

# Awareness and Acceptance of Emerging Technology and Quadruped Robots in Dementia Care: A Survey Study

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## Abstract

The rapid increase in the number of persons with Alzheimer’s Disease or related dementia has led many researchers to develop supplemental care to assist caregivers. One such form of care comes in the form of a quadruped robot that can interact with its environment to provide additional care. However, before such technology is fully implemented, researchers must understand how aware the public is of such technology for dementia care and how they perceive it. In this study, we surveyed 16 adults, all but one of which have been affected by dementia either directly or indirectly. We asked them questions regarding their attitude towards technology in healthcare and the quadruped robot that was demoed for them. It was found that people positively accept these robotic forms of dementia care, even if they do not have a comprehensive understanding of them. Furthermore, regarding the quadruped robot, people do perceive it positively but are not as confident in its ability to provide adequate care. They also have reservations about using robots to care for persons with dementia, mostly because of the lack of a “human touch,” and are afraid that robots might replace human caregivers altogether. From these results, researchers must do their best to not only develop the technology to be as robust as possible but keep the public informed of their research to bridge the gap between this revolutionary technology and its end users.

## Introduction

The Alzheimer’s Association reports that, as of 2023, 6.7 million people in the United States suffer from Alzheimer’s disease (Alzheimer’s Association 2023). As such, the need for additional care and support for persons with Alzheimer’s disease and related dementia (PwADRD) and their caregivers is on the rise. One such supplementary care comes in the form of social assistive robotics (SARs), which can interact with PwADRD and their environment and aid in their care. Such systems promise to not only provide ample forms of care that can have a positive impact on the cognitive, physical, and emotional well-being of PwADRD but also provide relief to overburdened caregivers. Overall, the development of SARs is a key step in improving the care of PwADRD.

One key step in the development of SARs is improving user acceptance. SARs have been developed in a variety of ways and designs, from humanoid robots like the Pepper robot to quadruped, dog-like robots. Previous studies have shown that humanoid robots are well-received by PwADRD and their caregivers (Yuan et al. 2021, Yuan et al. 2022a). However, non-humanoid robots have been underdeveloped. The PARO robot, for example, is a non-human, animal-like robot that has boasted high reviews from dementia patients and caregivers alike (Hung et al. 2021, McGlynn et al. 2014). However, even the PARO robot is unable to interact with the environment like other non-humanoid robots, such as a quadruped robot. These can have attachable arms that can grab objects and assist with tasks (Morris et al. 2022). Therefore, due to their ability to better assist in caregiving tasks, it is important to gain an understanding of how people might react to these robots. Any major repeating opinions or concerns can be used to guide the future development of these novel technologies. This includes the implementation of artificial intelligence (AI) into these systems.

The purpose of this study is to survey individuals on their opinions of a quadruped robot for the care of PwADRD. Data was collected regarding the opinions of the AlienGo robot from Unitree. The purpose of the survey was to answer 2 key research questions: 1) people’s general attitudes and awareness of technology and robotics in healthcare, and 2) their perception and acceptance of quadruped robotics in dementia care.

In contrast to previous work, this study accomplishes two things: 1) focus on quadruped robots rather than traditional social robots, and 2) assess the perceptions of people who do not have dementia, but have been indirectly affected. First, previous studies have focused almost entirely on humanoid robots (Andtfolk et al. 2022, Lee et al. 2023, Yuan et al. 2021, Yuan et al. 2022a). While this is sufficient for SARs that focus on social interaction, it limits the functionality of the target systems. Non-humanoid robots, like the quadruped robot that is the focus of this study, have a wider

range of functionality as they can interact with the environment, such as task assistance/completion for PwADRD (Morris et al. 2022). Furthermore, prior studies have focused on the perception of PwADRD regarding robotics (Broadbent et al. 2009, Smarr et al. 2014, Søråa et al. 2023, Pino et al. 2015), but fail to assess how those around PwADRD (caregivers, loved ones, etc.) perceive them. This study bridges that gap by surveying all those affected by dementia.

