law, Policy, and Regulations for Human-Robot Interaction.

[14] See Ellefssen & Stenshold, 2018. Testet språkroboten «Romibo»: – Ikke bra nok. Den pelskledde roboten som skulle lære bort språk til autistiske barn, floppet. https://www.nrk.no/vestfoldogtelemark/_-sprakrobot-_romibo_-er-ikke-bra-nok-1.14005371

*Story description.* An elderly facility, with over 100 people living on their own, was provided with some robotic pets. Some of the elderly living there are in good shape and spend time on social activities, while others spend most of their time in their own apartments, feeling lonely and depressed. Some of the elderly also have cognitive decline and lack social interaction of any kind. Some staff at the elderly facility argue that these groups of elderly people could benefit from having these robots. These can simulate some behaviors of a real pet. They can move their heads, blink their eyes, move legs and paws, and make some pet sounds. They can also vibrate and purr like a cat. Staff at the elderly facility are convinced that the robots could be useful and help with feelings of comfort the elderly people. The elderly family members have different opinions about this: some of them are for using these robots, while others are against their use. The opinions among healthcare professionals are also divided: some think that this is beneficial, while others are concerned about whether this is the right thing to do, from an ethical perspective. The elderly people's opinions are also divided: some think this is very beneficial and it is wonderful to have such possibility – however, they think that they are not the right group for using these robotic pets. Others are worried about the cost of these robotic pets, while others could think to use them themselves at an older age.

Figure 3 Photo of companion robots from JoyForAll. (Photo by Diana Saplacan)

## 3.4 Story 4: Robots using sign language being able to interact with deaf

Motivation. The fourth case was chosen based on a previous study published by Antonioni et al. (2022)[15], where one-armed TIAGo from Pal Robotics is used in research with deaf people and people using sign language. The article sheds light on the importance of recognizing specific characteristics of sign language, but also cultural norms in sign language. The aim of the paper was to explore new possibilities of automated sign language, through the inclusion of robots. Since only one arm was used for TIAGo, the signs to be configured were categorized in simple signs (one configuration), composed signs (two configurations) and phrases (three or more configurations). This story was based on this article since it showcases how robots can be used with other types of vulnerable groups, besides elderly and children with autism, such as deaf (or blind people). In this way, we covered a wider range of vulnerable groups.

[15] Antonioni, Emanuele, Cristiana Sanalitro, Olga Capirci, Alessio Di Renzo, Maria Beatrice D'aversa, Domenico Bloisi, Wang Lun, et al. 2022. "Nothing about Us without Us: A Participatory Design for an Inclusive Signing Tiago Robot." In Proceedings of the 31st IEEE International Conference on Robot & Human Interactive Communication. Italy, Neaple: IEEE.

Story description. Ania is 25 years old and passionate about history and travelling. She was born deaf. Often, when she travels, she encounters a challenge in communicating at airports, train stations, restaurants, and shops. She has this problem both when travelling abroad and within her own home country. She uses usually sign language to communicate with her friends at home. However, sign language differs from one country to another. She recently travelled to Italy and noticed TIAGo in a coffee shop. TIAGo greeted her and asked what she wanted through sign language. Ania thought this was a very cool idea, making the coffee shop more accessible for her. Similarly, when she went to the grocery store to buy some food, she found out that another TIAGo was there. This TIAgo accompanied her through the store, read the labels in Italian on different products, and explained to her through sign language which products contain gluten and lactose. Both TIAGos interacted with her through sign language. To her delight, she found the robot expressing the signs quite well. However, she noticed that the robot had a gripper (the hand) with only two ”fingers”, making it difficult for her to sometimes understand all the signs. She thinks the robot should have been equipped with a screen, where the signs are better displayed. She also noticed a delay in the robots’ sign language, because of the mechanical issues. She found this a bit frustrating, but overall, she thought that the idea of having robots being able to interact with people that are deaf, or blind is quite promising

Figure 4 TIAGo robot from PAL Robotics (Photo by Diana Saplacan)

## 3.5 Structure of the workshops

The workshops were divided into three main parts: introduction, SDM sessions, and Conclusions and reflections. Each of these parts is summarized below. A more detailed description regarding the questions asked during each part, is given in 8Appendix A2.

### 3.5.1 Part I: Introduction

In the first part, the participants were welcomed. Thereafter, the informed consent was addressed, followed by the description of the values for the SDM method. For these workshops, the following **values** were chosen:

- **Feeling welcomed:** all the participants in the workshops should feel welcome.
- **Trust:** the workshops were based on creating a safe place where the participants can trust each other and share their experiences or reflections around robots and vulnerable groups.
- **Vulnerability**: the participants should be able to share personal experiences, and feel vulnerable, without any consequences for them
- **Care:** the concept of care as in ”home-” and ”healthcare”, but also as care for the participants during the workshop was one of pre-set values for the workshops.

The participants were informed that they can use English, Norwegian or Swedish language during the workshop, that they can interrupt at any time and ask questions.

During the introduction, the main facilitator clearly specified that no previous experience with robots was necessary to take part in the workshop. At the same time, an image with various types of social and/or assistive robots was shown to the participants, in order to provide context and to show how different robots may look. The same image was also used in the other data collection method, namely the distributed surveys.

After presenting the values and setting the premises for the workshop, an introduction round took place, where the participants were asked to share their name, their background, if they have worked with vulnerable groups before, and if yes, to specify with which groups, and to specify in case they have any experiences with robots since before.

### 3.5.2 Part II – SDM sessions

The SDM sessions are organized around a structure dialogue, following the standard sessions:

1. Storytelling
2. Reflection circle
3. Structured Dialogue:
    - description of the problem or issues encountered based on the cases chosen (WHAT-type of questions)
    - explanation (WHY type of questions)
    - synthetization (SO WHAT-type of questions), and
    - action (NOW WHAT-type of questions)
4. Reviewing the story records.
5. Create insight cards

### 3.5.3 Part III – Conclusion and reflections.

During this part, the participants were asked to summarize their learning in three takeaway points.

## 3.6 Summary - Preliminary findings

In general, the participants think that robots are future helpers and that they will be part of the healthcare services. They agreed that the robots will be helpful for vulnerable groups, and reduce the burden on the healthcare, while may improve the quality of life amongst vulnerable groups.

However, the participants also pointed out some of the challenges with including robots within healthcare. According to the participants, the challenges cover:

- Ethical dilemmas
- Infrastructure considerations
- User considerations
- Design considerations

### 3.6.1 Ethical dilemmas

The participants agreed that the robots should not replace care professionals. At the same time, the participants agreed that robots can be useful in training purposes, such as for instance, training social skills of children with autism, when teachers are not available.

However, the participants also admitted that there is a danger when more responsibility is put on the user. One of the participants took up the example of when banks went over to self-service and online banking, promising customers that the banks will still be open for in-person customer service. However, as the participant pointed out, after some time, we see that this is not necessarily the case, and customers need often to deal with technology by themselves, such as self-service and chatbots. Through this analogy, the participant reminded us on some of the vulnerabilities that may come when introducing new technologies, namely that the technology might be used in a way that was not intended from the start. This was also one of the concerns pointed out by the participants, when it comes to the use of social robots within home- and healthcare.

Further, the participants expressed some concern about how these robots may not be used with common sense. Specifically, the participants drew attention to how these robots may be very well intended and might be very helpful in certain contexts and for certain purposes of use. However, if researchers fail to inform and communicate in which settings and contexts of use these robots are not useful or beneficial, there is a risk that the robots are used in a wrong way. In addition, there is also a risk that the use of robots may become harmful or detrimental for both care receivers and users.

Similarly, another participant expressed that we humans develop and interact best with things that are natural to us: interacting with people, rather than with technology.

Amongst other ethical aspects that were pointed out, the participants named: safety, data security and privacy, how the data will be used, and preserving the right to private life when robots will be used in home settings. Finally, the participants agreed that these aspects need to be ensured, in different ways.

### 3.6.2 Infrastructure considerations

*A question of responsibility*

One of the dilemmas addressed regarding the use of robots withing home and healthcare was related to how these robots should be included within home- and healthcare: whether they should be a service offered by the municipalities or state, or if the care received should be able to buy these robots by themselves.

The participants also pointed out that if the robots are bought privately and used as part of a care process, questions of responsibility may arise in case of accidents.

Some of the participants expressed scepticism towards robots and agreed that it is important that we still have “humans-in-the-loop” within the process of *care:* that healthcare professionals are present physically for care giving. At the same time, one of the participants pointed out that it is important to consider robots for the future of care. The participant starting thinking, as he said, “robotical thoughts,” that can help society to progress. The participant also pointed out that society needs to develop an awareness of what robots can or cannot do, in order to make good decisions when it comes to process of care. In that sense, he agrees that robots may have very advanced and beneficial functionalities. However, he does not want that robots fully replace human care.

*Divisions of roles and tasks amongst healthcare professionals and robots*

Another participant pointed out that it is important to be aware of their own role and tasks as healthcare professionals, but also to identify which of these tasks *can* be transferred to robots, and which *should not* be transferred to robots.

*The need of necessary training for healthcare professionals in using social and assistive robots*

One of the challenges that the participants named was that of having already educated healthcare professional within the clinical practice but needing to deal with technology in their professional lives, but without having any formal- or very little training in understanding how these technologies work. Similarly, the majority of the participants pointed out that, in general, technology takes a lot of places in healthcare professionals' everyday working life, but not much focus is put on the healthcare professionals education and training regarding these technologies, different challenges, and to be actively involved in this development. The participants stressed the fact that it is important that healthcare professionals get the necessary training, instructions, and support when using new technology such as robots. They also pointed out that it is essential to train healthcare professionals also regarding the latest technology that will most likely be part of their professional everyday life sooner or later. Currently, according to the participants, there are few incentives to encourage getting this extra training, but they hope there is more incentives for training in the near future.

Some of the healthcare professionals participating in the workshop expressed that human contact is the most important within care. However, healthcare professionals need to take into consideration technological advancement, and that it is better to be part of the change and be able to influence and contribute to the eventual direction the care tech is taking, rather than not being part of it. In this way, the technology will become better, and thus, the care that includes technology will become better. They also pointed out that it is essential to make visible the importance of healthcare professionals in the technological development, including social and assistive robots.

### 3.6.3 User considerations

Several aspects were discussed with regard to the user. For instance, the participants questioned who the vulnerable user is: whether the vulnerable user is the care receiver or the healthcare professionals, or both. At the same time, the participants pointed out how important the user participants are.

Another aspect pointed out by the participants was related to how technology may undermine the trust in healthcare if the technology does not work in practice. As one of the participants explained, vulnerable users should not be exposed to technology that does not work properly from the start. If we do that, their trust in care and care professionals may be undermined. Therefore, technology that works well, including social and assistive robots, should be well tested before being used with vulnerable groups.

In addition, social and assistive robots should meet the individual needs of the primary, secondary, and tertiary users, while also being adapted to the individuals' context of use. At the same time these robots should support tasks done during everyday life (e.g., learning for children, social aspects and functional aspects that support the everyday life of the users).

Finally, the robots' design should be user friendly, and include early user participation in the design process.

### 3.6.4 Design considerations

The workshop reminded some of the participants about some important aspects that need to be taken into consideration. Robots should be helpful, facilitate the care process, and they should not introduce new problems for vulnerable groups. While the participants pointed out the importance of individual adaptation of the design to the different user's needs, they also pointed out the dilemma of how to balance well the strive after fulfilling the universal design principles, to meet the users' needs of as many as possible, while also designing social and assistive robots that can be individually adapted, personalized or customized.

