Fundamental Study of Robot Behavior that Encourages Human to Tidy up Table

ABSTRACT

In this study, we investigate the influence of a robot's behavior that motivates human tidying up. Using this scenario, robot can accomplish tidying up tasks effectively through human-robot cooperation (HRC). We developed a system that can tidy up a table through HRC. To validate what behavior effectively encourage human to tidy up, we conducted a preliminary experiment with 8 male-participants, aged 21-23. This paper describes its elementary results.

CCS CONCEPTS

• **Computer systems organization → Robotic control**.

KEYWORDS

Insert keyword text, Insert keyword text, Insert keyword text, Insert keyword text

1 INTRODUCTION

Keeping a living and working spaces tidy is very important for healthy daily life. The efficiency in working rises when the office is tidy [1]. Recently, autonomous cleaning robots have become popular (e.g., Roomba, iRobot). These robots collect dust on the floor; however, they do not replace objects in tidy order, even when the objects are cluttered around.

Object arrangement task comprises two sub-tasks. The first is object recognition and classification, i.e., classifying objects that should or should not be tidied up. The second is conveyance, i.e., carrying the objects to suitable places (such as a shelf). For several decades, many studies on object recognition system have been conducted. However, most studies on automation of conveyance have been conducted for limited settings such as a factory or a warehouse. In such environments, the weight and size of the objects are limited. On the other hand, objects placed in a living room or an office have various weights and sizes. In addition, these objects have a variety of suitable places. Such unstructured situation incurs difficulty of automation of conveyance.

In this study, we propose a system that tidies up a workplace through human robot cooperation. In this system, the robot judges whether an object that exists in its around requires arranging or not. Then, the robot encourages a human to convey the thing to a suitable place. The system tries to solve the difficulty of conveyance in daily environment using a human-robot interaction approach. Through the use of the proposed system, users are expected to make tidying up behaviors their habits.

There are some related studies about robots that encourage humans to tidy up. Fink et al.[2] proposed a robot toy box "Ranger" and applied it to the task of children tidying up their room. Yamaji et al.[3] proposed a robot garbage-can that collects trash with a cooperation with children. We developed a system that enables tidying up of a table with a cooperation of a human.

To validate the proposed system, we conducted a psychological experiment about the effectiveness of encouraging behavior. In this study, we focus on tidying up a littered table. We conducted a preliminary experiment with 8 male-participants, aged 21-23 a small mobile robot. The robot is remote-controlled by a human to drop objects from the table to the floor. We build a hypothesis: Such an exclusive behavior of the robot encourages a human to tidy up the table. This paper describes its elementary result.

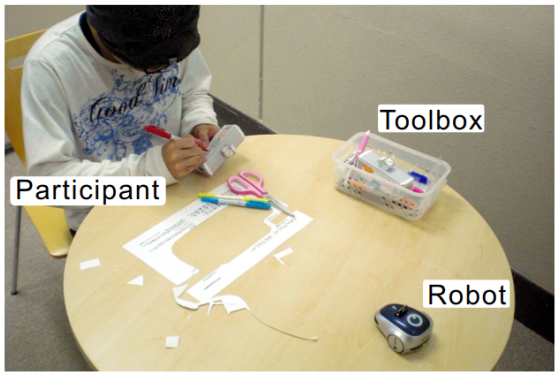

Figure 1: Environmental setup. Stationery, toolboxes, and robots are placed on the table.

2 METHODS

2.1 Experimental Setup

In the experiment, a participant was asked to sit on a chair and make a paper craft on the table (Fig. 1). The participant can use stationery (e.g., scissors, pens, and paste) to make it. A small robot mOway (Minirobots S.L.) is placed on the opposite end of the table. At the start of the experiment, all of the stationery is in a toolbox. The tools inside the box are defined as "tidied objects," and the tools placed outside the box are defined as "objects in disorder." The experimental procedure (Fig. 2) is as follows:

- A participant enters the room according to an entrance signal and starts creating a paper craft.
- After 4 minutes and 30 seconds, a preliminary message, "30 seconds left to leave," is announced to the participant.

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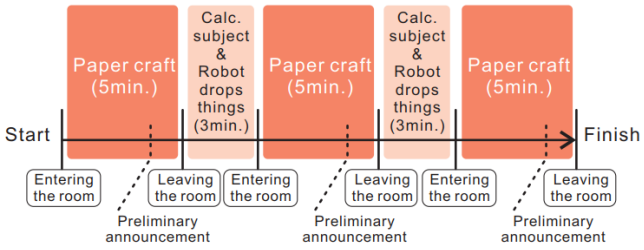

Figure 2: The experimental procedure. Participants executed paper craft task and calculation task alternately. The robot drops objects while the participant performs the calculation task outside a room, where the participants executed the paper craft task.

- The participant leaves the room to perform a calculation task 5 minutes after the start of the paper craft task.
- After 3 minutes of the calculation task, the participant is directed back into the room. Creation of paper craft is resumed, and these processes 1-4 are repeated.

In this experiment, participants tried the paper craft task thrice. After that, they filled a questionnaire. The remote-controlled robot dropped objects that were in disorder on the table while the participant was out of the room. We assume that such actions of the robot encourage the participant to tidy up the table. The participant knows nobody is in the room while he is out of the room. Only robot's motor is sounding.

To investigate the effectiveness of the robot's behavior, eight participants attended the experiment individually. We divided all participants into two groups: one for which the robot did not move during the experiment (group A) and other for which the robot dropped the stationery (group B).

3 EXPERIMENTAL RESULTS

Figure 3 shows the transitions of the answers to the ques- tionnaire item "I would tidy up the table before leaving." The participants rated their agreement with 5 level semantic differential scale method (1: agree, 5: disagree). The par- ticipants were asked whether the table should be tidied up at the time of leaving. The left side of the ïňĄgure shows the answers given by group A. The right side shows the answers given by group B. The figure shows that some of the answers of group B changed between "1st leaving" and "2nd leaving." We could also ob- serve the change of answer between "2nd leaving" and "last leaving" for both groups.

4 CONCLUSIONS AND FUTURE WORKS

In this study, we proposed a system that tidies up a work- place by human-robot cooperation. In this system, the robot judges whether a thing that exists in its environment should be tidied up or not. Then, the robot encourages the human to convey objects to a suitable place. We conducted the experiment to confirm the effectiveness of the robot's behavior in encouraging the human to tidy up a cluttered table. We found no statistically significant difference between the case where the robot moves and where it does not

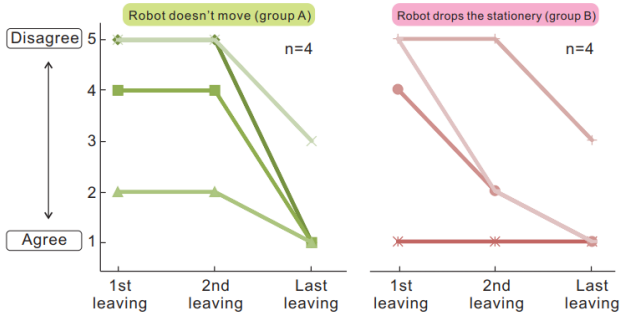

Figure 3: Results of questionnaire item "I would tidy up the table before leaving." Participants rated their agreement with 5 level semantic differential scale method (1: agree, 5: disagree).

move. According to these results, the validity of our hypothesis could not be shown.

In future, we will involve more participants to verify the effectiveness of robot's behavior.

ACKNOWLEDGMENTS

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