Facilitating Unmotivated Tasks Based on Affection for Virtual Pet

Kaori Fujinami
Daily Life Computing Laboratory
Department of Computer and Information Sciences
Tokyo University of Agriculture and Technology
Tokyo, Japan
fujinami@cc.tuat.ac.jp

***Abstract*—In our daily lives, some tasks are burdensome for people and are not willing to do them; however, people often do such tasks for their pets even though they are tired or busy due to affection for the pets. In this paper, we introduce a virtual pet to establish and maintain close relationship with the user to foster a similar feeling with real pets, and a platform for Android OS-based smartphone is developed. Particularly, we show an experiment to investigate the effect of reflective behavior of a virtual pet in increasing affection and accepting requests from the virtual pet, in which activity data collection for supervised-machine learning was chosen as an example of bothersome task. As a result, we confirmed that the reflective behavior significantly contributed to increase affection for the virtual pet, but acceptance rate of a task request did not increased, compared with a non-reflective one.**

***Index Terms*—Virtual pet, Persuasion, Supervised-learning, Annotation**

I. Introduction

In our daily lives, some tasks are burdensome for people. For example, sorting and tagging hundreds of digital photos taken during a trip is a burdensome task. People need to have strong motivation to start and continue to do such tasks. On the other side, people often do burdensome tasks for their companion animals even though they are tired or busy. For example, they take their dogs on regular walks and feed them even if the owners are tired. We consider that this is because of intimacy for the pet and that this altruistic behavior might also be seen in the relationship with artifacts with intimacy, which is based on a report that people reconfigured their homes so that robotic cleaners (Roombas) could complete their missions [1]. Thus, we apply a metaphor of companion animals to maintain close relationship between the user and the device, in which a virtual pet exists in a home screen of a smartphone.

In this paper, we show a platform for intimacy-driven persuasion for bothersome tasks called vPet system, which is built on top of Android OS and the LiveWallpaper system. In our earlier report [2], we found a potential of the affection-driven persuasion for bothersome work by comparing a task supported by virtual pet just talking about itself with a task without a virtual pet (completely depending on the user's motivation). In this paper, we examine the effect of behavior of the virtual pet that reflects the owner's recent activities; the virtual pet talks to the owner about various topic depending on the owner's activities, e.g., about a picture when a camera application was used, to foster intimacy. A user study is carried out to examine if the reflective behaviors of the virtual pet increase the affection for the virtual pet as well as the users can be motivated to do a bothersome task. The rest of the paper is organized as follows. Section II shows related work, while, in Section III, we describes the design and implementation of vPet system. A four week user study is presented in Section IV, followed by the discussion in Section V. Finally, Section VI concludes the paper.

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II. Related Work

Various methods exist to motivate people to carry out bothersome or less meaningful tasks. Gamification, a concept that adds enthusiasm-promoting elements of games to services and systems [3], is intended to maintain and improve users' motivation with incentives such as a sense of accomplishment to reach particular stages and a competitive spirit. Gamification is applied into a wide range of application domains; for example, environmental data collection in a context of human-centric sensing [4] [5], improving worker's motivation in an office work context [6], improving sedentary lifestyle, reducing wasted resource consumption. The source of motivation in vPet system is *affection* for the virtual pet, rather than competing with other people who play the same game.

Another approach is to use computers as persuasive media, in which a persuasive computer changes the attitude or behaviors of a person using interaction with the person [7]. Major application domains include behavior change for healthier lifestyle [8] [9] and resource savings [10] [11] [12]. In persuasive systems, ambient displays [13] are popular to deliver persuasive messages intuitively as well as implicitly with a metaphor of target resources [9] [12] or with subtle change of shape and color of the display itself [14] [11]. Namely, the persuasive messages are feedbacks to the user's behaviors and thus domain-specific. By contrast, people can also be persuaded through conversation with embodied agents. Relational agent [15] is defined "as computational artifacts designed to establish and maintain long-term social-emotional

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relationships with their users". It uses various relational strategies that people do in face-to-face conversation including hand gestures, change of posture, and facial animations as well as conversations. Our vPet system is also designed to handle emotional relationships with the user and thus strongly relates to relational agents; however, a difference is that, unlike relational agent that is based on human-to-human relationship, vPet is based on the relationship with companion animals. So, the feeling on the virtual pet is something "non-negligible", rather than respectful, likable, and trustful that are established by relational agents.

