An Efficient and Interpretable Vehicle Controller for Safe Navigation in Neighborhood Environment With Riemannian Motion Policies

Xu, Eddy (School: Miller School of Albemarle)
Wang, Zitong (School: Shanghai Pinghe Bilingual School)

Navigating through unstructured environments is a basic capability of autonomous robots, and thus is of fundamental interest in the study and development of autonomy. Long-range navigation of autonomous vehicles is a complex cognitive task that relies on developing an internal representation of space with simple semantic information, that can simultaneously support continuous obstacle and road detection. Building around an semantic LiDAR and camera that can detect obstacles, roads, and stop signs, we present a control system based on Riemannian Motion Policies that provides fast and interpretable results for goal-driven navigation, obstacle avoidance, along the center of the road, and traffic rule obedience via analytical computation for the optimal control signal. We demonstrate that our controller tested in the AirSim Neighborhood environment generates a street map with semantic information in real-time and arrives at the position of the goal successfully, while keeping the autonomous vehicle safe when physical occlusions or lack of point cloud or vision occur such as when driving close to road guards, parked cars, deviating from the center of the path, and encountering wild animals. We show that our framework can be used for safe goal-driven navigation in the previously unseen neighborhood environment. In addition, the navigation system can be incorporated into manual driving scenarios to assist path planning and obstacle avoidance to provide the optimal direction of driving.