Artificial Companions for the Elderly

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Seminar: How Will Artificial Intelligence Change Humanity?
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Abstract

In this paper, I will examine the characteristics of certain technologies dubbed "artificial companions" that are already being deployed to care for the elderly, as well as discuss potential directions for future developments and their implications.

Introduction

Many existing healthcare systems are expected to experience severe shortages in staff and expertise as the population ages and increases demand for medical services [2]. It is important to understand methods both in use and in development in order to combat the healthcare crisis.

This pursuit is of personal interest to me. My grandmother was diagnosed with Alzheimer's disease in 2009 when she was in her early 60s. Before she turned 70, she could no longer remember the names of her family members and lived in a state of unawareness. In contrast, her husband, my grandfather, almost 85 years old, remained sharp and active; he continued to learn new skills like playing the banjo.

As my grandmother's condition worsened, they were forced to move to a community for the elderly where my grandfather could receive care assistance. The move was exhausting and emotionally damaging to a couple who had lived in the same place for decades. The new community was far away, expensive and even proved to offer unsatisfying care assistance. The result was that my grandfather was isolated from his family and still heavily depended on by my grandmother, whose condition and disposition noticeably worsened after moving.

For decades, every morning my grandfather walked his dog in a park adjacent to his house. Now, when I pass by this park, I often wonder whether he made a mistake in moving to an assisted living community. Are there better options? This is an important question to answer because the health and happiness of real people is at stake.

This is a single anecdote, but it contains truth that reflects the experiences of many Perhaps the set of attitudes and procedures that are available to the elderly are similar to those that were available to medical practitioners in the medieval ages; they are uninformed and unequipped to optimize people's health. But what if they were given some simple modern tools to use?

In this paper, I will discuss how the introduction of innovative technology into the field of healthcare for the elderly is a prospect that could fundamentally change the way the elderly live their lives. These technologies could reduce the burden that the elderly and infirm are on each other, their loved ones and health care professionals while potentially allowing them to live outside of assisted living communities for longer or permanently.

The Healthcare Crisis

Throughout this paper, "the elderly" refers to the group of individuals that suffers from age-related illness or disability and does not rely on a strict age definition. This distinction extends the discussed consequences to a larger group and does not unnecessarily remove people from consideration.

The health problems that the elderly experience range from physiological issues like decreased mobility and fall trauma, to psychological problems like depression and dementia. Additionally, the elderly suffer from loneliness. Loneliness has been shown to correlate to negative health outcomes [7]. Indeed, depression is strongly correlated to the loss of companions in old age. Furthermore, many of these issues are currently undertreated and undiagnosed amongst the elderly [6].

We can only expect to see more age-related health issues because the world is getting older. In 2015, the percentage of the population older than 65 years was 9%. By 2050, this measure is expected to increase to 17% [1]. This demographic shift presents numerous social and political problems. Healthcare

costs are low for young people, rise during middle age and then increase exponentially after age 50 [3] with approximately half of all expenditures occuring during senior years [4]. Thus, many existing healthcare systems are expected to experience severe staff and expertise shortages as the population ages and increases demand for medical services [2].

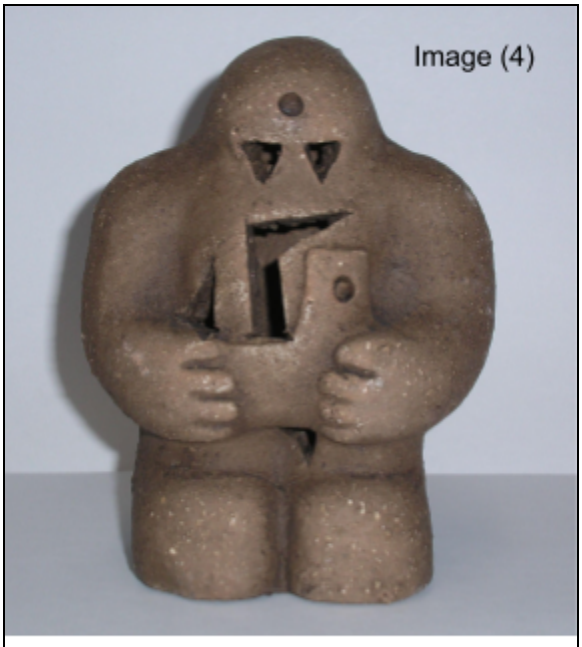
Many researchers have begun considering technological solutions to these problems in the form of artificial companions (ACs). Examples of technologies that have been referred to as ACs are diverse in both form and function. *Paro*, a robotic seal, improves mood and sociability in elderly patients in nursing homes [8]. *Pearl*, dubbed a "nursebot," reminds patients to take their medication and helps them navigate environments [9]. *Huggable* is a reactive companion that responds with motion and audio to affective touch [10]. Despite the numerous examples of products dubbed ACs, there is no clear consensus on what constitutes an artificial companion. For the purposes of this paper, we can consider objects that are interactive, non-biological and emotionally engaging to be ACs.