III. vPet System Design and Implementation

A. Strategies of Increasing Affection

The strategies to increase affection for a virtual pet are driven by two theories of social psychology. The attitudinal effects of mere exposure [16] indicates that offering a feeling of being always with the user is effective to increase affection. So, we decided to realize the system as a smartphone application; especially, the virtual pet appears in the home screen, similar to the notion of "glanceable display" [8]. In addition, the principle of reciprocity [17] suggests that the showing interests to an individual emerges a positive emotional effect on the person. So, a mechanism to make the user feel "being interested" is introduced. From the point of view of an application, various tasks should be incorporated into the vPet system without any or with limited effort for adaptation.

B. Appearances and Behaviors of Virtual Pet

We designed the appearance of the virtual pet to be an animal type-neutral, rather than using a particular type of animal such as a dog and a cat. To determine the appearance of the virtual pet, we asked 11 university students to rank three types of appearance according to their preference: basic circular, lean, and flat forms as shown in Fig. 1. As a result, the basic type with a circular form was preferred most. So, we determined to use type a) painted in warm color as a base appearance, which changes according to the behavior of the virtual pet.

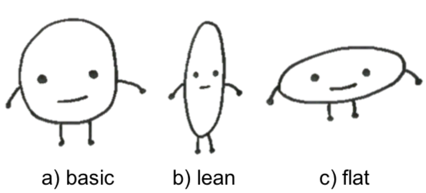

Fig. 1. Candidates of the appearance of virtual pet

As described above, the virtual pet "lives" in a user's smartphone to increase a feeling of being always with the user, and changes the appearance according to its activities and emotional states. A balloon can be added to express talking and request to the user. Some activities of the virtual pet reflect the user's activities to facilitate a feeling of "being interested in the user" such as taking a picture and asking what the user took when the user actually took pictures, and expressing gratitude for the acceptance of a task request. The user can also interact with the virtual pet explicitly by touching its body, in which the virtual pet reacts to the action by happy facial expression and words. Other activities are, for example, sleeping in bed at night and resting on a sofa with a cup of tea. Some examples are shown in Fig. 2. In all cases, the facial expression and gestures are presented in an animated manner to allow the user feel it alive (See Fig. 3). A long sentence is divided into several phrases and shown in different frames. Fig. 2 a) shows one of phrases.

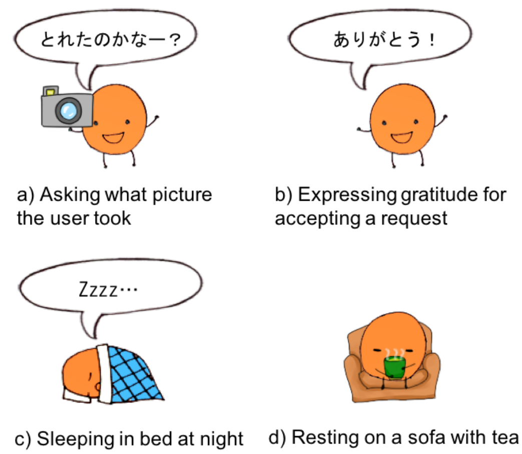

Fig. 2. Example expressions of activities and emotional states of virtual pet

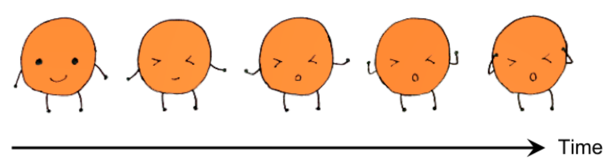

Fig. 3. Example of animated expression (showing regret for rejecting a task request).

