Designing Robotic Movement with Personality

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ABSTRACT

As robots are starting to inhabit more intimate social spheres, their functionality and acceptance in a fundamentally social environment greatly depend on them being tolerated by humans. One factor contributing to successfully accomplishing tasks in a collaborative manner is how robots' actions and motions are interpreted by the people around them. Our broader research seeks to explore this gap aiming to design movement that is expressive, culturally dependent and contextually sensitive. A country that is at the forefront of this, in terms of social robots and their acceptance in society, is Japan. Therefore, as the first phases of this broader research, we present a new process, including a design toolkit, an open brief and a participatory structure. We discuss the resulting robot morphologies and participant feedback from a workshop in Japan, and conclude by discussing limitations and further research in designing robots with expressive movement, contextually sensitive within an HRI-for-all paradigm.

CCS CONCEPTS

• Human-centered computing • Interaction design, theory, concepts and paradigms

KEYWORDS

Design Research, Design-centric HRI, Robots, Participatory Design

1 Introduction

The latest HRI developments see robots moving from their customary automated manufacturing contexts, into the most intimate of social spheres, whereby robots and humans work closely together [10]. Thus, the task of designing interactions where the human and the robot can jointly accomplish tasks, in a collaborative manner, raises further questions on how robots' actions and motions are interpreted by the people around them.

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Work by Sebanz et al., Lakin and related research in joint-action [11,22], has shown that non-conscious mimicry of gestures and mannerisms can foster liking. In this sense, while considerable efforts have been made to move away from the "crude, choppy, and awkward mannerisms" we are accustomed to when thinking about robotic movement [7], fewer efforts have been made to understand how robotic motion may also be culturally dependent. Additionally, while it has been demonstrated that the social context greatly impacts human-robot systems – since people generally feel more relaxed when interacting in culturally normative ways [4,23] – designing robots is predominately focused on function and the extent to which this applies to robotic movement is yet to be explored.

This is the gap that our broader research on designing contextually sensitive robotic movement aims to explore. As first phases towards this broader research, we present a method for co-designing movement that may more accurately express intentions, purpose, and personality contextually. Therefore, the ensuing method differs from the more prevalent design approaches in HRI through its open brief and participatory structure and a focus on movement rather than function, which may better reflect the context in which it is carried.

2 Related Work

Generally, we find that the socio-cultural context deeply impacts the human-robot dynamic since people are more comfortable when interacting in culturally acceptable ways [4,14,24]. As a result of this, we should also be able to find discernable differences in what is accepted and expected of robots depending on the context in which they operate.

In this vein, we noticed how the Western discourse often portrays robots as potentially threatening (Skynet, Ultron, Ava), while the Japanese media provides less antagonistic portrayals, such in the cases of AstroBoy [25] or Doraemon, seen as guardian angels or alter-egos. This appears in line with prior research by Kaplan [9] and by Park et al. [20] on the differences in robot acceptance between Japan as a collectivist culture and individualist Western cultures.

In this direction, we find studies such as Hoffman & Ju's Designing Robots with Movement in Mind [7], which proposes a technique for a movement-centric design approach, which leads to "sophistication in the way [robots] move instead of the way they

look". Similarly, Meerbeek et al. [18] offer a personality design method that aims to integrate a user-centered, artistic approach to designing robots based on the five known personality types rather than their technical requirements. These examples and our prior research [12][13], share the underlying need to expand the design space through user insights rather than resort to the traditional approach which more generally focuses on technical feasibility.

These approaches see movement as a rich communicative medium to which humans are highly sensitive – sensitivity that is not only limited to intuitively understanding the communicative information and spatial proxemics [19], but it extends to our innate capability of inferring complex information such as internal states and intentions based on minimal cues [1,2,21]. This has been repeatedly demonstrated in various studies that have revealed the relationship between animacy and causality, regardless of the complexity of the moving entities. From abstract moving shapes seen as agents with personality, emotions and intentions [6] to inferring other people's complex intentions from 2d simplified reenactments of non-human forms [1], movement's expressive power plays a crucial role in our interpretation and therefore acceptance of non-human systems.

