

AIBO's Magic Looking Glass: Human-Robot Interaction Mediated by a Detached Display

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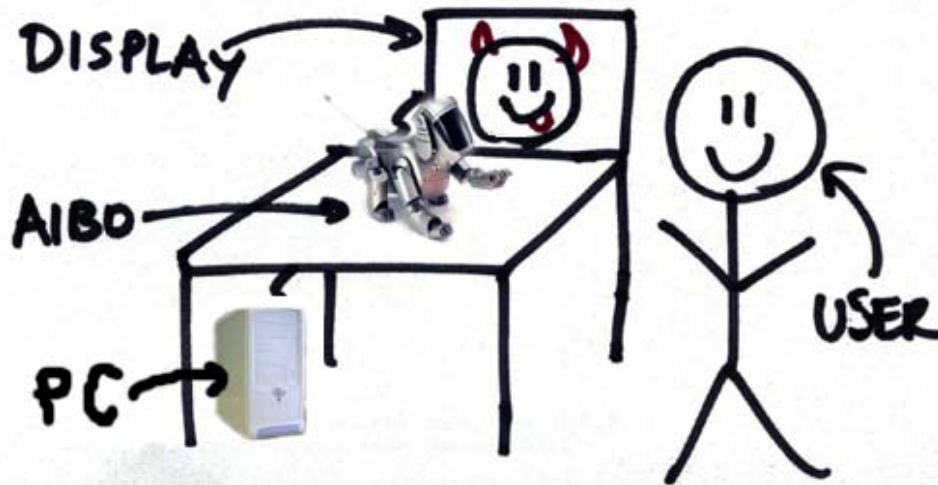
General Project Description:

The Sony AIBO occupies a unique niche in the design space of personal and educational robots. Its small size allows it to operate on a tabletop rather than the floor. But unlike most tabletop robots (e.g., Lego Mindstorms, or Khepera), AIBO is an advanced platform with sensory and computational abilities comparable to much larger robots. The latest AIBO version, model ERS-7, includes a color video camera providing 30 frames per second at 208x160 pixel resolution, a 576 MHz MIPS processor with 64 MB of RAM, and a built-in 802.11b wireless Ethernet connection. AIBO can “see” and “think” well enough to allow interesting interactions with humans.



AIBO model ERS-7

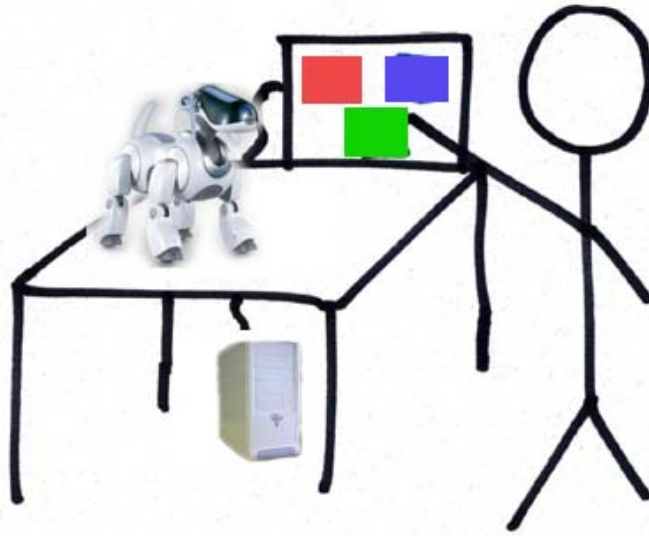
This project will investigate a variety of ways in which human-robot interaction can be mediated by a detached flat-panel display mounted perpendicular to the tabletop and controlled by the robot via the Ethernet. We will focus on entertainment applications. In keeping with the whimsical nature of the robot and its intended use, we call the display “AIBO's Magic Looking Glass”.



Specific Questions/Hypotheses:

The primary question to be answered by this work is: What interaction styles between human, robot, and display work well in practice? Some examples to be investigated are:

- 1 Scenery backdrop. The AIBO stands between the looking glass and the user and uses the display to present scenery as a backdrop for a dramatic presentation, such as quoting Shakespeare, or singing a song.
- 2 AIBO's POV: the looking glass shows AIBO's "point of view" by displaying its current map of the environment, or its currently active state in a state machine diagram.
- 3 Game scoreboard: Suppose AIBO would like to play some sort of game (tic-tac-toe, guessing game, etc) with a user, he may wish to keep the score. AIBO would keep score by making it show up on the scoreboard (display) where both players can see.
- 4 Photo gallery: AIBO could take snapshots of the user or other interesting objects and manipulate them in standard ways. Alterations to the pictures include devil's horns, halos and moustaches for humor, and hearts and cupids for affection. These photos would be displayed on the monitor.
- 5 Menu: AIBO might want to play a game with the user where it offers some sort of choice. For example, AIBO might ask the user to pick his favorite color, by bringing up 5 different colors on the display. To communicate to the robot that he has made a selection, the user would have to point to the appropriate color, and AIBO would recognize the user's finger. Another example of interaction could be AIBO creating a play list of songs for a user. The user could select songs to be queued and AIBO could dance while the song was being played.



