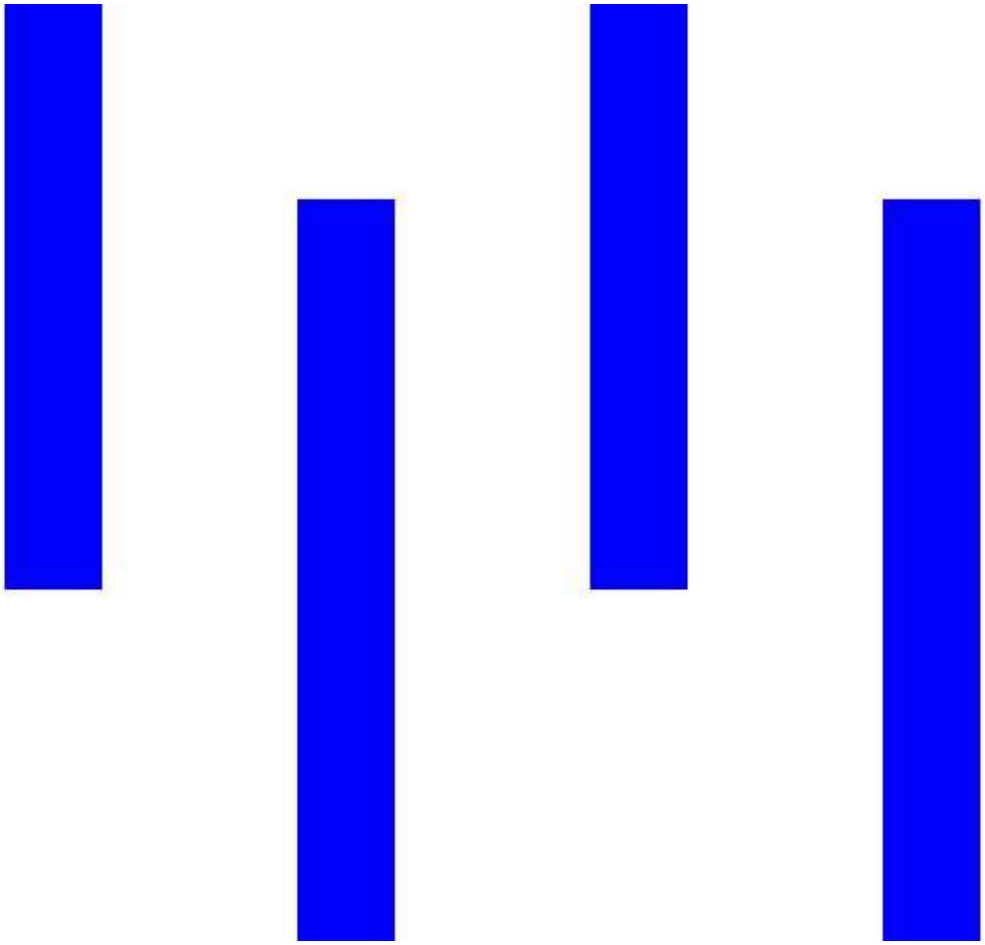
Bi-directional RRT* Implementation Report

METHOD:

- Implemented all 3 variants of Bi-directional RRT* algorithm (Connect + Extend, Extend + Extend, Connect + Connect)
- Benchmarked the algorithm with the original RRT and RRT* algorithms.
- Ran all the algorithms for 10 instances and the results obtained have been reported below.

MAP:

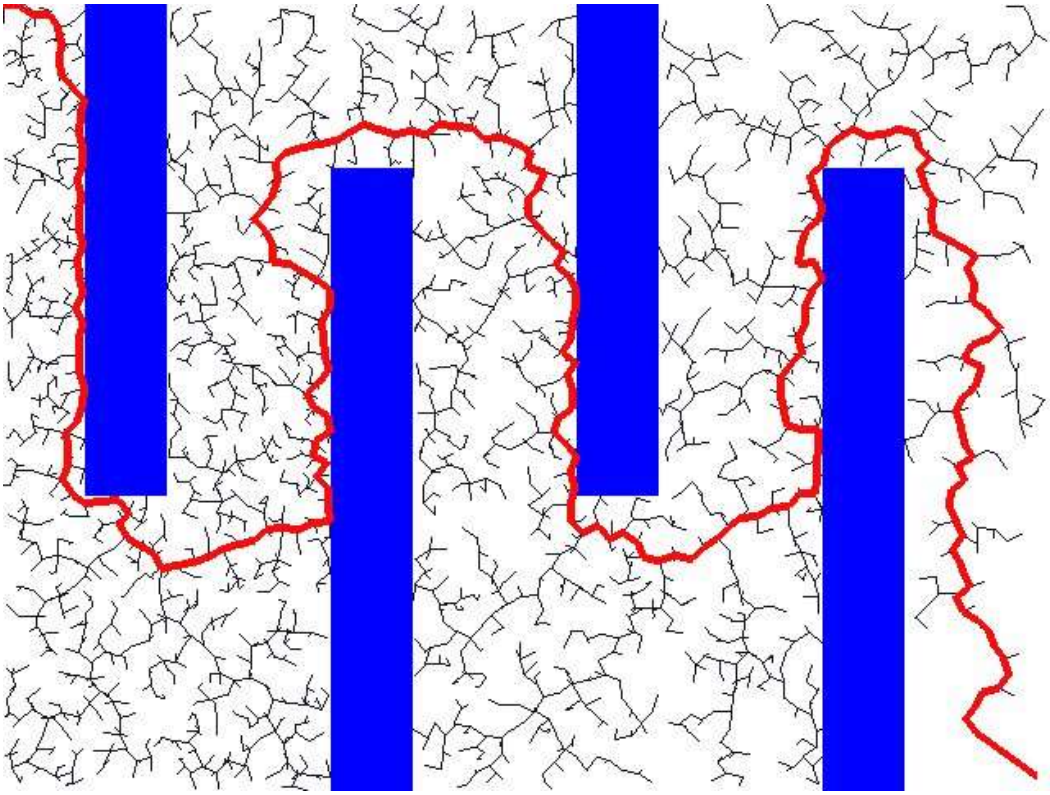


Start Node: [0,0] (Top-left Corner)