3 Method

We are developing a methodology for designing expressive and contextually sensitive robotic movement, including a semi-structured open brief, a co-design method and a design toolkit. We used it in an experiment in the form of a co-design workshop in Japan, aimed at exploring the feasibility of designing movement rather than function first and the efficacy of the methodology and toolkit to generating expressive robotic movement prototypes. Our methodology is situated within research through design methods [16] and designerly ways of knowing in human-robot interaction [15].

3.1 Co-design Teams

A total of 20 participants took part in this workshop. All were working in Japan in a range of academic, industry and art and design organizations. They were grouped into four teams of five, which each included 2 men and 3 women, with one non-Japanese person in each team. The teams were also balanced by discipline, with 3 roboticists and 2 designers in each. Participants were given an information project sheet and signed individual consent forms, in line with our institutions' research ethics policy. Translation was also provided, if needed, to overcome language barriers between participants and researchers.

3.2 Procedure

Participants were provided with three sets of tools: 1) Personality Cards, 2) Movement Cards and 3) Movement-Making Tools. They were required to design a robotic prototype by: first, design the personality of their robot by choosing five out of the fifty Personality Cards; second, use the Movement Cards to prescribe expressive movement to their robotic design and finally, to use the materials provided in the Movement-Making tools to prototype their robotic movements.

3.3 Toolkit

For the Personality cards, we used a set of 50 cards, built on prior work by Meerbeek et al. [17] and Lalioti [12], with each containing one word denoting a human strength (e.g., analytical, creative, empathetic, structured) (Figure 1). It should be noted that while many psychological studies on human typologies [3,8,26] differentiate between five distinct personality types, in this research and based on more recent work on human typology [5] – which challenges the existence of personality types as categorical models of individual differences – the cards did not present participants with discreet personality dimensions, but rather with distinct types of human strengths.

Figure 1: Personality cards (left) and Movement cards (right) used in the co-design workshop.

The six Movement Cards are double-sided, with one side showing the categories of movement, while the other was pointing toward six examples of movements under the corresponding category. There were six categories in total: greeting, tactile, spatial, balance, travel and mechanical, each accompanied by six examples (Figure 1). Participants were then free to select as many movement cards as they deemed fit and add their own movements, if more suitable for their robotic designs.

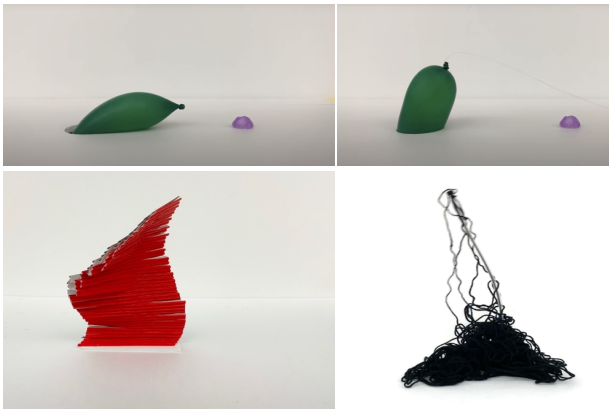

Figure 2: Movement-Making by humans (top), through stop-frame animation (bottom left) and motors (bottom right).

Finally, participants were provided with three categories of tools to help participants prototype their movement design (Figure 2):

1. Movement by Humans: transparent strings to operate a marionette-like robot
2. Movement by GIFs: iPads to document, create GIFs and make stop motion animations
3. Movement by Motor: motors & gearboxes to make self-propelled prototypes

3.4 Data Collection

The workshop took place in a large room, with 4 tables and a presentation screen. To differentiate more easily between the work of each group, each table was assigned one color from red, green, blue, and yellow, by placing a colored dot on a blackboard, in the middle of the table. Each table also had a set of post-its, felt markers, a small box with a motor and 3D printed components, a set of colored dots of the same color as the table, an iPad and finally, a set of Personality Cards, Movement Cards and Movement-Making tools.

