Whole-Body Robot Sensing Is Prerequisite for Human-Robot Interaction and Teams

Vladimir Lumelsky
NASA, University of Maryland

Abstract

While control via sensing in robotics and in human-robot interaction is important for both robot autonomous vehicles and arm manipulators, it is more prescient and less understood in robot arm manipulation tasks. Analysis of such systems suggests the following:

- Mutual safety of humans *vis-a-vie* robots *vis-a-vie* other objects in an unstructured environment dictates a need for massive coverage of the whole robot body with sensors.
- Achieving robot motion planning skills sufficient for an unstructured setting dictates the same, whole-body sensing.
- Theory shows that whole-body robot sensing gives rise to interesting and efficient motion planning algorithms that compete with human skills.
- Whole-body sensing hardware and its control present a variety of challenges to today's electronics, material science, and embedded microprocessor control.
- Humans have cognitive difficulties controlling robots in real time – causing severe constraints for human-robot teams, such as a robot helper for the elderly or a robot assistant to an astronaut.
- There is a happy circumstance: in some motion planning tasks humans can think better than robots, while in some others robots *can think* better than humans. The latter is true only if the robot is given enough sensing – and it points to a natural synergy of human-robot teams.

Satisfactory resolution of the issues involved promises to deliver robot systems that are, on the one hand, cautious and friendly to their hosts and environment (think of the Azimov's laws), and on the other, allow unsupervised automation in unpredictable settings. In this talk we will expand on the bullets above, trying to shape them in terms of the issues in the disciplines involved:

- Algorithms for motion planning – kinematics, computational geometry & topology issues
- Cognitive science – studying (poorly-understood) human motion planning skills
- Electronics – large-area sensing arrays, sensitive skin design, tactile *vs* proximity sensing
- Material science – bendable and stretchable sensitive skins
- Control - tradeoffs between sensor density, array sizes, sensitivity of motion planning