

Designing Interactive Technologies for Supporting Research in Autism Spectrum Disorders.



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Background:

Emerging evidence suggests that some children with autism spectrum disorders (ASD) tend to increase their levels of social behavior when interacting with a robot. There are many plausible explanations for the effects that a robot has on children with ASD. Since children with ASD have difficulty with the self-initiation of social behavior, and that initiation of behavior is important for social skill development, a robot that helps with initiation of social behavior could be potentially valuable in both research and intervention.

The aim of this work is to determine if such a link exists, and if so, what elements of a robot's form and function (contingency, anthropomorphism, embodiment, etc.) correlate with changes in social behavior. We also aim to detect and interpret the child's interactions, especially social behavior relevant to ASD (body position, head direction, gestures, vocal prosody, etc.). Finally, we are designing a robot system that can act appropriately in a social setting that could be used to augment established diagnostic and therapeutic regimens for children with ASD.

Approach:

To accomplish these objectives, we are designing an interactive robot-based experimental environment. The robot is a mobile base and an upper-torso with actuated arms, neck and face. The robot can use movement and speakers to play synthetic and pre-recorded speech sounds. The robot can also be equipped with relevant toys, such as a bubble-blower. We have created variations on this design to isolate contingent from random behavior, anthropomorphic from more mechanical appearance, and embodiment from non-embodiment (e.g., a virtual agent on a computer screen).

We use single and multi-session within-subject experiments to test the effectiveness of the various robot configurations. To observe changes in both human-human and human-robot interaction, a parent or experimenter will always be in the room. We will evaluate the interactions using established human-rated behavior metrics. We are also developing means for autonomously detecting and quantifying social behavior of children from the multi-modal audio-video signals. Our experiments take place at the Boone Fetter Clinic at Children's Hospital, Los Angeles.

Robot Behavior:

The behavior of the robot is designed to observe and encourage social behavior from the child, including:

- Attention
- Speech
- Movement
- Gestures
- Play

In order to encourage this behavior, the robot observes the child using the sensing available in the room. The robot can then use the following simple behavior autonomously as encouragement for the child:

- Non-verbal vocalizations
- Bubble-blowing
- Gestures (waving, nodding and shaking head, etc.)
- Movement (toward and away from the child)

Since the robot is not able to understand complex speech, or intricate gestures, we designed the behavior of the robot to be as simple as possible to avoid giving children the impression that the robot is more intelligent than it is.



Automatic Sensing:

Our experiments take place at the Boone Fetter Clinic at Children's Hospital, Los Angeles. The experiment room is outfitted with several sensors:

- Four cameras in room positioned so as to capture the mobile aspects of the interaction
- Downward-looking overhead camera to detect the relative positions of the people/robot/objects in room
- Two cameras, one in each of the robot's eyes to capture when the child is looking at the robot (and vice-versa)
- Two microphones on robot and four wall-mounted microphones

These sensors can be used in the following ways:

- Use microphones to capture the time difference of arrival between sounds to aid in automatic object localization
- Real-time face detection
- Localization and tracking of robots and people
- Automatic speech detection
- Automatic voice, speech, and language analysis
- Simple speech act detection (question detection)

Ongoing Work:

- Real-time detection of specific acoustic events, also for use in informing the robot's actions
- Attempt to mimic evaluations of human coding of behavior using signal processing
- Speech detection/recognition to detect vocalizations and speech
- Automatic detection of head orientation
- Extract psychologist-inspired features from the audio/video signals
- Train models that mimic psychologists' grading patterns (very difficult problem for this unconstrained domain)

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