A new way to improve automated systems

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Researchers from Zhejiang University in China have developed a new way to boost the performance of automated systems such as energy plants, airplanes and electronics. The researchers published their method in the July issue of *IEEE/CAA Journal of Automatica Sinica* (*JAS*), a joint publication of the Institute of Electrical and Electronic Engineers (IEEE) and the Chinese Association of Automation (CAA).

Automated systems employ model predictive control to efficiently use power. The method analyzes current behaviors and time frames to predict and initiate the best next steps to optimize the goals of the system. For example, the automated flying system in an airplane must examine flight elevation, speed, weather conditions, the distance to destination, fuel supplies, and more to efficiently use its resources to arrive safely.

"Model predictive control is widely used because of its ability to effectively handle the complex dynamics of systems with multiple inputs and outputs, system constraints, and conflicting control objectives," wrote Hongye Su, an author on the paper and a professor at Zhejiang University, China. "A key role in this framework is something called 'feasible set.'"

The feasible set is all of the potential actions a system can perform while staying within pre-determined constraints—like all the roads you could take, within a state, to reach the same destination. These possible solutions can be mathematically visualized as a space within specific shapes, and as constraints change, so do the shapes.

Su and his team have designed an algorithm that computes the feasible set using constraints represented by geometric shapes. The program can quickly determine the angle of the inner connections within each shape, resulting in the feasible set or all possible actions with ease.

"The simulation shows that the proposed method is especially efficient for low dimensional feasible set computation and avoids the non-unicity problem of optimizers, as well as the memory consumption problem encountered by projection of algorithms," Su wrote.

Optimizing the systems of such things as energy use can take significant memory and time, especially with an extraordinary number of constraints to consider. By applying what Su and his team call the "polyhedral feasible set computation," the problem can be solved quicker and with less computing power, in terms of the memory required.

Su warns that this only holds true for low dimensional feasible sets, however. The fewer constraints to consider, the fewer dimensions a feasible set contains.

"If the dimension of the feasible set is very large, the computational burden of the proposed method would be horrific," Su wrote, noting that a possible solution may lay in changing the shapes used in the computation to polyhedrons and more work is needed to further explore this possibility.

More information: Lantao Xie et al, Polyhedral feasible set computation of MPC-based optimal control problems, *IEEE/CAA Journal of Automatica Sinica* (2018). DOI: 10.1109/JAS.2018.7511126

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