History of Artificial Companions

Ancient ACs

To understand the full potential of ACs, it is important to consider their histories, perceptions and stigmas. These qualities inform the way in which people interact with these technologies today.

Ancient Jewish folklore contains countless narratives describing a creature known as a *golem*. The *golem* is a creature formed from inanimate matter like rock and clay that can perform tasks and also exercise its will. The use of the *golem* across the centuries is predictably varied and dynamic. In some stories, it is a helpful hero; in others, it becomes erratic and causes great damage [15]. While this particular artificial companion is said to have been created with magic and



The Golem

no there is no proof of its existence, it is certainly clear that artificial companions have been on humans' minds for some time - at least for some millenia.

The myth of Pygmalion also echoes concepts of artificial companionship. Pygmalion, a gifted sculptor, crafts a beautiful statue of a woman from ivory upon renouncing his involvement with women of any sort. He begins to develop affections for the statue and prays for a woman who is as beautiful as it. Aphrodite obliges and transforms the statue into a woman which he marries [16]. This is perhaps a more dubious example of artificial companionship. It is not clear whether Pygmalion's wife is artificial and made from ivory or whether she truly becomes a human. Despite this, it is clear that the concept of the AC is powerful enough to extend even into romantic and physical love.

Perhaps most famous among fictional ACs is Frankenstein's Monster from Mary Shelley's *Frankenstein; or the Modern Prometheus*. One common thematic interpretation of the Monster is that it represents the perils of unchecked scientific discovery [35]. This example alludes to the fear and uncertainty surrounding the consequences of AC technology; once we build an AC, will we be able to control it?

Looking at all the examples, several things are clear. First, humans began thinking about ACs for a very long time and continued to do so (or at least did not ever completely remove ACs from our consciousnesses). Second, the exact purpose of the AC has varied immensely. This shows that ACs have a very broad range of appealing potentials (and terrifying traits). Lastly, the ultimate nature of the AC varies; some are good and some are evil. These observations tend to color the way in which we think about ACs today and are important to keep in mind while reading about real-world experiences involving ACs.

For the majority of human history, ACs have been relegated to conceptual entities. Teddy bears, dolls, figurines and other toys have served in strong roles of companionship for human beings for millennia. However, while these objects are both emotionally engaging [18] and non-biological, they lack the interactivity requirement and do not constitute true ACs. To discuss the first real ACs - albeit primitive ones - we return to the very recent past.

The First ACs

The first widespread use of artificial companion technology began with the *Tamagotchi*, released in Japan in 1996 by Bandai. According to wikipedia, a *Tamagotchi* is a 2-D screen avatar embedded in a colorful egg shape that represents a creature that needs to be fed, played with and cleaned up after. If cared for properly, the *Tamagotchi* ages and demonstrates signs of happiness and affection. If not cared for properly, the virtual pet can become sick and die [19]. Despite such simple functionality, the attachment human owners felt towards *Tamagotchi* pets could be very extreme. In 1998, Reuter's published a piece featuring images of adults and children standing in a cemetery above several small colored eggs, mourning the "deaths" of their virtual pets [20].

A Tamagotchi Pet

Tamagotchi was an enormous commercial success. When the product was released throughout the rest of the world in 1997, people lined up outside of stores to purchase it. Within three years, 40 million units had been sold [17]. Its success inspired a slew of imitations and knock-offs (*Digimon, Pixel-Chix*), as well as some examples of innovative AC concepts and technologies.

Furby, by Tiger Electronics, innovated the virtual pet concept by placing the pet in a alien-like physical body with a number of sensors and actuators. *Furby* can move in space, adjust its eyes and "speak," using a combination of preset nonsense words ("Furbish"). Over time, *Furby* begins to speak simple English words, which often gives its users the illusion of having learned language [21]. In fact, the capabilities of *Furby* were sufficiently misunderstood such that the US government banned it from its National Security Agency premises in 1999 fearing covert audio recording [22]. *Furby* enjoyed commercial success similar to the *Tamagotchi*.

Another well-known AC worldwide is Sony's *AIBO*. Released in 1999, *AIBO* is a four-legged dog-like robot that has numerous capabilities like limited speech recognition, learning tricks, programmability and realistic, fluid movement. Most interestingly, it can always choose to ignore a command and "misbehave" [12]. Additionally, the frequency of bad behavior decreases with time, simulating the process of aging and encouraging users to invest time. *AIBO* was a huge commercial success and was produced until 2006. In 2018, Sony began releasing a new version of the *AIBO* which has received considerable demand in both the US and Japan [23]. Numerous studies have been conducted using the *AIBO*. The emotional engagement in one such study was sufficient that human children characterized *AIBO* as having a mix of machine-like and life-like qualities [26].

