

# House\_Experiment\_1\_\_

## Comparsion of controllers

### -Global planner: NavFn

Controller type	Trajectory type	Success rate (%)	Average execution time (sec)	CPU(%)		Memory usage(%)		Average number of recoveries	Average path length(m)	Min distance to obstacles(m)	Average Path Deviation
				Mean	Max	Mean	Max				
DWB	single_goal_0	100.0	76.82	20.47	30.4	8.07	8.2	0.33	16.37	0.31	0.94
DWB	waypoints_1	100.0	96.59	20.57	29.3	8.16	8.2	0.33	21.62	0.29	2.03
DWB	circle_2	100.0	43.97	19.19	28.4	8.10	8.2	0.33	8.73	0.59	0.58
DWB	square_3	93.33	57.75	19.62	28.1	8.16	8.2	1.00	11.69	0.57	1.62
RPP	single_goal_0	100.0	71.32	18.89	28.8	8.23	8.3	0.33	16.40	0.31	0.87
RPP	waypoints_1	100.0	93.91	18.88	27.6	8.29	8.3	0.33	21.97	0.27	1.78
RPP	circle_2	100.0	40.90	18.10	26.4	8.23	8.4	0.07	8.82	0.62	0.66
RPP	square_3	100.0	48.20	18.17	26.7	8.25	8.3	0.00	10.35	0.58	1.33
DWB_RSC	single_goal_0	100.0	84.24	20.58	42.8	8.30	8.4	1.13	16.37	0.32	1.03
DWB_RSC	waypoints_1	100.0	98.73	20.61	30.9	8.31	8.4	0.40	21.83	0.3	1.66
DWB_RSC	circle_2	100.0	44.43	19.42	29.5	8.30	8.3	0.33	8.76	0.61	0.61
DWB_RSC	square_3	86.67	73.81	20.09	29.1	8.31	8.4	1.93	12.55	0.54	1.98
RPP_RSC	single_goal_0	100.0	71.39	19.37	36.1	8.35	8.9	0.07	16.39	0.28	0.89
RPP_RSC	waypoints_1	100.0	94.00	18.88	27.6	8.39	8.5	0.33	21.92	0.27	1.73
RPP_RSC	circle_2	100.0	40.37	18.91	28.2	8.37	8.5	0.07	8.80	0.62	0.62
RPP_RSC	square_3	100.0	47.69	18.44	26.0	8.38	8.4	0.00	10.33	0.57	1.37
MPPI	single_goal_0	100.0	78.27	21.74	31.1	8.43	8.5	0.40	16.22	0.31	1.0
MPPI	waypoints_1	100.0	88.98	22.02	30.9	8.48	8.5	0.00	21.76	0.34	1.42
MPPI	circle_2	100.0	35.83	20.32	28.0	8.42	8.5	0.00	8.54	0.59	0.56
MPPI	square_3	100.0	41.83	20.78	28.5	8.44	8.5	0.00	10.14	0.57	0.69
Graceful	single_goal_0	100.0	76.08	19.97	28.2	8.49	8.6	0.00	16.53	0.29	0.83
Graceful	waypoints_1	100.0	108.27	20.23	27.8	8.50	8.6	0.00	22.41	0.29	1.54
Graceful	circle_2	100.0	47.30	18.65	25.6	8.50	8.5	0.13	8.94	0.56	0.92
Graceful	square_3	100.0	53.88	19.36	26.6	8.50	8.5	0.00	10.49	0.53	1.07

### -Global planner: smac\_planner

Controller type	Trajectory type	Success rate (%)	Average execution time (sec)	CPU(%)		Memory usage(%)		Average number of recoveries	Average path length(m)	Min distance to obstacles(m)	Average Path Deviation
				Mean	Max	Mean	Max				
DWB	single_goal_0	100.0	75.34	20.61	28.6	8.50	8.6	0.20	16.19	0.31	1.02
DWB	waypoints_1	100.0	96.44	20.25	29.7	8.51	8.6	0.47	21.28	0.3	2.26
DWB	circle_2	100.0	44.30	19.83	28.2	8.50	8.5	0.27	8.75	0.59	0.65
DWB	square_3	93.33	59.03	20.12	28.8	8.54	8.7	0.93	11.91	0.58	1.56
RPP	single_goal_0	100.0	70.24	19.33	27.2	8.70	8.8	0.00	16.23	0.28	0.91
RPP	waypoints_1	100.0	91.62	19.29	29.1	8.70	8.8	0.00	21.52	0.32	1.89
RPP	circle_2	100.0	39.80	18.77	26.2	8.70	8.7	0.00	8.77	0.62	0.64
RPP	square_3	100.0	47.74	19.08	25.6	8.70	8.8	0.00	10.32	0.58	1.45
DWB_RSC	single_goal_0	100.0	79.45	21.63	29.7	8.76	8.8	0.67	16.27	0.34	0.94
DWB_RSC	waypoints_1	100.0	98.36	21.34	28.2	8.69	8.8	0.60	21.42	0.32	2.05
DWB_RSC	circle_2	100.0	43.15	20.72	27.7	8.60	8.7	0.13	8.74	0.61	0.6
DWB_RSC	square_3	73.33	92.46	20.79	27.7	8.62	8.7	3.93	14.05	0.57	2.93
RPP_RSC	single_goal_0	100.0	70.28	20.24	28.6	8.65	8.7	0.00	16.21	0.33	0.87
RPP_RSC	waypoints_1	100.0	91.72	20.24	27.6	8.68	8.7	0.33	21.52	0.3	1.85
RPP_RSC	circle_2	100.0	40.09	19.54	26.2	8.65	8.7	0.00	8.78	0.6	0.63
RPP_RSC	square_3	100.0	47.79	19.45	27.1	8.65	8.7	0.00	10.31	0.57	1.44
MPPI	single_goal_0	100.0	70.35	22.72	30.7	8.70	8.8	0.33	15.93	0.34	1.03
MPPI	waypoints_1	100.0	87.02	22.79	29.9	8.70	8.8	0.00	21.31	0.34	1.67
MPPI	circle_2	100.0	36.20	21.98	28.7	8.70	8.7	0.00	8.51	0.57	0.61
MPPI	square_3	100.0	45.97	22.22	30.1	8.70	8.8	0.13	10.62	0.43	0.79
Graceful	single_goal_0	100.0	78.60	21.39	28.7	8.72	8.8	0.00	16.46	0.34	0.92
Graceful	waypoints_1	100.0	107.78	20.70	28.1	8.76	8.8	0.00	22.08	0.33	1.67
Graceful	circle_2	100.0	47.07	20.47	28.2	8.73	8.8	0.00	8.98	0.55	1.04
Graceful	square_3	100.0	53.24	20.65	27.8	8.76	8.8	0.00	10.44	0.55	0.94

**-Global planner: ThetaStar**

Controller type	Trajectory type	Success rate (%)	Average execution time (sec)	CPU(%)		Memory usage(%)		Average number of recoveries	Average path length(m)	Min distance to obstacles(m)	Average Path Deviation
				Mean	Max	Mean	Max				
DWB	single_goal_0	86.67	82.92	22.54	30.7	8.80	8.9	4.40	15.35	0.23	1.25
DWB	waypoints_1	86.67	118.21	22.68	30.9	8.80	8.9	2.80	20.53	0.24	2.53
DWB	circle_2	100.0	46.81	22.14	28.8	8.80	8.9	0.60	8.79	0.59	0.68
DWB	square_3	100.0	48.16	21.82	29.4	8.80	8.8	0.07	10.20	0.58	0.89
RPP	single_goal_0	93.33	72.00	21.39	28.6	8.81	8.9	2.73	15.63	0.28	1.03
RPP	waypoints_1	100.0	90.00	20.82	28.5	8.84	8.9	0.00	20.73	0.31	1.8

RPP	circle_2	100.0	40.95	20.74	27.5	8.81	8.9	0.00	8.80	0.6	0.68
RPP	square_3	100.0	47.87	21.09	28.4	8.83	8.9	0.00	10.33	0.58	1.28
DWB_RSC	single_goal_0	100.0	94.00	23.47	51.1	8.88	8.9	3.93	16.00	0.31	1.21
DWB_RSC	waypoints_1	93.33	108.29	23.20	30.2	8.90	9.0	1.73	20.74	0.27	2.0
DWB_RSC	circle_2	100.0	48.07	22.45	29.8	8.90	8.9	0.53	8.81	0.57	0.71
DWB_RSC	square_3	93.33	59.21	22.77	30.2	8.90	9.0	1.00	11.15	0.59	1.35
RPP_RSC	single_goal_0	93.33	73.69	21.95	29.6	8.91	9.0	4.13	15.66	0.3	1.03
RPP_RSC	waypoints_1	100.0	89.77	22.01	31.0	8.92	9.0	0.00	20.74	0.31	1.74
RPP_RSC	circle_2	100.0	40.19	21.78	31.2	8.91	9.0	0.00	8.79	0.61	0.67
RPP_RSC	square_3	100.0	47.93	21.34	27.1	8.91	9.0	0.00	10.32	0.57	1.24
MPPI	single_goal_0	100.0	69.62	24.50	32.6	8.98	9.0	0.73	15.77	0.33	0.99
MPPI	waypoints_1	100.0	84.52	24.62	31.9	8.99	9.1	0.27	20.75	0.32	1.63
MPPI	circle_2	100.0	35.89	23.80	30.9	9.00	9.1	0.00	8.48	0.56	0.61
MPPI	square_3	100.0	52.35	23.99	32.3	9.00	9.1	0.60	10.82	0.38	0.88
Graceful	single_goal_0	100.0	72.12	23.09	29.8	9.00	9.1	0.00	16.02	0.29	0.77
Graceful	waypoints_1	100.0	102.24	22.91	28.7	9.04	9.1	0.00	21.32	0.31	1.7
Graceful	circle_2	100.0	46.78	22.16	28.3	9.02	9.1	0.00	9.00	0.55	1.02
Graceful	square_3	100.0	53.28	22.34	28.9	9.03	9.1	0.07	10.43	0.54	0.94

