Building Robots that Live with Us

Lijin Aryananda

Artificial Intelligence Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

http://www.ai.mit.edu

The Problem: For the past several years, our group has built humanoid robotic platforms and learned meaningful insights from various projects on themes of development, social interaction, physical embodiment, and integration [3, 2]. This project aims to address a particular limitation of existing robots, i.e. they have not been designed to be up and running for long periods of time. They are usually only fully turned on during learning procedures, debugging, testing, and demonstrations. Depending on project schedule, this could mean several hours per day or nothing all week. They are rarely left running without supervision due to various safety hazards, ranging from burning motors to software crash. As a result, they do not live in the world for 24 hours a day, 7 days a week the way we do.

Motivation: One could imagine that a sociable robot that is robust and reliable enough to be left on and running all the time will have quite interesting effects. In the same way, if our dogs and cats were only awake several hours a week and freeze the rest of the time, our interactions with them would probably not be as exciting. A robot that is continuously living in the world, either playing with us or simply resting at times, will develop to be a part of our environment. We predict that as a result, more dynamic social interactions will emerge. Longer term learning processes and experiments, which were not previously viable, may lead to motivating insights. Moreover, previous simplifying assumptions will be relaxed, forcing us to deal with increased complexity in certain areas. For example, we will have to deal with the continuous stream of data entering the robot’s perceptual system.

Previous Work: Bischoff [1] suggested that issues regarding system reliability and safety have not received the proper amount of attention in humanoid robotic research due to a false belief that when the time comes for robots to be expedited, someone else will eventually deal with it. While many complex robots and impressive results have been achieved, the criteria for robots’ robustness and reliability have generally been limited to the span of testing periods and end-of-project demonstrations. It is certainly reasonable to not get bogged down with the occasional hazards when it is difficult enough to get a robot to perform in the world. However, we argue that for our particular goals, we need to begin addressing these issues and maybe temporarily trade off some complexity for robustness in order to dramatically increase our robots’ running time because we may be missing something important otherwise.

Approach: In building our next robotic platform for investigations of situated and associative learning, we are going to allocate a significant portion of the design process to carefully deal with robustness and reliability issues. We aim to equip this robot with the capability to boot quickly, turn on easily, run safely without supervision for days at a time, and recover gracefully upon serious failures, i.e. system crash, power loss, etc. This does not mean that the robot will always be actively moving, socializing with people, while cranking learning algorithms all at the same time. Like human, the robot may use several hours of the day to sleep to allow various parts to recuperate and also give an opportunity for heavy post-processing computations to run.

In order for this to happen, thorough consideration is needed throughout the design process. Past robot implementations have taught us lessons and we will apply them in each design step, from deciding on robot size, joint design, actuators, motion control, to choosing material, gears, bearing, cable, connectors, etc. For example, we have learned to avoid heavy and singular axes and that we should implement various sensors to increase fault detection ability. We also intend to utilize the latest technology and organize our resources to minimize, modularize, and modernize both hardware and software components as much as possible.

Impact: A reliable robotic platform that is continuously up and running in the world may not only reveal some emergent properties and useful insights in our investigations of situated and associative learning, but could also be a useful asset for future projects in general.
Future Work: Except for a very preliminary robot head design, this is all otherwise future work.

Research Support: This work is funded by DARPA as part of the “Natural Tasking of Robots Based on Human Interaction Cues” project under contract number DABT 63-00-C-10102 and the Nippon Telegraph and Telephone Corporation as part of the NTT/MIT Collaboration Agreement.

References:

