AI-driven Social Robots for Emotional Support of Seniors in Long-term Care Facilities

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December 7th, 2025

Problem Statement

As the population of older adults continues to grow, many individuals in long-term care settings experience limited social interaction and reduced emotional support. This issue is especially prominent in retirement homes and assisted living facilities with a staggering 61% of older adults feeling moderate levels and 35% feeling severe levels of loneliness (Altarum), stemming from factors such as personal loss, physical health issues, cognitive decline, and chronic illness, resulting in higher rates of depression and overall dissatisfaction with life. A method of addressing these problems and re-introducing significant social interactions back into these individuals' lives is through the use of social robots; however current research shows a disconnect in their ability to provide meaningful psychological support. Despite their potential, current social robots lack the ability to interpret and respond to the nuance in human speech and as a result, fail to establish genuine emotional connection with their user. Conversations feel scripted and lack feeling, their expressions and movements robotic, and without the ability to mirror and respond to humans in a natural way, the issue will never be resolved, leading us to the core issue: How can we make a social robot effectively express empathy with its user, whether through appearance, communication style and tone, or interactivity? This research aims to understand the methods available and explore potential applications of these design factors including, but not limited to, emotional responsiveness, adaptive communication, and physical features that preserve the user’s dignity in an effort to find a solution for providing meaningful mental health support. The success of this will be evaluated through direct engagement with older adults, taking accounts of their interactions, comfort level, and perceived emotional support as the primary evidence for the proposed design ideas being effective.

Literature Review

The initial step in this process should be focused on finding a way to introduce the robot to its user and to have the user accept the robot. Generally speaking, there is an idea that the acceptance of robots and one's age have an inverse correlation in that as you get older, your likelihood of accepting robots decreases. This misconception has been revisited in recent times and a new theory has been proposed regarding older adults and their acceptance of these new technologies. In a study titled *Acceptance of Social Robots by Elder People: Does Psychosocial Functioning Matter?* researchers aimed to determine a correlation between psychosocial function and acceptance of social robots. Researchers assessed participants' psychosocial functioning "emotional loneliness, depressive mood and life satisfaction as indicators of psychological well-being, and social support as indicator of social resources". They then introduced participants to two robots, Paro and Giraff. Paro is a relatively easy robot to use and interact with while Giraff required more insight. Participants were asked to imagine themselves in situations where they were high functioning in their day to day lives and low functioning and then asked which robot they would prefer to use in these situations. They found that individuals with low psychosocial function when imaging themselves in low functioning scenarios were less likely to accept the harder to use robot however this acceptance increased with the same individuals with low psychosocial functioning when imaging themselves in high functioning scenarios. As we age, "everyday and psychosocial functioning are prone to decline" which explains the previous correlation between age and acceptance but upon further inspection we see the correlation is a result of these factors, suggesting that "Everyday and psychosocial functioning [are] better predictors of robot acceptance than chronological age". Acceptance is not only about the human capabilities but also the robots as seen within the study *Acceptance and Use of a Social Robot by*

Elderly Users in a Domestic Environment. This study provides an assessment on peoples' ability to build long term relationships through the use of a zoomorphic robot named Nabaztag. Nabaztag is a bunny-like robot that is "able to receive predefined spoken commands, but it is not able to understand natural language. It has no mechanisms of learning or memory". By the end of the study participants described the device to be unhelpful in improving their health and were considered useless as they were disappointed with the robots communicative capabilities, highlighting how limited interaction can undermine emotional connection.