There were two more tables in the room: a long one with additional design materials and another one featuring a green screen for final prototype video recordings. The workshop was captured on videos, photos as well as annotations of the correlations between Personality and Movement Cards. Participants were given reflection/feedback forms which they filled in at the end of the workshop. These were anonymous.

4 Results and Discussion

This section discusses the outputs and participant feedback, as well as limitations and future phases of this work in our broader research in designing contextually sensitive, expressive robotic movement. This section also contains participants' quotes, translated into English; these have been extracted from the anonymous reflection forms that participants filled out at the end of the workshop.

Four distinctive robotic prototypes were made using the three Movement Making tools, one using motors, two using the GIF method and a fourth powered by humans. All were built around a choice of 5 personality strengths, matched with a selection of movements from the Movement cards. The groups then co-designed the robotic prototypes to express the movements from the cards.

For example, the prototype using motor, had the proficient, cooperative, instinctive, systematic and practical personality cards. These were associated with the following movements: distribute, bow and back-and-forth. This robotic prototype translated a back-and-forth movement into bowing, to distribute business cards. One of the animated GIF prototypes had personality strengths as harmonizing, adaptable, disciplined, data-driven and loyal, associated with the movements: gather, push-pull and inflate, stroke, step, bow. This robotic prototype, used a rope to gather garbage, by push-pull/stroke it into a particular area and bow once the step was finished (Figure 3).

We observed that across all groups participants experimented with the Movement making tools and the materials available spending at least a third and up to two-thirds of the robotic prototyping phase experimenting with different movements and materials first, before they start discussing functionality.

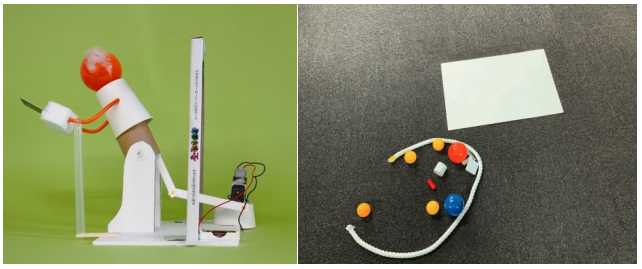

Figure 3: Examples of robotic prototypes from the co-design workshop with movement by motor (left) and by GIF (right).

The open brief on designing robotic movement, as opposed to a whole robotic intervention, encouraged participants to focus on designing movement irrespective of form or function. It also encouraged them to build a variety of diverse prototypes, as one participant reflected:

> "Useful way to choose materials and make something in a short time, I discovered that even a rope can behave like a sophisticated robot."

The open brief in conjunction with the design toolkit enabled roboticists to think beyond the technical:

> "I tend to think too much about technical things, which could limit my ideas. Robots could be natural, cooperative, smooth, not so accurate but work fine, just like humans."

and was equally helpful for non-roboticists:

> "It was my first time creating something physical, so I learned a vast amount of new ways to create a movement out of materials that are static."

Participants appear to have commented the most on the use of human-strengths in the design process:

> "The process of involving personality into a robot was interesting. It was also introducing how a movement is representing a certain personality."
> "It was interesting to arrange the personality of robots and make movement prototype based on the personality. At first, I felt strange to adjust personality to robots, but in a moment, I rethink it was important process in order to perceive new types of robots."
> "The process of using versions of adjectives to explore and find new types of robots was most useful."

Finally, the movement-making tools were designed to go beyond the Wizard of Oz method [18], and as summarized by a participant:

> "the (making) tools offered were inspiring, stimulating me to think about it (movement) more deeply."

