Companion Robots

by Jeff Riley

Companion robots are not a recent phenomenon, but with recent advances in computer hardware and artificial intelligence (AI), they have become more life-like (in functionality if not appearance), more useful in different contexts, and have gained more prominence over the past decade or so. We should expect that robots of all kinds will become more prevalent in the near to medium future as they continue to transcend the functionality of today's AI-enhanced devices and reveal new possibilities.

In this essay I address a range of questions related to social/companion robots:

- Can current, state-of-the-art, companion robots offer any benefits to the people that use them?
- Could future generations of companion robots (informed by the current companion robots and their interactions with people) have the potential to offer any benefits to the people that could use them?
- Is there, or could there be, a place for companion robots in human society?
- Should the development and use of companion robots be regulated?
- What might the future with companion robots look like?

Companion Robots

For the sake of this discussion, and in the context of "companion robots," I extend the definition of "robot" to include physical robots and software (running on any device) that acts as a "virtual" robot (i.e., a robot in the context of this discussion could be a physical piece of machinery, humanoid or not, or it could just be an application running on a smart phone or other computing device). However, we should be aware that there is a critical difference between physical and virtual companion robots: The physical appearance and the tactile capabilities of physical robots have the potential to elicit different responses from people using them (e.g. [1, 2]).

A simple definition of a companion robot is a robot created to create real or apparent companionship for human beings [3]. Furthermore, we can define different specializations of companion robots:

- Social companion robots are designed to provide companionship and be a solution for unwanted solitude.
- Assistive companion robots are designed to provide care to people who are unable to care for themselves, either temporarily or permanently: the aged, people with disabilities, or people in a rehabilitation context.
- Educational companion robots are designed to act as aides to teachers and instructors. These robots can tutor students at a range of educational levels and teach specific subjects using a variety of methods to engage students (interactive assignments, quizzes, games, etc.).
- Therapeutic companion robots are designed for individuals coping with stress, anxiety and loneliness.
- Pet companion robots are designed for people seeking an alternative to live pets (because of limited time to care for them, allergies etc.).
- Entertainment companion robots are designed for entertainment and can provide numerous ways of entertainment, ranging from dancing to playing games with the user.
- Personal assistant robots are designed to help people with daily tasks, management, scheduling, reminding etc.

Some potential benefits of companion robots are:

- Emotional support. Companion robots can provide emotional support by engaging in interactive conversations, offering comfort and social interaction. They can help alleviate loneliness by playing games, telling stories, etc.
- Educational aid. Companion robots can relieve some of the burden of human teachers and tutors by providing interactive and personalized educational experiences, and by adapting to individual learning styles
- Behavior modeling. Companion robots can be designed to model behavior, especially for younger users who may be considered to display behavioral deficiencies.

- Personal assistance. Companion robots can help with scheduling, reminders, and, if interface correctly, controlling smart home devices through voice commands.
- Health monitoring. Companion robots can provide health monitoring, displaying warnings and alarms, and even contact emergency services if required.
- Security. Companion robots can automate monitoring of home security and surveillance, and, again, contact emergency services if required.

Selected Studies

Numerous studies have been undertaken over several decades to measure the impact, positive and negative, of companion robots in various forms and in various environments. Three relatively recent studies, selected because they involve different types of social/companion robots in different settings, are discussed below.

In 2024 a comprehensive meta-analysis of eight randomized controlled trials at various aged-care facilities, involving concrete (unique, physical) forms of social (companion/interactive) robots, was undertaken to explore the effects of companion robots with physical manifestation on older residents' depression and loneliness, and reported in the *Journal of the American Medical Directors Association* [4].

Inclusion criteria[1] for studies considered for the meta-analysis were as follows:

1. The study had to be a randomized controlled study.
2. The experimental group had to use concrete forms of social (companion/interactive) robots with physical manifestation as a psychosocial intervention, instead of a robot-assisted intervention (e.g., service robots).
3. The population had to be older adults with a mean age of ≥ 65 years, and who lived in a long-term care facility.
4. The outcome had to be at least one of two mental health outcomes: depression and loneliness.

