DOMER: A Wizard of Oz interface for using interactive robots to scaffold social skills for children with autism spectrum disorders

CONFERENCE PAPER · JANUARY 2011

DOI: 10.1145/1957656.1957770 · Source: DBLP

Michael Villano
University of Notre Dame

Kristin Grumbine Wier
University of Notre Dame

Karen Tang
University of Notre Dame

Joshua John Diehl
University of Notre Dame

DOMER: A Wizard of Oz Interface for Using Interactive Robots to Scaffold Social Skills for Children with Autism Spectrum Disorders

Michael Villano, Charles R. Crowell, Kristin Wier, Karen Tang, Brynn Thomas, Nicole Shea, Lauren M. Schmitt, Joshua J. Diehl
University of Notre Dame
Notre Dame, Indiana, USA
001 574 631 9894

michael.a.villano.4@nd.edu, ccrowell@nd.edu, joshua.diehl@nd.edu

ABSTRACT
This report describes the development of a prototypical Wizard of Oz, graphical user interface to wirelessly control a small, humanoid robot (Aldebaran Nao) during a therapy session for children with Autism Spectrum Disorders (ASD). The Dynamically Operated Manually Executed Robot interface (DOMER) enables an operator to initiate pre-developed behavior sequences for the robot as well as access the text-to-speech capability of the robot in real-time interactions between children with ASD and their therapist. Preliminary results from a pilot study suggest that the interface enables the operator to control the robot with sufficient fidelity such that the robot can provide positive feedback, practice social dialogue, and play the game, "Simon Says" in a convincing and engaging manner.

Categories and Subject Descriptors
H.5.2 [**Information Interfaces and Presentation**]: User Interfaces – *Graphical user interfaces (GUI).*

General Terms
Performance, Design, Experimentation, Human Factors, Theory.

Keywords
Wizard of Oz, human-robot interaction, autism, interface.

1. INTRODUCTION
The clinical use of robots with children with Autism Spectrum Disorders (ASD) has received considerable media attention over the past decade, even though efficacy research on this topic is in its infancy. Children with ASD are more intrinsically interested in treatment when it involves electronic or robotic components [1]. A recent review paper examined pioneering approaches to integrating robotics into innovative treatments and highlighted the need for additional rigorous empirical studies [2]. Three broad areas of clinical application for children with ASD were identified: 1) eliciting target behaviors, 2) modeling, teaching and practicing skills, and 3) providing feedback and encouragement.

Children with ASD may have profound deficits in communication and social interaction. Currently, the most widely used and researched therapy for children with ASD is Applied Behavior Analysis (ABA) [3], which involves a therapist who provides explicit instruction to develop social skills. One crucial therapeutic component of ABA is giving positive rewards for successful behavior. Children with ASD present special challenges to therapists because a signature characteristic of ASD is that the child does not respond well to social feedback, so rewards often consist of food items or time to play with a preferred toy. Thus, more effective reward systems are needed to promote social learning. Robots have the unique feature of being human-like objects. They are physical devices that can be made to mimic human sounds and behaviors in an interactive way. Thus, unlike other physical objects such as computers and dolls, robots seem uniquely suited to social skill development first by capturing attention as an object and then transferring that attention to the human-like qualities and features that robots are uniquely capable of exhibiting. Interactive robots could hasten the children's progression from receiving object-related feedback (food, toys) to the more desirable responsiveness to human social feedback by bridging the gap between the physical and social worlds.

HRI'11, March 6–9, 2011, Lausanne, Switzerland.
ACM 978-1-4503-0561-7/11/03.

In this report, we describe a prototypical Wizard of Oz (WoO) graphical user interface (GUI) developed to wirelessly control a robot during a therapy session for children with ASD. The WoO GUI, Dynamically Operated Manually Executed Robot (DOMER), enables an operator to initiate pre-developed behavior sequences for the robot as well as access the text-to-speech capability of the robot in real-time interactions between the child and the therapist during a therapy session.

2. PILOT STUDY
The purpose of our pilot study was to determine the feasibility of using our interface to control an interactive robot during an ABA-based social-communication therapy. The child in the pilot study was a nine-year-old male with ASD whose IQ and language skills were measured at 3 standard deviations below the mean for his age. At the beginning of the study, the child's language was predominantly echolalic (i.e., involuntary repetition of words), but did contain some spontaneous communication. The child attended one baseline visit, followed by 50-minute therapy sessions two times a week for 8 weeks with a certified behavior analyst and a robot, as well as one posttest visit. The robot was a 23-inch, Aldebaran Nao capable of real-time text-to-speech and movement that allowed for human-like social gestures. We developed therapy scripts relevant to the child's ABA goals of initiating/responding to greetings, answering questions about feelings, and answering/asking recall questions. During the session, the child would alternate between interacting with either the therapist or the robot. The therapy session was monitored by an operator through a one-way mirror and audio/video feeds. The operator controlled the robot using the DOMER interface.

A variety of pre-defined behavior and verbal sequences were developed for the robot using the vendor-supplied software, Choregraphe. These sequences included behaviors to provide positive feedback, such as a "touchdown sign" sequence which consisted of the robot making the (American football) touchdown sign by raising both arms straight up. Other sequences were primarily verbal, such as asking the recall question, "What did you do last night?" which was accompanied by a "questioning" hand movement- both hands at hip level with palms facing up.

