pc-dbCBS: Kinodynamic Motion Planning of Physically-Coupled Robot Teams

(Regular Video)

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***Abstract*— Motion planning problems for physically-coupled multi-robot systems in cluttered environments are challenging due to their high dimensionality. Existing methods combining sampling-based planners with trajectory optimization produce suboptimal results and lack theoretical guarantees.**

We propose pc-dbCBS, a kinodynamic motion planner for high-dimensional physically-coupled systems. Our method extends discontinuity-bounded Conflict-Based Search (db-CBS) to the physically-coupled systems domain. Our hybrid approach uses a discrete search over motion primitives that are computed for individual robots offline and allows bounded violations for the physical coupling constraints. The resulting solution is transformed to a different minimal-state representation that is then used by a trajectory optimization, enforcing physical coupling constraints implicitly. By repeating these steps iteratively, the resulting algorithm becomes probabilistically complete and asymptotically optimal.

We demonstrate on a benchmark with 25 problems in simulation and 6 problems on real robots that our method is generalizable across different robot types, namely cable-suspended payload transport using multirotors and differential-drive robots connected via rigid rods. Our approach outperforms the state-of-the-art by solving more instances and producing solutions that are twice as fast with significant lower computational effort.

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Code: https://github.com/IMRCLab/db-CBS/tree/tdbastar-quad-payload

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