DEPARTMENT OF MECHANICAL ENGINEERING
WILLIAM MAXWELL REED SEMINAR SERIES

"Constrained control design for spatiotemporal requirements with provable guarantees."

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Abstract:
Spatial constraints, i.e., constraints requiring the system trajectories to evolve in a safe set while visiting some goal set(s), are typical in safety-critical applications. Furthermore, temporal constraints, i.e., constraints on the time of convergence, appear in time-critical applications, for instance, when a task must complete within a fixed time due to an internal or an external deadline. Spatiotemporal requirements can be used to pose most of the practical robotics and control problems. Some examples include distributed control for drone-delivery systems requiring agents to reach their respective locations in a given time limit while avoiding collisions and motion planning of a surveillance drone to hover over an area of interest while keeping in a safe zone where it cannot be detected. The limited actuation capacities of dynamical systems introduce new challenges in control design for simultaneous satisfaction of safety and convergence. The main focus of today's talk is a systematic design framework for real-time constrained control synthesis with provable guarantees for both safety and convergence. We will start with new results on fixed-time stability under input constraints to facilitate satisfaction of temporal constraints with limited actuation. Then, we will present a novel quadratic programming (QP) formulation for real-time implementable control input. The proposed QP utilizes slack variables in a manner such that safety is never compromised and it is provably feasible on the viability domain. Finally, we will present a sampling-based method of efficiently computing the viability domain. In contrast to the reachability-based methods, the sampling-based method is computationally fast, scalable with the system dimension, and applicable to a larger class of dynamical systems.

Speaker Bio:
Kunal Garg received Bachelor of Technology in Aerospace Engineering from the Indian Institute of Technology, Mumbai, India, in 2016, Master of Science in Engineering, and Ph.D. in Aerospace Engineering from the University of Michigan, Ann Arbor in 2019 and 2021, respectively. He is currently a postdoctoral scholar in the Department of Electrical and Computer Engineering at the University of California, Santa Cruz. His research interests include robust multi-agent motion planning for UAS, finite- and fixed-time stability of dynamical systems with applications to control synthesis for spatiotemporal specifications and continuous-time optimization, and control-theory aided provable security of Cyber-physical systems. He is a member of the IEEE.

Date: Monday, February 28, 2022 **Time: 3:00 PM EST**
Place: Whitehall Classroom Building 114 **Contact: Dr. Alexandre Martin 257-4462**

Attendance open to all interested persons

College of Engineering

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