**-Global planner: Lattice**

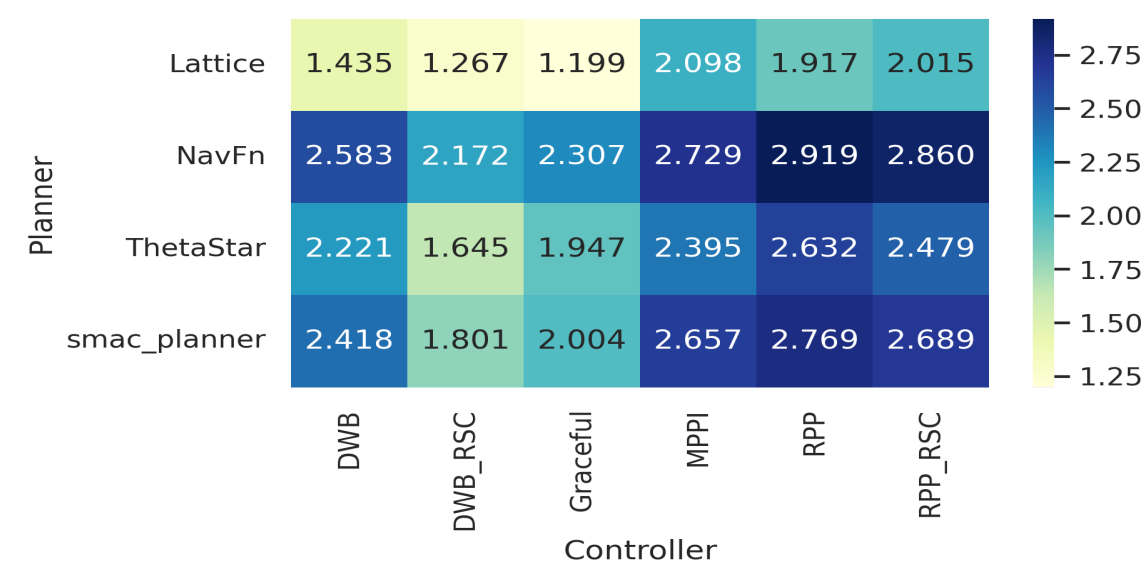
Controller type	Trajectory type	Success rate (%)	Average execution time (sec)	CPU(%)		Memory usage(%)		Average number of recoveries	Average path length(m)	Min distance to obstacles(m)	Average Path Deviation
				Mean	Max	Mean	Max				
DWB	single_goal_0	93.33	81.20	24.67	32.6	9.08	9.1	3.47	15.89	0.24	1.47
DWB	waypoints_1	46.67	144.35	24.12	31.8	9.10	9.2	9.07	18.22	0.2	3.54
DWB	circle_2	100.0	43.09	24.25	32.4	9.10	9.2	0.27	8.67	0.58	0.78
DWB	square_3	86.67	76.63	23.80	30.7	9.12	9.3	2.20	14.82	0.58	2.27
RPP	single_goal_0	100.0	70.31	23.25	30.7	9.17	9.2	0.27	16.21	0.33	1.08
RPP	waypoints_1	93.33	93.25	22.63	28.9	9.20	9.3	3.27	20.33	0.22	1.95
RPP	circle_2	100.0	44.16	22.53	27.6	9.19	9.3	0.47	9.19	0.67	0.76
RPP	square_3	100.0	49.99	22.42	28.6	9.20	9.3	0.00	10.61	0.56	1.32
DWB_RSC	single_goal_0	100.0	83.00	24.53	32.4	9.20	9.3	1.07	16.20	0.32	1.19
DWB_RSC	waypoints_1	80.0	136.26	24.19	31.0	9.20	9.3	5.47	19.98	0.26	2.84
DWB_RSC	circle_2	100.0	45.50	24.20	30.5	9.20	9.2	0.47	8.75	0.6	0.82
DWB_RSC	square_3	86.67	72.22	23.82	31.7	9.20	9.2	2.00	12.03	0.6	1.68
RPP_RSC	single_goal_0	100.0	69.82	23.13	29.8	9.24	9.3	0.00	16.19	0.33	1.1
RPP_RSC	waypoints_1	86.67	89.00	22.92	29.5	9.28	9.3	3.40	19.26	0.26	1.93
RPP_RSC	circle_2	100.0	41.76	22.57	28.5	9.25	9.3	0.07	9.14	0.68	0.75

RPP_RSC	square_3	100.0	50.27	22.46	28.5	9.25	9.3	0.00	10.62	0.58	1.3
MPPI	single_goal_0	100.0	67.83	25.44	33.3	9.29	9.4	0.73	15.91	0.38	1.1
MPPI	waypoints_1	100.0	87.24	25.16	35.4	9.30	9.3	0.27	20.99	0.33	1.67
MPPI	circle_2	100.0	36.18	24.82	35.9	9.30	9.4	0.00	8.53	0.51	0.8
MPPI	square_3	100.0	45.08	24.64	30.1	9.29	9.3	0.53	10.47	0.58	0.97
Graceful	single_goal_0	100.0	78.05	23.63	31.4	9.30	9.4	0.00	16.37	0.31	1.14
Graceful	waypoints_1	100.0	111.93	23.15	33.9	9.31	9.4	0.33	21.46	0.28	1.94
Graceful	circle_2	100.0	53.36	23.15	29.9	9.31	9.4	0.20	9.19	0.63	1.22
Graceful	square_3	100.0	67.79	22.71	29.9	9.30	9.4	0.00	10.79	0.54	1.51

## Performace analysis

Based on the criteria:Time, path\_length, CPU, Memory, Safety

The score of each controller and planner combinations are:



### Success rate

Planners' success rate are:

Planner: Lattice, Success Rate: 94.72%

Planner: ThetaStar, Success Rate: 97.78%

Planner: smac\_planner, Success Rate: 98.61%

Planner: NavFn, Success Rate: 99.17%

### Controllers' success rate are:

Controller: Graceful, Success Rate: 100.00%

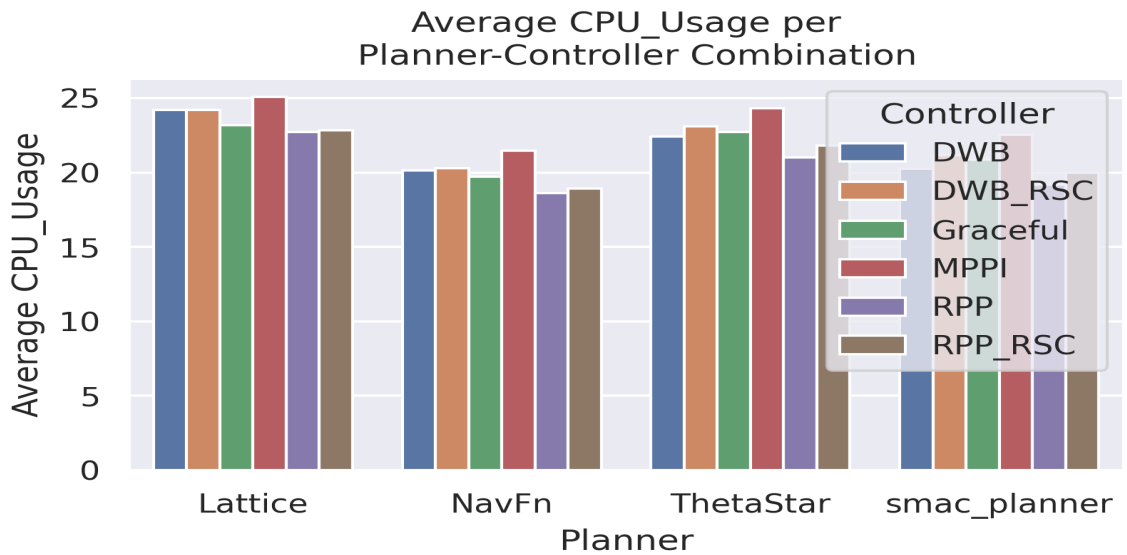
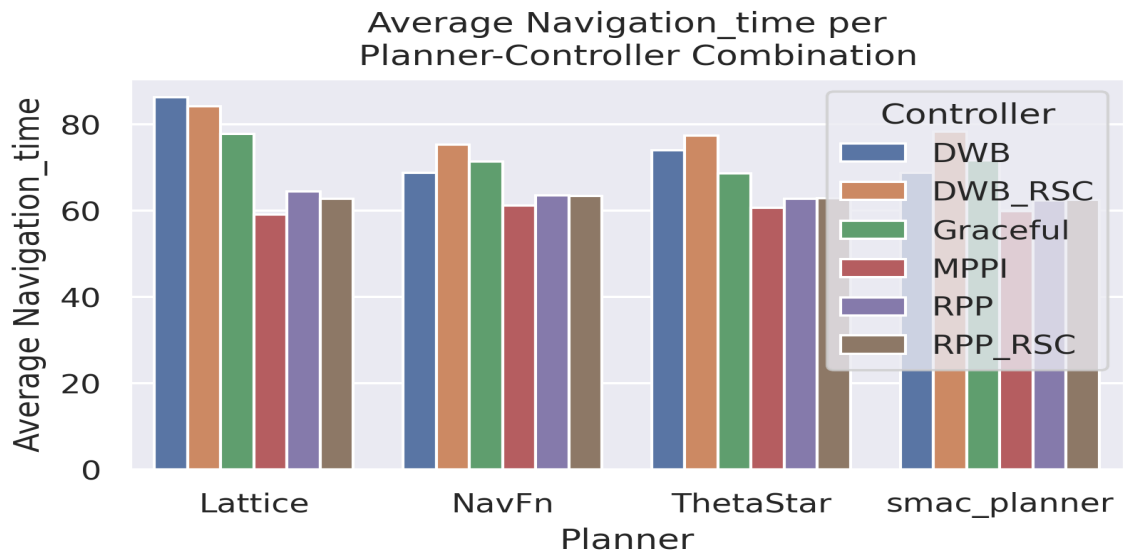
Controller: MPPI, Success Rate: 100.00%