Further, the participants suggested having universal design as a base. That is, they suggested that Universal Design is very important, but it should be seen as the "starting package". Then, the design of these social and assistive robots should have options to be further customized and personalized to the needs of the users.

## 3.7 Limitations

The participants indicated that the workshops were useful to learn more about robots, and to increase their awareness about how different robots can be, but also to think new thoughts and it changed their way of thinking around robots within home- and healthcare. At the same time, the participants agreed that some things still remain confusing, such as:

- Whether these robots will replace the healthcare professionals, or will be only assistive robots?
- Whether the robots will have access to healthcare professionals?
- Whether these robots will have social skills and communicate directly with the users in the healthcare settings?

# 4 Survey 1 on Universal Design of Robots (preliminary results)

## 4.1 Overview of the respondents and their previous experiences in working with vulnerable groups.

Table 3 Gender distribution

| Gender | Participants | In percentage |
|---|---|---|
| Male | 10 | 36,8% |
| Female | 7 | 52,6% |
| Other | 2 | 10,5% |
| Total | 19 | 100% |

Table 4 Age distribution

| Range of age | Number of participants | In percentage |
|---|---|---|
| 18-30 | 3 | 15.8% |
| 31-40 | 7 | 36.8% |
| 41-50 | 5 | 26.3% |
| 51-60 | 4 | 21.1% |
| 61+ | 0 | 0% |

Based on their education, the respondents indicated the following professions: assistant professor, University lecturer, researcher, Law, Research scientist, PhD student, academic, researcher, Programming, Engineering, Software Engineer, automation engineer, Developer, computer science, Research liaison officer, Midwife, Computer scientist.

The respondents indicated that they currently work within the following fields: education, Nursing, Public health, robot ethics, Technology for all, Informatics (design), robots, HRI, Software engineer, Environmental research, IT, building technology, IT, teaching computer science at the university, At a university, midwifery education, Information technology field.

Table 5 Education

| Highest education | Number of participants | In percentage |
|---|---|---|
| Highschool | 0 | 0% |
| Vocational studies (less than 3 years) | 1 | 5.3% |
| 3 years university studies (bachelor program) | 3 | 15.8% |
| Master studies (4 years university studies or more) | 6 | 31.6% |
| Doctoral degree | 9 | 47.4% |

Those who answered ”yes” when asked if they have previously worked with vulnerable groups, have mentioned one or several of the following vulnerable groups: children, immigrants, vision and hearing impairment, elderly, people with dementia, people with autism and down syndrome, people with aphasia of speech, students with disabilities, and others.

Table 6 Previous experience with working with vulnerable groups (e.g., elderly, individuals with functional variability, children, immigrants etc.)

| Previous experience with working with vulnerable groups | Number of participants | In percentage |
|---|---|---|
| Yes. | 8 | 42,1% |
| No. | 11 | 57,9% |

## 4.2 Questions related to Universal Design principles applied to robots

An image of six different robots was provided (as shown in the figure below), where each of the robots was associated with a different letter. The respondents were then asked to indicate which of the 7 Universal Design principles were fulfilled best by which robot.

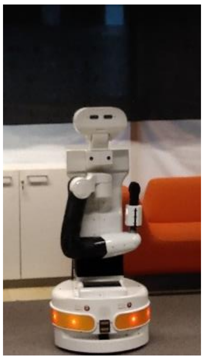
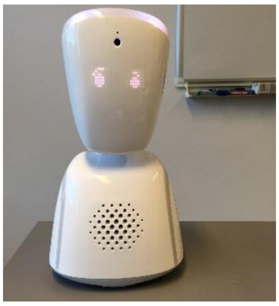
| | | |
|---|---|---|
| Robot A - Robotic pets<br><br>(Photo Diana Saplacan) | Robot B – TIAGo<br><br>(Photo Diana Saplacan) | Robot C – NAO<br><br>(Photo Diana Saplacan) |
| Robot D – Pepper<br><br>(Photo Diana Saplacan) | Robot E – AV1<br><br>(Photo Trenton Schulz) | Robot F - Berntsen<br><br>(Photo Trenton Schulz) |

Figure 5. Examples of some of social and/or assistive robots

The six robots were:

Robot A: Companion pet robots cats and dogs from JoyForAll,

Robot B: TIAGo robot from Pal Robotics,

Robot C: NAO robot from Softbank Robotics,

Robot D: Pepper Robot from Softbank Robotics,

Robot E: AV1 from No Isolation, and

Robot F: Bernsten Robot from Innocom.

These robots are also shown in Figure 5.

Table 7 Overview answers (compiled answers)

| Principle | Robot A | Robot B | Robot C | Robot D | Robot E | Robot F |
|---|---|---|---|---|---|---|
| 1. Equitable use: The design is useful and marketable to people with diverse abilities. | 7 | 6 | 5 | 8 | 6 | 6 |
| 2. Flexibility in use: The design accommodates a wide range of individual preferences and abilities. | 2 | 6 | 5 | 10 | 2 | 3 |
| 3. Simple and intuitive use: Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level. | 8 | 3 | 4 | 6 | 4 | 6 |
| 4. Perceptible information: The design communicates necessary information effectively to the user regardless of ambient conditions (such as light) or the user's sensory abilities (ability to hear, see etc.) | 6 | 2 | 4 | 9 | 3 | 5 |
| 5. Tolerance for error: The design minimizes hazards and the adverse consequences of accidental or unintended actions. | 6 | 5 | 4 | 5 | 8 | 4 |
| 6. Low physical effort: The design can be used efficiently and comfortably and with a minimum of fatigue. | 8 | 6 | 4 | 7 | 7 | 3 |
| 7. Size and space for approach and use: Appropriate size and space is provided for | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| approach, reach, manipulation, and use regardless of user's body size, posture, or mobility. | 7 | 5 | 4 | 5 | 6 | 6 |
| Total | 44 | 33 | 30 | 50 | 36 | 33 |

### 4.2.1 Overview answers (compiled answers given in percentage)

Table 8 verview answers (compiled answers given in percentage)

| Principle | Robot A | Robot B | Robot C | Robot D | Robot E | Robot F |
|---|---|---|---|---|---|---|
| 1. Equitable use: The design is useful and marketable to people with diverse abilities. | 36,8% | 31,6% | 26,3% | 42,1% | 31,6% | 31.6% |
| 2. Flexibility in use: The design accommodates a wide range of individual preferences and abilities. | 10,5% | 31,6% | 26,3% | 52,6% | 10,5% | 15,8% |
| 3. Simple and intuitive use: Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level. | 42.1% | 15,8% | 21,1% | 31,6% | 21,1% | 31,6% |
| 4. Perceptible information: The design communicates necessary information effectively to the user regardless of ambient conditions (such as light) or the user's sensory abilities (ability to hear, see etc.) | 31,6% | 10,5% | 21,1% | 47,4% | 15,8% | 26,3% |
| 5. Tolerance for error: The design minimizes hazards and the adverse consequences of accidental or unintended actions. | 31,6% | 26,3% | 21,1% | 26,3% | 42,1% | 21,1% |
| 6. Low physical effort: The design can be used efficiently and comfortably and with a minimum of fatigue. | 42,1% | 31,6% | 21,1% | 36,8% | 36,8% | 15,8% |

| | | | | | | |
|---|---|---|---|---|---|---|
| 7. Size and space for approach and use: Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility. | 36,8% | 26,3% | 21,1% | 26,3% | 31,6% | 31,6% |
| Total | 231,5% | 173,7% | 158,1% | 263,1% | 189,5% | 173,8 |

### 4.2.2 Interpretation of quantitative results: How robots are ranked in relation to their appearance and Universal Design principles?

Our quantitative data indicates the following results presented in the table below.

Table 9 Summary of quantitative results

| Universal Design principle | Ranks highest | Ranks lowest |
|---|---|---|
| 1. Equitable use: The design is useful and marketable to people with diverse abilities. | Robot D (Pepper) | Robot C (Nao) |
| 2. Flexibility in use: The design accommodate a wide range of individuals preferences and abilities. | Robot D (Pepper) | Robot A (companion robots) |
| 3. Simple and intuitive use: Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level. | Robot A (companion robots) | Robot B (TIAGo) |
| 4. Perceptible information: The design communicates necessary information effectively to the user regardless of ambient conditions (such as light) or the user's sensory abilities (ability to hear, see etc.) | Robot D (Pepper) | Robot B (TIAGo) |
| 5. Tolerance for error: The design minimizes hazards and the adverse consequences of accidental or unintended actions. | Robot E (AV1) | Robot C (NAO) |

| | | |
|---|---|---|
| 6. Low physical effort: The design can be used efficiently and comfortably and with a minimum of fatigue. | Robot A (companion robots) | Robot F (telecommunication robot Berntsen) |
| 7. Size and space for approach and use: Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility. | Robot A (companion robots) | Robot C (NAO) |

Robot A (companion robots) with a zoomorphic appearance and robot D (Pepper) with the most humanoid appearance, seem to have the largest distribution with regard to Universal Design principles, both ranking highest on 3 out of 7 principles. Robot A (companion robots) ranked highest on principle #3 Simple and intuitive use, #6 low physical effort, and #7 size and space for approach and use. Robot D (Pepper) was rated highest on the following principles: principle #1 equitable use, principle #2 flexibility in use, and principle #4 perceptible information.

At the same time, the respondents ranked highest robot E (AV1) on principle #5 tolerance for error.

Considering the physical appearance of these robots and their imagined functionalities based on their appearance, our interpretation of the results is that the respondents have rated highest those robots that have rated highest on their zoo- or anthropomorphic appearance. However, for principle #5, tolerance for error, it seems that the participants assumed that a robot that cannot navigate a physical space (AV1), ranks highest on tolerance for error.

Regarding the rating of the robots as fulfilling overall worst the principles of Universal Design, it seems that robot C (NAO) was rated as fulfilling the worst three out of seven principles, namely: #1 equitable use principle, along with principle #5 tolerance for error, and with principle #7 size and space for approach and use.

Robot B (TIAGo) was rated as the next worst in relation to its appearance and Universal Design principles. The robot seems to fulfill the worst principle #3 simple and intuitive use, and principle #4, perceptible information.

At the same time, robot A (companion robots) ranked worst on principle #2 flexibility in use, while robot F (telecommunication robot Berntsen) was rated as worst in relation to principle #6 low physical effort.

We are not sure why the overall rating of robots as fulfilling the least the principles of Universal Design resulted in this way. We can assume that this was based on either respondent's lack of experience with these robots, or that they had some information or knowledge about these robots since before. Our assumption is that NAO was rated as worst on fulfilling three out of 7 Universal Design principles due to its appearance as a humanoid robot, however with a look of a toy. We assume that robot B (TIAGo) was rated as next worst with regard to Universal Design principle due to its humanoid assymetric look, i.e., having only one arm, and due to its lack of a screen that can provide additional information. Finally, we assume that robot A (companion robots) was rated as the third-worst due to its appearance as a toy, but also because the robot appears to not very advanced in terms of functionality. With regard to robot F (telecommunication robot Berntsen), we assume that the robot was rated as third worst because of its design: it doesn't have an adjustable height (at least as seen in the picture), being equipped only with a screen on wheels, but having no arms or other body parts being able to execute other tasks, besides telecommunication.

### 4.2.3 Summary of findings based on quantitative data

A summary of findings based on the quantitative data is shown in the Table below.

