2025 IEEE/SICE International Symposium on System Integration (SII)
January 21-24, 2025, Munich, Germany

Prototyping Support System for Co-development of Performance Robots by Robot Engineers and Dance Performers

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Abstract— **Robots are used in many situations. However, there are fields that could potentially use robotic technology but do not at present. The art field is one of these. Compared with new media art, there are few art forms that use robots. Robots are media with a body and intelligence and facilitate various types of interactions. This is different from recent new media. Therefore, robotic media will provide novel experiences with artworks not only to the audience but also to the artist, just as new media provides interactive and immersive experiences with artworks. Our long-term goal is to create robotic media artworks and to reveal what is occurring with these artworks. Our initial aim is to facilitate interactive discussions with dance performers and to develop a co-development tool named "Prototyping Support System." This system consists of an RGB-D camera, PC, and projector, and achieves touch interaction with a robot in VR. Furthermore, we investigated the impact of a robot's reaction time on the robot's perceived emotion using this system. An experiment showed, especially in the case where the robot reacted by transforming, that a faster reaction time for the robot resulted in a greater perception that the robot was surprised. This paper discusses the system and its application in an experiment designed to determine the impact of the robot's reaction time and form in VR.**

I. INTRODUCTION

The integration of electronic technology and art has been present in cinema, music, and video for some time. More recently, the focus has shifted to new media art [1]. This type of artwork utilizes sensor and computer technologies to provide an interactive and immersive experience for the audience. Additionally, some artworks use bodily media, such as the dance performances produced by Rhizomatiks [2] and performances that use JIZAI arms [3]. These bodily media artworks will provide new experiences not only for audiences but also for artists. These experiences will differ from those produced by recent new media art. This study focused on the use of robots as a medium.

The human–robot interaction (HRI) research field is vast and diverse. There are robots with various types of appearances, including humanoid robots (e.g., KOBIAN [4], TWENDY-ONE [5], ERICA [6], Pepper [7]), animal-inspired robots (e.g., AIBO [8] and Paro [9]), uniquely shaped robots (e.g., LAVOT [10] and Keepon [11]), and flying robots such as drones [12–14]. Additionally, robots can interact in various ways, including through gestures and facial expressions [4], verbal communication [6], and touch [5, 8–10]. Robots are capable of various interactions with different types of bodies. Because of these features, various studies have been conducted on artworks produced using robots [2, 15–19], and robots have been used in various types of performances, especially dance. For example, Ms-DanceR [15] performs ballroom dances with humans, and biped humanoid robots have been produced that stamp their feet in time with musical beats like humans [16]. However, fewer studies have focused on robots as media. Therefore, we focused on the relationship between performers and robotic media.

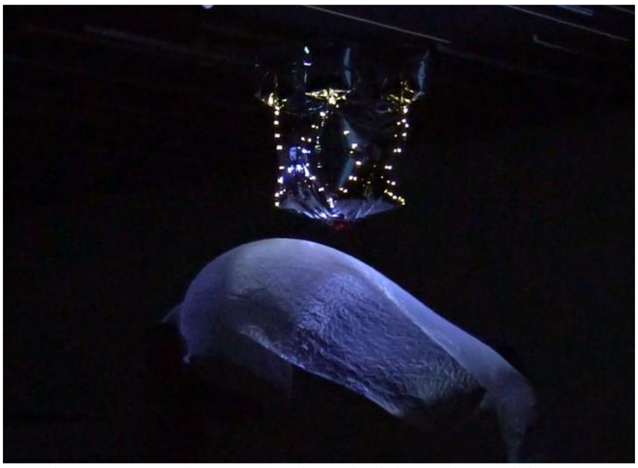

Figure 1. Artwork created by the Soft Flying Robot and dance performers [20].

Thus far, we have developed a new type of flying robot called the "Soft Flying Robot" [20], which can become a dance performance partner. This robot flies using a buoyant force from a helium-filled aluminum balloon and thrust forces from piezoelectric micro-air pumps. Its blade-free flight mechanism makes it relatively safe to touch the robot compared to unmanned aerial vehicles (UAVs) [12–14]. Additionally, it facilitates touch interaction with a human through capacitive touch sensors and LEDs. In the study [20], the Soft Flying Robot was introduced in a dance workshop with performers. Together, they created unique art performances (see Fig. 1) that differed from those performed with UAVs [2]. The performances induced extraordinary feelings in the performers. Thus, we hypothesized that robotic media artworks will become co-creational because of their unique hardware. This feature will be not only in the performance itself but also in its development process. Thus, we focused on its process.

