MODEL PREDICTIVE CONTROL FOR SPACE APPLICATIONS

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ABSTRACT

Model Predictive Control (MPC) is proposed as an effective technology for the control of spacecraft, ranging from standard "low-level" control tasks, such as attitude control, to more "high-level" tasks such as mission-management, mid-mission re-planning, active fault-tolerance, and in general increased autonomy. MPC provides a unified approach to planning and control in dynamic environments. Its online, real-time optimisation can exploit knowledge of system models and behaviour constraints to make complex decisions without unnecessary conservatism. Furthermore, links to fundamental control theory enable MPC to provide guarantees such as assured levels of performance despite unknown disturbances. Basic MPC, for simple formation control for example, requires the online solution of a convex linear or quadratic program, which can be done very fast. However, for more complex problems such as discrete-decision making, managing computational complexity becomes a key challenge to implementation. A second challenge for space use of MPC is to identify a route to design validation: well-established tools such as frequency-domain analysis have limited applicability to MPC and alternative analyses are necessary. MPC is a mature and successful technology in the process industries: this presentation outlines its potential for use in space and the research areas needed to achieve this potential.