Sony AIBO

The above are all examples of commercially viable ACs. Of course, commercial viability does not predict success in treating health concerns amongst the elderly. Instead, it is important to examine the popular origins of the technological movement in order to understand where it is going. Furthermore, despite the aforementioned ACs being primarily successful amongst younger demographics, it is not unreasonable to suspect that certain characteristics are generally desirable.

To better understand general trends in ACs, we can start to look at certain common characteristics between the three mentioned. First, we can notice that the physical form of the AC varies from a 2D avatar to a furry animal to a highly functional dog robot, so it is not clear how the physical form is perceived. Mori famously studied human perceptions of robots as the robots took forms that appeared increasingly human and found that perception becomes more positive until a sharp decline into the "uncanny valley" at close emulation of human appearance [24]. This might indicate that the ACs above are sufficiently disparate from human likeness to warrant repulsion. Second, each AC expresses some time-dependent behaviour; the user experience on the first day will be inherently different than on the

30th day. This appears to reflect the basic observation that most human relationships also require some time investment in order to see them develop [29]. Perhaps a dynamic relationship prevents boredom. Lastly, each example has some level of interactivity. These ACs do not do exactly what its user commands it to do. The result is an exchange of action and reaction between the user and the AC.

Artificial Companions for the Elderly

We can categorize artificial companions for the elderly into two main groups: social companions and assistive companions [32]. Examples of social companions are virtual pets [30] [31] [10]. Examples of assistive companions are "nursebots" [9]. Important to note is that these categories are not mutually exclusive and a single AC may embody traits belonging to both categories.

Social Robots

In general, the effects of the elderly interacting with artificial social companions are positive. Using the baby seal robot *Paro*, Wada et al. 2002 found that even limited contact with *Paro* resulted in increased feelings of vigor and sociability among a group of elderly women at a nursing home over a five-week period [31]. One of the common concerns with artificial companion technology is that the user will quickly become bored. In this study, there were individuals who engaged with *Paro* more in the final week of study than in the second week, indicating that some interest increased. Another primary concern of companion technology is developing sufficiently complex intelligence. However, in this study, there was a correlation between measurements of touch and increased mood reporting. This is a strong testimony to the potential strength of ACs: It is not necessary for highly

advanced intelligence to both exist and be commodified in order to impart some benefit. Important to note is that in this study the positive effects were small and no negative effects were reported.

It is also relevant to consider the context in which the individual is interacting with the companion. Another study looked at interactions in the private homes of elderly people using a rabbit companion capable of speech called *Nabaztag*. Human participants were observed to express initial interest in engaging the companion, but some then suffered from disinterest as the novelty effect wore off. In some cases, participants expressed frustration towards the companion when its behavior patterns were too slow or awkward. These findings indicate that the role of a social companion may be extremely context-specific. When surrounded by other people in a public place, interaction with a robot may be pleasant. It could be seen as something that is auxiliary to the reality of a social group. In the privacy of the home, a companion may not supply nearly the same amount of satisfaction. Artificial companions have been documented in increasing sociability in group settings; does this effect persist in other settings?

Perhaps one of the strongest indicators for the potential health benefits of ACs relies on research involving pets. Many studies have shown that interacting with animals, whether through pet ownership or animal therapy, has positive health benefits for the elderly, among other groups [13] [14]. However, there are many legal and practical barriers that prevent animal interaction in many settings. Examples of such barriers are laws against animals in certain spaces like hospitals and the maintenance and monetary costs of owning a pet. ACs, if designed to effectively emulate the positive qualities of animals, could potentially afford many of the benefits of animal interaction to those who you them without running up against the same barriers [26].

Assistive Robots

Assistive robots are in some ways a direct answer to the healthcare crisis in the face of an aging population. *Pearl* is a an assistive robot developed by Carnegie-Mellon University which is intended to fulfill basic tasks of caretakers at healthcare facilities. *Pearl* is able to navigate complex environments and understand directions, so that healthcare workers are not needed to simply accompany an elderly person

to a destination. Additionally, *Pearl* is equipped with a reminder program that can increase the likelihood that the user will perform some task, for example, take his or her medication [9].

Image (1)

The practicality of assistive care robots is perhaps much clearer than that of social companions. Many tasks involved in healthcare - in particular taking care of the elderly - are often preventative. For example, a nurse may accompany a slow-moving patient to a doctor's appointment so as to prevent a sudden fall, becoming lost or forgetting about the appointment entirely. Assistive companions like *Pearl* could significantly reduce the time and energy burden that is placed on an already-stressed nursing staff.