Goal Node: [630, 470] (Bottom-right Corner)

RESULTS:

RRT Algorithm



Statistics:

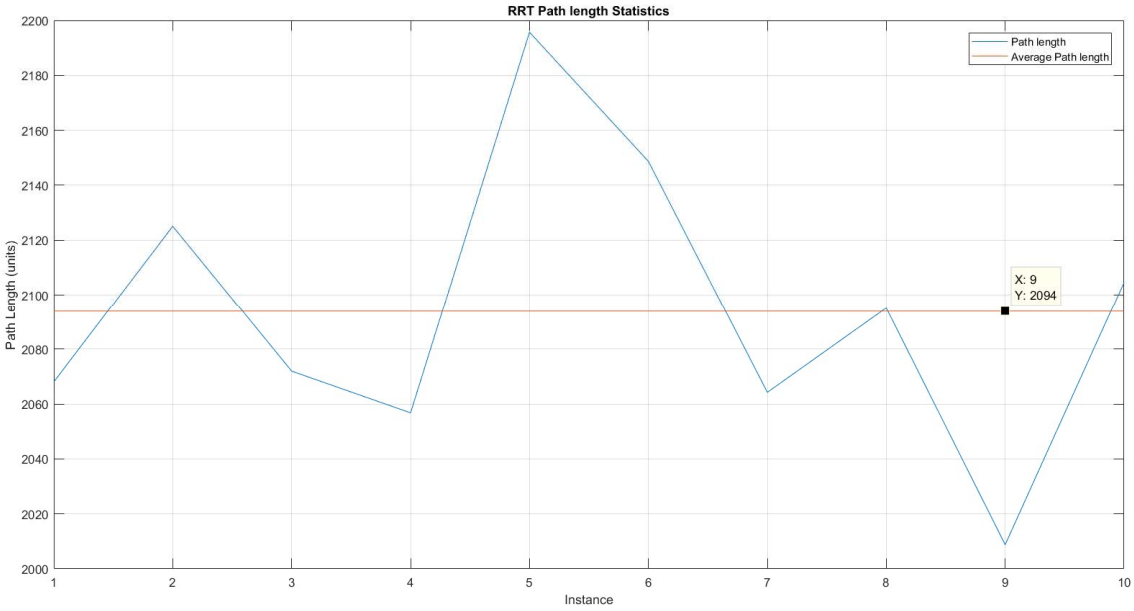
Iteration	Path Length (units)	Time Taken (sec)
1	2068.05	20.96
2	2125.06	18.08
3	2071.97	18.35
4	2056.78	19.67
5	2195.69	31.93
6	2148.68	40.88
7	2064.25	23.65
8	2095.04	21.44
9	2008.78	16.05
10	2104.53	16.26

Average Path Length: **2093.88 units**

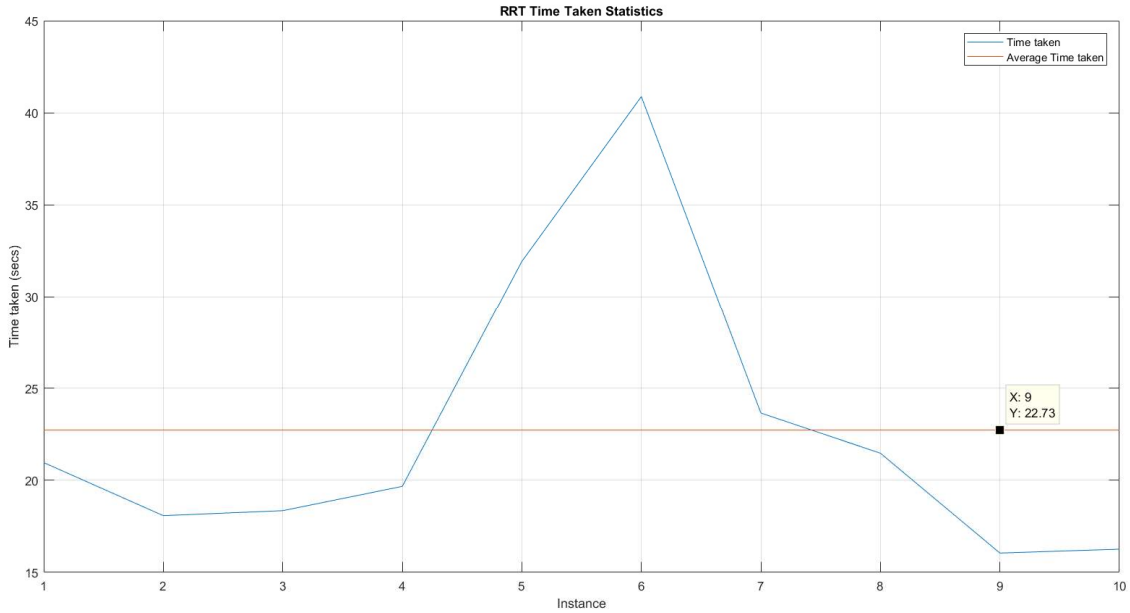
Average Time Taken: **22.73 sec**

Graphs:

