Effect of Haptic Perception on Remote Human-Pet Interaction

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Abstract. Even when a pet owner is away from his/her pet, he/she often wants to feel closer to the pet. The purpose of this study is to provide a means for the pet owner to feel the presence of his/her pet even when away from it; this is achieved by exchange of haptic feedback. In this paper, we describe such a remote haptic interaction system that consists of haptic devices for remote haptic communication; we also utilize tablets for video chat. A pet owner and his/her pet can feel closer to one another via haptic responses generated by corresponding haptic device. Two experimental evaluations were conducted to compare interactions between a pet owner and his/her pet using our system with another interactions achieved only via video chat. Results showed that these remote haptic interactions increased the pet owner's feeling of communicating with his/her pet. In general, pet owners reported feeling closer to their pet by using our system.

Keywords: haptic interaction, remote interaction, pet interaction.

1 Introduction

Many individuals and families have pets and often treat their pets as their family members. While pet owners are away from their pets, they still wish to interact with them. Therefore, some systems have been proposed to enable such interactions using video and audio devices [1,2]. With these systems, pet owners can enjoy watching the movements of their pets or listening to their pets' sounds. However, these systems lack an important perception, i.e., haptic perception. Haptic perception has an important role in the interaction between owners and pets.

Lee et al. introduced a haptic interaction system between a pet chicken and its owner [3]. The pet chicken wore a special jacket that reproduced the touching sensation of its owner. A pet doll that resembles the chicken was positioned in front of the pet owner. When the pet owner touched the pet doll, the touch signals were transmitted to the pet chicken through the special jacket. Further, the owner wore a special shoe that transmitted movements of the chicken as mild muscle stimulations. With this system, the owner could transmit touching sensations to his/her pet chicken. However, it seems difficult for the owner to associate the movements of the chicken with his/her touch actions.

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The purpose of our study is to give pet owners a greater ability to feel the presence of their pets while away from them by the exchange of haptic feedback. In this paper, we propose a remote haptic interaction system for owners and their pet dogs. As a typical example for using our system, we assume that owners and their dogs often pull dog treats and toys between each other. We conducted experiments to evaluate the effects of haptic perception on the interaction between the owners and spatially separated their dogs.

2 Remote Haptic Interaction System

As shown in Fig. 1, our system consists of haptic devices for transmitting force feedback between them and video/audio devices for exchanging video images and sounds. Novint Falcons [4] are used as haptic devices and Apple iPads [5] are used as video/audio devices.

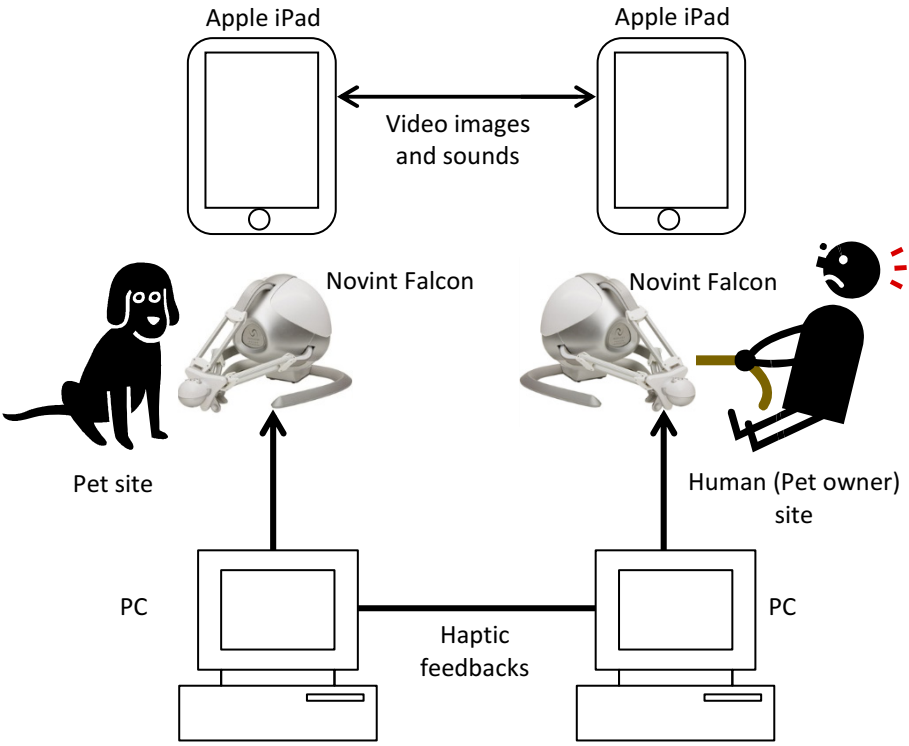

Fig. 1. Haptic devices for transmitting force feedback between a pet dog and the owner and video/audio devices for exchanging video images and sounds

