American Journal of Humanities and Social Sciences Research (AJHSSR)
e-ISSN :2378-703X
Volume-3, Issue-6, pp-223-231
www.ajhssr.com
Research Paper Open Access

The Importance of Representation in Robot Interaction

Noelle LeRoy[1], Damian Schofield[1]
[1](Department of Computer Science, State University of New York, USA)
Corresponding author: Damian Schofield

ABSTRACT : An artificial consciousness permeates globalized societies; technology is all around us, in science, in science fiction, in daily life. This relationship continues to be processual, technologies continue to move forward, assisting or, perhaps, encroaching on the human body. In modern society, we are increasingly becoming merged with the technology around us, wearing it and implanting it. This allows us to contemplate the merging of the organic and the inorganic. Bodies are being remapped by technology and rigid notions of subjectivity are reconfigured and societal norms are disrupted and shifted. Questions and issues regarding ability, identity, and a struggle for embedded agency in relation to technologies are principal concerns of the late twentieth and early twenty-first centuries. Immediately recognizable, culturally ubiquitous, androids, cyborgs, and robots, need no introduction. Yet their very familiarity obscures their meaning, this paper attempts to unpack how humans see these artificial humans and how we interpret their representation.

KEYWORDS: *Robot, Android, Cyborg, Representation, Appearance, Human-Robot Interaction*

I.INTRODUCTION

In this section, we briefly survey events and work that have made modern robot technology possible. Although most robot technology was primarily developed in the mid and late 20th century, it is important to note that the notion of robot-like behavior and its implications for humans have been around for centuries in religion, mythology, philosophy, and fiction [1].

There are reports of automata and mechanical creatures from ancient Egypt, Greece, and China. The Iliad refers to golden maids that behave like real people [2]. The idea of golem, an “artificial being of Hebrew folklore endowed with life” has been around for centuries [3,4]. Ancient Chinese legends and compilations mention robot-like creations, such as the story from the West Zhou Dynasty (1066BC–771BC) that describes how the craftsman Yanshi presented a humanoid. The creation looked and moved so much like a human that, when it winked at the concubines, it was necessary to dismantle it to prove that it was an artificial creation [5]. During the Tang Dynasty, a craftsman, Yang Wullian made a humanoid robot which resembled a monk. It could beg for alms with a copper cup, put it in place after collecting and even bow down to the person who gave alms to the robot. All these movements were mechanically actuated and were either in a fixed sequence or under manual control [6]. Similar robotic devices, such as a wooden ox and floating horse, were believed to have been invented by the Chinese strategist Zhuge Liang [1], and a famous Chinese carpenter was reported to have created a wooden/bamboo magpie that could stay aloft for up to three days [7].

In the 15th century, Leonardo da Vinci drew up schematics for a mechanical robot knight. It consisted of a knight’s armor, which was fitted with gears, wheels and pulleys. It was controlled using cables and pulleys. This robotic knight could lift its visor, sit or stand and could move its head. Using the plans of the robotic knight made by Leonardo da Vinci, robotist Mark Rosheim built a prototype of the knight in 2002. He further modified the design and made it more advanced by introducing the ability to walk [8].

Early robot implementations were remotely operated devices with minimal autonomy. In 1898, Nicola Tesla demonstrated a radio-controlled boat, which he described as incorporating “a borrowed mind.” In fact, Tesla controlled the boat remotely. Tesla hypothesized, “. . . you see there the first of a race of robots, mechanical men which will do the laborious work of the human race.” He even envisioned one or more operators simultaneously directing 50 or 100 vehicles [1].

In the 20th century we entered the era of robotics. An early example includes the Naval Research Laboratory’s “Electric Dog” robot from 1923. Robots were created for many different purposes in multiple industries, including attempts to remotely pilot bombers during World War II, the creation of remotely piloted vehicles, and mechanical creatures designed to give the appearance of life [9]. In 1940, the first humanoid robot named Elektro [10] was created by Westinghouse Electric Corporation. It could only move its arms and head, move around on a wheel in its base, and it could play recorded speech. It consisted of photoelectric eyes and could distinguish between red and green light [6].

Complementing the advances in robot mechanics, research in artificial intelligence has attempted to develop fully autonomous robots. The most commonly cited example of an early autonomous robot was Shakey, which was capable of navigating through a block world under carefully controlled lighting conditions at the glacially slow speed of approximately 2 meters per hour [11]. Many agree that these early works laid a foundation for much that goes on in robot hybrid control architectures today [12,13].