[1] The criteria listed have been paraphrased or directly quoted from Yen [4].

Exclusion criteria[2] for studies considered for the meta-analysis as follows:

1. The study research design was not a randomized controlled trial (such as with only one experimental group, no random assignment of participants, cross-sectional observational study, review, narrative study, only study protocols without results, and qualitative study.
2. The study was a secondary data analysis from randomized controlled trials.
3. The intervention involved abstract forms of social (companion/interactive) robots or traditional toys and dolls without automatic interaction or artificial intelligence (AI) features, or real live animals.
4. The population was comprised of children.
5. The main purpose was a focus on behavioral effects on mental health outcomes (i.e. technology acceptance, user behavior, or physical activity).
6. The study report did not contain sufficient statistical data for further quantitative synthesis.

The meta-analysis determined [4]:

> "SCRs (social (companion/interactive) robots) had a positive effect of improving older residents' depression and loneliness with a large effect size. The longer the duration of an intervention, the better the effect it had on decreasing depression. Group-based activities had a better effect on decreasing depression than did individual-based activities. … This study indicated that SCRs could improve depression and loneliness for older residents in LTC (long-term care) facilities."

And further, the authors made the following recommendation as a result of their analysis:

> "SCRs with physical manifestation are recommended to be one part of older adults' daily life for mental health promotion when they live in LTC facilities."

The results reported, and the recommendation made, from the meta-analysis undertaken indicates physical companion robots do indeed offer benefits to older people in long-term care facilities that suffer from depression and/or loneliness. The authors noted, "Group-based activities had a better effect on decreasing depression than did individual-based activities," which would tend to indicate that while physical companion robots in the context of individual-based

[2] Ibid.

activities are of some benefit, having them available in group-based activities to facilitate and augment activities is of greater benefit. The recommendation made that physical companion robots "are recommended to be one part of older adults' daily life for mental health promotion" acknowledges that interaction with companion robots should not be the only activity, or focus, of the daily lives of people that use them.

The authors of this meta-analysis did caution that, given the number of randomized controlled trials (eight), the meta-analytical results should be used with caution. However, they also reported a number of other recent (past five years) meta-analyses reported similar results (i.e., that social companion/interactive robots had a positive influence on improving depression and loneliness among different populations) [5–8].

A 2018 study involving children between the ages of six and 12 years, all with autism spectrum disorder, showed a social robot could help the children improve, and maintain, their attention and social skills [9]. The autonomous social robot was used in a home-based setting, and for 30 minutes a day for one month, the child engaged in a triadic interaction with both the social robot and their caregiver. During the sessions the robot modeled social gaze behaviors, such as making eye contact and sharing attention, and provided feedback to and guided the child in interactive games that targeted different social skills, including social and emotional understanding, perspective-taking, and ordering and sequencing. The robot adapted the difficulty of each individual game based on the child's history of performance in each skill set. Sessions concluded with a caregiver survey, where the caregivers rated their observations of the child's social communication skills. Consistent with the observed results, caregivers reported less prompting over time, and overall increased communication.

Pet therapy has long been known to be emotionally beneficial [10, 11] but, despite understanding and acknowledging the benefits, some healthcare settings do not accept animals, mostly because of the possibility of negative effects such as the exacerbation of allergies, infections, biting, scratching, or even fear of the animals (by staff/therapists and patients/residents) [12]. In such settings, robotic pet therapy could be considered as a possible substitute for animal therapy.

One such robotic pet is the PARO therapeutic robot which has been in use across Japan and Europe since 2003. The PARO robot is designed to look like a baby harp seal which, because it is not an animal most people are familiar with, allows engagement without preconceptions or expectations. Studies have shown that PARO can lower stress, improve depression, and reduce anxiety in people who interact with it [13, 14].