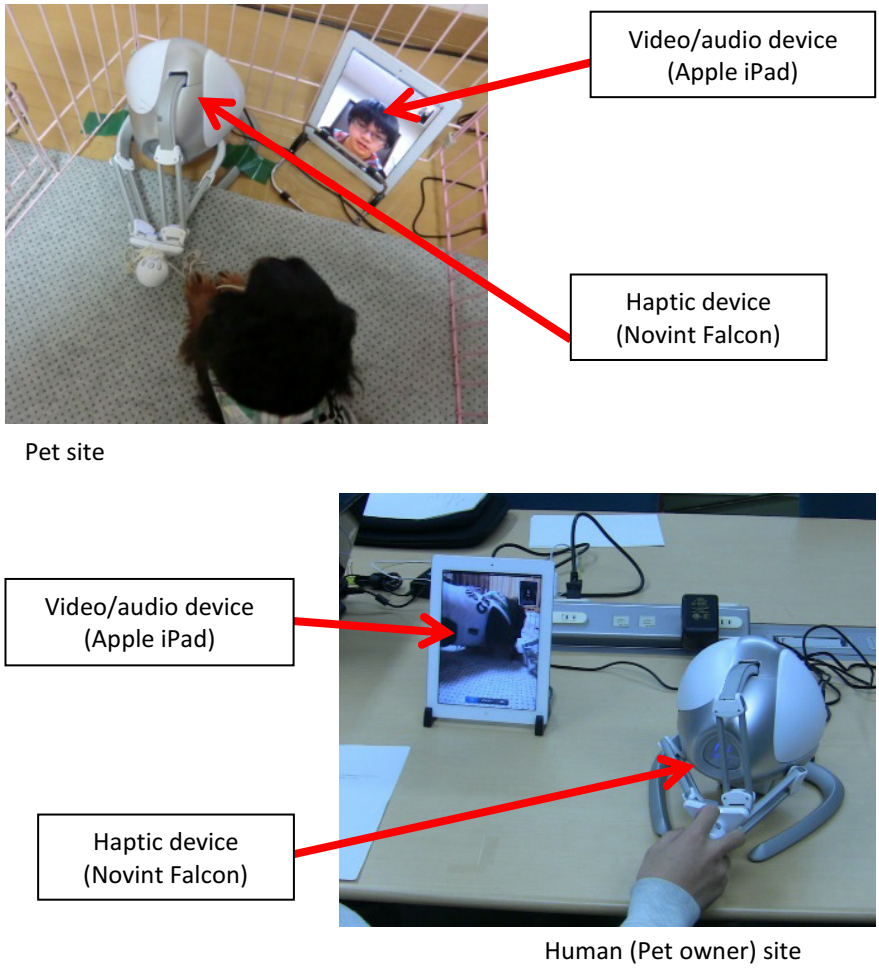

Fig. 2. Devices used in realizing our remote haptic interaction system between a pet dog and the owner

When a user manipulates the haptic device, the corresponding haptic device with the pet dog moves in sync with the user's device. The dog's pulling movement of the haptic device is transmitted to the haptic device with the user. Thus, the user and the dog both feel haptic perception of pulling each other. Further, both the dog and the user can see each other while manipulating the haptic device. Consequently, the user feels that the dog, even though away from him/her, is close to him/her via the exchange of haptic, video and audio feedbacks. Fig. 2 shows devices used in realizing our remote haptic interaction system between a pet dog and the owner.

3 Experiments

To evaluate the effectiveness of haptic perception, two types of interaction systems were used in our experiments. The first system was our proposed remote haptic interaction system, which consisted of a haptic device and a video/audio device; we denote this as "haptic system." The second system consisted only of a video/audio device, which we denote as "video/audio system."

