Dodger: Generating Safe Trajectories in Stochastic Dynamic Environments by Leveraging Information about Obstacle Motion

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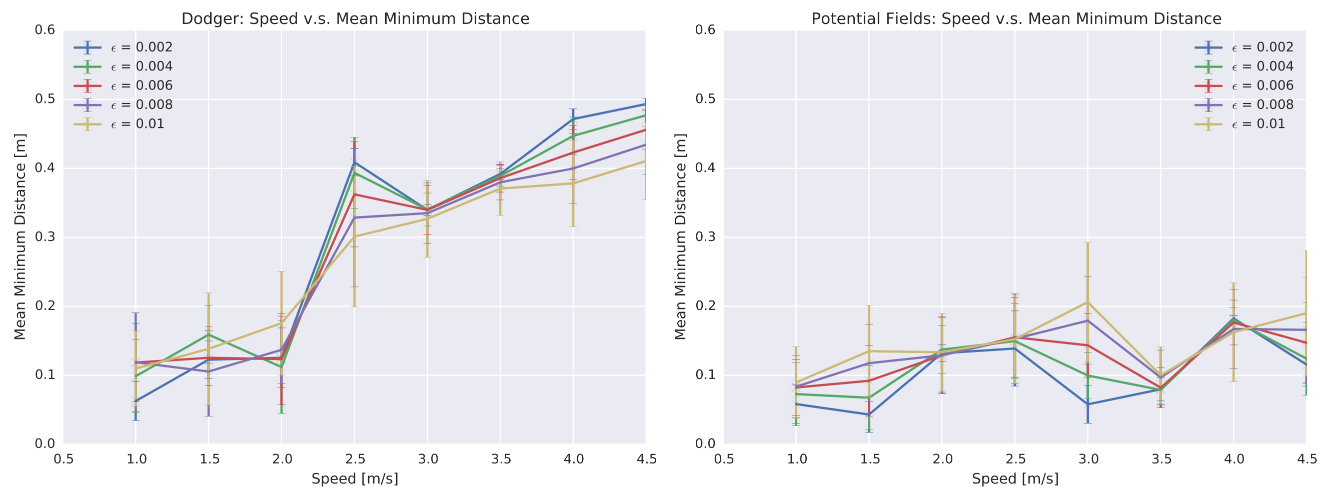
1. PROBLEM FORMULATION

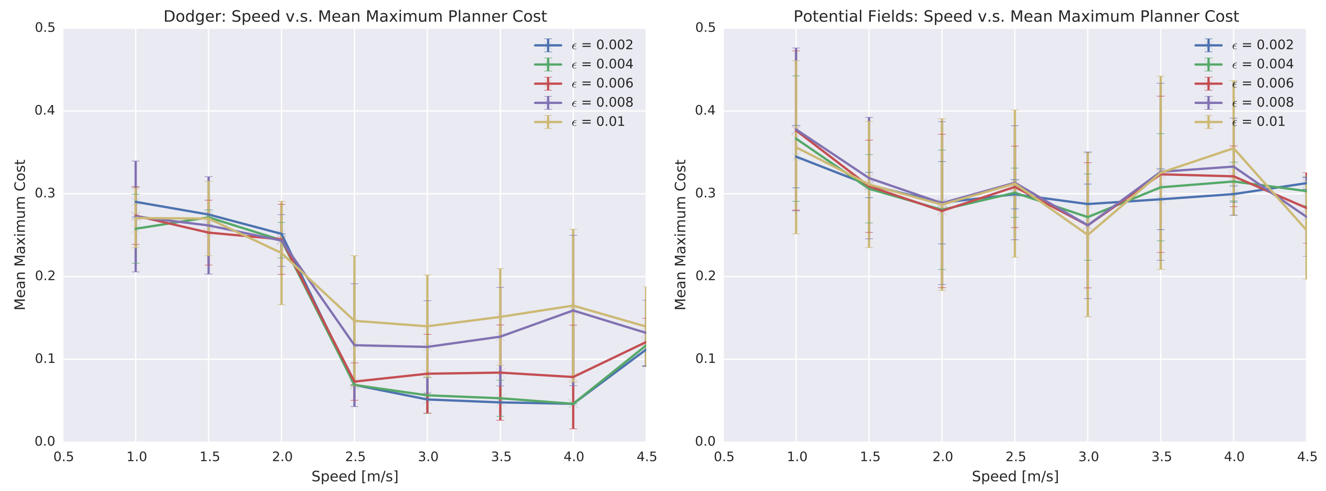
- Develop a probabilistic representation of dynamic obstacles that accounts for their motion
- Use this representation to build a cost distribution that can be used as a heuristic to guide the search
- Generate a trajectory for a robot that reaches the goal region whilst avoiding collisions with static and dynamic obstacles
- Utilize information about the motion of obstacles and their associated cost distributions
- Replan if the obstacles deviate a significant amount from their predicted paths

3. EXPERIMENTAL RESULTS

The figure below shows the average minimum distance to any obstacle compared to a potential fields planner as the speed increases. The higher the minimum distance to an obstacle, the safer the path.



