

Petbe: Projecting a Real Being onto a Social Robot using Contextual Data for a Pet Monitoring Method

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ABSTRACT

The demand for pet monitoring devices is growing due to the increasing number of one-person households raising pets. However, current monitoring methods using video camera entail various problems, which may lead to discontinued usage. To overcome this problem, we propose Petbe, a social robot that projects your own pet using a context-aware approach based on BLE beacons and Raspberry Pis. The corresponding smartphone application provides various robot status updates (robot head) and movements (robot body). With the development of Petbe, we conducted an exploratory study to verify the advancement of the above issues on monitoring user's own pets with the following factors: privacy concern, companionship, awareness, connectivity, and satisfaction. The outcomes indicate that Petbe helps to reduce privacy concerns and build companionship through empathetic interaction.

CCS CONCEPTS

• **Human-centered computing** → **Contextual design**; *Empirical studies in interaction design*; Mobile devices.

KEYWORDS

Social Robot; Context aware; Pet Monitoring; Projection

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1 INTRODUCTION

As the number of one-person households is increasing, some are experiencing psychological issues such as depression, loneliness, and lack of social interaction. They are trying to address these issues through raising pets, as studies have shown that doing so may be helpful in dealing with such problems [4, 7]. Accordingly, various pet-related IoT devices have been developed to provide a monitoring function for people who leave their pet alone at home for long periods during the day [6, 9, 11]. However, most of these

products are based on a built-in camera to let users monitor their pet while they are out for work. The built-in cameras have caused various issues related to privacy concerns and lack of awareness of the system presence, which leads to anxiety and discontinued usage of the product [1, 2, 5, 8, 12, 13].

Therefore, this paper proposes Petbe (see Figure 1) as a social robot that projects a user's own pet to overcome negative issues of current monitoring methods through cameras. First, for relieving user's privacy concerns, we designed Petbe to use context-aware technology for tracking pet-related home events in real-time. To accomplish this, the Raspberry Pi and BLE beacon are used to implement indoor tracking, and all the outputs from tracking are saved as in text format instead of video or image. Next, with the insights from the online survey from 51 people of their pet monitoring experience, we assigned five set of status-location pairs (e.g. Normal, Eating, Waiting, Sleeping, Making Trouble) to project pets onto a social robot. Users can monitor their pet through the Petbe body interactions and facial expressions. We conducted an exploratory study with in-depth individual interview, showing that the monitoring method through a social robot successfully relieved users' anxiety and developing a companionable relationship.

2 PETBE SYSTEM DESIGN

We used Raspberry Pi Zero W, HS-311 servo motor and 3D printed body frame for Petbe body and developed an Android application for Petbe face. Since the Petbe is targeted to people such as student or office worker, who are sitting long period at the desk and uses computer while working, we designed Petbe's neck on the body as a smartphone holder so users can interact with Petbe while working, motivating them to use Petbe.

To project the pet on Petbe, we used pets' behavioral tendencies and status categories from the survey. The survey showed that pets have common actions and were trained to do some actions in specific locations. We analyzed these actions and locations with some assistance from veterinary medical students, arranging the actions and locations by indicated owner priority. Then, we implemented an in-door pet tracking system by calculating distance with the signal strength of BLE beacon in Raspberry Pi.

Finally, we presented these status into Petbe by using facial and body interaction. As Melson et al. [10] indicated that the actions of these stimuli are important for users to understand what the social robot is doing and expressing, we designed stimuli for each part to make Petbe's interaction easily understandable and alive. Thus, we added eye blinking to the application UI and developed Petbe body movement with a servo motor to let users know Petbe is working and to cause them to perceive it as a living being [3].

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Pet status	When status changes	When touch event occurs
Normal		
Eating		
Waiting		
Sleeping		
Trouble		

Table 1: Petbe body actions for status changes or touch events. Dotted lines show the movement, and bold lines indicate the final Petbe neck pose. (Video: <http://bit.ly/2N0rO6P>)

Also, we designed Petbe to move its head when the status changed or when the user touched it (see Table 1).

3 EVALUATION METHOD

We conducted an exploratory field study to verify whether Petbe had achieved our goals and successfully addressed the problems identified in the existing monitoring method. Total 6-people, who raise pet and leaves home for more than 7-hours daily, participated to the study and paid \$45. We analyzed log and interview data to get a sense of participants’ reactions and evaluation of their 3-day experience. We organized these results in terms of privacy concerns, companionship, awareness, connectivity, and satisfaction.

4 DISCUSSION

We identified some insights and factors that we aimed for when we designed Petbe from the field study data. Participants commented that Petbe has improved the sense of privacy and companionship as compared to the previous monitoring method with video. However, each participant had very different perspectives on awareness, connectivity, and satisfaction. Participants indicated that Petbe had accomplished some parts of each factor but had some points that were weaker than those of the previous method.

First, our findings from exploratory research show that Petbe had a relieving effect on privacy concerns compared to monitoring with a camera-embedded IoT product. In particular, participants



Figure 1: Black-, brown-, and white-toned Petbe bodies with color-matched smartphone application face UI.

perceived Petbe’s sensors as less threatening in regards to privacy concerns than using cameras. In addition, they perceived their privacy to be protected because the data types logged by Petbe were all related only to their pets.

Secondly, Petbe has formed more relational effects than current IoT products with cameras. The interesting point is that participants perceived Petbe as being like their own pet because of expressions of contextual situations such as eating behavior. Furthermore, they said that Petbe’s interface induced them to perceive it as empathetic experiences, like those they might have with their own pets.

In terms of awareness, participants perceived Petbe more often and were more aware of its presence than when viewing video from a camera. In particular, participants tended to interact with Petbe more than the monitoring application. We can explain that they wanted to interact with their own pet more positively through Petbe because of experiencing sensory modalities like visual expressions and motions.

Lastly, both Petbe and the previous monitoring method with a camera were evaluated similarly in terms of connectivity and satisfaction from interview comments. However, we could find some interesting details about these factors. Participants were satisfied with Petbe providing pet statuses in an easy and directly understandable way while they are busy working. They liked the appearance of Petbe’s face and movement interactions, but they also wanted a real image of their pet.

5 CONCLUSION

Through the study of Petbe, we confirmed the possibility of providing not only an experience of interaction with social robots, but also the mediation role of a mutual relationship with someone or something else, like a pet. Future studies will investigate how to overcome various inconvenient issues that participants mentioned, for example, providing more pet status options such as using the toilet or playing and implementing bidirectional interaction. With these improvements, we are planning to conduct an extended period of user research to compare pet type social robot with and without projection of real being to get a variety of views and evaluations of Petbe system design.

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