Beyond simply replacing current human labor tasks with automated ones, artificial companions could encourage the elderly to engage in all together unfamiliar or unlikely activities. One example of this is *SAR*, an exercise coach robot for the elderly. *SAR* encourages its users to exercise more frequently while tracking progress and being aware of personalized safety concerns [34]. And while exercise is incredibly important to general physical and mental health, there is no need for the uses to stop there. This general concept could be applied in many different domains: There could be social, dating, chess, dancing, drawing, singing coaches for the elderly. Increased cognitive ability is correlated to increased mental and physical health. Thus, activity coach companions would be able to engage elderly persons and positively impact general health.

Hybrids

Of course, as a rule, an AC need not fit into exclusively one category. For example, in many cases, a human might own a dog for both affective and assistive reasons. Support dogs are excellent examples of this; the human relies on the dog for a specific service but also most likely has a strong emotional attachment with her pet. It seems like the more functionality an AC has, the better.

Indeed, there are examples of ACs that are "hybrids." Consider *HOMIE* [37]. *HOMIE* is equipped with many of the same capabilities we have seen in other affective robots such as the ability to communicate, respond to touch and express emotion. However, in addition, *HOMIE* has numerous assistive capabilities that range from being able to monitor blood pressure and heart rate via a wearable bracelet, to receiving and sending text messages through audio play and voice recording.

While the benefits of vital monitoring are obvious, the potential value in increased connectivity to technology cannot be understated. For older people who are not skilled with navigating modern technology, having a friendly and even loving interface with communications networks could vastly increase one's ability to access valuable information, entertainment and interact with loved ones. An example of such a connective assistant is *PHOTOPAL* [25]. *PHOTOPAL* may not constitute a companion - it's emotional engagement is not emphasized - but it represents the kind of interface that could be applied to a companion in order to connect its user to some technology or tool. *PHOTOPAL* appears on-screen as a digital avatar who can both speak and respond to natural language and gestures as it helps the user search, organize and share her photos. By integrating similar connective assistants into artificial companions, the elderly could more easily engage with others in the world using modern technologies.

The likely efficacy of hybrid ACs is not surprising when we consider our relationships with many "things" that surround us. How often do we interact with an object as something that is purely servile or purely sentimental? Even if we never think about whether our shoes have souls, is it not true that sometimes one feels a pang of sadness when a pair is lost or destroyed? The trend is much clearer for all things that may constitute companions: Friends, pets, coworkers all play roles that are affective and assistive in our lives. It follows that ACs might as well.

Concerns

Most of the focus has been on the potential benefits of artificial companionship. As with any technology closely bound to humans, there are inevitable consequences. It is important to realistically consider the possible pitfalls of using such technologies.

General use of ACs amongst the elderly may result in decreased social interaction [40]. This is a problem with both affective and assistive robots. For many elderly people, the small interactions they have with various assistive care workers may constitute much of the human interaction they receive in general. Moreover, increases in social relationships and the meaningfulness of those relationships has been linked to better quality of life [39]. For those elderly people who have strong relationships in addition to frequent contact with human assistants, a switch to more artificial workers may not be very detrimental. However, consider an older gentleman at a nursing home who needs to be walked to and from the bathroom; on the way there, he may engage in some of the only conversation of the day. By replacing his aid with a robot, he might lose a significant portion of his human interaction. Thus, there is the clear possibility that the replacement of human aid workers with artificial ones could negatively impact the welfare of the elderly.

ACs that monitor the elderly may violate personal privacy and liberties [38]. Consider an AC that is designed to prevent patients with dementia from wandering off at night. This AC would be able to track the patient's position and would also have some means of recourse, either the ability to lock the doors or call emergency assistance or family members. In general, it seems like these capabilities would be beneficial as they would increase the safety of the user. However, there are many situations that present challenges. What if there is an emergency and the user needs to leave the home? What if the user decides he simply wants to leave the house? What if the AC functions in ways that the user was not initially aware of? How does the user confirm that his data is being used in accordance with his wishes? All of these questions are relevant to situations where users rely on ACs to monitor various parameters.

This is by no means an exhaustive list of the potential drawbacks of AC technology. This is meant to balance the discussion so that the reader understands the potential for ACs within a realistic space where there are both payoffs and risks. In addition, with any new technology designed for some purpose, it is generally the case that while the intended positive impacts are well understood, there exists a set of unintended consequences, some of which can be negative. Thus, this portion also serves as a stimulus to encourage the reader to consider those unintended consequences.

Conclusion

The potential benefits of AC technology are numerous and increasingly documented. We can only expect the number of studies to increase, as well as the prevalence of ACs used in practice. Considering the impending strain on the healthcare field, the usage of these technologies seems all but inevitable on a sufficiently long time-scale. Thus, it is important that the general population is aware of the costs and benefits of using AC technology and is able to make informed decisions because these decisions will ultimately impact our loved ones and most likely ourselves.

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