Industrial Workshop on "Safety Systems, Driver Assistance and Optimal Control" - DAOC 27-28 January 2014, Wolfsburg, Germany

Abstracts

January 10, 2014

Speaker: Robert Baier (University of Bayreuth)
Title: Optimization-Based Reachability Analysis with Applications in Collision Avoidance.
Abstract: For the calculation of all end points of feasible solutions of nonlinear control problems, the so-called reachable set, the use of optimal control solvers provides new numerical methods. Since the reachable set coincides with the feasible set of the control problem, we can set up a parametric optimal control problem by introducing an objective function that measures the distance from an arbitrary grid point in state space to the unknown reachable set. We discuss advantages and drawbacks of this approach which is combined with a suitable subdivision technique and apply this technique to collision avoidance scenarios in which reachable sets needs to be calculated.

Speaker: Roberto Ferretti (Università di Roma Tre)
Title: Recent advances in the numerical analysis of optimal hybrid control problems.
Authors: R. Ferretti, A. Sassi and H. Zidani
Abstract:
Monotone schemes have been proved to provide a convergent and robust technique to solve the dynamic programming equation for hybrid systems, although their implementation in vaue iteration form suffers from a slow convergence. We discuss in this work a more efficient implementation in policy iteration form. Moreover, we present a convergent technique to extract the approximate optimal feedback and a variety of numerical tests on problems of interest for applications.

Speaker: Dante Kalise (RICAM, Linz)
Title: Closed-loop control for PDE's. Towards an efficient numerical implementation.
Abstract:
In this talk we present a computationally feasible approach to feedback optimal control of partial differential equations. Starting from an abstract, infinite-dimensional system, a large-scale, finite-dimensional system is obtained via classical discretization techniques. At this level, the resulting dynamics are still intractable for dynamic programming-based controllers and therefore, a reduced-order model is considered. Finally, for an online implementation of the approximate feedback rule, state estimation techniques are included in the control

loop. We discuss the structure of the different building blocks constituting our approach, and focus on issues related to accuracy, stability and robustness.

Speaker: John Lygeros (ETH Zurich)
Title: Reachability properties for stochastic and hybrid systems.
Abstract: Stochastic hybrid systems have emerged as a general framework for modeling systems that involve the interaction of discrete and continuous dynamics, as well as probabilistic uncertainty. Research in this area has been motivated by applications to areas as diverse as systems biology, transportation, telecommunications, and electrical power networks. Motivated by a brief introduction to reachability for continuous time continuous state systems, we will show how reachability problems for discrete time, stochastic and hybrid systems can be addressed based on methods from stochastic optimal control. We will also discuss extensions to more general properties encoded in probabilistic temporal logics.

Speaker: Luís Tiago Paiva (Universidade do Porto)
Title: Mesh Refinement in Optimal Control: Nonholonomic Vehicles Maneuver Problems.
Authors: L. T. Paiva and F.A.C.C. Fontes
Abstract:
Optimal control problems involving maneuvers of nonholonomic vehicles are characterized by presenting strong nonlinearities and by having discontinuous controls. To solve such problems one needs to define very accurately the controls and trajectories for some timeintervals. Direct methods are becoming the most used technique to solve nonlinear optimal control problems. Regular time meshes having equidistant spacing are most frequently used. However, in some cases these meshes cannot cope accurately with nonlinear behavior. Increasing uniformly the number of mesh nodes is not always a safe approach since it may lead to a more complex problem, resulting in an incoherent solution. Another way to improve the solution involves adaptive mesh refinement. A timemesh refinement strategy was developed and it was applied to solve nonholonomic systems. This technique led to results with higher accuracy and yet with lower overall computational time, when compared to meshes having equidistant spacing. In addition, the algorithm using the proposed refinement strategy showed more robustness, since it was able to obtain a solution in cases when the traditional approach starting with a very large number of mesh nodes failed to do it.

Speaker: Jürgen Pannek (Bundeswehruniversität München)
Title: Autonomous Predictive Driving utilizing Car2Car Communication.
Abstract:
We consider a distributed non cooperative control setting in which systems are interconnected via state constraints. Each of these systems is governed by an agent which is responsible for exchanging information with its neighbours and computing a feedback law using a nonlinear model predictive controller to avoid violations of constraints. For this setting we present an algorithm which generates a parallelizable hierarchy among the systems. Moreover, we show both feasibility and stability of the closed loop using only abstract properties of this algorithm. To this end, we utilize a trajectory based stability result which we extend to the distributed setting. The scope of the results is illustrated using numerical simulations for crossroad, roundabout and takeover scenarios.

Speaker: Hasnaa Zidani (ENSTA ParisTech, Paris)
Title: Reachability analysis and energy management of hybrid systems under lag constraints.
Abstract: T.B.A.