Potential Field Guided Sampling Based Obstacle Avoidance

Reid Rizvi Rahman , Sakshi Sinha

{reidrr,sakshis}@iitk.ac.in

Mentor: Prof. Amitabh Mukerjee

amit@cse.iitk.ac.in

INTRODUCTION

The problem statement is to find a path which is sampling based as well as it incorporates potential biased path planning. The randomly generated points are biased away from obstacles and start point and towards the goal as they are directed towards the decreasing potential. This leads to less dispersion of samples in the configuration space which provides a faster converging rate than RRT*

PREVIOUS WORK

- Many Sampling Based methods like Probabilistic Roadmap(PRM), Rapidly Exploring Tree (RRT), RRT*,RRT-smart etc. have been developed which runs by generating a random new point for the tree growth
- RRT does not provide an optimal solution
- RRT* provides sure convergence and provides an optimal path. It has asymptotic optimality. But slow execution
- Potential field path planning has been there which works by creating an artificial potential field for the source, destination and the obstacles in the workspace

NOVELITY

- The randomly generated points in the new algorithm are biased towards the goal.
- The new path tries to maximize the distance from the obstacle
- It removes the problem of local minima.

PROBLEM MODELLING

- Path is represented as a tree rooted at the source
- For RRT* , all the obstacles are modeled as polygons
- For Potential Field Method , all the obstacle polygons are approximated as a set of circles
- This approximation makes it easier to define potential due to obstacles' as they can be treated to be concentrated at the circle.

SAMPLING

- Generate a random point (x)
- Generate a new point which is at an incremental distance from the x and is biased towards the goal .
- This is done by moving x along the direction of decreasing potential.
- It ensures that the point added to the tree is biased away from the obstacles and towards the goal.
- Implement the RRT* algorithm by adding this new point to the tree.
- This finds the optimal path required

METHODOLOGY

- Fix the number of sample nodes in the graph
- Add the source node to the tree T
- In each iteration, a new random node(x) is generated
- Apply potential gradient to x to get a new node z.
- The navigation function used for the purpose is:

$$\gamma(q) = \frac{d^2(q,goal)}{\left[d(q,goal)^{2K} + \beta(q)\right]^{1/K}}$$

Where β is given by

$$\beta(q) = \prod_{i=0}^{n} \beta_i(q)$$

$$\beta_i(q) = \begin{cases} -d^2(q,q_i) + r_i^2, & i = 0 \\ d^2(q,q_i) - r_i^2, & i > 0 \end{cases}$$

- Set S contains the k nearest neighbors of z in T
- An edge is added between z and a node in S which minimizes the distance from source to z.
- All the new distances are updated.
- This gives a required path at the end of all iterations