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The objective of this study was to develop a co-development tool for prototyping robots and creating robotic media artworks. Through the development of interactive robots for performing arts [20], we obtained the idea of a co-development tool to share images of the interactive robots before assembling prototypes, using virtual reality technologies. This tool can provide more interactive and exciting discussions between robot engineers and dance performers. In this study, we developed a co-development tool called the "Prototyping Support System" to facilitate interactive discussions between robot engineers and dance performers. This tool utilizes virtual reality (VR) technology to visualize various appearances and behaviors, including interactions with interactive robots in VR. Additionally, we investigated the impact of a robot's reaction time on its perceived emotion in VR, with the goal of designing the emotional behavior of non-humanoid robots such as the Soft Flying Robot [20].

The remainder of this paper is organized as follows. Section 2 describes the concepts and configuration of the system. Section 3 covers the design of the experiment. Section 4 presents the experimental results. Section 5 discusses the results and observations of the study. Finally, section 6 presents a conclusion and the outlook for future research.

II. PROTOTYPING SUPPORT SYSTEM

Fig. 2 displays an application image of the Prototyping Support System (PSS). To facilitate co-development with performers, it is important to visualize the robot's appearance and behavior, especially for performers who want to express themselves through their bodies. However, prototyping robots is time-consuming, and it is challenging to prototype various types of robots for each meeting or workshop. The system was designed to visualize the appearance and behaviors of a robot in VR, which facilitates discussions between robot engineers and dance performers. The concepts of the system are shown below.

Concept A. *Make it easy to change the appearance and behavior of the robot.* To ideate what the performer needs to express, it is important to visualize many robotic ideas. This is in line with the principles of design thinking [21].

Concept B. *Use marker-less motion capture to reflect human motion onto an avatar in VR.* Markers and other motion capture accessories become obstacles. Marker-less motion capture is necessary to capture performances in natural ways.

Concept C. *Interact with the robot in VR.* During performances, performers interact with the robot. It is important to discuss not only the robot's appearance but also the details of this interaction (e.g., reaction form and reaction time) before prototyping.

A. System Configuration

Fig. 3 shows the system configuration of the PSS. The system allows an avatar in VR to reflect a real human pose, using data from an RGB-D camera. The method for as a 3D real-time pose estimation method [22]. Fig. 4 shows its

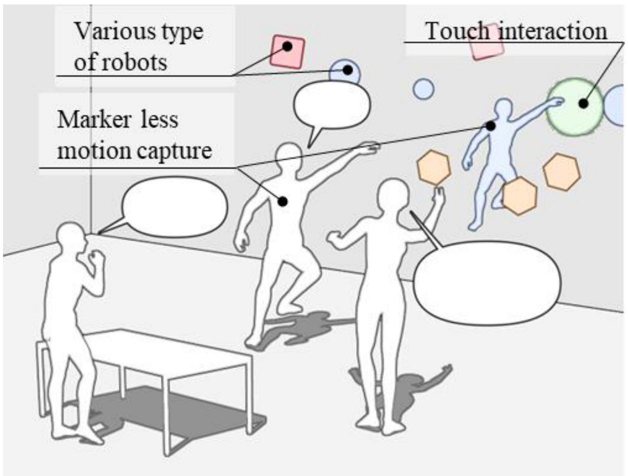


Figure 2. Usage image of the PSS.

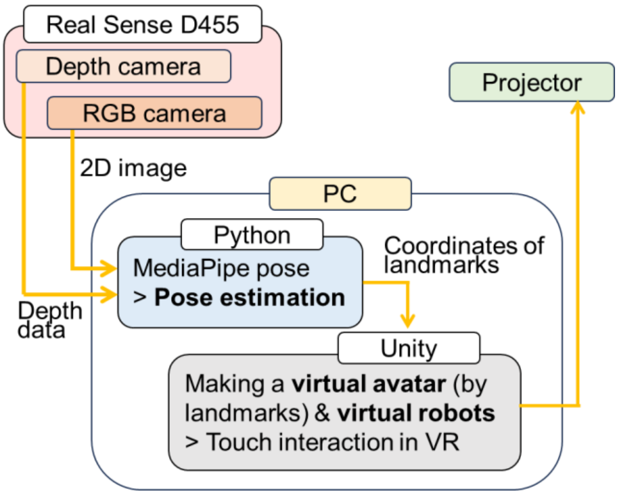


Figure 3. System configuration of the PSS.
All devices are connected by cables.