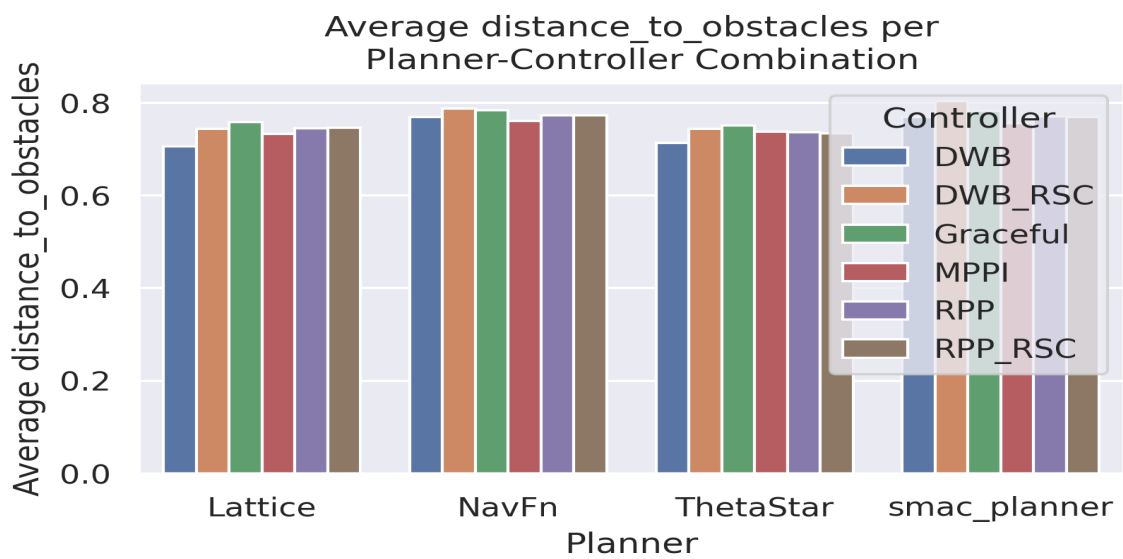
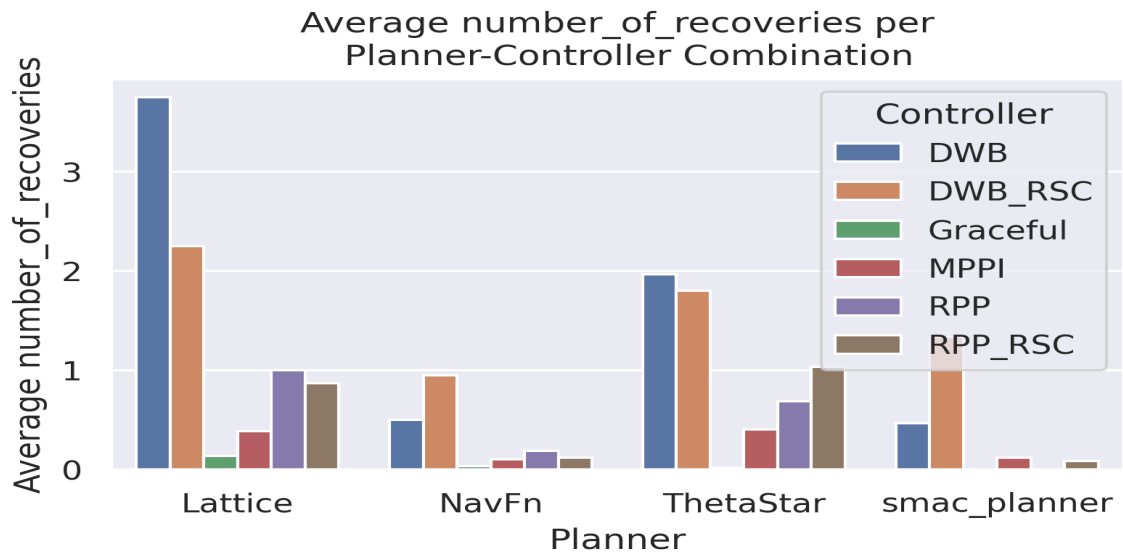
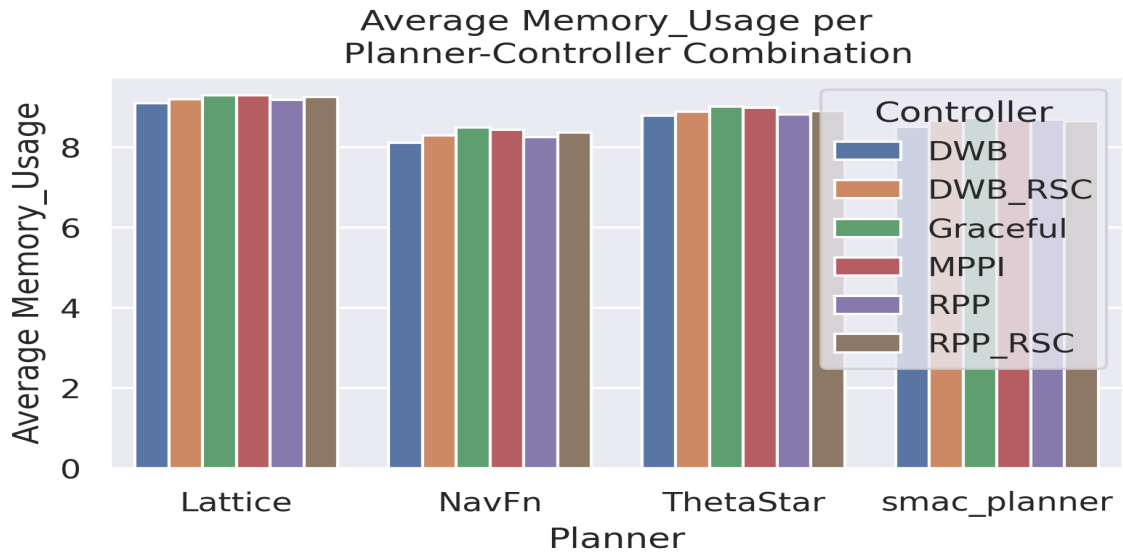
Controller: RPP\_RSC, Success Rate: 98.75%