C. Functional Components

Fig. 4 illustrates a functional component diagram of vPet system, in which a dark and white rectangles indicate task-dependent functionality and task-independent, i.e., system's core, functionality, respectively. The figure includes two processes: facilitating intimacy with a virtual pet and requesting particular tasks. In the former process, four components are involved: 1) User Status Detector, 2) vPet Controller, 3) Behavior Chooser, and 4) User Interface. By contrast, the latter process handles an event of requesting a particular task to a user, in which six components are involved: 5) Requester, 3) Behavior Chooser, 4) User Interface, 2) vPet Controller, 6) External Application Invoker (ExtAppInvoker), and 7) external application's user interface.

1) User Status Detector: This functionality is responsible for detecting implicit interaction with the smartphone terminal to determine the behavior of the virtual pet. Two types of implicit interaction are supported: i) arriving at and leaving particular place, and ii) utilizing particular types of applications, which are intended to facilitate the effect of the principle of reciprocity. As special places, the user's home and office are supported by the system.

2) vPet Controller: A change of user's status and a user's attitude toward a virtual pet, as well as a request for particular task, is handled to change the behavior of virtual pet. In addition, a task-specific application's user interface is invoked through ExtAppInvoker if a request for a particular task is accepted by a user.

3) Behavior Chooser: The appearance and utterance of a virtual pet is determined based on the implicit and explicit interaction with the user, a request for task, and spontaneous trigger from an internal clock.

4) vPet User Interface: The decision on a behavior of the virtual pet is directed to User Interface of vPet system, which actually shows a virtual pet. An attitude of accepting the request is expressed by tapping the body of the virtual pet, while rejection is detected by ignoring the request for certain period of time. Also, a user can touch the body of the virtual pet at any time. In either case, the status is sent to vPet Controller to reflect the behavior of the virtual pet.

5) Requester: In the task request process, various applications can become a task requester, which includes, for example, the ones that asks a user to do exercise and that request a user to annotate an unknown data segment for online classifier training based on an active-learning principle. Each application has dedicated timing for requesting a user and notifies the timing of vPet Controller.

6) External Application Invoker (ExtAppInvoker): A developer who wish to add a task-specific user interface needs to implement this component to keep the vPet system task independent. vPet Controller sends an requester (application) ID to dedicated invoker, and the corresponding application user interface is finally invoked.

7) Task-specific User Interface: Each task has dedicated user interface to instruct a user what to do. This may form a mere textual or graphical description, otherwise a particular smartphone application such as a photo album and a data collection tool.

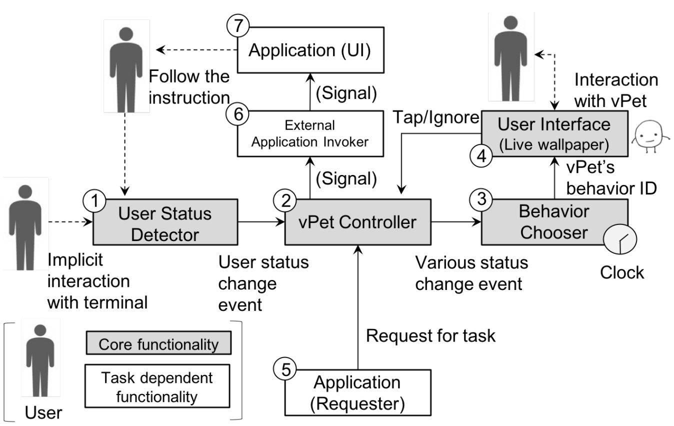

Fig. 4. Functional Component Diagram of vPet System

D. Implementation

In User Status Detector, the change of place of the user (smartphone) is detected by referring current SSID of WiFi access points or cell tower IDs to registered ones. A simple application was also developed to help the user register the information by just one tapping. The use of applications is detected by finding "keywords" for particular types of applications in a log stream provided by Android OS, i.e., `logcat`. Every time an application is invoked, a string tagged with `ActivityManager` is generated in the log stream, which contains a variable `cmp` and the name of Android application (Activity) class as the value. Examples are shown in Table I. In total, 15 applications pre-installed into five models of smartphone terminals were supported. Note that `logcat` needs to be checked when a new application is supported because the strings are developer-dependent.

