Carnegie Mellon University
THE ROBOTICS INSTITUTE

Thesis Defense

Matthew Tesch

Thesis Committee

Howie Choset
Chair

Jeff Schneider

J. Andrew Bagnell

Jared Cohon

Stefan Schaal
University of Southern California

Improving Robot Locomotion Through Learning Methods for Expensive Black-Box Systems

Monday, November 25, 2013
Newell Simon Hall 3305
10:00 a.m.

Abstract

The modular snake robots in Carnegie Mellon's Biorobotics lab have been shown to excel at a variety of locomotive tasks and have incredible potential for navigating complex terrains, but much of that potential remains untapped. The motivation to expand the capabilities of these robots stems from experiencing several failures and limitations in real world tests.

This thesis addresses the improvement of these capabilities through the optimization of functions which are expensive (requiring significant time, money, computation, or other resources), black-box (providing no gradient or derivative information), need not be convex or linear, and may have many local optima. Objectives evaluated through tests on physical robotic systems often fit these categories.

Several approaches are derived and tested for optimization of snake robot gait motion, leading to improved locomotion across flat and sloped terrain. Additional unique challenges posed by robotic systems are addressed, including stochasticity in the objective, consideration of multiple conflicting objectives, and the desire to adapt to changing environments. These learning approaches are extended to optimize complex motions for navigation over large obstacles, even in the case of very limited feedback (a binary success or failure signal).

Overall, these algorithms allow snake robot locomotion through any type of environment to be optimized. Furthermore, the generality inherent in the black-box approach allows these techniques to be applicable to a wide variety of problems in robotics.