## Methods

This study includes survey data from 16 adults who had attended a Walk to End Alzheimer’s Event in Knoxville, Tennessee where the quadruped robot was first demoed. The protocol was approved by the Institutional Review Board (IRB) (IRB number is UTK IRB-21-06631-XM). All 16 adults provided their consent to use the survey data in this publication, and the demographic data can be seen in Table 1. While their exact relation to dementia was not recorded, all but one of the participants have interacted with, cared for, or at least know an individual with dementia.

Table 1: Demographic data of participants ( $n=16$ )

Demographic Variable	Number of Participants
Age (years)	$n$ (%)
<50	1 (6.25%)
50-55	7 (43.75%)
56-60	3 (18.75%)
61-65	2 (12.5%)
66-70	1 (6.25%)
>70	2 (12.55%)
Gender	$n$ (%)
Female	11 (68.75%)
Male	5 (31.25%)
Education	$n$ (%)
High school diploma or equivalent	5 (31.25%)
Some college or associate degree	5 (31.25%)
Bachelor's degree	2 (12.5%)
Master's degree	4 (25%)

Notably, the participant demographics are not evenly spread, specifically regarding gender. This is a current limitation of this study and should be worked on in the future. However, at this time the research team was unable to gather additional participants to address this limitation.

### Procedure and Data Collection

At the event, the AlienGo robot was shown, with simple remote-controlled movements, such as walking around and shifting stances; see Figure 1. During this demo, people were invited to fill out a 25-question survey. Most questions were on the 5-point Likert scale, with 1 being the least positive and 5 being the most positive. The survey also included open-ended response questions where participants could leave additional opinions or comments. Participants were

free to either take the paper survey with them and return it with them, fill it out later, or fill it out at the table.



Figure 1: The AlienGo robot was presented at a Walk to End Alzheimer’s event.

### Data Analysis

After the event, the surveys were collected and recorded digitally. The survey responses were entered into a Microsoft Excel sheet where they were later analyzed. Descriptive statistics, including the mean and standard deviation, were taken for the survey questions on the Likert scale (1 being the most negative and 5 being the most positive), resulting in a series of quantitative data on two topics: 1) the general attitudes and awareness towards technology and healthcare robotics and 2) the perception of quadruped robots and factors influencing acceptance. The open-ended question was analyzed qualitatively, with the responses being taken into consideration when concluding.

## Results

### Quantitative Data

**General Attitudes and Awareness Towards Technology and Healthcare Robots.** Regarding the role of technology in healthcare, 62.50% of respondents were already aware of the use of robots in healthcare before the survey. Their primary sources of information about healthcare robots were news media and word of mouth. The perceived benefits of quadruped robots in dementia care were acknowledged by a majority of respondents. Specifically, providing companionship and emotional support, monitoring vital signs and alerting caregivers in emergencies, and enhancing cognitive stimulation and memory exercises were viewed as potential benefits by 81.25%, 81.25%, and 75% of respondents respectively. These numbers are similar to those found in previous studies that assess the perception of PwADRD regarding social robots (Lee et al. 2023, Pino et al. 2015, Smarr et al. 2014). Also, 68.75% of participants acknowledged the usefulness of quadruped robots in assisting with daily tasks, such as medication reminders and meal preparation, and in promoting physical activity and mobility.

**Perception of Quadruped Robots and Factors Influencing Acceptance** When asked about factors that could influence the acceptance of quadruped robots in dementia care, 87.50% of participants emphasized the importance of demonstrated effectiveness and positive outcomes. Additionally, 68.75% of respondents indicated that public educa-

tion and awareness campaigns would be crucial in increasing acceptance. Previous studies that assess the perception of both humanoid (Andtfolk et al. 2002, Broadben et al. 2009) and non-humanoid (Hung et al. 2021, McGlynn et al. 2014) social robots show similar results, thus proving quadruped robots will be accepted on a similar scale.

However, respondents also raised concerns about the use of quadruped robots, with the most common being lack of human interaction and personal touch, and cost and affordability, as noted by 73.33% of respondents. Other potential barriers to acceptance included concerns about potential harm or accidents caused by robots, limited accessibility or affordability for certain populations, fear of technology replacing human caregivers, and lack of trust in robot capabilities and reliability, reported by 68.75%, 62.5%, 62.5% and 56.25% of respondents respectively.