TABLE I
EXAMPLES OF APPLICATIONS AND THEIR ACTIVITY CLASSES

Application	Activity class (ActivityManager: ..... cmp=xxx)
Facebook	com.facebook.katana/.LoginActivity
Telephone	com.android.contacts/.DialtactsActivity
Camera	com.android.camera/.Camera

To realize the attitudinal effects of mere exposure, the user interface is realized as LiveWallpaper supported by Android 2.1 or higher. LiveWallpaper is not a static wallpaper, but can show animation and accept an input from a user.

Requester is implemented as an independent `Service` in Android, which issues an `Intent` to vPet Controller so that it can forward an event of status change to Behavior Controller. vPet UI were designed to show task-independent behaviors by asking the user "Hey, may I ask you a task?". Therefore, any task request can be handled without affecting vPet system.

ExtAppInvoker was introduced so that vPet system can be independent of task-specific UI. vPet Controller issues a special `Intent` with a parameter `Action=START_DOTASK`. When ExAppInvoker, which is a task-dependent component, receives the `Intent` from vPet Controller, `Activity` (UI) for corresponding task is executed. External App. Invoker is responsible for judging the completion of a requested task and sends another `Intent` with a parameter `Action=DOTASK`. The information about task completion is utilized to change the behavior of the virtual pet to look happy as a positive feedback to the user. The completion can be judged, for example, by counting the number of steps based on accelerometer readings for a task of walking exercise or by finding a specific keyword in `logcat` log stream for a task of data collection for supervised machine learning using a dedicated tool. This mechanism enables vPet system to be independent of particular task; only the invoker needs to be customized for a particular application. Note that the current implementation of `Intent` does not contain the information of a task, which makes it impossible to invoke a task UI at a different timing. To address this issue, a task ID needs to be embedded in an `Intent` issues from Requester and carry over the ID to ExAppInvoker.

IV. User Study

A. Objectives

A user study was carried out to answer the following questions:

RQ1: Does the behaviors of the virtual pet that reflect the user's activities increase affection for it?

RQ2: Does the reflective behaviors contribute to motivate the user to do a particular task?

B. Methodology

Two types of the virtual pet were developed. One type of the virtual pet reflects the user's activities. The other type does not have such reflective property, but just presents its behavior randomly, i.e., a control group. These two types are referred to as "REF" and "CTL".

Seven persons (20's, four males and three females, and six university students and one office worker) participated into the experiment who use Android smartphones. The participants used their own terminals because we would like to make a situation where the users interact with the virtual pet in their daily livings.

The seven participants were divided into two groups: one group (three persons) uses REF for the first two weeks followed by CTL for two weeks, while the other group (four persons) uses the two systems in a different order to counterbalance the effect of order of experience. The number of requests, acceptances, and completed tasks were recorded in the system. At the end of every week a questionnaire survey based on the Companion Animal Semantic differential (CAS) [18] was conducted to assess the level of affection. CAS was inherently developed to assess the perception of a childhood companion animals using 18 bipolar semantic differential word pairs with rating from 1 to 6. The word pairs include Loving–Not Loving, Friendly–Not Friendly, and Sweet–Bitter, for example. The sum of the rating for 18 word pairs were used for assessment, in which the lower the value the more the person has affection for the companion animal. Additionally, the participants were asked to answer the impression on the reflective behaviors of the virtual pet.