Table 10 Summary of findings based on quantitative data

| | Robot rating (from best to worst) | How the robots are rated |
|---|---|---|
| 1 | Robot D (Pepper) | Rates overall best amongst the six robots.<br><br>Rates also highest on:<br><br>#1 equitable use<br><br>#2 flexibility in use, and<br><br>#4 perceptible information. |
| 2 | Robot A (companion robots) | Rates overall next best amongst the six robots.<br><br>Rates highest on:<br><br>#3 Simple and intuitive use,<br><br>#6 low physical effort, and<br><br>#7 size and space for approach and use<br><br>However, it rates worst on<br><br>#2 flexibility in use. |
| 3 | Robot E (AV1) | Rates overall third highest.<br><br>Rates best on:<br><br>#5 tolerance for error |

| | | |
|---|---|---|
| 4 | B (TIAGo) | Rates overall fourth. We don't know whether it fulfills well any of the UD principles, but we know that it seems to fulfill worst the following two principles (at least based on its apperance):<br><br>#3 simple and intuitive use<br><br>#4 perceptible information. |
| 4 | F (Berntsen) | Rates overall fourth and shares the same place with robot B (TIAGo). We don't know whether it fulfills well any of the UD principles, but we know that it seems to fulfill worst the following principle (at least based on its apperance):<br><br>#6 low physical effort |
| 5 | C (NAO) | Robot C is ranked last in relation to UD principles. |

Note that these findings are based only on the quantitative data and the respondents of 19 participants. To make sure that our interpretation is correct, we also need to look into the qualitative data collected, where the respondents were asked to elaborate on their answer, by bringing arguments for their choices. We do this in the next section.

# 5 What the respondents said regarding the robots' appearance and their relation to Universal Design principles

## 5.1 Principle 1: Equitable Use. The design is useful and marketable to people with diverse abilities.

Based on the quantitative and qualitative data, as well as based on the discussion of our preliminary findings, we compiled some guidelines for principle #1 equitable use with regard to social and assistive robots. These guidelines are, by no means, the only possible guidelines, but these are the ones that emerged from our data.

Table 11 Principle 1 and social and/or assistive robots

| | Robot rating (from best to worst) | How the robots are rated in relation to **equitable use** principle | Reasons why the robots were rated as fullfilling the equitable use principle |
|---|---|---|---|
| 1 | Robot D (Pepper) | Rates overall best amongst the six robots.<br><br>Rates also highest on:<br><br>#1 equitable use | • Designed for social aspects (verbal and non-verbal interaction)<br>• The robot can move (local movement, i.e., movement of its arms and head, and global movement – navigating a physical space)<br>• It is potentially able to meet the abilities of a variety of people.<br>• Accessible due to being equipped with a screen (e.g., deaf users) |
| 2 | Robot A (companion robots) | Rates overall next best amongst the six robots. | • Small in size<br>• Soft appearance<br>• Cute appearance<br>• Easy to interact with<br>• Non-threatening appearance<br>• Several user groups can use it: It appears as it is destined to interact with children and people with disabilities, but also with elderly people<br>• Affordable, inexpensive |
| 3 | Robot E (AV1) | Rates overall third highest. | • Telecommunication function – enables the use of it by different users, with different abilities<br>• Small in size<br>• Easy to carry |
| 4 | B (TIAGo) | Rates overall fourth. | • Anthropomorphic appearance<br>• Has a robotic arm and therefore is able to execute some tasks similar to humans (picking up items, carrying items)<br>• Stable base – therefore, is safe when navigating the physical environment<br>• May conduct conversations |
| 4 | F (Berntsen) | Rates overall fourth and shares the same place with robot B (TIAGo). | • Versatile and modular<br>• Telecommuncation functionality, and therefore it can be used by a variety of users, with different abilities<br>• Simple to use |

| | | | |
|---|---|---|---|
| 5 | C (NAO) | Robot C is ranked last in relation to UD principles. | • Can move by itself<br>• Does not have a screen<br>• It has a cute appearance |

**A robot is considered to fulfill the equitable use principle if it fulfills as many of the guidelines listed below, as possible. However, the following list of guidelines does not exclude that other guidelines might also be applicable, although not listed here. These guidelines emerged solely based on the findings from this survey.**

1. **Appearance:**
   a. Small in size
   b. Soft appearance
   c. Cute appearance
   d. Non-threatening appearance
   e. Easy to carry
   f. Anthro- or zoomorphic appearance
2. **Functionality**
   a. Designed for social aspects (verbal and non-verbal interaction)
   b. Telecommunication function – enables the use of it by different users, with different abilities
   c. Has a robotic arm and therefore is able to execute some tasks similar to humans (picking up items, carrying items)
   d. Stable base – therefore, is safe when navigating the physical environment
   e. May conduct conversations
   f. Versatile and modular
   g. Simple to use
   h. Can move by itself
3. **Motion**
   a. The robot can move (local movement, i.e., movement of its arms and head, and global movement – navigating a physical space)
4. **User groups:**
   a. It is potentially able to meet the abilities of three or more groups of people (e.g., children, people with disabilities, elderly etc. )
5. **Accessibility:**
   a. Equipped with a screen (e.g., deaf users also use the robot)
   b. Does not have a screen
   c. Easy to interact with
6. **Costs:**
   a. Affordable/inexpensive

## 5.2 Principle 2: Flexibility in Use. The design accommodates a wide range of individual preferences and abilities.

Based on the quantitative and qualitative data, as well as based on our discussion of our preliminary findings, we compiled some guidelines for principle **#2 flexibility in use** with regard to social and assistive robots. These guidelines are, by no means, the only possible guidelines, but these are the ones that emerged from our data.

Table 12 Principle 2 and social and/or assistive robots

| | Robot rating (from best to worst) | How the robots are rated in relation to **flexibility in use** principle | Reasons why the robots were rated as fulfilling the flexibility in use principle |
|---|---|---|---|
| 1 | Robot D (Pepper) | Rates overall best amongst the six robots, including rating best on the flexibility in use principle. | • It can move by itself<br>• Equipped with arms<br>• High technical capabilities (the more capable the robot is, the more flexibility it has, in terms of interaction)<br>• Flexible body parts (many joints lead to higher physical flexibility)<br>• Equipped with a screen<br>• Different functions<br>• Steady or stable base |
| 2 | Robot B (TIAGo) | Rates next best on flexibility in use. | • It can move by itself<br>• It is equipped with arms, thus can execute different types of tasks<br>• High technical capabilities (the more capable the robot is, the more flexibility it has, in terms of interaction)<br>• Flexible body parts (many joints lead to higher physical flexibility) |
| 3 | Robot C (NAO) | Rates third best on flexibility in use. | • It can move by itself<br>• It is equipped with arms, thus can execute different types of tasks<br>• It can interact in multiple way: it can play music, dance, and do gestures, and may communicate partly through light |
| 4 | Robot F (Berntsen) | | • Equipped with a screen<br>• Telecommunication robot |
| 5 | Robot A (companion robots) | | • Provides different appearances of robots, which can accommodate some different preferences.<br>• Small in size so it can be hold<br>• soft appearance, appearing as being very comfortable, and therefore can fit different types of users |

| | | | |
|---|---|---|---|
| 6 | Robot E (AV1) | | • telecommunication capabilities – the robot can be used by different types of users to different purposes<br>• small in size so it can be carried by different people with different abilities<br>• stable |

**A robot is considered to fulfil the flexibility in use principle if it fulfils as many of the guidelines listed below, as possible. However, the following list of guidelines does not exclude that other guidelines might also be applicable, although not listed here. These guidelines emerged solely based on the findings from this survey.**

1. **Appearance**
   a. Equipped with arms, thus can execute different types of tasks
   b. Equipped with a screen
   c. Steady or stable base
   d. Provides different appearances of robots, which can accommodate some different preferences.
   e. Small in size so it can be hold
   f. Soft-appearance that increases the likability of the robot and thus it several types of users can interact with it

2. **Functionality**
   a. High technical capabilities (the more capable the robot is, the more flexibility it has, in terms of interaction)
   b. Flexible body parts (many joints lead to higher physical flexibility)
   c. Different functions
   d. Multimodal interaction: It can interact in multiple way, e.g., it can play music, dance, and do gestures, and may communicate partly through light
   e. Telecommunication capabilities

3. **Motion**
   a. It can move by itself

4. **User groups**
   a. telecommunication capabilities – the robot can be used by different types of users to different purposes
   b. small in size so it can be carried by different people with different abilities
   c. appearing as being very comfortable, and therefore can fit different types of users

## 5.3 Principle 3: Simple and Intuitive. Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.

Based on the quantitative and qualitative data, as well as based on our discussion of our preliminary findings, we compiled some guidelines for principle **#3 simple and intuitive use** with regard to social and assistive robots. These guidelines are, by no means, the only possible guidelines, but these are the ones that emerged from our data.

Table 13 Principle 3 and social and/or assistive robots

| | Robot rating (from best to worst) | How the robots are rated in relation to **simple and intuitive use** principle | Reasons why the robots were rated as fulfilling the flexibility in use principle |
|---|---|---|---|
| 1 | Robot A (robotic companion) | Rates overall best amongst the six robots, including rating best on the simple and intuitive use principle. | • less functionality<br>• zoomorphic appearance indicates certain functionalities<br>• familiarity of user with familiarity with how pets look and behave gave an indication of how the robots can possibly interact with humans.<br>• the robots do not require interaction through language, only tactile interaction,<br>• an intuitive and simple design<br>• appears as having a simple design |
| 2 | Robot D (Pepper) | Rates next best on simple and intuitive use. | • Equipped with a screen - advantage by having a screen that can simplify the user experience.<br>• Humanoid appearance<br>• The screen may convey information<br>• Self-explanatory |
| 3 | Robot C (Berntsen) | Rates third best on simple and intuitive use. | • telecommunication functionality<br>• functionality being very visible<br>• being equipped with a screen<br>• the robot can interact through voice dedicated for those users who can interact through speech<br>• its design matches its purpose for communication<br>• limited in functionality |
| 4 | Robot C (NAO) | Did not fulfill well this principle | • used for teaching purposes – therefore simplicity and intuitiveness principle should be applied |
| 5 | Robot E (AV1) | | • Lacks many features<br>• Fulfills the simplicity principle<br>• Lack of hand and feet – limits the choices for the user, and adds to the simplicity<br>• Telecommunication functionality |

| | | | |
|---|---|---|---|
| 6 | Robot B (TIAGo) | Rates worst on simple and intuitive use | • Is equipped with a robotic arm and therefore intuitive to use |

**A robot is considered to fulfill the simple and intuitive use principle if it fulfills as many of the guidelines listed below. However, the following list of guidelines does not exclude that other guidelines might also be applicable, although not listed here. These guidelines emerged solely based on the findings from this survey.**

1. **Appearance**
   a. Zoomorphic or anthropomorphic appearance which indicates certain functionalities.
   b. Familiar appearance.
   c. Simple design
   d. Intuitive design
   e. Equipped with a screen.
   f. Equipped with an ar
   g. Limited design (e.g., Lacks arms and feet)
   h. If the robot is used for teaching purposes (if should therefore have a simple and intuitive design.)
   i. Self-explanatory design

2. **Functionality**
   a. Less functionality
   b. Zoomorphic or anthropomorphic appearances creates certain expectations on how the robot should work in practice – therefore those functionalities should work as expected as much as possible.
   c. Familiarity of the user with the robots' appearance (appearing as a pet or humanoid robot) indicates of how the robots can possibly interact with humans.
   d. Limited functionality:
      - Limited number of ways to interact with the robot: e.g., only through language, or only through tangible interaction
      - Lacks many functionalities, e.g.: lacks arms and feet or other body parts, limiting the choice, in terms of functionalities, for the user.
   e. If the robot has a screen, the screen may convey information.
   f. Telecommunication functionality
   g. Functionality that is very visible (obvious)
   h. Voice interaction
   i. Well defined and limited purpose and functionality (e.g., communication)
   j. Fulfills the simplicity principle.

