Design and Implementation of Kawaii Robots by Japanese and American University Students using Remote Collaboration

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Abstract: This paper describes our approach to the design and implementation of virtual Kawaii robots and spaces by Japanese and American university students using remote collaboration. Because of the COVID-19 pandemic, we had to change our planned 7-week collaboration from in-person to virtual with a resultant change in the target product of our collaboration from real robots to virtual robots. Based on our new plan, students designed virtual spaces with robot pairs, proposed evaluation items for the robot pairs, evaluated their designs, and analyzed the results. The students designed each robot pair with the goal that one robot would be more kawaii and the other would be less kawaii due to a variation in a single attribute such as shape or color. The evaluation instrument used adjective pairs that were suitable to evaluate the affective values of the robot pairs and the virtual spaces the robots occupied. Through the design experience, students learned a lot about Kawaii Engineering and affective evaluation, which gave them a deeper understanding of Japanese culture from the viewpoint of Kansei/Affective Engineering.

Keywords: *Remote Collaboration, Virtual space, Kawaii, Robot, Adjective pair*

1. INTRODUCTION

Our International Research Experiences for Undergraduates (IRES) proposal was accepted by the National Science Foundation (NSF) in 2019 [1]. The Non-technical abstract of the proposal reads as follows:

As robotic gadgets, and eventually robots, become increasingly common in daily life, it is critical that roboticists design devices that are accepted by diverse users. This collaboration between DePauw University in the United States and Shibaura Institute of Technology (SIT) in Japan will lead to a deeper understanding of the role that cuteness plays in fostering positive human response to, and acceptance of, robotic gadgets. Building on research related to the Japanese concept of *kawaii* (Japanese cuteness), this project involves designing prototypes of robotic gadgets with varying levels and types of cuteness, and conducting multi-site, cross-cultural user studies that evaluate user's reactions to varied designs. A long term goal of this research is to deepen our understanding of how designers can use the concept of *kawaii* to build robotic gadgets that are accepted by diverse users. This International Research Experiences for Undergraduates (IRES) project provides educational and research experiences, at the individual and cohort level, for a diverse group of twelve students comprised of four undergraduates participating in each of three summers. Before departing for Japan, students will complete cultural and technical preparatory activities led collaboratively by two DePauw faculty members with remote contributions from three Shibaura Institute of Technology faculty members. Each student will then conduct research for seven weeks at Shibaura Institute of Technology under the primary mentorship of the Shibaura faculty members with supplemental remote and on-site mentorship from the DePauw faculty members. In addition to informing inclusive design practices for robotic gadgets, the project will serve as a catalyst for ongoing collaborations between DePauw University and Shibaura Institute of Technology.

NSF reviewers described the submission as "a very well thought [out] proposal that will take advantage of the kawaii design culture in Japan to help future robot gadget design. It can potentially generate both significant

intellectual merits and broad impact. The site selection is well justified and is very unique." [1].

Based on this accepted proposal, we had designed a 7-week collaborative project for cross-cultural teams to design, build and evaluate robotic gadgets, which would begin in June 2020 at SIT's Toyosu Campus. However, because of the COVID-19 pandemic, it became impossible for students from DePauw University to travel to Japan and work together with SIT students at the SIT campus. In fact, even the SIT students couldn't enter the campus. Therefore, we designed new remote collaborative approaches and activities based on a previous class and global Project Based Learning (PBL) work conducted by the first author [2, 3].

This paper describes the design and implementation of the virtual collaboration approaches and activities carried out by the students from both universities to design, build and evaluate kawaii robots and virtual spaces that these robots inhabit.

2. DESIGN OF COLLABORATIVE ACTIVITIES

2.1 Outline

Our plan for collaborative work, as described in the NSF proposal, revolved around the construction of kawaii robots and the affective evaluation of these robots. However, because the collaboration had to be conducted remotely, we changed from constructing real robots in real space to constructing virtual robots that operated in virtual spaces. Unity was employed to construct both the virtual robots and the virtual spaces. Zoom and Slack were employed for weekly and daily communication.

Two teams of students were formed with each team consisting of two students from DePauw University and two students from SIT. Each team designed and implemented a virtual space and each student designed and implemented a pair of robots to operate in that virtual space. For each pair of robots, one was designed to be more kawaii than the other.

