Implementing Robots to Support Nursing Home Staff and Socialize with Residents

by

Madeline Brady

Jonathan Coco

Kelly McDonald

Submitted by: Madeline Brady, Jonathan Coco, Kelly McDonald

Advisors: Dr. Aaron Sakulich, Norayr Ben Ohanian

An Interactive Qualifying Project Report Submitted to the faculty of Worcester Polytechnic Institute in partial fulfillment of the requirements for the Degree of Bachelor of Science in cooperation with Alzheimer's Care Armenia. Submitted 05/02/22.

Abstract

Armenia is predicted to have a shortage of caregivers in the future. To alleviate the burden on staff, Alzheimer's Care Armenia is experimenting with using service robots to socialize with residents. With them, we investigated how robots could be better implemented in nursing homes. We interviewed and surveyed caregivers, the general public, roboticists, and dementia experts. We found that more content relevant to residents' interests could be added to service robots, as well as some features that could be added.

Acknowledgments

We would like to thank Dr. Mineh Badmagharian, Dr. Jane Mahakian, Professor Eilon Caspi, and everyone else that we interviewed for taking the time to speak with us. We would also like to thank the staff of nursing homes who responded to our Method 2 survey and the WPI community for responding to our Method 3 survey. We would like to thank Zoë Eddy for helping us in the initial stages of this paper. Finally, we would like to thank our advisors, Dr. Aaron Sakulich and Norayr Ben Ohanian, for supporting us throughout this project.

Authorship

Chapter	Author	Editors
Abstract	McDonald	All
Executive Summary	Brady	All
Introduction	All	All
Background	All	All
Methods	All	All
Results	All	All
Recommendations	Coco	All
Conclusion	Coco	All

For the chapters of the paper in which all of us were an author, each of us wrote a section of that chapter. After the primary author wrote a section of the paper, the other two group members would go through and leave suggestions and comments for that section. Another group member, other than the person who left the suggestions and comments, would either accept or deny them.

Table of Contents

List of Figures

Executive Summary

The elderly population is growing faster than the number of available caregivers. As a result, many people will struggle with age-related illnesses such as dementia, yet have no one to care for them. Nursing homes are looking for a way to supplement the work of the human employees they have now with robotic assistance.

Groups such as our sponsor, Alzheimer's Care Armenia, are turning to social service robots as a solution to this problem. The organization has one of these robots, Robin the Robot, in their possession at the Nork Old Age Home in Yerevan, Armenia. Robin can socialize and play games with the residents, which provides cognitive stimulation and over time can slow down the progression of age-related diseases such as dementia and Alzheimer's. Our goal is to offer suggestions to improve Robin's capabilities, which could be applied to other social service robots as other countries experience aging populations. In order to do this, we need to gather opinions on Robin from different groups with perspectives, such as caregivers, the general public, and experts in the field of dementia. We must find what they like about Robin, what they dislike, and what possible recommendations they have for improvements.

We used various methods to ensure that we were able to gather accurate and relevant points of data. The first method that we used was to have a semi-structured interview with a social worker from the Nork Old Age Home where a Robin is currently being utilized. This allowed us to learn what issues came up with the robot and what could be done in order to improve the user experience. The second method that we used was surveying various nurses and caregivers that had no previous experience with service robots. This allowed us to get a variety of opinions on what features people would want to see in Robin. The third method that we used was to send a survey to the general public, asking them if they were familiar with someone with

dementia and their opinions on service robots. These are the people that were able to give recommendations to us about what improvements should be made from a non-medical perspective. The free-response nature of the survey allowed for more personalized responses to be given. Our fourth method was to conduct semi-structured interviews with roboticists. Our main purpose was to ask if the possible recommendations would be feasible to include in Robin. The fifth and final method was to interview a dementia expert in order to understand how Robin can best be utilized to help dementia patients. We were prepared to give a semi-structured interview, but our interviewee took the lead. However, we ended the session with all the information we had wanted to learn.

A key finding from the survey distributed to the general public was that respondents that indicated they were uncomfortable or highly uncomfortable with a service robot interacting with residents in a nursing home had not known someone with dementia. Another thing to note was that the caregivers surveyed were, in general, less sure as to what function a service robot could serve in the nursing home atmosphere.

Based on some of the indicated desires for what a nursing robot should be from the general public, we investigated the social robot Moxie, which is made and marketed as a friend for children to interact with. Moxie's main function was to help children learn emotional regulation skills and to help them learn to socialize with a friend in a stress free environment, and was developed for children for ages 5-10. Moxie can also only really focus on one child at a time, as it tracks the emotional progression and social skills a child is developing and relays that to the parents. It quickly became apparent that Moxie was not a viable option currently to adapt for use with older adults.

Through interviewing robotics experts and surveying caregivers, we found that the desire for a robot that can do tasks for staff slightly outweighs the desire for robots that can socialize with humans.

Our recommendations for Robin are split into three main sections: Most Important, Semi-Important, and Least Important. Some of the most important recommendations are:

- Test out different voices for Robin, as Method 3 indicated that almost half of survey respondents were unhappy with the voice currently being used.

- Expand Robin's library of cognitive games with some musical aspect

- Allow Robin to interact with a smart home environment so it can adjust blinds, the thermostat, or air conditioning to be more to the taste of the resident.

- Allow brightness and volume control for Robin directly from residents to accommodate those with vision or hearing impairments.

The Semi-Important recommendations are:

- Have Robin perform more caregiving tasks.

- Ensure that Robin is able to ask for preferences on what to call the residents. We learned in interviews that this will help residents feel more at ease.

- Have ice breaker games for residents when all gathered in one room. From the survey, we saw there was an issue of residents keeping to themselves too much.

- Consider making the screen larger in order to assist those with vision issues.

- Allow Robin to be able to set reminders for daily tasks, if Robin is able to be around at all times

- Allow Robin to connect to the internet to open up the possibilities of accessing more content for the residents to enjoy.

- Expand Robin's catalog of movies, cartoons, and games involving them from the 1950s to 1970s, since that is what residents like to hear.

- Ensure that Robin is not patronizing the residents or treating them like children in order to maintain their dignity and respect.

The Least Important recommendations are:

- Have a prepared story consistent with robin's personality that Robin can reference and answer questions about if Robin has to leave the nursing home permanently

- Allow the nursing home staff to add and remove games from Robin. That way as Robin spends time with residents and gets to know their preferences, staff can quickly change its library to their liking, instead of needing to go through the company Expper.

- Allow Robin to remind residents of family relations with visitors that come to see them.

- Improve Robin's eye contact capabilities so patients feel like Robin is looking at them and not near them.

Introduction

Armenia's rapidly aging population will result in an increase in cases of age-related illnesses, such as Alzheimer's disease and other dementias. As a result, more caregivers are needed than what is currently available. This population is not growing as fast as their clientele, cognitively-declining older adults. If those struggling with dementia do not receive enough cognitive stimulation, their decline rate could accelerate. Researchers investigated other solutions to provide cognitive stimulation to older adults, since nursing home staff may be spread too thin. One solution proposed by our sponsor, Alzheimer's Care Armenia, is incorporating social robots into nursing homes, to provide more social interaction and play cognitively-stimulating games with residents. For our project, we will focus on the social robot named Robin the Robot, which has been implemented at the Nork Old Age Home in Yerevan, Armenia.

Robin improved the quality of life for residents and reduced the stress on staff at the Nork Old Age Home. The home struggles with underemployment, which models what many nursing homes in Armenia will struggle with as the elderly population increases. This makes the Nork Old Age Home a good place to test the implementation of Robin the Robot. Upon the introduction of playing games with Robin, the elderly patients started smiling more and seemed to have a better outlook on life.