The figure below shows the maximum cost incurred by the robot along the paths generated by Dodger and a potential fields planner. The cost is defined by the cost distribution given by the dynamic obstacle representation. The lower the cost, the safer the path.



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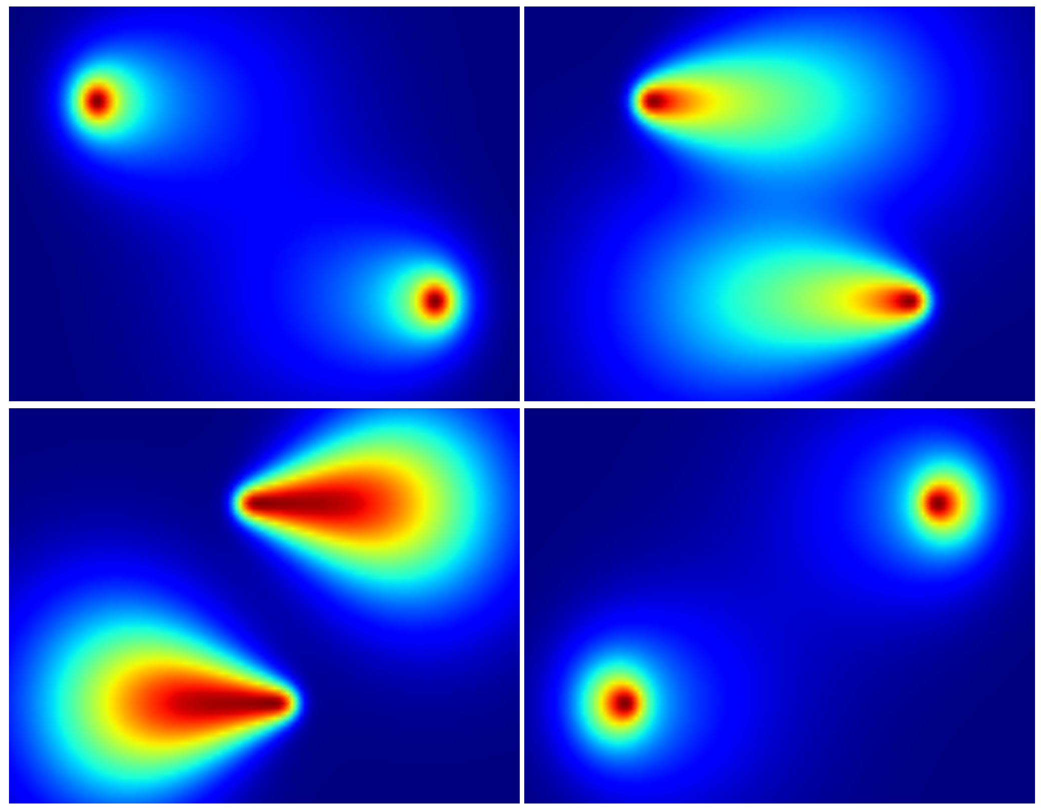
2. APPROACH

