Real-Time Flood Navigation of Waterborne Vehicles using Improved A*

Report

Sanjana Reddy Tummala - 2020csb1137
Muskan - 2020CSB1100
Shruti Sikri - 2020csb1128

Course Instructor: Dr. Shashi Shekhar Jha

Department of Computer Science & Engineering

Problem Statement & Objective

The problem statement is during floods the boat/rescue team to the target location. In the path there could be various obstacles which are moving, also the depth of the water is not uniform therefore there is a possibility of the boat getting stuck.

Approach

We defined the path as serviceable or non serviceable. If the depth of the water is more than the threshold and there are no obstacles then the boat can move therefore it is called a serviceable path.

While finding the best possible algorithm to find the shortest path, in least time we experimented it with RRT, RRT*, ERRT, A*.

Performance metrics we considered are Average run-time, average number of expanded nodes, average serviceable path length.

In these algorithms one step ahead is done and the next best possible path is chosen.

The cost function considered for improved/modified A* is:

$$q^c_{ImprovedA*} = v^c + g^c + o^c$$

$$o^c = \begin{cases} \lambda & if \;\; \mathbb{W}^c_l \geq \mathcal{W} \; and \; O^c == true \\ \infty & if \;\; \mathbb{W}^c_l < \mathcal{W} \\ 0 & otherwise \end{cases}$$

Fig1. Cost function for A*.

$\mathbb{W}^c_l$ - Critical depth of the water considered safe for the boat.

$\mathcal{W}$ - Depth of the water at the processing node.

O^c - Obstacle found.

Plots and results

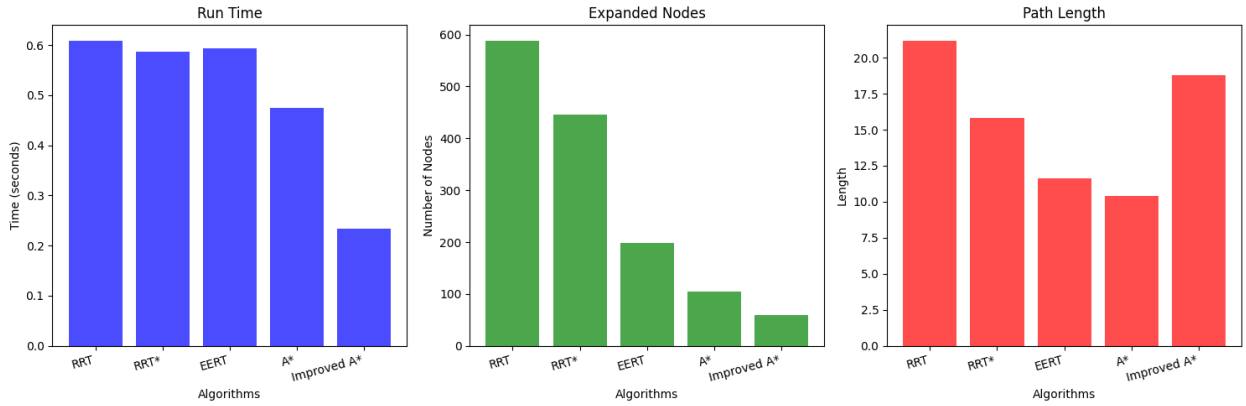

Fig2. Plots of metrics (averaged over multiple cases)

Justification

The expanded nodes in RRT, RRT*, ERRT are high on an average because they expand on random and A*, improved A* only move towards the goal based on the depth and obstacle information. They lead to less explored nodes and less path length compared to other random exploring algorithms. The path length in improved A* is higher than A* this is because its increased cost to partially serviceable paths and it prunes the non serviceable paths. But this improved algorithm finds a path faster than other algorithms.