3. **Motion**
   *No indication to how the robot should move or navigate the environment in relation to simple and intuitive use principles was indicated. However, the idea of motion that is simple and intuitive to understand should be*

*considered a form of non-verbal communication within the interaction between the human user and the robot.*

## 5.4 Principle 4: Perceptible Information. The design communicates necessary information effectively to the user regardless of ambient conditions (such as light) or the user's sensory abilities (ability to hear, see etc.).

Based on the quantitative and qualitative data, as well as based on our discussion of our preliminary findings, we compiled some guidelines for principle **#4 perceptible information** with regard to social and assistive robots. These guidelines are, by no means, the only possible guidelines, but these are the ones emerged from our data.

Table 14 Principle 4 and social and/or assistive robots

| | Robot rating (from best to worst) | How the robots are rated in relation to **perceptible information** principle | Reasons why the robots were rated as fulfilling the **perceptible information principle** |
|---|---|---|---|
| 1 | Robot D (Pepper) | Rates overall best amongst the six robots, including rating best on the perceptible information principle | • Appearance as a humanoid robot<br>• Technical equipment that includes: cameras, sensors, speakers, mircophones, and a screen that may convey information.<br>• Good communication skills<br>• It has a screen for alternative communication |
| 2 | Robot A (companion robots) | Rates next best on the perceptible information principle | • Familiar appearance (as a pet)<br>• Presence of familiar elements such as fur, head, arms, legs<br>• Robot’s shape and material<br>• Verbal and non-verbal communication<br>• Interaction is highly limited, therefore the information conveyed by the robot is limited and easy to be perceived by the users<br>• Users that can interact with the robot need to need to see, hear, or feel (tangible interaction)<br>• Visible usability of the robot |
| 3 | Robot F (Berntsen) | Rates third best on perceptible information principle | • equipped with a screen, and microphones<br>• can convey information<br>• telecommunication robot |

| | | | |
|---|---|---|---|
| 4 | Robot C (NAO) | Did not fulfill well this principle | • robot's appearance as a humanoid robot<br>• equipped with elements such as head, arms and legs,<br>• expected to move, thus if the movement can be translated into perceptible information, then the robot is considered to fulfill the principle, at least, at some level |
| 5 | Robot E (AV1) | Rates as next worst on the perceptible information principle | • appearance |
| 6 | Robot B (TIAGo) | Rates worst on perceptible information principle | • Humanoid appearance<br>• technical equipment, such as: cameras, sensors, speakers, and eventually microphones for listening. |

**A robot is considered to fulfill the perceptible information principle if it fulfills as many of the guidelines listed below. However, the following list of guidelines does not exclude that other guidelines might also be applicable, although not listed here. These guidelines emerged solely based on the findings from this survey.**

1. **Appearance**
   a. Appearance as a anthropomorphic (humanoid) or zoomorphic (pet) robot
   b. The shape and material of the robot appearing as familiar to the user
      i. Familiar appearance (e.g., as a pet) OR
      ii. The robot being equipped with familiar elements (e.g., fur, head, arms, legs, or a screen)
2. **Functionality**
   a. Technical equipment of the robot may include: cameras, sensors, speakers, microphones, and a screen that may convey information.
   b. The robot has good communication skills (verbal and/or non-verbal communication capabilities)
   c. Limited interaction: interaction is highly limited, therefore the information conveyed by the robot is limited and easy to be perceived by the users
   d. Telecommunications capabilities.
3. **Motion**
   a. The robot's motion (as a form of non-verbal communication) can be translated into perceptible information

4. **User groups**
    a. The robot is designed for at least two or three user groups that can interact with the robot through tangible interaction, through speech or sound, or other visual feedback.
    b. The robot is usable by different user groups with different abilities.

5. **Accessibility**
    a. Limited interaction: interaction is highly limited, therefore the information conveyed by the robot is limited and easy to be perceived by different types of users with different abilities.

## 5.5 Principle 5: Tolerance for Error. The design minimizes hazards and the adverse consequences of accidental or unintended actions.

Based on the quantitative and qualitative data, as well as based on our discussion of our preliminary findings, we compiled some guidelines for principle **#5 tolerance for error** with regard to social and assistive robots. These guidelines are, by no means, the only possible guidelines, but these are the ones that emerged from our data.

Table 15 Principle 5 and social and/or assistive robots

| | Robot rating (from best to worst) | How the robots are rated in relation to **tolerance for error** principle | Reasons why the robots were rated as fullfilling the **tolerance for error principle** |
|---|---|---|---|
| 1 | Robot E (AV1) | Rates overall best amongst the six robots, including rating best on the tolerance for error principle | • the size of the robot: small and steady, less likely to tip over<br>• fewer functionalities: lack of many buttons, and therefore less likely that these parts get loosen or break<br>• telecommunication robot, and the user interaction will be done through the robot rather than with the robot<br>• the robot is static, light, and small in size,<br>• cannot physically hurt users<br>• stable (does not move).<br>• functionalities as a telecommunication robot are not so complex à tolerance for error is higher,<br>• mimic a human, or interact with a human in more complex ways may also have a lower tolerance for error |

| | | | |
|---|---|---|---|
| 2 | Robot A (companion robots) | Rates next best on the tolerance for error principle | • the robot appears as small and steady, thus the robot will not tip over<br>• fewer functionalities, and less complex functionalities: higher chance that parts of the robot do not break, or get loosen<br>• limited functonality<br>• static robot<br>• lack of advanced motion capabilities à robust robots<br>• less tolerant for error if the user tries to clean or wash them |
| 3 | Robot B (TIAGo) | Rates third best on tolerance for error principle | • advanced and it is pre-programmed to tolerate errors when interacting with humans<br>• safety certifications<br>• appears as stable (or steady) (it does not easily flip over) |
| 4 | Robot D (Pepper) | Rates fourth best on tolerance for error principle. | • Requires pre-programming<br>• Requires certain safety certifications<br>• Motion requires also ways to recover when something goes wrong (if the robot falls down)<br>• Ability to communicate in different ways in case of error, depending on the ability of the user (e.g., speech for blind users, light or clear text for deaf users etc.) |
| 5 | Robot C (NAO) | Rates worst on the principle of tolerance for error | • Mimicking humans<br>• Small and light-weighted |
| 6 | Robot F (Berntsen) | Rates worst on tolerance for error principle (along with Robot C) | *No reason given.* |

**A robot is considered to fulfil the tolerance for error principle if it fulfils as many of the guidelines listed below. However, the following list of guidelines does not exclude that other guidelines might also be applicable, although not listed here. These guidelines emerged solely based on the findings from this survey.**

1. **Appearance**
    a. Size of the robot: light, small and steady (e.g., less likely to tip over)

2. **Functionality**
    a. Limited number of functionalities and equipment (e.g., less likely that something breaks, or that its parts get loosen)
    b. Telecommunication functionalities: when the interaction is done *through* the robot rather than *with* the robot
    c. Complex ways of interactions capabilities may indicate higher chances of lower tolerance for error. These robot may have higher tolerance for error if it is programmed well, but not otherwise.
    d. Some robots may require pre-programming to be tolerant for error.
    e. Some robots may need different safety certifications to be tolerant for error.
    f. The need for recovering capabilities when something goes wrong

3. **Motion**
    a. Static or stable robot (e.g., less likely to navigate a space or hurt a user because of its movements)
    b. Lack of (advanced) motion capabilties makes the robot more robuts from a tolerance of error point of view (given that the robot is not pre-programmed)
    c. The need for recovering capabilities when something goes wrong (from a motion point of view.)

4. **User groups**
    a. Ability to communicate in different ways in case of error, depending on the ability of the user (e.g., speech for blind users, light or clear text for deaf users etc.)

5. **Other:**
    a. A robot may be less tolerrant for error in some context (if the user tries to clean or wash it, without the robot being designed for this purpose).

## 5.6 Principle 6: Low Physical Effort. The design can be used efficiently and comfortably and with a minimum of fatigue.

Based on the quantitative and qualitative data, as well as based on our discussion of our preliminary findings, we compiled some guidelines for principle **#6 low (physical) effort** with regard to social and assistive robots. These guidelines are, by no means, the only possible guidelines, but these are the ones that emerged from our data. **Note also that we adapted this principle from low *physical* effort to low effort, because we wanted to include both physical- and cognitive aspects.**

Table 16 Principle 6 and social and/or assistive robots

| | Robot rating (from best to worst) | How the robots are rated in relation to **low effort principle** | Reasons why the robots were rated as fulfilling the **low effort principle** |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 1 | Robot A (companion robots) | Rates overall best amongst the six robots, including rating best on low effort principle | • Easy to use<br>• Intuitive to interact with (e.g., tangible interaction)<br>• Contains elements of familiarity (e.g., as interacting with pets) and therefore it requires a low physical effort from the users<br>• Elements of familiarity give feelings of calmness to the users<br>• Shell made out of soft materials (e.g., fur) has an important role in avoiding fatigue<br>• A mechanical appearance and use of non-natural materials of the robot's shell (e.g., plastic) require more physical effort and lead to fatigue<br>• Non-advanced robots require less cognitive effort<br>• Robots that give comfort require less cognitive effort<br>• The required physical effort depends also on the context of use (e.g., leisure, therapy, teaching etc.) and who the user is<br>• The size of the robot plays also an important role: smaller robots require less physical effort and increase the comfort (as opposed to bigger robots in size, that are heavier, and may increase fatigue) |
| 2 | Robot D (Pepper) | Rates next best on the low effort principle | • It does not require any physical effort because the robot is not buildt for physical interaction<br>• It requires cognitive effort to interact with the robot<br>• The purpose of the robot plays an important role<br>• It would be good if the height of the robot would be adjustable<br>• Multimodal ways of interaction (sound, screen, picking up stuff, motion etc.) and quality of these elements in conveying information (the better the quality, the lower the physical or cognitive effort required)<br>• The ability of the robot's verbal communication capabilities to understand unclear language due to stutter, accent or dialect |

| | | | |
|---|---|---|---|
| 2 | Robot E (AV1) | Rates also next best on low effort principle | • does not necessarily require physical interaction: either the physical interaction required is limited, and/or the focus is mainly on telecommunication<br>• robot appearance suggests comfort<br>• size of the robot, as a small robot, requires low physical effort, does not lead to fatigue and increases comfort levels |
| 3 | Robot B (TIAGo) | Rates fourth best on low effort principle | • the need to know the robot's purpose<br>• quality of multimodal interaction (sound, screen, picking up stuff, motion, etc.)<br>• how the robot conveys information<br>• how the robot interacts with different types of users<br>• higher quality of interaction means less effort<br>• robot's (verbal) interaction should be designed to be sensitive to the language of the user, such as if the user stutters, speaks a language with a different accent, or speaks a dialect |
| 4 | Robot C (NAO) | Rates worst on the principle of low effort principle | • the robot does not require physical interaction |
| 5 | Robot F (Berntsen) | Rates worst on low effort principle | • it does not necessarily require physical interaction, that it is a telecommunication robot,<br>• size: as it does not seem as a robot which weights a lot<br>• seems easy to transport and therefore require less physical effort<br>• meets some comfort levels of people with different abilities |

**A robot is considered to fulfil the low effort principle if it fulfils as many of the guidelines listed below. However, the following list of guidelines does not exclude that other guidelines might also be applicable, although not listed here. These guidelines emerged solely based on the findings from this survey.**

1. **Appearance**
a. Contains elements of **familiarity** (e.g., as interacting with pets) and therefore it requires a low physical effort from the users
    i. Elements of familiarity give feelings of **calmness** to the users

**b.** Robot appearance suggests **comfort**
- **Shell** made out of **soft materials** (e.g., fur) has an important role in avoiding fatigue
- A mechanical appearance and use of non-natural materials of the robot's shell (e.g., plastic) require more physical effort and lead to fatigue

c. The **size** of the robot plays also an important role: **smaller robots** require less physical effort and increase the comfort (as opposed to bigger robots in size, that are heavier, and may increase fatigue)
**d.** It would be good if the **height** of the robot would be **adjustable**
e. **Weight** of the robot: **easy to carry/transport**

2. **Functionality**
    **a. Easy to use or interact with**
    b. **Intuitive to interact with** (e.g., tangible interaction)
    - Non-advanced robots require less cognitive effort
    - Robots that give **comfort** require **less cognitive effort**

    c. **Multimodal ways of interaction** (sound, screen, pickin up stuff, motion etc.)
- **quality** of these elements **in conveying information** (the better the quality, the lower the physical or cognitive effort required)
- The ability of **the robot's verbal communication capabilities** to understand unclear language due to stutter, accent or dialect

    d. **Does not necessarily require physical interaction**
    - either the **physical interaction** required is **limited,** and/or
    - the focus is mainly on **telecommunication**

3. **Accesibility**
    **a. how the robot interacts with different types of users**
    b. robot's (verbal) interaction should be designed to be sensitive to the language of the user, such as if the user stutters, speaks a language with a different accent, or speaks a dialect

4. **Usability and user experience**
**a.** Meets some **comfort levels of people with different abilities through its sensorial design**

5. **Other**
    e. **The purpose** of the robot plays an important role
    f. The required **physical effort** depends also on the **context of use** (e.g., leisure, therapy, teaching etc.) and who the user is
    g. Whether the robot is built for **physical or/and cognitive interaction** may require **less or more physical of cognitive effort**.

