Psychological Effect of Robot Interruption in Game

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Abstract: In this paper, we report psychological effect of robot interruption on human. Although many robots are developed to help people in daily life, such robots sometimes make users live a reactive life. On the contrary, some researchers developed robots that depend on users. These types of robots require users' assists to do their tasks and users need to be active due to its dependence like children. Children not only require our help to do their tasks but also interrupt us. In spite of their interruption, people come to like children and would like to interact with children. To achieve long-term interaction between human and robot, we expect that adequate interruption to users may have some merits rather than helping users at all times. To investigate our hypothesis, we developed two types of robot and designed a simple game with the robots. Throughout the experiments, users have stronger motivation to interact with robot that interrupted users than the robot that did not interrupt them.

1 INTRODUCTION

Recently, a lot of robots are developed to support our daily life such as housework and navigation (Hiroi et al., 2003, Iwata and Sugano, 2009, Matsuyama et al., 2010). Although many types of robots have been developed, they have silimar features, i.e., they are basically designed to do their tasks perfectly without errors to help users.

However, in psychological area, some reports describe that unlimited supports from humans and robots have disadvantage rather than advantage. For example, it is remarkable that physical and mental decays of elderly people proceed rapidly when they lost something to do and live a bleak life after reaching the mandatory retirement age (Iguchi, 2002, Takanaka et al., 2005). According to other researchers, people who require nursing care feel strong stress even if they receive good skilled care because they feel loss of independence due to their passive lives (Tanaka et al., 1997).

Some researchers noted the importance of works, and recommend people to have some tasks to be done in daily life. These types of tasks give people a purpose in life (Kamiya, 2004).

Based on the above prospects, some authors have developed the robots that require humans' assists. These robots cannot work without users' help unlike typical life supporting robots.

For example, a baby-like robot named Babyloid was developed by Kanoh et al (Kanoh and Shimizu, 2011). It cannot do anything without users' help like baby and wait users' help by doing some actions such as changing its facial expression and crying. They expect that users intend to have active interaction with Babyloid due to its ineffectuality.

Yoshida et al. have developed a trash box type robot named Sociable Trash Box (Yoshida et al., 2009). Although Social Trash Box can move and bow its body, it cannot take garbage. Social Trash Box only bows when users pick up the garbage and dump it to Social Trash Box. Social Trash Box requires users' help and aim to encourage users' active support by using the robot ineffectuality. They labeled this concept *power of weakness* and confirmed its availability.

We also developed a robot that sometimes makes mistakes (Yasuda and Matsumoto, 2013). Although it is considered that mistakes are not good for robot design and should be avoided in common, experimental results showed that some mistakes cause users affection and interests to the robot. However, it was still short-term interaction and more study on long-term interaction should be done.

In this paper, we designed a simple game, and developed two types of robots to investigate the effect of the robot interruption to longer-term

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interaction.

We expect that people live more active life not by being helped by the robots any time but by sometimes helping the robots.

In the next section, we summarize the characteristics of the robot that sometimes interrupts users, and its advantage compared to the typical supporting robots. In Sec. III, we describe the specification of our developed robots, and report some experimental results of field experiments for common people in our university. Discussion and conclusion follow in Sec. IV.

2 CONCEPT OF MISTAKE-BASED INTERACTION

In our research, we propose the concept of mistake-based interaction, that is, the interaction between human and the incomplete robot that sometimes interrupts users unlike typical robots that aim to support human perfectly. In this section, we describe the features of incomplete robots, and summarize the aim of this approach.

To clarify the characteristics of the proposed concept, we give two figures. Figure 1 shows interaction between a user and a typical supporting robot. As shown in Fig.1, the existing robot tries to support users. The user expects the robot to do tasks perfectly and robot is not allowed to make any mistakes. Although this approach is very useful, as a result, it may set the user passive position in their interaction.

On the other hand, in mistake-based interaction, the robot sometimes makes mistakes and interrupt users as shown in Fig.2. In this approach, a user needs to make active interaction from him/her to the robot by its mistakes, and to behave as a caretaker for the robot in some cases. Babies and infants seek to do all things that they can do, whereas they bring trouble to adults when they fail in things that they do. Adults become more attached to them due to their efforts and failures. In a similar fashion, we expect that the robots become more human-like and users may feel more humaneness and affection on it when the robot is designed to make mistakes in some cases.

Figure 3 shows the orientation of this approach compared to the other approaches.

Our aim is to encourage users to interact with the robot actively by increasing the robot's incompleteness as shown in Fig.3.

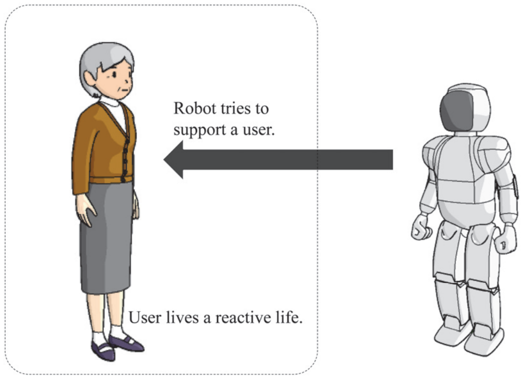

Figure 1: Interaction between users and existing robots.