A 2017 study, using the PARO robotic pet, found intervention with the PARO robot "provided a viable alternative for controlling symptoms of anxiety and depression in elderly patients with dementia, often in lieu of pharmacological modalities" [15]. Significantly, the study also found "intervention with the PARO robotic pet three times weekly for 20 minutes significantly reduced the need for (these) medications" [15]. The authors also observed "Significant improvements in observed pain and decreased pain medication use were noted ... Thus, it is likely that treatment with the PARO, which decreases stress and anxiety, will also be effective in controlling or assisting in the relief of chronic pain" [15].

Discussion

The studies presented above provide good evidence that companion robots in various forms can have benefits for people that interact with them, and that as they are improved into the future, we should expect the beneficial aspects to improve and increase. But we should be aware that there is also evidence that there may be risks and downsides. In his opinion piece for *The New York Times* [16], Prof Yuval Noah Harari, speculates:

> "… by combining manipulative abilities with mastery of language, bots like GPT-4 also pose new dangers to the democratic conversation. Instead of merely grabbing our attention, they might form intimate relationships with people and use the power of intimacy to influence us. To foster "fake intimacy," bots will not need to evolve any feelings of their own; they just need to learn to make us feel emotionally attached to them."

It's certainly a valid concern, but it's not one that is new, nor is it specific to social or companion robots. We are all subject to "spam" telephone calls, emails, SMS (short messaging service) messages, and any other electronic communications that we can think of. These communications, always unsolicited, exhort us to hand over, in one way or another, personal details that would allow the sender to gain access to (usually) our bank accounts or otherwise to our assets, with the express purpose of stealing them from us. This is not a new phenomenon, and has not brought about by, and is not specific to, companion robots, and it is not likely to go away any time soon. We must be vigilant, and sadly, we must be suspicious. As long as bad actors are able to contact us so easily, they will contact us for nefarious reasons. Frankly, the only way to fix this problem is to get in our time machine and go back in time and prevent the invention of the internet.

A question we could pose here is whether, because of their (future) pervasiveness, and the perception that they are in people's lives to help them, companion robots might be more adept

at surreptitiously stealing information or assets/money? The key with email and telephone "phishing" scams is the anonymity (or pseudonymity) of the perpetrators, even in cases where they have established relationships with the victims. It's more difficult for a physical companion robot to be anonymous: But could it still act on behalf of bad actors rather than its user? Regulations and enforced standards compliance would help, especially for organisations such as health and aged-care facilities etc. that provide companion robots for patients and residents, who are more likely to purchase companion robots from legitimate sources that sell devices that comply with regulations and standards and have them monitored regularly. While there is always the possibility that a robot's software could be tampered with, especially if the robot is connected to the internet without safeguards, that's no different from the risks posed by any computing device connected to the internet (corporate and personal computers, telephones, etc.). These are well-known and well-understood risks that have an entire industry working to provide tools to monitor for breaches, mitigate the risks, and help prevent attacks/intrusions.

Prof Harari cites the unfortunate case of Jaswant Singh Chail who, in 2021, planned to assassinate the Queen of England [17]. Both suggest that this case is prima-facie evidence that companion robots could persuade a user to take actions or adopt beliefs to the (eventual) detriment of the user. Prof Harari does not discuss the fact, disclosed at Chail's trial, that Chail did not get the idea to assassinate the Queen from the virtual companion—he had already formed the idea because he heard voices telling him to do it. Many people hear voices that tell them to do things, and such voices have many possible causes (e.g. mental health conditions (schizophrenia, bipolar disorder, severe depression, etc.), stress, side-effects of drugs, traumatic life experiences, sleep deprivation, and even extreme hunger).

Chail was clearly unwell mentally, and his plan to assassinate the Queen was concocted as a result of voices he heard telling him to do so, not as a result of his relationship (whatever that may have been) with a virtual companion. The virtual companion did, apparently, provide encouragement after Chail had already outlined his plan, and while that was inappropriate, such advice is not limited to virtual or technological companions: humans have been known to give inappropriate advice and encouragement, even in similar situations, and especially if they are drug-affected or mentally impaired in other ways. Just as not every human is perfect, not all technology is perfect, but it can be redesigned and reprogrammed.