## 5.7 Principle 7: Size and Space for Approach and Use. Appropriate size and space are provided for approach, reach, manipulation, and use regardless of the user's body size, posture, or mobility.

Based on the quantitative and qualitative data, as well as based on the discussion of our preliminary findings, we compiled some guidelines for principle **#7 size and space for approach and use** with regard to social and assistive robots. These guidelines are, by no means, the only possible guidelines, but these are the ones that emerged from our data.

Table 17 Principle 7 and social and/or assistive robots

| | Robot rating (from best to worst) | How the robots are rated in relation to **size and space for approach and use** | Reasons why the robots were rated as fulfilling the **size and space for approach and use** |
|---|---|---|---|
| 1 | Robot A (companion robots) | Rates overall best amongst the six robots, including rating best on size and space for approach and use | • Appears stationary (static, i.e., does not move by itself in space) – easier to approach<br>• For users with reduced mobility, a mobile robot might be more appropriate, because the robot may navigate the physical space by itself<br>• Small size: can be easily held by people<br>• Weight: light weight<br>• Easy to manipulate, regardless of the user's body position, posture, and mobility (whether the user is laying down, sitting or standing).<br>• It can be handled with the hands. |
| 2 | Robot E (AV1) | Rates next best on the size and space for approach and use principle | • stationary robot<br>• easier to be handled by the people with different abilities<br>• robots that may navigate the spaces themselves, such as mobile robots, may also be appropriate for this purpose<br>• important to know who the user is, and the context of use.<br>• the size of the robot, and its weight (being light-weighted robot<br>• the robot uses less space<br>• the robot balances well weight and size<br>• simple design: functional and useful |

| | | | |
|---|---|---|---|
| 2 | Robot F (Berntsen) | Rates also next best on size and space for approach and use | • the robot uses little space<br>• be easily adapted to the user's size or position (**not sure, however if this is the case*)<br>• the robot balances well the weight, size, and functionality<br>• simple design that is both functional and usable |
| 3 | Robot B (TIAGo) | Rates third best on size and space for approach and use principle | • easy to manipulate, in a such way, that the robot can adjust to the user's body position, posture and mobility (while laying down, sitting or standing)<br>• the robot's torso which can be lowered or heightened.<br>• the robot seems to require more space, which seems to be a disadvantage<br>• the robot is also able to pick up things, |
| 3 | Robot D (Pepper) | Rates third best on size and space for approach and use principle (along with Robot B - TIAGo) | • the robot could perhaps adjust<br>• weight, size, and functionality are well balanced<br>• the user should not feel intimidated by the robot's height. |
| 5 | Robot C (NAO) | Rates worst on size and space for approach and use | • Small in size<br>• Light-weighted |

**A robot is considered to fulfil the size and space for approach and use if it fulfills as many of the guidelines listed below. However, the following list of guidelines does not exclude that other guidelines might also be applicable, although not listed here. These guidelines emerged solely based on the findings from this survey.**

1. **Appearance**
    a. Stationary or mobile robots:

- Appears stationary (static, i.e., does not move by itself in space) – easier to approach. However mobile robots might be more appropriate for people with reduced mobility.

b. **Size**
   - Preferably of **small size**
   - can be easily **held by people**, and/or
   - uses **less space**.
   - **Adjustable size** that can be easily adapted to the user's size or position
   - Robot with a **torso: adjustable**
   - the user should not feel intimidated by the robot's **height.**

c. **Weight: light-weight**
   - can be handled with the hands.

d. **Interplay between weight and size:** the robot balances well weight and size

e. **Simple design** that is both functional and usable

2. **Functionality**
   a. **easy to manipulate**, regardless of the user's body position, posture, and mobility (whether the user is laying down, sitting or standing).
   b. **simple design:** functional and useful
   c. **Size** and weight is well balanced with functionality of the robot
   d. **Adjustable functionality:**
      - the robot's torso which can be raised or lowered.
      - the robot is also able to pick up things,
3. **Motion**
   a. Static or mobile robots: For users with reduced mobility, a mobile robot might be more appropriate, because the robot may navigate the physical space by itself. Others might prefer static robots. However, it depends on the purpose of the robot.

4. **Accessibility**
   a. easier to be handled by the people with different abilities

5. **Other**
   a. important to know who the user is, and the context of use.

## 5.8 Other principles or guidelines that could be relevant for the Universal Design of robots

Over half of the respondents, more exactly 52.63% (10 out of 19), chose to indicate some other principles or guidelines that could be useful to analyze robots in relation to Universal Design principles. These included:

- User Experience principles, such as: ”enjoyable” or ”likable.”
- Human factors and ergonomics of the robots, along with ISO standards
- Eventually to look into Japanese principles of designing robots, or animation principles

- The importance of being able to assess the reliability of the system: both from a physical perspective (hardware) and from a virtual perspective (software wise). This was pointed out to be especially important if the robot is supposed to assist someone as part of home- and/or healthcare services.
- The assessment of interconnectivity of a robot: how able the robot is to talk with other platforms or robots;
- Open standards
- The ability of a robot to contact a human, or to provide instructions
- How robust is the robot
- The navigation capabilities of the robot in a new environment, or follow routes
- The capability of a robot to carry things
- Assessment of the robot's usability: the robot should be able to be used by both children and the elderly, for instance.
- The robots should have physical modularity and the functions a robot has should fulfill the requirements or needs of the user: a robot should never be equipped with a head if the head does not fulfil any function; a robot should be equipped to speech and the user should be able to choose speech or another form of getting the message.
- The robot should be able to give feedback through various modalities
- If the robot is equipped with speech, the robot should be able to be adjusted in terms of voice (male, female, neutral), pitch of voice, language, dialect etc.
- The robot should be physically safe to interact with – for instance, by making use of soft materials.
- The user should be able to choose amongst the robots' functionalities, which ones to enable, and based on its abilities, needs, and age
- The robot should follow the principle of simplicity when being designed: always having in mind the user and the diversity of its users.
- From a sustainability point of view, the robot should be easy to produce and have a high life-cycle assessment

## 5.9 Limitations of the survey and other comments

Only 6 out of 19 participants chose to give some other comments to the survey. Three of the respondents pointed out that the survey was interesting or fun, whereas one of the participants specified that she or he was not familiar with these robots and therefore it was difficult to judge the robots in relation to Universal Design principles.

One of the limitations was that we could not provide high-resolution images due to the limitation of the online tool, namely of Nettskjema. Therefore, the images' quality was limited, which could have affected the participants' understanding of the robots. This was also one of the limitations mentioned by one of the respondents.

We also considered incorporating videos in the survey. However, due to the limitation of the online tool, we could not do this. We recommend in the future that perhaps other tools are used, that allow incorporating videos directly in the survey. It will, however, be necessary to consider whether all functionalities of the robots should be shown, and if yes, whether the same scenario should be applied to all robots (e.g., home care, health care etc.).

One participant specified that we need to consider the design of "delicate motions" as part of these kind of social and assistive robots, whereas another one pointed out that robots need to be designed in a such way that they can be adjusted to various needs, similar to functionalities in a car: “Great job! I think the key is to make robots that can be adjusted to various need, just like we adjust the car seat etc.”

# 6 Survey 2 on the Use of Social and Assistive Robots in Home- and Healthcare Settings (preliminary results)

In a total the 35 people chose to answer this survey. The demographic overview of those participated is illustrated in Table 18.

Table 18 Demographic overview - Survey 2

| **Gender** | **%** |
|---|---|
| Male | 63% |
| Female | 34% |
| Other | 10% |
| **Age** | |
| 18-30 | 11% |
| 31-40 | 28% |
| 41-50 | 26% |
| 51-60 | 26% |
| 61+ | 9% |
| **Education level** | |
| Highschool | 0% |
| Vocational studies (less than 3 years) | 0 % |
| 3 years of university studies (bachelor program) | 3% |
| Master studies (4 years of university studies or more) | 34% |
| Doctoral degree | 63% |

Among the professions, it was reported that they were professors of medicine, doctors, biologists, top leaders in business organizations, researchers, nurses, political science project leaders, computer scientists and sociologists. The participants reported the following work context as university, specialist healthcare and education. Majority (63%) of participants have previously worked with old people followed work (46%) with individuals with functional variability, and (40%) with children.

Robots such as NAO and Pepper were the ones with which the participants had the most experience (29%). The majority (46%) had experience with other robots such as surgery robots, Cellulo, Cozmo, Sege DreamCat, MyKeepon, Baxter, LEGO and GrowMeUp. Robots most appealing to participants based on their physical appearance were robots Pepper (63%), Robotic pets (57%), and NAO (46%).

Regarding which vulnerable groups would benefit most from the various robots, the results show that Pepper would benefit several groups, such as people with impaired vision and hearing, paralysis, wheelchair users and dyslexia. The companion robots from JoyForAll could be of benefit to people with fatigue, dementia, reduced mental health, loneliness and autism. For vulnerable groups with balance problems and tremors, study participants believe that TIAGo would be of the best benefit. Other people who would benefit from using robots were people isolated in hospitals, in drug rehab, those with back problems, risk of falling, migrants so they would get help in communicating, people in care facilities, nursing homes and nursing homes, nursing homes (healthy) and special needs, palliative care, bedridden, comatose patients, confined to institutions with the insufficient nursing staff. Most participants could imagine using a robot in their work and can recommend robots to help their colleagues in their work.

Specifically, the participants could consider using robots in their work in the following situations: information given to my patient, as a personal assistant, managing schedule, setting reminders, suggesting activities, keeping track of deadlines, recording hours and completing travel reports, performing online searches and cross-reference information from multiple sources, finding articles and trends in published research, or providing support for logistics:

- picking up equipment, tools and even visitors when they come to the building
- picking up coffee, snacks and lunch
- to give trainings, to support meetings, as an illustrator of innovation
- to detect possible fall risks
- simulation with my students
- office support with repetitive tasks
- demonstration of gender or development-related roles using robots as in role-play
- recording and making accurate transcripts of interviews and reminding of precautions.

