Devilishly Charming Robots and Charismatic Machines

Heather Knight, heatherbot@cmu.edu
Carnegie Mellon University

Introduction

Just as robotic soccer competitions motivated development of algorithms for multi-robot coordination and the DARPA Grand Challenge furthered the autonomous capabilities of vehicle navigation, I believe Robot Theater will inspire transformative algorithms for applications in everyday human-robot interaction.

This work builds upon Breazeal's call to action in [1]: "*The script places constraints on dialog and interaction, and it defines concise test scenarios. The stage constrains the environment, especially if it is equipped with special sensing, communication or computational infrastructure. More importantly, the intelligent stage, with its embedded computing and sensing systems, is a resource that autonomous robotic performers could use to bolster their own ability to perceive and interact with people within the environment*"

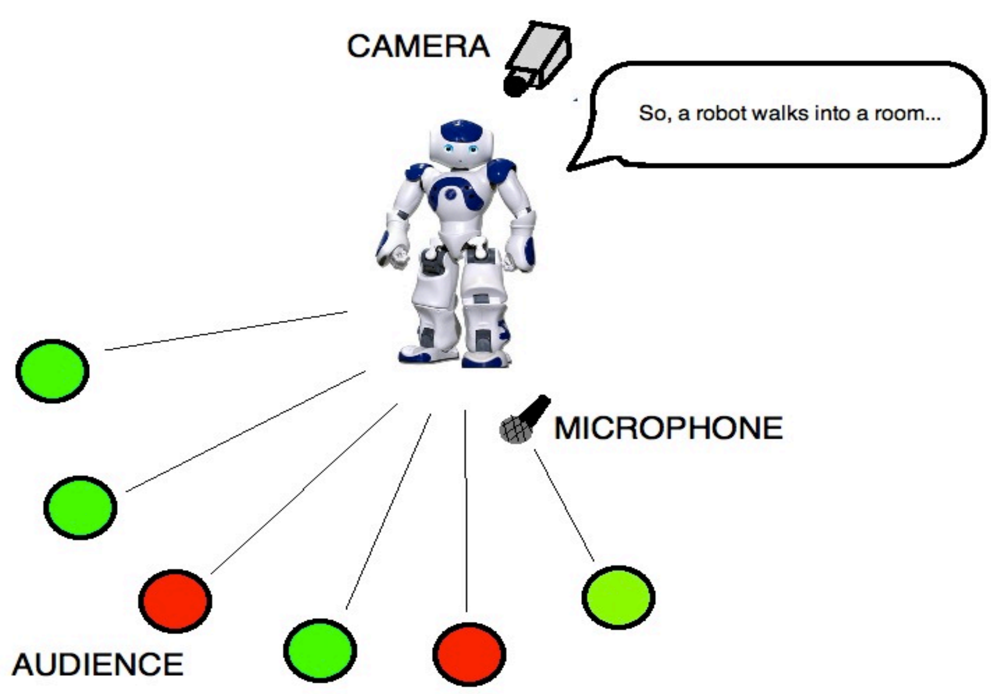

Figure 1. Set-up for a Robot Comedian with on-line learning of the audience model through audio-visual tracking

Background

Various forays have been made into the topic of robotic performance, including ([1][3][6][7]). The key addition in this project is the integration of intelligent audience sensing, which allows conscious and subconscious human behaviors to motivate live performance generation. In this process, we transform the theater into a valuable arena for interaction research.

Storytelling is a central facet of being human. It is common to spend much of our free time watching movies, sharing gossip and reading the newspaper. Robots' embodied presence and ability to touch and move around in the physical world allows us to communicate with them in novel ways, which are more naturally human. The past projects in Figure 2 bear example to this idea, particularly Cyberflora, an interactive robotic flower installation at the Smithsonian Cooper-Hewitt Design Museum in 2003 and The Sensate Bear, part of the Huggable Project at the MIT Media Lab [5].

Technical Goals

In investigating robot performance, we hope to reverse engineer constrained aspects of human social behavior in terms that a machine can understand and replicate.