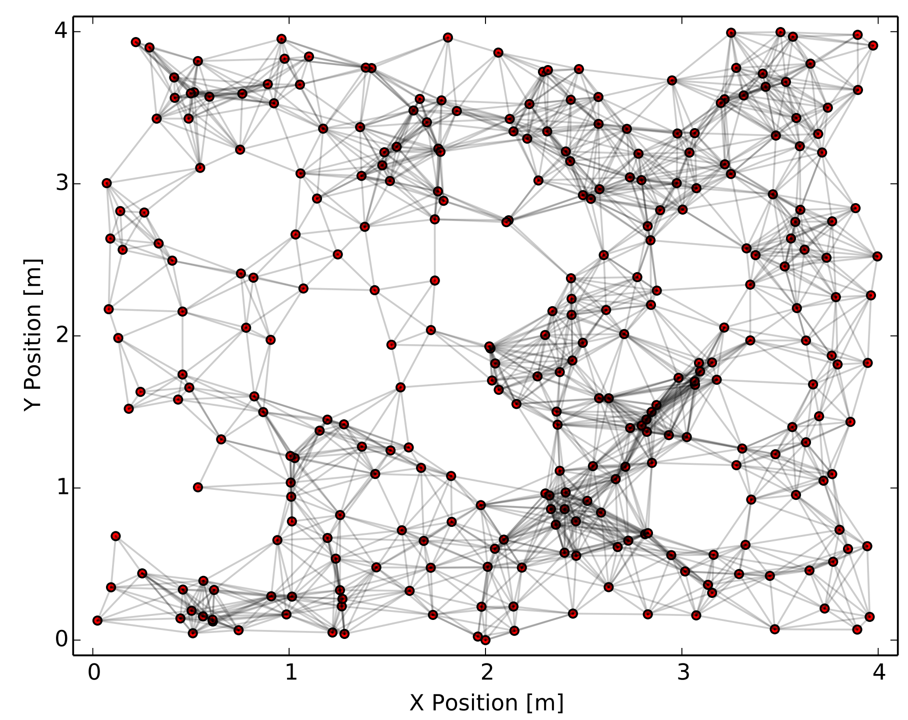
1. Dynamic Obstacle Representation

A stochastic representation has been developed that accounts for the trajectories of dynamic obstacles. The figure below represents the cost incurred by a robot moving to a certain location in the environment for a given time period. This scene has two obstacles moving side to side in a sinusoidal fashion.



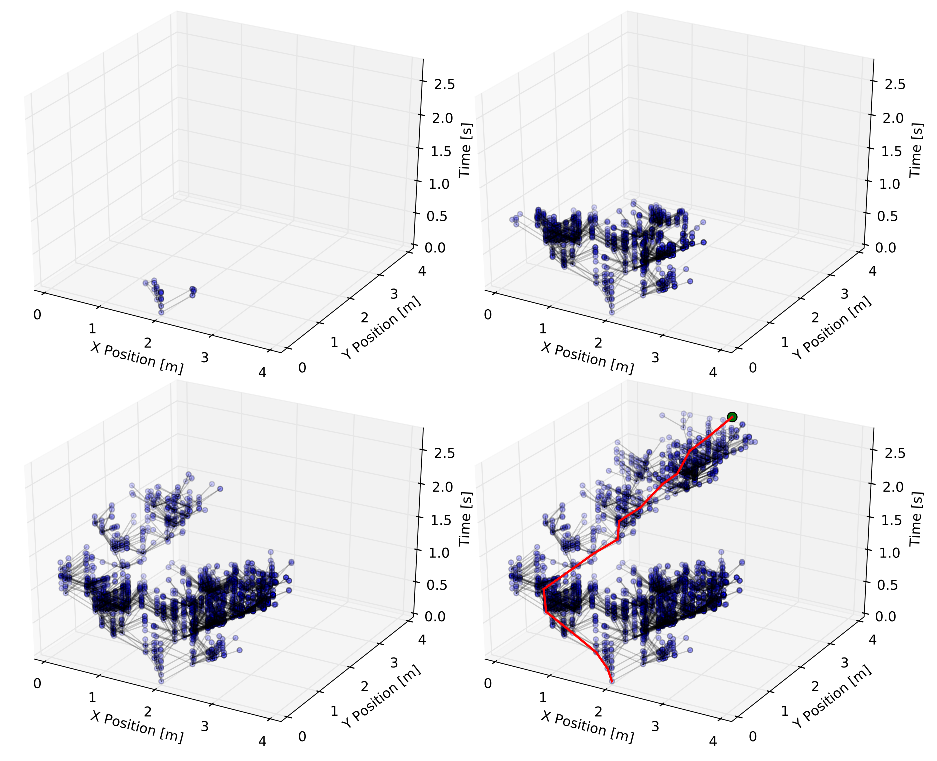
2. Generating the Probabilistic Roadmap (PRM)

A PRM is a graph that is generated by randomly sampling points in the environment and adding an edge between two points if their within some distance. It is constructed over the configuration space of the robot and is used to guide the expansion of the temporal graph search. An example PRM is shown below.



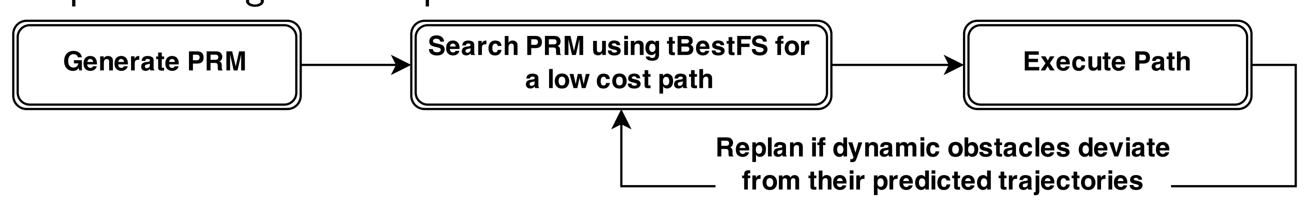
3. Searching the PRM

A novel search algorithm has been developed to search the probabilistic roadmap to find low cost paths where the cost is dynamic and time-dependent.



4. Replanning

Information about obstacle motion is not perfect and the plan may need to adapt to changes in the predicted environment.



Below is a figure showing the progression of the path around stochastic dynamic obstacles.