HYBRID HUMANOID ROBOT

MUTUAL SHAPING OF SOCIETY AND TECHNOLOGY IN ELDER CARE

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By
Lucas Murphy

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Technical Team Members:
Austin Davis
Karthik Eswarapragada
Orlando Sadek
Sagar Sapkobeenta
Yushek Sitoula

On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

ADVISORS

Kent Wayland, Department of Engineering and Society

Tomonari Furukawa, Department of Mechanical Engineering

General Research Problem: **Navigating the Societal Integration of Humanoid Robots: Ensuring Safety, Equity, and Harmony**

How can society seamlessly integrate humanoid robots into various sectors without compromising safety, equity, and the intrinsic values that define human interactions?

The rise of humanoid robots, bearing an uncanny resemblance to humans, signals a transformative era. These anthropomorphic machines integrate into our societal fabric, inspiring both wonder and caution. In the realm of naval warfare, experts envision humanoid robots actively traversing ships. Their ability to switch between bipedal and wheeled movements suggests a potential future where these machines handle high-risk operations, thus reducing human casualties. (Postma et al, 2014)

Meanwhile, Japanese eldercare facilities introduce a gentler kind of humanoid: the socially assistive robots (SARs). Rather than exerting dominance, these robots aim to assist, soothe, and foster connections. The primary challenges here revolve around cultural perception and tradition. Many elderly residents have welcomed SARs, but their increasing numbers prompt us to question entrenched cultural norms surrounding caregiving and the nature of human interaction (Martinez et al, 2023). Can the soft hum of a SAR replicate the comfort of a human touch? And as reliance on these robots grows, do we risk sidelining human caregivers or distorting cherished care traditions?

Prosocial behavior, in the context of robot behavior, refers to a broad spectrum of actions aimed at benefiting others. (Peter et. al, 2014). Prosocial behavior in robots offers transformative potential for human-machine interactions. By fostering cooperative, altruistic tendencies in robots, we can not only enhance the effectiveness and harmony of their tasks but also cultivate trust and acceptance among their human counterparts (Almeida et al, 2023). This facilitation of positive social interactions becomes pivotal, especially in environments where robots and humans share close quarters, ensuring smooth collaborations and reinforcing the social fabric of shared spaces.

The contrasting roles of humanoid robots—whether as formidable entities on naval vessels or as compassionate aids in care homes—highlight a pressing societal dilemma: How can we integrate these machines thoughtfully, prioritizing not just safety but the subtle intricacies that shape human society? At this crossroads, we must critically examine and shape the role of humanoid robots in society, striving for a future where machines complement, not eclipse, human existence.

Hybrid Humanoid Robot

Development of a hybrid humanoid robot for traversing naval warfare vessels with capabilities of both a bipedal and wheeled machine.

The technical project is designing a hybrid humanoid robot. Mechanical systems, original code, and mechatronic designs will be integrated into the robot's structure. These systems will possess the capability to detect a range of elements, such as edges, walls, steps, and even other human operators, in real-time. The unique, never been done before, part of our design lies in the compliant wheel/foot mechanism. In order to complete this we must design the robot's wheels to roll and lock in place, allowing for quick adaptation when encountering obstacles or navigating steps where using feet instead of wheels is necessary.

The robot will need to perform on-the-fly calculations, determining its optimal speed and the precise adjustments required for leg height when ascending or descending stairs. A key to the success of this project lies in the utilization of the Robot Operating System (ROS). ROS is the software that will play a pivotal role in creating packages that can effectively process data from the robot's sensors and cameras (Woodall et al, 2014). It will also facilitate seamless communication with the numerous motors responsible for controlling the robot's precise movements, which is especially crucial given the robot's impressive 23 degrees of freedom. This intricate interplay between hardware and software will ultimately bring the project to fruition, allowing the robot to navigate its environment with agility and adaptability.

In delving deeper into the technical aspects of this project, my primary focus has been on the mechatronics components of the design. These multifaceted responsibilities span from schematic design, ensuring each electronic component is strategically placed for optimal functionality, to the meticulous wiring of electrical components, guaranteeing both safety and performance. The integration of these mechatronic elements is both intricate and pivotal, ensuring that every movement is calculated and every decision is informed.

The significance of this technical project is underscored by the groundbreaking compliant foot/wheel mechanism—a novel concept that promises to revolutionize humanoid robot locomotion. Its potential to adapt and respond to varying terrains and obstacles highlights not just a technological achievement but also a societal one. By bridging the gap between traditional bipedal movement and wheel-based transportation, this design elevates robots from mere tools to companions capable of navigating the human world with ease. In a society where robots are becoming indispensable, particularly in high-risk environments, the introduction of such a mechanism stands as a testament to innovation's ability to augment human safety, efficiency, and overall quality of life.