Online Learning & Audience Tracking

Online learning provides the ability for a robot to incorporate new data, as it arrives, into its model of the world. By continuously updating inferred state (are viewers and/or interaction-partners paying attention, laughing, wandering away) and direct feedback modes (literal communication of desires), the robot can match its higher-level decisions to particular groups.This learning goes hand and hand with audience-tracking capabilities, i.e., using sensors to understand the human response.

The Standup Comedian robot, based on the Nao platform, pictured in Figure 1, uses online learning to cater its jokes, animation level, and interactivity to individual audiences. We model audience state by generalizing audio-visual features such as total volume (due to laughter, applause) and colored paddles (indicating like/dislike) to estimate what attributes an audience enjoys. [4]

This tracking will ultimately involve an exploration of a variety of technologies, which might be local to the robot, mounted on an intelligent stage, installed in the auditorium chairs or handed out to audience members, such as button-based input devices or even biometric sensing bracelets. We also hope that this audience modeling may cross apply to abstracted group behaviors, e.g. during a robot led tour.

Generating Robot Expression

Generating robot expression involves learning from human psychology and storytelling. Modes of expression could include tone of voice, timing, movement, LED illumination, facial expression, pose, overall animation level and interactivity. We hope to learn from the existing literature in drama research and practice to develop techniques relevant to society on a much wider scale [2].

To begin with, we are identifying particular expressive attributes (e.g. aggression, engagement, formality, valence), and evaluating them along a linear scale. The first study assesses the success of a robot's tour guide presentation, evaluating group body language and survey response. Continuing into the future, we hope create a taxonomy of non- verbal robot communication, as in the touch gesture library I developed for the Sensate Bear as part of my Master's Thesis [5]. In this case, the audience acts as a collective user study to evaluate the robot-expressions.

Abstracted Behavior Creation

If we know what performance parameters we want to control, we can create software that abstracts expression based on the taxonomies developed, simplifying the creation of new movements and performances, extending the work done in [3]. Smooth control software will also enable collaborations with human performers and potentially enhance the information-flow and shared intelligence those in the dramatic arts might be able to convey relevant to the creation of charismatic robots.