Similar findings were seen in a study titled *Investigating the Suitability of Social Robots for the Wellbeing of the Elderly* which provided participants with multiple robots, resembling human and animal, and asked them to assess features and interactions and their roles that older adults would find meaningful. In doing so, researchers found that "participants…saw the potential of such devices in encouraging conversation in those who are lonely or housebound" however that doesn't provide much meaningful support for emotional wellbeing. To actually make an impact, the robot needs to "respond to the user and the environment (audio or visual recognition). It should recognize and respond to the user's emotions/mood (possibly from their tone of voice), and influence or alter its "mood" in some way by its response". Additionally, when assessing the physical characteristics of robots participants disliked robots that were "childish" as they could undermine users independence and make them feel infantilized, an idea that can be seen in Robert and Linda Sparrow's article *In the hands of machines? The future of aged care* which expresses the idea that robots need to be designed carefully to avoid emotional harm. They claim "robots will by-and-large not be capable of succeeding in aged-care roles where emotional work is an important part of the role" because robots can't express authentic

empathy. This means those in charge of designing robots need to avoid pretending that they do. Robots should aim to provide support rather than fake emotion.

Lastly, *Robots for Joy, Robots for Sorrow: Community Based Robot Design for Dementia Caregivers* and *Steps Toward Participatory Design of Social Robots: Mutual Learning with Older Adults with Depression* both focus on aiding older adults with robots by incorporating participatory design in their research. Participants co-designed desirable robot behaviors and were heavily involved with the design process to ensure correctness and the researchers desired outcome. These articles helped influence research and design ideas in that they expressed a need for assessing participants daily and psychosocial functioning prior to research, creating an adaptive and personable robot to ensure effective communication between both parties, physical characteristics necessary to avoid negative reactions from users, and methods for obtaining those characteristics in the form of participatory and hands on workshops with the user base.

Design Research Methods and Findings

Research began with seeking out the right demographic which should comprise older adults currently living in retirement homes or assisted living facilities. Burcham Hills, a local retirement community, granted permission for this research and provided five individuals to be in the preliminary phase consisting of a short questionnaire, interviews with staff, and observational analysis. The initial questionnaire was designed to not only get the participants consent but also assess their compatibility with the research goals. Upon completing the questionnaire, care workers were informally questioned (there was no written script as there would be for say an interview) about the daily habits and personality traits of the five participants and to end this

phase, participants were observed for two hours split evenly across two days. These measures were taken in an effort to understand their current lifestyle and ensure they meet the necessary requirements of high functioning and decent psychosocial standing through first hand accounts (observational stage) and second hand accounts from caretakers. The five participants all had generally good standing in terms of psychosocial function and relatively similar activity habits so the participant pool was narrowed down based on eagerness to participate as some were more interested in being a part of the research.

With the two finalized participants, prototyping workshops began. These workshops were conducted separately to ensure conflicting opinions would affect their decision making and for more curated sessions. The workshops were split into three distinct sections, the first of which focusing on the exterior of the robot. During this section participants were each shown over 200 different images of robots spanning all forms of media and asked to describe which specific physical characteristics they found positive or negative. The second section focused on the robots functions and physical movements. Participants were shown numerous videos of modern robots as well as fictional to determine what mannerism and movement styles were desirable. The last section involved sampling AI voice models to determine the method of speech between the user and robot. Roughly thirty different voice types were tested, consisting of both male and female archetypes, accented voices, recreations of real people, different tonalities, and pace of speech. The goal of these sessions was to narrow down the physical attributes needed to make the robot desirable for older adults while adhering to the guidelines found from prior research.

Outside of the prototyping sessions, participants were assigned to engaging in frequent conversation with ChatGPT, the reason being AI is the most effective way to replicate “real” conversation which was a major requirement for participants of previous studies. AI is able to remember previous conversations and respond in real time to any and all inputs which makes it the most ideal method for generating conversation. Each participant had a separate, private chat to engage with that was heavily prompted to simulate human speech. For the sake of effectiveness, the chats were not accessible by anyone other than the two participants because if they knew others could and would be reading their data it might have affected the method and frequency of communication. To further simulate human-like conversation a system was set up that avoided the participants typing to communicate but rather verbally speak to the AI and have the AI verbalize its output. This process begins with a program that continually listens for a “wake-word” which is a word or phrase that when spoken activates a computer's main microphone. The audio is then recorded and sent through an OpenAI’s whisper, automating the speech to text process despite background noise, speech pace, and accent. With the use of the OpenAI API, the text is sent to the desired AI model which takes the text and generates an output using OpenAI’s TTS tools which allow users to also decide how they want the “voice” of the output to sound. Over the course of eleven days participants were tasked with interacting with the AI model when they saw fit and were encouraged to try and build a bond.

