# GPU-based Robot Dynamics Simulator for Semi-Infinite Nonlinear Optimization

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**Abstract:** We propose a GPU-based computation method to solve computationally-expensive semi-infinite optimization problems for motion planning of robotic systems. Our approach relies on the computational capabilities of many-core GPUs to compute the constraints and their gradients in parallel, before providing the result to a nonlinear optimization solver.

Previous work relied on a CPU-based multithreaded implementation that used time intervals as a basis for parallelization. This method led to hour-long computations which limited its scope of use to offline motion database generation. In this work, we further consider the dynamics algorithm and the independent gradients to create a highly-parallelizable computational model that can greatly benefit from the GPU architecture.

We demonstrate the result of our method with 3D models such as kinematic chains and actual humanoid robot models. The current results hint at a speedup of several orders of magnitude compared to the previous CPU-based parallel version. Thus, this research lays the groundwork for a full-fledged GPU-based multi-contact motion planning library dedicated to humanoid robotics problems.

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