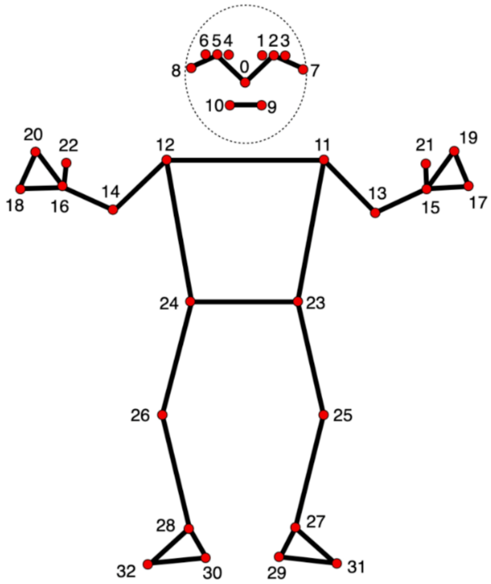


Figure 4. Pose landmark model of MediaPipe Pose [22].

landmark locations. This method simplifies the equipment compared to other methods of human pose estimation, such as the 3D DLT method [23] and volumetric capture method [24].

Users will interact with the virtual robot using their avatar body in VR. Their avatar body is created by the Unity engine. The image is projected onto a screen, allowing users to experience a simulated environment. The system's configuration enables the achievement of Concepts A and B. It is necessary to consider the form of interaction to achieve Concept C.

B. *Interaction Design*

We selected touch interaction from the various types of possible interaction methods. There were two reasons. First, their physical body is an important factor in how a human experiences the world. Several studies on touch interaction have supported its importance [25–27]. Second, touch interaction with a robot will be utilized in dance performances.

The preliminary reactions selected for robot interaction were transformation, sound emission, and light emission because these reactions will be available in VR. However, there was no method for designing the artistic behavior of a robot. Therefore, we conducted an experiment to investigate the effect of behavioral factors (e.g., the reaction form and time of the robot) on its perceived emotion because art is based on the expression of emotion.

III. EXPERIMENT

A. *Objective of the Experiment*

The objective of this experiment was to examine how a robot's reaction form and time impact the emotion that the robot is perceived by a human to be expressing through touch interaction in VR.

B. *Experimental Environment and Equipment*

Fig. 5 shows the experimental environment, which mainly consisted of the PSS. The contents of the equipment are listed in Table I. The virtual robot's appearance was based on that of the Soft Flying Robot [20]. The questionnaire asked, "*How did you think the robot was feeling during the interaction? Please select an answer from 1 (very unlikely) to 4 (very likely) on the excel sheet*." The target emotions are listed in Table II, which refers to Ekman's six basic emotions [28].

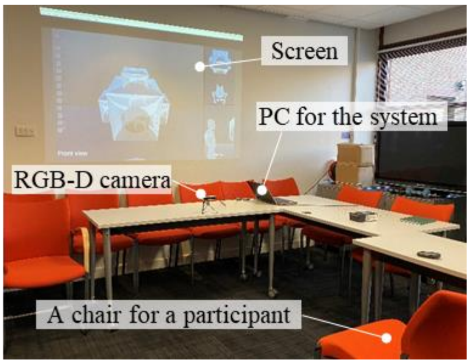


Figure 5. Experimental environment.

TABLE I. EQUIPMENT USED IN THE EXPERIMENT

Equipment
RGB-D camera (Intel RealSense D455)
PC (CPU: Intel core i7 Gen 11th) for the system
Projector
Questionnaire in the other PC

TABLE II. TARGET EMOTIONS IN THE EXPERIMENT

Number	Emotion
1	Happiness
2	Surprise
3	Anger
4	Fear
5	Disgusted
6	Sadness
7	Neutral

C. *Method*

Fig. 6 shows the flow of the experiment. Before the experiment, we obtained informed consent in writing. The experiment was explained verbally and in writing. First, the virtual environment was explained. This was followed by explanations of the interaction method and process used in the experiment. Fig. 7 shows a view of the system and the neutral condition of the VR robot. The experimental conditions are listed in Table III. There were two reaction time conditions because preference changes between 0 s and 1 s on instruction

