“Live within your role!”: 소셜 로봇의 커뮤니케이션 스타일이 사용자와의 동반자 관계에 미치는 영향

“Live within your role!”: The impact of communication style of social robot on companionship

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요약 본 연구는 기계와 사용자의 동반자 관계에 대한 고려 사항을 제시한 연구이다. 인간 – 로봇 관계가 중요해짐에 따라 로봇의 역할과 커뮤니케이션 스타일이 중요해졌다. 본 연구는 소셜 로봇의 커뮤니케이션 스타일을 어떻게 디자인해야하는지 보기 위해 사전 연구를 기반으로 시나리오를 생성했다. 예상되는 역할과 커뮤니케이션 스타일에 따라 4 가지 조건을 비교하기 위해 2x2 실험을 수행했다. 예상되는 역할을 지배력에 따라 역할을 담당하고 역할로 나눴다. 또한, 한 가지 조건에서 커뮤니케이션 스타일을 맞추었고 다른 한 가지에서는 일치하지 않게 설정했다. 연구 결과 커뮤니케이션 스타일과 일치하는 역할이 어떤 역할에서는 중요하지만 모든 역할에서 중요하지 않다는 것을 밝혔다. 본 연구는 HCI가 인간 – 컴퓨터 관계로 확장되며, 인간과 로봇 간의 교제에 대한 미래의 연구에 영감을 줄 것이다.

Abstract This paper provokes considerations on companionship. As human-robot relation becomes important, the role and communication styles of robot become crucial. In order to see how we should design communication styles of social robots, we generated scenarios based on pre-studies. Then, we conducted a 2x2 experiment to compare four different conditions by expected role and communication style. We divided expected roles into playing and serving role by dominance level. Also, we matched communication style on one condition and mismatched on the other. The results imply matching role with communication style is crucial in some role, however not in every role. As HCI expands to human-computer relation, our study would inspire future research on companionship between human and robots.

해심어: *Social robot, Companionship, Companion technology, Companion role, HRI, Interpersonal theory*

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1. Introduction

Social robots are becoming companions of human[1]. Social robots are characterized by behaving as social actor that understands and communicate in a humanlike way while they undertake certain tasks[3]. In a sense, as robot technology advances, human-robot communication comes to resemble interpersonal communication[13].

Interpersonal theories emphasize importance of role-taking in human-human relation[23]. role-taking refers to anticipating the responses of others implicated with one in some social act. Likewise, social robots would also play a role, forming certain relations with human[6]. Role Expectation toward another person and the fulfillment of it determines satisfaction of the relationship[27]. In this paper, we named expected role as what people anticipate from a certain social robot by its external characteristics.

Social roles are classified using the dominance as a major criterion[5]. Dominance has been defined as "the degree to which one actor attempts to regulate the behavior of the other"[9]. Dominance is usually identified as a key factor of psychological response to computers[17]. Therefore, we classified the roles of social robots into two categories: high and low dominance. In high dominance, a social robot is hierarchically equal to a user; in low dominance the robot is hierarchically lower than the user. We selected representing role examples in each dimension: playing role for high dominance and serving role for the other.

Previous studies in human-robot interaction dealt with dominance[14,19] however, more specific design in accordance with dominance level is not yet discussed in detail. We looked through dominance with communication style, as it is a keystone to building relations. Just as humans differ from each other in terms of characteristics, social robots are also distinguished by their communication style and appearance[15]. Therefore, we investigate the design of communication style depending on the role of robots.

Previous researches measured human-robot interaction by usefulness, ease of use, enjoyment and anthropomorphism[8]. However, previous measurements do not seem enough to measure relationship. As Benyon argues, human-computer interaction evolves to 'Human-companion relation'[1]. In this sense, in order to evaluate human-robot companion relation, we brought the concept and measurement of companionship from family and communication studies[11,22,27].

Our research questions are as follows: 1) how do different communication styles affect companionship? 2) Is there any difference between when communication styles match with expected roles vs. when mismatch? 3) If there is a difference, which affects more: in Expected Playing Role (EPR) or Expected Serving Role (ESR)?

2. Communication style

We have reviewed communication style constructs for robot companion comprehensively. As a result of literature reviews, ten constructs were found: cognitive autonomy, behavioral autonomy, trustworthiness, expertise, sharing activity, feeling, and interest, emotional& relational support, and practical support. Cognitive autonomy includes multiple-perspective-taking and inferential social reasoning [10]. Behavioral autonomy varies in definition: self-reliant behavior, intrinsically motivated behavior, and the ability to make independent decisions[21]. Trustworthiness means believability of a statement or object, whether it is unbiased and trustful[7]. Expertise is defined as "capability, knowledge, experience, and competency to capture the perceived knowledge and skill of the source"[25]. Sharing part can be classified into activity sharing, feeling sharing, and interest sharing[4,24]. Support part is composed of practical support, emotional support , and relational support[16,25].

