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P4.1096 Actuator Management via Real-time Optimization for Integrated Control in Tokamaks

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In ITER, only a limited number of actuators is available to carry out a great variety of control tasks, some of which may be closely coupled. Safe operation while attaining high plasma performance will require an integrated Plasma Control System (PCS) that has the capability of simultaneously regulating as many aspects of the plasma dynamics as possible. Moreover, such integrated PCS must include supervisory and actuator management systems. The goal of such systems is to determine and assign in real time the authority of each control task over the available actuation mechanisms depending on the plasma state. In this work, an integrated controller with actuator management capabilities is proposed for simultaneous control of the central safety factor, q_0, the edge safety factor, q_edge, the total stored energy, W , the bulk toroidal rotation, Ωφ , and/or line-average electron density,n̄_e. Figure 1 shows a simplified schematic of a possible PCS architecture in which the integrated controller proposed in this work could be embedded. The integrated controller is based on zero-dimensional, controllevel models of the plasma dynamics, and is synthesized using nonlinear, robust Lyapunov techniques to ensure high performance despite nonlinear, unknown plasma dynamics. The actuator management algorithm employs the time-varying, plasma-state-dependent control priorities to decide which actuators are utilized for each control task. The actuator management problem is solved as a real-time optimization problem, providing substantial flexibility to include changing control objectives in the form of time-varying constraints. Also, this scheme allows for performing the two main kinds of actuator sharing envisioned for ITER: Simultaneous Multiple Mission (SMM) sharing and Repurposing (RP) sharing [1]. The proposed control algorithm is tested in onedimensional simulations using the Control Oriented Transport SIMulator (COTSIM) code.

References

[1] D. Humphreys et al, Novel aspects of plasma control in ITER, Phys. Plasmas 22, 021806 (2015)

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