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Safe Autonomy for Aerospace and Vehicle Systems

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Ensuring safety in aerospace systems and autonomous vehicles often hinges on effective management of constraints. For instance, a satellite operates under constraints such as orbital position and angular pointing accuracy as well as available electrical power and communication bandwidth, along with actuator range and rate limits. The algorithmic and software complexity required for limit protection systems can surpass that of the original control system. Complexity increases with growing vehicle integration as limits in the trajectory, propulsion, electrical power and heating subsystems may need to be simultaneously handled.

Effective controllers for constrained systems must be nonlinear and rely on prediction or invariance properties. They also frequently incorporate iterative onboard optimization, and this introduces challenges related to real-time solution computation. Another source of difficulty is that some elements in the control loop may be specified as neural networks.

The talk will survey several constrained control methods based on reference governors and model predictive control (MPC). The potential for these methods in aerospace applications and other vehicle control problems, such as spacecraft rendezvous and proximity operations, spacecraft attitude control, and self-driving cars will be highlighted.