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Optimizing Senior Living with Robots: A User Study on Social and Architectural Integration

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Motivation

Technical devices offer the option to compensate for physical limitations without depending on caregivers. Advancements in technology bring the vision of personal assistant robots closer to reality — robots capable of delivering breakfast, cleaning the kitchen, compensating for motor impairments, and handling heavy household items are already under development. To optimally integrate such assistance technology into future users' lives and living environments, it is essential to consider their attitudes, desires, and concerns.

The interdisciplinary project JuBot at the Karlsruhe Institute of Technology (KIT) investigates the integration of humanoid robots and assistive technologies for a senior-friendly living environment to maximize their independence and support caregivers without replacing interpersonal contact. The JuBot team brings together researchers "from robotics, artificial intelligence, human-machine interfaces, IT security, engineering and sports sciences, and architecture and technology assessment"

Methodology

The survey covered the following areas:
Part 1: Demographics and physical condition
Part 2: Technical affinity, openness, and everyday tasks
Part 3: Residential needs

The User Study was reviewed by the ethics committee and data protection officer of the KIT and has been conducted in accordance with their principles .

The study was conducted in Germany. All participant quotes and survey content were originally in German and have been translated into English for this paper.

The Questions are aimed at the aging population. The option of reading and writing support allowed us to reach a group of participants with very different cognitive and physical abilities. In addition, the survey was divided into three parts to adapt the number of questions to the attention span of each individual. Participation in the study was voluntary and without monetary compensation. Each person was informed beforehand that they could withdraw at any time, even after receiving the questionnaire, without providing a reason or facing any disadvantages. The results were anonymized to prevent any identification of our participants. In the questionnaire, we used Likert scales to ensure comparability. In addition, respondents were also given the option to express further thoughts in open-text fields for each question.

Demographics and physical condition

Part 1 of the study provides information on the demographic characteristics of the respondents. A total of 8 residents of the "Alte Mälzerei" nursing home in Karlsruhe, Germany and 13 individuals living independently participated in the study. The sample group consisted predominantly of persons over 50 without significant cognitive limitations. Most volunteers are from southern and western Germany. Twice as many women as men took part in the survey.

More than half of the respondents held a university entrance qualification or a master's degree as their highest level of education. The professional backgrounds were diverse. Slightly more than half of the respondents used a mobility aid. (Figure 1)

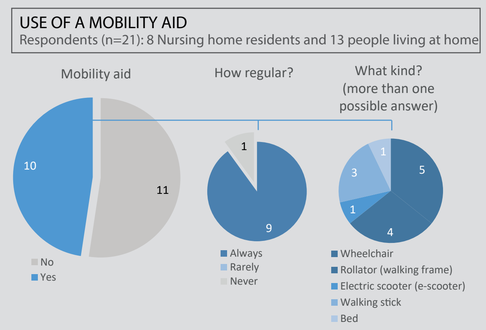


Figure 1: Use of mobility aid of interviewees

Abstract

This research investigates the integration of Humanoid Assistance Robots into senior living environments to enhance independence and reduce the burden on caregivers. The user study of this paper was conducted to identify the housing needs of seniors and their openness to assistive technology, focusing on their technical competence and preferences for daily task assistance. The findings show a general openness towards technology that is intuitive and easily accessible. The participants strongly favored robotic assistance for physically demanding and repetitive chores but preferred human support for tasks requiring physical and emotional closeness. The results also highlight the need for ergonomic and accessible design. In the context of our Project JuBot at Karlsruhe Institute of Technology, the survey is relevant for the development of our humanoid robot ARMAR and a user-centered living typology. The project aims to enhance safety, independence, and autonomy by balancing technological assistance with human interaction.

Openness to Assistive Robotics

The responses to questions about opportunities and concerns regarding technical assistance in the home (Figure 2) were generally positive. Participants identified key opportunities in increased independence, enhanced safety (such as the ability to contact help in emergencies), reduced physical strain, and the potential to live at home longer.

Notably, there was strong agreement that robots and assistive technologies should handle physically demanding tasks. One respondent emphasized this in the open comments, stating: "Assistance robots don't have a bad mood or get sick. - They are more reliable than humans".

The strong agreement that caregivers would gain more time for human interaction with robots highlights the value of human connection in old age. In line with this, most respondents disagreed with the statement, "I would have someone to talk to" (Figure 2), indicating that they do not perceive social benefits from social robotic interaction.

Concerns with Assistive Robotics

When asked about reservations, participants expressed concerns about dependence on technology, security risks, and potential privacy breaches. Despite providing primarily positive feedback, one respondent remarked, "Unless it gets hacked". Addressing these issues will be essential to building and strengthening trust and encouraging the use of assistive devices in the daily lives of senior citizens.