However, the participants cannot imagine working with robots in the following situations such as:

- intellectual work such as writing papers, editing manuscripts, etc.
- tasks that require direct contact with other people
- tasks that involve creative thinking such as coming up with new ideas for research
- at work with psychotic people

- in personal meeting/discussion/examination with patient,
- in an intensive care unit
- for a patient consultation
- doing the writing and reporting work
- in acute problems
- in parenting
- using robots in friendship,
- using robots in decision making or creative tasks
- using robots for solving emotional issues, when the work involves feelings and ethical decision-making, personal conversations with patients when working with dying patients and their families and when empathy is needed – e.g., when you must tell bad news or explain something very well.

A large majority (94%) believe that robots can be suitable for use by the elderly. The participants felt that the elderly could benefit from using a robot for medication, portable oxygen equipment, removing obstacles that can cause falls, small everyday tasks such as serving a meal, retrieving something from some inaccessible place, etc.) and even supporting them having more privacy (e.g., being able to do more things by yourself and choose which tasks to do when), and as social companionship. The following challenges can be ethical and personal challenges, how it affects other people around the person using a robot, and technical support.

The participants believe that most robots are still far from smooth integration in everyday contexts. Attitudes, expectations, and acceptance of robots in different groups are still in their infancy. Privacy, safety, and security aspects, especially in cases where the robots rely on online services, potentially transmitting a lot of personal information, technical shortcomings, internet infrastructure, maintenance, technical support, and software updates.

The two most essential functions for the participants were that the robot could communicate through auditory and visual feedback. The following features for robots were desirable to have the ability to change its height so it can reach areas I can't (especially for items on high shelves). The operating arm must have more dexterity - capable of performing all the actions of a human hand. Ability to adjust behavior/communication based on previous interactions, even predicting what will happen next in a daily routine Ability to work "offline" and/or to be "off", not intruding when not wanted. Being able to self-charge and maintain "awareness" of its own function and possible maintenance requirements. Easy to clean, repair and update. Must be able to locate a lost mobile phone, play music or call relatives/friends/carers. To measure a user's breathing rate or detect if a user falls or has another emergency incident and take appropriate action. Rapid respiratory rate can be an early and important indicator of serious illness. The robot must be able to perform care tasks and provide support for eating and drinking. The robot must look natural, like a human. Must have simple programming and a simple operating system and that it is well developed and can interact with the users in a close to human way. If it is a pet robot, it should resemble a pet in its behavior. 91% of participants wanted the robot to be able to interact with them via speech.

Other tasks that the participants wanted were for the robot to remind or have a dialogue with the user, to help the person up from the floor if they fall, to warn of a possibly dangerous situation, to locate objects, to have a caring robot that they can command that lets them watch TV, call loved ones on a video call or play games, tell jokes or play soothing music - and which can be wiped down with disinfectant afterwards. Robot assisting simulation for communication training, playing games, doing housework, cleaning etc., interacting with vulnerable to entertain them and train them to do daily chores. Some requirements from the respondents were that the robot must be able to connect emotionally: the robot must be able to distinguish between emotional expressions and know which appropriate action to take. At the same time, robots must be able to perform repetitive tasks, such as loading washing machines/dryers and dishwashers and cleaning houses/apartments/specific rooms.

In the following other contexts, the participants thought that robots are suitable for use in the education of nursing students, at home, at school, and in all areas of public life.

# 7 Dissemination venues

## 7.1 Webpages

The UD-Robots project was disseminated through dedicated webpages at each of the partner institutions: at the Norwegian Computing Center[16], at the University of Oslo[17], and at VID Specialized University[18]. The project was registered on the national research information system Current research information system in Norway (Cristin). All are available online.

National or local contexts where the project was disseminated

The project was disseminated in national and local context. A presentation[19] was held for the Research Council of Norway and Standards Norway during a Standard Morning event.

Further, the research project was disseminated during a presentation[20] for the National Committee in research Ethics in Science and Technology (NENT), along with other ongoing research projects at Robotics and Intelligent Systems Research Group, at Department of Informatics, Oslo.

Finally, a debate was held around the theme of whether robots should or should not be involved within care tasks[21]. The event took place at a Care+ facility for elderly people – an activity center for independent living elderly. Both elderly user representatives, staff, academics within robotics, design and welfare technology, as well as people from

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[16] Schulz, Trenton. Webpage at Norwegian Computing Center: https://nr.no/prosjekter/universell-design-av-roboter-ud-robots/.

[17] Saplacan, Diana. Webpage at University of Oslo, Department of Informatics. https://www.mn.uio.no/ifi/english/people/aca/dianasa/universal-design-of-robots-%28ud-robots%29-research-pr/universal-design-of-robots.html.

[18] Pajalic, Zada. Webpage at VID Specialized University, https://www.vid.no/forskning/forskningsprosjekter/universal-design-of-robots/.

[19] Saplacan, Diana. The importance of standarization within new technological areas. Standard Morgen: Forskning og standardisering hånd i hånd i Horisont Europa; 2022-06-14 - 2022-06-14

[20] Saplacan, Diana. Ongoing research with Social and Assistive Robots - Presentation for the National Commitee in Research Ethics in Science and Technology (NENT). Presentation for NENT; 2022-11-23 - 2022-11-23.

[21] Saplacan, Diana. TIAGo wishes you welcome to a debate on the theme: Should a robot be involved in care tasks? (Norwegian title: TIAGo ønsker velkommen til en debatt med tema: Bør en robot involveres i omsorgsoppgaver?). Debate at a Care+ Facility for the elderly people; 2022-11-09 - 2022-11-09

the medical field took part in the debate. In addition, nurses participated in the audience.

## 7.2 International venues

### 7.2.1 Mentions during international tutorials

The project was mentioned and referred to during two international tutorials, along with other ongoing projects at the University of Oslo, Department of Informatics, Research Group of Robotics and Intelligent Systems.

The first tutorial[22] was held during 31st IEEE International Conference on Robot & Human Interactive Communication (RO-MAN), in Italy, Napoli.

The second tutorial[23] was held during The 2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2022) in Kyoto, Japan and online.

### 7.2.2 Mentions during two talks at two different international workshops

Similar to the tutorials, the research project was disseminated also during two international workshops.

The first workshop[24] was held during 31st IEEE International Conference on Robot & Human Interactive Communication.

The second workshop was held during JURIX - Interdisciplinary Workshop on the Governance for Social Robots (SORO)[25] at the 35th International Conference on Legal Knowledge and Information Systems, Saarland University, Saarbrucken, Germany. Specifically. The title of the talk was: "Ethics and Social Robots: A Universal Design Perspective".

### 7.2.3 Mentions during international panel debate

Similarly, during the launch of Transdisciplinary AI for Good of All, at Umeå University, Sweden, the project was referred to and acknowledged.[26]

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[22] Saplacan, Diana. Tutorial presentation. Title: "Robots and Society: Challenges and Opportunities within social Human-Robot Interaction" at 31st IEEE International Conference on Robot & Human Interactive Communication. Tutorial at RO-MAN 2022: Robots and Society (RO-SO): Ethical, Social, Legal, and Technical Perspectives on Integrating Social Robots in the Home- and Healthcare Systems and Services (Second Edition); 2022-08-29 - 2022-08-29

[23] Saplacan, Diana. Ethical challenges and opportunities with (care) robots - Universal Design as an ethical charter for inclusive robot design and interaction. Ethical, Legal and User Perspectives on Robots and Systems (ELAUPORAS) - part of The IROS 2022 IEEE/RSJ International Conference on Intelligent Robots and Systems; 2022-10-23 - 2022-10-23

[24] Saplacan, Diana. Presentation at The 2nd Workshop on Design-Centered HRI and Governance. Title: Making Care Robots Understandable: An Introduction to Universal Design Principles as Design and Ethical Guidelines of Social Assistive Robots. The 2nd Workshop on Design-Centered HRI and Governance at 31st IEEE International Conference on Robot & Human Interactive Communication; 2022-09-03 - 2022-09-03

[25] Saplacan, Diana. Presentation at the JURIX - Interdisciplinary Workshop on the Governance for Social Robots (SORO) at the , Saarland University, Saarbrucken, Germany. Specifically. The title of the talk was: "Ethics and Social Robots: A Universal Design Perspective".

[26] Brinck, Ingar; Paiva, Ana; Saplacan, Diana; Bensch, Suna. Debate during the symposium: "The Future of Human-Robot Interaction Science" at the Transdisciplinary AI for Good of All (TAIGA) Inauguration Conference, leaded by Prof. Thomas Hellström and Ass. Prof. Niclas Kaiser leading TAIGAS focus area on Embodied interactive AI, at Umeå University, Sweden. AI for Good? TAIGAs Inauguration Conference; 2022-10-26 - 2022-10-28

## 7.3 Mentions of the project in various guest lectures

The project was mentioned and referred to in various guest lectures, during the following talks:

Ethical Issues in Mobile Robots[27]

Ethics: Autonomous Technologies for All[28]

Ethics: Research Ethics and Autonomous Technologies for User Diversity[29]

Ongoing research with Social and Assistive Robots: Research projects, empirical examples, and theory[30]

What do we talk about when we talk about social robots vs. robot sociomorphism? Empirical examples from previous and ongoing research[31]

## 7.4 Scientific articles, book chapters, conference papers, or master theses acknowledging UD-robots project

Based on the data collected during this research project, we plan to write a minimum of three scientific articles (one based on workshops, one based on surveys, and one merged article, based on the evaluation method and the other two studies).

We, so far, have acknowledged the project in a book chapter[32] to be published (if accepted) under Cambridge University Press. However, the book chapter is not based on the data collected during this project but addresses the idea of Universal Design principles applied to social and assistive robots, which is also relevant to UD-Robot research project. Therefore, the book chapter acknowledges as well this project.

We hope to be able to build further upon this work, the upcoming articles from the data collected during the UD-robots project.

Further, at least two master theses at University of Oslo, are expected to acknowledge the project. First, a master thesis focusing on the consequences of robot hand gripper morphology and composition for human-robot interaction[33], which applies some of the Universal Design principles. Specifically, the project applies Principle 1: Equitable Use and Principle 3: Simple and intuitive Use to design of a robot gripper to be used on TIAGo. The master thesis is expected to be submitted during Spring 2023.

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[27] Saplacan, Diana. Ethical Issues in Mobile Robots - Guest Lecture for Norwegian University of Life Sciences (NMBU), at the Faculty of Science and Technology, part of Human-Robot Interaction Course, Advanced Topics in Mobile robots. Guest Lecture Guest Lecture for Norwegian University of Life Sciences (NMBU), Fac. of Sci, and Tech., Norway; 2022-11-30 - 2022-11-30

[28] Saplacan, Diana. Ethics: Autonomous Technologies for All (ATA)?. IN5620 - Interaction with AI and autonomous systems, at University of Oslo, Norway; 2022-09-14 - 2022-09-14

[29] Saplacan, Diana. Ethics: Research Ethics and Autonomous Technologies for User Diversity. IN5490 – Advanced Topics in Artificial Intelligence for Intelligent Systems, at University of Oslo; 2022-09-26 - 2022-09-26

[30] Saplacan, Diana. Guest Lecture: Ongoing research with Social and Assistive Robots: Research projects, empirical examples, and theory. Guest Lecture at Kristianstad University, Sweden; 2022-11-14 - 2022-11-14

[31] Saplacan, Diana. What do we talk about when we talk about social robots vs. robot sociomorphism ? Empirical examples from previous and ongoing research. Interaction Design Course at Ostfold University College, Norway. Theme: Social Robots; 2022-10-11 - 2022-10-11

[32] Saplacan et al. (2022, submitted) Should Social and Assistive Robots Integrated within Home- and Healthcare Services Be Universally Designed? Submitted to Cambridge University Press

[33] Meijer, Frida (ongoing, to be submitted during Spring 2023). Consequences of Robot Hand Gripper morphology and composition on Human-Robot. Supervisor: Saplacan, D.