**Quantitative Summary** The mean scores and standard deviations for each of the four dimensions are summarized in Table 2.

Table 2: Participants' responses, Mean ( $\mu$ ), and Standard Deviation ( $\sigma$ ) were calculated on a 5-point Likert scale (1 = very negative, 5 = very positive).

Survey Question	$\mu \pm \sigma$
<b>General Attitudes Towards Technology</b>	
Q1: How comfortable are you with the use of technology in daily life?	4.31 $\pm 0.70$
Q2: How open are you to new technological advancements?	4.38 $\pm 0.72$
Q3: Do you believe technology can improve healthcare?	4.44 $\pm 0.63$
<b>Awareness and Knowledge About Robots in Healthcare</b>	
Q1: How would you rate your understanding of the role of robots in healthcare?	3.31 $\pm 0.79$
<b>Familiarity and Perception of Quadruped Robots in Dementia Care</b>	
Q1: How familiar are you with the concept of using robots for dementia care?	1.68 $\pm 0.87$
Q2: What is your initial reaction to the idea of using quadruped robots for dementia care?	4.25 $\pm 0.68$
Q3: How comfortable are you with the idea of quadruped robots providing care to dementia patients?	4.38 $\pm 0.72$
<b>Trust and Acceptance</b>	
Q1: How confident would you be in the abilities of a quadruped robot to provide effective care to a dementia patient?	3.81 $\pm 0.66$
Q2: Would you accept the use of quadruped robots in the care of a loved one with dementia?	4.06 $\pm 0.68$
Q3: How likely would you be to recommend the use of a quadruped robot for dementia care to someone who needs it?	3.62 $\pm 0.62$
<b>Perceived Acceptance and Adoption</b>	

Q1: How receptive do you think the general public would be to the use of a quadruped robot for dementia care?	3.88 $\pm 0.81$
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### Qualitative Feedback

Seven participants provided additional comments. These comments are cataloged in Table 3 by participant ID.

Table 3: Participants' responses to the open-ended question ("Please provide any additional comments, concerns, or suggestions you may have regarding the use of quadruped robots for dementia care").

ID	Responses
2	Be open-minded
5	Thank you
10	I believe robots would help current caregivers, who are mentally and physically exhausted, in assisted living facilities. These robots could aid with paperwork, provide breaks, or handle some patient activities.
11	For the necessary personal touch and human interaction, robots can assist with dementia patients' initial assessments and health responses. However, a connection with a human healthcare provider is still necessary for trust and personal care. Robots can help overworked healthcare providers by distracting cognitive patients and potentially mitigating cognitive loss.
12	I am impressed with the prototype robots and am eager for their availability for home use.
15	We need to supplement personal care and human touch as our population grows older.
16	Human contact is crucial for psychological well-being. My worry is that if robots are used in care facilities, they should not replace human caregivers completely. My fear is that they could be seen as more cost-effective, leading to corporations replacing people. Robots could be beneficial as assistants to reduce stress, not as full replacements.

## Discussion

### General Awareness and Acceptance of Robots in Healthcare

From the first section of the survey shown in Table 2, most people are comfortable with technology and technological advancement. This aligns with previous studies, including those on larger scales (Dosso et al. 2022, Yuan et al. 2022b). With average scores on each question reaching above 4/5, this survey shows that people, including those affected by dementia in some way, are accepting of technology in healthcare. This is great for future research, as it shows that people are more willing to accept new technologies as they are developed. This, in turn, makes the implementation of novel healthcare technologies easier for researchers.

However, the second section of the survey in Table 2 indicates that people are less familiar with robots in healthcare. Although some of the open-response results show an eagerness for robots in the care of dementia patients, there is still a gap in the public's familiarity with such technology. With a score of 3.31/5, people are only partially familiar with the role of this technology. Even worse, according to Q1 in the third section of the survey with an average score of 1.68/5, very few respondents are familiar with the concept of robots being used for dementia care. These results are similar to those found in other studies that focus on PwADRD perception of robots in healthcare (Broadbent et al. 2009, Smarr et al. 2014, Søråa et al. 2023, Pino et al. 2015). This point shows that researchers must do a better job of informing the public of their research and its impact on the healthcare world.