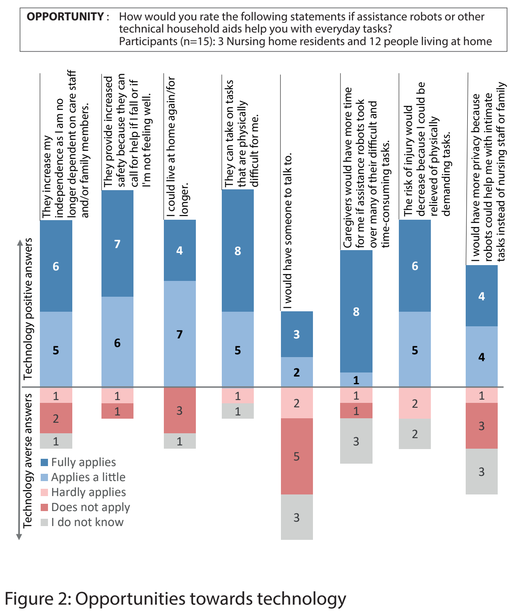


Figure 2: Opportunities towards technology

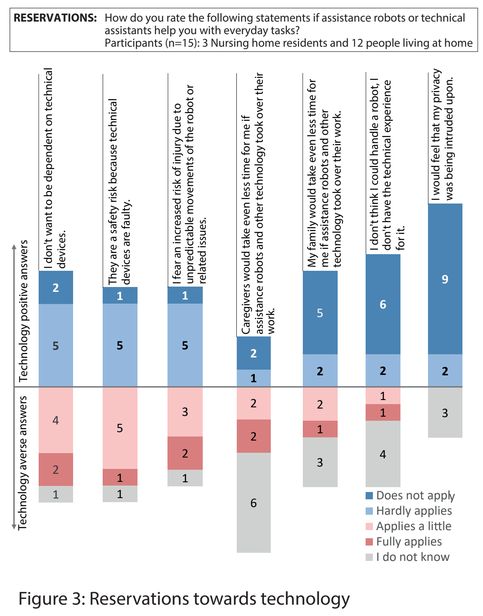


Figure 3: Reservations towards technology

Preferences for Assistance Tasks

The questions evaluating the acceptance of technical household aids for various daily tasks and activities are categorized into Household, Body care, Healthcare, and Leisure Activities.

The set of daily activities was already collected in an earlier project stage for a function-based analysis of user scenarios for assistive technology. The current user study now evaluates the potential distribution of stakeholders within the care setting.

Figure 4 presents the revised study results, with tasks arranged from left (high acceptance of technical support) to right (low acceptance of technical support). The answer option "equal" (indicating no preference) was interpreted as positive feedback towards technology, as the aim of this analysis is to identify growth potential for technical aids and pinpoint the task areas where caregivers and family members can be most effectively relieved.

The blue and purple areas of the graph indicate a preference for technical support. The upper boundary of the blue area reflects the combined responses for: "only technology," "rather technology," and "equal" preference. In contrast, the red line represents answers in favor of human support, comprising the responses: "only human" and "rather human".

The overall graphs show strong positive feedback for technical support in physically demanding and time-consuming tasks, such as carrying heavy objects, retrieving items, cleaning windows, refrigerators, and kitchens. Repetitive chores also benefit from technical assistance, especially when familiar technical aids are available. Key tasks in this category include remembering appointments, vacuuming, mopping floors, ironing clothes, and dusting.

In contrast, tasks involving emotional significance or physical contact are generally preferred to be handled by humans. These tasks include setting the table, washing dishes by hand, storing dishes, administering healthcare, or treating wounds. These findings align with the attitudes towards technology observed in earlier questions.

Growth potential of Assistance Tasks

The area where technology acceptance decreases and the preference for human support increases (the "narrowing gap of preferences") represents a key growth potential for technical solutions. Since there is no clear preference for human or technical support, the cautious openness can be further directed towards technology. Developing strategies that build trust and address the reservations are essential to increase acceptance and implementation areas. Since each use case combines its own set of benefits and concerns, the next chapter serves as an orientation to allocate those to design appropriate individual strategies for each use case.