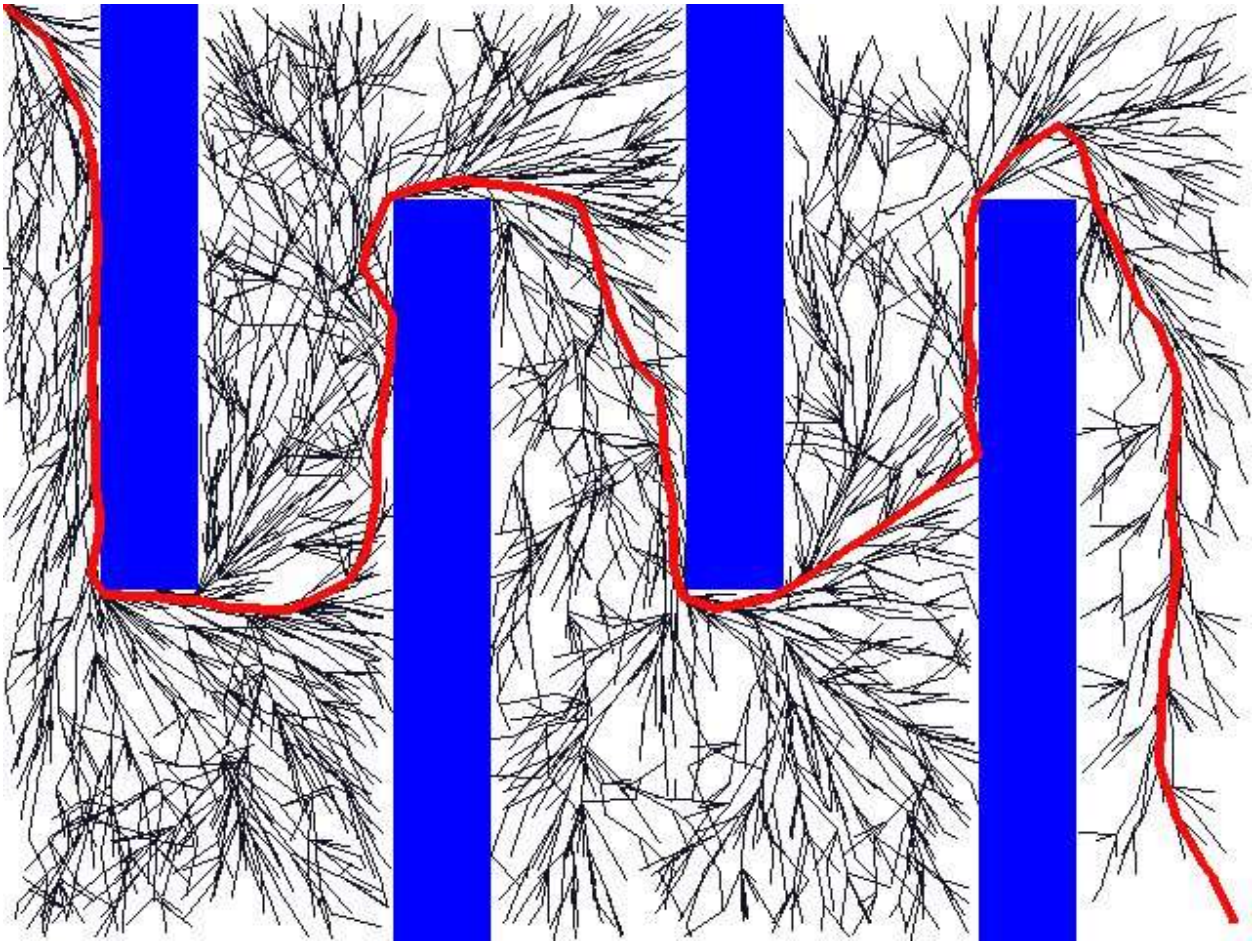
Path Length vs Iteration



Time Taken vs Iteration



RRT* Algorithm



Statistics:

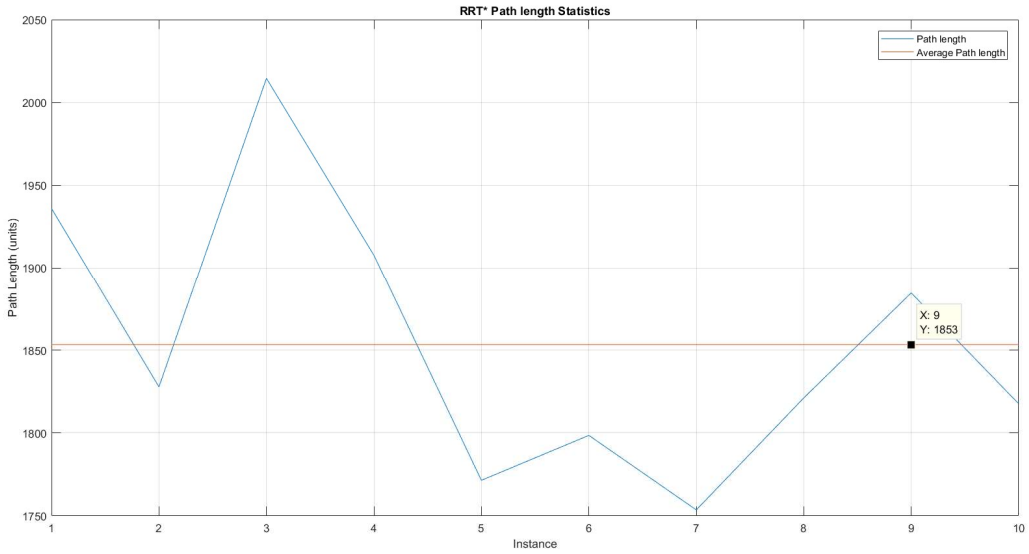
Iteration	Path Length (units)	Time Taken (sec)
1	1936.06	148.41
2	1827.82	96.05
3	2014.57	131.18
4	1907.81	139.20
5	1771.44	176.50
6	1798.56	112.92
7	1753.60	83.81
8	1821.16	83.12
9	1884.58	152.90
10	1817.60	94.44