Other questions include how to best position the looking glass relative to the AIBO and the user, how to manage the interaction between the robot and the PC to which the looking glass is attached, and how the robot can use the display for orientation and navigation. (In order to position itself correctly relative to the display, AIBO must first locate the display. To do this, it might ask the PC to flash the screen rapidly, and then use its camera to search for a large flashing region.)

Methods:

The research will be conducted using Tekkotsu, an application development framework for the AIBO being developed in Professor Touretzky's lab. ("Tekkotsu" is a Japanese word meaning "framework".) For more information, including source code, tutorials, sample programs, and online documentation, see Tekkotsu.org.

Tekkotsu applications that run on the robot are programmed in C++. In addition, Tekkotsu provides an extensive collection of GUI tools written in Java for monitoring the robot state and controlling it remotely. These tools run on a PC and communicate with the robot via the 802.11b Ethernet link.

The proposed research will require construction of a new GUI application that runs on the PC to which the looking glass is attached, and accepts requests from the robot to load and display images, flash the screen, etc. In addition, we will develop a variety of small application programs on the robot in order to make use of the looking glass in the different modes described above.

As background reading, we will study some earlier projects where users interacted with an intelligent entity and a display, such as Richard Bolt's "Put that there" system (Bolt, 1980), or the various interactive installations created by Bruce Blumberg's Synthetic Characters Group (Tomlinson et al., 2001).

References:

- Bolt, R. A. (1980) "Put that there: Voice and gesture at the graphics interface. Proceedings of the 7th annual conference on computer graphics and interactive techniques, pp. 262—270. Seattle, Washington.
- Tekkotsu Development Framework for AIBO Robots. (2004) Web site, available at <http://Tekkotsu.org>.
- Tomlinson, B., Downie, M., and Blumberg, B. (2001) Multiple conceptions of character-based interactive installations. Unpublished manuscript, available at http://characters.media.mit.edu/Papers/CHI_2001_character.pdf

Impact on the Goal of CREU

This project will provide an opportunity for two female computer science majors to collaborate on a significant research problem. The two will be part of a larger research group working in the Touretzky lab that includes two senior CS majors working on honors theses (unrelated to the looking glass idea), and a full-time research programmer, Ethan Tira-Thompson, the principal architect of Tekkotsu. If the project is successful, the students may be offered part time programming positions in the lab, or positions as teaching assistants for an undergraduate course in Cognitive Robotics based on Tekkotsu that Professor Touretzky is in the process of developing.

Student Activity and Responsibility

The students will create Java code to implement the looking glass server, and C++ application code to explore various human/robot/display interaction modes as described earlier. The students will work in Professor Touretzky's AIBO lab and participate in lab activities such as weekly research meetings and occasional demos for lab visitors. At the conclusion of the project the students and their advisor will jointly write a paper describing their results.

Faculty Activity and Responsibility

The faculty advisor will meet with the students at least once per week to discuss their research progress and suggest new tasks or new approaches to try. The lab's research programmer will also be available to assist the students as necessary.

Budget

The students will require accounts in the Computer Science Department's research computing facility (this is separate from the educational computing facility normally used for coursework), which will cost roughly \$450. Other costs include a flat-panel display that can be positioned at tabletop level (\$500), extra memory sticks (\$100), and miscellaneous supplies (\$25). These costs will be borne by Professor Touretzky's faculty discretionary account.

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Selected Coursework:

Advanced Java Programming

Calculus in 3 Dimensions

Matrix Algebra

System Skills in C

Principles of Programming (Standard ML)

Introduction to Electrical & Computer Engineering

Concepts of Mathematics (Logic)

Fundamental Data Structures & Algorithms (Java)

Great Theoretical Ideas in Computer Science I

Introduction to Computer Systems

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Matrix Algebra

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Concepts of Mathematics (Logic)

Fundamental Data Structures & Algorithms (Java)

Great Theoretical Ideas in Computer Science I

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David S. Touretzky is a Research Professor in the Computer Science Department and the Center for the Neural Basis of Cognition at Carnegie Mellon. His primary research areas are computational neuroscience (focusing on hippocampus and the rodent navigation system), models of animal learning, and cognitive robotics. Publications relevant to this proposal include:

Saksida, L. M., Raymond, S. M., and Touretzky, D. S. (1998) Shaping robot behavior using principles from instrumental conditioning. *Robotics and Autonomous Systems*, 22(3/4):231—249.

Touretzky, D. S., Daw, N. D., and Tira-Thompson, E. J. (2002) Combining configural and TD learning on a robot. Second International Conference on Development and Learning, pp. 47—52. IEEE Computer Society.

Dr. Touretzky has advised or co-advised roughly a dozen undergraduate researchers in the past ten years, using a combination of NSF REU supplement awards, independent studies, and paid programmer positions. Almost all of these students have gone on to pursue graduate work.