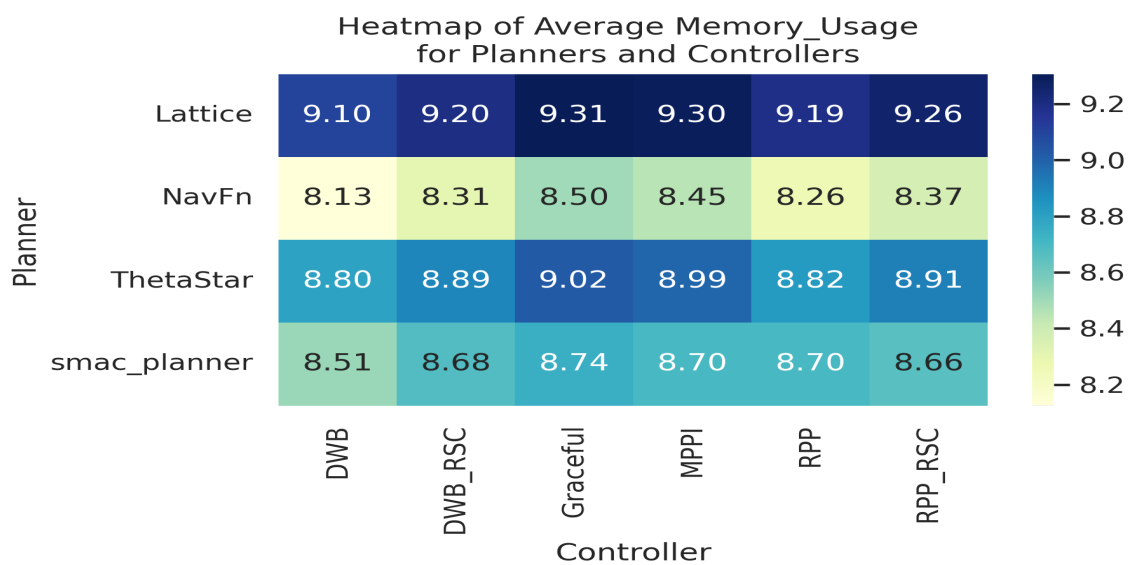
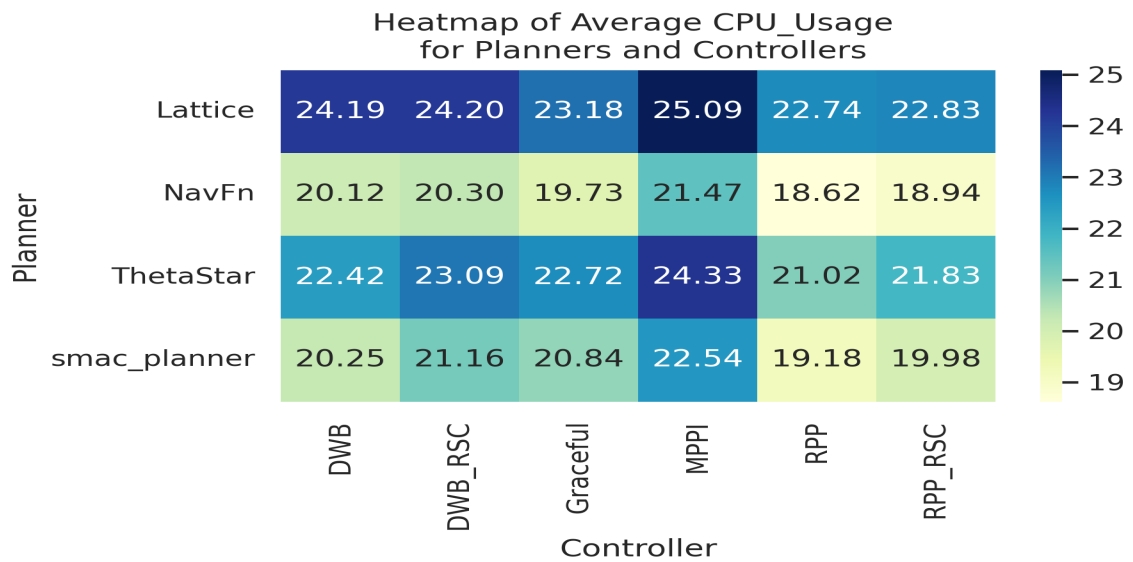
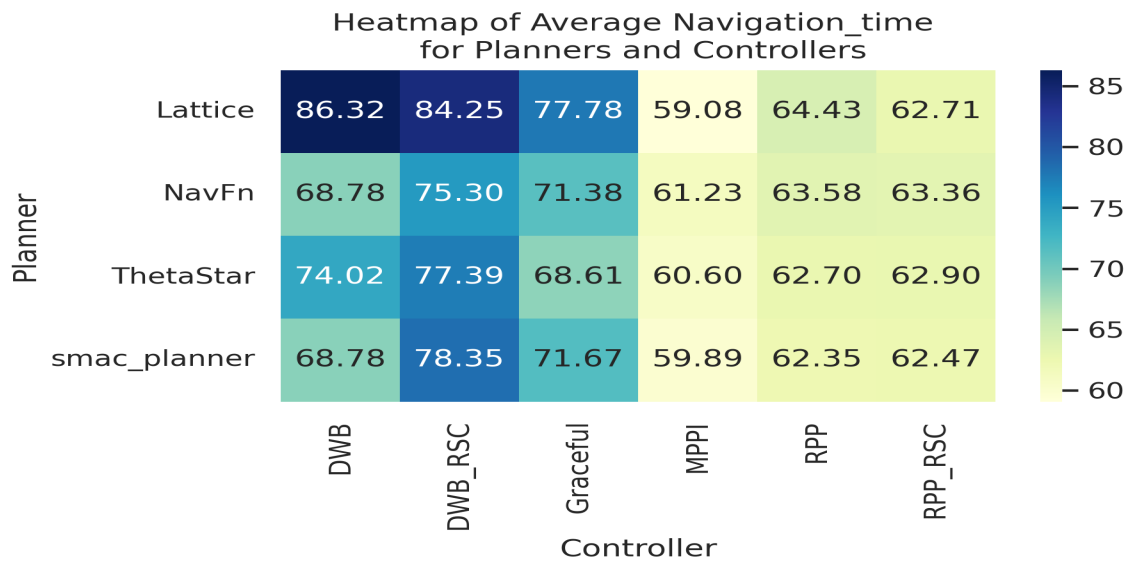
Controller: DWB\_RSC, Success Rate: 94.58%

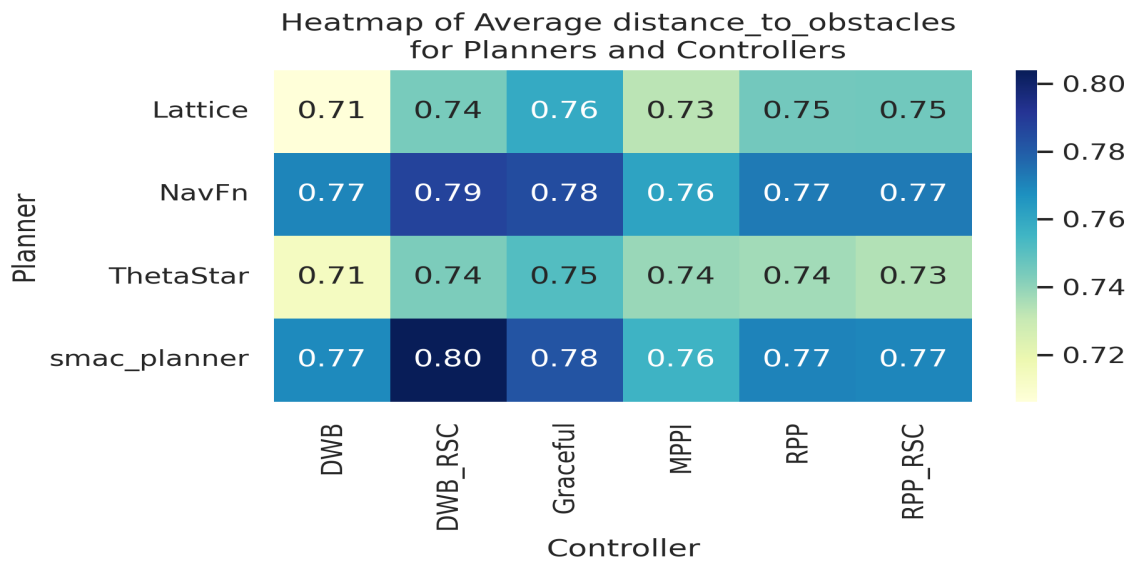
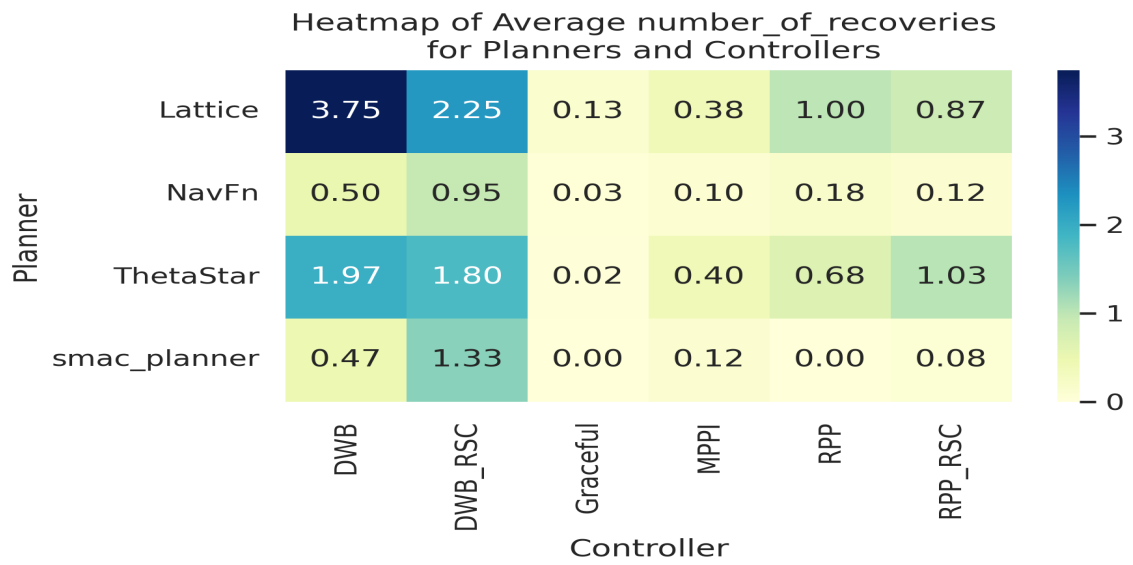
Controller: RPP, Success Rate: 99.17%

