Real-Time Motion Planning of Construction Equipment Mechanism by Dual-Resolution Heuristic Search

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Introduction of embedded computer control in construction equipment paves the way for implementation of enhancements to improve overall productivity and competitiveness of machines. One of these features is the capability for automated or autonomous machine operation.

This research present a memory efficient real-time motion planning algorithm for the blade linkage mechanism of a motor grader. This enables to execute repetitive blade positioning tasks and to move the blade between any two positions without operator interaction while automatically avoiding collision between the blade and frame or wheel parts during the motion of the blade.

Collision-free blade configurations are obtained in a preprocessing phase utilizing deterministic dual-resolution sampling. Moving obstacles such as front wheels and articulation functionality, both used for machine steering, are decoupled for complexity and memory reduction. Solutions to particular path planning problems are computed in real-time by heuristic driven A* path search. To enable path planning on current and future anticipated low-cost embedded computer resources of construction machinery, the search strategy is optimized by designing the behavior of heuristic functions specifically for this problem space. An adaptive closed-loop control approach is proposed enabling multi-axis coordinated motion control of the blade under varying load conditions and transient hydraulic system pressure fluctuations.

The performance of the approach is evaluated, and simulation and experimental results show that path and trajectory planning can be accomplished in real-time on the target application.

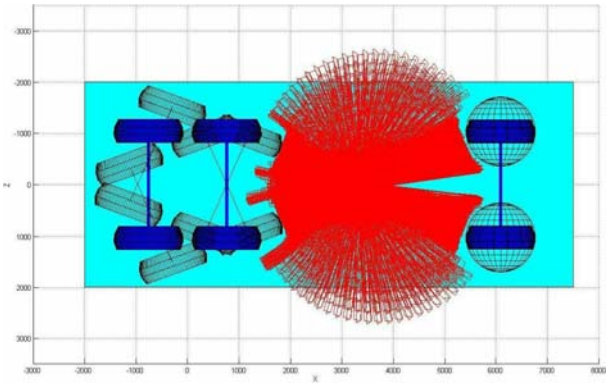

Fig.1: Dual-resolution sampling with decoupled steering and frame articulation.

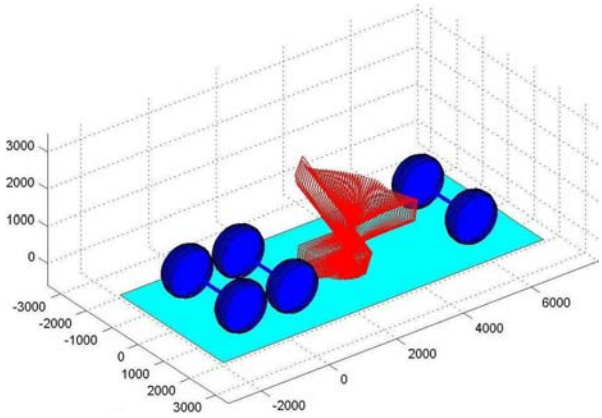

Fig.2: Example trajectory of end-effector.