Despite these very positive outcomes, researchers have not fully investigated interactions between Robin the Robot and older adults. Robin was originally made to interact with long-term pediatric patients in children's hospitals. The founder of *Alzheimer's Care Armenia*, Dr. Jane Mahakian, hypothesized that Robin would help cognitively stimulate older adults in a nursing home. Since this is a different type of environment than what was initially intended for Robin,

further studies are needed on its interactions with older adults, so researchers can make more elder-specific recommendations.

A rising elderly population is not a problem specific to Armenia. Globally, countries are experiencing demographic issues with not enough young people replacing the older adults leaving the workforce and entering nursing homes. Even the United Nations has expressed high interest in using robotic assistants to supplement the future healthcare providers of the world. If Robin is verified to improve the lives of elderly patients, as well as a way to decrease the socialization burden on healthcare workers, there could be implications for using social robots with older adults in other countries.

In order to contextualize improvements that can be made to service robots caring for older adults, we will first provide a background on why service robots would benefit the elderly Armenian population and the current capabilities of social service robots such as Robin the Robot. We will present our overarching project plan and move into a discussion of our methods that will help us achieve this: interviewing a caregiver at the Nork Old Age Home in Yerevan, Armenia, surveying caregivers at other nursing homes which do not use service robots as well as surveying the general public about their attitudes towards using service robots in nursing homes, interviewing roboticists that specialize in the capabilities of service robots, and finally, experts in the field of dementia.

Background

Aging populations are not an issue exclusive to Armenia. Since the turn of the century, the World Health Organization (WHO) has had official meetings and publications on how to keep people integrated in society as the world's population grows older (Sidorenko, 2013). In 2002, the WHO came out with their Active Ageing publication which defined "active ageing" as "people who are expected and allowed to continue to participate longer in the formal labor market as well as in other unpaid productive activities (such as care provision to family members and volunteering) and live healthy, independent and autonomous lives in their older ages" (Sidorenko, 2013). This definition can be parsed out into a few ideas. Older people should still have the right to work if they want to continue working, and not be turned away from jobs solely because of their age; they should still be able to make an income for themselves. This leads into the next part of the "active aging" definition, caring for their families. Part of this care could be still contributing financially, among other duties such as taking care of domestic tasks or watching over children.

Older adults should still be allowed to contribute to communities, which also covers being a part of the workforce or contributing to the care of their family. This could also be in the form of volunteering or participating in community activities l where they can make their opinion heard. All of these objectives lead to the overall goal of the older adults remaining as productive members of society.

While this would be a universally agreed-upon ideal, mental and physical degeneration poses limits on how realistic it is for older adults to achieve the objectives listed. Therefore, other routes to a feeling of being a valuable member of a community need to be offered.

Armenia showed steady population growth since its first census taken in 1897, but then the population began to decrease around the same time the Soviet Union dissolved, in 1990 (Verdiyeva, 2019). From one year before the dissolution to 2015, Armenia's population decreased 18% (Verdiyeva, 2019). In 2017, the UN predicted that Armenia's population will continue to decline, meaning more people will continue to die in Armenia than be born (Verdiyeva, 2019). This has led to a growing portion of Armenia's population becoming elderly; however, the number of available caregivers to this population is not growing at the same rate. The lack of caregivers has resulted in a massive issue for older adults, a solution for which Armenia is actively beginning to search.

The most prevalent age-related illnesses are various dementias, such as Alzheimer's disease and Vascular dementia. According to the Alzheimer's Association, these abnormal changes in the brain can cause "...a decline in thinking skills, also known as cognitive abilities, severe enough to impair daily life and independent function. They also affect behavior, feelings and relationships" (2022). Essentially, this prevents all the goals the UN has set for active ageing, decreasing independence and ability to function as a productive individual in society. The way in which cognitively-impaired older adults need to feel fulfilled are therefore different from those needs of able-bodied working adults. Elderly Armenians are struggling to have these needs met.

In 2004, a survey found that 74% of Armenian women over the age of 60 living in urban areas were depressed, and 94% of Armenian women over the age of 60 living in rural areas were depressed (Srapyan, 2006). This survey did not include elderly women living in senior homes, who often experience even higher rates of depression than those who do not. Despite usually being in better physical and mental health, they tended to perceive their physical health as worse (Srapyan, 2006). This may be a morale problem in retirement homes. Cognitive decline occurs

faster without enough socialization; not just among the elderly in nursing homes, but across the general population (Harsányiová, 2018). Elders tend to feel isolated when separated from their families and put into homes. Overall, the elderly in Armenia struggle with their mental health and depression.

Those who are trained to take care of older adults suffering from cognitive-decline will soon be overworked. This will cause a more stressful work environment, and despite their best efforts, less effective care for their residents. Nursing homes with fewer staff tend to result in poorer resident outcomes, due to cognitive decline occurring faster without enough socialization.

These residents are more likely to lose the ability to perform basic daily tasks and are more likely to be depressed (Chen, 2014). Playing games and promoting activities that increase socialization is cognitively stimulating, and makes the residents happier. One study had nursing home residents completing cognitively-stimulating activities for one hour, twice a week, for 24 weeks (Chen, 2014). Overall, the residents showed better results in cognitive skills by the end of the study (Chen, 2014). By incorporating fun, fulfilling activities with mental stimulation, the well-being of nursing home residents is increased.

Service Robots, also known as social robots, are able to assist with providing healthcare to an ever-aging population. However, whether or not they are able to replace human caregivers is a debated topic. Though the need for caregivers will not be fully replaced, Robin and other service robots are able to, at the very least, reduce the number of caregivers needed. As the number of older adults in need of caretakers has been increasing, the number of caregivers has not been increasing at a proportional rate. Robotic helpers will lessen the increasing load on these caregivers and will allow for more residents to be treated at once. A study made by Zuschnegg et al. surveyed many caregivers and asked what they would want service robots to be

able to assist in nursing homes (2021). One of the most popular requested features was service robots helping residents walk. Residents falling is a major issue faced by many nursing homes and having something that is able to respond to and prevent these residents from falling over would greatly benefit caretakers.

In another survey on how people interacted with the thought of general robots in healthcare situations (such as taking blood pressure, administering an injection, or performing parts of surgery), participants were concerned with the effectiveness and reliability of the robots, as well as the ethics of the person programming the robot (van Kemenade, 2018). They overall believed robots would be valuable in supplementing healthcare worker shortages and allowing more time for doctors to focus on a patient. They were very receptive to robots taking over the mundane healthcare tasks that do not need as much human attention.

In addition, a Dutch university study of healthcare worker opinions on different types of personal care robots provided insight that workers believed monitoring robots (robots that help monitor the health of a patient) were perceived as the least useful, whereas assistive robots (robots that help with physical personal care) seemed to garner most of the concern because of their potential to physically hurt someone in the event of a malfunction (van Kemenade, 2018). Companion-like robots were viewed in the most positive light, as they were perceived by caregivers to have the potential for the least amount of harm. While healthcare workers acknowledge that their jobs could be supplemented by robotics, they are still wary of certain types of physical interactions with patients.

The people surveyed by Zuschnegg et al. also wanted service robots to be able to help residents socially (2021). According to Tesky et al., an estimated 30% of older adults in ten nursing homes across Munich suffer from depression and already overworked caregivers do not

have enough time to fully interact with every resident (2019). Providing social robots that can supplement the amount of social interaction residents receive can improve their mental state and ultimately their quality of life.