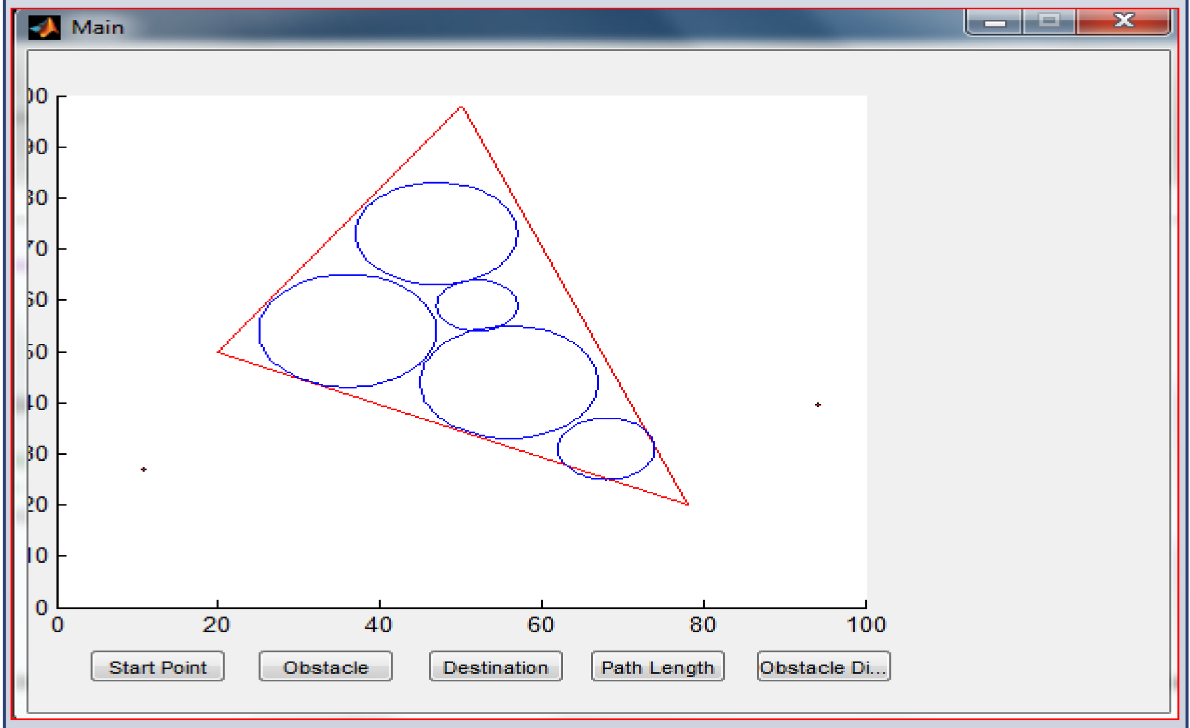
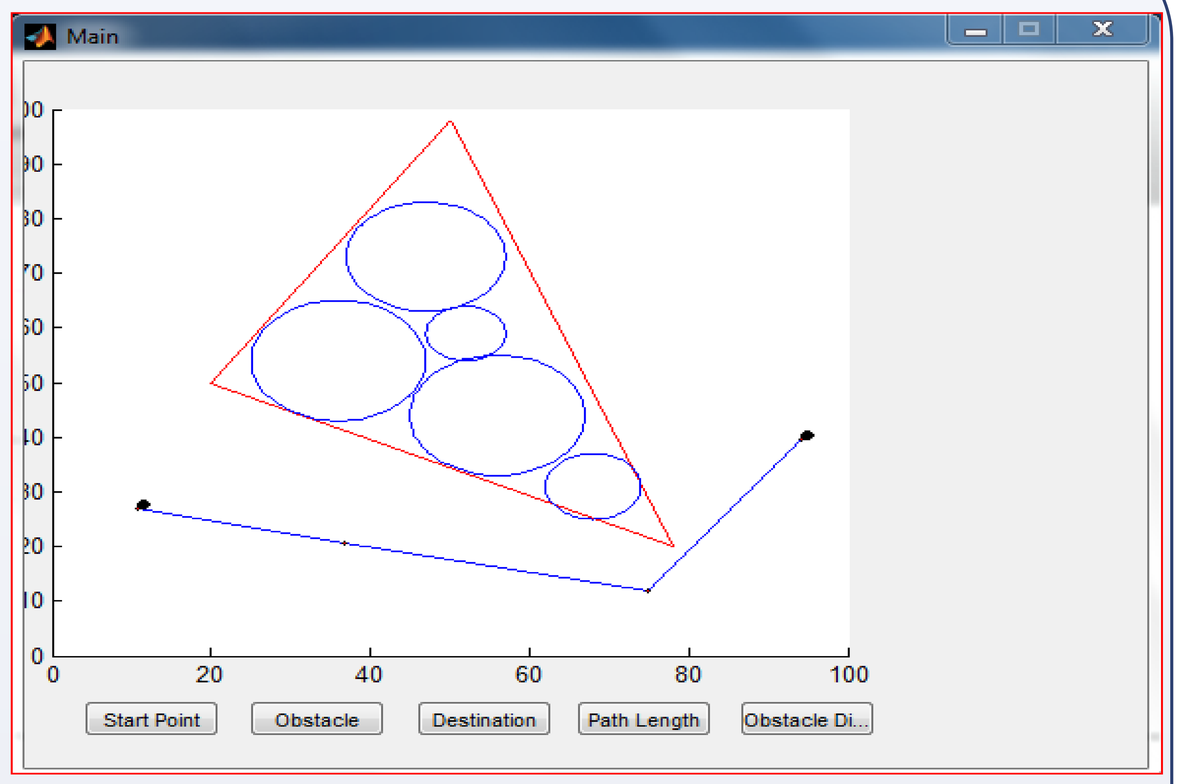


Fig: Left node represents the start node and the right one the goal point. The triangle represents the obstacle and the circles are the equivalent obstacles for the potential function.