The real challenge in production of autonomous humanoid robot is not just the designing but also programming and developing human functionality. It is important to design a humanoid robot as closely as possible to the design characteristics of a human being. The robot should also be able to communicate easily with the others and also should be able to take decisions on its own. The design was a difficult part to execute, since the extra ordinary balancing capability of the human being was not an easy task to understand and imply on a humanoid robot [6].

In 1973, Wabot-1, the first humanoid robot which could walk on two legs, communicate with a human and transport objects was created by Waseda University [14]. Although it could walk on two legs, the robot could only walk on flat surfaces.

A further breakthrough in autonomous robot technology occurred in the mid-1980s with work in behavior-based robotics [15,16]. Indeed, it could be argued that this work is a foundation for many current robotic applications. Behavior-based robotics breaks with the monolithic sense-plan-act loop of a centralized system, and instead uses distributed sense-response loops to generate appropriate responses to external stimuli.

The combination of these distributed responses produces "emergent" behavior that can produce very sophisticated responses that are robust to changes in the environment.

Robot behaviors initially focused on mobility, but more recent contributions seek to develop lifelike anthropomorphic behaviors [17] acceptable behaviors of household robots [18], and desirable behaviors for robots that follow, pass, or approach humans [19,20,21].

Robots have also factored in multiple works of fiction, such as the mechanical-like birds that were present in the 1933 poem Byzantium by W. B. Yeats [22]. Robots have always had a large presence in science fiction literature, most notably the works of Isaac Asimov [23]. Many state that Asimov's Laws of Robotics acted as forerunners to the first design guidelines for human-robot interaction metaphors.

1.1 Definitions

The word "robot" originates from the Czechoslovakian word robota which means work [6]. "Robot" appears to have first been used in Karel Chapek's 1920's play Rossum's Universal Robots (the character was a servant robot, which resembled the structure of a human being), though this was by no means the earliest example of a human-like machine [24].

The term cyborg was first used in 1960 to describe human-machine interfaces (cybernetic organisms) which could adapt to new environments, specifically space travel [25]. These cyborgs were intended to taken care of tasks automatically and unconsciously, leaving their creators free to explore, to create, to think, and to feel. A summary of accepted definitions is given in the following list [26].

- ***Cyborg***:An organism with synthetic hardware which interacts directly with the brain, and alters the way it functions.
- ***Robot***:A machine designed to perform a task. A digitally driven creature that senses and moves.
- ***Android***:A robot designed to mimic human behavior and/or appearance.
- ***Bionic***:Any organism which has mechanical or robotic hardware designed to augment or enhance the body.
- ***Sentient***:Responsive to or conscious of some impression and context; aware.

The words 'robot', 'android' and 'cyborg' permeate modern culture, demonstrating a need for a radical rethinking about human positioning in the world. Our human subjectivity, seen in relation here to the digital technologies that surround us, becomes a shifting, difficult concept. Some argue that we are already cyborgs and therefore there is no need to question the shift; that humans are slipping into the technology world, appearing only as projections as we are becoming fully immersed in the technology [27,28].

McLuhan and Moos [29] describe how we often see technology as an extension of our bodies, perhaps a response to existential and spiritual uncertainties, as we try to leave our fallible mortal bodies behind. A range of modern technologies are able to reconfigure our bodies as "dynamic fields of action in need of regulation and control" [30]. The terms robot and cyborg can be viewed in both a literal and metaphoric sense, asking questions regarding what it means to have a body, to share a body, and what it means to lose physical control of your own body [31].

Artificial people may be mechanical, but they may also be engineered through chemical or biotechnological means, cloned, altered, or reconstructed. While such modes of production reference technological realities, actual artificial people are truly imaginary, creatures of fiction, the imagination, and the magic of representational media. And yet despite their unreality they seem to inform a host of cultural domains and debates, participating in a dense web of interactions between fiction and reality in contemporary culture [32].

1.2 Applications

There are millions of robots in day-to-day use all around the world, and the rate of take-up of these systems is increasing rapidly [33]. Over time, it has been the goal for creators and manufacturers to expand the definition of what a robot is; in other words, the tasks robots are able to perform are continually expanding with manufacturing, hospitals and space exploration seen as common areas of interest for robotics [34.35]. It is generally felt that robots have emerged into an era of ‘weak’ Artificial Intelligence (A.I.) where currently they can imitate humans without being independent [36]. Either through autonomous means, or extensive exhaustive programming, robots have the potential to better everyday life.

