CCC Research Roadmap Proposal

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For most of its history, the field of robotics has been cleaved in half. On one side is mobility, on the other manipulation. Researchers working in mobility have been building "intelligent" systems that use sensors to model and navigate their environments, but are unable to effect physical changes. Researchers on the other side have been building "automation" and "teleoperation" systems that can manipulate objects, but operate in a fixed workspace. The challenge of developing assistive healthcare robots will require these two camps to come together and work collaboratively on *mobile manipulation*.

Fortunately, this collaboration is already underway, with a number of research groups working on mobile manipulation systems. But progress is hindered by two obstacles: the bar to entry, and the lack of code reuse. If a researcher wants to get into mobile manipulation, she must first buy or build a hardware platform. Neither option is appealing, given the scarcity and cost of off-the-shelf systems, and the difficulty and complexity of building a new system. Even given the hardware, there remains an enormous amount of software to be developed, for everything from 2-D navigation to arm control. In the current development model, this software is implemented and reimplemented by each group, with little or no sharing of even the basic building blocks that are common across all platforms. Higher-level "application" functionality is shared even less.

The key components missing in the research community are standard hardware and software platforms. The availability of a robust, relatively inexpensive mobile manipulation robot with modular components and open hardware interfaces would have great impact. The hardware would be accompanied by a flexible, modular software framework, again with open interfaces. Atop this framework, the robot would "ship" with an application stack comprising state-of-the-art solutions to solved problems. For example, 2-D navigation (mapping, localization, planning) in indoor environments is a solved problem. Therefore, mobile manipulation researchers should spend zero time working on navigation; it should be a built-in capability of the robot. For problems that remain open, such as object recognition and arm control, the best current algorithms should be implemented and available, "out of the box." The researcher is free to build upon, modify, or simply replace any of these modules.

Importantly, any module or system of modules that are developed by one researcher can be immediately used by another. Imagine that the next time your fellow researcher at another university demonstrates a fantastic mobile manipulation demo, she publishes her code, and you then run and test her demo in your lab. This kind of cross-validation and code-sharing can be made possible by community adoption of common, open hardware and software.

To see the possibilities, we have only to look at the example of that workhorse of mobile robots, the SICK-equipped Pioneer, usually running Player or CARMEN. Mobile robot research was greatly accelerated by the critical mass of groups that were using this common platform. The same can, and should, be done for mobile manipulation, which will be a key enabler for medical and healthcare applications.