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Contention-Resolving Model Predictive Control for Coupled Control Systems with Shared Resources

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ABSTRACT: Priority-based scheduling strategies are often used to resolve contentions in resource constrained control systems. Such scheduling strategies inevitably introduce time delays into controls, which may degrade the performance or sabotage the stability of control systems. Considering the coupling between priority assignment and control, this talk presents a novel method to co-design priority assignments and control laws for each system, which aims to minimize the overall performance degradation caused by contentions. The co-design problem is formulated as a mixed integer optimization problem with a very large search space, rendering difficulty in computing the optimal solution. To solve the problem, we develop a contention-resolving model predictive control method to dynamically assign priorities and compute an optimal control. The priority assignment can be determined using a sample-based approach without excessive demand on computing resources, and optimal controls can be computed iteratively following the order of the assigned priorities. With fundamental assumptions in real-time scheduling, the solution computed by the contention-resolving model predictive control is proved to be globally optimal. The effectiveness of the presented method is verified in three real-world applications, which are networked control systems, traffic intersection management systems, and human-robot collaboration systems. The performance of our method is compared with the well-known scheduling methods and demonstrate significant improvements using our method.

BIOGRAPHY: Dr. Ningshi Yao is currently a Posdoctoral researcher in Geogia Tech System Research lab. She received her Ph.D. degree from the School of Electrical and Computer Engineering at Georgia Institute of Technology, in 2020. She received the B.S. degree from Zhejiang University, China, in 2010. Her research interests include scheduling and control co-design, cyber physical system, real-time scheduling, machine learning and human robot interaction.

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