Designing a Humanoid Robot Face to Fulfill a Social Contract

Aaron Edsinger and Una-May O'Reilly
Artificial Intelligence Lab, MIT
edsinger@ai.mit.edu, unamay@ai.mit.edu

In building humanoid robots, we are also building in implicit expectations about the social abilities and interactions that the machine should exhibit. The morphology and aesthetic of the robot play a critical role in defining these expectations. Specifically, the robot face plays a paramount role in establishing the social competence of the machine, and in defining a social contract between the observer and the robot.

We will discuss the development of a face for our robot humanoid, Cog. This endeavor poses a host of design issues, from the technical constraints created by the mechanics of the head, to considerations of the impact of the face on the social contract which the robot will establish with its audience.

Previous work with humanoid faces tends to lie along a spectrum ranging from highly consistent realism [2]to a caricature of the human face, stressing the social role to be played by the robot [1]. In between these two extremes of realism and caricature lies a middle ground, which we define as iconic.

In considering a face for Cog, we are looking towards an iconic representation. This demands providing the critical facial cues such that the physical features of the head are suggested, the intended morphology is understood, yet the features are not so defined that the human viewer creates rigid social expectations that are easily broken.

While this approach implies an inherently neutral face, in terms of gender and race, we need to bias the design in terms of age and morphology. The robot morphology implies a level of physical and mental maturation, and this heavily defines the social expectations that the viewer imparts upon the robot. For Cog, we are looking at placing the developmental expectations at around the age of a 5 to 6 year old child.

Unfortunately the mechanical structures necessary in building robots often force anatomical distortions and disproportions that work against the desired social contract. Cog's existing body, on which the face is to be built, is more easily construed as a large, adult male than that of a young child. Thus the humanoid face plays a pivotal role in counterbalancing such opposing forces.

There are numerous technical considerations as well. Cog's head currently contains 6 degrees of freedom (DOF), including 2 CCD cameras for each eye.

The head imposes constraints in terms of weight, bulky mechanical structures, cable routing, and DOF that are not human-like in their motion. These constraints have necessitated moving to a new prototyping methodology. This methodology is based on using 3D Solid Modeling to generate Rapid Prototype models via a 3D printer. Using this method of design, we can rapidly evaluate new facial designs while moving towards more curvilinear mechanical structures than has previously been possible.

Finally, the overall aesthetic is an often neglected area in developing research robots. However, when the goal is to build socially competent humanoids, then the robot's ability to aesthetically invite the human into an interaction becomes important. In designing our face, we have given special attention to the social impact of the facial aesthetic.

References

[1] Cynthia Breazeal and Brian Scassellati. Infant-like social interactions between a robot and a human caretakere. In *Adaptive Behavior (To Appear)*, August 2000.

[2] Fumio Hara, Hiroshi Kobayashi, Fumiya Iida, and Massoki Tabata. Personality characterization of animate face robot through interactive communication with human. In *IARP First International Workshop in Humanoid and Human Friendly Robotics*, pages 1–10, Tsukuba, Japan, October 1998.