Average Path Length: **1853.32 units**

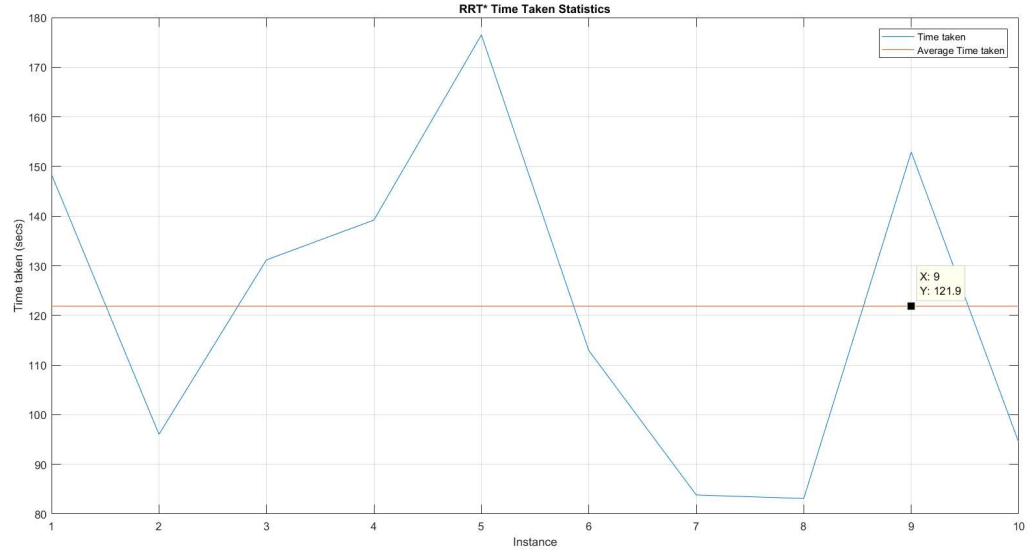
Average Time Taken: **121.85 sec**

Graphs:

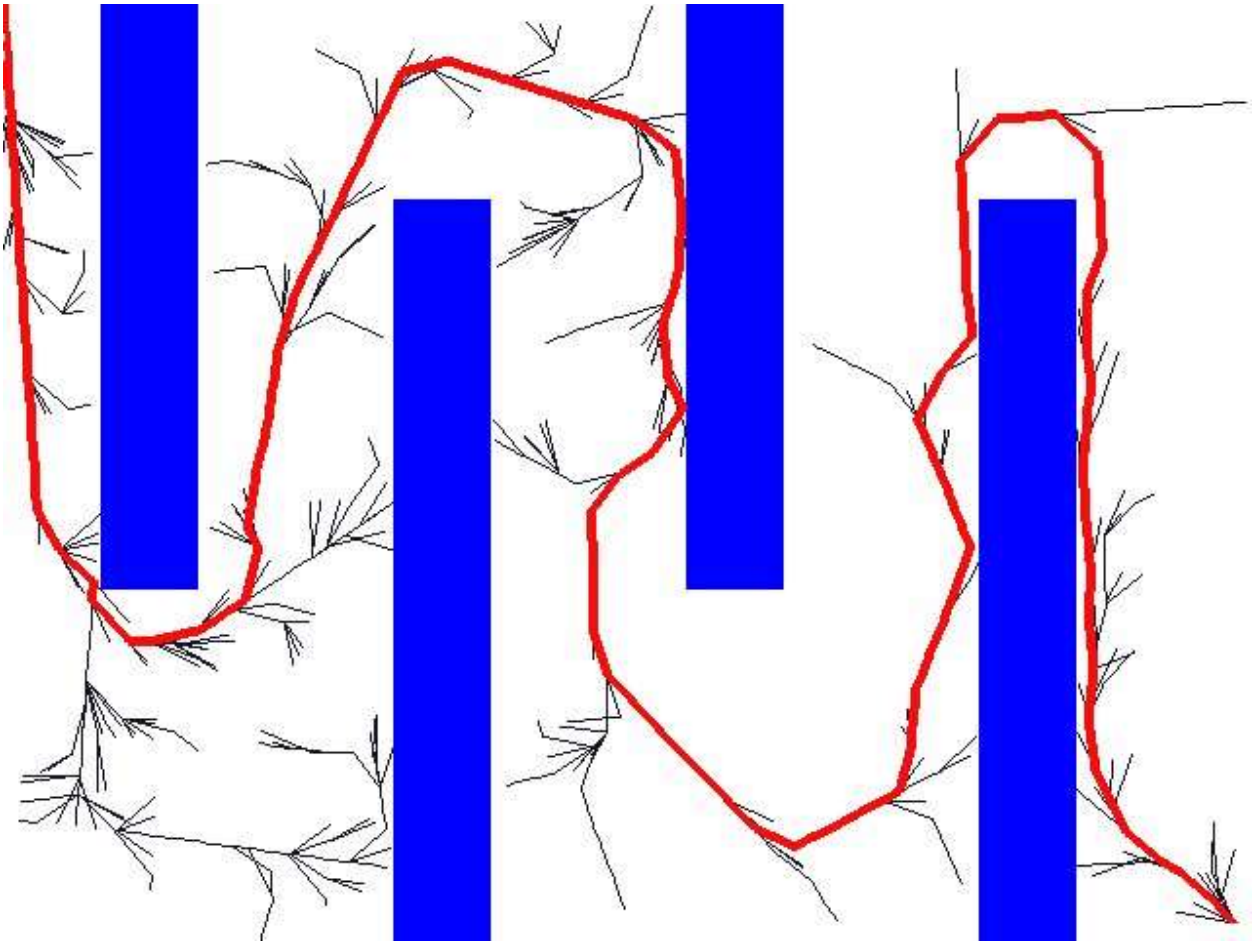
Path Length vs Iteration



Time Taken vs Iteration



Bi-directional RRT* (Connect + Extend)



Statistics:

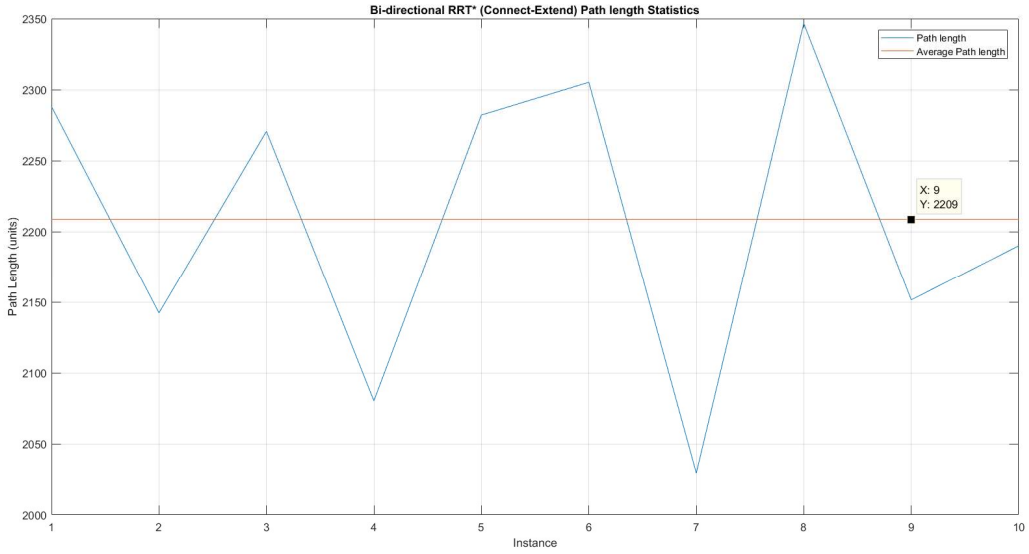
Iteration	Path Length (units)	Time Taken (sec)
1	2288.13	4.64
2	2142.20	4.83
3	2270.64	3.40
4	2080.25	4.36
5	2282.11	4.43
6	2305.21	3.80
7	2029.39	3.49
8	2346.66	5.24
9	2151.43	4.38
10	2190.07	3.11

Average Path Length: **2208.60 units**

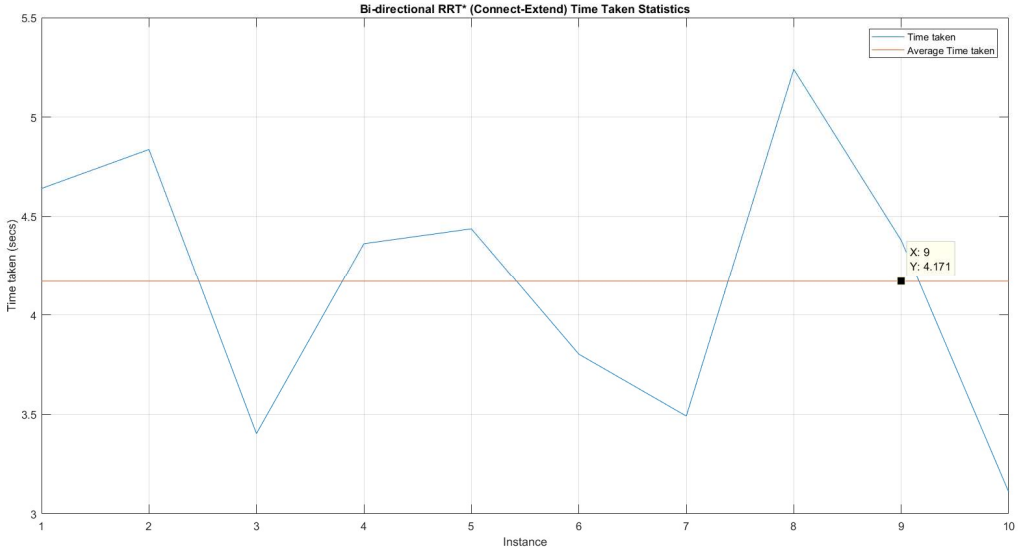
Average Time Taken: **4.17 sec**

Graphs:

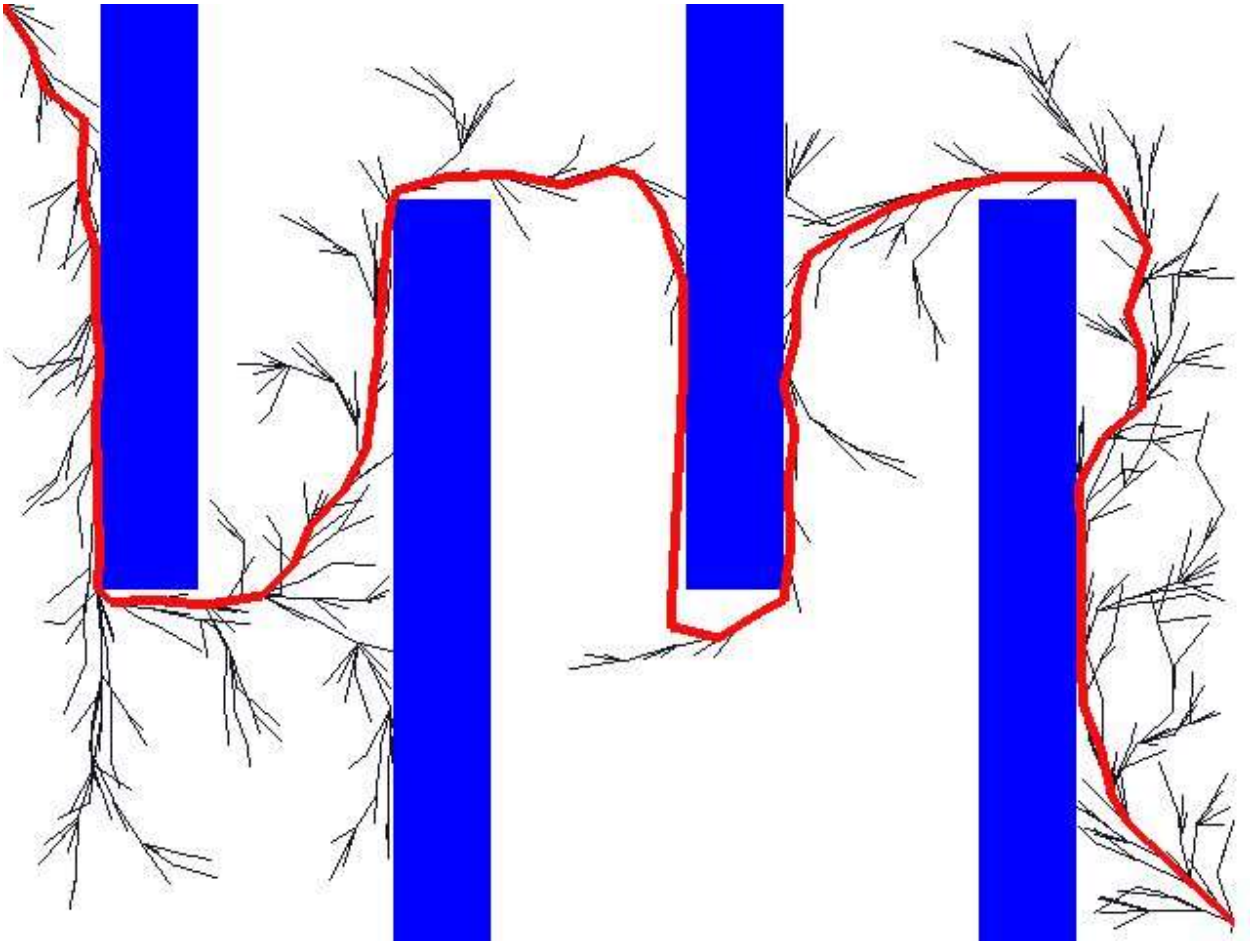
Path Length vs Iteration



Time Taken vs Iteration



Bi-directional RRT* (Extend + Extend)



Statistics:

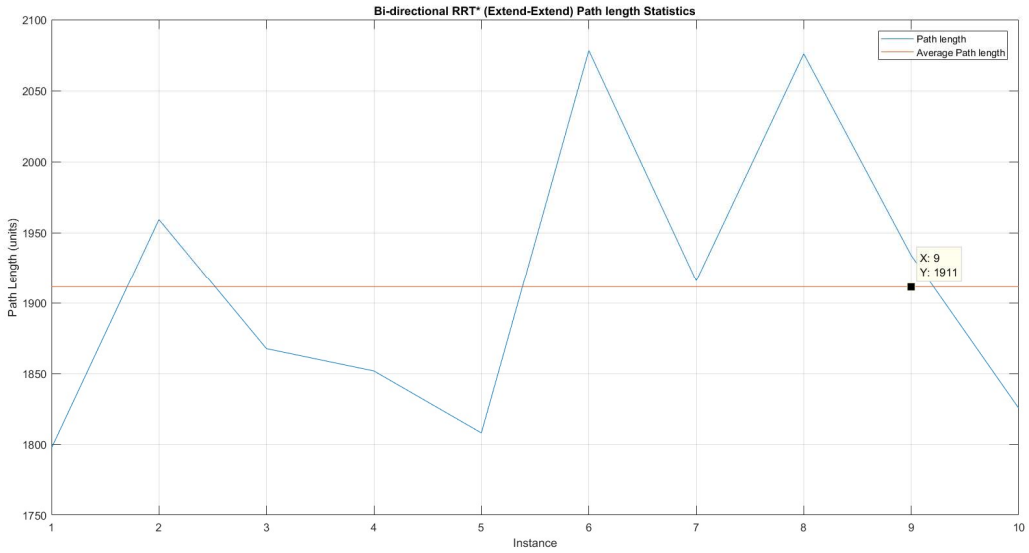
Iteration	Path Length (units)	Time Taken (sec)
1	1797.31	3.41
2	1959.27	4.85
3	1867.58	3.46
4	1851.79	3.95
5	1808.02	4.67
6	2078.26	4.93
7	1915.76	3.07
8	2075.93	5.04
9	1933.91	4.60
10	1825.49	3.35