Second, another master thesis[34] is supposed to use some of the results from UD-Robots project in order to develop further the knowledge. This project is not part of the UD-Robots project, but rather of another ongoing research project at the Norwegian Computing Center, namely Robot Supported Education for Children with Autism Spectrum Disorder (ROSA)[35].

## 7.5 Other dissemination channels

The project was also disseminated on social media, mainly on Linkedin, through the authors' own professional networks. Similarly, information about the project was sent out through email to the authors' own professional networks. We also plan on presenting results from the project at the MeetUp group: Universell utforming av IKT & digital inkludering, in the winter or spring of 2023.

# 8 Further work

This project has shown a need to continue working on including users and potential users in the design of new generations of social robots. Therefore, we plan to develop the project further based on the findings and apply for a new project period. The planned approach will be participatory action research. Our ambition is to get project grants over several years that can involve researchers, master's students and doctoral students at national and international levels. The intention is that future follow-up projects put robot research on the national and international map.

We managed to also pick up some additional contacts along the way. First, during survey data collection, we received recognition for this project and offered to establish collaboration with the University of South Florida and the top management of the international Gerontology association. We have already started planning the first meeting already in January 2023.

Second, while reviewing literature, we reached out and established contact with Malak Masnad Irshed Al-Qbilat, Ph.D and her former advisor Ana Iglesias. They have written a couple of articles about accessibility guidelines for socially assistive robotics that showed up recently[36][37][38]. We had a conversation with them about the project, how it was best to use the guidelines, and any things that they noticed while creating them. We agreed to stay in touch and work together on a future article.

[34] Badescu, Claudia (ongoing, planned to be submitted during Spring 2024). Controlling a robot for assisting language learning for children with ASD. Supervisors: Trenton Schultz (main), and Diana Saplacan (co-supervisor).

[35] https://nr.no/en/projects/robot-supported-education-for-children-with-asd-rosa/

[36] Qbilat, M., & Iglesias, A. (2018). Accessibility Guidelines for Tactile Displays in Human-Robot Interaction. A Comparative Study and Proposal. In K. Miesenberger & G. Kouroupetroglou (Eds.), Computers Helping People with Special Needs (pp. 217–220). Springer International Publishing. https://doi.org/10.1007/978-3-319-94274-2_29

[37] Qbilat, M., Iglesias, A., & Belpaeme, T. (2021). A Proposal of Accessibility Guidelines for Human-Robot Interaction. Electronics, 10(5), Article 5. https://doi.org/10.3390/electronics10050561

[38] Al-Qbilat, M. M. I. (2022). Accessibility requirements for human-robot interaction for socially assistive robots [Ph.D., Universidad Carlos III de Madrid. Departamento de Informática]. https://e-archivo.uc3m.es/handle/10016/35142

# Appendix A1 Forms for informed consent & applications to NSD and REKK

## A1.1 Informed consent for participation in the research project (Only available in Norwegian)

# Vil du delta i forskningsprosjektet UD-Robots: Universal Design of Robots?

Dette er en invitasjon til deg om å delta i et forskningsprosjekt hvor formålet er undersøke hvordan vi kan lage roboter som er universell utformet. Vi ønsker å vite deres meninger rundt bruk av roboter og hvilken grad de er tilgjengelig eller ikke. I dette skrivet gir vi deg informasjon om målene for prosjektet og hva deltakelse vil innebære for deg.

## Formål

Formålet med prosjektet er å undersøke man kan undersøk og evaluere om en robot er universell utformet. Universell utforming av teknologi innebærer idéen at teknologi kan brukes av alle uavhengig av funksjonsnedsettelser. For teknologi er det fokus på retningslinjer som for websider og mobile app'er. Roboter har en annerledes profil og egenskapers enn en websider eller en app og muligens trenger ekstra retningslinjer eller nye metoder å undersøke om en robot er universell utformet.

Forskningsspørsmålene handler om hvordan vi kan bruke en robot for å støtte kommunikasjon og sosial læring for barna og hvordan vi kan utvikle et verktøy som er enkelt å bruke for alle involverte.

Prosjektet er et samarbeidsprosjekt mellom Norsk Regnesentral, Universitet i Oslo og VID vitenskapelig høgskole. Prosjektet er støttet av Barne-, ungdoms- og familiedirektoratets tilskudd for universell utforming.

## Hvem er ansvarlig for forskningsprosjektet?

Norsk Regnesentral er ansvarlig for prosjektet. Norsk Regnesentral (www.nr.no) er en uavhengig forskningsstiftelse.

## Hvorfor får du spørsmål om å delta?

Invitasjonen formidles gjennom lokallag av Norges sykepleierforbund, Sveriges läkarförbund eller gjennom forskernes nettverk.

## Hva innebærer det for deg å delta?

Deltakelse innebærer at blir invitert å dele dine erfaringer og meninger rundt forskjellige tema relatert til UD-Robots prosjektet. Du vil bli invitert til å delta i fokusgruppe (gruppeintervju) eller elektronisk spørreskjema. Du kan bestemme hva som passer best for deg. Om du tillater det vil vi ta lydopptak, bilder eller video fra aktivitetene.

For **fokusgrupper (gruppeintervju)**

I **elektronisk spørreskjema** vil du får en lenke til en lenke til et spørreskjema med spørsmål knyttet til tema i UD-Robots. Spørsmålene er en blanding av tekst og flerevalg oppgaver.

Om du tillater det vil vi ta lydopptak, bilder eller video fra aktivitetene. I tillegg vil vi registrere kontaktinformasjon, alder, kjønn, generell informasjon om erfaring med roboter, arbeid med «sårbare personer» og med bruk av digitale hjelpemidler i slik situasjoner, samt eventuell stilling og faglig bakgrunn.

## Det er frivillig å delta

Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykket tilbake uten å oppgi noen grunn. Alle dine personopplysninger vil da bli slettet. Det vil ikke ha noen negative konsekvenser for deg om du ikke vil delta eller senere velger å trekke deg. Data samlet inn under disse aktivitetene brukes kun i forskningsprosjektet og ikke til andre aktiviteter.

## Ditt personvern – hvordan vi oppbevarer og bruker dine opplysninger

Vi vil bare bruke opplysningene om deg til formålene vi har fortalt om i dette skrivet. Vi behandler opplysningene konfidensielt og i samsvar med personvernregelverket.

Det er bare forskere i forskningsprosjektet som jobber direkte med observasjonsaktivitetene som har tilgang til dataene. Det vil si at forskere fra Norsk Regnesentral, Universitetet i Oslo og Vid vitenskapelig høgskole.

Navnet og kontaktopplysningene dine vil bli erstattet med en kode som lagres på en egen navneliste adskilt fra øvrige data. Kodene skal lagres fysisk på papir på et trygt område og er bare tilgjengelig for prosjektmedarbeidere på Norsk Regnesentral.

Annet datamateriale lagres på en sikker skytjeneste (Microsoft Online Services) som er egnet for lagring av fortrolige data med begrenset tilgang og multifaktor autentisering for å sikre at kun utvalgte prosjektmedarbeidere har tilgang til dataene. Dataene lagres på datamaskiner i EU, og skal flyttes til Norge i løpet av 2021.

Kun anonymisert informasjon vil bli publisert fra prosjektet. Det skal *ikke* være mulig at deltakerne vil kunne gjenkjennes i eventuelle publikasjoner eller andre media som kommer ut av prosjektet med mindre det er avtalt spesielt.

## Hva skjer med opplysningene dine når vi avslutter forskningsprosjektet?

Prosjektet skal etter planen være ferdig rapportert og avsluttet innen utgangen av 2023. Deretter vil opplysningene bli slettet eller anonymisert. Ved eventuell anonymisering av videoopptak eller bilder benyttes standard anonymiseringstiltak som sladding av fjesene og endring av stemmen.

## Dine rettigheter

Så lenge du kan identifiseres i datamaterialet, har du rett til:

- innsyn i hvilke personopplysninger som er registrert om deg, og å få utlevert en kopi av opplysningene,
- å få rettet personopplysninger om deg,
- å få slettet personopplysninger om deg, og
- å sende klage til Datatilsynet om behandlingen av dine personopplysninger.

## Hva gir oss rett til å behandle personopplysninger om ditt barn?

Vi behandler opplysninger om deg og barnet ditt basert på ditt samtykke. På oppdrag fra Norsk Regnesentral har NSD – Norsk senter for forskningsdata AS vurdert at behandlingen av personopplysninger i dette prosjektet er i samsvar med personvernregelverket.

## Hvor kan jeg finne ut mer?

Hvis du har spørsmål til studien, eller ønsker å benytte deg av dine eller ditt barns rettigheter, ta kontakt med:

Norsk Regnesentral ved Trenton Schulz på epost (trenton@nr.no) eller på telefon: 22 85 26 70.

Vårt personvernombud Kari Åse Homme på e-post (personvernombud@nr.no) eller på telefon 22 85 26 27.

Hvis du har spørsmål knyttet til NSD sin vurdering av prosjektet, kan du ta kontakt med:

NSD – Norsk senter for forskningsdata AS på epost (personverntjenester@nsd.no) eller på telefon: 55 58 21 17.

Med vennlig hilsen

Trenton Schulz

Seniorforsker

Norsk Regnesentral

# Samtykkeerklæring

Jeg har mottatt og forstått informasjon om prosjektet UD-ROBOTS, og har fått anledning til å stille spørsmål. Jeg samtykker til

- å delta i fokusgruppe (gruppeintervju)
- å delta elektroniske spørreskjema
- at det tas lydopptak
- at det tas bilder eller video
- at anonymiserte bilder kan brukes i rapporter, artikler og presentasjoner fra prosjektet.

Jeg samtykker til at mine opplysninger behandles frem til prosjektet er ferdig rapportert og avsluttet innen utgangen av 2023.

Navn: ____________________________________________

Telefonnummer____________________________________________

E-post:____________________________________________

______________________ ______________________________

(Sted og dato) (Signatur)

## A1.2 Approval from the Norwegian Center for Research Data (NSD)

Meldeskjema / Universal Design of Robots (UD-Robots) / Vurdering

# Vurdering

**Dato**
21.06.2022

**Type**
Standard

**Referansenummer**
972068

**Prosjekttittel**
Universal Design of Robots (UD-Robots)

**Behandlingsansvarlig institusjon**
Norsk Regnesentral

**Felles behandlingsansvarlige institusjoner**
VID vitenskapelige høgskole / Fakultet for helsefag / Fakultet for helsefag Oslo
Universitetet i Oslo / Det matematisk-naturvitenskapelige fakultet / Institutt for informatikk

**Prosjektansvarlig**
TRENTON WADE SCHULZ

**Prosjektperiode**
18.05.2022 - 18.05.2023

Meldeskjema

**Kommentar**
OM VURDERINGEN
Personverntjenester har en avtale med institusjonen du forsker eller studerer ved. Denne avtalen innebærer at vi skal gi deg råd slik at behandlingen av personopplysninger i prosjektet ditt er lovlig etter personvernregelverket.

Personverntjenester har nå vurdert den planlagte behandlingen av personopplysninger. Vår vurdering er at behandlingen er lovlig, hvis den gjennomføres slik den er beskrevet i meldeskjemaet med dialog og vedlegg.