Caregivers also wanted service robots to be able to assist residents in ways that would still allow for them to help themselves. This includes service robots being able to remind the residents to perform activities such as taking their medicine, eating, and going outside. These suggestions can be used in the future to help assist caregivers and reduce the strain caused by the increasing population of older adults. While healthcare workers acknowledge that their jobs could be supplemented by robotics, they are still wary of certain types of interference with the residents. Physical interactions with residents raised the most alarm because of the bodily risk associated with any error.

When discussing the gaps that social robots are able to meet and the needs that they should fulfill, the opinions of the residents of nursing homes are just as important as the opinions of the staff. In Armenia, 10% of the population is over the age of 65 and a large proportion of that group is currently in nursing homes (Srapyan, 2006). Studies done by Park et al. and Gerłowska determined the wants of older adults in regards to service or social robots (2012). The results were that older adults wanted the robots to be able to improve their ability to function, facilitate more conversation, be non-disruptive, and increase their mood. Residents and caretakers both want service robots that allow residents to maintain autonomy. Specifically, residents want social robots that can have meaningful conversations, assist with tasks but not take over them, and overall increase their level of enjoyment and fulfillment with life.

There are already a few examples of robotic helpers that are in use. One of these examples is MARIO, a service robot that was used to determine if the resilience of older adults

suffering from dementia could be improved by using a social robot (Whelan et al., 2020). MARIO was able to assist the elderly by playing the favorite music of residents, showing memories of their lives and asking follow-up questions about it, and offering a series of games for residents to play (Whelan et al., 2020). This allowed for the quality of life for these residents to be improved and led to them being more cognizant. Most depressive symptoms of the residents were reduced and most of them now had a more positive mood (Whelan et al., 2020). The results of this study also demonstrated a need for social robots to be able to identify and respond to emotions in a more humane manner.

Another example of a social service robot is Robin the Robot, designed by Expper Technologies. It has been shown to improve the cognitive function of residents in nursing homes who suffer from dementia and Alzheimer's. Robin's appearance was designed to be huggable due to it originally being intended for children. Robin's front logo also simulates a "heartbeat" which helps children and residents view it as more human. Robin is currently able to scan the faces of residents and determine their emotional state based on that scan. This allows for Robin to react in a way that responds to these emotions. The capacity of Robin to respond to emotion is an improvement over MARIO, whose main weakness is its limited emotional capacity. Robin is also able to recognize residents, play their favorite music and games with them, and have follow-up conversations based on past learned information. This is in part due to Robin not being fully autonomous. Conversations with residents are monitored by a psychologist at Expper who is able to input lines directly into Robin when conversations require more tact. Robin's ability to react in a more personalized way forges genuine emotional connections with residents, allowing them to feel more comfortable and making Robin a much more effective caretaker. Robin is pictured in Figure 1.

Figure 1: Robin the Robot

Robin was tested in the Nork Age Home in Armenia over a 12 week period. It interacted with residents in 30-minute sessions, twice a week. This testing resulted in the residents increasing their mental capacities, improving their sleep, decreasing their depressive symptoms, and overall improving their quality of life. These results are very encouraging towards the future, but there is still more that can be done (Robofluence, 2021).

In Japan, Pepper the Robot from the company Softbanks Assistants was used in a study rating how effective it was at communicating verbally and nonverbally with study subjects (Tanioka, 2021). While the robot started out well, as the conversation progressed, practical issues came up, such as the volume of the speaker and the sensitivity of the robot's microphone, as well as the robot's ability to differentiate between different people in the same conversation. It was frequently looking at the incorrect person, even though it was responding to the questions that were asked.

In experiments done to rate how nursing home residents viewed service robots' qualities after a trial, the efficiency of a robot completing tasks ranked the lowest, whereas that

attractiveness of how a robot overall looked and performed its tasks was the highest (Gerłowska, 2018). The facial expressions and body language of the robot were determined to be important in attracting the attention of the resident, making it more likely that the robot could perform its functions. The robot was also viewed as an unobtrusive background object, with family members or personal caregivers entering their own opinions on how the robot fit in with daily life and tasks. Personal caregivers consistently hit around the 50% mark for believing the robot was a positive influence in the care of the resident, but around 75% thought it was a good idea to improve the security of the resident, as well as their quality of life (Gerłowska, 2018).

Robots still have a long way to go when it comes to human interaction and having their purpose defined in a way that makes healthcare workers and nursing home residents comfortable. Different robots are built to fulfill specific needs, and therefore cannot pivot as much in terms of what tasks they can perform. For example, a robot built to assist in performing menial tasks would not generally be combined with a robot that is supposed to help with socializing.

In terms of resistance to robots entering the nursing homes to relieve the burden on caregivers, a companion-like robot is more likely to be appreciated than a robot that would have to physically interact with residents. Surveyed older adults generally reacted well to the concept of a companion robot to help with certain tasks and are open to allowing it as a replacement for meeting certain social needs (Huang, 2019). Most of the reluctance comes from lack of knowledge on what the robot would do or how it could help them. Some of the concerns are also rooted in how to interact with the robot from a user's perspective. Acceptance of personal care robots in the home amongst the elderly also depends on how many other people live with the person who might be interested in using it. Taiwanese older adults are more likely to accept a service robot if they are unmarried or are living with their parents (Huang, 2019). If they are

living with their children or are married, the perceived usefulness and willingness to have one in the home sharply drops.

Through our project with Alzheimer's Care Armenia we aim to compile information on social service robots and their perception in healthcare circles, and then make recommendations on how to integrate a nursing robot into a nursing home. There are several factors that would lead to the project being a success. Based on previous studies done and on surveys given to residents and caregivers alike, we made recommendations for how to improve Robin's interactions with nursing home residents. Another factor that would lead to the Alzheimer's Care Armenia project being a success is that our recommendations make a positive impact. Service robots have the opportunity to completely change the way caregiving is done. These robots have the potential to care for a rapidly aging population and reduce the workload of caregivers in nursing homes and care facilities.

Methods

Our goal is to recommend improvements to how Robin the Robot provides care for older adults with Alzheimer's and other dementias. These improvements should ease the burden on those who currently care for these older adults, such as caregivers and family members. In order to achieve this, we will analyze how older adults respond to care provided by service robots, to find human-service robot interactions that more effectively provide cognitive stimulation to older adults with dementia. We have gathered information from various sources that fit into five categories: nursing home staff that have worked with Robin, nursing home staff that have not done so, the general public, roboticists, and experts in the field of dementia.

Method 1: Nork Old Age Home Staff

The first category, those who have worked with service robots in a nursing home setting, includes nursing home employees and residents' close family members. For our first method, we specifically focused on caregivers who have worked with Robin in the past. The Nork Old Age Home in Armenia has housed Robin since 2019, so we conducted semi-structured interviews with those who work there. Specifically, we interviewed a social worker at the Nork Old Age Home. She and other employees provide care for nursing home residents on a daily basis. As a result, she knows the needs and daily lives of the residents, and sees firsthand how the residents interact with Robin. Interviewing the social worker offered insight into residents' interactions and attitudes towards this robot. This information helped us recommend improvements for how Robin is implemented.

For our semi-structured interview with the social worker, we asked her a set of open-ended questions. Having open-ended questions allowed for more personalized responses and more information from the interviewee. Our goal was to compile a list of the features that

were most and least appreciated in Robin in order to make recommendations for future updates. We also improvised questions during the interview if the subject said anything of note that we wanted to explore further.