Average Path Length: **1911.33 units**

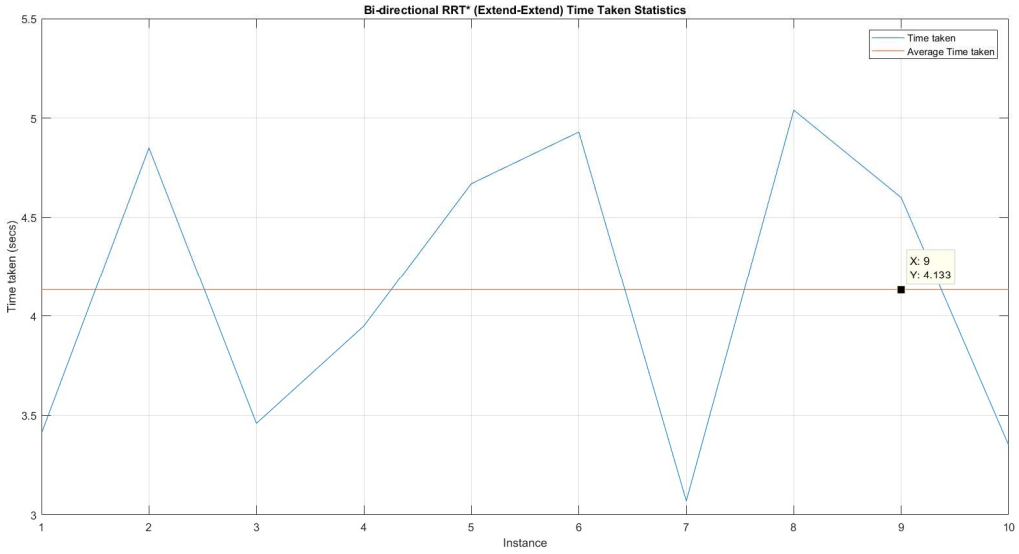
Average Time Taken: **4.13 sec**

Graphs:

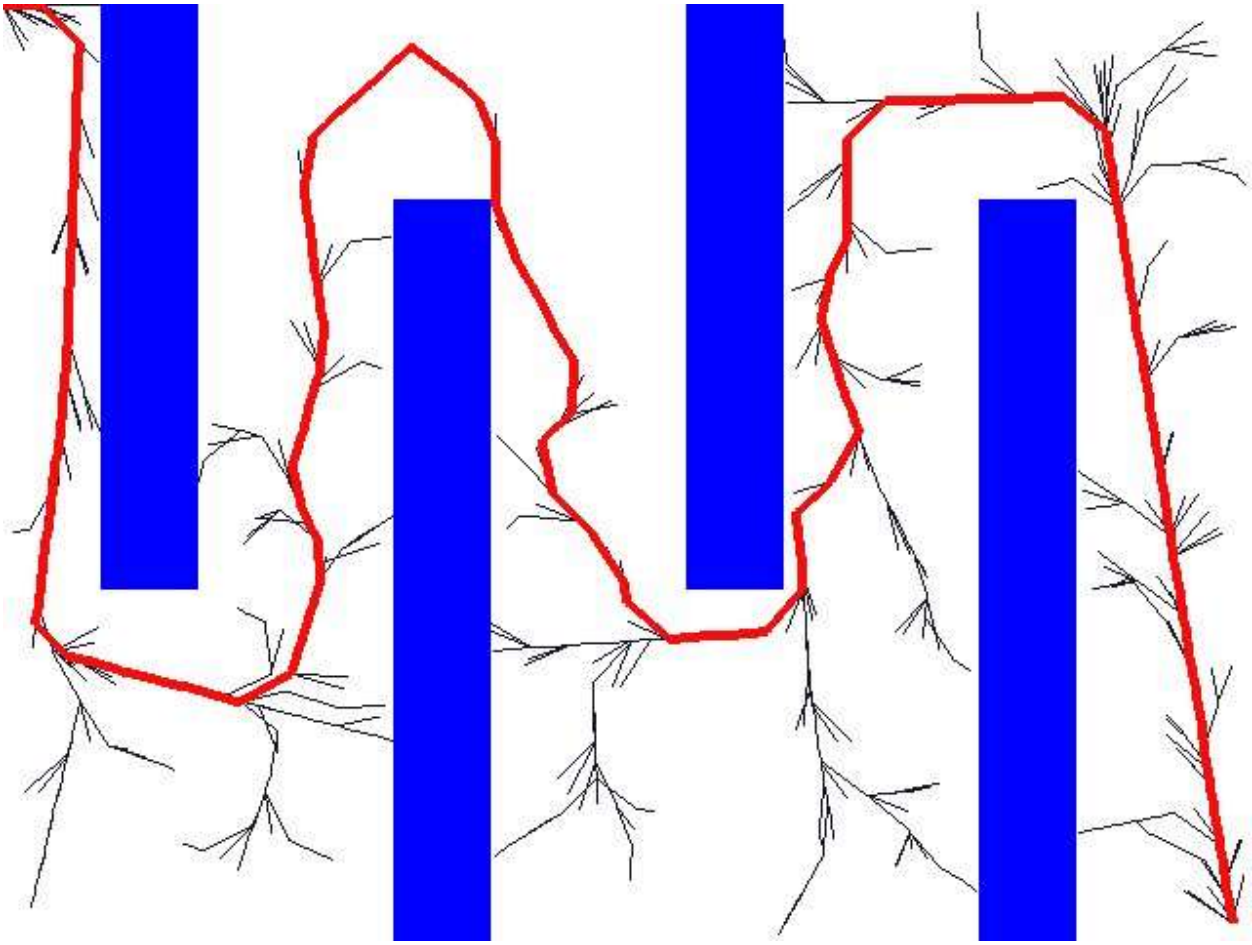
Path Length vs Iteration



Time Taken vs Iteration



Bi-directional RRT* (Connect + Connect)