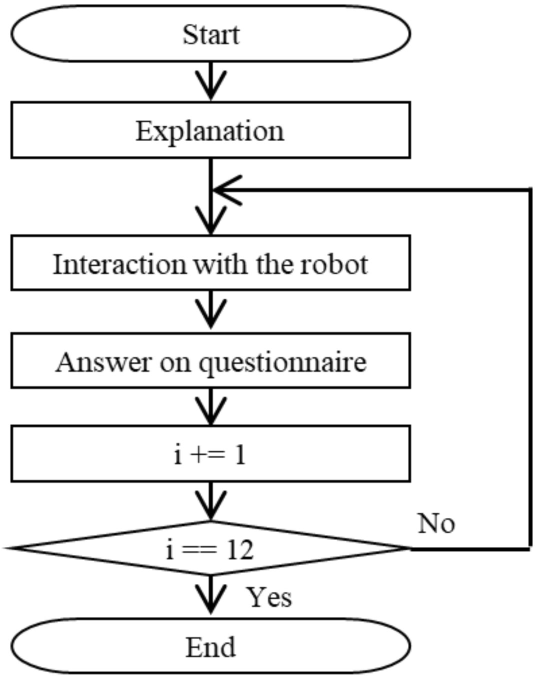


Figure 6. Flow of the experiment.

TABLE III. EXPERIMENTAL CONDITIONS

Number	Reaction form of the robot	Reaction time [s]
1	Transforming	1
2		0
3	Loud sound emitting	1
4		0
5	Soft sound emitting	1
6		0
7	Red light emitting	1
8		0
9	Blue light emitting	1
10		0
11	Yellow light emitting	1
12		0

with GUI [29]. There were loud and soft sounds emitted as reaction conditions because different impressions are made in the presence of loud and soft sounds [30]. There were red, blue, and yellow light emitted as reaction conditions because different impressions are made in the presence of these colors [31]. These 12 experimental conditions were randomized using the balanced Latin squares method. There were 84 results per participant (12 conditions × 7 emotions). The participants consisted of 13 (male: 11, female: 2) students from Loughborough University. The study was approved by the Loughborough University Ethics Approvals (Human Participants) Sub-Committee (project ID: 16375).

IV. RESULT

A. *Overview*

When comparing the reaction times in the same reaction form, there were different combinations, and variation was found in the answers among the participants. In this paper, we focus on the red-light emitting reaction condition (Fig. 8.a) and transforming reaction condition (Fig. 8.b) because a trend was found under these reaction conditions.

B. *Red Light-emitting Reaction*

More than half of the participants perceived that the robot was angry or unhappy. Fig. 9 shows that there was a small difference in the number of participants (11 under the 1 s condition and 9 under the 0 s condition) who perceived that the robot was angry. Furthermore, no participants perceived that the robot was happy under either condition. Therefore, the robot expressed anger or unhappiness through the red-light emitting reaction, regardless of whether the reaction time was 0 s or 1 s in VR. There were three related studies on reactions that induced anger or unhappiness. In the first, the color red was often associated with anger [32, 33]. In the second, human faces turned red when they were angry [34]. In the third, anger was positioned opposite to happiness in Russell's circumplex model [35].

C. *Transforming Reaction*

More than half of the participants perceived that the robot was surprised. Fig. 10 shows that 9 participants under the 1 s

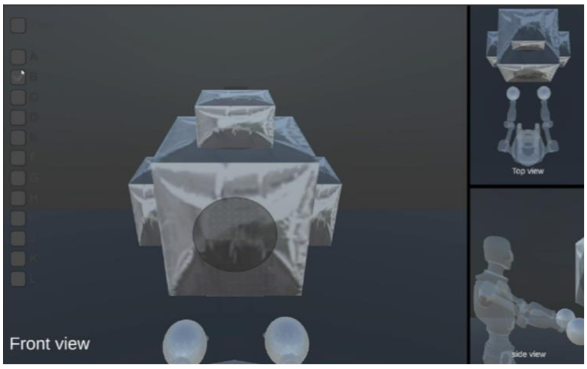
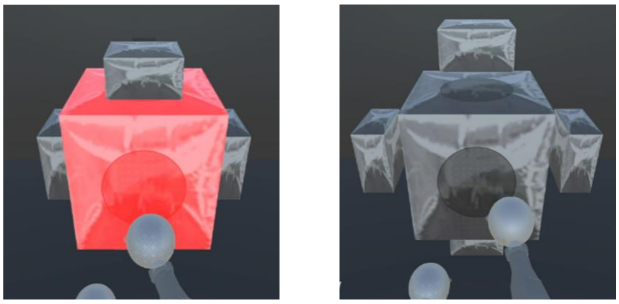
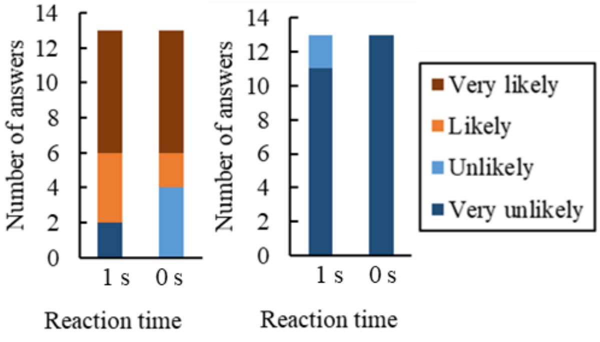


