AA 203 Final Project Proposal

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Abstract

Path planning is a corner stone of Robotic Autonomy, as a robot has to be able to evolve in his environment to be considered truly autonomous. Our project aims at comparing some state-of-the art optimal control methods to solve the problem of optimal path planning for autonomous mobile robots. It would be part of a common project with the class AA222 (Engineering Design Optimization), in which both of us are enrolled, with the approval of Pr. Kochenderfer. For that other part of the project, we will apply cutting-edge optimization techniques to solve the problem (namely, we will consider Genetic Algorithms).

1 Problem

The formulation of our problem is as follows : given a continuous, bounded, 2D space and a continuous cost function over this space, the goal is to find an optimal admissible path between the initial and the final point. The cost function takes values between 0 and 1 characterizing the difficulty of passing through that point : 0 means no effort, 1 means insurmountable barrier. The space can for example seen as a 2D map where the cost at each point would correspond to the elevation gain at that particular point in space. Obstacles can also be present on the map and are dealt with by adding constraints on the robot's state.

2 Approach

For our project, we want to study a novel method in optimal control. We will focus our attention on a paper presented at the International Conference on Robotics and Automation (ICRA) in 2017 [XLH17]. In their paper, the authors develop a new method for Differential Dynamic Programming applicable to problems with nonlinear constraints. This perfectly fits into our problem as the obstacles can constitute nonlinear constraints. The efficiency of this new method will be compared to the famous A* search algorithm [HNR68] that would operate on a discretized version of our continuous space. Since A* is the reference method for 2D path planning, we expect it to perform better than Constrained Differential Dynamic Programming and Genetic Algorithms.

References

[HNR68] P. E. Hart, N. J. Nilsson, and B. Raphael. A formal basis for the heuristic determination of minimum cost paths. *IEEE Transactions on Systems Science and Cybernetics*, 4(2):100–107, July 1968.

[XLH17] Z. Xie, C. K. Liu, and K. Hauser. Differential dynamic programming with nonlinear constraints. In *2017 IEEE International Conference on Robotics and Automation (ICRA)*, pages 695–702, May 2017.