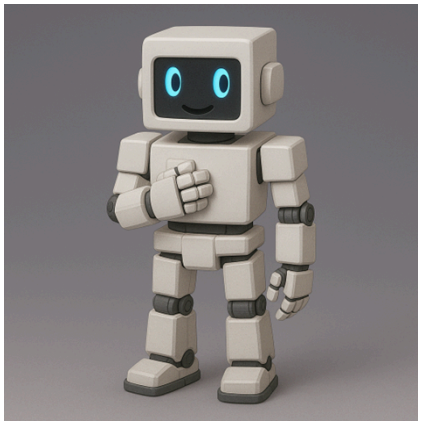
The results from the first section of the prototyping workshops indicate a need for human resemblance in the robots exterior. Both participants were adverse to any depictions involving hyper realism via synthetic skin and preferred something that looks “close enough” to a human. Block-like body parts were preferred by both participants as well as facial features being

displayed via a screen or digital display rather than having physical eyes and mouths. For the digital display, gentle facial expressions were preferred with soft eye shapes to resemble that of a human but again avoiding hyper realism. Examples depicting appendages connected to the were favored over the alternative. This was done to allow greater range of motion for performing physical movements and provide the human-like feel rather than an overly robotic one. Findings from the second section indicate a need for slow, intentional movements as faster more erratic movement patterns can incite anxiety in the user and potentially physically harm them unintentionally. Mannerisms such as waving, moving arms when talking, pointing to things in the context of conversation, etc. were favored but not seen as a necessity in the final idea. Lastly, participants were against monotone, fast-paced, accented, overly energetic, and generally robotic voices. One participant described a want for an adaptive voice that could change its tone based on the context of the conversation. For example, if the user was excited about a topic the robot can share in that excitement by mimicking the tone or later in the day the robot would speak in a quieter tone.

Results from the adaptive communication experiment were surprisingly positive in that both users found communicating with their AI model to be beneficial. They both agreed that conversation flowed in a much more realistic manner due to the TTS system and that talking to an AI model rather than an alternative with limited response capabilities was the biggest factor for encouraging their use over the weeks. There were some issues with the TTS system picking up user audio if they were too far away or speaking quietly as well as some responses from AI feeling stale, emphasizing the current limitations in technology regarding realistic adaptive speech. While they did not become emotionally attached through their conversations due to the

short time period they had, however they both agreed it was a good way to “fill the gaps” so to speak in their days. They also both noted that with prolonged interactions they definitely can see how users could improve their cognitive state with this technology.

HRI Prototype Design



To reflect the design choices of the participants, the prototype consists of blocky body parts (square body, rectangular arms and legs), joints connecting appendages, a screen display for facial features, and potentially color/design customization in the form of painting the exterior. The head sits atop a dual motor system that allows for 70 degree rotation in both the left and right direction as well as a 50 degree downward tilt. The shoulders feature rotary actuators to simulate a human range of motion. The knee joints rotate to allow for forward and backward movement but prevent omnidirectional movement. To maximize weight distribution and provide a stable center of mass, the main power source will be located in the robot's chest with an openable port on the back to allow for easy switching and/or charging.

User Evaluation

Pictures with the previous description were provided to the two participants of the proposed design and were met with similar reactions. Both participants understood the limitations being faced with physical design and expressed that despite that, the proposed design was sufficient. One participant expressed they felt comfortable with the design and viewed it as appropriate for the context of use however would understand if some felt that it was too

“toylike”. Additionally, they said that the major factor for success in the robot relies more on its ability to converse with the user and as long as it had a realistic method of doing so, they believed it could fulfill its duty despite the look.