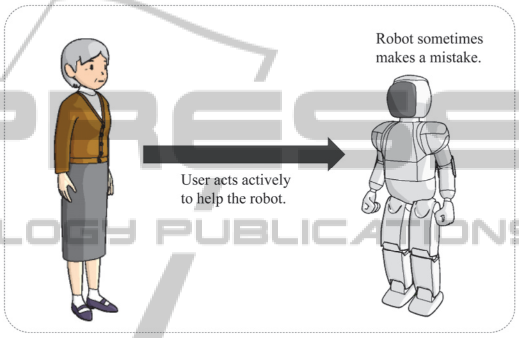

Figure 2: Interaction between users and incomplete robots.

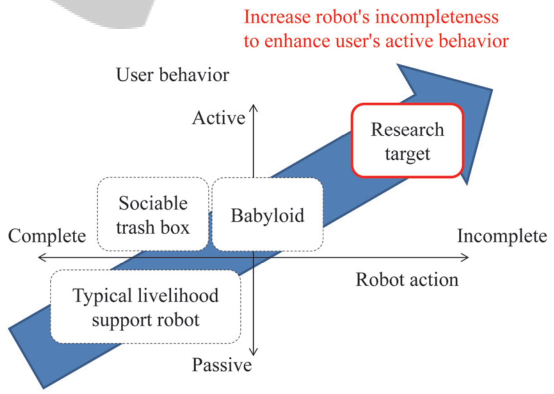

Figure 3: Comparison of our approach with other approaches.

3 EXPERIMENTS

3.1 Experimental Contents

The degree of interruption changes depending on the tasks that users ask. The range of users' allowance on mistakes also varies depending on users. In this study, we designed a game "ball in the basket".

Figure 4: Prepared robots (Rowdy and Goodboy).

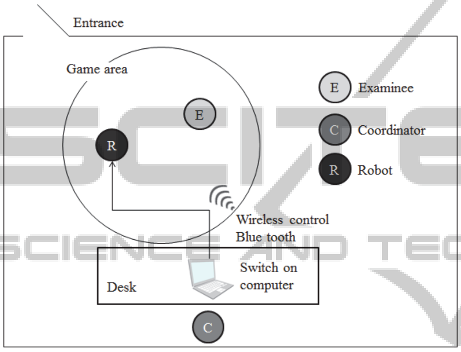

Figure 5: Experimental setup.

Figure 6: Appearance of experimental environment.

The rule of ball in the basket is simple. Users tried to put some balls into the basket on the robot within given area. The limited time was 30 seconds. We asked users to chase the robot and put balls into the basket as possible.

We developed two types of robots.

One robot is Rowdy shown in the right in Fig.4. It moves randomly and acts up to spill the ball out. As the basket is fixed with movable stick, the balls are spilled during the robot movement.

The other is Goodboy shown in the left in Fig.4. It just moves randomly. As the basket was fixed, the robot does not spilled balls.

As the robots' functions are different, maximal balls are 12 in Rowdy, while are 6 in Goodboy.

We set the following three rules for the game.

1. Users are not allowed to catch or stop the robot.
2. Users should put the ball to the robot one by one and should not throw it to the robot.
3. Users should continue to put the ball into the basket during the game.

The robots were developed based on BeautoRover (Vstone Co., Ltd.). They can be controlled through remote computer via bluetooth connection.

We developed some programs to control the robot. When we push the button on the programs, the robot starts to move. The robot action was the combination of "Move forward", "Move backward", "Turn right", "Turn left" and "Stop". The actions were selected randomly to run away from users.

To focus on the effect of robots' mistake, we did not implement speech function to the robot, and gave similar appearance to Rowdy and Goodboy. We told subjects basic functions of them before the experiments.

3.2 Experimental Condition

Figure 5 shows the experimental setup. As shown in Fig.5, a coordinator joined the experiments. He explained users about the game and controlled the robot during the game. We demonstrated the experiment as a part of our laboratory’s introduction of open campus in our university. Visitors to our laboratory were subjects in the experiments. 11 visitors joined the experiments. Figure 6 shows the appearance of the experimental environment. The outline of the experiment is summarized as follows:

We introduced the robot to subjects at our laboratory and asked them to answer a questionnaire about the robot behaviors after obtaining the agreement from them. The detailed scenario of the experiment and contents of the questionnaire are summarized as follows:

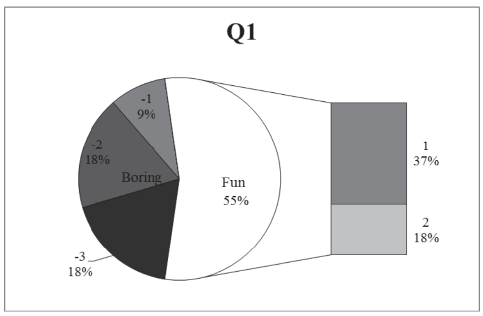

Figure 7: Experimental result on Q1.