Controller: DWB, Success Rate: 92.92%



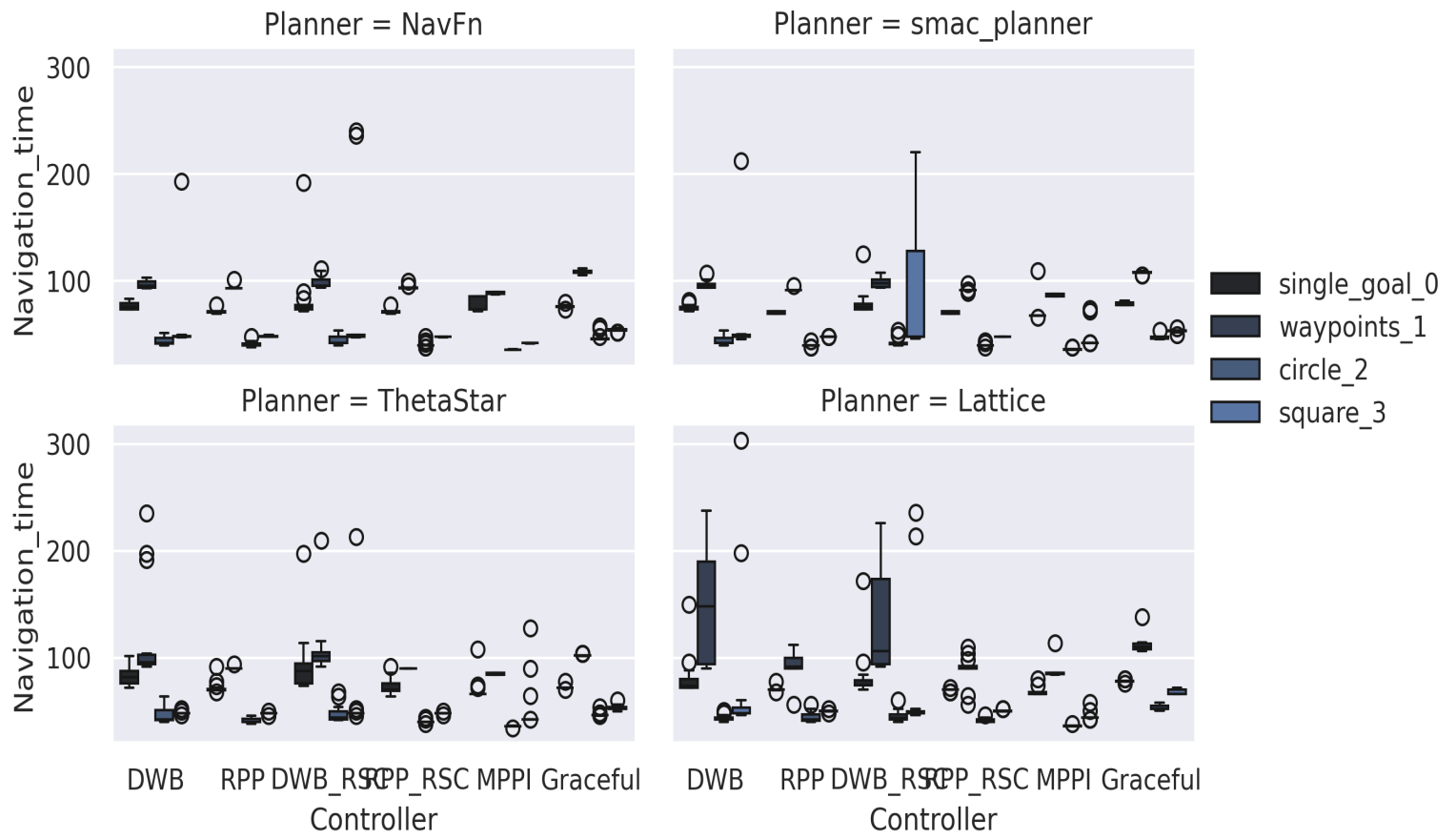




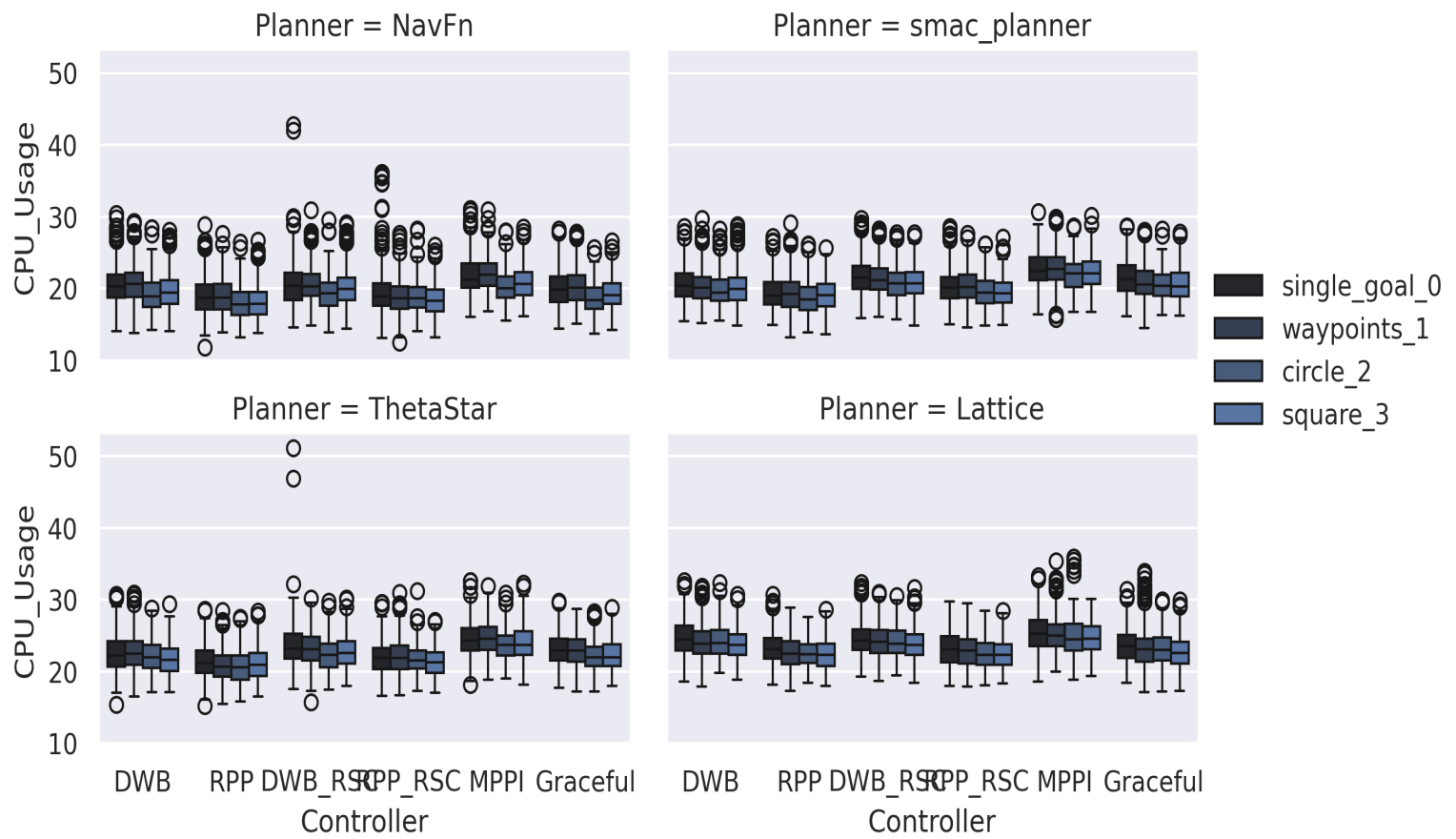




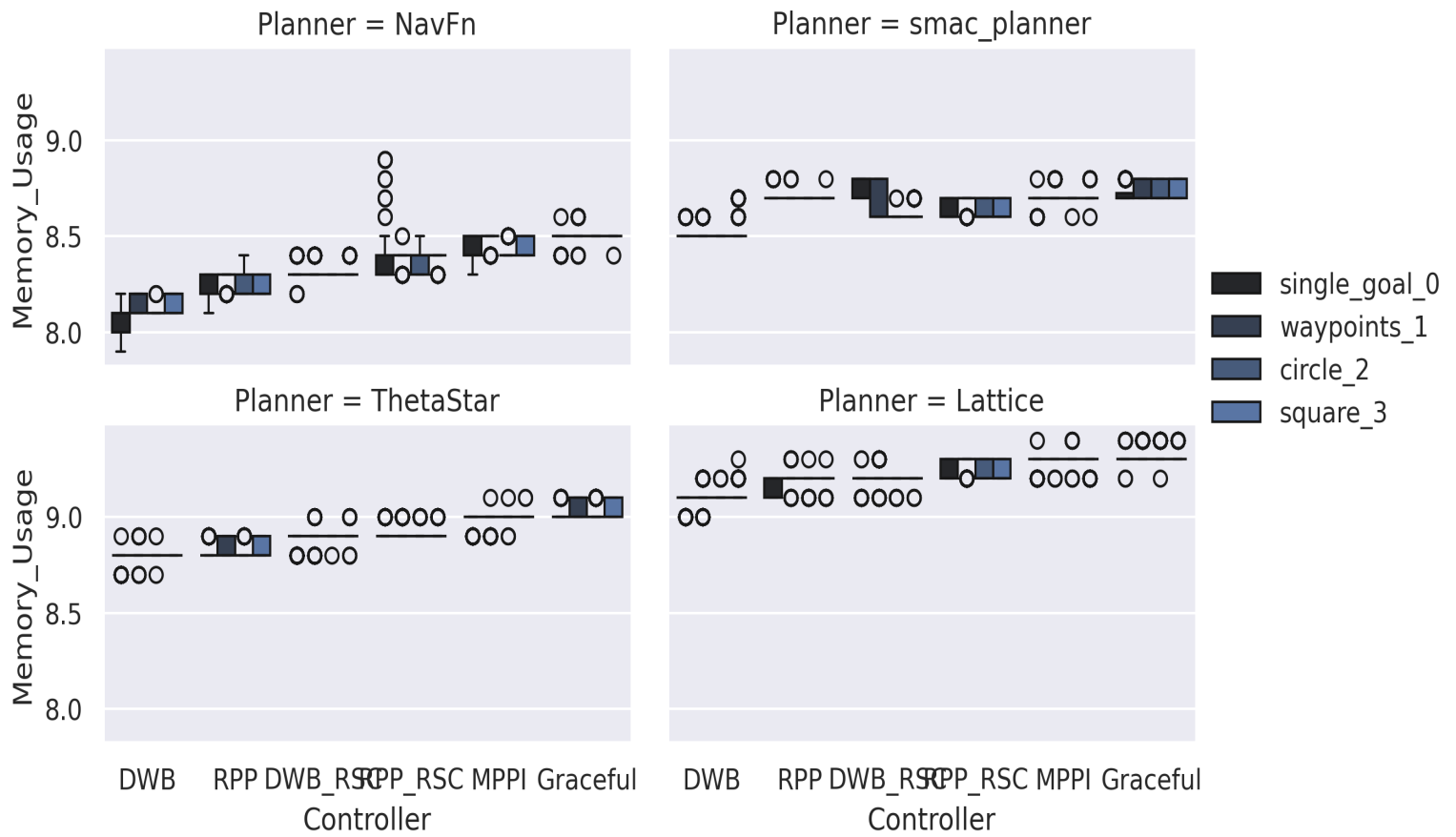
