PhD Dissertation Defense Announcement
Mechanical and Aerospace Engineering Department
University of Texas at Arlington

Reactive Motion Planning of Autonomous Vehicles in 3-Dimensional Environments using Collision and Rendezvous Cones

By

Kashish Dhal

Thesis Advisor: Dr. Animesh Chakravarthy

August 2nd, 2022

Woolf Hall, Room 413

Teams link

Abstract

This thesis develops methods for reactive motion planning using the notion of collision/rendezvous cones. The collision (rendezvous) cone is the cone of velocities of a moving object that will cause it to lie on a collision (rendezvous) course with another moving object. It has applications for a range of reactive motion planning applications. Many of the 3D motion planning algorithms in the literature model the shapes of the robot and obstacles as spheres. However, such an approximation can become over-conservative especially when the objects are more elongated in one direction than another and/or are non-convex. In such cases, using quadric surfaces (or a combination of such surfaces) or n-faced polyhedrons can provide better shape approximations for the objects and thereby reduce the conservativeness of spherical approximations. This research is focused on analytical methods to compute collision cones for objects of different shapes and subsequently derive analytical guidance laws to perform collision avoidance or rendezvous. These guidance laws are computationally efficient and are suitable for real-time applications. They are used to enable a robotic fish to perform maneuvers through a moving orifice, for an unmanned aerial vehicle to track multiple moving, maneuvering ground targets, and to enable cooperative and non-cooperative collision avoidance as well as rendezvous for objects with heterogeneous shapes that may change with time.