Statistics:

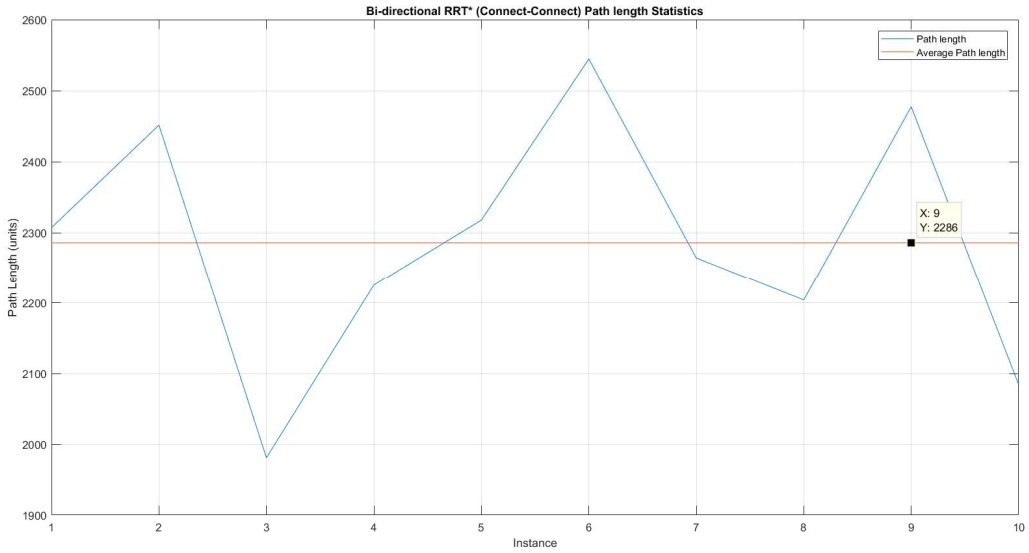
Iteration	Path Length (units)	Time Taken (sec)
1	2307.16	2.35
2	2451.52	2.69
3	1980.94	2.44
4	2225.31	2.83
5	2317.80	2.29
6	2544.65	2.21
7	2264.24	2.29
8	2204.06	2.95
9	2477.39	2.88
10	2084.11	2.59

Average Path Length: **2285.71 units**

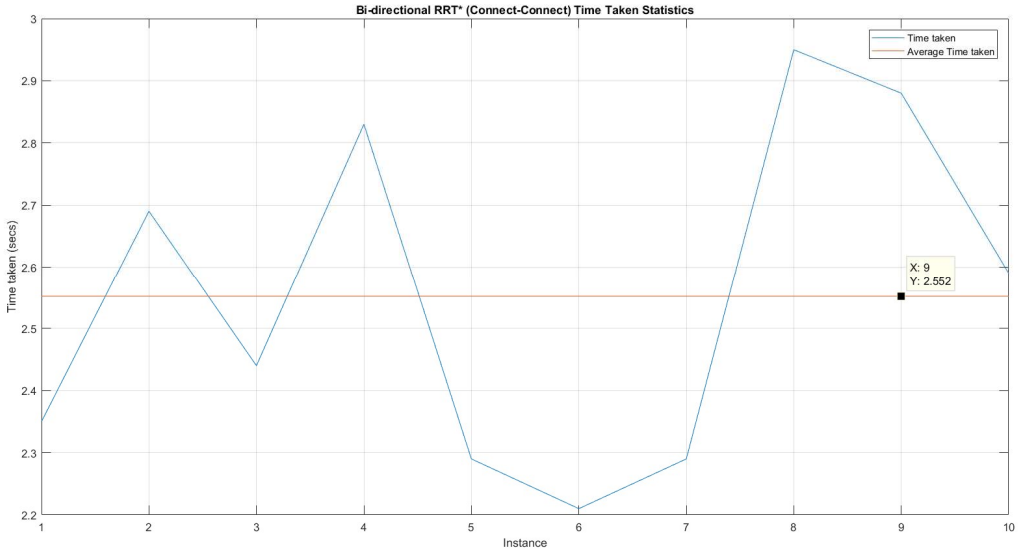
Average Time Taken: **2.55 sec**

Graphs:

Path Length vs Iteration



Time Taken vs Iteration



CONCLUSION:

- RRT finds the path in a reasonable amount of time but it is not a smooth path and not close to optimal path.
- RRT* finds the best path of all the variants (very close to optimal) but it takes forever to find one.
- Bi-directional RRT* (Connect + Connect) finds the path in the least time but it is very far from being optimal. This can be improved by reducing the step size but there will a trade-off on the time taken.
- Bi-directional RRT* (Extend + Extend) offers the best trade-off between time taken and path cost. The path found is close to the optimal path and it takes only about a few seconds to find a solution.
- Performance of Bi-directional RRT* (Connect + Extend) is somewhere in between the previous 2 variants.