Use of Robot Simulations can Enhance Integration

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1 Introduction

To simulate or not to simulate? This has become a key issue in adaptive robotics. As the following quotes suggest, there is still no consensus on how to answer this question.

> There is currently a hot debate among people trying to understand and reproduce intelligent agents, that could be stated as follows: Is the simulation a powerful enough tool to draw sound conclusions, or should a theory or an approach be tested on a real agent, i.e. a robot? [2]

> Simulation in robotics, control theory, and AI has mostly been a complete waste of time. [1]

> ... it does appear that simulations are not quite the dead-end some had suggested. For simpler cases at least it has been shown that they can be made accurate enough. [3]

Generally the debate about simulations centers around the so called *correspondence problem*—whether results obtained on a simulator will transfer to a real robot. However, the goal of trying to integrate current research results adds a new twist to this debate. We believe that the use of simulations can aid integration and thus the continued development of good simulations is merited.

2 Why Simulate?

It is expensive and time consuming to maintain many different robot platforms, therefore most labs focus on a few platforms. As a result, control strategies tend to be designed and tuned for particular platforms leading to integration difficulties.

Most robot manufacturers provide simulations of their products. Once such a simulation exists it is generally simpler to deal with than the actual hardware because real robots break down, wear out, and can be tempramental. A software simulation of a robot is more easily manipulated and monitored. Even more importantly, learning on a simulation is significantly faster than learning on an actual robot in real time.

If simulations where made available as shareware or for a nominal fee (manufacturers could be induced to do this because it would expose many potential customers to their products), it would be possible for researchers to test out a control idea on a wide variety of platforms. Ideas that proved successful in simulation on several platforms would still need to be tested on real robots, but passing this simulation milestone would provide some confidence in their viability.

Having to interface a control system with a variety of platforms should lead to more communication and sharing amongst researchers. Rather than narrowly focusing our attention on a single type of robot, using simulations as a testbed could lead to more robust and generalizable results.

Currently, simulations deal with relatively simple sensors, such as sonar, and simple affectors, such as wheels. As the sensory capabilities of robots become richer, it will become increasingly difficult to construct accurate enough simulations. In the near future it may become more time consuming and expensive to build a simulation than it is to just do online learning. Should we abandon simulations at this point?

3 The Future of Simulations

One possible approach is to *learn the simulation itself.* A robot could explore an environment and collect appropriate data about it. Then one of two types of models could be constructed from this data: implicit or explicit.

An implicit model wouldn't have an actual representation of walls or objects. Rather, the simulator would learn relationships such as when the front sonar reading senses something close, the front bumper is likely to activate. This is simply an association of senses with other senses with affectors changing the state in a learned fashion. Exact location cannot be determined, because everything is implicit.

An explicit model would have data structures representing walls, chairs, tables, etc. Computations would be necessary to determine when a sensor should be activated. For example, methods such as ray-tracing would be required to compute how much light would be shining on a light sensor. In this type of model model, exact location in the simulation can be determined as it would be explicitly represented.

Certainly an implicit model would be much simpler to construct but would it contain enough information to be useful? As for explicit models, would it even be possible to learn them? These are open questions (and mirror many of the issues raised between the subsymbolic and symbolic paradigms). However, the idea of applying learning to the construction of simulations is worth further exploration.

4 The Next Leap

In order to make the next leap in robotics research, we believe that simulations can be made which are capable of handling more complex sensors (such as vision). In addition, such simulators could provide a foundation for integrated research independent of robotic platform.

References

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