Figure 7. Three system viewpoints: front, top, and side, with the VR robot in neutral condition.



(a) Red-light emitting reaction (b) Transforming reaction

Figure 8. Appearances of the reaction forms.



(a) Anger (b) Happiness

Figure 9. Answers in red light emitting condition.

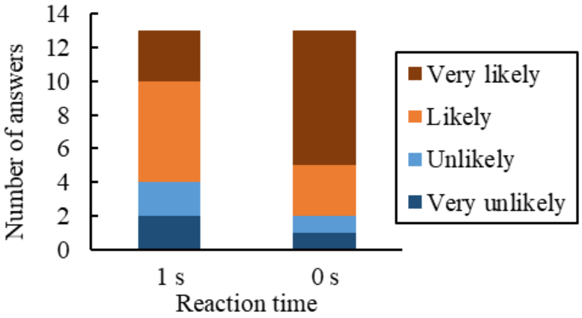


Figure 10. Answers indicating surprise under the transforming condition.

condition and 11 participants under the 0 s condition perceived the robot to be surprised. Furthermore, 5 more participants answered very likely under the 0 s condition than under the 1 s condition. These results suggest that the reaction time affects the perceived surprise of a robot in VR. This transforming reaction (Fig. 8.b) may have been perceived as surprise because the reaction is similar to the human expression of surprise [36]. Additionally, surprise was the fastest of the emotions, which was why a faster reaction was more often perceived as surprise [36].

V. DISCUSSION

A. *Possibility to Enhance Discussion in Prototyping*

In the experiment, all the participants recognized the VR robot as an interactive agent and answered questions about the VR robot's emotions. Therefore, we believe that our PSS simulates some parts of interactions between a user and the robot in the real world. It can be useful to facilitate interactive discussions between robot engineers and dance performers, during the prototyping phase of the interactive robots. For instance, we are planning to conduct workshops with dance performers to design novel soft flying robots.

Furthermore, this system can be used in various art performances. One possible application of this system is as a prototyping support tool for installation art that involves robots [37]. The system allows robot engineers and installation artists to visualize the appearance and motion of the installation artworks using robotics. The system facilitates interactive discussions between robot engineers and non-engineers similar to a dance performance with robots.

Another possible application of this system is as a performance support tool for dance performances [38]. With this system, dance performers are able to access the virtual body and virtual environment. For instance, when a dance performer wishes to transform into a dragon, the virtual avatar transforms its appearance into a dragon. When a dance performer wishes to dance into the sky, the virtual environment adapts accordingly.

The system will facilitate the evolution of artworks by serving as both a prototyping and performance support tool. However, this system has a limitation in providing tactile feedback. Recent studies suggest that tactile feedback is also important for interactive systems[39, 40]. Therefore, our next step is the development of a tactile feedback device for a more interactive PSS.

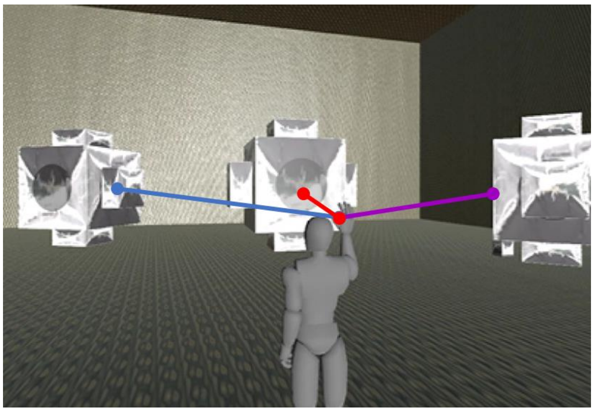


Figure 11. Image of a flexible viewpoint with colored beams
The red beams represent an object that is near, while the blue beams represent a distant object.