C. Task in the Experiment

Data collection for supervised machine-learning classifier was chosen as a task in the experiment because people are generally unmotivated to do such a burdensome task. Similar to what persuasive technologies can motivate people to do exercise and save wasteful energy, those who consider labeling sensor data as burdensome or unnecessary could be changed their minds with proper support from the system. In this experiment, the dataset to recognize the position of a portable device on the body was collected; the participants were asked to store their terminals in a specific position and performed an activity for 20 seconds. Note that the participants could choose the position and activity from one of five positions and six activities, respectively.

Acceleration data were recorded in the background, and the name of storing position was added as a label. The frequency of request from the virtual pet was set to 7 times per day to collect all combination of positions and activities, i.e., 5×6, assuming an acceptance rate of 60%, i.e., 30 times of data collection per day. We consider that data collection is a suitable task for the system because the data collection and labeling is relevant yet cumbersome task that people usually do not carry out in their daily lives and thus do not find it valuable at the beginning.

We utilized a data collection tool HASCLogger as a task-specific UI and developed App. Invoker by ourselves. Requestor generates a request for task once an hour in the daytime, and App. Invoker is invoked by vPet Controller once a user accepts the request (Fig. 5 left). When the participant taps a button "invoke", HASCLogger application is invoked (Fig. 5 right). In case of spontaneous task execution, the participant just start App. Invoker by him/herself. The completion of a task is detected by App. Invoker by monitoring a special word "HascLogInfo" in the log stream of `logcat` that was generated by HASCLogger when it finishes recording. The completion of a task is regarded as a change of the user status and handled in User Status Detector.

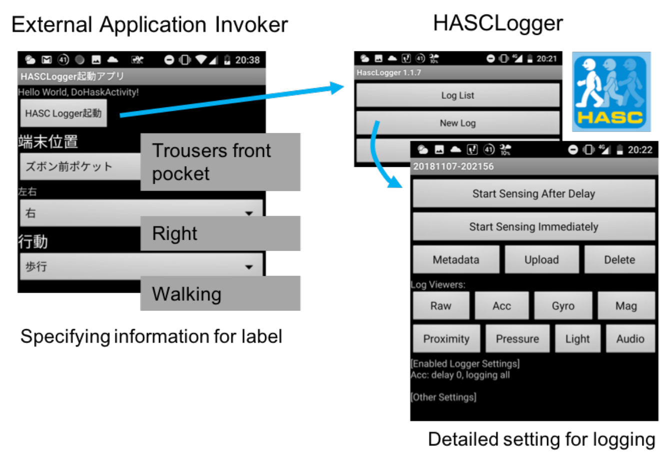

Fig. 5. User Interfaces of External Application Invoker (left) and External Application (HASCLogger, right)

D. Result

1) CAS Score: We show if the CAS scores of REF condition are lower than that of CTL, which is to confirm the effect of reflecting the user's states in the behavior of the virtual pet in increasing the level of affection for the virtual pet. As described above, the order of testing two conditions REF and CTL were counterbalanced in the two groups. To examine if the order of condition had an impact on the CAS score, we carried out a Fisher's exact test, in which the null hypothesis was that there was not a difference between "REF-first" and "CTL-first" in the ratio of the number of the cases that the CAS score for REF was smaller than that of CTL. We found that, in both the questionnaires for first week and second week, there were not significant difference in the order of test condition with a p-value of 0.05. Therefore, we merged the results of the two orders for further analysis.

The scores are averaged by the number of the questions, i.e., 18. Since the score in CAS ranges from 1 (positive in the affection for a companion animal) to 6 (negative), it is straightforward to see how the participants felt the virtual pet. Fig. 6 shows the box plot of the scores for the first and second weeks of CTL and REF conditions. As a result of one-tailed Wilcoxon signed-rank test ($p < 0.05$) showed that an average CAS score of REF was significantly lower than that of CTL in the first week, as well as in the second week.