2.2 Curriculum

Table 1 shows the schedule of weekly and additional meetings. Each meeting was held via Zoom. The collaborative experiences were organized into seven parts:

1. Introduction and farewell meetings
2. Design of a virtual space and robot pairs
3. Development of the virtual space and robot pairs
4. Proposal of evaluation items for the virtual space and robot pairs

Table 1: Schedule

	EDT	JST	CONTENT
1	31 May	1 June	Introduction, Introducing each other, Begin design of a virtual space with robots
2	2 June	3 June	Regular meeting (Continue designing)
3	9 June	10 June	Presentation of virtual space with robots. Begin development
4	16 June	17 June	Regular meeting (Continue development), Lecture by Dr. Laohakangvalvit
	21 June	22 June	Lecture by Prof. Nittono (Osaka University)
5	23 June	24 June	Regular meeting (Continue development, Discuss evaluation questionnaire items)
6	30 June	1 July	Presentation of evaluation questionnaire items (Continue development)
7	7 July	8 July	Presentation of virtual space with robots and evaluation of spaces and robots. Begin summarizing the evaluation results, and discussion
8	14 July	15 July	Presentation of discussion results. Sum-up
	16 July	17 July	Farewell Meeting

Figure 1: Introduction of organizers

5. Evaluation of the virtual spaces and robot pairs
6. Summarization of the evaluation results
7. Special lectures by Dr. Laohakangvalvit and by Prof. Nittono on their kawaii research [4-6]

3. IMPLEMENTATION OF COLLABORATIVE PRACTICE

3.1 Introduction

After a welcome message from the SIT faculty and a staff member from the SIT International Section, we introduced the faculty organizers and SIT's Toyosu Campus (Figure 1). Then, the SIT faculty members introduced the outline of the schedule for the seven-week collaborative activities, and explained the roles of robots in future society. Additionally, students from both universities introduced themselves.

3.2 Design of a virtual space and robot pairs

Each team used Zoom and Slack to discuss the virtual space they wanted to construct. As a result of these discussions, Team A decided to construct a train station, and Team B decided to construct a futuristic version of the

SIT campus. In addition, each student designed their own robot pairs to interact in the context of their team's virtual space. Students were required to design their robot pairs so that one robot in the pair was more kawaii than the other one.

3.3 Development of a virtual space and robot pairs

Each team began to collaborate on the development of their virtual space using Unity and each student began to construct robot pairs individually, also using Unity. Students could use the cloud platform provided by Unity to collaborate. Figure 2 shows the completed virtual spaces with example robot pairs. Based on previous knowledge about kawaii engineering [7, 8], each student selected an attribute to vary in order to make one robot in the pair more kawaii than the other robot. For example, in Figure 3 the right robot has a rounder head and more cylindric body compared with the robot on the left because previous work shows that rounder objects are generally perceived to be more kawaii.

3.4 Proposed evaluation items for virtual spaces and robot pairs

Each team collaborated to propose evaluation items, which were to be adjective pairs suitable to evaluate the affective values of the team's virtual space and robot pairs. Each team then presented their proposed evaluation items for the virtual space and robot pairs. Table 2 shows some examples of proposed evaluation items. The 4th robot pair in Table 2 (b) is the robot pair shown in Figure 3.

3.5 Evaluation of the virtual spaces and robot pairs

Using Google Forms, the first author developed an evaluation questionnaire for the virtual spaces and robot pairs based on each team's proposals. During each team's presentation of the virtual spaces and robot pairs, all the faculty organizers and all the students completed the questionnaire, in which the virtual spaces were evaluated absolutely, and robot pairs were evaluated relatively. The results of the analysis of the questionnaire will be described in the future by the SIT faculty [9].

In addition, we developed a more detailed questionnaire to evaluate the robot pairs in a research study. The details of this experiment and its results will be described in the future [10].