# Complex Distribution of Navigation\_time by Planner, Controller, and Trajectory Type



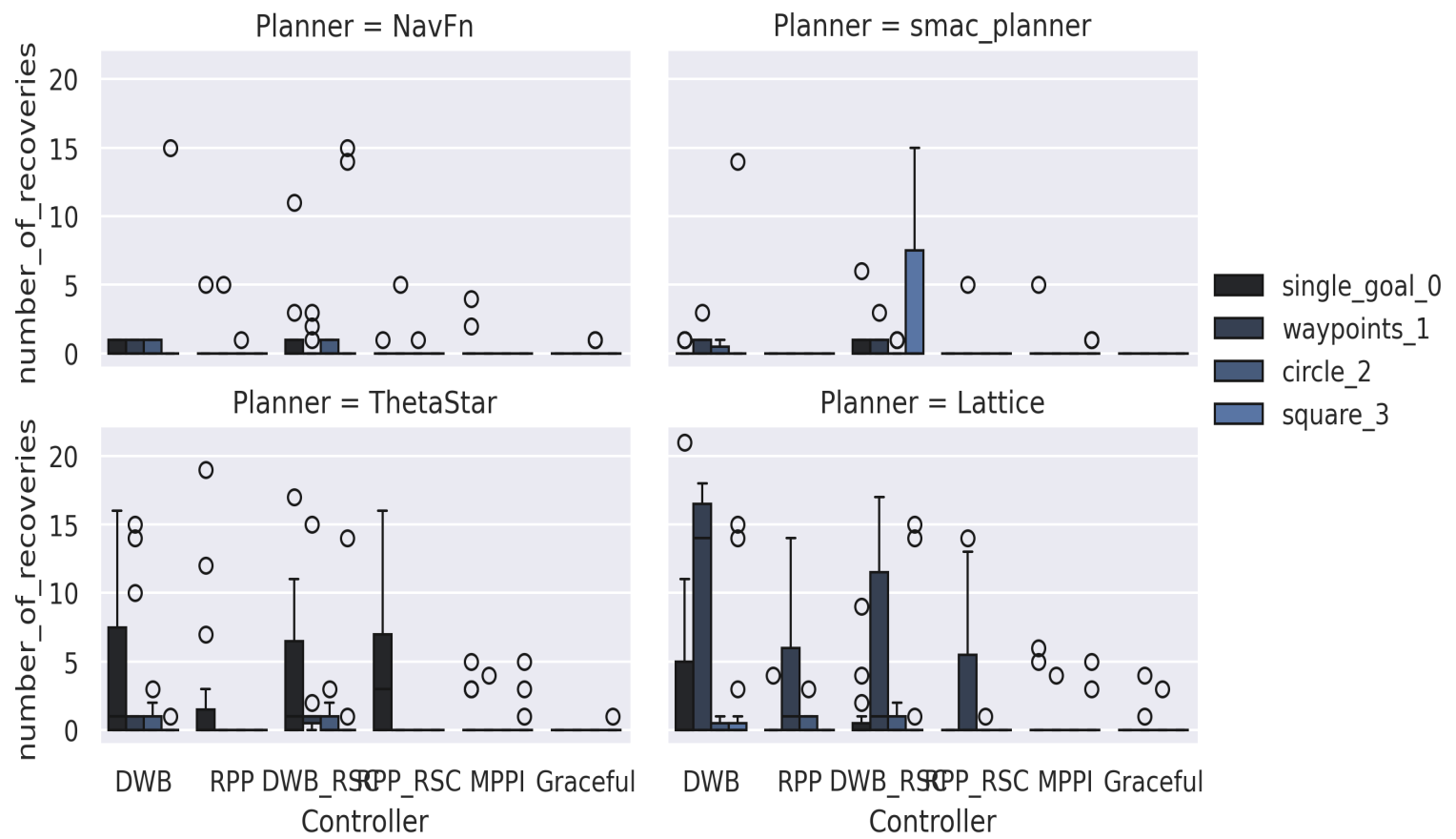
# Complex Distribution of CPU\_Usage by Planner, Controller, and Trajectory Type



