

Preliminary Survey Analysis in Participatory Design: Repositioning, Transferring, and Personal Care Robots

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ABSTRACT

Robotic aids can perform repositioning, transferring, and personal care tasks and increase independence of persons who have reduced motor functionality. Our goal is to develop robotic aids by actively involving the target population, their caregivers, family members, and friends early in the design process to increase user acceptability through participatory design. We conducted a survey to explore the needs for robotic aids and to evaluate the perceived pros and cons of prototypes that we have designed and built-in simulation. Topic Modeling with Latent Dirichlet Allocation was used to detect trends and characteristics from the open-ended survey questions. This information will help us interpret the survey responses to increase usability and acceptance when building a physical robot.

CCS Concepts

•Computing methodologies → Simulation evaluation;
•Human-centered computing → Accessibility design and evaluation methods;

Keywords

survey analysis; assistive robotics; participatory design

1. INTRODUCTION

With advances in robotics technology, there is immense potential for supporting the demands of caregiving. We aim to utilize our questionnaire survey to evaluate the perceived limitations and advantages of robotic prototypes that we have designed and built-in simulation for repositioning, transferring, and personal care assistance. The purpose of our survey is to identify the perceived importance and satisfaction of each robotic prototype and assessing expectations of hardware and software interaction requirements. Text analysis of the survey responses will cheap the development

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of physical realizations of our prototypes by effectively addressing the challenges in the assistive robotics domain.

2. BACKGROUND AND RELATED WORK

In [2] a web-based interface for tele-operating an assistive robotics system with a single button mouse or equivalent was developed to increase accessibility with user-centered design. Results showed that clinically significant improvement was provided by using the robotic system in comparison to the unassisted individual's physical capacities.

While existing robotic systems become more accessible by improving from feedback received from user-centered design techniques, we aim to learn and accurately interpret the functional requirements and preferences of potential users to support researchers with mechanical design requirements of the robotic prototypes.

In the field of text analysis, the Latent Dirichlet Allocation (LDA) presented in [1] uses a collection of documents to create a distribution of topics for each document, along with a distribution of words per topic. In LDA, the assumption is that topic distributions along with word distributions per topic generated the corpus of documents, and the goal is to determine these distributions. The result is a list of topics with a coherent listing of words, which aid in document classification/retrieval tasks. This is used for identifying trends with different types of responses in this survey.

3. CURRENT RESEARCH

3.1 Approach and Methodology

We launched a Web-based questionnaire survey that approximately takes 30 minutes to complete. Following a user-centered participatory design approach, our survey was structured with several demographic questions, and inquired their opinions after viewing a series of videos of robotic prototypes for repositioning, transferring, and personal care tasks. There was no identifying information about the participants recorded unless the participant decided to submit their email address to stay informed about survey results.

We targeted 200–300 survey responses. Participants that must be 18 years or older were recruited from contacting organizations such as Cure SMA and the Muscular Dystrophy Association via email and posting messages on social media groups. For example, participants were asked to comment on each design and make suggestions for improvements from viewing the 3D video simulations of a robotic mattress (Piano Mattress), three different transferring systems, toileting

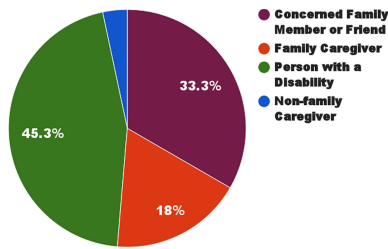


Figure 1: Types of Participants.

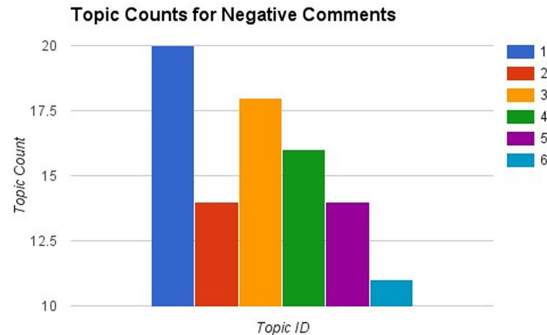


Figure 2: Frequencies of the topics in the top 3 highest topic proportions for all negative comments.

aid, robotic toothbrush, and universal gripper (UniGripper). Their responses have shaped ongoing development of the prototype devices by identifying attractive alternative design solutions. The study was reviewed and approved by the UMBC Institutional Review Board (IRB).

Additional information about the survey can be found here [3]. The survey can be accessed here: <http://www.csee.umbc.edu/~kavi1/survey.html>.

3.2 Preliminary Results

As of now, we have 150 survey participants. The survey participant proportions are shown in Figure 1. Additionally, all of our prototypes have received positive ratings in our preliminary results. This is very positive for our research and provides confirmation to move forward.

Survey analysis was conducted on a question asking to describe pros and cons for the Piano Mattress. Topic modeling was conducted using LDA with the tool Mallet, while treating each response as a separate document. In our study, 100 iterations and 15 topics were set. Frequencies of the top 3 topics for positive and negative comments were counted. Figure 2 shows the results for negative comments. Topic 4 was found to be more prominent for negative comments whereas topic 6 was more prominent for positive comments. Table 1 shows the top words for topics 4 and 6. These words can be utilized to provide an overview of word usage relat-

4	side end	back turn	air pain	moving isn't find joints
6	movement tiles	individual included	remote easily	adjust long fear comfortable

Table 1: Top words for topics 4 and 6.

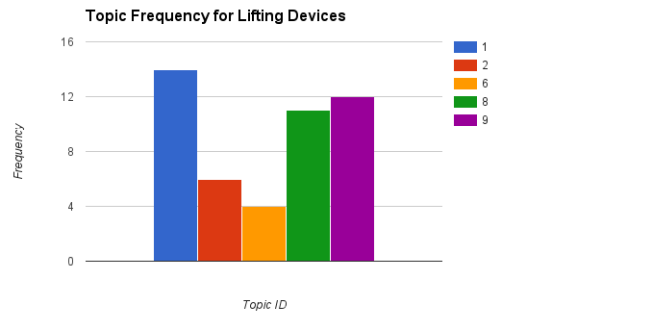


Figure 3: Topics Frequency for transfer prototypes.

8	lift	hoyer	lifting	takes	it's
9	ceiling	hoist	sling	lifted	required

Table 2: Top words for topics 8 and 9.

ing to complaints or compliments. For example, the words “side” and “turn” in topic 4 highlight the frequency in complaints about the lack of side to side adjusting functionality, whereas words like “pain” show concerns of possibly painful movements.

Figure 3 and Table 2 show characteristics of comments regarding use of lifting aids for transferring from wheelchair to bed. Topics 8 and 9 were highly popular, where some of the top words, such as “hoyer”, “ceiling”, and “hoist” show characteristics of popular devices used. Ceiling lifts and Hoyer lifts were popular among the survey responses.

3.3 Conclusion and Remaining Work

Our results are a valuable source of information to explore and discover the target population’s point of view that inform mechanical design configuration for robotic systems to overcome the challenges faced by persons with physical disabilities. To achieve a user-centered design and development of assistive robots for the target population, we need to thoroughly understand both the perceptions and expectations of robotic systems that can provide support for repositioning, transferring, and personal care to provide insightful opportunities for promoting higher rates of user acceptance and usefulness. Future work will also involve conducting significance tests on word frequencies to determine statistical significance of topic content.

4. REFERENCES

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