Do teleoperated androids take tele-embodiment too far?

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Abstract
We explore the theoretical motivations for and empirically-assessed perceptions of teleoperated androids for telepresence. In particular, we consider the affordances of their physical embodiment, as well as the adverse effects (owing to the uncanny valley) of such highly humanlike robots. Via analysis of several exemplars, we conclude with a few implications regarding the design of anthropomorphic embodied proxies for telepresence.

Author Keywords
Androids, tele-embodiment, uncanny valley

Introduction
What do users of telepresence want and need of their communication system? Based on the importance of embodiment in human-human interaction and social experience (e.g., [6]), tele-embodiment – telepresence with a physical proxy for the human operator – has been of long-standing interest towards facilitating effective communication between distributed interactants. In particular, systems with physical proxies have been found to improve social presence in telecommunications (e.g., [9, 11, 14]). For example, a proxy can give a teleoperating person greater sense of being in and sharing the physical space of a remote location [1], and improve interlocutors’ understanding of the operator’s actions [12].
The premise of embodied proxies was taken to the extreme when Robert Venditti penned his sci-fi comic book series, “The Surrogates”\(^1\). In the series (which ran from 2005 to 2006), Venditti describes a distant future in which tele-embodiment is not only commonplace, but moreover, involves the use of highly humanlike robotic proxies ("humanoid remote control vehicles"). Venditti’s writings were further stylized and put into action in Disney’s 2009 film adaptation; however, the idea of humanlike robots for telepresence became a reality long before.

In 2007, *teleoperated androids* — telepresence robots with a highly humanlike appearance — were introduced via the public release of ATR’s (Advanced Telecommunications Research Institute International) Geminoid HI-1 \(^7\). Similar to Venditti’s *surrogate* idea, the Geminoid HI-1 is a teleoperated robot whose appearance so closely resembles that of its human counterpart (Hiroshi Ishiguro) that it is often perceived as human \(^10\). Since then, several additional androids have been produced for teleoperation: the Geminoids F and DK, as well as the HI series, and the Telenoid/Elfoid. Relative to more simplistic embodied proxies, the design of these android robots is intended to further convey the operator’s presence by way of his/her appearance and personal mannerisms \(^7\).

While the Geminoids were modeled after individual people, the latter systems (the Elfoid and Telenoid) were created in an attempt to convey the presence of any operator regardless of his/her specific appearance. As described by its developers (ATR and Osaka University), the humanlike Telenoid can present “as both male and female, as both old and young”\(^2\). This ambiguous appearance of the Telendoid thus allows general adoption of the agent for telepresence (currently a more practical solution than designing a geminoid for every teleoperating person).

In both cases – teleoperated androids for individual (i.e., Geminoids) or general use (e.g., Telenoid) – the gains in social presence impact both the teleoperating person and remote interlocutors. In particular, communication of one’s actions and experience to others relies on both perceptual and motoric representation (embodiment), so much so that the lack of embodiment can actually impede both the speaker’s and his/her interlocutors’ understanding. For instance, while congruence between physical expression (embodiment) of emotion and the emotional tone of one’s speech facilitates comprehension of the speaker’s emotional state, incongruence will impair it \(^6\). Thus, the android systems — which can fully embody a person’s actions (e.g., from small facial expressions to large nonverbal gesturing) — afford the operator congruence between the distributed representations of themself (their body and remote proxy) and furthermore, afford remote interactants congruence in the operator’s perceptual (e.g., speech) and motoric cues.

Moreover, due to their humanlike skin and body size, these robots uniquely afford the capacity for naturalistic touch-based interaction relative to less humanlike/embodied alternatives. For instance, one could hug the Telenoid and feel as if one were being hugged in return, whereas other systems cannot provide such intimacy. As touch is an important component of attachment and social behavior in human-human interaction (e.g., \([3, 4]\)), the capacity for touch-based interaction is particularly important to emotionally-sensitive situations (e.g., when an interactant wishes to communicate affection or provide comfort).