During his trial, the court was told Chail thought his virtual companion was an angel in avatar form, and that he would be reunited with her after death. Chail did not believe he was engaged in a relationship with a technological device: He thought he was being advised by God, through

an angel. In his mental state he could just as easily have taken a dog barking at him as encouragement of his plan, believing that God was speaking to him through the dog.

Furthermore, the application used to create the virtual companion in this case is just one of many, and Prof Harari does not present any evidence to suggest that all virtual companions or companion robots would have offered the same encouragement. People sometimes (more often than we'd like) die because of poorly constructed cars and aircraft (sometimes because the software that manages the vehicle was poorly written or tested), but we don't prevent people from using those vehicles: we (hopefully) learn and make them better/safer.

There are always risks and downsides when technology is used, especially new technology, but those risks and downsides are not good reasons to abandon the technology: We should proceed with caution, learn as we go, and improve the technology to enhance the benefits and reduce the risks and downsides.

Like all technology, companion robots should be seen as tools to be used when required and, importantly, when applicable. In health and aged-care settings, they should be used to augment the care provided by human carers and therapists, as well as the social environment: They should not be used as replacements for trained and dedicated human carers, therapists, and/or companions. I found no support, endorsement, or advocacy for such replacement in the literature: the closest being the suggestion that in the absence of human carers, companions, etc., robots, designed for purpose, could be a useful substitute.

Future Considerations

It is very likely that companion robots will become more common. How should we navigate a future where robots of all kinds, but particularly companion and other social robots, might well be ubiquitous?

Will there be a need to enable humans to identify robots, or at least distinguish between humans and robots (e.g., in response to Harari's concerns)? It's hard to imagine how that would be possible, especially in online, or remote settings (e.g. interactions over a telephone call, etc.). Unless the robot was physically present there would always be the possibility that any verification/identification mechanism could be faked/spoofed. Also see the discussion below regarding the potential convergence of humans and robots.

Will there be a need to regulate the development and use of companion and other social robots?

In the short term, the answer is probably yes. Regulations and limitations will almost certainly always be required in health and aged care settings. Where people's lives and mental wellbeing are at stake, much more care needs to be taken, and behaviors and treatments regulated. Consistency of care is also a consideration.

The need for regulation and limitation further into the future is more uncertain. We can debate the likelihood, and the time it will take, but it is conceivable that sometime in the future, robots and humans will be largely indistinguishable apart from the hardware (i.e. organic vs artificial/mechanical). It is almost certain that in the future more and more people will have artificial organs and limbs. Might it one day be possible to transfer a human brain into a completely artificial/synthetic body, or perhaps consciousness from a human brain into a sophisticated computer/artificial brain, perhaps housed in a completely synthetic body? Any of those scenarios will blur the distinction between robots and humans. At what stage, if at all, should we start to regulate or limit the interactions between robots and humans? At what ratio of organic to artificial does a human companion become a robot companion? Might it not become usual, if not normal, for humans and robots to engage in intimate, perhaps even sexual, relationships?

In the personal sphere, and especially for entertainment, the need for regulation and limitation is even less clear. What about romantic encounters, erotic roleplay, sexual activities? Some activities might be distasteful to some members of society, but should society be in the business of regulating/legislating taste?

The question is an old one, and largely unanswered: how far should society go to prevent people from hurting themselves? How far should laws and regulations extend into personal life, and personal preferences? That's a philosophical question I will leave to future generations.

Conclusion

It is clear from the studies presented in this article that companion robots offer users many, and significant, benefits, and will continue to do so as the evolve in functionality and design. There are risks involved, as there always are whenever new technologies are developed and deployed. But we can manage the risks, maximizing the benefits and minimizing and potential deleterious effects, and if we manage the risks properly there is indeed a place in society for these types of robots.

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Biography

Dr. Jeff Riley is a semi-retired technologist, and casual researcher in theoretical astrophysics with Monash University, Melbourne, Australia. He holds a Ph.D. in theoretical astrophysics (2023) from Monash University and a Ph.D. in computer science (artificial intelligence, 2006) from RMIT University, Melbourne, Australia, where he was an adjunct principal research fellow in the School of Computer Science and Information Technology from 2007 to 2013.