This is perhaps nowhere more evident than in the very successful application of unmanned underwater vehicles that have been used to explore the ocean’s surface to find lost ships, explore underwater life, assist in underwater construction, and study geothermal activity [37]. The development of robust robot platforms and communications technologies for extreme environments has also been successfully used by NASA and other international space agencies. Space agencies have had several high profile robotic projects, designed with an eye toward safely exploring remote planets and moons. Examples include early successes of the Soviet Lunokhods [38] and NASA’s more recent success of exploring the surface of Mars [39,40].

Another of the major fields where humanoid robots have brought significant help is medical. For example, statistics have shown an epidemic increase since 1960’s in cases of Autistic Spectrum Disorders (ASD). In recent years, robots have been increasingly used in autism diagnosis and treatment [41]. Humanoid robots have also been used for the treatment for cerebral palsy disabilities present in children that cause impairment in movement and posture [42]. Socially Assistive Robotics (SAR) is an example of a high end technology that assists humans in rehabilitation treatment of CP and ASD. Using human like responses from humanoid robots it has been possible to develop motor skills in CP patients and to Improving social and imitation skills in autistic children [41,42].

Robot technology continues to develop, ever moving in the direction of increasing autonomy. Robot developers are working toward building robots that can act on their own, independent of specific direction from users. This type of “smart technology”, as it is sometimes called, has begun to make its way into the everyday life of humans [43].

Robot technology developers have started developing physical robots that interact with humans in everyday settings. These robots are known as social robots. Social robots hold a variety of different functions, including aiding the elderly, acting as tour guides, and even tutoring [44]. The robots can also have emotional roles, acting as companions, allowing people to cope with negative states such as depression, loneliness, and disability [45]. The use of robots in these areas has begun to open up a whole range of other areas of human endeavor to mechanical devices, including challenging areas of the arts and humanities that were traditionally the exclusive domain of humans [46,47].

There are many different examples of autonomous robots: mechanical (or physical) robots, and software agents (softbots) which are now an everyday part of our internet experience in cyberspace [48]. This paper primarily focuses on physical robots, particularly those aspects that involve human interaction and communication.

II. ROBOT APPEARANCE

Issues such as race, gender, age, sexuality, class and ability remain important concerns in modern contexts, too important to disappear easily whatever technological advances press upon us. These stereotypes and impressions are prevalent in modern society, no matter how ardent the desire to challenge and overcome them [49]. In modern media (movies in particular), robots and cyborgs often seem to be upholding (conforming to) traditional stereotypes, they are often given human features and almost always allocated a gender, allowing the audience to perhaps empathise and relate to the robot characters. Even the earliest representations of robots, such as Capek’s [24] Insect Play and Fritz Lang’s Metropolis [50], imposed sexual roles on their robot creations [51]. The issues surrounding human stereotypes whether in relation to sex, gender, ability, race, ethnicity, class, and so on, are too critical to be ignored when considering depictions in cyborg theatre.

2.1 Humanoid Robots

Autonomous robots that have anthropomorphic dimensions, mimicing human-like behaviors, and including human-like reasoning are known as humanoid robots; work in this area has been ongoing for over a decade and is rapidly expanding [1,16,52]. To make people perceive the agency of robots, certain human inclinations can be utilized. Researchers have found that complicity arises between humans and their encounters with certain inanimate objects, including robots: people describe certain robots as if they have minds, and the interactions between humans and robots as those between two humans [53]. Behind the construction of this complicity lies a more general tendency of anthropomorphism (the ascription of human characteristics to nonhuman entities) which makes people treat machines or computers as if they were human [53,54].

A different but related concept is in effect when humans view robots. Besides anthropomorphism, animism (attributing life to something lifeless) is usually also at work. Certainly there are moments when the two can be distinguished. Nevertheless, the two often happen together, as animism feeds into anthropomorphism: when we treat something as alive, with our full catalog of mental states [55].

Guthrie [56] gives a good example of this:

"we animate but not anthropomorphize . . . if we say, an automobile purrs like a kitten, and anthropomorphize but do not animate if we speak to our pet turtle. If we speak to the automobile, however, we both animate and anthropomorphize"

Researchers report that humans prefer human-like robots (over machine-like robots) to perform in human-like capacities, such as: actor, instructor, sales representative, office clerk, food carrier, museum tour guide, and hospital messenger [57]. The communication mechanisms rely on many aspects of 'human-like' attributes. One obvious form of human behavior important in cinema is natural language processing [48]. Hence, to act the robot must have a verbal communicative medium. Additionally, they may also provide interactive measures via sensory, cognitive, and emotional means [45]. Robots that have human-like hands and arms can make gestures such as waving and pointing [35], while robots with moving eyes/heads may have facial recognition and the ability to track a person regardless of where they are. Social robots, like humans, should also evoke appropriate emotional responses. They are capable of interacting both verbally and non-verbally [48]. This means that as with humans, the robot's actions as a whole are important to communication, not purely their voice and facial expression.

Among all factors of human-like robots, the appearance of the robots is the most important. Studies have offered evidence that perceptions of the robots can change, simply by altering how they appear [57]. According to Mori [58] humans also generally view movement as a significant sign of life. Thus movements must be made to the humanoid's physical appearance in order to establish a sense of life. For example, gaze direction and facial expression are two techniques utilized by some human-like robots to portray different facial dynamic ability [48]. General movements of the arms and legs should follow this dynamic approach [35]. In summary, to perform, robots should be capable of doing just about everything that humans can do on a stage, including similar degrees of movement throughout the body.

Social psychology, on the other hand, has shown that cultural differences exist in the way people perceive technology [59]. Although cultural differences have been shown to affect certain areas of human perception of robots [60], this is only one of many factors that contribute towards robot perception. Previous research also suggests that culture has a significant effect in human perception of robots during passive interaction. A robot that follows strategies of human behaviour when giving advice to other humans, for example, is perceived as effective when this interaction is observed but not necessarily when the person is interacting directly with the robot [61].

2.2 Autonomy

Human–Robot Interaction (HRI) is a field of study dedicated to understanding, designing, and evaluating robotic systems for use by or with humans. Interaction, by definition, requires communication between robots and humans. Communication between a human and a robot may take several forms, but these forms are largely influenced by whether the human and the robot are in close proximity to each other or not. Thus, communication and, therefore, interaction can be separated into two general categories:

- Remote interaction: The human and the robot are not collocated and are separated spatially or even temporally (for example, the Mars Rovers are separated from earth both in space and time).
- Proximate interaction: The humans and the robots are collocated (for example, service robots may be in the same room as humans).

Within these general categories, it is useful to distinguish between applications that require mobility, physical manipulation, or social interaction. Remote interaction with mobile robots is often referred to as teleoperation or supervisory control, and remote interaction with a physical manipulator is often referred to as telemanipulation. Proximate interaction with mobile robots may take the form of a robot assistant, and proximate interaction may include a physical interaction [1].

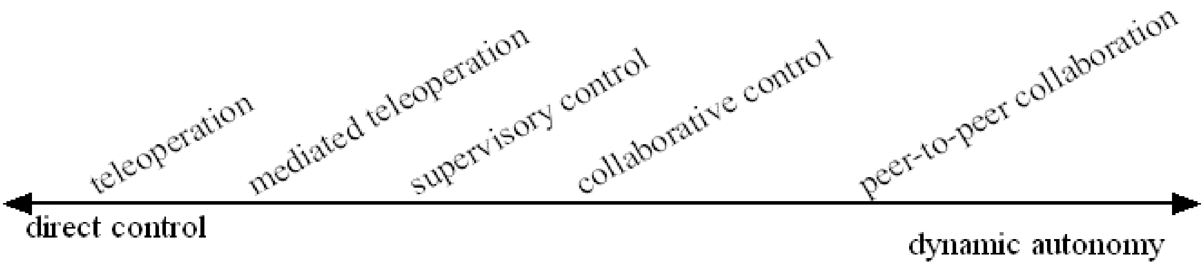

Figure 1. Levels of Autonomy with Emphasis on Human Interaction [1].

Proximity scales have been developed and used by various authors [16,62]. While such (average) scales are appropriate to describe how autonomous a robot is, from a HRI point of view, a complementary way to consider autonomy is by describing to what level the human and robot interact and the degree to which each is capable of autonomy. The scale presented in Figure 1 gives an emphasis to mixed-initiative interaction, which has been defined as a flexible interaction strategy in which each agent (human and robot) contributes what it is best suited at the most appropriate time [63].

Various and different HRI issues arise along this scale. On the direct control side, the issues tend toward making a user interface that reduces the cognitive load of the operator. On the other extreme of peer-to-peer collaboration, issues arise in how to create robots with the appropriate cognitive skills to interact naturally or efficiently with a human.

2.3 Social Robots

Social interaction includes social, emotive, and cognitive aspects of interaction. In social interaction, the humans and robots interact as peers or companions. Importantly, social interactions with robots appear to be proximate rather than remote. Many of these problems are extremely challenging and have strong societal implications.