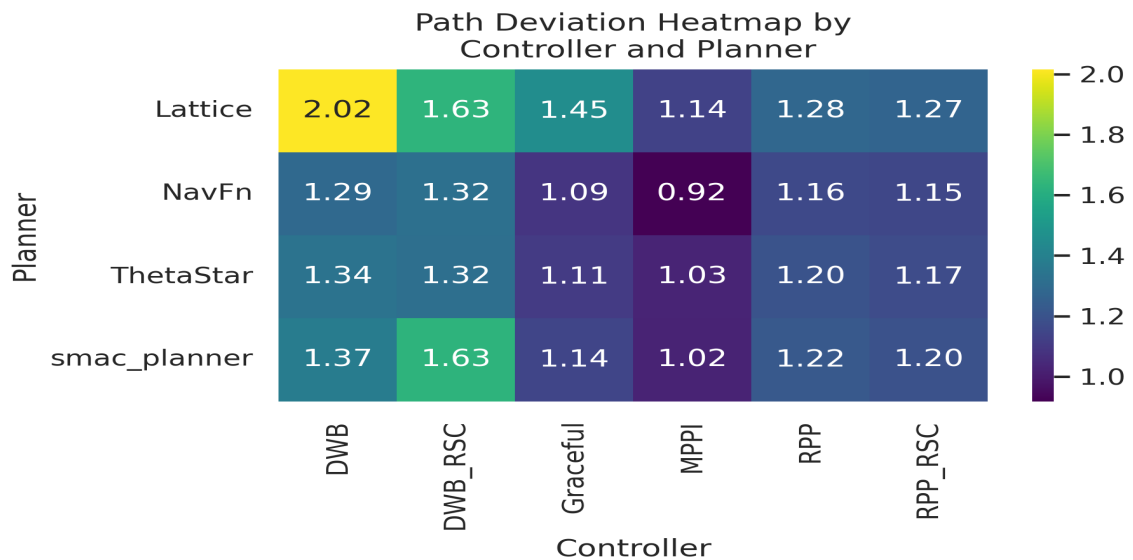
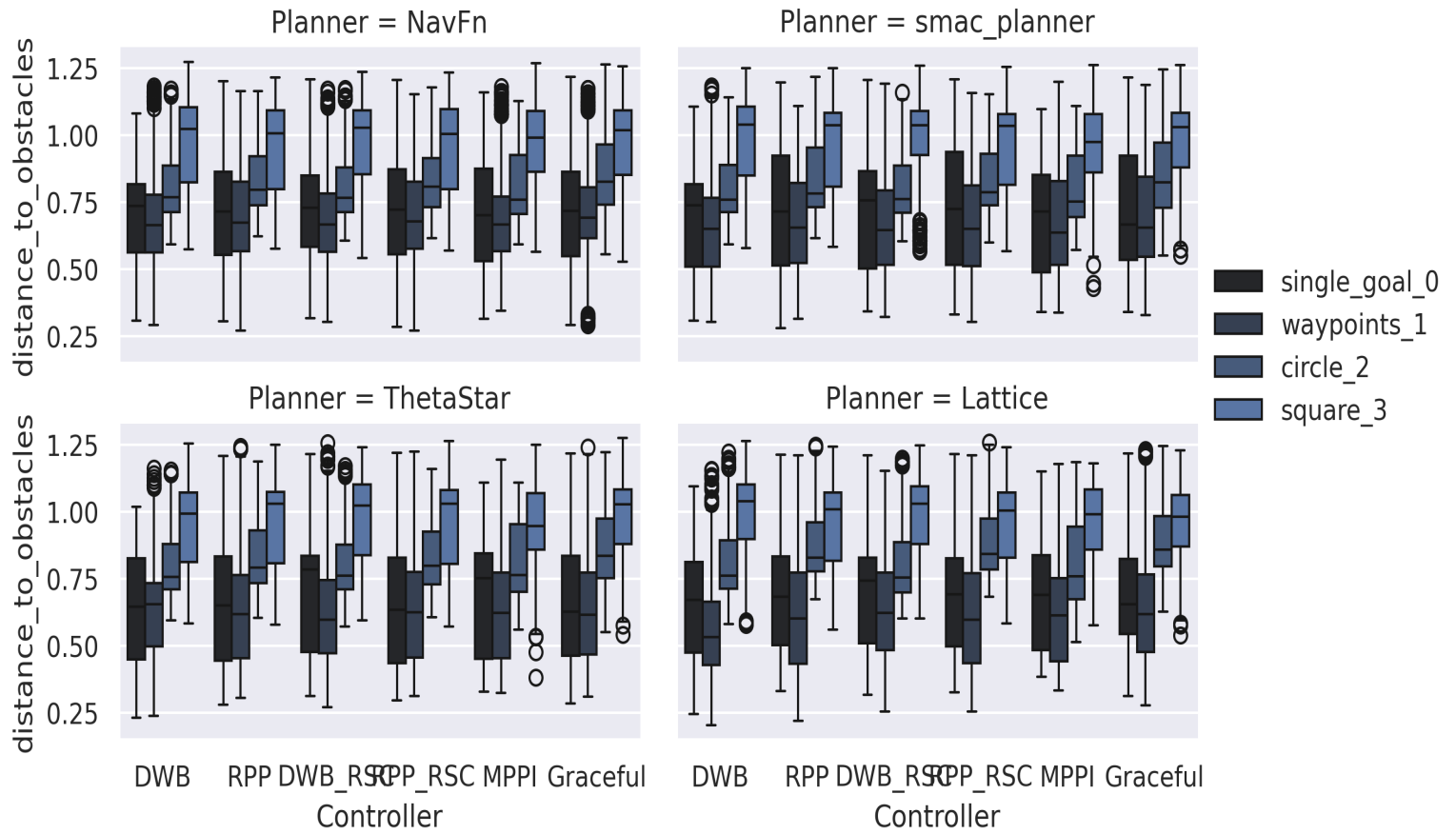
# Complex Distribution of Memory\_Usage by Planner, Controller, and Trajectory Type