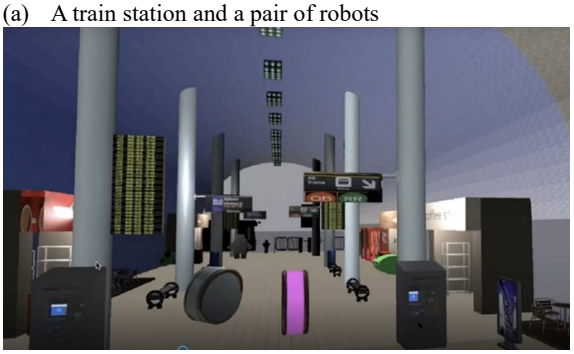
3.6 Summarizing the evaluation results

Each student team presented the evaluation results for their own virtual space and robot pairs.

4. DISCUSSION

As described in the Introduction, our original plan called for the students and professors from DePauw University to travel to SIT's Toyosu Campus in Tokyo. The students from DePauw University would have then collaborated with SIT students to design and build real

Figure 2: Examples of virtual spaces and robot pairs
(a) A train station and a pair of robots



(b) Future Toyosu Campus and a pair of robots

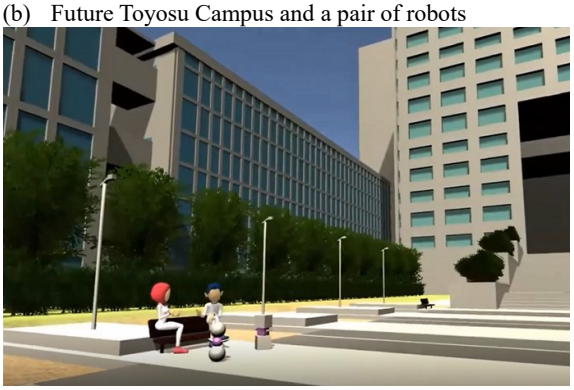


Figure 3: An example of a robot pair

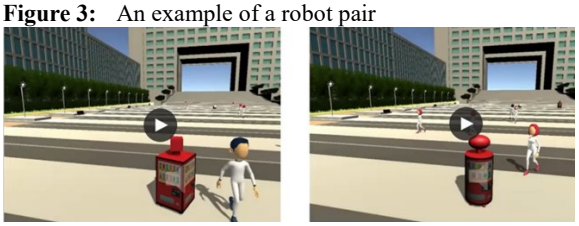


Table 2: Examples of evaluation items

(a) Space

SPACE	EVALUATION ITEMS
Station	Modern – Futuristic Innovative – Simple Realistic – Unrealistic
Future Toyosu Campus	Familiar – Unfamiliar Interesting – Boring Stylish – Plain

(b) Robot

ROBOT PAIR	EVALUATION ITEMS
1	Entertaining – Dull Approachable - Unapproachable
2	Friendly – Unfriendly Lovely - Unlovely
3	Cool – Not cool Enjoyable - Unenjoyable
4	Safe – Scary Warm – Cold

robots with kawaii appearances and behaviors. However, because of the COVID-19 pandemic, neither DePauw University students nor SIT students could enter the Toyosu Campus. Therefore, we designed a new remote collaboration approaches and activities. Based on our new plan, each student team designed and developed a virtual space using Unity. Each team discussed how to make virtual kawaii robots via Zoom and Slack. In addition, they proposed the evaluation items, evaluated their spaces and robot pairs, and summarized the results of the evaluation.

In our original plan, students would have visited exhibitions by Team Lab and other exhibitions related to modern Japanese culture, and they would have visited some universities including Osaka University and Kyoto Seika University. None of these activities could be realized. However, our design and implementation of new remote collaboration approaches and activities provided an enriching experience for each student. From May to July, students learned a lot about Kawaii Engineering and affective evaluation, which gave them a deeper understanding of Japanese culture from the viewpoint of Kansei/Affective Engineering. Quantitative evaluation of the virtual collaboration approach remains as future work.

5. CONCLUSION

Because of the COVID-19 pandemic, we had to change the targets of our 7-week collaboration from real robots to virtual robots. Based on our new plan, students designed virtual spaces with robot pairs, proposed evaluation items for them, evaluated them, and analyzed the results. For each robot pair, one robot was required to be more kawaii and the other to be less kawaii by changing an attribute such as shape. The evaluation items were required to be adjective pairs that were suitable to evaluate the affective values of the developed virtual space and robot pairs. Through the activities, students learned a lot about Kawaii Engineering and affective evaluation. Quantitative evaluation of the virtual collaboration approach remains as future work.

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