For a social robot to function in a fitting manner it orients itself to the mind of an individual and acts upon the individual for purposes of eliciting certain behavior and emotion, with the resulting goal of the human "partner" believing that the robot has a mind [64]. Everyday tasks almost always involves interaction and communication. To interact and communicate effectively with other robots (and with a humans), it is important that social robots have certain key traits. Perhaps most crucial is the idea of a social robot being sensitive to, or aware of, the social context in which they are embedded [65].

In addition to its intrinsic value, investigating human-robot interaction has research value in developing everyday robots [66,67,68]. By combining resources and creating a better mesh between these domains, it may be possible to bootstrap the development of deeper and more effective HRI, particularly in the domain of non-verbal interaction.

Knight [69] describes the eight lessons that can be learned about non-verbal interaction using cyber thespians :

1. The charm of relatable gestures;
2. How affect derives from physicality;
3. Movement metaphors;
4. The import of perceived rather than true robot state;
5. The gulf between machine and agent;
6. Multi-agent sociability attributions;
7. The utility of audience feedback;
8. Roles for machine humor.

Using the cinema context and body of knowledge to bootstrap the development of effective social robots is important because non-verbal expression is a key to understanding sociability. In general, nonverbal response tracking capabilities could allow for more accurate social research data as such expressions are intrinsic to natural interaction. Furthermore, a robot's movement and engagement pattern impact our interpretation of its intention, capability, and state. With a long history of encoding and honing expression, cyborg cinema provides pre-processed methodologies for interpreting and communicating human non-verbal behaviors that we are beginning to test on robots [69].

Understanding the audience's activity and intent are necessary components of interaction for robot actors to allow them to respond appropriately and in a timely fashion [70]. For example the same robot may not be necessarily found appropriate for all performances. Some audiences find them annoying and irritating while some may find them delightful and fun [71,72]. Most of which relies on the appropriateness of the robot and the ability to flexibly adapt to different types of situations. If we are to successfully use robots in the realm of cinema there is little doubt that these robots must learn from actors and directors in order to understand the importance of context. Essentially, in order for robots to gain contextual knowledge and become aware of their surroundings, they must become more "human-like" [73,74].

Human-like robots must also be approachable and non-threatening. Many recent social robots have been created with a 'friendly' interface driven design [75]. Essentially, without a human like appearance any attempts to pass information or alter the human's behavior and emotional state by the robot will often fail from the lack of trust felt by the human [70]. Studies have offered evidence that perceptions of the robots can change, simply by altering how they appear [76]. One study showed that just by adding a lab coat and stethoscope, a robot can appear to be increasingly medically competent [48,72].

This opportunity human-robot interaction provides as a potential testing laboratory is especially important for social robots, for they are designed to smoothly interact with people. Roboticists have been trying to figure out the right codes for the conduct of social robots, so that people will be more comfortable interacting with them. This search justifies the interdisciplinary collaborations, as roboticists attempt to find parallels between humans and robots [77].

III. CONCLUSIONS

It is possible to compare impressions and behaviors during simple interaction for humanoid robots which have different appearances. Verbal and non-verbal behaviors as their subjective impressions of the robots can be assessed. Research has consistently shown how differently human participants behave toward these robots in these experiments. The different behaviours can be explained by the impressions and attributions discussed in this paper.

The perception on the humanoid robot often depends on the usage of humanoid robots and whether such a difference is essential. This paper puts forward evidence
that could perhaps help future roboticists in deciding whether a particular difference in appearance should be considered for a particular usage.

REFERENCES

[1] Goodrich, M.A. and Shultz, A.C. (2007). Human-Robot Interaction: A Survey, Foundations and Trends in Human Computer Interaction, 1(3), 203-275.

[2] Homer, (circa 800 BC). The Iliad. Book XVIII.

[3] Webster, (1996). Webster's Seventh New Collegiate Dictionary, Springfield, MA: G. and C. Merriam Company.

[4] Wiener, N., (1966). God and Golem Inc.: A Comment on Certain Points where Cybernetics Impinges on Religion, Cambridge, MA, USA: MIT Press.

[5] Youkou, L., (circa 500 BC). Book of Master Lie.

[6] Denny, J., Elyas, M., D'Costa, S.A. and D'Souza, R.D., (2016). Humanoid Robots – Past Present and the Future, European Journal of Advances in Engineering and Technology, 3(5), 8-15.

[7] Tzu, M. (circa 400 BC). Book of Master Mo.