Mutual Shaping of Society and Technology in Elder Care

How do elderly residents in Japanese care facilities perceive and interact with social companion robots, and how does the integration of these robots influence traditional care routines and expectations?

Elderly care in Japan is facing new challenges in the modern world that it hasn't faced before. Caring for one's elders has been a job that has historically been a cultural expectation in many parts of Japan; each generation has been raised to take care of both the next generation and the generation before them. In recent history, the ratio of old japanese citizens to younger japanese citizens has increased due to a decline in birth rate. Advancements in mechanics could propose an alternative: social companion robots. It is important to understand that these robots are not just tools to be used and they are a crucial actor in a delicate socio-cultural landscape. Lots of small intricacies and topics arise when analyzing how age-old traditions meet cutting-edge robotics. The intrigue is not just limited to an academic review, the implications span emotional, societal, and ethical domains. This paper will look to uncover the mutual shaping of technology and elderly care in Japan, seeking insights, not solutions or suggestions. In some care facilities that have been integrating social companion robots into their care already, the response has been largely favorable from the perspective of the residents (Yamazaki et al, 2023). Some residents have found similarities in the way they interact with SARs with their lifetime's interactions with their pets and other animals, resulting in decreased reports of loneliness and depressive symptoms. Like with most cases of new technology, support is not a unanimous consensus. A segment of caregiving professionals continue to warn the industry that they do not see the potential for these robots to supplant traditional human interaction (Frennert & Östlund, 2014). This puts the potential for long term implications of these SARs into question as people who align with this thought process remain hesitant to increase the research and incorporation of social companion robots. Still, currently and likely in the future, Japanese care facilities are benefiting from social companion robots and using the technology to increase the quality and capacity of their elderly care.

Background:

The challenge Japan faces is its rapidly aging population. With the average age of citizens increasing due to many societal factors, but most succinctly put as a declining birth rate and growing life expectancy, efficient and effective elderly care solutions are needed. In the past care traditions have been largely familial and they prioritized companionship and respect. When this is provided by family members it includes an element of human companionship that can't be perfectly replicated with any robot. However, with the younger population shrinking, these care facilities struggle to maintain these traditional practices (Yamato 2006). To adapt, some Japanese care facilities have turned to technology to solve this problem. Social companion robots are emerging as a possible solution in many of these facilities right now. These robots are not just

concepts; they are actively interacting with elderly residents, providing them with assistance, companionship, and even emotional support (Aronsson 2020).

It is important to explore further than just the pragmatic gap between care needed and care given fulfilled by these robots. The socio-technical implications of these robots' introduction need to be explored to fully understand the system. How do positively impacted elderly residents react to them? How do negatively impacted and neutrally impacted residents react? Is there a world where social companion robots are seen as more than just machines? Importantly, are traditional elderly care values being upheld, reshaped, or potentially even ignored? Japanese residents in elderly care facilities must navigate their evolving relationship with new technologies that are being introduced with the intent of helping them. These dynamics highlight the overarching focus of the investigation: a clear look at how technology and society shape each other through the lens of elderly care.

Theoretical Framework:

Actor-Network Theory (ANT) will be the leading theoretical framework used for this investigation. ANT proposes that both non-human and human entities, “actants”, work together to shape social phenomena of interconnected networks. In this theory, an actant is something that possesses agency and contributes to the continuous construction and reconfiguration of these changing networks (Callon, 1999). Using ANT, this study will uncover the ecosystem of interactions surrounding social companion robots in Japanese elder care. Using the ANT framework allows for the creation of a lens with which to understand how various actors shape and are shaped by this technology (Latour 1996). The actants currently identified are as follows:

The elderly residents must be at the forefront of the investigation. Any caregiving system, at its heart, is designed so that these residents have their needs met. Their experiences and feedback are useful data points that can be incorporated into future designs.

Caregivers in these facilities act as a connection between the technology and those affected by it. They serve in a role as both a member of the society aspect and a bridge for society and technology by putting the technology into use.

The companies producing these robots, or manufacturers, take in feedback from the users, both residents and caregivers, and design these robots in a way that directly addresses their customer needs. The decisions made in the design process have a direct impact on what elderly care needs are prioritized, from a commercial perspective.

Government officials and policymakers are the commanding body that is able to rule over the interactions in this network. Setting regulations for the manufacturers, caregivers, and regulating the overall care system is something that can only be done by those making policies in Japan. The laws set by a country should, in theory, represent the feelings of the people that reside in that country.