When a participant used the haptic system, dog treats were attached to the haptic device for a dog to allow the participant and the dog to play by pulling the dog treats together, as shown in Fig. 3. In our experiments, participants were asked to interact with a pet dog.

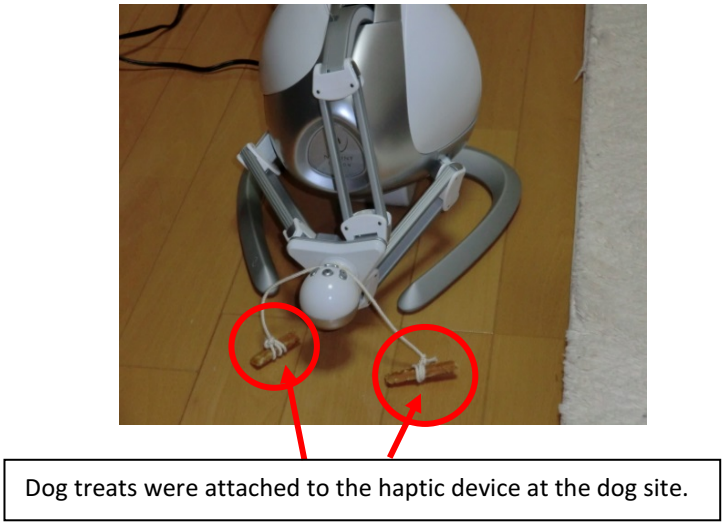

Fig. 3. A haptic device with dog treats attached

3.1 Experiment 1: Interaction between Pet Owners and Their Pet Dog

We selected three volunteers to participate in this experiment. The participants were a pet owner, his wife and his daughter. They were asked to repeat the following task three times.

1. Play with their dog using the haptic system for 3 min
2. Answer a questionnaire for subjective evaluation
3. Play with their dog using the video/audio system for 3 min
4. Again answer a questionnaire for subjective evaluation

In the questionnaires, the participants were asked to rate the following statements using a scale of 1–5.

1. You felt like communicating with your dog (1: disagree–5: agree)
2. You felt the presence of your dog (1: disagree–5: agree)
3. Which was the more satisfying system, the video/audio system or the haptic system? (1: video/audio–5: haptic)
4. Which system would you like to use to feel the presence of your dog, the video/audio system or the haptic system? (1: video/audio–5: haptic)

3.2 Experiment 2: Interaction between Non-pet Owners and an Unknown Dog

Ten volunteers from our university were selected as participants in this experiment. Each participant was asked to perform the task below with an unknown dog. The dog was the same dog used in Experiment 1.

1. Play with the dog using the video/audio system for 3 min
2. Answer a questionnaire for subjective evaluation
3. Play with the dog using the haptic system for 3 min
4. Answer a questionnaire for subjective evaluation
5. Play with the dog using the video/audio again for 3 min
6. Answer a questionnaire for subjective evaluation

The reason for asking the participants to use the video/audio system twice was to confirm the differences between before and after experiencing the haptic system. In the questionnaires, participants were asked to rate the following statements using a scale of 1–5.

1. You felt like communicating with your dog (1: disagree–5: agree)
2. You felt the presence of the dog (1: disagree–5: agree)
3. Please arrange the following systems in the order in which you most strongly felt the presence of the dog:

- the video/audio system (1st time)
- the haptic system
- the video/audio system (2nd time)

4 Results

Fig. 4 shows the results of our questionnaires used in Experiment 1. As shown in the figure, participants felt communication with the haptic system was more effective than that with the video/audio system. The average score of questionnaire question #3 was 3.67; similarly, the average score of questionnaire question #4 was 4.11. These results indicate that participants preferred the haptic system over the video/audio system. Further, in our observations, there were few responses from the dog with the video/audio system, whereas with the haptic system, the dog and the participant actively pulled the haptic device. Participants felt that they were just looking at the dog when they used the video/audio system; conversely, with the haptic system, they felt the responses of the dog. Hence, we conclude that the evaluated values of the haptic system were higher than that of the video/audio system.