[8] Rosheim, M.E., (2006). Leonardo's Lost Robot, Berlin: Springer Verlag.

[9] Fong, T. and Thorpe, C., (2001). Vehicle Teleoperation Interfaces, Autonomous Robots, 11(1), 9–18.

[10] Televox, H., (1983). The Robots of Westinghouse, History of Computers, Retrieved From: http://historycomputer.com/Dreamers/Elektro.html

[11] Bainbridge, L., (1983). Ironies of Automation, Automatica, 19(6), 775–779.

[12] Murphy, R.R., (2000). Introduction to AI Robotics, Cambridge, MA: The MIT Press.

[13] Parker, L.E., (1994). ALLIANCE: An Architecture for Fault Tolerant, Cooperative Control of Heterogeneous Mobile Robots, Proceedings of IEEE/RSJ/GI International Conference on Intelligent Robots and Systems, Munich, Germany, 776–783.

[14] Takanishi, A., (2002). Humanoid Robotics Research and Its Applications, Hadaly-2 and WABIAN, Humanoid Robots in Waseda University, 12(1), 25-38.

[15] Arkin, R.C., (1998). Behavior-Based Robotics, Cambridge, MA: The MIT Press.

[16] Brooks, R.A., (1986). A Robust Layered Control System for a Mobile Robot, IEEE Journal of Robotics and Automation, 2, 14–23.

[17] Yamaoka, F., Kanda, T., Ishiguro, H., and Hagita, N., (2005). Lifelike Behavior of Communication Robots Based on Developmental Psychology Findings, Proceedings of IEEERAS International Conference on Humanoid Robots, Tsukuba, Japan.

[18] Kim, H.J., Lee, H., and Kim, C., (2007). Autonomous Behavior Design for Robotic Appliance, Proceedings of ACM/IEEE International Conference on Human-Robot Interaction, Arlington, VA, USA.

[19] Gockley, R., Forlizzi, J., and Simmons, R., (2007). Natural Person-Following Behavior for Social Robots, Proceedings of ACM/IEEE International Conference on Human-Robot Interaction, Arlington, VA, USA.

[20] Pacchierotti, E., Christensen, H.I., and Jensfelt, P., (2006). Evaluation of Passing Distance for Social Robots, Proceedings of IEEE International Workshop on Robot and Human Interactive Communication, Hatfield, UK.

[21] Walters, M.L., Dautenhahn, K., Woods, S.N., and Koay, K.l., (2007). Robot Etiquette: Results from User Studies Involving a Fetch and Carry Task, Proceedings of ACM/IEEE International Conference on Human-Robot Interaction, Arlington, VA, USA.

[22] Yeats, W.B., (1933). The Winding Stair and Other Poems, Reprinted by Kessinger Publishing.

[23] Asimov, I., (1986). Robot Dreams, New York: Ace Books.

[24] Capek, K., and Capek, J., (1961). R.U.R. and The Insect Play, London: Oxford University Press.

[25] Clynes, M.E., and Kline, N.S., (1995). Cyborgs and Space, in C.H. Grey (Ed), The Cyborg Handbook, (pp 29-33), New York: Routledge.

[26] Garreau, J., (2005). Radical Evolution: The Promise and Peril of Enhancing our Minds, Our Bodies - And What It Means To Be Human, New York: Doubleday.

[27] Caygill, H., (1997). Stelarc and the Chimera, Art Journal, 56(1), 46-57.

[28] MacKenzie, J., (2001). Perform or Else: From Discipline to Performance, New York: Routledge.

[29] McLuhan, M., and Moos, M.A., (1997). Media Research: Technology, Art, Communication, Amsterdam: G & B Arts.

[30] Cartwright, L. (1995). Screening the Body: Tracing Medicine's Visual Culture, Minneapolis: University of Minnesota Press.

[31] Parker-Starbuck, J. (2011). Cyborg Theatre: Corporeal / Technological Intersections in Multimedia Performance, Basinstoke, UK: Palgrave Macmillan.

[32] Kakoudaki, D. (2014). Anatomy of a Robot: Literature, Cinema, and the Cultural Work of Artificial People, New Jersey: Rutgers University Press.

[33] IFR, (2016). Industrial Robot Statistics – 2016, International Federation of Robotics.

[34] Presher, A., (2010). Robotics Make a Move Toward Autonomous Service, Design News, 65(6), m12 - m14.

[35] Behnke, S., (2008). Humanoid Robots - From Fiction to Reality? KL-zeitschrift, 4(8), 5-9.

