Behavioral Accommodation towards a Dance Robot Tutor

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ABSTRACT

We report first results on children adaptive behavior towards a dance tutoring robot. We can observe that children behavior rapidly evolves through few sessions in order to accommodate with the robotic tutor rhythm and instructions.

Categories and Subject Descriptors

H.1.2 [Models and Principles]: User/Machine Systems;
I.2.9 [Robotics]: Commercial robots and applications

Keywords

interaction adaptation; child-robot interaction; dance

1. INTRODUCTION

Social interaction can be defined as a dynamic sequence of social actions between individuals (or groups) where interactors modify their actions and reactions based on the each other. Some examples of interaction adaptation that take place when people interact are matching other's behaviors, synchronizing the timing of behavior, or even behave in dissimilar ways [2].

Within the HRI community, most effort has been put on researching strategies to adapt the robot behavior to the user. In other words, considering the adaptation of a single interactor, instead of both. Though indeed it is a major goal to reach, we believe that taking into account the user capabilities and strategies to accommodate to the robot should be also considered and studied more deeply.

Most research on adaptive interaction has been focused in conversational interactions, such as the Communication Accommodation Theory (CAT) developed by Howard Giles, where it is argued that people adjust speech, vocal patterns and gestures to accommodate to others. Following these ideas, linguistic adaptation of the user towards automatic systems, both in computer-interaction and robot-interaction, have been observed in the past [4, 1, 3]. How-

ever, little attention has been paid to behavioral (action) adaptation, specially in HRI.

In this paper we report first results on children adaptive behavior towards a dance tutoring robot. We can observe that children behavior rapidly evolves through few sessions in order to accommodate with the robotic tutor rhythm and instructions.

We next briefly describe the dance task and the robotic system used in this work, followed by results obtained from first analysis of the experiments carried out.

2. A DANCE ROBOT TUTOR

The present work is based on the approach presented in [5], where creative dance is used as the interaction activity between robot and child. Creative dance is a form of dance where the goal is to explore the body movement based on a set of general guidelines (movement concepts).

Several methods are used to teach dance. In this work, we focus on what we call the *concept-based learning*. In this model dance concepts are sequentially shown and children explore the new ideas using their own body. They are free to create any variation they can think of as long as it corresponds to the concept described. Next, a process of *request-respond* takes place. The robot asks for a dance concept and the child has four seconds to perform it. If he/she fails, the robot shows an example and the child may (or not) respond in some way. Table 1 summarizes the available *request-respond* pairs observed in the experiments we report here.

The robot used is the Nao, a humanoid robot from Aldebaran Robotics.¹ The robot behavior addresses two main aspects during the interactions: (i) it performs the dance activity where it acts as a tutor guiding the child through the different stages; and (ii) keeps the child engaged in the task as much as possible, not only to finish the task, but to repeat the encounter in future occasions. To this end, basic social queues have been developed along with motivation strategies (such as providing constant positive feedback, head movements, name reference, etc. described in detail in [5]).

3. RESULTS

The experiments were carried out with 11 children during 4 days. Each child was expected to interact in three sessions -each in different days-. However, due to technical problems, only three children could complete the three sessions

¹www.aldebaran-robotics.com

request (robot)	response (child)	interpretation
ask	ok	performs correctly
	fail	fails performing either creating its own motion or copying the robot's motion
	observe	observes and waits for robot's action
	distracted	does not follow robot's instructions
show	copy	performs correctly copying the robot's motion
	fail	fails performing either creating its own motion or copying the robot's motion
	observe	observes robot's motion
	distracted	does not follow robot's instructions

Table 1: Set of possible combinations of request-response pairs (robot and child actions).

(users 1 to 3), seven children interacted twice (users 4 to 10) and one child could only participate in one session. Since we are interested in observing behavioral adaptation across sessions, we remove the child having a single session from the results reported here.

In this work, we only focus on the *request-respond* period of the sessions, which correspond to 5 min in average per session (26% of the session duration). The child has two opportunities to respond to the robot's movement requests, where the second chance (*show* request) only takes place if the child fails to do so in the first time (*ask* request). Thus, we measure the accommodation level as the complement of the ratio between the *show* requests and the *ask* requests, where values near 0.0 corresponds to low accommodation level (i.e., for every *ask* request, the robot had to perform a *show* request afterwards), and 1.0, to maximum accommodation level (i.e., the child responded after the first request):

$$accommodation = 1 - (show/ask)$$

where *show* and *ask* corresponds to the number of times the robot shows and asks a motion to the user respectively. We must remark that failing to respond in the first time does not exclusively mean that no behavioral adaptation occurs, but that the child may not know the motion.

Figure 1 depicts the evolution of the level of accommodation for each user across sessions. Significant increase can be observed through the sessions, meaning that most of them accommodated their behavior to the rhythm of the robot as they interacted. It is worth to mention that although the teaching methodology is the same throughout the sessions, the movements performed are completely different in between sessions. Therefore, the increase of accommodation level is not due to a memorizing exercise or performance improvement from one session to another, but due to an understanding and behavioral adaptation from the user to the robot's rhythm.

There is only one exception, user 7, who actually decreased its accommodation level. Through observational analysis of the recordings we verified that the second half of the last session the child was not engaged in the task any more, and therefore, his behavior was not aligned with that of the robot.

Figure 1: Accommodation level evolution per user across sessions (darkest bar corresponds to first session, while lightest one, to the child's last session).

4. CONCLUSIONS AND FUTURE WORK

We have presented first results that show that behavior accommodation from the user perspective can take place across sessions. We believe that considering the adaptability of humans towards their interactors is an open opportunity for the HRI community. Assessing the accommodation level not only can serve as a guideline of how efficient the interaction is, but also could provide additional information on which aspects the robotic system should emphasize its adaptive behavior.

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