B. *Emotional Behavior of Non-humanoid Robot*

Based on the experiment results, it is suggested that participants anthropomorphized the non-humanoid robot and assumed it had emotions based solely on visual cues. When the robot turned red, the participants perceived the robot as angry or unhappy. The same is true when the human face turns red [34]. Additionally, when the robot transformed like opening from the center quickly, the participants viewed the robot as surprised. The same is true when a human opens his eyes and mouth wide [36]. The relationship between a robot's reactions and perceived emotions was similar to that of humans. Therefore, if audiences and performers assume that the robot has emotions, human facial expressions [28] and emotional models [34] could be used to design the emotional behavior of a non-humanoid robot, which will be like that of humans [4]. However, our experiment results are limited to simple expressions. Non-humanoid robots can exhibit more complex behaviors due to their bodies differing significantly from humans. Therefore, our next step is to investigate the relationship between non-humanoid robot's emotions and their various forms and behaviors using the PSS.

C. *Scheme for Flexible Viewpoint*

During the experiment, participants interacted with the virtual robot using their avatar's hand. The experimental system provided three viewpoints (front, side, and top) because it is challenging to perceive the distance between avatars and virtual agents in VR (refer to Fig. 7). However, to achieve the image shown in Fig. 2, a non-fixed viewpoint is necessary. To achieve this, we propose visualizing the angle and distance using a colored beam (see Fig. 11), which would be useful.

VI. CONCLUSION

In this study, we aimed to realize interactive discussions with performers and developed a "Prototyping Support System." This system achieved interaction with robots in VR and was used in an experiment to investigate the impact of a robot's reaction time on its perceived emotion. The contributions of this study center around robotic media artworks and the emotional expression of robots in VR. In the future, we aim to develop tactile feedback devices, investigate more complex emotional expressions in robots, and propose using the system to co-develop various types of robots with performers, along with developing methods for creating robotic media artworks.

ACKNOWLEDGMENT

This work was supported by JSPS KAKENHI JP 19J01130, 21H05055, and 23H03443. The study was approved by Loughborough University Ethics Approvals (Human Participants) Sub-Committee (project ID: 16375). We also thank the participants in the experiment.

REFERENCES

[1] teamLab, “ART”, https://www.teamlab.art/, viewed on March 7, 2024.

[2] Rhizomatiks, “America’s Got Talent”, https://rhizomatiks.com/en/work/agt_elevenplay/, viewed on March 7, 2024.

[3] N. Yamamura, et al., “Social digital cyborgs: The collaborative design process of JIZAI ARMS.” In *Proc. 2023 CHI Conf. Hum. Factors Comput. Syst. (CHI '23)*, Association for Computing Machinery, New York, NY, USA, Article 369, pp. 1–19, 2023, https://doi.org/10.1145/3544548.3581169

[4] M. Zecca, et al., "Whole body emotion expressions for KOBIAN humanoid robot — preliminary experiments with different Emotional patterns —," RO-MAN 2009 - *18th IEEE Int. Symp. Rob. Hum. Interact. Commun.*, Toyama, Japan, 2009, pp. 381–386, https://doi.org/10.1109/ROMAN.2009.5326184

[5] H. Iwata and S. Sugano, "Design of human symbiotic robot TWENDY-ONE," *2009 IEEE Int. Conf. Rob. Autom.*, Kobe, Japan, 2009, pp. 580-586, https://doi.org/10.1109/ROBOT.2009.5152702

[6] D. F. Glas, et al., "ERICA: The ERATO Intelligent Conversational Android," *2016 25th IEEE Int. Symp. Rob. Hum. Interact. Commun. (RO-MAN)*, New York, NY, USA, 2016, pp. 22–29, https://doi.org/10.1109/ROMAN.2016.7745086

[7] A. K. Pandey and R. Gelin, "A Mass-Produced Sociable Humanoid Robot: Pepper: The First Machine of Its Kind," In *IEEE Rob. Autom. Mag.*, vol. 25, no. 3, pp. 40–48, Sept. 2018, https://doi.org/10.1109/MRA.2018.2833157

[8] M. Fujita, “AIBO: Toward the era of digital creatures,” *Int. J. Rob. Res.*, vol. 20, no, 10, pp. 781–794, 2001. https://doi.org/10.1177/02783640122068092