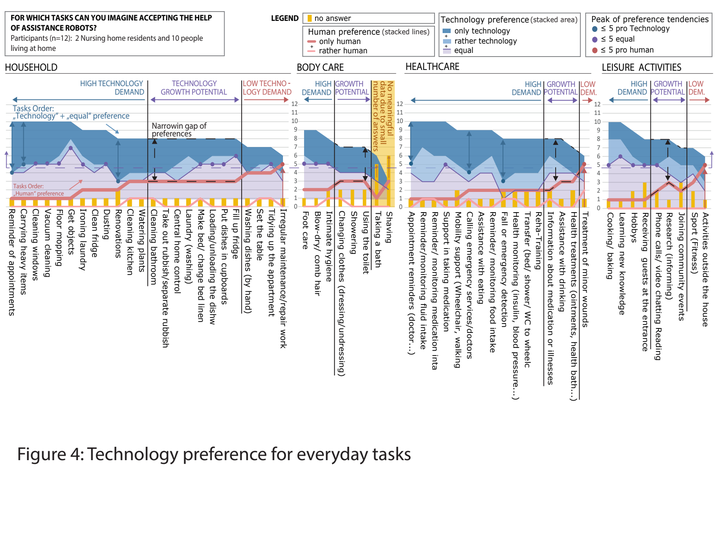


Figure 4: Technology preference for everyday tasks

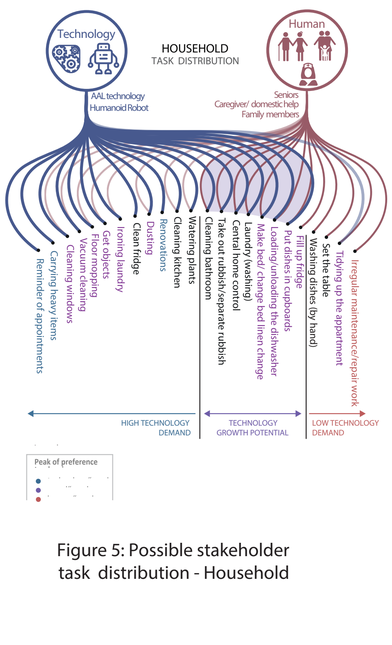


Figure 5: Possible stakeholder task distribution - Household

Architectural needs and preferences

The survey's Architectural questions focus on senior citizens' housing needs. The results indicate that respondents place high importance on accessibility, ergonomic design, and privacy.

Participants were first asked which rooms they occasionally find challenging to navigate independently. The bathroom was mentioned most, followed by the kitchen, living room, and hallway. Common reasons included insufficient space (e.g., for wheelchairs), obstacles like door thresholds, and limitations related to medical conditions such as multiple sclerosis.

In response to the question "Where would you prefer to live?" (with multiple answers allowed), 12 participants clearly preferred living in their own apartment or house. This was followed by the preference for multi-generational housing (with four votes) and living with family (with three votes). Retirement homes and private residential communities with other senior citizens were even less favored.

When asked about the importance of different aspects of living (Figure 6), 17 of the 21 participants rated privacy and the ability to retreat from shared spaces as "very important." The ability to choose between privacy and social interaction was also highly valued. Participants placed similar importance on having an aesthetically pleasing living environment, a private bathroom, and the freedom to personalize their space.

The survey also explored preferences for specific living area features. A floor-level shower with no steps or thresholds was considered "very important" (by 15 participants). Additionally, many respondents preferred natural lighting, direct outdoor views from the bedroom, access to outdoor spaces from both private and communal areas, ergonomic kitchen designs, and a seating option in the shower.

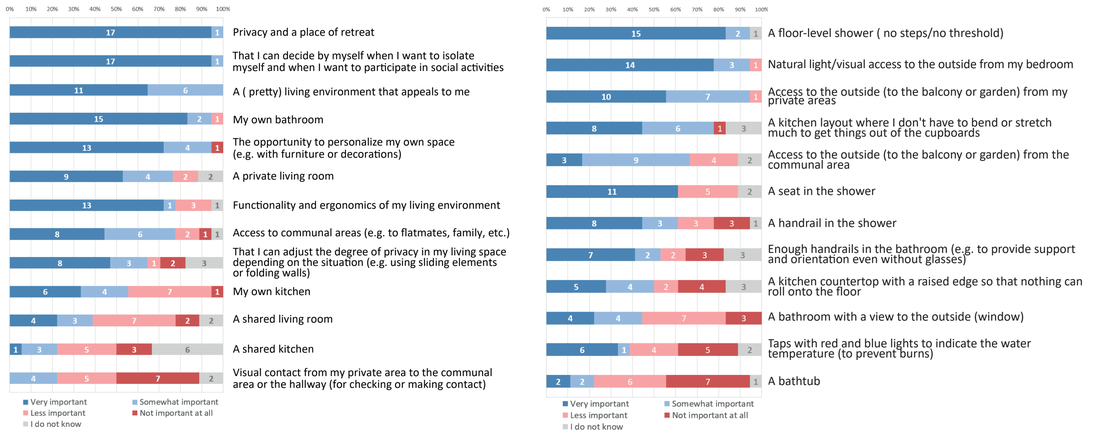


Figure 6: Living space preferences

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