Initially, the sequences were triggered from the Choregraphe interface, but there were several drawbacks to this approach. First, the Choregraphe display quickly became cluttered with the relatively large behavior box icons after more than a dozen behaviors had been designed. Second, because triggering a behavior required a mouse click on a relatively small input trigger icon, it was easy for an operator of the robot to miss the click area. Third, a delay was incurred in initiating behaviors from the Choregraphe interface. Finally, this approach required all speech to be stored in Choregraphe behaviors files, making it extremely difficult, if not impossible, to generate custom speech during the interaction with a child.

In order to address many of these issues, the WoO GUI DOMER was developed (Fig. 1). This interface is a Windows® Application

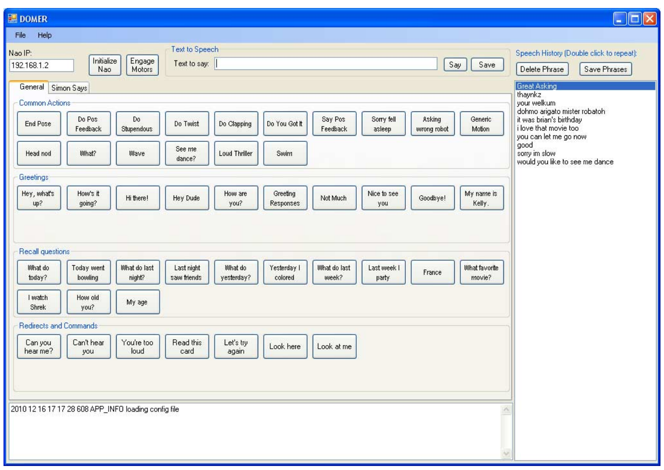

Figure 1. WoO GUI DOMER.

developed in Microsoft® Visual Studio® 2008 written in C#. The main GUI design elements of the interface include an area for establishing connectivity with the robot and engaging the robot's motors, a Text-to-Speech grouping which includes a text box where any speech phrases that are typed are transmitted to the robot and spoken through the onboard text-to-speech converter, a Speech History text area where typed speech phrases are stored for replay, and 4 sets of 20 buttons which can be preprogrammed to initiate behaviors created in advance with Choregraphe.

Many aspects of the interface are customizable through the use of a name-value pair configuration file. The interface components that can be configured include the initial value of the IP address of the robot, the text-To-speech phrase history (which can therefore be preloaded with phrases before a therapy session), and various details regarding the programmable buttons. The programmable button attributes include the group name assigned to one of the four button groups, the label of each individual button, the behavior file which the button triggers (which is preloaded on to the robot prior to use), help tip text, and optionally, a speech phrase which is spoken by the robot when the button is pressed and the behavior is initiated. This last feature allows the speech text to be decoupled from the Choregraphe behavior files and allows for more rapid changes in the speech phrases associated with a behavior during development. A button can also have more than one behavior file associated with it, in which case the interface will select randomly from among the list of behaviors to be triggered. One application of this one-to-many mapping of a button to behaviors enables the "collapsing" of several positive feedback behaviors into a single positive feedback button which helps de-clutter the interface. In addition, the text-to-speech text box and history functions are associated in the configuration file with a collection of "generic movement" behavior files which are randomly selected by the interface and initiate subtle conversational movements, such as gesturing with one hand, palm up at hip level, whenever the robot speaks a custom phrase. In addition, a "Simon Says" interface tab has been developed (not shown) which enables several appropriate gestures to be triggered and allows the robot to serve as leader or follower in the game.

Over the course of the pilot study, the interface was modified with input from both the therapist and the operator. Preliminary results suggest that the interface enables the operator to control the robot with sufficient fidelity such that the robot can play the children's game "Simon Says" (elicit behavior), practice social dialogue (practice skills) and provide positive feedback in a convincing and engaging manner. The robot has participated in two Skype calls during presentations regarding this study and during one exchange, an audience member asked, "Are you self-aware?"

3. FUTURE WORK

An experimental evaluation of the efficacy of a DOMER-controlled robot's role in ASD therapy is underway. Other applications of the DOMER interface to human-robot interaction experiments are also planned (anthropomorphism studies).

4. ACKNOWLEDGMENTS

This work was sponsored by a Rodney F. Ganey Collaborative Community-based Research Mini-grant and an NIH Indiana Clinical Translational Sciences Institutes (NIH RR025761) – Notre Dame Project Development Team Grant.

5. REFERENCES

[1] Robins, B., Dautenhahn, K., & Dubowski, J. 2006. Does appearance matter in the interaction of children with autism with a humanoid robot? *Interaction Studies*, 7, 509-512.

[2] Schmitt, L. M., Diehl, J. J., Villano, M., Crowell, C. R. 2010. The clinical use of robots for children with Autism Spectrum Disorders: A critical review. *Unpublished*.

[3] Rogers, S. J., & Vismara, L. A. 2008. Evidence-based comprehensive treatments for early autism. *Journal of Clinical Child and Adolescent Psychology*, 37(1), 8-38