In our previous study, we surveyed 67 participants to verify which constructs accord with each role[12]. Specifically, we showed companion robots in movie clips and asked the participants to scale importance of constructs for each role. As a result, the constructs for playing communication style are the following: cognitive autonomy, behavioral autonomy, activity sharing interest sharing and relational support. On the other hand, serving communication style includes: expertise, trustworthiness, feeling sharing, practical support, and emotional support are important.

With the result, we developed experiment scenarios of four conditions(Figure 1). To equalize the amount of stimulus, we adjusted the number of conversation sentences the same for each scenario.

We designed 2 (EPR, ESR) x 2 (Match, Mismatch) on companionship within-subjects factorial design. 'Matching' refers to a condition on which expected role and communication style align: playing communication style

Communication Style	Construct	Matched (Expected Playing Role)	Misatched (Expected Serving Role)
Playing Communication Style	Cognitive Autonomy	"I see the treasure is white in color. It'll be hard to find it from the bed, it's also white. Look carefully."	"Now it's time for the laundry, my friend."
	Behavioral Autonomy	"Let's go find it! I'll go this way, you go there."	"Let me show you the house. Follow me!"
	Activity Sharing	"How about we look inside the room? Can you please open the door for me, my friend?"	"How about we start from the bed? I cover the bottom, and you cover the other."
	Interest Sharing	"I love Sherlock Holmes! How about you?"	"What is your hobby? Do you like movies?"
	Relational Support	"We are the best friend forever."	"We are the perfect team."
		Matched (Expected Playing Role)	**Mismatched (Expected Serving Role)**
Serving Communication Style	Expertise	"I recognizw fatigue in your leg muscles. You'd better rest immediately"	"I'm expert hunter. As I'm small and fast, I am able to look for everywhere than anyone."
	Trustworthiness	"Please permit me to go. Only you can control me."	"I'll follow your orders, master."
	Feeling Sharing	"I can feel you are stresssed out. Sir, you should rest."	"How are you feeling today, master?"
	Practical Support	"You saved 2 minutes for finding the treasure."	"I've taken care of the house as you ordered."
	Emotional Support	"Don't worry and don't get nervous. I'll make you feel great as your best friend."	"I'm here for your happiness."

Figure 1. Conversation Scenario

matches with expected playing role and mismatches with expected serving role.

We recruited 23 participants via online and offline bulletin board. They were 7 males (30.4%) and 16 females (69.6%) and aged 19 to 32 (M=24.6, SD=3.4). After the experiment, we compensated the participants with $10 each.

We manipulated expected role with the type of device and the corresponding tasks. We chose the activities that best represent the characteristics of each device. For EPR, We selected a mini drone named Jumping Sumo from Parrot[18]. Jumping sumo is controlled by mobile application and has functions including rolls, rushes, zig-zags, circles, takes turns and jumping. For main activity, we generated user scenario of treasure hunt as EPR. And we chose ESR as a robot cleaner, Samsung Powerbot[20]. The robot vacuum cleaner is controlled by remote controller and it can either automatically clean a room or be moved to clean certain spots. The robot cleaner in the experiment was for housework.

Experiment: WOz

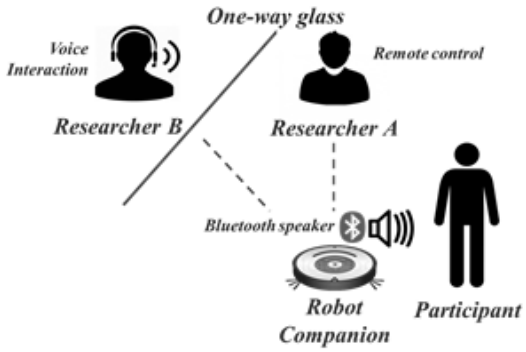

Figure 2. Wizard of Oz Design

We implemented an experiment Wizard-of-Oz(see figure 2). Researcher A operated devices with a remote controller and observed the participants during the experiment. Researcher B performed an intelligent agent that conversed with participants. The participants were told they were to talk with advanced social robots.

To derive natural conversations, we used two smartphones to call and talk with the participants. One was located in the middle of the room, and researcher B called to communicate with the participants each period. In this way, the researcher responded to the participants and conversed spontaneously as she was sitting at the observer room, hiding from the setting room. Participants communicated with the companion devices by hearing the researcher's voice through a bluetooth speaker attached to the devices. We designed a laboratory setting, which imitated a living room: a sofa, a bed, a microwave, a refrigerator, a washer, a drone and two tables were arranged.

Each participant experienced total four conditions. To

Figure 3. In the picture above the participant was served by powerbot and in the below she played treasure hunt with Jumping Sumo.

measure human-robot relation, we adopted companionship as a measurement concept companionship is comprised of attachment, commitment, and intimacy[11,22,27]. We measured companionship after each condition.