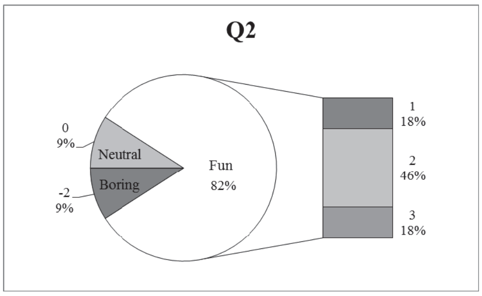

Figure 8: Experimental result on Q2.

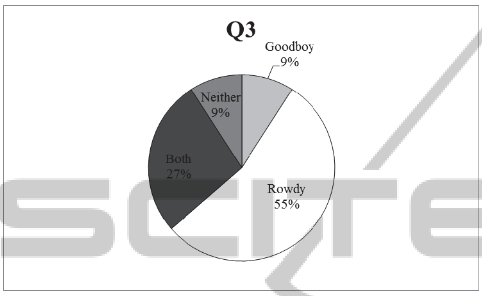

Figure 9: Experimental result on Q3.

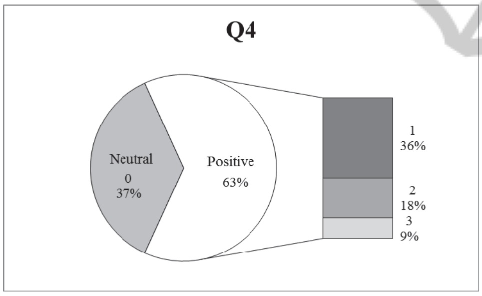

Figure 10: Experimental result on Q4.

** Scenario

1. Subjects visited our laboratory room.
2. The experimenter introduced the robot to subjects and asked them to play with robots when he explained about our laboratory.

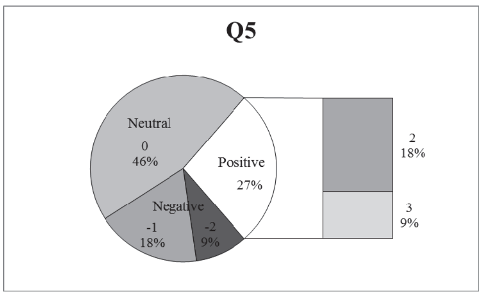

Figure 11: Experimental result on Q5.

3. The experiment started the game and users played with Rowdy and Goodboy.
4. The experimenter asked users to answer the questionaires.

The contents of the questionnaire are as follows:
We ask you about your impression on the robots and game.

- We first ask users the impression on the game.
  Q1: How did you feel the game with Goodboy?
  Q2: How did you feel the game with Rowdy?
  Q3: Do you want to play the game again?
- We second ask users the impression on the robot.
  Q4: How did you feel the robot, Goodboy?
  Q5: How did you feel the robot, Rowdy?

The answer's method of the questionnaire has 7-point scale except Q3. The following is grading on the answer.

-3: Unpleasant, 0: Neutral, 3: Pleasant

The answer of Q3 is as follows:
I would like play again with

1. Goodboy, 2. Rowdy, 3. Both, 4. Neither

3.3 Experimental Results

Figures 7, 8, 9, 10 and 11 show the summaries of subjects' impression on the robot for Q1, Q2, Q3, Q4, and Q5, respectively. Let us summarize the results of questionnaire in order. In the answer for Q1, no one felt neutral impression. About half of subjects (6 people) felt positive impression on Goodboy and remains (5 people) felt negative impression as shown in Fig.6. On the other hand, in the answer for Q2, many people (9 people) felt positive impression on Rowdy, while few people felt neutral and negative impression.

Although Rowdy acted to interrupt users action compared to Goodboy, users felt more positive impression on the game with Rowdy than that with Goodboy.

As shown in Fig.9, half of users would like to play again with only Rowdy, and 3 users would like to play again with both robots.

We think that these results gave us important sights in human-robot interaction.

4 DISCUSSION AND CONCLUSIONS

In this paper, we developed two types of robots, Rowdy and Goodboy and investigated psychological effect of interruption during games to users. For achieving medium-term interaction, we designed a simple game and evaluate the effect of interruption-based interaction on medium term interaction.

Although the game was simple, we think that the results give some insight about human-robot interaction.

The system designer normally designs the robot to be positive impression to users for creating good relationship between human robot. However, some interruptions attract users and give some motivation to users to continue interaction with robot according to the results of the experiments.

We consider that long-term interaction is a key factor for robot to be common in our daily life, and some interruptions may become important factors for it.

For future works, we would like to design more sophisticated game, and investigate the factor for long-term interaction. We also aim to study the effect of the robot voice, the robot appearance to the users impression. Growth of the robot during the game should also be considered.

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