[9] T. Shibata, Y. Kawaguchi, and K. Wada, "Investigation on people living with Paro at home," *RO-MAN 2009 - 18th IEEE Int. Symp. Rob. Hum. Interact. Commun.*, Toyama, Japan, 2009, pp. 1131–1136, https://doi.org/10.1109/ROMAN.2009.5326201

[10] N. Yoshida, S. Yonemura, M. Emoto, et al., “Production of character animation in a home robot: A case study of LOVOT,” *Int. J. Soc. Rob.*, vol. 14, pp. 39–54, 2022. https://doi.org/10.1007/s12369-021-00746-0

[11] H. Kozima, M. P. Michalowski, and C. Nakagawa, “Keepon,” *Int. J. Soc. Rob.*, vol. 1, pp. 3–18, 2009. https://doi.org/10.1007/s12369-008-0009-8

[12] J. R. Cauchard, et al., “Drone & me: An exploration into natural human-drone interaction,” In *Proc. 2015 ACM Int. Joint Conf. Pervasive Ubiquitous Comput. (UbiComp '15),* Association for Computing Machinery, New York, NY, USA, pp, 361–365, 2015, https://doi.org/10.1145/2750858.2805823

[13] A. Cherpillod, D. Floreano, and S. Mintchev, "Embodied flight with a drone," *2019 Third IEEE Int. Conf. Rob. Comput. (IRC)*, Naples, Italy, 2019, pp. 386–390, https://doi.org/10.1109/IRC.2019.00070

[14] K. Nitta et al., “HoverBall: Augmented sports with a flying ball,” In *Proc. 5th Augment. Hum. Int. Con. (AH '14)*. New York, NY, USA: Association for Computing Machinery, 2014, pp. 1–4, article 13, https://doi.org/10.1145/2582051.2582064

[15] K. Kosuge, T. Hayashi, Y. Hirata, and R. Tobiyama, "Dance partner robot - Ms DanceR," *Proc. 2003 IEEE/RSJ Int. Conf. Intell. Rob. Syst. (IROS 2003)* (Cat. No.03CH37453), Las Vegas, NV, USA, 2003, vol. 3, pp. 3459–3464, https://doi.org/10.1109/IROS.2003.1249691

[16] K. Yoshii, et al., "A biped robot that keeps steps in time with musical beats while listening to music with its own ears," *2007 IEEE/RSJ Int. Conf. Intell. Rob. Syst.*, San Diego, CA, USA, 2007, pp. 1743–1750, https://doi.org/10.1109/IROS.2007.4399244

[17] A. Vick, D. Surdilovic, A. K. Dräger, and J. Krüger, "The industrial robot as intelligent tool carrier for human-robot interactive artwork," *23rd IEEE Int. Symp. Rob. Hum. Interact. Commun.*, Edinburgh, UK, 2014, pp. 880–885, https://doi.org/10.1109/ROMAN.2014.6926364

[18] R. C. Luo, M. -J. Hong, and P. -C. Chung, "Robot artist for colorful picture painting with visual control system," *2016 IEEE/RSJ Int. Conf. Intell. Rob. Syst. (IROS)*, Daejeon, Korea (South), 2016, pp. 2998–3003, https://doi.org/10.1109/IROS.2016.7759464

[19] P. Cohen, "Harold Cohen and AARON," *AI Mag*., vol. 37, no. 4, pp. 63–66, 2016, https://doi.org/10.1609/aimag.v37i4.2695

[20] H. Shido, H. Nishi, and H. Ishii, "Proposal of a new performance partner: Soft Flying Robot," *2023 32nd IEEE Int. Conf. Rob. Hum. Interact. Commun. (RO-MAN)*, Busan, Republic of Korea, 2023, pp. 153–158, https://doi.org/10.1109/RO-MAN57019.2023.10309393

[21] T. Brown, "Design thinking," *Harvard Bus. Rev.*, vol. 86, no. 6, pp. 84–92, 2008.

[22] Google for Developers, MediaPipe/Solutions/Pose landmark detection guide, https://developers.google.com/mediapipe/solutions/vision/pose_landmarker, viewed on March 7, 2024.