Our study is limited by the number of participants that took part in the co-design workshop, as it is not sufficient sample to draw

generalized conclusions. However, in our contention, this report is a first phase in an ongoing research in employing participatory design methods and developing tools for exploring robotic movement and contextual effects in co-design. As this exploration ultimately implies, there are still many aspects of the dynamism between socio-cultural contexts and robotic movement left to be uncovered. We aim to position this within an iterative design process to refine the toolkit and validate the efficacy of participatory methods in designing contextually sensitive robotic movement.

8 Conclusions

We developed a design-centric approach to designing contextually expressive robotic movement, including a design toolkit, an open brief and a participatory structure intended to better reflect the cultural context in which the design is being carried. This is particularly important, as robots are used more and more in social contexts and in care. Design-centric research with movement in focus will support these important social fields of HRI and the development of HRI-for-all paradigms needed as robots are becoming part of our societies.

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REFERENCES

[1] Philip W. Blythe, Peter M. Todd, and Geoffrey F. Miller. 1999. How motion reveals intention: Categorizing social interactions. In *Simple heuristics that make us smart*. Oxford University Press, New York, NY, US, 257–285.

[2] Tao Gao, George E. Newman, and Brian J. Scholl. 2009. The psychophysics of chasing: A case study in the perception of animacy. *Cognitive Psychology* 59, (2009), 154–179. DOI:https://doi.org/10.1016/j.cogpsych.2009.03.001

[3] Lewis R Goldberg. An Alternative "Description of Personality": The Big-Five Factor Structure. 14.

[4] Edward T. Hall. 1989. *Beyond culture* (Anchor books ed ed.). Anchor Books, New York. Retrieved September 12, 2022 from https://www.loc.gov/catdir/enhancements/fy1701/89018232-b.html

[5] Nick Haslam. 2019. Unicorns, snarks, and personality types: A review of the first 102 taxometric studies of personality. *Australian Journal of Psychology* 71, 1 (March 2019), 39–49. DOI:https://doi.org/10.1111/ajpy.12228

[6] F. Heider and M. Simmel. 1944. An experimental study of apparent behavior. *The American Journal of Psychology* 57, (1944), 243–259. DOI:https://doi.org/10.2307/1416950

[7] Guy Hoffman and Wendy Ju. 2014. Designing Robots With Movement in Mind. *Journal of Human-Robot Interaction* 3, 1 (March 2014), 89. DOI:https://doi.org/10.5898/JHRI.3.1.Hoffman

[8] C.G. Jung. 2014. *The Collected Works of C.G. Jung: Complete digital Edition*. Princeton. Retrieved September 13, 2022 from https://press.princeton.edu/books/ebook/9781400851065/the-collected-works-of-cg-jung

[9] Frédéric Kaplan. 2004. WHO IS AFRAID OF THE HUMANOID? INVESTIGATING CULTURAL DIFFERENCES IN THE ACCEPTANCE OF ROBOTS. *Int. J. Human. Robot.* 01, 03 (September 2004), 465–480. DOI:https://doi.org/10.1142/S0219843604000289

[10] Peter Kopacek. 2013. Development trends in robotics. *Elektrotech. Inftech.* 130, 2 (March 2013), 42–47. DOI:https://doi.org/10.1007/s00502-013-0129-1

[11] Jessica L. Lakin, Valerie E. Jefferis, Clara Michelle Cheng, and Tanya L. Chartrand. 2003. The Chameleon Effect as Social Glue: Evidence for the Evolutionary Significance of Nonconscious Mimicry. *Journal of Nonverbal Behavior* 27, 3 (September 2003), 145–162. DOI:https://doi.org/10.1023/A:1025389814290

[12] Vali Lalioti. 2019. RethinkAI™: Designing the Human and AI relationship in the Future of Work.

[13] Vali Lalioti. 2019. RethinkAITM: Designing the Impact of AI in the Future of Work.