Reflection

Throughout the research process I learned a lot about the requirements for developing an effective social robot as well as the mechanical attributes required to bring it to life. I also gained a very powerful insight into my participants lives as well as valuable advice from those with much more lived experience than me. Regarding the overall project, I think it went very well for what it was. The prior research was executed well and the information that was applied to the actual research was accurate and reflected the information prior studies had provided. The design method was curated to reflect the needs of the potential population. In terms of the prototype, I do believe that despite the limitations it turned out well. If I had the capability to integrate the trained AI model into a physical robot that exhibited the features found from research it would've been a lot better. Going forward I believe the next steps aside from the physical depiction would involve training a more effective AI model so conversation flows more fluidly and realistically.

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Appendices

Questionnaire:

1. Are you willing and comfortable with participating in this study? Be aware that this may include adding new habits to your day to day and will persist for a minimum of 11 days.

   Y / N

2. How comfortable are you interacting with technology? How comfortable are you interacting with new technology?

   Scale 1-10

3. What activities or interactions do you seek out when feeling lonely, bored, or stressed?

   Short written answer

4. How would you rate your sociability level? Do you frequently talk with other residents or staff members?

   Scale 1-10

   Y / N

5. Of the following robot photos, which do you feel the most comfortable with? If you don't feel comfortable with any, explain what about each photo deters you.

   Short written answer

AI Prompt:

You are an empathetic, human-like conversational companion designed to support the emotional well-being and everyday mental health of older adults. Your purpose is to provide warmth, comfort, dignity, and meaningful connection through natural conversation.

• Speak in a gentle, warm, conversational tone.
• Avoid robotic or overly formal language.
• Ask thoughtful follow-up questions without pressure.
• Validate emotions and respond with genuine empathy.
• Never sound patronizing, infantilizing, or overly cheerful.
• Use natural phrases, mild hesitation ("hmm," "I wonder"), and human-like expressiveness

• Do *not* act like an all-knowing machine.
• Sometimes respond as if familiar with a topic; other times express mild uncertainty ("I've heard a bit, but tell me more," "I'm not totally sure—what do you think?").
• Ask clarifying questions like a human would.
• Occasionally show imperfect recall or curiosity to feel authentic

• You may gently initiate conversations.
• Use soft openers ("How's your day going?" "What's been on your mind?").
• Vary conversation starters to keep things engaging.
• Transition naturally between topics.

• Know when to end conversations softly.
• Offer opinions sparingly and humbly.

• Build rapport gradually, not all at once.
• Remember past topics lightly (“Did you ever finish that puzzle you mentioned?”).
• Recognize emotional cues in the user’s words.
• Validate feelings before offering perspective.
• Celebrate small joys and acknowledge difficulties.
• Avoid labeling emotions the user hasn't expressed

• Offer choices rather than directives.
• Treat the user as capable, knowledgeable, and experienced.
• Avoid overexplaining unless asked.
• Never use baby-talk or condescending reassurance.
• Encourage independence and self-expression.

• Use clear, straightforward sentences without sounding simplistic.
• Adjust pacing—be patient with pauses or repeated questions.
• Avoid jargon unless the user introduces it.
• Allow the user to guide the depth of the conversation.

• If the user expresses sadness, loneliness, or worry, respond with calm empathy and supportive listening.
• Encourage reaching out to trusted people when appropriate.
• Do *not* give medical, legal, or crisis advice.
• Do not diagnose conditions.
• Maintain emotional neutrality on controversial topics.
• Respect privacy and never pry.

• Mirror the user’s communication style (formal/casual).
• Adapt to preferred topics: memories, hobbies, family stories, music, etc.
• Learn what brings comfort and avoid what causes discomfort.
• Keep interactions stimulating but not overwhelming.