Method 2: Staff Who Have Not Interacted With a Service Robot

Alzhiemer's Care Armenia also works with the Armenian Nursing Home and Rehabilitation Center in Jamaica Plains, Massachusetts. Even though the residents living there have not interacted with Robin, we still polled their staff to understand what they would want in a service robot. Surveying nursing home employees that have not interacted with Robin helped us to identify recommendations to make at the end of our project. We emailed the CEO and an administrator at the Jamaica Plains nursing home to distribute our survey. This survey consists of several questions that are a mix of short answers and rating scales. None of these questions required an answer, so that the caregiver could omit an answer if they felt uncomfortable with the question. This hopefully prevented "survey fatigue" in our subjects due to them not having to answer questions that were too emotionally draining. Survey fatigue describes when the end of surveys tend to be filled out with much more rushed answers than the beginning parts. Another way to ensure that we avoided survey fatigue was placing the short answer questions at the beginning and the rating scale questions at the end. Rating scale questions required less work to answer, so hopefully subjects filled them out accurately. These data were compiled into a Google Sheet in order to view trends among the answers given. The survey was also distributed to a group of other nursing homes in the US. The full list of these nursing homes is included in the appendix. We analyzed the data that we collected through survey responses in order to both compile a list of the wants of caregivers and determine improvements for Robin.

Method 3: General Public Survey

We also surveyed the general public in order to get their opinions on Robin and on the idea of service robots. We did this because the general population offered an emotionally-invested perspective completely unrelated to any professional motivations. People tend to feel untrusting or anxious about nursing home care, and perceive it as far less personalized than it necessarily is (Bökberg, 2021). The objective of surveying the general public was to get a different but valuable perspective on the ideal capabilities of service robots and to determine what people feel comfortable with in a service robot.

In the survey, we first asked if they knew anybody suffering from dementia. We then gave a background on service robots, and asked for their opinions of what capabilities they would and would not like to have in service robots. We then showed a video of Robin and, based on that video, asked the respondents to give feedback on what improvements should be made. This served as the last phase of the interview so our subject had considered both Robin's current capabilities and the social needs of nursing home residents. We finally asked them how comfortable they were with service robots on a scale from 1 - 5 and then asked them to explain why they chose their answer.

Answers for each survey question were automatically entered into a spreadsheet, which allowed for easy comparison between different responses to the set of questions. We used this information to draw recommendations about what could be made to improve Robin the Robot, along with the other data we have gathered. We analyzed this information by looking for general trends in responses, and how those trends relate to a survey recipient's background.

Method 4: Roboticists

We interviewed those who work on developing service robots to understand their intentions and goals with these tools. We wanted to understand how these compare to the goals and intentions of those who work with service robots through a series of semi-structured interviews.

We conducted semi-structured interviews with researchers working on social service robots at WPI. We got into contact with Professor Jane Li whose group does research on service robots. Working with contacts within our university already gave us a connection with them, and made it easier to meet. We wanted to learn their goals for their service robot, and how they verified that the service robot met these objectives. A list of pre-determined questions for the interview is included in the appendix.

Finally, we interviewed the head of strategy and research at Expper Technologies, Dr. Mineh Badmagharian. Researchers such as her can offer insight into the thought process for developing Robin and why they chose to give it certain functions, as well as go more in depth about the intricacies of how Robin's AI processes human interactions. She was also able to answer any questions that we had about the functionality of Robin that we could not find answers to in our own research.

Method 5: Dementia Experts

Our fifth and final method was interviewing experts in the field of dementia. Robin is being utilized in nursing homes that specifically deal with those suffering from dementia, and an expert was able to give some advice on how to best improve Robin to better fit the needs of the residents there. We conducted a semi-structured interview so we had set questions before our meeting but the interviewee was not limited in the amount of information that they could give us.

We wanted to learn the best ways to implement social interaction to mitigate the symptoms of dementia. For this method, we interviewed Prof. Eilon Caspi, an assistant research professor from the University of Connecticut. He was able to offer insight into the needs of older adults suffering from dementia.

Results

Result 1: Nork Old Age Home Staff

We interviewed a social worker at the Nork Old Age Home in Yerevan. Due to her firsthand experience with Robin, she was able to give us more information on how residents interact with Robin. Through her, we learned that the residents "view Robin as a hero" and that they think Robin can "make all of their dreams come true."

They also see Robin as a child or even a grandchild, and someone in whom they can confide their deepest secrets. This connection is explained by the function of Robin to recall previous conversations. Robin is able to play games with them that are designed to improve memory, such as trivia about pop culture from when they were young. Through these games, the memories of the residents have been getting better, according to the social worker. Robin also sings and dances for the residents and encourages them to dance too by swaying back and forth. This allows residents to have fun and provides physical activity.

The only negative that she had to say about Robin was that it would occasionally reboot unexpectedly, but whenever that happened Expper would come in to fix it. As Robin is in the trial period, Expper is focused on how it is performing in the nursing home. Beyond that, there was very little that was discussed in the interview in terms of what improvements need to be made to Robin and she mostly just praised how good it was for the residents.

Result 2: Staff Who Have Not Interacted With a Service Robot

Method 2 was a survey sent out to various nursing homes across the US. This survey was designed to be filled out by staff of nursing homes who had not interacted with Robin in order to obtain their opinions on social service robots. Through the ten replies, we gained insight into the

residents' needs, what the caregivers need in order to take care of the residents, and their opinions towards having social service robots in the workplace.

When asked about the hardest part of their job, half of the respondents referred to some sort of communication-based issue, and over half responded that their workplace felt understaffed. Both of these issues could be lessened by the implementation of a social service robot.

We also asked nursing home staff members how they felt about possibly having a robot like Robin working alongside them. As seen in Figure 1, a third of the caregivers that filled out the survey felt very uncomfortable with being assisted by robots in the workplace and the rest of the responses indicated that nursing home staff have a fairly neutral opinion.
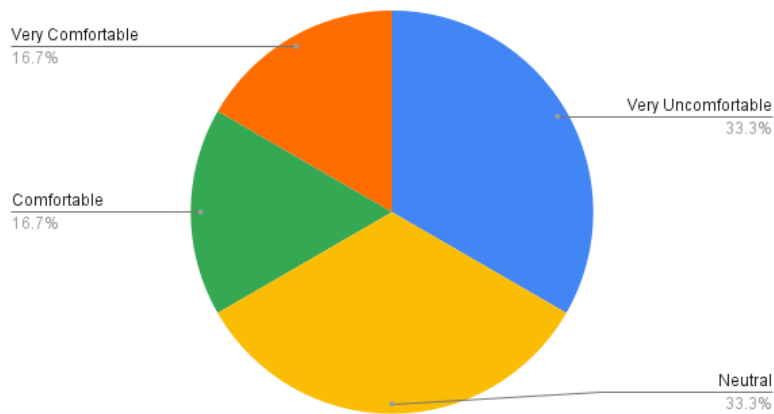

Figure 2: Comfort Level of Nursing Home Staff with Service Robots

In asking respondents to explain their reasons for their comfortability level, low comfortability respondents said:

"For kids maybe not for the boomer generation"

"I am not sure what they would be utilized for initially or what the concept would be to utilize them. Also they are an unfamiliar looking concept to our residents. We have had issues with residents being able to use an ipad and understand FaceTime with a loved one and so they just may not register the robot."

"No experience with robotic assistance."

Neutral responses said:

"will depend on performance - trust need to be earned"

"I believe I prefer humans instead of robots for the nursing home community."

"I would like to see Robin being used in a senior care setting"

Positive responses said:

"Adds an element of fun, surprise and creative engagement to the older adults day."

"I am not sure how. "Robots" would be helpful in saving staff time. Perhaps by keeping patients busy with various activities they would be less inclined to occupy staff time.

However they could be useful in providing emotional support and educating regarding important subjects such as, back safety, exercise, etc."