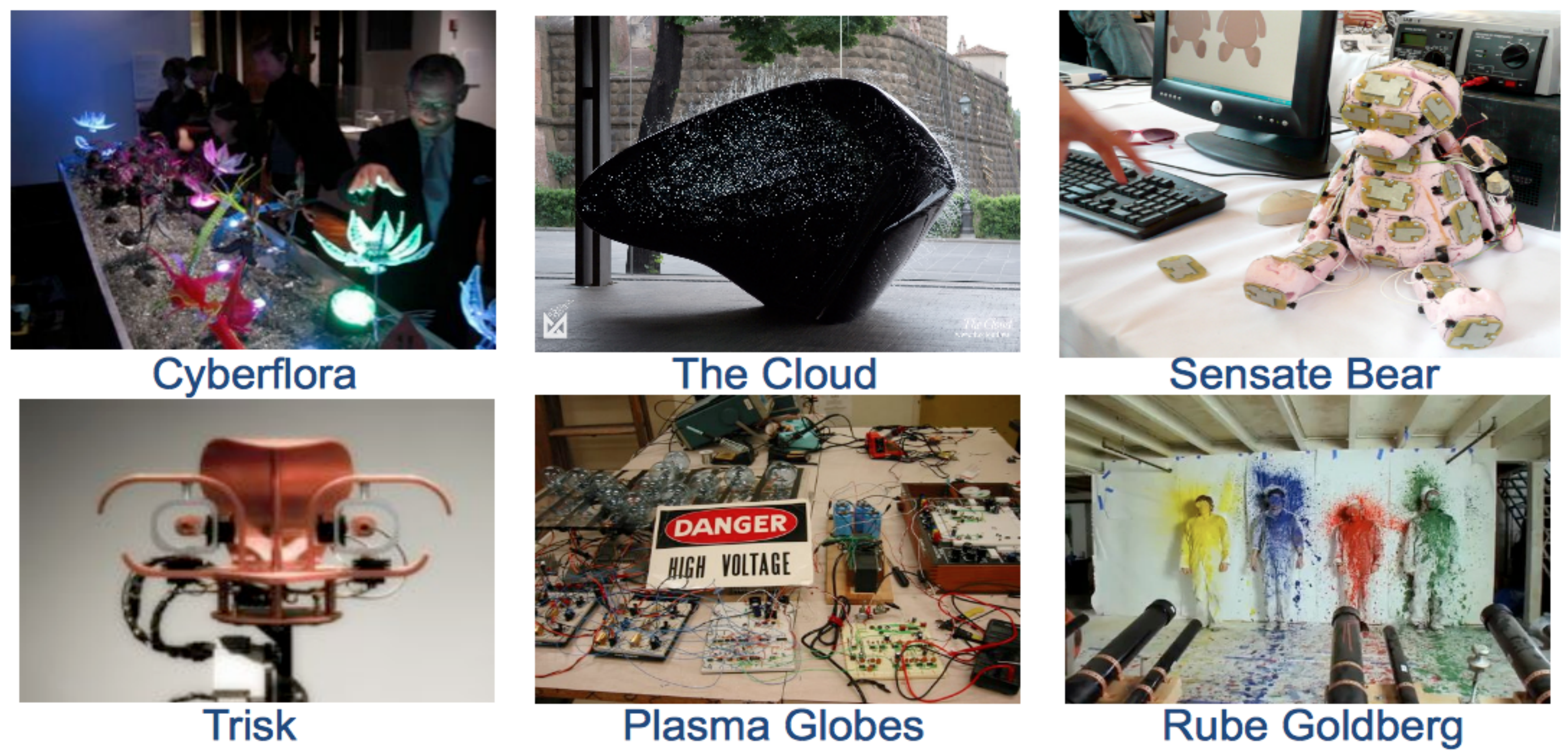

Figure 2. Previous projects that inform current work: Cyberflora, Sensate Bear, Trisk (MIT Media Lab), The Cloud (MIT Mobility Lab), Plasma Globes (MIT CSAIL), Rube Goldberg Machine for OK GO "This too shall pass" music video (Syynlabs)

Anthropomorphic Physical Design

The stage will allow us to evaluate the influence of physical configurations on perceived character within a constrained and repeatable environment [1]. By using robot designs that have different degrees of human-like physiology, we could undertake a deeper analysis of the "uncanny valley," a theory about the humanness of a robot's design, in collaboration with the human professionals of artificial expression and personality.

We can begin to characterize and define manifestations of anthropomorphism in robots, and explore whether human-like attributes are needed to imbue the robot with effective expression and personality. My hypothesis is that recognition of relatable physiology can both smooth and confuse communication, depending on the coherency of the robots behaviors. Perhaps we will find that 'anthropomorphic movement' and the 'social intelligence' one infers from a robot's behaviors have as much or more influence on natural interactions as a robot's physical form.

Conclusion

In our case, the metaphor of robotic theater has already served to develop algorithm concepts that apply directly to everyday robotics research. We hope to adapt the robot comedian software to a tour-guide robot that individualizes the sequence, style and topics of its tour based on self-supervised tracking, as part of an autonomous mobile robots initiative at CMU. It would incorporate online sequencing of content and constrained forms of spontaneous interaction.

In follow-up projects, it will be important to partner with and learn from those in the arts community. Ultimately, we hope these investigations will include full theatrical performances, deepening the understanding of character, motivation, and, even, relationships with other robotic or human actors on stage. The work has only just begun.

References

[1] Breazeal, C., et al. Interactive Robot Theatre. Comm. of ACM, 2003, 76-85.
[2] Demers, L. Machine Performers: Neither Agentic nor Automatic. HRI workshop on Collab. with Arts, 2010.
[3] Hoffman, G., Kubat, R. A Hybrid Control System for Puppeteering a Live Robotic Stage Actor. RoMan, 2008.
[4] Knight, H. A Savvy Robot Standup Comic: Online Learning through Audience Tracking. WiP, TEI 2011.
[5] Knight., H. et al. Real-time social touch gesture recognition for sensate robots. IROS, 2009, 3715-3720.
[6] Lin, Chyi-Yeu, et al. Humanoid robots and theatric performance. ICAR, Advanced Robotics, 2009, 1-6.
[7] Murphy, R., et al. Midsummer's Night Dream (with Flying Robots). HRI workshop on Collab. with Arts, 2010.

For further information

Please contact *heatherbot@cmu.edu*. More information on this and related projects can be obtained at *www.marilynmonrobot.com.*