Voronoi Diagram Based Roadmap Motion Planning

CS365: Artificial Intelligence
Project Proposal

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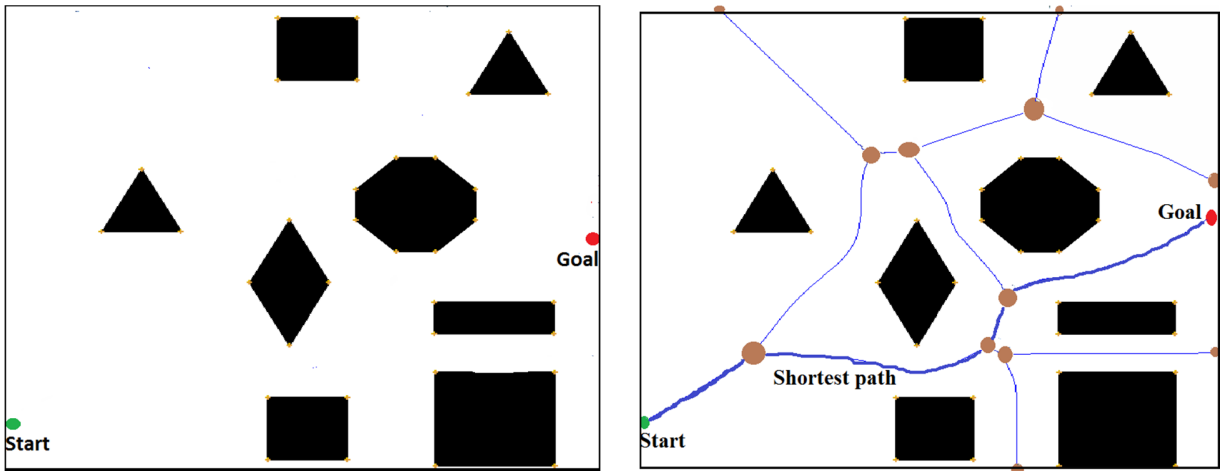
Introduction:

Robot Motion planning is one of the fundamental problem in robotics. It has various applications such as in Ware house automations, Driverless cars, Robotic surgery etc. The path planning problem is described as: to find a shortest or optimized path between start point and goal in a spatial configuration consists of obstacles of various types. There are many fundamentally different approaches suitable for different environmental configurations. The various methods are Cell Decomposition, Sampling method, Probabilistic Roadmap methods, Generalized Voronoi diagrams etc. In this project we will be exploring for Generalized voronoi diagrams in Robot motion planning.

Voronoi Diagrams: '*A Voronoi diagram of a **set of sites** in the plane is a collection of regions that divide up the plane. Each region corresponds to one of the sites and all the points in one region are closer to the site representing the region than to any other site.*' [2]
The path generated by Voronoi diagram ensures minimum collision risk if any possible.

Problem Statement Formulation:

In our basic problem we will have an input image file consists of white background and various types of obstacles like point objects, polygon sided objects, circular objects and start point and goal point with different colors. Our objective will be to find the shortest collision free path between start point and goal point. We will demonstrate the motion of robot on the path on **Player Stage** software. The following figure shows the input file and the shortest path generated using Voronoi diagram and graph search algorithm.



Approach:

First step is to draw generalised Voronoi diagram from the given input image file. For that as we have assumed that the obstacle can be point, polygonal and circular, we will take obstacles as a sets of their boundaries which are approximated by straight lines. Then we can easily compute the bisectors between point and point, point and line or line and line as per the figure:2

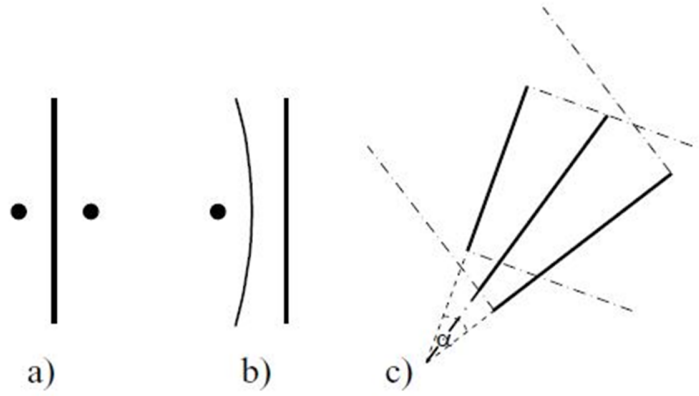


Figure 2: Edges in Generalized Voronoi Diagram Image courtesy [1]

Figure 2 shows a) bisector between two points is the perpendicular bisector of line segment joining the two points, b) bisector between point and line is a parabola with focus as given point and directrix as the given line, c) bisector between two lines is angular bisector between the two lines. Therefore, the output Voronoi diagram will contain straight lines and parabolas. It is to be noted that all edges in Voronoi diagram are collision free.

In second step we will take Voronoi diagram as an input graph whose edges are path segments consists of parabolas and lines, whose weights are lengths in the Voronoi diagram. The vertices are intersected points in Voronoi diagram. Then we will use shortest path algorithms to find the shortest collision free path between start and goal points.

References:

[1] *MILOŠ ŠEDA, VÁCLAV PICH. (August 20-22, 2008). Robot Motion Planning Using Generalised Voronoi Diagrams.*

[2] *M.de Berg, M.van Kreveld, M.Overmars and O.Schwarzkopf, Computational Geometry: Algorithms and Applications, Springer-Verlag, Berlin, 2000.*