Graduate Student Research Seminar

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Safe Navigation using Analytical Density Functions

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3:00 pm (EST) – 132 Fluor Daniel Building

Abstract

Safe navigation of mission-critical systems is of utmost importance in many modern autonomous applications. It involves planning a safe trajectory (motion plan) at the high level and executing a set of feasible control inputs at the low level, which drives the system towards the goal in a safe manner. Existing methods, such as Rapidly exploring Random Trees (RRT), require extensive sampling of the workspace and only constitute a motion plan. Navigation functions can be used to generate a motion plan and control simultaneously. However, their construction is non-intuitive, can introduce local minima, cannot represent arbitrarily shaped obstacles, and doesn't scale well to high dimensions. This presentation outlines an alternative approach using analytical density functions which provides a solution to both the motion planning and control problem. They have a nice physical interpretation of the underlying dynamics and can be constructed as a product of inverse bump functions and a Lyapunov measure. They serve as a safety certificate for the system, and the controller can be implemented in real-time. In this work, density functions are used to solve navigation problems in complex environments in high dimensions, dynamic obstacles, trajectory tracking, etc., with safety guarantees for autonomous vehicles, robotic arms, and legged robots.

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