Dwight Look College of ENGINEERING
TEXAS A&M UNIVERSITY

SEMINAR

AEROSPACE ENGINEERING SEMINAR SERIES


## Emilio Frazzoli

Professor of Aeronautics and Astronautics
Laboratory for Information and Decision Systems and Operations Research Center
Massachusetts Institute of Technology
Frazzoli@mit.edu


Thursday, April 16, 2015
4:00 p.m. / 202 Reed McDonald Building

# Minimum-violation Planning for Autonomous Vehicles


**ABSTRACT:** This talk addresses the problem of "anytime" control strategy synthesis for dynamical systems, proposing a general framework based on the incremental refinement of a finite "concretization" of the system. We focus on the problem of designing a plan to fulfill a given task specification while satisfying a set of safety rules, and in particular to task specifications that become feasible only if a subset of the safety rules are violated. The proposed algorithm then computes a control law, that minimizes the level of unsafety for a trajectory that satisfies the given task specification. This problem is motivated by an autonomous car navigating an urban environment while following rules of the road such as "always travel in right lane" and "do not change lanes frequently," or UAVs planning a mission balancing mission objectives, rules of engagements, and environmental constraints. Ideas behind sampling based motion-planning algorithms, such as the Probabilistic Road Map (PRM) and Rapidly-exploring Random Tree (RRT), are employed to incrementally construct a finite concretization of the dynamics as a durational Kripke structure. In conjunction with this, a finite automaton that captures the safety rules is used in order to find an optimal trajectory that minimizes the violation of safety rules. It is shown that the proposed algorithm guarantees asymptotic optimality, i.e., almost-sure convergence to optimal solutions. The algorithms are demonstrated on an autonomous vehicle platform---showing perhaps for the first time the applicability of formal methods to full-scale, real-world robotic systems.


**BIO:** Emilio Frazzoli is a Professor of Aeronautics and Astronautics with the Laboratory for Information and Decision Systems, and the Operations Research Center at the Massachusetts Institute of Technology. He received a Laurea degree in Aerospace Engineering from the University of Rome, "Sapienza" , Italy, in 1994, and a Ph. D. degree from the Department of Aeronautics and Astronautics of the Massachusetts Institute of Technology, in 2001. Before returning to MIT in 2006, he held faculty positions at the University of Illinois, Urbana-Champaign, and at the University of California, Los Angeles. He is currently the Director of the Transportation@MIT initiative, and the Lead Principal Investigator of the Future Urban Mobility IRG of the Singapore-MIT Alliance for Research and Technology (SMART). He was the recipient of a NSF CAREER award in 2002. He is an Associate Fellow of the American Institute of Aeronautics and Astronautics and a Senior Member of the Institute for Electrical and Electronics Engineers. Dr. Frazzoli's current research interests focus primarily on autonomous vehicles, mobile robotics, and transportation systems.

Refreshments will be served at 3:45 p.m.
Hosted by: Daniele Mortari