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A review on simulation-based optimization methods applied to building performance analysis

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Abstract—In this paper we present two path planning algo- rithms based on Be´zier curves for autonomous vehicles with waypoints and corridor constraints. Be´zier curves have useful properties for the path generation problem. The paper describes how the algorithms apply these properties to generate the refer- ence trajectory for vehicles to satisfy the path constraints. Both algorithms join cubic Be´zier curve segments smoothly to generate the path. Additionally, we discuss the constrained optimization problem that optimizes the resulting path for user-defined cost function. The simulation shows the generation of successful routes for autonomous vehicles using these algorithms as wellas control results for a simple kinematic vehicle. Extensions of these algorithms towards navigating through an unstructuredenvironment with limited sensor range are discussed.
Keywords–Bézier curve; path planning; optimization; au- tonomous vehicle; feedback control

INTRODUCTION

Exploiting the versatility of autonomous vehicles for aca-demic, industrial, and military applications will have a pro-found effect on future applications. Current research on controlsystems for autonomous vehicles demonstrates that trajectorygeneration is hardly a "solved" problem. For vehicle viability, it is imperative to be able to generate safe paths in real time. Many path planning techniques for autonomous vehicles have been discussed in the literature. Cornell University Teamfor 2005 DARPA Grand Challenge [9] used a path plannerbased on Bézier curves of degree 3 in a sensing/action feedback loop to generate smooth paths that are consistent with vehicle dynamics. Skrjanc [8] proposed a new cooperative collision avoidance method for multiple robots with constraints and known start and goal velocities based on Bézier curves of degree 4. In this method, four control points out of five areplaced such that desired positions and velocities of the startand the goal point are satisfied. The fifth point is obtained

SUMMARY AND CONCLUSIONS

This paper presents two path planning algorithms based on Bézier curves for autonomous vehicles with waypoints and corridor constraints. Bézier curves provide an efficient way to generate the optimized path and satisfy the constraints at the same time. The simulation results also show that the trajectoryof the vehicle follows the planned path within the constraints.

These path planning algorithms will be implemented on the Overbot [4], the autonomous ground vehicle at Autonomous Systems Lab at UCSC.

In this work, proposed algorithms only generate a nominal path. Enabling autonomous vehicles to detect unknown obsta-cles and safely avoid them is essential to future operations. Future work will employ receding horizon control methodsto generate real- time Bézier-based optimal trajectories while avoiding obstacles.

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