With the actor-network theory, the investigation will aim to shed light on how these different actants, along with the non-human entities they are involved with, influence and

collaborate with each other. This being done with a main focus on the changing role of SARs in Japan should give a unique insight into the social phenomena that is this dynamic network. ANT can be applied to the analysis of how Pepper, a robot created by Softbank, has been implemented into elderly care in some areas of Japan (Tuomi, 2021). When ANT is applied to this sociotechnical system, the exact role of all these actants will be called into question, especially the role of SARs in these facilities.

Literature Exploration:

There is a growing discourse on humanoid robots that is constantly changing as these devices become more ubiquitous in many fields and industries. It interestingly provides an intersection between technology and social integration. Some research suggests that robots with prosocial behavior and perspective-taking capabilities foster trust and collaborative tendencies in human-machine interactions (Almeida et al., 2023). Some studies indicate that trust in these technologies is highly dependent on group dynamics and cultural nuances (Martinez et al., 2023) which supports the idea that designing prosocial behavior is beneficial for obtaining mass appeal in studies examining social acceptance. Within the elderly care sphere, companion robots have shown potential in alleviating feelings of loneliness among seniors (Yamazaki et al., 2023). However, as mentioned earlier, there are concerns about the implications of such robots sidelining human interactions or reshaping cultural values (Frennert & Östlund, 2014). This could cause people who believe that robots could never match the care that humans provide to think that the current development of robots would eventually be detrimental. The capabilities of these robots is also often discussed in these literatures, with academics arguing on both sides of what is currently possible. Technological advancements like the somewhat user-friendly Robot Operating System (ROS) packages offer encouragement that the capabilities of robots in society are growing quickly (Woodall et al., 2014). However, with so many people hesitant to accept SARs, it's crucial to navigate the delicate balance between technology, societal acceptance, and well-being (Potenza et al., 2020). The literature available underscores the need for a multidimensional approach, considering technical abilities with socio-cultural sensitivities.

Methods:

The goal of the paper is to comprehensively address the role of human-robot interaction in elderly care settings while seeing its implications on the social network it operates in. A crucial part of the investigation is focusing on Softbank's Pepper robot. Looking at its design, possible functionalities, and intended user experience in a detailed study will be a large part of the research. Pepper was chosen as a prime representative for social care robots in this study because it has been used in Japanese care facilities in a social companion capacity. Pepper is a programmable robot that was manufactured from 2014 to 2021 and has been programmed for a variety of purposes. Pertinent to this investigation, in 2019 Pepper was being used and researched as a humanoid nursing robot at the Mifune Hospital in the Kagawa prefecture (Tanioka 2019). Drawing from ANT, the analysis will analyze the actor network that was

previously defined as it relates to the integration of Pepper into social care facilities. The aim here is to show the underlying reasons for design choices that could shed light on the mutual shaping of technology and society in this industry.

In addition to applying ANT in a case study, a literature review of academic papers, conference proceedings on humanoid robotics, and topical journal articles should put together a nuanced understanding of the current landscape of the topic. This review will help the research stay focused on the wealth of knowledge that is credible and already exists on elderly care in Japanese facilities and social robot developments. These insights, when used in tandem with the ANT analysis, will allow for a well-rounded examination of the topic.

Conclusion:

Using the STS research outlined above, I anticipate being able to gather insights that concern and analyze the relationship between society and technology in the very specific interactions of social companion robots in elderly care facilities in Japan. Understanding the nuances of how these robots shape and are shaped by human and non-human actants will reveal meaningful implications for the future of caregiving as society advances technologically. It will also show implications for the changing values of elderly care in Japan, if they even change at all. It would be damaging to the research project to assume that any of the factors discussed are relevant, they must be proven later on in the research. The hybrid humanoid robot's design looks to revolutionize potential ways of motion for humanoid robots. Potentially, it could lead to minimizing high risk actions undertaken by humans and improving efficiency in the workforce. The exploration of this STS topic in conjunction with the technical topic relates to a broader, overarching theme: the seamless integration of humanoid robots into our societal fabric.

The path forward with this research involves taking the potential implications of this research and applying it to either more general cases or similar cases within other industries. The prevalent theme between these projects is the harmonization of technological innovations with societal sensitivities. There is a lot to explore around the world especially since the world is not equitable in terms of technological resources or equal in terms of cultural perspectives. Continued research should address people's concerns with technology changing the society people see themselves as a part of, while also recognizing the potential positive impacts that could be made on people's lives.

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