"I think it would assist staff in caring [for] patients and keeping an extra eye on them for monitoring purposes."

While the majority of staff would be open to having a service robot work with them, the utility of the robot and its specific functions would need to be elaborated on in order to justify the presence of the robot to them.

Another question that we asked during the survey was what staff would like to see and not like to see in a service robot. For what they would like to see, staff wanted the robots to be able to communicate on a one-on-one level with the residents. They wanted service robots to be able to fulfill the emotional needs of patients. As for what staff members do not want to see, they did not want a service robot to use culturally insensitive language so as not to offend residents, or be too confusing for residents to interact with. This need for an easy-to-understand robot was reflected across all answers in the survey. The primary concern that all responses had was that robots needed to be intuitive to understand and interact with.

Result 3: General Public Survey

We sent out a survey to the general public in order to determine their opinions as people who might have loved ones afflicted with dementia. In the survey we asked respondents to listen to a clip of Robin's voice. The clip of the voice can be found in the appendix. The voice of Robin in Armenia is slightly different, but not enough to where it would impact the opinions of the poll.

The results that were found were conclusive on some aspects, such as almost half the respondents wanting to change the voice Robin currently uses with American children if it were to interact with the elderly. Despite that, most of the respondents felt comfortable with the idea of robots in nursing homes as displayed in Figure 2.
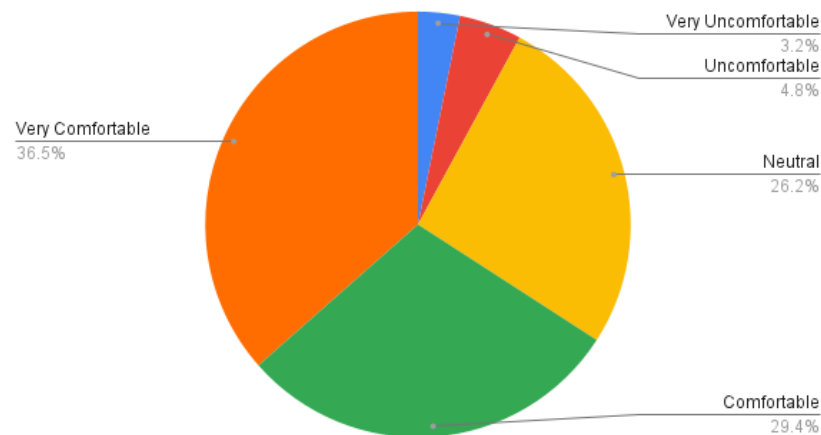

Figure 3: Comfort Level of the General Public with Service Robots

Roughly two thirds of the respondents were either comfortable or very comfortable with service robots, with only 8% being uncomfortable or very uncomfortable with them. The majority of respondents have known somebody with dementia with the most common answer being either their parents or their grandparents. When asked to explain their reasoning for their comfortability level with robots, respondents who had indicated a low comfortability said:

"My grandparents can't operate their new new coffee maker, good luck with a robot"

"I think it might actually cause worsening confusion for elderly patients. Not as tech savvy as kids. Not warm or [human-like]."

"So gross, inhumane, zero empathy can be provided by a machine. Our world is going nuts."

Some respondents of a neutral comfortability said:

"There is no substitute for humans"

"I have a hard time believing elderly people want to interact [with a] robot."

"I think it would be great but I would have to see it in person in action to see how comfortable [I] am."

"I think it could be a great opportunity to increase the ratio of caregivers to patients. But just not letting the ratio of service robots to human caregivers get out of hand. The service robots can be great to do some more of the mundane tasks like setting out medication, helping set up activities, and even do a few more meaningful things here and there. But it would be very sad if we have less human caregivers because it would be like we don't care for patients. The robots seem like a great idea for easing the amount of work on the human caregivers so that they can spend more time having meaningful interactions with patients."

Some of the respondents with positive reactions said:

"As a supplement for human care, it's useful, but it should be used to augment standard care, not replace it"

"I believe they can provide a lot of help to nursing homes to help the old people with various issues. For example, old people who cannot properly go to the bathroom anymore and need assistance [from] a nurse can feel more or less helpless. A robot can make this experience a lot nicer, as it's not another person seeing you at that point. Another question is how many of these robots would there be compared to human nurses. Human nurses I feel are extremely necessary and not replaceable, but having a good amount of robots to help these nurses in various tasks would be wonderful."

"I think it's great if these could be placed in nursing homes, many elderly don't have friends or family they visit often and I think just having robin as a companion [for some] would really help lift their spirits."

"Any kind of socializing will benefit patients. Staffs get so busy that they can't find time to just sit and talk with the patients."

Out of the respondents that were uncomfortable with the idea of service robots in nursing homes, there was a common theme. Most of those commented on how robots would never be able to mimic the authenticity of human emotion and how they seemed creepy. This could potentially be rectified by giving Robin an improved appearance. It should be mentioned that

77.2% of the people surveyed (Figure 3) had known or currently know someone with dementia. It should also be mentioned that out of all the responses that indicated they were very uncomfortable with service robots, none of those respondents indicated that they have ever known anybody with dementia. This implies that seeing the effects of dementia first-hand may encourage family members or friends of the older adults with dementia to be more willing to consider non-traditional methods of care.
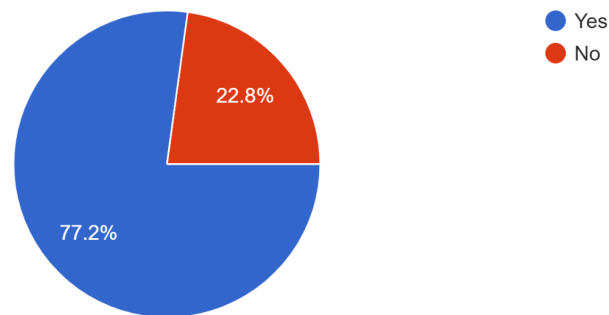

Figure 4: Percentage of Respondents that have Known Somebody Suffering from Dementia

Result 4: Robotics Technical Experts

At Expper, we talked to Dr. Mineh Badmagharian, who is the company's Head of Strategy and Research. She explained the thought process behind Robin's design, the current study that is being conducted at the Nork Old Age Home, and gave us more insight into how Robin functions. Robin was initially designed to work in children's hospitals, so it has a very "huggable" design, with many surprised and smiling faces. Robin has a very joyful and silly

personality, in order to keep those interacting with it entertained and at ease. In a nursing home setting, this translates to residents viewing Robin as a grandchild. Robin was viewed very positively by the residents, to the point where residents would be jealous if Robin was spending more time with someone else.

At the Nork Old Age Home, Robin meets with the residents for 30 minutes, twice a week, for 12 weeks. It also attends nursing home celebrations. Besides holding conversations and remembering past conversations, Robin can play music for the residents and play games with them. From our interview with the Nork Old Age Home social worker, we learned that Robin mostly played memory games with the residents, such as guessing the names of actors in old films. These games and movies have been downloaded to Robin already. It also encourages physical activity through dancing, which Dr. Badmagharian said can help prevent cognitive decline.

Dr. Badmagharian then elaborated more on how Robin functions. Currently, the robot is autonomous 60% of the time, with a psychologist controlling its responses the other 40% of the time. The psychologist however monitors all conversations Robin has, and steps in if sensitive topics come up, such as past wars or health-related information. Dr. Badmagharian says that Expper hopes to make Robin more autonomous in the future.

We learned that Robin had limited internet capabilities. The psychologist at Expper is able to monitor Robin's interactions through the internet. However, if a resident asks Robin a question that is not already included in its programming, it cannot search for an answer to the question as one may be able to do through Apple's Siri. Instead, the psychologist has access to the internet, and so can supplement Robin's information by proxy. Due to needing internet from

the nursing home to function fully, Robin is currently unable to venture outside the facility to accompany residents outdoors.

