Visibility-based Robot Path Planning for a Planar Robot

Joan Gerard, ULB

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1 Project Description

A robot needs to be capable of building the path from its initial position to a given place in the environment in order to plan its moves and finally get to the goal position.

The problem will be solved using computational geometry techniques but some assumptions will be given in order to limit the complexity of the problem. A static (no people or other robots moving around the environment) 2D rectangle environment will be considered as shown in figure 1. A robot will be defined to be planar with a shape of a polygon which will be considered to be convex. The obstacles in the environment will be defined as polygons not necessarily convexes. The robot should be able to plan the shortest path from a given start and end position coordinate in the environment, avoiding collisions with obstacles and walls. Notice that rotation of the robot is not considered within this problem.

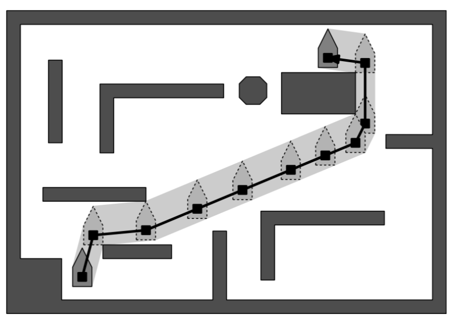

Figure 1: Robot Motion Planning. Image obtained from [1].

2 Computability Geometry Techniques Proposal

The problem should be partitioned into sub problems and solved them individually. Here some proposed techniques to be used are mentioned but not detailed. The technique to solve this problem is based on Lee's technique [2].

All the obstacles polygons should be grown by the robot polygon using a technique called Minkowski sum [3] in order to obtain a new configuration space where the robot does not penetrate nor collide within any obstacle.

Compute the shortest path between two points in the space using a visibility graph[4]. Such graph connects all the vertices of the obstacles that are visible between each other then assign a weight to each edge and use Dijsktra's algorithm to find the shortest path.

3 Interface

The project will be built using ECMAScript 6 (JS). The interface will consist in two parts basically. The first part will be for a creation of an environment where the user will be able to add obstacles and determine the shape of a robot. The second part will consist in showing the solution of the problem to the user who will be able to determine where the robot is and where it should go. Additionally, the user will be able to see the result of applying the Minkowski sum and the Visibility Graph.

References

[1] Mark de Berg et al. *Computational Geometry: Algorithms and Applications.* 3rd ed. Santa Clara, CA, USA: Springer-Verlag TELOS, 2008.

[2] Der-Tsai Lee. "Proximity and Reachability in the Plane." AAI7913526. PhD thesis. Champaign, IL, USA, 1978.

[3] Joseph O'Rourke. *Computational Geometry in C.* 2nd. New York, NY, USA: Cambridge University Press, 1998. ISBN: 0521640105.

[4] Tomás Lozano-Pérez and Michael A. Wesley. "An Algorithm for Planning Collision-free Paths Among Polyhedral Obstacles". In: *Commun. ACM* 22.10 (Oct. 1979), pp. 560–570. ISSN: 0001-0782. DOI: 10.1145/359156.359164. URL: http://doi.acm.org/10.1145/359156.359164.