A Mobile Robot for Social Interaction

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The Problem: To create a mobile robot with morphology that is conducive to human interaction and equipped with sufficient sensors and actuators that social behavior is possible. This research is a continuation of the work done on the Yuppy robot.

Motivation: Artificial social behavior models require a platform that provides both sensory input and a medium for behavioral output. The amount and quality of sensory information provided to the software directly impacts performance and capabilities for further development. In the same way, the repertoire of expression directly effects how well the system will be perceived to be working. A mobile platform adds an entirely new dimension to both the sensory systems and behavior generation by allowing everything the robot senses and does to be related to physical position. Human factors also play into the success of a particular behavior model; if people have difficulty interacting with the platform then the abilities of the model will be put at a disadvantage.

Previous Work: Many robots have been built to test behavioral and sensing systems. Most closely related to this effort is Yuppy, a mobile robot based on a commercial wheeled platform that was augmented with a two-degree-of-freedom vision head, an actuated tail, and a pressure-sensing bag for tactile stimulus. Other robots include Cog and Kismet[1, 2].

Yuppy was a mobile platform but it was not exceptionally articulate. The Cog and Kismet robots have vast capabilities for expression but their lack of mobility limits sensory information to one location and similarly inhibits expressiveness.

Approach: A small robot, (approximately 0.5 meters in length weighing 9.1kg) named Coco, has been designed and built. To maximize both mobility and human approachability the robot is quadrupedal. The robot's morphology is roughly based on that of a gorilla. The characteristic long forelimbs and shorter hind legs of the gorilla have been accentuated in Coco to provide a duality of usefulness in walking and expressive gesture.

Coco has two degrees of freedom in its shoulders and one degree of freedom in each hip, knee, and elbow. Coco also has a five degree-of-freedom vision head. The robot is controlled by an on-board DSP that actuates servos for each degree of freedom. A serial link provides high-level position commands to the robot from an off-board computer array. Coco is designed to be modular so improvements to actuators and sensors can be made incrementally. The limbs and head bolt into a monocoque body chassis that houses the motor-control electronics.

Difficulty: The main difficulty in creating a small mobile robot is the power-to-weight ratio of the actuators. The robot needs to be powerful to maximize maneuverability and expressiveness but adding power adds weight, which creates a need for more power. Along the same lines, designing strong and light mechanisms is an equally imposing challenge.

Sensors also pose a problem in a small robot. Tactile, force, and position sensing are all desirable in a social robot but these sensors take up space and add weight in critical areas of the robot.

Impact: Research into social robots has potential for improving the utility of machines by investigating ways for humans to interact with them more like they interact with other humans.

Future Work: Improving Coco's sensory capabilities is the next step for the robot. We have created a working shell that is rich in expressive capability. Implementations of tactile and joint force sensors, as well as closed-loop force control are ongoing initiatives.

References:

[1] B. Scassellati. "Investigating Models of Social Development using a Humanoid Robot". AAAI Fall Symposium "Robots and Biology: Developing Connections", 1998.

[2] C. Breazeal, B. Scassellati.
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