A Brochette of Socially Interactive Robots

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Abstract

The design of interactive mobile robots is a multidisciplinary endeavor that profits from putting robots with people and studying their effects and impacts. To do so, two main issues must be addressed: giving robots capabilities in order to interact in meaningful and efficient ways with people, and the ability to move in human settings. This paper briefly describes four robotic platforms that are going to be demonstrated at the AAAI 2005 Robot Competition.

Interactive Capabilities for Mobile Robots

Spartacus is the robotic platform we have designed for high-level interaction with people in real life settings. The robot built is shown left in Figure 1 and is equipped with a SICK LMS200 laser range finder, Sony SNC-RZ30N 25X pan-tilt-zoom color camera, an array of eight microphones placed in the robot's body, a touch screen interface, an audio system, one on-board computer and one laptop computer. The robot is also equipped with a business card dispenser, which is part of the robot's schmoozing strategy.

Numerous algorithms must be integrated to provide Spartacus with interactive capabilities. MARIE (Mobile and Autonomous Robot Integrated Environment) is our middleware programming environment allowing multiple applications, operating on one or multiple machines/OS, to work together in order to facilitate program reusability. MARIE currently links Player/Stage/Gazebo (Vaughan, Gerkey, & Howard 2003), CARMEN (Montemerlo, Roy, & Thrun 2003), pmap[1] and RobotFlow/FlowDesigner (Cote *et al.* 2004). Algorithms to read messages (Letourneau, Michaud, & Valin 2004) and to follow people are used by Spartacus to interact with people. An artificial audition system makes it capable of simultaneously localizing and tracking sound sources in the presence of noise and reverberation (Valin *et al.* 1). The system can also separate sound sources in real time (Valin, Rouat, & Michaud 2004) in order

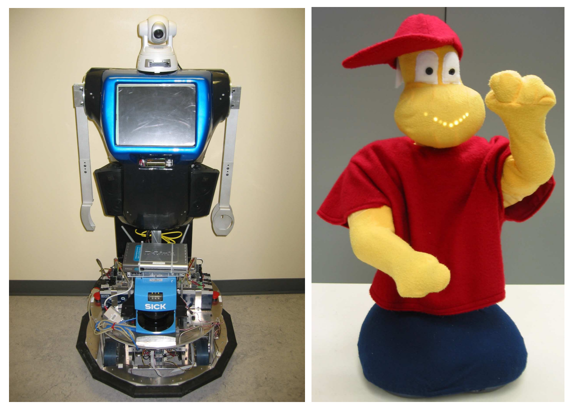

Figure 1: Spartacus (left) and Tito (right).

to process communicated information from different interlocutors, NUANCE[2] is used for speech recognition. Finally, for autonomous use of these capabilities, we are developing a computational architecture based on the notion of motivated selection of behavior-producing modules (Beaudry *et al.* 2005).

Autonomy is not always a requirement for interactive robots. To study the use of mobile robots as pedagogical tools to help children diagnosed with autism develop social and communication skills, we needed a teleoperated robot with various capabilities. Tito, shown right in Figure 1, is approximately 60 cm tall. It uses wheels to move, but its structure shows two feet and two legs to emulate a humanoid shape. It has two arms that can move up and down rapidly, a head that can rotate (to indicate 'no') and rise up (to express surprise), a mouth (for smiling), two eyes, a nose, hair (made from fiber optic cable to illuminate). Also, since eye gaze toward Tito is something interesting to measure, a small wireless microphone-camera is installed as one of the robot's eye. Different parts of Tito's body can be illuminated and the robot is able to sense if it is being shaken

[1]http://robotics.usc.edu/ ahoward/pmap/

[2]http://www.nuance.com/

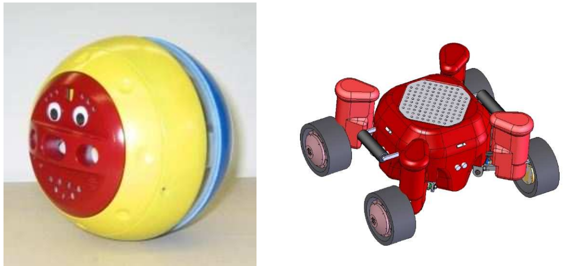

Figure 2: Roball-2 (left) and AZIMUT-2 (right).

or if it has flipped over. Tito can generate vocal requests through pre-recorded messages. A wireless remote control is used for teleoperation, and an on-board microcontroller enables pre-programed sequences of behaviors (motion and vocal messages). Tito records and stores internally the timing between the interactions of the child with the robot. Trials were conducted by a psycho-educator with Tito and four autistic children of approximately five years of age. Results are currently being analyzed in relation to the research objectives and hypothesis, but preliminary conclusions indicate that imitation is observed and that the robot becomes an incentive for the child, even in interacting with the educator.

Locomotion Capabilities in Social Settings

Considering making a robot that can move in a home environment, filled with all kinds of obstacles, requires particular locomotion capabilities. A mobile robotic toy for toddlers would have to move around other toys and objects, and be able to sustain rough interplay situations. Encapsulating the robot inside a sphere and using this sphere to make the robot move around in the environment is one solution. The robot, being spherical, can navigate smoothly through obstacles, and create simple and appealing interactions with toddlers. The encapsulating shell of the robot helps protect its fragile electronics. Roball's second prototype, shown left in Figure 2, was specifically developed to be a toy and used to study interactions between a robot and toddlers using quantitative and qualitative evaluation techniques (Laplante *et al.* 2005). Observations confirm that Roball's physical structure and locomotion dynamics generate interest and various interplay situations influenced by environmental settings and the child's personality. Roball is currently being used to see how child interaction can be perceived directly from onboard navigation sensors.

AZIMUT, on the other hand, addresses the challenge of making multiple mechanisms available for locomotion on the same robotic platform. AZIMUT has four independent articulations that can be wheels (as shown right in Figure 2 - this version should be completed by June 2005), legs or tracks (to eventually handle staircases), or a combination of these (Michaud *et al.* 2005). By changing the direction of its articulations, AZIMUT is also capable of moving sideways without changing its orientation, making it omnidirectional. All these capabilities provide the robot with the ability to move in tight areas. AZIMUT is designed to be highly modular, placing for instance the actuators in the articulations so that the wheels can be easily replaced by leg-track articulations for all-terrain operations. Elastic actuators are used to sense the effects of the actuators on the environment. Mechatronic modules, such as the wheel-motor that is used in the wheel and the leg-track configurations, and the use of a distributed processing architecture with multiple microcontrollers communicating through shared data buses, make AZIMUT's design a rich framework to create a great variety of socially interactive robots.

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