This study also lays the foundation for AI development. Rather than focusing on the public perception of the AI itself, this study shows that the potential end-users of AI in dementia care positively perceive the physical systems that the AIs are embedded into. Researchers can implement their AI for dementia care into robotic systems that have already been well received, thus boosting user perception.

#### **Familiarity and Acceptance of a Quadruped Robot in Dementia Care**

The third section of the survey shown in Table 2 indicates that most people react positively to the quadruped robot and its possible implementation in dementia care. This further reflects the results from the first half of the study and other works, which show that people are generally receptive to new technologies in healthcare (Dosso et al. 2022, Morris et al. 2022, Yuan et al. 2022b). Therefore, the development of the quadruped robot is viable in improving dementia care as it is already well received. One notable point, however, is that from the last question in the fifth section, respondents believe the public would be less receptive to the quadruped robot than they were. The results were positive with an average score of 3.88/5, but it is still about half a point lower than the average acceptance of the individual respondents. This could indicate one of two things: 1) the respondents of this survey were simply more receptive to the quadruped robot due to external factors or 2) the public would be more receptive to the robot than individual persons believe they would be. Due to the small sample size of this study, it is difficult to make a solid conclusion, but previous studies would indicate the latter as they have shown similar results regarding other robots (Dosso et al. 2022, Yuan et al. 2022b). More specifically, these results are similar to those found in studies regarding humanoid robots (Andtfolk et al. 2022, Lee et al. 2023, Yuan et al. 2021, Yuan et al. 2022a), suggesting that the quadruped robot would be accepted at a similar rate and therefore just as viable for dementia care.

All of the average scores for the questions in section 4 of the survey are positive, but they are slightly less than those in section 3. Respondents indicate they are less likely to trust

its ability to perform adequately (the definition of such performance is left vague). Altogether, this section of the survey shows that, although generally positive, people are less likely to believe in the feasibility of the quadruped robot.

#### **Public Apprehensions for Robots in Healthcare and How to Address Them**

From the average results in the survey questions and the open-response results, it is apparent that some hold reservations about using robots in the care of PwADRD. One of the most common comments shown in Table 3 is the lack of "human touch" that comes with the use of robots. Many are afraid that by using robots to care for PwADRD, human caregivers will be less employed, and care will become automatic. This is a valid concern, as many industries feel the same way with the rise of robots and AI technology. However, it is important to note that the development of SARs to care for PwADRD is not meant to replace caregivers, but to alleviate overburdened caregivers and provide additional support. Researchers and developers must explain this in their work to alleviate tensions with public opinion.

Understanding how people perceive the quadruped robot specifically helps researchers determine the cost of implementing AI into it. As shown by the results, people are less likely to accept the robot citing concerns of adequate performance. This, however, could be addressed by AI, as one could drastically improve the performance of a quadruped robot, thus alleviating potential user concerns while also allowing AI to be used more in a healthcare setting. Ways to assess and improve user trust in AI are already being researched (Hasija and Esper, 2022), and studies have shown that user perception of AI is trending positively in some fields already, such as education (Chounta et al. 2022)

## **Conclusion**

This study shows that people who have been affected by dementia, either directly or indirectly, are accepting of new technology to care for PwADRD, but may not be fully aware of their applications. Respondents were comfortable with new technologies, including the quadruped robot, when introduced to them. However, there seems to be a gap in their knowledge regarding the use and abilities in caring for PwADRD. This gap is reflected in their concerns regarding the use of robots, mostly stemming from a loss of the "human touch" that can only be provided by human caregivers. Therefore, it is important for researchers to not only develop more robust and capable technologies but also keep the public informed so they will be less apprehensive in the future.

