
Evaluating an Intuitive Teleoperation Platform Explored In a Long-distance Interview

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Abstract

SWoOZ is an intuitive teleoperation platform using a humanoid robot as a proxy between two humans: a remote user teleoperating the robot and a local user interacting directly with it. NAO (Aldebaran) is the proxy used in this study. The remote user controls its head motion with his own movements (live) while his real voice is transmitted to the local user with an unnoticeable lag time. This paper presents a user study of the platform in the context of a long-distance survey and investigates the possible effect of the remote user's previous experience with robots on the local users' evaluation of the proxy. Although found useful, likable and satisfying by all the local users, only the ones interviewed by the non-naive user find it averagely credible. Results fail to validate an effect of the remote users' previous experience with robots on the local users.

Author Keywords

Teleoperation; user study; humanoid proxy; social robotics; previous experience with robots; head motion.

ACM Classification Keywords

Design; experimentation; human factors; measurement.

Introduction

Various studies show the interest of using teleoperation and telepresence robots [2, 4] in different fields such as remote education health care environments or offices. We developed SWoOZ, a teleoperation setup that mirrors face, eye and head motion on a humanoid robot and consequently allows the generation of spontaneous movements in order to support a natural interaction [1]. In this setup, a humanoid robot is used as a proxy between two humans. One human, the remote user, is bound with the humanoid robot and controls its head motion in real-time and free of attached sensors. The remote user perceives the scene almost as if she or he was present in the same room with his human interlocutor, called the local user. The humanoid head motion for instance, as the local user sees it, is the direct translation of the remote user's motion. In order to evaluate this teleoperation platform, we started a study in the context of a realistic long-distance survey.

Methods

Experimental Setup & Equipment

The SWoOZ platform consists of A) a system able to estimate the remote user's head pose thanks to a consumer depth camera [1]. B) A software program to apply online manipulation to specific parameters. C) A humanoid robot: NAO (Aldebaran). Once the data are estimated, they are sent to the robot so that it mimics the estimated motion of the remote user's head. Further information about the SWoOZ platform can be found in [2]. The remote user's voice captured by a microphone is transmitted to the local user interacting with the robot through a small speaker positioned behind it. To bind the remote user to the robot and enable her or him to sense the scene almost as if she

or he was seated in its place, auditory and visual feedbacks are transmitted to her or him using a High Definition webcam positioned behind the robot and binaural microphones discreetly placed on its body.

Participants

Two male remote users (one naive and another non-naive) and 20 naive local users (previous exposure to robots was controlled prior to the experiment) volunteered to take part in the study. The 22 candidates are Japanese students from Tokyo University of Agriculture and Technology (TUAT). All of them range in age from 19 to 25 years old. The naive remote user (never used or interacted with robots before) interviewed 14 local users (9 males, 5 females). This group of local users will be referred as X in the rest of the text. The non-naive remote user (who has previously used NAO for HRI studies) interviewed 6 local users (5 males; 1 female). This group of local users will be referred as Y. Both were trained to perform the interview. More generally, the experimental design aims at defining a precise and repeatable conversational context.

Materials, Procedure & Data collection

The experiment took place on a Japanese university campus. The local and the remote users volunteered to participate in an anonymous survey lead by a Japanese researcher working in France. They were informed about the following: a) The interview is live mediated by a humanoid robot, b) The interview room is filmed using two cameras, c) The remote user's and the local user's voices are recorded and IMU sensors are used for head motion capture for future analysis. The remote user teleoperating the robot is in room A while the robot NAO and the local user are facing each other in room B, a real meeting room. When the local user is

seated, the remote user addresses him or her, and provides a recapitulation of the survey context. The local user is reminded that there are no false and right answers: only personal opinions are expected. Then the interview starts. It consists of 15 questions revolving around the specificities of the Japanese and French cultures. The interview's overall duration is 10 min and when it is completed, the remote user asks the local user to fill the questionnaire placed on the table.

The questionnaire consists of 40 items divided into 5 sets assessing various aspects of the local users' evaluation of the proxy. At this first phase of the study, only two sets of the questionnaire (the first and the fourth) are used to investigate (1) the local users' evaluation of the robot proxy as teleoperated through the SWoOZ platform, (2) the effects of the remote user's previous exposure to robots on the local users' evaluation. These two sets use a 5-point Likert scale (the points go from 0 to 4; 0 = not at all; 4 = to a high degree). The Cronbach's alpha of the questionnaire is 0.91 which shows a good internal reliability.

