An approach to optimal motion generation for hydraulic robots

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Hydraulic machines are widely used in a variety of applications ranging from aircraft actuator systems to construction, mining, excavation, and forestry. Roboticists are now beginning to examine problems related to automating a few repetitive tasks in the above mentioned areas since there exists room for enhancing productivity while decreasing production costs. Through consistent optimal performance a robotic machine can yield significant gains over a manually operated machine. The objective function for the optimal operation can be chosen to optimize not merely productivity (tons/hr) but rather a combination of productivity and cost of production ($/ton).

I propose a strategy for addressing the problem of optimal motion computation for hydraulic robots. This consists of two parts:

- Developing a "usable" model of the hydraulic robot.

- Using the hydraulic robot model for optimal motion computation.

A complete hydraulic robot analytical model is impractical for optimal motion generation since it is computationally expensive. A typical model requires the simultaneous solution of a system of a few hundred non-linear equations. A simplified usably fast model must however capture the complex and non-linear characteristics of the hydraulic robot, which are due to the inherently non-linear nature of fluid flow through an orifice, and due to hydraulic system interactions between the different joint actuators.

I have developed a new approach to building hydraulic system models using memory-based learning. These models are about an order of magnitude faster than comparable analytical models and seem to be capable of capturing the important characteristics of a hydraulic system.

I have also conducted some initial experiments with the use of the Simulated Annealing algorithm in searching for the optimal robot motions and the results are promising. I propose to implement a scheme to compute optimal motions for a hydraulic excavator. This will use a hydraulic robot model built using the approach developed in this work, and the Simulated Annealing algorithm to conduct the search for the optimal motions. I propose to demonstrate my results on a real hydraulic excavator testbed.