[14] Hee Rin Lee and Selma Sabanović. 2014. Culturally variable preferences for robot design and use in South Korea, Turkey, and the United States. In *Proceedings of the 2014 ACM/IEEE international conference on Human-robot interaction* (HRI '14), Association for Computing Machinery, New York, NY, USA, 17–24. DOI:https://doi.org/10.1145/2559636.2559676

[15] Maria Luce Lupetti, Cristina Zaga, and Nazli Cila. 2021. Designerly Ways of Knowing in HRI: Broadening the Scope of Design-oriented HRI Through the Concept of Intermediate-level Knowledge. In *Proceedings of the 2021 ACM/IEEE International Conference on Human-Robot Interaction*, ACM, Boulder CO USA, 389–398. DOI:https://doi.org/10.1145/3434073.3444668

[16] Michal Luria, Marius Hoggenmüller, Wen-Ying Lee, Luke Hespanhol, Malte Jung, and Jodi Forlizzi. 2021. Research through Design Approaches in Human-Robot Interaction. In *Companion of the 2021 ACM/IEEE International Conference on Human-Robot Interaction*, ACM, Boulder CO USA, 685–687. DOI:https://doi.org/10.1145/3434074.3444868

[17] Bernt Meerbeek, Martin Saerbeck, and Christoph Bartneck. 2009. Towards a design method for expressive robots. In *Proceedings of the 4th ACM/IEEE international conference on Human robot interaction - HRI '09*, ACM Press, La Jolla, California, USA, 277. DOI:https://doi.org/10.1145/1514095.1514174

[18] Bernt Meerbeek, Martin Saerbeck, and Christoph Bartneck. 2009. Towards a design method for expressive robots. In *Proceedings of the 4th ACM/IEEE international conference on Human robot interaction* (HRI '09), Association for Computing Machinery, New York, NY, USA, 277–278. DOI:https://doi.org/10.1145/1514095.1514174

[19] Kensho Miyoshi. 2020. *Designing Objects in Motion* (1st ed.). Birkhauser.

[20] Joonha Park, Nick Haslam, Yoshi Kashima, and Vinai Norasakkunkit. 2016. Empathy, culture and self-humanising: Empathising reduces the attribution of greater humanness to the self more in Japan than Australia: EMPATHY, CULTURE AND SELF-HUMANISING. *Int J Psychol* 51, 4 (August 2016), 301–306. DOI:https://doi.org/10.1002/ijop.12164

[21] null Scholl and null Tremoulet. 2000. Perceptual causality and animacy. *Trends Cogn Sci* 4, 8 (August 2000), 299–309. DOI:https://doi.org/10.1016/s1364-6613(00)01506-0

[22] Natalie Sebanz, Harold Bekkering, and Günther Knoblich. 2006. Joint action: bodies and minds moving together. *Trends in Cognitive Sciences* 10, 2 (February 2006), 70–76. DOI:https://doi.org/10.1016/j.tics.2005.12.009

[23] Gabriele Trovato, Massimiliano Zecca, Salvatore Sessa, Lorenzo Jamone, Jaap Ham, Kenji Hashimoto, and Atsuo Takanishi. 2013. Cross-cultural study on human-robot greeting interaction: acceptance and discomfort by Egyptians and Japanese. *Paladyn, Journal of Behavioral Robotics* 4, 2 (December 2013), 83–93. DOI:https://doi.org/10.2478/pjbr-2013-0006

[24] Lin Wang, Pei-Luen Patrick Rau, Vanessa Evers, Benjamin Krisper Robinson, and Pamela Hinds. 2010. When in Rome: the role of culture & context in adherence to robot recommendations. In *Proceedings of the 5th ACM/IEEE international conference on Human-robot interaction* (HRI '10), IEEE Press, Osaka, Japan, 359–366.

[25] The Astro Boy Essays. *Stone Bridge Press*. Retrieved September 13, 2022 from https://www.stonebridge.com/catalog-2020/The-Astro-Boy-Essays

[26] Gifts Differing by Myers, Isabel Briggs. Retrieved September 13, 2022 from https://www.biblio.com/gifts-differing-by-myers-isabel-briggs/work/61102