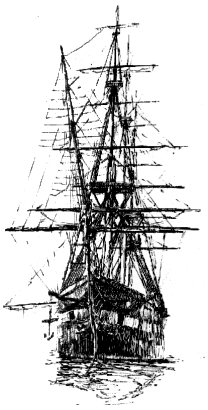

Mobile Autonomous Robotic Systems for Unstructured Environments-- With Application to the USS Constitution

Steven Dubowsky, Principal Investigator
Jeffrey Cole
Nathan Rutman
Craig Sunada
Department of Mechanical Engineering
Massachusetts Institute of Technology
Cambridge, MA O2139 USA

Abstract

This SGER (Small Grants for Exploratory Research) program focuses on some issues in the design, control and planning for field robotic systems. The study is being done within the context of the development of field robotic systems to assist in the conservation and preservation of artistic, historical architectural and archaeological treasures and monuments, with *The USS Constitution* as a demonstration project.

1. Motivation

Robots are needed for important missions in field environments, including nuclear power maintenance, disaster mitigation, cleanup of toxic waste dumps, terrorist bomb disposal, infrastructure inspection, and commercial tanker hull maintenance[1]. Robotic systems could remove humans from dangerous mission tasks or enter locations that are not readily accessible. Robotic systems could also be more cost effective than humans for such applications as the inspection of the undersides of highway bridges.

A great deal of research has been done to develop robots for work in specially structured manufacturing cells. Current research is developing field robotic systems to perform missions in environments that are not well known. Field systems must be capable of mobility and be able to manipulated the environment[2]. These systems must also be robust, be self contained, power efficient, dexterous, agile, and have a high degree of autonomy. Besides these technical challenges, a major limitation to their practical use is their cost and development time. Such systems are not now "mass produced,"--each is generally designed for a specific mission. This technology is prohibitively expensive for most applications.

2. Research Objective and Approach

The objective of this research is to develop paradigms for design, control and planning to permit field robotic systems to developed quickly and cost effectively. The approach being taken focuses on multi-limbed mobile robotic systems constructed with modular components. As has been shown for modular industrial manipulators[3], modular field systems designs, based on task requirements, would have a number of advantages. This research is exploiting two principle advantages of modular design. The first is that it reduces "the optimal design problem" to a search of a relatively small finite dimensional discrete space for a feasible or workable solution. Mathematical search techniques that are not applicable for a general design problem become quite effective for a modular design problem. The second is that modular systems reduce cost through the use of standard subassemblies, including matching control and planning software modules.

It has been shown that, with good knowledge of a system and its environment, effective planing and control algorithms[4] can be developed for the real-time control of a multi-limbed system. For complex modular systems operating in unstructured environments these model-based methods can become computationally excessive. Behavior based algorithms have been proposed that rely on a set of preprogrammed behaviors[5]. This approach requires minimal real-time computation. However they are generally formulated in an ad hoc manner. Applying this approach for a new field system could require many man hours of programming and testing time to establish the underlying behaviors. The behavior-based approach is being extended here to rapidly deployable modular systems, by developing methods for the development of new behaviors based on the physical nature of these systems, rather than ones that rely a programmer's judgments. The use of genetic algorithms to evolve these behaviors to meet changing environmental conditions is also being studied.

3. The Project Constitution

The study is be done within the context of the development of field robotic systems to assist in the conservation, restoration, and preservation of artistic, architectural and archaeological treasures and monuments[6]. *The USS Constitution* is serving as a demonstration project. *Old Ironsides* is the oldest fully commissioned warship in the world, and a proud symbol of America's naval history. Her preservation is an important . In this research, she will provide a testbed to evaluate and demonstrate the design paradigms and control and planning algorithms for field systems being developed. This research would have the benefit of opening this meaningful area for society to the use of robotic technology. It appears that robotics could make an important contribution to the preservation of the Constitution[7].

4. Conclusions

This research is focusing on technical issues whose solutions would contribute to our ability to develop field robots that could have considerably improved performance and be more cost effective.

5. Acknowledgement

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