Hypotheses

We first hypothesize that the remote user's previous exposure to HRI will impact the local users' experience of the interaction as well as their ratings and that the evaluations made by X will be significantly different from the ones made by Y (H1). Regarding the local users' evaluation of the proxy, the focus is on their ratings of its usefulness, likability, credibility and on their satisfaction with it. Based on a preliminary study performed using the SWoOz setup [2] as well as on the proxy's capacity to mirror the remote user's head motion and transmit his real human voice in real-time, we expect the local users' ratings of usefulness, likability and satisfaction to be above the average

score, 2 being the average on this 5-point Likert scale (H2). From another perspective, the authors in [3] showed that the participants expect the robot's appearance to match its task during an interview context. Knowing that the appearance of this 58-cm tall humanoid does not seem the most appropriate to match the image of a researcher, we expect that the local users give poor ratings to its credibility (H3).

Results

We calculated the descriptive statistics (95% CI) based on the local users' ratings of the humanoid proxy's performance. X and Y generally gave it medium-to-low ratings and Y seemed to have given more generous scores than X. X considered that the robot failed in being credible (X: M= 1.28, SD= 1.03) (H3 validated for X). Nevertheless, they found the proxy rather satisfying (X: M= 2.14, SD= 1.30), likable (X: M= 2.07, SD= 1.10) and useful (X: M= 2.5, SD= 1.11) (H2 validated for X). Y found the proxy averagely satisfying (Y: M= 2.00, SD= 0.81), likable (Y: M= 2.83, SD= 0.68) and useful (Y: M= 2.5, SD= 1.11) (H2 validated for Y). Contrary to X, they found the NAO proxy rather credible (Y: M= 2.33, SD= 1.10) (H3 infirmed for Y).

We did a Mann-Whitney test to ascertain if the differences between X and Y scores are statistically significant, thus implying an effect of the remote users' previous experience with robots on their evaluations. The observed U-values ranged between 22 and 41.5 and failed to be significant as they were superior to the U critical value (17) at $p \leq 0.05$ (H1 infirmed). Some interesting associations regarding the useful aspect of the proxy were revealed for both X and Y when calculating the Spearman rank correlations. These positive dependencies showed that the more the local users found NAO useful, the more they appreciated its

credibility (X: corr.= 0.61, p= 0.01; Y: corr.= 0.78, p= 0.06) and the more they found it satisfying (X: corr.= 0.57, p= 0.03; Y: corr.= 0.91, p= 0.01).

Discussion and Conclusion

The local users showed a moderate to low appraisal of the proxy's performance. The results failed to validate an effect of the remote users' previous experience with robots on their answers (H1 infirmed). The hypotheses 2 and 3 were validated for X but only hypothesis 2 was confirmed for Y who rated the proxy as averagely credible. The validated correlations also showed that the proxy's credibility is positively correlated with its usefulness which is also associated to the satisfaction of the local users with it. Based on that and knowing that the proxy's usefulness was averagely rated, it is possible to suggest that in order to improve the local users' evaluation of the proxy's usefulness, one interesting possibility would be to work on enhancing its credibility by investigating what might have limited it in this study: the lack of adequacy of the robot's appearance with the researcher's role or its limited communication and expressive features. Indeed, it is possible that NAO's appearance and its interactive abilities did not match its role as a mediator.

When considering the difference between X and Y when rating the proxy's credibility, the question of whether the remote users' previous experience impacted their evaluations or not, appears legitimate. But the statistical results did not validate this effect. The small size of the sample interviewed by the non-naive user could explain this lack of significance. Also, the intuitive mediation characteristics of the SWoOZ platform might have mitigated the remote users' effect. The proxy's mediation, as it interferes in the human dyad, is in

favor of rendering a rather homogeneous behavior of the robot, especially that only the remote users' head motion is mirrored here. The failure to prove a significant effect of the remote users' previous experience with robots is interesting in regards to the platform's usability as it strongly suggests that any naive person could, with some preparation, successfully use SWoOZ as a remote user and be as equivalently effective as a more experienced person. Knowing that the SWoOZ setup is compatible with different humanoid robots, the replication of our experiment with another humanoid would probably clarify our findings.

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