Despite their affordances, however, teleoperated androids...
may have adverse effects on users’ perceptions. For example, though people find operators to have the greatest presence via the Geminoid HI-1 relative to video-based alternatives, they also find the android to be unnerving [11]. This may come as no surprise, since, consistent with Masahiro Mori’s uncanny valley hypothesis ([5]), people are generally averse to highly humanlike robots. In particular, in our recent study, we found that highly humanlike robots (such as the Geminoids) are so unnerving that they motivate people to avoid looking at images in which they are shown [13]. While the images themselves were both innocuous and fleeting, the robots’ appearances were so negatively received that participants frequently sought to end the encounters before the full viewing duration (just 12s) had elapsed.

Taken together, it is unclear whether the benefits of present teleoperated androids outweigh their adverse effects. Their physical presence is motivated by theories of attachment and embodiment, but related work shows their appearances elicit aversion in observers. However, such investigations are rooted in perceptions of image-based stimuli. Thus, in the subsequent section, we explore two exemplars investigating peoples’ reactions to teleoperated androids when encountered in the real world.

**Exemplars**

Below we discuss several field studies which employed the Geminoid HI-1 or Telenoid teleoperated androids. Since our work has considered reactions to only image-based representations of such highly humanlike robots, we find it worth analyzing encounters that occur in settings that are more closely related to their intended usage.

In 2009, the Geminoid HI-1 was set up for interaction at the Austrian ARS Electronica festival [2, 10]. While there, Becker-Asano and colleagues interviewed 24 people who had unguided interactions with the android while it was teleoperated by one of the researchers. Though the researches found that many of the participants enjoyed the interaction (29%), a greater number (37%) reported a feeling of unease in response to the android. However, in five cases, people reported that their feelings became more positive during the interaction. This finding suggests that prolonged exposure or interaction may help to mitigate the negative reactions evoked by the android’s appearance.

At this festival, Rosenthal-von der Pütten and colleagues interviewed 107 additional people who passed by either the android or its human counterpart (Hiroshi Ishiguro). In contrast to Becker-Asano et al., only 4% of people in this sampling reported that the Geminoid gave them an uneasy feeling. Furthermore, when passers-by were asked whether they noticed the android, 47% either mistook it to be human or did not notice it at all. This may indicate that the android’s appearance was sufficiently innocuous (relative to the surrounding settings) such that it didn’t flag peoples’ attention. However, of those that recognized it as a robot, only 50% approached it (or conversely, 50% declined to approach it) to engage in further interaction. One reason for this may be that people more motivated by other nearby imperatives (e.g., getting a coffee). Alternatively, participants may have been either too disinterested or too unnerved to initiate an interaction.

More recent work by Ogawa and colleagues would suggest the latter. In their interviews with 75 mall-goers who interacted with the Telenoid, approximately half of the interactants reported a negative response to the robot at first glance [8]. However, similar to Becker-Asano et al.’s findings, these same people changed their initial opinions after interacting further with the robot. In particular, their
observations suggest that touch-based interaction (namely, giving the Telenoid a hug) is sufficient to improve peoples’ perceptions and does so to the extent that it changes peoples’ responding from negative to positive.

**Discussion & Conclusions**

In sum, people appear to respond negatively towards highly humanlike robots (at least initially), regardless of whether they are exposed to such agents via photographs or in real-world settings. For telepresence, this effect is particularly undesirable, as one of the primary purposes of the embodied proxy is to facilitate (not interfere) interactions between the operator and on-site interactants. However, the above exemplars provide some indication that prolonged exposure (particularly, via touch-based interaction) can reverse peoples’ responding to be more positive. Hence, given more prevalent exposure/adoptance of teleoperated androids for telepresence, the benefits (particularly, their capacity for touch-based interaction) may outweigh and outlast initial discomfort due to their unusual appearance.

**References**