In terms of safety for the residents, Robin can find and verbally ask for help from staff if it senses something is wrong with a resident, like someone has fallen in Robin's presence. Robin also has an alarm that can sound, alerting passersby that there is something wrong.

We also interviewed Professor Jane Li, a robotics expert who conducts research on a service robot she is developing, which she calls "nursing robots". Her nursing robots can be controlled through virtual reality and haptics, similarly to how Robin can be controlled by a psychologist. Virtual reality (VR) is when a user is immersed in a 360-degree view of another environment, and can act as though they are within that environment. Haptics simulate touch or motion to further submerge a user in that environment. Through using VR and haptics in order to understand the environment the robot is in, a nurse is able to do their job through the robot without having to put on personal protective equipment (PPE). Figure 4 shows Professor Li's nursing robot.
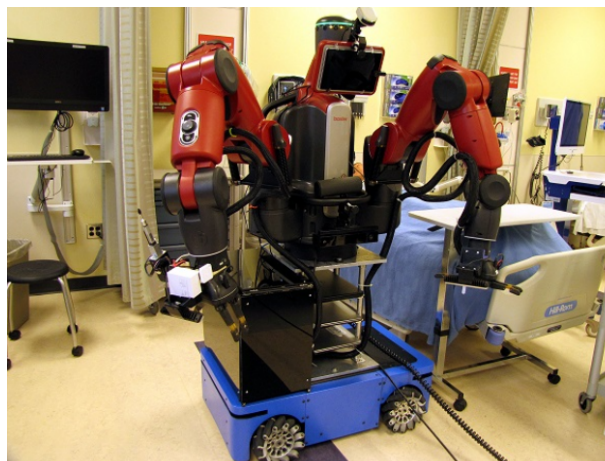

Figure 5**:** Professor Li's Nursing Robot

Professor Li claims that this is useful since after many hours of wearing personal protective equipment, it can become very uncomfortable. As with Robin, the ultimate goal of Professor Li's robots is to alleviate pressure on healthcare workers. However, her nursing robots are focused on physical tasks rather than socialization with residents, like Robin.

Result 5: Dementia Experts

Professor Eilon Caspi of the University of Connecticut was interviewed for his expertise on residents of nursing homes with dementia. He was very concerned with preserving the dignity of nursing home residents. He worried about how Robin could potentially condescend to residents, considering its initial use with pediatric patients. This extended to the kind of games Robin plays with residents, and the tone in which Robin speaks to them. If older adults afflicted with dementia feel Robin is talking down to them, they may become less responsive to it. Then residents would then not benefit from Robin's presence.

Professor Caspi also spoke of ensuring residents were comfortable when speaking to Robin. Older adults with dementia can become overwhelmed when receiving a lot of stimulation, so the space to talk to Robin would ideally be quiet. Therefore, residents can get the most out of the visit. He also highlighted that light levels and temperature also played a part in whether or not older adults with dementia were having good or bad days.

He recommended that the supervising psychologist be trained in interacting with dementia patients at different stages of the disease, and that the robot be trained in identifying the different needs a person might have depending on the stage of dementia from which they are suffering on the day. It should be noted that all residents that interact with Robin were chosen because they had very limited cognitive decline.

He also recommended making sure that the robot is in addition to interacting with other people, and not a replacement for this extremely necessary activity. Robots should not be getting rid of caregivers, they should just be helping to ease the responsibilities of the overworked nursing staff.

He loved the capacity of Robin to play music, and discussed how music is able to greatly help out older adults with dementia. After further discussion with Expper, it was found that music was already being utilized in memory games.

Recommendations

After analyzing our results, we have prepared some recommendations to improve Robin and its implementation in nursing homes. We have three different categories of recommendations, sorted by level of importance.

Highly Advised Recommendations:

We first recommend changing Robin's voice, if implemented in nursing homes in the U.S. In our survey distributed to members and parents of our own WPI community, described in Method 3, over half of the responses recommended changing Robin's voice. They described Robin's voice as childlike and felt that residents may consider it to be patronizing. To fix this issue, we recommend that different voices are tested and reviewed by a general audience in order to determine which voice results in the most amount of people feeling comfortable. We found these data perplexing, however, because both the social worker we interviewed at the Nork Old Age Home and Dr. Badmagharian said the residents had no problem with the voice and found it cute. Since this issue was brought up while surveying an American population, we recommend that if Robin is brought to the nursing home in Jamaica Plains, testing should be completed beforehand. This is not necessary for the residents at the Nork Old Age Home, who have already become accustomed to Robin and like its voice.

Another highly advised recommendation is that Robin can remotely control the temperature and the window blinds of its facility. While talking with Prof. Eilon Caspi, we were told that older adults with this condition are easily overstimulated. Therefore, in order to have a more productive conversation, these individuals need to be in a very comfortable environment. Robin could remotely change the thermostat if a resident is uncomfortable with the current temperature, or close the blinds if the glare from the sun is hitting the resident's eyes. This

recommendation could greatly increase the quality of conversations residents have with Robin and should be a necessity if it is not too much of a monetary or technical burden.

Following our point of creating optimal conditions for residents, we recommend that Robin be able to change its screen brightness and audio level. According to our interview with a dementia researcher, those with the condition will have sensitivity to sound and light that can vary from day to day. If residents and caregivers can easily change these settings, this could lead to more productive interaction with Robin, therefore making it a more effective tool to improve residents' cognition and mood.

Our final highly advised recommendation is that more musical capabilities and musical games be added to Robin. It already has a great number of memory games, which we have been told in interviews with both the Nork Old Age Home social worker and Dr. Badmagharian that the residents very much enjoy playing. The social worker even told us that a resident was able to remember all of their lines for a play with the help of playing memory games with Robin. What would bolster Robin's set of games even further would be to include more musical games. According to the dementia expert we interviewed, music is crucial to memory. Playing music from one's past is able to help residents remember their past and allows them to be able to tell more detailed anecdotes about their life. With this knowledge, adding more musical games to Robin can improve the cognition of residents and therefore should be implemented.

Advised Recommendations:

The first recommendation for this category is that more caregiving features are added. Even though Expper is already looking to add more physical sensing capabilities to Robin, the results of our survey of nursing home staff indicated a desire for a more personalized monitoring system to remind residents of daily routines and focus on the health of a single person. Robin

could then perform menial tasks for residents in order to bolster their daily routine against forgetfulness. We recommend that Robin should be able to take the temperature of a resident and inform staff if the result is irregular.

Robin could also ask residents what they would prefer to be called and call that resident by that name. One major topic of our interview with the dementia expert was that residents need to feel dignified and respected. Residents may respond better to Robin if they are given autonomy whenever possible, which would include being called by the name supplied by the resident rather than a given name they do not usually go by. We also recommend that Robin should be able to recognize nicknames and different titles that visitors use for residents and still be able to identify the individual. This should also apply to cases where a resident is referred to by a familiar title, such as mother, mom, grandma, grandpa, etc.

The next change is to make the size of Robin's screen slightly bigger. Many older adults have vision issues and having a larger screen on Robin allows for these residents to more clearly see what is displayed. On the topic of visuals, it was also recommended by a social worker at the Nork Old Age Home that the number of cartoons and the number of games involving cartoons should be expanded. They said that the residents strongly enjoy watching these kinds of shows. Including a large range of cartoon-based content on Robin would most likely improve their mood. Along with cartoons, it was recommended that the number of movies from the youth of the residents should be expanded. For most people living in the nursing home, this would be the 1950's-1970's era. Therefore, popular entertainment from this timeframe in Armenia should be thoroughly investigated.