[36] Beck, A., Cañamero, L., and Bard,K.A., (2010). Towards an Affect Space for Robots to Display Emotional Body Language. Proceedings of 19th International Symposium on Robot and Human Interactive Communication, Viareggio, Italy.

[37] Whitcomb, L.L., (2000). Underwater robotics: Out of the Research Laboratory and into the Field, Proceedings of IEEE International Conference on Robotics and Automation, San Francisco, CA.

[38] Fong, T., Thorpe C., and Baur, C., (1999). A Robot-Centric Model for Vehicle Teleoperation, Proceedings of AAAI Spring Symposium: Agents with Adjsutable Autonomy, Stanford, CA.

[39] Leger, P.C.,Trebi-Ollennu, A., Wright, J.R., Maxwell, S.A., Bonitz, R.G., Biesiadecki, J.J., Hartman, F.R., Cooper, B.K., Baumgartner, E.T., and Maimone, M.W., 2005). Mars Exploration Rover Surface Operations: Driving Spirit at Gusev Crater, Proceedings of IEEE International Conference on Systems, Man, and Cybernetics, Hawaii.

[40] Wilcox B., and Nguyen, T., (1998). Sojourner on Mars and Lessons Learned for Future Planetary Rovers, Proceedings of SAE International Conference on Environmental Systems, Danvers, MA, USA.

[41] Taheri, A.R., Alemi, M., Meghdari, A., Pour Etemad, A.H., and Holderrea, S.L., (2015). Clinical Application of Humanoid Robots in Playing Imitation Games for Autistic Children in Iran, Procedia - Social and Behavioral Sciences, 176, 898–906.

[42] Rahman, R.A., Hanapiah, F.A., Basri, H.H., Malik, N.A., and Yussof, H., (2015). Use of Robot in Children with Cerebral Palsy: Ups and downs in Clinical Experience, Procedia Computer Science, 76, 394–399.

[43] Bernstein, D., and Crowley, K., (2008). Searching for Signs of Intelligent Life: An Investigation of Young Children's Beliefs about Robot Intelligence, Journal of the Learning Sciences, 17, 225-247.

[44] Fior, M., Ramirez-Serrano, A., Beran, T., Nugent, S., and Kuzyk, R., (2010). Children's Relationships with Robots: Robot is Child's New Friend, Journal of Physical Agents, 4(3), 9-17.

[45] Libin, A., and Libin, E., (2004). Person–Robot Interactions from the Robopsychologists' Point of View: The Robotic Psychology and Robotherapy Approach, Proceedings of the IEEE, 92(11), 1789 – 1803.

[46] Hatano, G., Siegler, R.S., Richards, D.D., Inagaki, K., Stavy, R., and Wax, N., (1993). The Development of Biological Knowledge: A Multi-National Study, Cognitive Development, 8, 47–62.

[47] Barakova, E., and Lourens, T., (2010). Expressing and Interpreting Emotional Movements in Social Games with Robots, Personal Ubiquitous Computing, 14, 457-467.