3. Results and Discussion

We excluded five participants who checked wrong in checking role questions in the survey. To analyze, we used repeated measure ANOVA.

The main effect of matching conditions on companionship showed statistical significance ($F(1, 17) = 26.337$, $p < .01$). However, the main effect of expected role on companionship was not statistically significant ($F(1, 17) = .016$, $p > .05$). The result indicates that companionship could be formed if communication style and expected role matched. The interaction effect of expected role and matching on companionship was also significant ($F(1, 17) = 9.108$, $p < .01$). As a result of paired samples t-test, when playing role was presented, difference of companionship between matching and mismatching was statistically significant ($t(22) = 6.061$, $p = .000$). However, in case of serving role, difference between matching and mismatching was not significant ($t(22) = -1.749$, $p > .05$).

The results implies that the condition of matching expected role with appropriate communication style would lead to building better human- robot companionship. Thus, we suggest that when designing a robot companion, designers define the expected role of it at first and appropriate communication style accordingly. More specifically, we showed how communication style could be designed in detail with role-related constructs. Future design studies could be conducted with the constructs we developed.

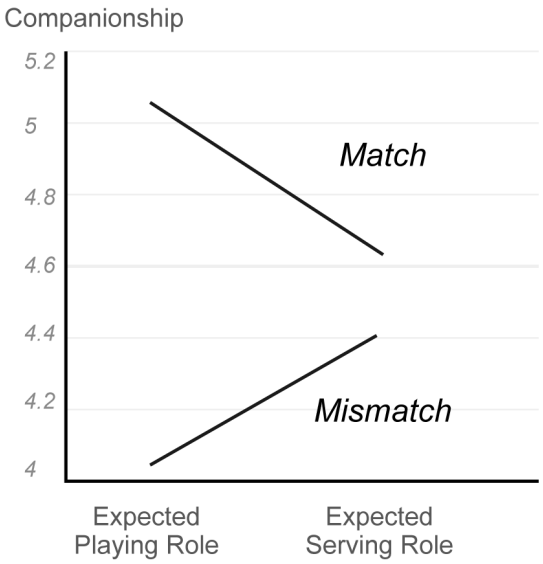

Figure 4. The result of Experiment

Interaction effect in EPR (Expected Playing Role) was statistically significant, while in ESR (Expected Serving Role) it was not. In other words, matching

communication style with ESR would not be a keystone in forming companionship. We could find clues from post-survey interviews. P3 said "If the device really understands me, I think this robot vacuum cleaner doesn't have to talk that much. It was noisy." P21 also said "It would be better if it served me with the simplest conversation." P14 said, "I thought that the robot vacuum cleaner was quite loyal but it did not clean the room perfectly. I think it's more important to do his own work than loyal or not."

Overall, participants were not satisfied with given conversation stimuli. Rather, they looked for completion of given tasks. We looked for previous studies regarding this matter. The studies regarding acceptance of social robot take hedonic/utilitarian approach[15,17]. They divide task performed by robot into two categories: hedonic task and utilitarian task. In this perspective, we interpret the participants recognized ESR as utilitarian. Utilitarian logic pinpoints how well a task is performed and completed. Likewise, communication style might not have been a

determinant factor of companionship with serving robots.

The result has several practical implications. When customizing robots, oftentimes practitioners have problems deciding allocation of limited resources. Regarding the impact of communication style on expected role, especially designers should treat social robots differently by its role. We suggest that when designing communication style for playing robot companion, communication style should be invested and developed with precision more than serving robot companion.

4. Limitations and future work

Even though the experiment result implies interesting insights, our study has several limitations. First, evaluating companionship through controlled environment could have drawn unnatural behavior from participants. Although the experimental setting imitated a real house, still it could be felt unfamiliar. Thus, in order to spur natural interaction with companion device, future study should be implemented in real home context, for example , in houses of participants.

Secondly, we conducted the experiment for only short period of timeframe. In terms of relationship, according to some researchers, long-term study is essential[2]. Thus, we need to evaluate robot usage for longer period of time.

In this pilot study, we divided roles by dominance. Furthermore, there are other dimensions regarding classification of role-taking. For instance, we can classify role of robot companion by affiliation level or utilitarian/hedonic.

Finally, we suggested companionship as a construct of relationship between human and robot companion. In the future, we will search for its meaning with psychological well-being.

5. Conclusion

In this paper, we viewed upon human-robot relation, which is evolving more like interpersonal relationship. We divided expected roles into playing and serving role by dominance level. To measure companionship of different roles, we implemented the experiment with conversational stimuli. As the result shows, matching expected role with conversation style is indeed important. Above all, we would like to emphasize how a relationship should be measured with companionship and how conversation styles could be designed. As HCI expands to human-computer relation, our study would inspire future research on companionship between human and robots.

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