Control Synthesis and Visual Perception for Agile Autonomous Vehicles

Agile autonomous vehicles that can exploit the full envelope of their dynamics to navigate through complex environments at high speeds require fast, accurate perception and control algorithms. In the first part of the talk, we focus on the control synthesis problems for agile vehicles. We present computationally-efficient algorithms for automated controller synthesis for systems with high-dimensional state spaces. In a nutshell, the new algorithms represent the value function in a compressed form enabled by a novel compression technique called the function train decomposition; and compute the controller using dynamic programming techniques while keeping the value function in this compressed format. We show that the new algorithms have run times that scales polynomially with the dimensionality of the state space and the rank of the value of the value function. In computational experiments, the new algorithms provide up to ten orders of magnitude improvement, when compared to standard dynamic programming algorithms, such as value iteration. In the second part of the talk, we focus on perception problems. We present new visual-inertial navigation algorithms that carefully select features to maximize the localization performance. The resulting algorithms are based on sub-modular optimization techniques, which lead to efficient algorithms with performance guarantees.