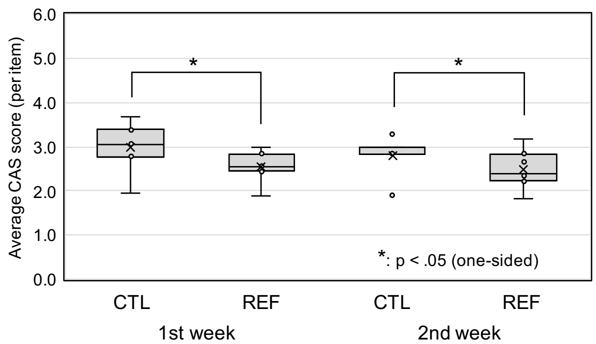

Fig. 6. Average CAS scores per item in different conditions

2) Request Acceptance Rate: A request acceptance rate is obtained as a ratio of the number of accepted requests to the total number of requests. In the same way as CAS score, we first examined the effect of the order of conditions. Since we confirmed that there was no effect, the results were merged. Fig. 7 shows the distribution of acceptance rates for each condition. A one-tailed Wilcoxon signed-rank test ($p < 0.05$) showed that the acceptance rate of REF was not significantly higher than that of CTL.

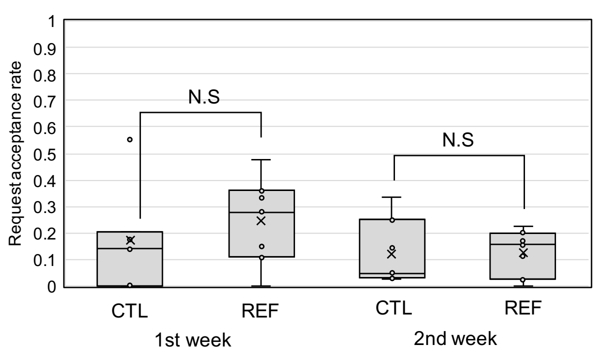

Fig. 7. Average request acceptance rates in different conditions

3) Subjective Opinions: We asked the participants in the following points, and the answers are shown in Table II:

Q1: How do you feel the two types of the virtual pet?
Q2: How do you feel the virtual pet after 1 month use?
Q3: Why did you accept the request for a task?
Q4: Why did you reject (neglect) the request for a task?

TABLE II
FEEDBACK FROM THE PARTICIPANTS TO QUESTIONS. A NOTATION A_{ij} INDICATES THAT IT IS j-TH ANSWER FOR Qi. THE NUMBER IS IN THE BRACKETS INDICATES THE NUMBER OF PERSONS WHO ANSWERED IT.

A_{11}	It (REF) was taking care of me, which made me happy. (3)
A_{12}	The emotional distance to it (REF) was closer than CTL. (2)
A_{21}	It (CTL) was one-way communication. (2)
A_{22}	I got used to the virtual pet after using it one month. (3)
A_{23}	I felt the emotional distance was getting closer at every request. (1)
A_{24}	The virtual pet was healable even just watching it. (1)
A_{25}	I noticed that the pattern of the virtual pet's behavior is limited; nevertheless, I felt it lovely. (1)
A_{31}	I wanted to see it look happy due to acceptance of the request. (1)
A_{32}	I did not want to make it sad due to rejection of the request. (1)
A_{33}	It was a reward for expressing the interest to me, which I felt from talking to recent activities in REF. (1)
A_{34}	I neglected previous requests. So, I accepted its request for compensation. (1)
A_{35}	Just for wasting time (1)
A_{36}	Just at the time of walking (1)
A_{37}	I just wanted to see what happens on acceptance. (1)
A_{41}	I was engaged with other tasks. So, I could not use the terminal. (4)
A_{42}	It was bothersome because the request came just after I sat on a chair. (1)
A_{43}	I notice that the behaviors of the virtual pet were affected by my latest attitude only. There is no risk of being refused forever even though I neglected every request, which discouraged me. (2)
A_{44}	I got bored because I saw all the behaviors of the virtual pet (2).
A_{45}	One-way communication of CTL made me feel bold. (1)