[23] E. Remelli, S. Han, S. Honari, P. Fua, and R. Wang, "Lightweight multi-view 3D pose estimation through camera-disentangled representation," *2020 IEEE/CVF Conf. Comp. Vis. Pattern Recognit. (CVPR)*, Seattle, WA, USA, 2020, pp. 6039–6048, https://doi.org/10.1109/CVPR42600.2020.00608

[24] K. Guo, *et al.,* “The relightables: Volumetric performance capture of humans with realistic relighting,” *ACM Trans. Graph.*, vol. 38, no. 6, Article 217 (December 2019), 19 pages. https://doi.org/10.1145/3355089.3356571.

[25] O. Zuckerman and A. Gal-Oz, "To TUI or not to TUI: Evaluating performance and preference in tangible vs. graphical user interfaces*," Int. J. Hum. Comput. Stud.*, vol. 71, no. 7–8, pp. 803–820, 2013, https://doi.org/10.1016/j.ijhcs.2013.04.003.

[26] S. Price et al., "Exploring whole-body interaction and design for museums," *Interact. Comput.*, vol. 28, no. 5, pp. 569–583, 2016, https://doi.org/10.1093/iwc/iwv032.

[27] T. Adachi, et al., "Human SUGOROKU: Full-body interaction system for students to learn vegetation succession," In *Proc. 12th Int. Conf. Interact. Design Children*, 2013, pp. 364–367, https://doi.org/10.1145/2485760.2485830.

[28] P. Ekman, et al., “Universals and cultural differences in the judgments of facial expressions of emotion,” *J. Personality and Social Psychol.*, vol. 53, no. 4, pp. 712–717, 1987. https://doi.org/10.1037/0022-3514.53.4.712

[29] T. Shiwa, T. Kanda, M. Imai, H. Ishiguro, and N. Hagita, “How quickly should communication robots respond?” In *Proc. 3rd ACM/IEEE international conference on Human robot interaction*, New York, NY, USA, 2008, pp. 153–160, https://doi.org/10.1145/1349822.1349843

[30] J. Edworthy and H. Waring, “The effects of music tempo and loudness level on treadmill exercise,” *Ergon*., vol. 49, no. 15, pp. 1597–1610, 2006, https://doi.org/10.1080/00140130600899104

[31] F. Takahashi and Y. Kawabata, “The association between colors and emotions for emotional words and facial expressions,” *Color Res. Appl*., vol. 43, no. 2, pp. 247–257, 2018, https://doi.org/10.1002/col.22186

[32] S. G. Young, et al., “Red enhances the processing of facial expressions of anger,” *Emot.*, vol. 13, no. 3, pp. 380–384, 2013. https://doi.org/10.1037/a0032471

[33] K, Naz and H. H. Epps. "Relationship between color and emotion: A study of college students," *Coll. Stud. J.*, vol. 38, no. 3, pp. 396–405, 2004.

[34] S. G. Young, C. A. Thorstenson, and A. D. Pazda, “Facial redness, expression, and masculinity influence perceptions of anger and health,” *Cogn. Emot.*, vol. 32, no. 1, pp. 49–60, 2018, https://doi.org/10.1080/02699931.2016.1273201

[35] J. A. Russell, “A circumplex model of affect,” *J. Pers. Soc. Psychol*., vol. 39, no. 6, pp. 1161–1178, 1980, https://doi.org/10.1037/h0077714

[36] Paul Ekman Group, “What is surprise?”, https://www.paulekman.com/universal-emotions/what-is-surprise/, viewed on March 7, 2024.

[37] C. Kroos, D. C. Herath, Stelarc, “Evoking Agency: Attention Model and Behavior Control in a Robotic Art Installation”, *Leonardo,* vol. 45, no.5, 2012, pp. 401–407. https://doi.org/10.1162/LEON_a_00435

[38] Rhizomatiks, “ELEVENPLAY × Rhizomatiks “antiparallel””, https://rhizomatiks.com/en/work/antiparallel/, viewed on March 19, 2024.

[39] G. Sziebig, B. Solvang, C. Kiss and P. Korondi, "Vibro-tactile feedback for VR systems," *2009 2nd Conf. on Human System Interactions*, Catania, Italy, 2009, pp. 406-410, https://doi.org/10.1109/HSI.2009.5091014

[40] E. Hoggan, A. Crossan, S. -A. Brewster, and T. Kaaresoja. “Audio or tactile feedback: which modality when?” *In Proc. of the SIGCHI Conference on Human Factors in Computing Systems (CHI '09). Association for Computing Machinery*, New York, USA, 2009, pp. 2253–2256. https://doi.org/10.1145/1518701.1519045