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## References

- Alzheimer's Association. 2023. 2023 Alzheimer's Disease Facts and Figures. *Alzheimers Dement* 19(4). doi: 10.1002/alz.13016.
- Andtfolk, M., Nyholm, L., Eide, H., & Fagerström, L. (2022). Humanoid robots in the care of older persons: A scoping review. *Assistive Technology*, 34(5), 518-526.
- Broadbent, E., Stafford, R., & MacDonald, B. (2009). Acceptance of healthcare robots for the older population: Review and future directions. *International journal of social robotics*, 1, 319-330.
- Chounta, I., Bardone, E., Raudsep, A. & Pedaste, M. (2022). Exploring Teachers' Perceptions of Artificial Intelligence as a Tool to Support their Practice in Estonian K-12 Education. *International Journal of Artificial Intelligence in Education* 32: 725-755.
- Dosso, J.A. et al. 2022. User perspectives on emotionally aligned social robots for older adults and persons living with dementia. *Journal of Rehabilitation and Assistive Technologies Engineering* 9: 1-15. doi:10.1177/20556683221108364.
- Hasija, A., Esper, T. L.. 2022. In artificial intelligence (AI) we trust: A qualitative investigation of AI technology acceptance. *Journal of Business Logistics* 43(3): 388-412. doi: 10.1111/jbl.12301
- Hung, L., Gregorio, M., Mann, J., Wallsworth, C., Horne, N., Berndt, A., ... & Chaudhury, H. (2021). Exploring the perceptions of people with dementia about the social robot PARO in a hospital setting. *Dementia*, 20(2), 485-504.
- Lee, H. R., Sun, F., Iqbal, T., & Roberts, B. (2023, March). Reimagining robots for dementia: From robots for care-receivers/giver to robots for carepartners. In Proceedings of the 2023 ACM/IEEE International Conference on Human-Robot Interaction (pp. 475-484).
- McGlynn SA, Kemple SC, Mitzner TL, King CH, Rogers WA. Understanding Older Adults' Perceptions of Usefulness for the Paro Robot. *Proc Hum Factors Ergon Soc Annu Meet*. 2014 Sep;58(1):1914-1918. doi: 10.1177/1541931214581400. Epub 2014 Oct 17. PMID: 31320791; PMCID: PMC6637739.
- Morris, T.; Dodge, H.; Cerel-Suhl, S.; and Zhao, X. 2022. Social Robots to support Assisted Living for persons with Alzheimer's and related Dementias. In Proceedings of the International Conference of Social Robotics 2022. Florence, Italy. doi:10.1007/978-3-031-24670-8\_21.
- Pino, M., Boulay, M., Jouen, F., & Rigaud, A. S. (2015). "Are we ready for robots that care for us?" Attitudes and opinions of older adults toward socially assistive robots. *Frontiers in aging neuroscience*, 7, 141.
- Smarr, C. A., Mitzner, T. L., Beer, J. M., Prakash, A., Chen, T. L., Kemp, C. C., & Rogers, W. A. (2014). Domestic robots for older adults: attitudes, preferences, and potential. *International journal of social robotics*, 6, 229-247.
- Søraa, R.A., Tøndel, G., Kharas, M. et al. What do Older Adults Want from Social Robots? A Qualitative Research Approach to Human-Robot Interaction (HRI) Studies. *Int J of Soc Robotics* 15, 411–424 (2023). <https://doi.org/10.1007/s12369-022-00914-w>
- Yuan, F., Klavon, E., Liu, Z., Lopez, R.P. and Zhao, X., 2021. A systematic review of robotic rehabilitation for cognitive training. *Frontiers in Robotics and AI*, 8, p.605715.
- Yuan, F. et al. 2022. Assessing the acceptability of a humanoid robot for Alzheimer's disease and related dementia care using an online survey. *International Journal of Social Robotics* 14(5): 1223–1237. doi:10.1007/s12369-021-00862-x.
- Yuan, F. et al. 2022. Development of robotic care for older adults with dementia: Focus Group and survey study. In Proceedings of the International Conference of Social Robotics 2022. Florence, Italy. doi:10.1007/978-3-031-24670-8\_30.