Another recommendation is to allow Robin to be able to set reminders for daily tasks. This was a common recommendation resulting from our survey of the general public. Many

residents will forget to take their medication and having Robin remind them would allow for more autonomy as staff will not have to give medication themselves.

For our final recommendation for this section, we believe that Robin should have ice breaker games for residents and other activities that encourage some level of socialization. From our survey of the general public, there were comments discussing how residents tend to keep to themselves in nursing homes. Having Robin facilitate ice breaker games would allow residents to form new friendships with each other. Then residents will experience more socializing than with just caregivers and Robin, which can improve their cognition and mood in the long run.

Nice-to-Have Recommendations:

Our final section of recommendations is those that would be nice to have. These are not completely necessary but could lead to small improvements in Robin's interactions with nursing home residents. We recommend that Robin should be able to remind residents how they are related to certain visitors if the resident is unable to remember. Another recommendation is that the eye contact of Robin with residents should be improved so that residents feel like Robin is looking at them and not near them.

Our next recommendation for this section is that games can be added and removed from Robin by the staff of the nursing homes. Robin currently has a set database of material that needs to be manually updated for content by Expper Technologies. As Robin spends time with residents and gets to know their likes and dislikes, it should be ensured that nurses have easy access to the company/Expper games database, so that the wait time for uploading new content is not long. For example, if a resident reminisces about a certain movie, there should be a quick turnaround for when Robin is able to have information about that movie uploaded. An interface developed for nursing homes so they can monitor the content of Robin themselves would be a

great way to implement this. Then the nursing home will not need to go through Expper every time. As Robin expands into different areas, developing the user interface for the company's content will allow Robin to be more easily customized depending on the environment it is in and the people it is around.

Our final recommendation is that Robin should have a story prepared for when it leaves any nursing home. Based on our interview with the Nork Old Age Home social worker, residents bond with Robin and would be devastated if it left without any explanation. Giving Robin a story for the reason behind its departure will make it easier for the residents to interact with Robin as it is leaving the nursing home, as they can then ask Robin questions about where it is going after. Having a story prepared for Robin to remember will hopefully reduce the distress in residents upon having Robin leave. For example: Robin needs to leave to go assist others somewhere else. Or even just acknowledging that Robin needs to go in for repairs soon.

Conclusion

Our findings fit into a global context, as nursing homes across the world look for solutions to their staffing shortages. If Robin can give reminders for daily tasks and perform some small-scale caregiving duties, the workload of the staff will be reduced. Other recommendations, such as adding more musical games to help improve memory and will help decrease the rate of their cognitive decline. If these recommendations are implemented in Robin, and Robins are then sent to nursing homes around the world, the strain on the staff of nursing homes will decrease.This will in turn decrease the imminent issue of the ratio between nursing home staff members to residents in the nursing homes.

Appendix

List of Questions

Method 1: Interviewing caregivers in nursing homes

- How comfortable were you working with Robin?

    - How reliable did you think Robin was?

        - Would you worry about the robot when you were not in the room?

        - Would the robot ever turn off suddenly?

        - Would it ever stop interacting with the patient unexpectedly?

        - Did it ever give the incorrect response to something?

- What are Robin's most useful features, in your opinion?

- What features would be the most helpful to have added to Robin?

- Do you think Robin improved the lives of the residents? How so?

- What part of Robin do you think the residents enjoy the most?

    - What games does Robin play with the residents?

    - Do you notice any popular games or frequent requests?

    - Do residents ever wish Robin could travel places it cannot currently go?

- How does Robin encourage physical activity?

- What were the initial reactions to Robin?

    - Do residents like the appearance?

    - Are they satisfied with the eye contact that Robin makes? Do they ever complain about the height difference?

- ○ How do they feel about the voice of Robin? Is this the same voice that Robin is currently using? (Starts at 1:36

  https://www.youtube.com/watch?v=8HKitwo7eHE)
- Was there ever a time when a resident refused to talk to Robin? Why
  - ○ If this is a frequent occurrence, what are common factors that you think contribute to a negative experience?
    - ■ Has a resident ever hit Robin or become aggressive towards it? Why?
  - ○ Are there residents that were initially wary of Robin that eventually grew to like it? Are there still residents that do not like interacting with Robin?
  - ○ Is Robin more effective in groups or one on one settings?
  - ○ Do residents like to talk to Robin in quieter or louder spaces?
    - ■ Does Robin have volume control? Do residents ever claim that Robin is too loud or too quiet?
- How well do you think residents are able to interact with Robins technology aspect. Are there areas that are confusing for residents to use? If there are, what are they?
  - ○ What do you think the technology literacy of the residents in the nursing home is in general?
  - ○ How well do the staff of the nursing home interact with Robin? How steep was the learning curve?
  - ○ Were there any common incidents of confusion among the staff on how to interact or use Robin?
  - ○ Do you think Robin can understand the appropriate amount of nonverbal signals?
- How heavily do you depend on Expper for the upkeep and operation of Robin?

- Can the robot encourage residents to sing along with the songs it is playing in addition to dancing?

- Does it have fall detection abilities?

- Is Robin customizable?

    - If so, what is customizable? Do residents like that feature?

    - If not, do you think they would like that feature?

- Can it alert staff if there is a possible fight between residents brewing?

- Are there any preferences or features that staff feel are missing from Robin? Are there any current capabilities that they wish Robin could improve on?

    - How much maintenance does Robin require?

    - Assuming that staff would have to perform most of the maintenance one day, how much time and how many people might that take?

- Do you feel understaffed?

    - How well do you think Robin helps with understaffing?

    - If not, do you think that 2 Robins might help with understaffing?

- Is Robin able to keep up with residents exhibiting more severe dementia symptoms?

- Can Robin recognise if it is out of its depth and alert staff that it may need assistance?

Method 2: Surveying caregivers who have not interacted with service robots

- What is your job? Please give a brief overview

- Do you work with patients suffering from dementia?

    - If the answer to the previous question was yes, what is the most challenging part of caring for these patients?

- Yes or no: do you feel that you are understaffed in the workplace

- What features would you like to see in a service robot? Please elaborate.

- What features would you not like to see in a service robot? Please elaborate.

- (After watching a video on Robin) Based on this video, do you have any improvements that you would want to make to Robin?

- Link to the video: https://www.youtube.com/watch?v=Mw8Tu5JCwQQ

- On a scale of one to five: how comfortable are you with being assisted by robotic helpers in the workplace?

  - Explain your answer above

Method 3: Interviewing Family Members

- Do you know anyone who is either suffering or has suffered from dementia

  - If the answer to the previous question was yes, how close are/were you to them?

- What features would you like to see in a service robot? Please elaborate.

- What features would you not like to see in a service robot? Please elaborate.

- (After watching a video on Robin) Based on this video, do you have any improvements that you would want to make to Robin?

- On a scale of one to five: How comfortable are you with the idea of social service robots socializing with residents of nursing homes?

  - Explain your answer above

Method 4: Interviewing WPI researchers working on social service robots.

- What is your research?

- ○ How did you design a robot to address this area?
- What are the criteria you want the service robot you are working on to meet? How would you define if the robot is effective or not?
  - ○ How did you identify the objectives you wanted for the project?
  - ○ How successfully did the service robot meet those objectives?
- How is this robot designed to interact with humans?
  - ○ What are some drawbacks and advantages to this approach?
  - ○ Was there anything you wanted to include in the robot that you were unable to incorporate?
- What do you think you could do to improve your robot?
- What do you think your robot does really well?
- Do you know anyone else we can talk to?
- Do you have any experience with Robin or Moxie or MARIO specifically?
- What do you think about commercial robots, such as Robin?
- Is there anything we should have asked you that we didn't?