V. DISCUSSION

A. Effect of Reflective Behavior in Increasing Affection

This is a topic for RQ1. As shown in Fig. 6, the median CAS scores of both REF and CTL were below 3.5, which means that, in either type, the virtual pet facilitated affection. We consider that subjective opinions A_{23} and A_{25} suggest that type-independent general characteristics of interactive animated virtual pet contributed to increase affection. Also, A_{24} implies that the nature of instant access to the wallpaper on a smartphone allowed glancing at the display and provided the user with an opportunity to be healed by the virtual pet. Furthermore, in Section IV-D1, the CAS scores of REF were significantly smaller than that of CTL in both first and second weeks. Also, the subjective opinions A_{11}, A_{12}, and A_{21} suggest that the reflective behavior of the virtual pet had positive impact on increasing affection for it.

B. Effect of Reflective Behavior in Motivating a Person

Regarding the answer to RQ2, the acceptance rates of task requests are shown in Section IV-D2, and the feedback from the participants are shown in A_{31} to A_{45} of Table II. As mentioned in Section IV-D2, no significant difference was found in the types of the virtual pet. However, in the feedbacks from the subjects, we can find a potential of a positive effect of reflective behavior of the virtual pet; a participant felt a need for reward for being taken care of the virtual pet (A_{33}). Also, in A_{45}, the nature of one-way communication of CTL made a participant felt bold, which we consider that the participant was less motivated than REF.

The type-independent reasons for accepting the requests A_{31}, A_{32} and A_{34} show that emotional bonding could certainly motivate the participants to accept the requests. According to the discussion in Section IV-D1, affection for the virtual pet is such an emotional bonding.

C. Toward Improving the Request Acceptance Rate

The primary objective of the experiment was to assess the effectiveness of reflective behavior of the virtual pet. There is a large room for improving the acceptance rate as a persuasive virtual pet system regardless of the reflective behavior. In Table II, the main reason for refusing the request is because the subjects were engaged in more important activities than the data collection task (A_{41}). In this regard, the current level of affection for the virtual pet is not so large enough to suspend the ongoing activities. For example, a participant could not respond to a task request during a job even if he noticed a request. Also, a participant could not perform data collection on a crowded train.

An opinion A_{42} implies that, not only such an available timing, but also appropriate timing is important for accepting a request. The reasons for accepting the requests A_{35} and A_{36} also support this. So, suitable time of the task should be identified. Note that the participants' complaints were not on increasing cognitive workload due to the interruption into their ongoing activities, but unsuitability of the moment of the particular task. An interruptibility-aware notification mechanism, e.g., [19], can find suitable moment for processing information about notification; however, a higher-level of component for timing decision needs to be investigated upon such a mechanism, which should be task-dependent and integrated in the Requester component.

Also, an opinion A_{43} suggests the importance of reflecting the responses of past requests for a certain period of time, which may be showing expression of happiness more when a request is accepted two consecutive times, as well as sulking for consecutive rejection.

VI. Conclusion

In this paper, the vPet system, a platform for motivating people to do bothersome tasks, was presented. A virtual pet "lives" in the home screen of Android-based smartphone realized as a LiveWallpaper, which was expected to facilitate the affection for the virtual pet based on the attitudinal effects of mere exposure and the principle of reciprocity. Additionally, in this paper, we aimed at highlighting the effect of the behaviors of the virtual pet that reflect the recent activity of the owner (user).

We evaluated the effect of reflective behavior of the virtual pet with a task of activity data collection for supervised machine learning. In a comparative experiment with seven persons for four weeks, we evaluated the level of affection based on CAS and found that the reflective behavior increased affection significantly compared with non-reflective version. By contrast, there was no significant difference in the acceptance rate of data collection requests from the virtual pet. The interview results revealed the necessity of task-dependent request timing decision, as well as behaving based on a certain period of time. We will improve the vPet system in this respect and apply it into a labeling task in active learning [20].

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