Optimization of Parameterized Transport Models in COTSIM

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COTSIM (Control Oriented Transport SIMulator) is a 1D transport code based on Matlab/Simulink, which makes it control-design friendly. It assumes a prescribed MHD equilibrium although coupling with a Grad-Shafranov solver is expected to become available in the future. It has a modular configuration, which makes adding or removing physics complexity extremely simple. This enables a speed-accuracy trade-off. COTSIM is capable of running off-line fast simulations, which makes it suitable for effective iterative control design. This includes the capabilities of testing control algorithms in closed-loop simulations and carrying out scenario planning by model-based optimization. Moreover, COTSIM is capable of providing real-time and faster-than-real-time predictions, which makes it suitable for real-time control applications such as feedback control, state estimation, state forecasting. and real-time optimization.

In this work, COTSIM is wrapped by an external optimizer in order to tailor parameterized transport models such as the Bohm/gyro-Bohm [1] and Coppi-Tang [2] models to device-specific experimental scenarios. As shown in Fig. 1, the optimizer adjusts the family of transport-model parameters α in order to minimize a cost function J subject to constraints. This cost function is defined as a measure of the mismatch between the experimental plasma state x and the COTSIM-predicted state $\bar{x}$ based on the associated experimental input u. The optimization problem is solved by sequential quadratic programming (SQP), which is predicated on determining a local minimizer of the original nonlinear program by iteratively solving a sequence of approximated quadratic programs. The approach will be illustrated by using DIII-D experimental data to enhance prediction of internal profile dynamics.

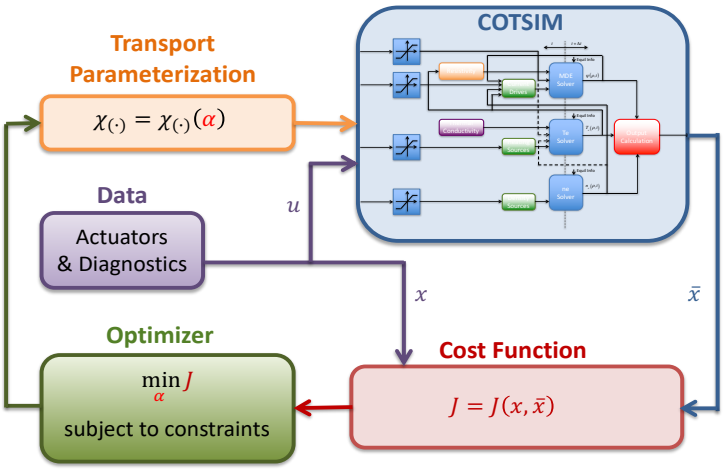

Figure 1: *Optimization scheme for transport parameter tuning.*

References

[1] M. Erba et al., "Validation of a new mixed Bohm/gyro-Bohm model for electron and ion heat transport against the ITER, Tore Supra and START database discharges," *Nuclear Fusion*, vol. 38, no. 7 (1998).

[2] S. Jardin, M. Bell, and N. Pomphrey, "TSC simulation of ohmic discharges in TFTR," *Nuclear Fusion*, vol. 33, no. 3 (1993).