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Development of Real Time Multiple Control Algorithm for Integrated Control of Plasma Profiles and Neoclassical Tearing Mode

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Control of plasma profiles and magneto hydrodynamic (MHD) instabilities is essential to establish advanced operation scenarios, a promising approach towards DEMO. For the purpose of simultaneous control of these plasma profiles and MHD instabilities, an integrated real time control algorithm is developed in this work. The developed control algorithm deals with electron temperature (Te) and safety factor (q) profiles for radial plasma profile control and the NTM for MHD instability control. Control of normalized beta is also considered for a global performance control. We address the issue of the actuator sharing by avoiding conflict among each multiple control variables while maintaining a high performance plasma. The Te and q profiles are controlled by using a new real time profile control approach which is applied to 2013 KSTAR experiments for its validation on control of Te. For NTM control, the minimum growth rate seeking algorithm is adopted as an extremum seeking control. The normalized beta is controlled using a classical Proportional-Integral-Derivative (PID) controller. Finally, all the control algorithms developed separately are combined into a multiple control algorithm. In this work, we employ a Multiple Model Multiple Controller Adaptive Controller which includes a supervisory control based on the Unfalsified Control principle and robust control techniques to synthesize the multiple controllers. In order to verify our approach, it is applied to KSTAR advanced operation scenarios developed using CRONOS by reflecting the planed KSTAR H/CD mix.

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