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Mrdjan Jankovic, Ph.D.

Ford Research and Advanced Engineering

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Collision Free Navigation with Interacting, Non-Communicating Obstacles

ABSTRACT

This talk addresses navigation in an environment occupied with other interacting agents (e.g. vehicles, robots, pedestrians, pods) that cannot communicate to one another. In contrast to the path planning problem, the difficulty here is that agents cooperate and compete, creating feedback loops each only partially controls. The talk starts with a very high level overview of two control design methods: Model Predictive Control (MPC) and Control Barrier Functions (CBF). The MPC is powerful, yet computationally expensive. The CBF approach is computationally simpler and handles non-convex constraints gracefully, while, being recently introduced, is only partially understood. Performance of a CBF controller is illustrated with a real industrial robot avoiding a stationary cone.

The problem with interacting, non-communicating agents is much more difficult than avoiding stationary objects. Each agent has only a portion of the information needed to compute the optimal or even a feasible action. Another difficulty is that, unless other agents are treated as non-interacting, the computational burden could quickly explode. The talk reviews some of the approaches including CBFs and Reinforcement Learning. A CBF approach developed in-house showed a very good performance avoiding collisions not only when all the agents are implementing the same algorithm, but also when an agent becomes non-interacting or even actively pursues another agent. The computational load remains reasonable with each agent as the host being able to handle up to 20 to 25 targets.

BIO

Mrdjan Jankovic received a bachelor degree from Belgrade University (1986), and masters and doctoral degrees from Washington University in St. Louis (1989 and 1992). He held postdoctoral positions with Washington University and University of California, Santa Barbara. He joined Ford Research in 1995. His responsibilities include project management, mentoring and supervision of technical staff, and direct technical contribution to development of engine and after-treatment control systems. Dr. Jankovic's research interests include automotive engine optimization and control, nonlinear control, and time-delay systems. He has coauthored one book (Constructive Nonlinear Control, Springer-Verlag, 1997), four book chapters, more than 100 external papers and more than 30 internal reports. He is a co-inventor on 57 US patents, 17 of which are used in Ford products sold world-wide. He is a Fellow of the IEEE.