Fig. 5 shows the results of the questionnaires used in Experiment 2. As with Experiment 1, the evaluated values of the haptic system were higher than that of the video/audio system. In particular, there was a significant difference ($F(2,18) = 8.870$, $p < 0.01$) in the evaluation of the statement, "You felt like communicating with your dog." Further, the evaluated value of the video/audio system on the second use was rarely different than that of the video/audio system on the first use. Results of questionnaire question #3 showed that nine participants felt the presence of the dog to be strongest when they used the haptic system.

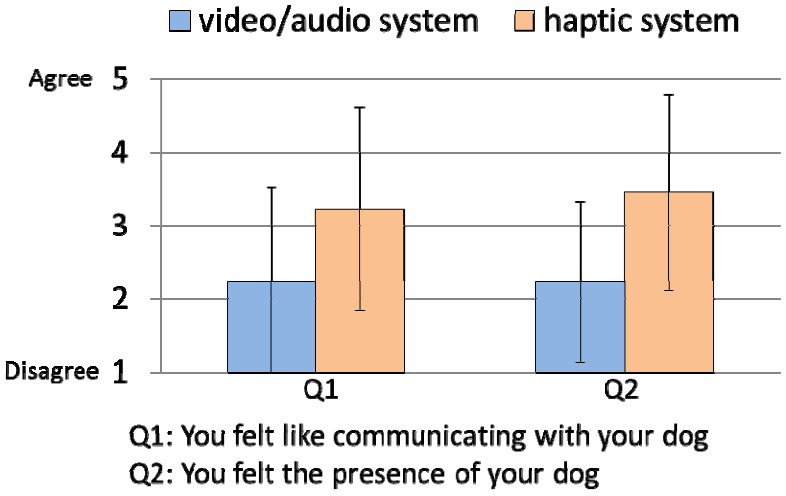

Fig. 4. Results of the questionnaires used in Experiment 1 (pet owners)

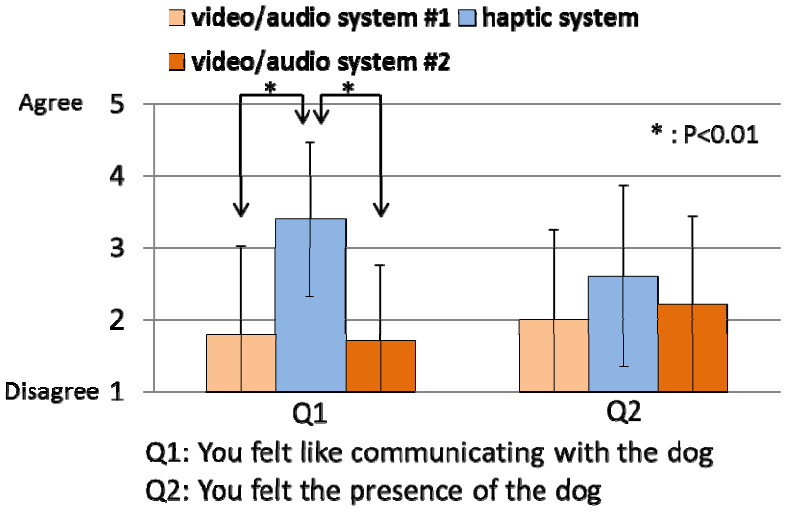

Fig. 5. Results of the questionnaires used in Experiment 2 (non-pet owners)

These results show that transmitting the force feedback of pulling the dog treats between one another enhanced the feeling of communication between the humans and the dog, even if there was no prior relationship between the human and dog.

Unlike human-to-human communication, pet owners cannot verbally communicate with their pets. Therefore, haptic interaction is an important approach that enhances communication between pet owners and their pets. From our experimental results, we believe that the haptic interaction is effective for human-pet interactions over long distances.

5 Conclusion

The purpose of this study was to provide pet owners a means to feel the presence of their pet, even when away from them, by exchanging haptic feedbacks with one another. In this paper, as a typical example of using our system, we assumed that pet owners and their dogs pulled dog treats and toys between each other. Therefore, we developed a remote haptic interaction system that consisted of haptic devices for remote haptic communication and tablet computers for video/audio communication. We conducted two experiments to evaluate the effectiveness of haptic interactions by comparing our haptic interaction system to a system with only video/audio devices. Results showed that remote haptic interaction increased pet owner's feelings of communicating with his/her pet. Moreover, the pet owner reported feeling the presence of his/her dog with haptic interaction.

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