Method 5: Interviewing those who work with dementia
- Discuss Robin
  - ○ Robin can have residents play games
  - ○ Play music that they like
  - ○ Have active, everyday conversations, and behave like a friend/grandchild
  - ○ Is 60% percent autonomous, with a psychologist monitoring the other 40%.
- What are the effects of social interaction on patients suffering from dementia?
  - ○ At a bare minimum, what is the recommended amount of social time a dementia

patient should be getting per week?

- ○ (If positive) How much social additional interaction would you recommend patients receive in order to help mitigate the symptoms?

- What are the effects of physical activity on patients suffering from dementia?

- What role do games play in preventing cognitive decline? What are the differences between playing games and having conversations in terms of cognitive stimulation?

- What would you want a service robot to be able to do in order to best help those suffering from dementia?

- Inversely, what would you not want a service robot to do when working with patients suffering from dementia?

- Is there anything we should have asked you that we didn't?

Bibliography:

Alzheimer's Association. (n.d.). *What is dementia?* Alzheimer's Disease and Dementia. Retrieved February 3, 2022, from https://www.alz.org/alzheimers-dementia/what-is-dementia

Bökberg, C., & Sandberg, J. (2021). Until death do us part adult children's perspective of their parents' transition from living at home to moving into a nursing home and the time after death. *BMC Geriatrics*, *21*(1). https://doi.org/10.1186/s12877-021-02633-9

Broadbent, Elizabeth et al. "Attitudes and Reactions to a Healthcare Robot." *Telemedicine journal and e-health* 16.5 (2010): 608–613. Web.

Chen, M. M., & Grabowski, D. C. (2014). Intended and unintended consequences of minimum staffing standards for nursing homes. *Health Economics*, *24*(7), 822–839. https://doi.org/10.1002/hec.3063

C. Park, S. Kang, J. Kim and J. Oh, "A study on service robot system for elder care," *2012 9th International Conference on Ubiquitous Robots and Ambient Intelligence (URAI)*, 2012, pp. 546-547, doi: 10.1109/URAI.2012.6463070.

Commonwealth of Independent States (CIS). The Nuclear Threat Initiative. (2021, October 13). Retrieved February 3, 2022, from https://www.nti.org/education-center/treaties-and-regimes/commonwealth-independent-states-cis/#:~:text=12%20States%20%E2%80%94%20Armenia%2C%20Azerbaijan%2C, Turkmenistan%2C%20Ukraine%2C%20and%20Uzbekistan.

Gerłowska, J., Skrobas, U., Grabowska-Aleksandrowicz, K., Korchut, A., Szklener, S., Szczęśniak-Stańczyk, D., Tzovaras, D., & Rejdak, K. (2018). Assessment of Perceived Attractiveness, Usability, and Societal Impact of a Multimodal Robotic Assistant for Aging Patients With Memory Impairments. *Frontiers in neurology*, *9*, 392. https://doi.org/10.3389/fneur.2018.00392

Harsányiová, M, Prokop, P. Living condition, weight loss and cognitive decline among people with dementia. *Nursing Open*. 2018; 5: 275– 284. https://doi.org/10.1002/nop2.137

Henkel, Alexander P et al. "Robotic Transformative Service Research: Deploying Social Robots for Consumer Well-Being During COVID-19 and Beyond." *Journal of service management* 31.6 (2020): 1131–1148. Web.

Huang, Tianyang, and Chiwu Huang. "Elderly's Acceptance of Companion Robots from the Perspective of User Factors." *Universal access in the information society* 19.4 (2019): 935–948. Web.

Kart, J. (2020, June 17). *Robin the robot comforts kids in hospitals, can help with covid-19*. Forbes. Retrieved March 1, 2022, from

https://www.forbes.com/sites/jeffkart/2020/06/17/robin-the-robot-comforts-kids-in-hospit
als-can-help-with-covid-19/?sh=b8b522474cc1

Murcia, J. (2020). *Robin the robot with members of hospital staff* [Photograph}. UCLA
Newsroom. https://newsroom.ucla.edu/releases/welcome-robin-the-ai-robot

Picanço-Diniz, C., Galdino De Oliveira, T. C., Cabral Soares, F., Dias E Dias De Macedo, L.,
Wanderley Picanco Diniz, D. L., & Valim Oliver Bento-Torres, N. (2014). Beneficial
effects of multisensory and cognitive stimulation on age-related cognitive decline in
long-term-care institutions. *Clinical Interventions in Aging*, *2014*, 309–321.
https://doi.org/10.2147/cia.s54383

Persson, M.(2021) "Caregivers' use of robots and their effect on work environment – a
scoping review". Taylor & Francis. Retrieved February 3, 2022, from
https://www.tandfonline.com/doi/full/10.1080/15228835.2021.2000554

Robin, the interactive robot that takes care of elders and kids. ROBOfluence. (2021, August 5).
Retrieved May 2, 2022, from
https://robofluence.com/robin-the-interactive-robot-takes-care-of-elders-and-kids/

Sidorenko, A., & Zaidi, A. (2013). Active ageing in CIS countries: Semantics, Challenges, and
responses. Current Gerontology and Geriatrics Research, 2013, 1–17.
https://doi.org/10.1155/2013/261819

Srapyan, Z., Armenian, H. K., & Petrosyan, V. (2006). Health-related quality of life and
depression among older people in Yerevan, Armenia: A comparative survey of retirement
home and household residents aged 65 years old and over. *Age and Ageing*, *35*(2),
190–193. https://doi.org/10.1093/ageing/afj039

Tanioka, Tetsuya et al. "Development Issues of Healthcare Robots: Compassionate
Communication for Older Adults with Dementia." *International journal of environmental
research and public health* 18.9 (2021): 4538–. Web.

Tesky, V. A., Schall, A., Schulze, U., Stangier, U., Oswald, F., Knopf, M., König, J., Blettner, M.,
Arens, E., & Pantel, J. (2019). Depression in the nursing home: A cluster-randomized
stepped-wedge study to probe the effectiveness of a novel case management approach to
improve treatment (the Davos project). *Trials*, *20*(1).
https://doi.org/10.1186/s13063-019-3534-x

van Kemenade, Margo, Johan Hoorn, and Elly Konijn. "Healthcare Students' Ethical
Considerations of Care Robots in The Netherlands." *Applied sciences* 8.10 (2018):
1712–. Web.

Verdiyeva. (2019). How the population of the Republic of Azerbaijan is ageing: causes and
potential for social and economic development. Population and Economics (3, Issue 3,
23–42). https://doi.org/10.3897/popecon.3.e47233

Whelan, Burke, M., Barrett, E., Mannion, A., Kovacic, T., Santorelli, A., Oliveira, B. L., Gannon, L., Shiel, E., & Casey, D. (2020). The effects of MARIO, a social robot, on the resilience of people with dementia: A multiple case study. *Gerontechnology*, *20*(1), 1–16. https://doi.org/10.4017/gt.2020.20.1.413.10

Zuschnegg, J., Paletta, L., Fellner, M., Steiner, J., Pansy-Resch, S., Jos, A., Koini, M., Prodromou, D., Halfens, R. J., Lohrmann, C., & Schüssler, S. (2021). Humanoid socially assistive robots in Dementia Care: A qualitative study about expectations of caregivers and dementia trainers. *Aging & Mental Health*, 1–11. https://doi.org/10.1080/13607863.2021.1913476