Error Plots

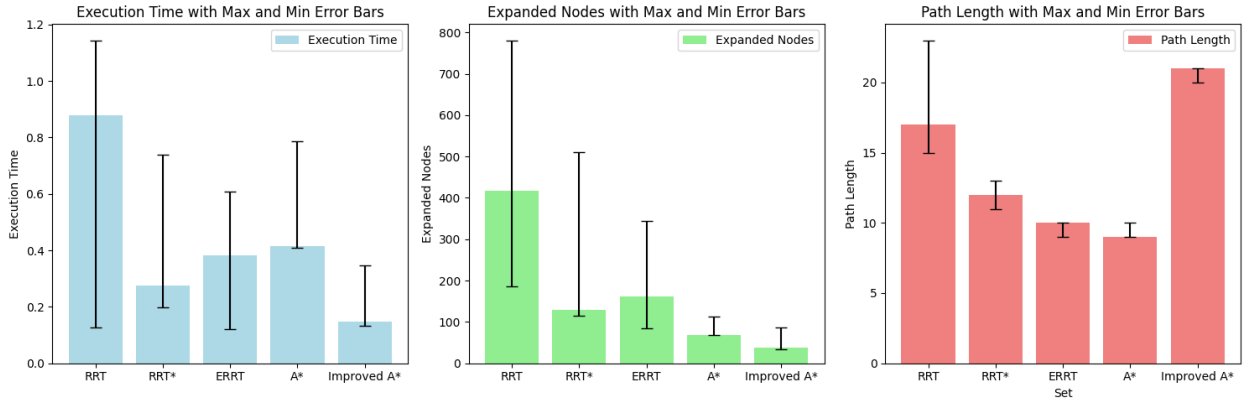

Fig3. Error Plots for case1.

Case1: Start 4,-4, Goal 0,4

Case 2: Start : 4,-11, Goal : -3,-5

The Fig3, Fig4 shows the plots of maximum and minimum in various runs for the case1 and case2 respectively. From the plots it is clear that the minimum and maximum of all the metrics

the randomized algorithms vary the most. The variations in all the algorithms are also due to the varying obstacles. The variations in A* and improved A* is least. Which supports our conclusions that improved A* is best to find a shorter path with low explored nodes and least time.

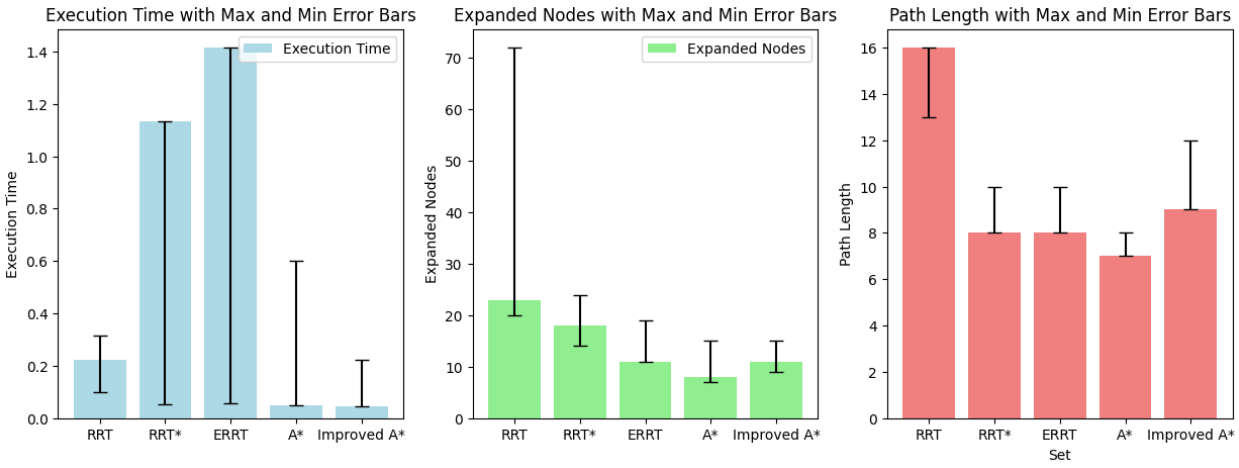

Fig4. Error Plots for case2.

More observations are in the doc: [Link]

Few Plots of RRT, RRT* reflecting randomness