[48] Zhao, S., (2006). Humanoid Social Robots as a Medium of Communication, New Media and Society, 8(3), 401-419.
[49] Polacek, R., (2010). Handbook of Good Practices to Combat Gender Stereotypes and Promote Equal Opportunities in Film, Television and Theatre in Europe, London: International Federation of Actors. Powers, A., Kramer, A.D., Lim, S., Kuo, J., Lee, S.L., and Kiesler, S., (2005). Eliciting Information from People with a Gendered Humanoid Robot, Proceedings of Robot and Human Interactive Communication (ROMAN 2005), 158-163
[50] Elsaesser, T., (2012). Metropolis, No. 54, New York: Palgrave Macmillan. Eyssel, F., and Hegel, F., (2012). (S)he's Got the Look: Gender Stereotyping of Robots, Journal of Applied Social Psychology, 42(9), 2213-2230.
[51] Case, S.E., (2007). Performing Science and the Virtual, New York: Routledge.
[52] Fong, T., Nourbakhsh, I., and Dautenhahn, K., (2003). A Survey of Socially Interactive Robots, Robotics and Autonomous Systems, 42, 143–166.
[53] Turkle, S., (2010). Alone Together: Why We Expect More from Technology and Less from Each Other, New York: Basic Books.
[54] Caporael, L.R., (1986). Anthropomorphism and Mechanomorphism: Two Faces of the Human Machine, Computers in Human Behavior, 2, 215–34.
[55] Hutson, M., (2012). The Seven Laws of Magical Thinking: How Irrational Beliefs Keep Us Happy, Healthy, and Sane. New York: Hudson Street.
[56] Guthrie, S., (1993). Faces in the Clouds: A New Theory of Religion, Oxford: Oxford University Press.
[57] Goetz, J., Kiesler, S. and Powers, A., (2003). Matching Robot Appearance and Behavior to Tasks to Improve Human-Robot Cooperation, Proceedings of the 12th IEEE Workshop on Robot and Human Interactive Communication (RO-MAN), California, USA.
[58] Mori, M., (1970). The Uncanny Valley, Energy, 7(4), 33-35.
[59]Straub, D., Keil, M., and Brenner, W., (1997). Testing the Technology Acceptance Model across Cultures: A Three Country Study, Information Management, 33(1), 1–11.
[60] Haring, K.S., Watanabe, K., and Mougenot, C., (2013). The Influence of Robot Appearance on Assessment. Proceedings of the ACM/IEEE International Conference on Human-Robot Interaction, IEEE, 131–132.
[61] Strait, M., Canning, C., amdScheutz, M., (2014). Let Me Tell You! Investigating the Effects of Robot Communication Strategies in Advice-Giving Situations Based on Robot Appearance, Interaction Modality and Distance, Proceedings of the ACM/IEEE International Conference on Human-Robot Interaction, ACM, 479–486.
[62] Kaber, D.B., and Endsley, M.R., (2004). The Effects of Level of Automation and Adaptive Automation on Human Performance, Situation Awareness and Workload in a Dynamic Control Task, Theoretical Issues in Ergonomics Science, 5(2), 113-153.
[63] Hearst, M.A., (1999). Mixed-initiative interaction: Trends and controversies, IEEE Intelligent Systems, 14–23.
[64] Nass, C., Steuer, J. and Tauber, E., (1994). Computers are Social Actors, Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: Celebrating Interdependence, Boston, USA.
[65] Dautenhahn, K., Walters, M., Woods, S. Koay, K.L., Nehaniv, C.L., Sisbot, E.A. and Alami, R., (2006). How May I Serve You? A Robot Companion Approaching a Seated Person in a Helping Context, Proceedings of ACM Conference on Human-Robot Interaction (HRI'06), Salt Lake City, Utah, USA, 172 – 179.
[66] Demers, L., (2010). Machine Performers: Neither Agentic nor Automatic, Proceedings of ACM/IEEE HRI Workshop on Collaborations with Arts, Osaka, Japan.
[67] Knight, H., (2010). A Savvy Robot Standup Comic: Online Learning through Audience Tracking, Workshop Paper, ACM TEI, MIT, MA, USA.
[68] Schofield, D., (2016). The Use of Computer Generated Imagery in Legal Proceedings, Digital Evidence & Electronic Signature, 13(3).
[69] Knight, H., (2011). Eight Lessons Learned about Non-Verbal Interactions Through Robot Theater, Proceedings of International Conference on Social Robotics, (pp. 42-51). Springer, Berlin, Heidelberg.
[70] Okamura, A., Matarić, M.J. and Christense, H.I., (2010). Medical and Health Care Robotics: Achievements and Opportunities, IEEE Robotics & Automation Magazine, 17(3), 26 – 37.
[71] Feil-Seifer, D., Skinner, K. and Matarić, M.J., (2007). Benchmarks for Evaluating Socially Assistive Robotics, Interaction Studies: Psychological Benchmarks of Human-Robot Interaction, 8(3), 423-429.
[72] Feil-Seifer, D. and Matarić, M.J., (2011). Ethical Principles for Socially Assistive Robotics, IEEE Robotics and Automation Magazine, 18(1), 24 – 31.
[73] Snae, C., and Brueckner, M., (2007). Personal Health Assistance Service Expert System (PHASES), World Academy of Science, Engineering and Technology, 32, 157 – 160.

[74] Schofield, D., and Young, D., (2016). Waiting for Robot Godot: A Cyborg Theatre Case Study, International Journal of Contemporary Humanities, 1(1).
[75] Alexander, E., (2011). Affordable Compact Humanoid Robot for Autism Spectrum Disorder in Children, Proceedings of the Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Boston, MA, USA.
[76] Calinon, S., and Billard, A., (2006). Teaching a Humanoid Robot to Recognize and Reproduce Social Cues, Proceedings of the IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN), Hatfield, UK.
[77] Lin, T., (2015). Theater as a Site for Technology Demonstration and Knowledge Production: Theatrical Robots in Japan and Taiwan, East Asian Science, Technology and Society, 9, 187-211.