RESULTS

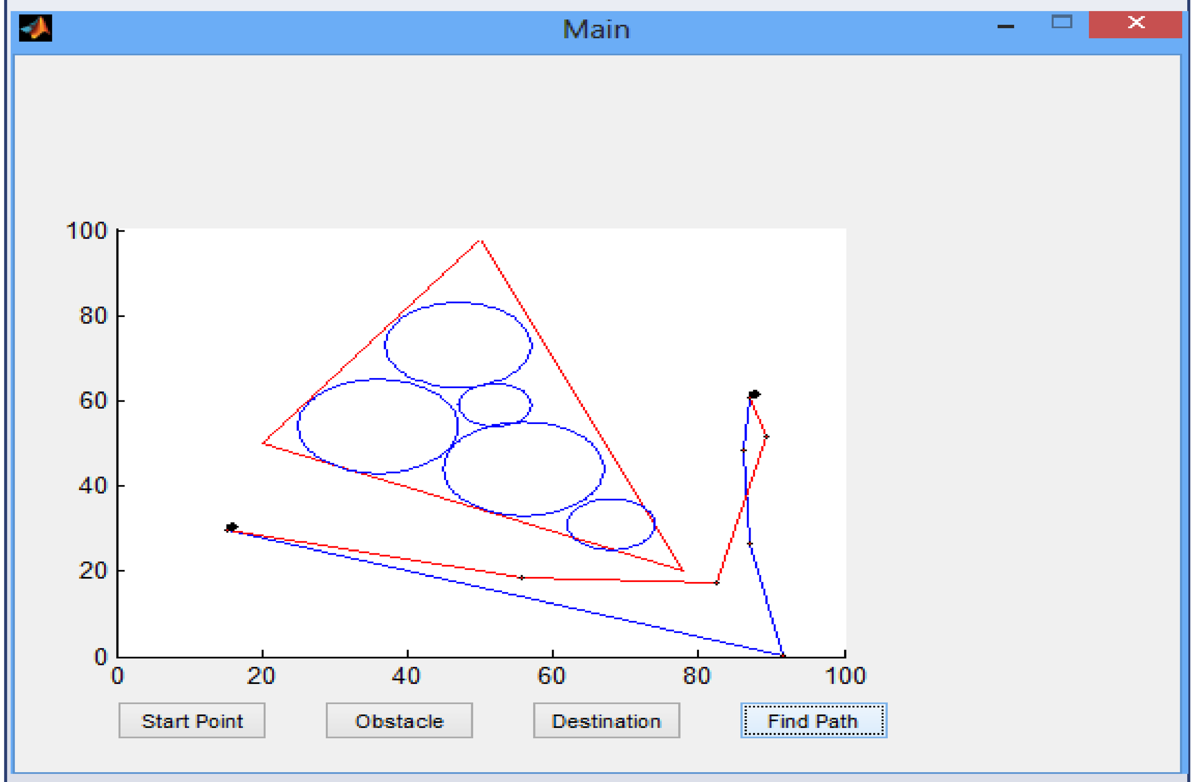


Fig: First path denotes RRT* with PRM path
Second path denotes maximum distance from obstacle path

IMPROVEMENTS and FUTURE WORK

- Changing the path measure
- Finite size robot

REFERENCES

- http://www.cs.bilkent.edu.tr/~culha/cs548/
- Sampling-based Algorithms for Optimal Motion Planning by I S. Karaman and E. Frazzoli
- Potential Guided Directional-RRT* for Accelerated Motion Planning in Cluttered Environments