VIKTIG INFORMASJON TIL DEG
Du må lagre, sende og sikre dataene i tråd med retningslinjene til din institusjon. Dette betyr at du må bruke leverandører for spørreskjema, skylagring, videosamtale o.l. som institusjonen din har avtale med. Vi gir generelle råd rundt dette, men det er institusjonens egne retningslinjer for informasjonssikkerhet som gjelder.

TYPE OPPLYSNINGER OG VARIGHET
Prosjektet vil behandle alminnelige kategorier av personopplysninger frem til 18.05.2023.

LOVLIG GRUNNLAG
Prosjektet vil innhente samtykke fra de registrerte til behandlingen av personopplysninger. Vår vurdering er at prosjektet legger opp til et samtykke i samsvar med kravene i art. 4 og 7, ved at det er en frivillig, spesifikk, informert og utvetydig bekreftelse som kan dokumenteres, og som den registrerte kan trekke tilbake. Lovlig grunnlag for behandlingen vil dermed være den registrertes samtykke, jf. personvernforordningen art. 6 nr. 1 bokstav a.

PERSONVERNPRINSIPPER
Personverntjenester vurderer at den planlagte behandlingen av personopplysninger vil følge prinsippene i personvernforordningen om:
lovlighet, rettferdighet og åpenhet (art. 5.1 a), ved at de registrerte får tilfredsstillende informasjon om og samtykker til behandlingen

formålsbegrensning (art. 5.1 b), ved at personopplysninger samles inn for spesifikke, uttrykkelig angitte og berettigede formål, og ikke viderebehandles til nye uforenlige formål

dataminimering (art. 5.1 c), ved at det kun behandles opplysninger som er adekvate, relevante og nødvendige for formålet med prosjektet

lagringsbegrensning (art. 5.1 e), ved at personopplysningene ikke lagres lengre enn nødvendig for å oppfylle formålet

DE REGISTRERTES RETTIGHETER
Personverntjenester vurderer at informasjonen om behandlingen som de registrerte vil motta oppfyller lovens krav til form og innhold, jf. art. 12.1 og art. 13.

Så lenge de registrerte kan identifiseres i datamaterialet vil de ha følgende rettigheter: innsyn (art. 15), retting (art. 16), sletting (art. 17), begrensning (art. 18) og dataportabilitet (art. 20).

Vi minner om at hvis en registrert tar kontakt om sine rettigheter, har behandlingsansvarlig institusjon plikt til å svare innen en måned.

FØLG DIN INSTITUSJONS RETNINGSLINJER
Personverntjenester legger til grunn at behandlingen oppfyller kravene i personvernforordningen om riktighet (art. 5.1 d), integritet og konfidensialitet (art. 5.1. f) og sikkerhet (art. 32).

UiO og VID er felles behandlingsansvarlig institusjoner. Vi legger til grunn at behandlingen oppfyller kravene til felles behandlingsansvar, jf. personvernforordningen art. 26.

Ved bruk av databehandler (spørreskjemaleverandør, skylagring, videosamtale o.l.) må behandlingen oppfylle kravene til bruk av databehandler, jf. art 28 og 29. Bruk leverandører som din institusjon har avtale med.

For å forsikre dere om at kravene oppfylles, må dere følge interne retningslinjer og eventuelt rådføre dere med behandlingsansvarlig institusjon.

MELD VESENTLIGE ENDRINGER
Dersom det skjer vesentlige endringer i behandlingen av personopplysninger, kan det være nødvendig å melde dette til oss ved å oppdatere meldeskjemaet. Før du melder inn en endring, oppfordrer vi deg til å lese om hvilke type endringer det er nødvendig å melde: https://www.nsd.no/personverntjenester/fylle-ut-meldeskjema-for-personopplysninger/melde-endringer-i-meldeskjema Du må vente på svar fra oss før endringen gjennomføres.

OPPFØLGING AV PROSJEKTET
Personverntjenester vil følge opp ved planlagt avslutning for å avklare om behandlingen av personopplysningene er avsluttet.

Kontaktperson hos oss: Anne Lene L. Nymoen

Lykke til med prosjektet!

## A1.3 Project Assessment from Regional Committee for Medical and Health Research Ethics (REK)

| Region: | Saksbehandler: | Telefon: | Vår dato: | Vår referanse: |
|---|---|---|---|---|
| REK sør-øst C | Claus Henning Thorsen | 22845515 | 12.07.2022 | 494243 |

Zada Pajalic

**Fremleggingsvurdering**: "Universel design av roboter"?
**Søknadsnummer**: 494243
**Forskningsansvarlig institusjon**: Norsk Regnesentral

# Prosjektet vurderes som ikke fremleggingspliktig

### Søkers beskrivelse

*Formålet med prosjektet er å undersøke man kan undersøk og evaluere om en robot er universell utformet. Universell utforming av teknologi innebærer idéen at teknologi kan brukes av alle uavhengig av funksjonsnedsettelser. For teknologi er det fokus på retningslinjer som for websider og mobile app'er. Roboter har en annerledes profil og egenskapers enn en websider eller en app og muligens trenger ekstra retningslinjer eller nye metoder å undersøke om en robot er universell utformet.*
*Forskningsspørsmålene handler om hvordan vi kan bruke en robot for å støtte kommunikasjon og sosial læring for barna og hvordan vi kan utvikle et verktøy som er enkelt å bruke for alle involverte.*
*Prosjektet er et samarbeidsprosjekt mellom Norsk Regnesentral, Universitet i Oslo og VID vitenskapelig høgskole. Prosjektet er støttet av Barne-, ungdoms- og familiedirektoratets tilskudd for universell utforming.*

Viser til skjema for fremleggingsvurdering for ovenstående prosjekt, mottatt 01.06.2022. Henvendelsen er vurdert av sekretariatet i REK sør-øst.

### REKs vurdering

Formålet med prosjektet, slik det fremgår av skjema og vedlegg, er å undersøke om man kan undersøke og evaluere om en robot er universelt utformet.

REK mener at selv om dette kan gi nyttig kunnskap om universell utforming hos roboter, så vil det ikke gi ny kunnskap om sykdom og helse slik dette forstås i helseforskningslovens § 4. Prosjektet fremstår derfor ikke som fremleggelsespliktig, jf. helseforskningslovens §§ 2 og 4.

Studien kan gjennomføres uten REK-godkjenning.

REK antar for øvrig at prosjektet kommer inn under de interne regler for behandling av opplysninger som gjelder ved ansvarlig virksomhet. Søker bør derfor ta kontakt med enten forskerstøtteavdeling eller personvernombud for å avklare hvilke retningslinjer som er gjeldende.

**Konklusjon**
Vi gjør oppmerksom på at avgjørelsen av spørsmålet om fremlegging er å anse som veiledende jf. forvaltningsloven § 11.

Med vennlig hilsen

Jacob Hølen
Sekretariatsleder, REK sør-øst

Marianne Bjørnerem
Rådgiver, REK sør-øst

*Kopi til:*
Norsk Regnesentral

# Appendix A2 Story Dialogue Method questions

The SDM sessions are organized around a structure dialogue, following the standard sessions:

1. Storytelling
2. Reflection circle
3. Structured Dialogue
4. Reviewing the story records.

Each of these steps are described in details below.

## A2.1 Story telling

First, the participants were asked to pick a story teller, a story listener, and a story recorder. The story-teller told the story that she or he has chosen. The story listener, just listened and reflected on what was being said. The story recorder, is usually supposed to jot down notes in a document. Because we audio and video recorded the workshop, we asked the participants to just talk, rather than jot down notes. Thereafter, the roles were changed amongst the participants.

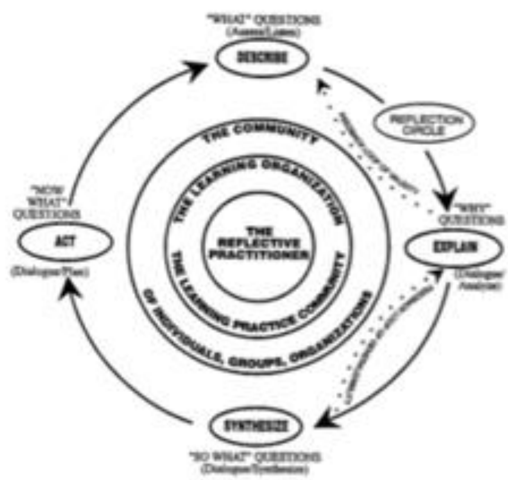
## A2.2 Reflection circle.

During the reflection circle, the following questions were asked. Each of the participants were welcomed to answer 2-3 of the questions, at their choice. The main facilitator leaded the structured dialogue.

1. *How is this story my story as well?*
2. *What is different/similar from my story?*
3. *Why did I relate to this story?*
4. *Why did I choose this story? What made me pick up this story?*
5. *Do I know other settings where robots are used with vulnerable groups (e.g., hospital, home)?*
6. *Why do we need inclusive robots (robots that can be used by vulnerable users)?*
7. *Why do we need accessible robots (robots that have interfaces that can be accessible by vulnerable users)?*
8. *Do I feel vulnerable myself when it comes to the use of robots? If yes, why do I feel so?*

## A2.3 Stuctured Dialogue

This part was structured into four main parts (as shown in the figure below)



Story Dialogue Method - Fig. 1 from Labonte & Feather (1996), p. 10

- **A.** Description.
- **B.** Explanation
- **C.** Synthetization
- **D.** Action

### A. Description WHAT questions (DESCRIPTION)

1. *What was the identified problem/need/issue?*
2. *What are the vulnerabilities revealed in the story?*
3. *Who is the most vulnerable in the story?*
4. *What is the role of the healthcare professionals in the story?*
5. *What can a robot do to help me in my work?*
6. *What are the challenges with integrating social and assistive robots within home- and healthcare?*
7. *What are the challenges with using robots with vulnerable people?*
8. *What does it mean for me that a robot is inclusive?*
9. *What are the benefits of inclusive robots, in my view? What are the tradeoffs, in my view?*
10. *What it means that a robot is accessible for me?*
11. *What it means that a robot is accessible for a vulnerable group?*
12. *What are the work tasks a robot could do for me?*
13. *What are the work tasks a robot could do for the vulnerable persons in the story?*
14. *What are the challenges with integrating robots within institutional/conventional care?*
15. *What are the challenges with integrating robots within home care?*
16. *What is the most important for me: the appearance of the robot (=how the robot looks), or the functionality of the robot (=what it can do)?*
17. *What is the most important: that the robot looks humanoid (like a human), or as a pet, or that it looks completely different?*
18. *What makes me think the appearance of the robot? Do I trust it more or less depending on its appearance?*

### B. WHY questions (EXPLANATION)

1. *Why I think what I think on this topic?*
2. *Why appearance of the robot is more/less important for me?*
3. *Why functionality of the robot is more/less important for me?*
4. *Why do I think robots will or will not play an important role in healthcare domain?*
5. *Why do I agree/disagree with having robots around within the healthcare domain?*

6. *Why do robots are important/less important to be integrated within home?*

**C. SO WHAT questions (SYNTHESIS)**

1. *What have I learned from this discussion?*
2. *What remains confusing?*
3. *Reflecting on these stories, did I found out something unexpected?*
4. *So what is my role as a healthcare professional within this domain?*
5. *So what am I afraid of?*
6. *So what is my standpoint regarding robots to be used with vulnerable groups?*
7. *So what is my standpoint regarding robots within home- and/or healthcare domain?*

**D. NOW WHAT questions (ACTION)**

1. *What are some concrete examples that I should be aware of regarding robots and vulnerable groups?*
2. *What power do I have with regard to robots and vulnerable groups?*
3. *What power do I have regarding robots within home- and healthcare?*
4. *What are the key lessons?*

*How can my power be increased when it comes to the use of robots with vulnerable groups?*

## A2.4 Story Records

## A2.5 Create insight cards.