Adaptive Optimization for System Performance: Parameterized Differential Dynamic Programming

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Emerging urban air mobility (UAM) sector in aerospace is driving development of unconventional multi-modal vehicle configurations and autonomous flight. The combination of multi-modal vehicle dynamics, complex environment, requirements to deal with flight contingencies in an efficient and safe manner, as well as necessity for precise trajectory following and performance, are the driving influence behind adaptive optimization for system performance. We are interested in trajectory optimization algorithm that would system parameter estimation and identifying the optimal switching time between modes of hybrid dynamical systems. This presentation discusses a parameterized optimal control trajectory optimization algorithm that is an extended and generalized version of Differential Dynamic Programming (DDP), titled Parameterized Differential Dynamic Programming (PDDP). DDP is an efficient trajectory optimization algorithm relying on second order approximations of a system's dynamics and cost function and has recently been applied to optimize systems with time invariant parameters. Experiments are presented applying PDDP to solve model predictive control (MPC) and moving horizon estimation (MHE) tasks simultaneously. In particular, PDDP is used to determine the optimal transition point between flight regimes of a complex urban air mobility (UAM) class vehicle exhibiting multiple phases of flight and to identify and compensate for actuation faults.

Bio: Irene M. Gregory is the NASA Senior Researcher (ST) for Advanced Control Theory and Applications. She leads a multidisciplinary research team across multiple programs and projects focusing on robust autonomous systems, intelligent contingency management, and resilient learning control for advanced, unconventional configurations with particular focus on urban air mobility and autonomous cargo. Her research, spanning all speed regimes, has been documented in over 140 technical publications. She received a S.B, in Aeronautics and Astronautics from MIT and a Ph.D. in Control and Dynamic Systems from Caltech. She is a Fellow of the AIAA, senior member of IEEE, and serves on IEEE Aerospace Control and Intelligent Control technical committees.