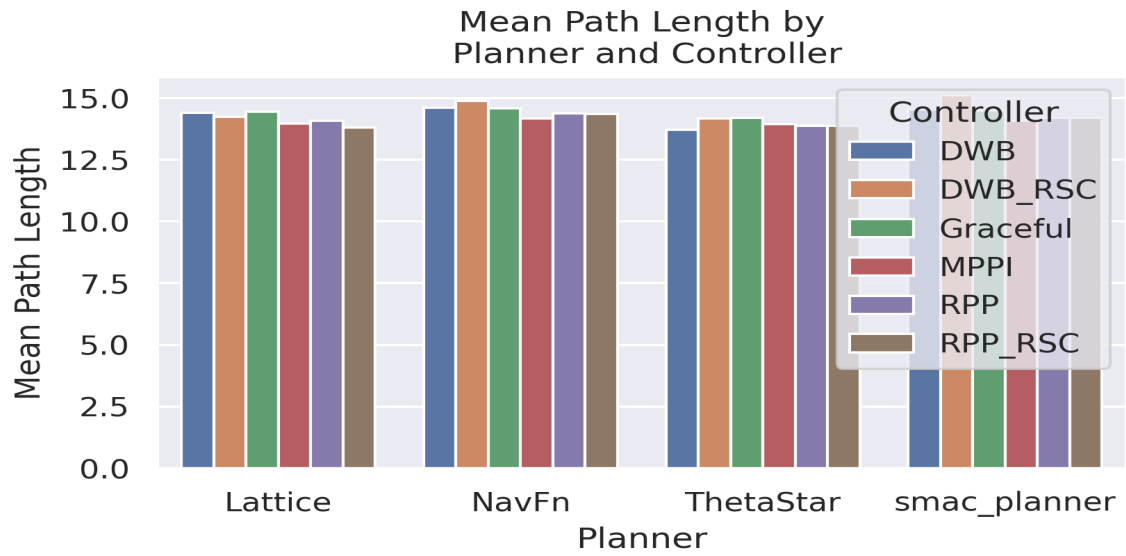


# Complex Distribution of number\_of\_recoveries by Planner, Controller, and Trajectory Type



## Complex Distribution of distance\_to\_obstacles by Planner, Controller, and Trajectory Type



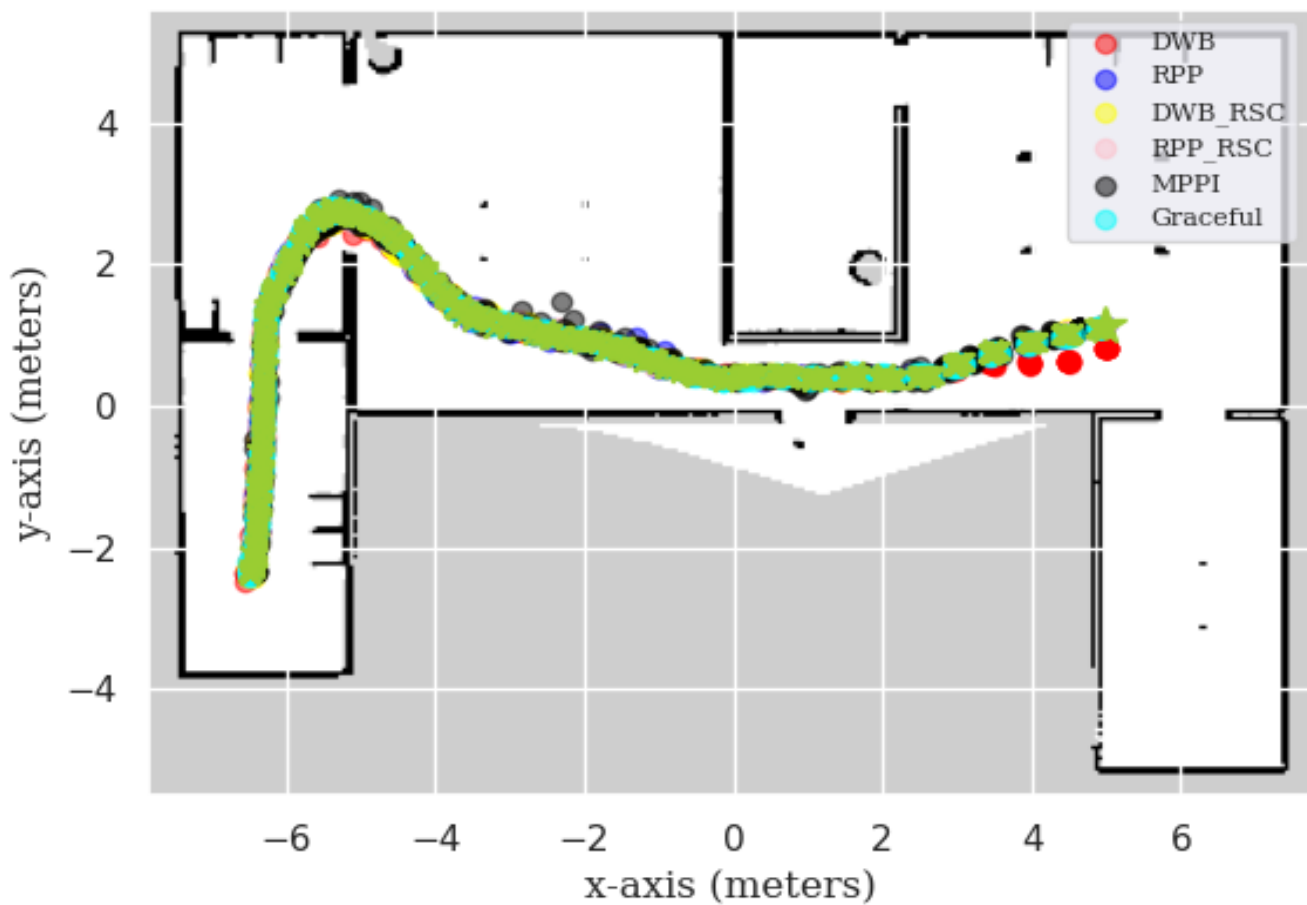


-Global planner: NavFn

-Trajectory type: single\_goal\_0

Traveled path

x Global planner path \* Waypoints ★ Initial pose



**-Trajectory type: waypoints\_1**

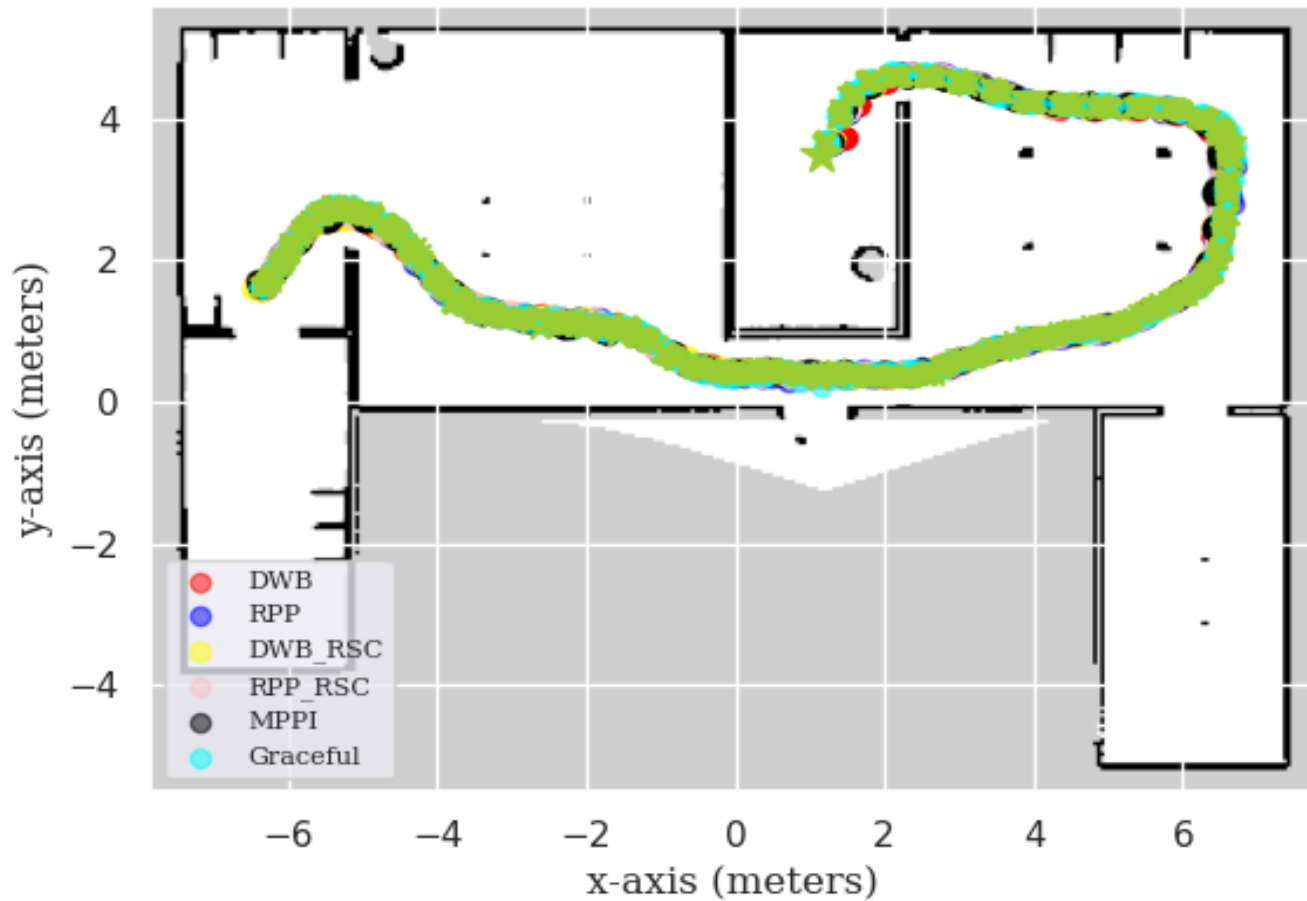
Traveled path

**-Trajectory type: waypoints\_1**

- x Global planner path

## \* Waypoints

★ Initial pose



**-Trajectory type: circle\_2**

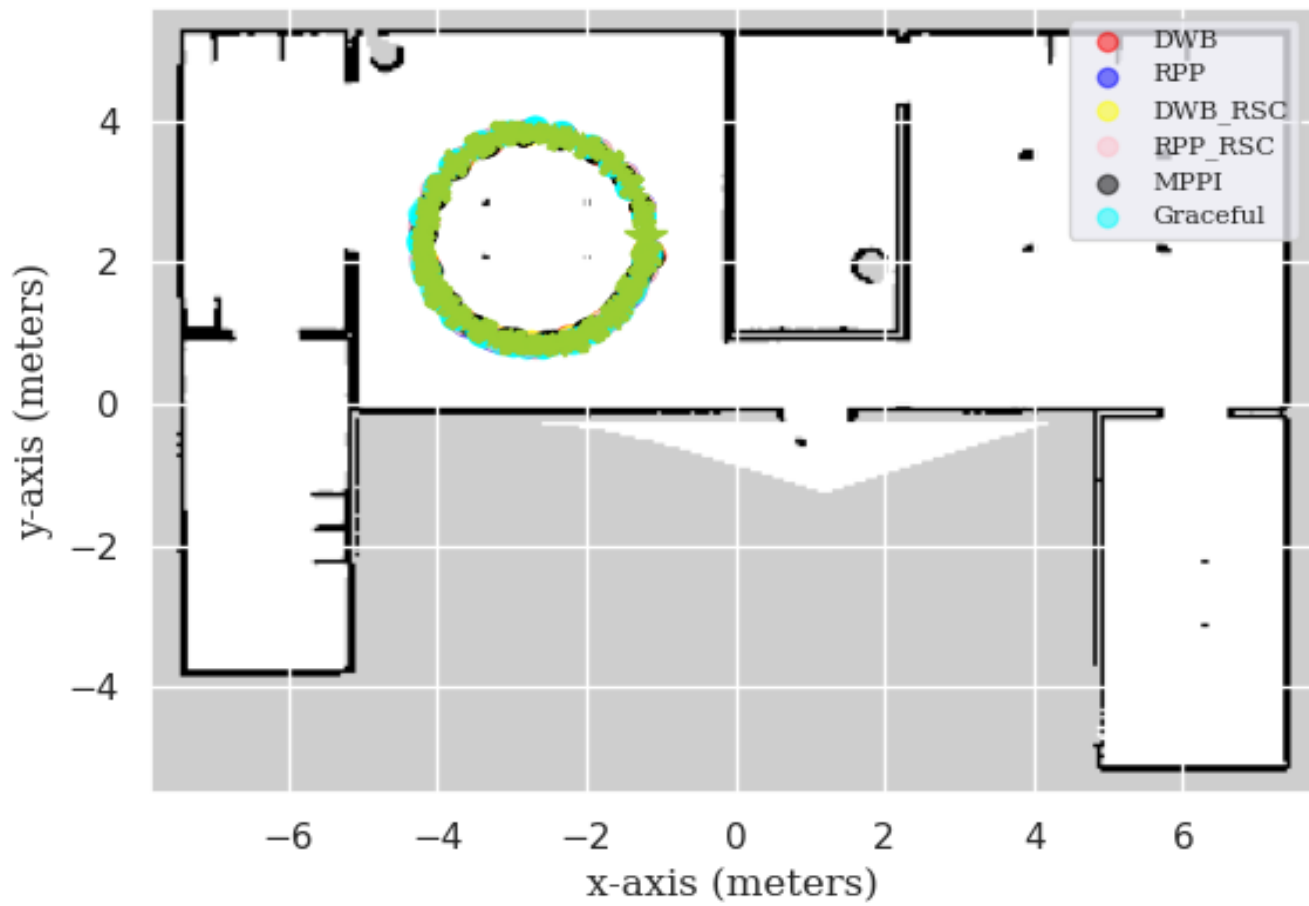
Traveled path

**-Trajectory type: circle\_2**

- x Global planner path

## \* Waypoints

★ Initial pose



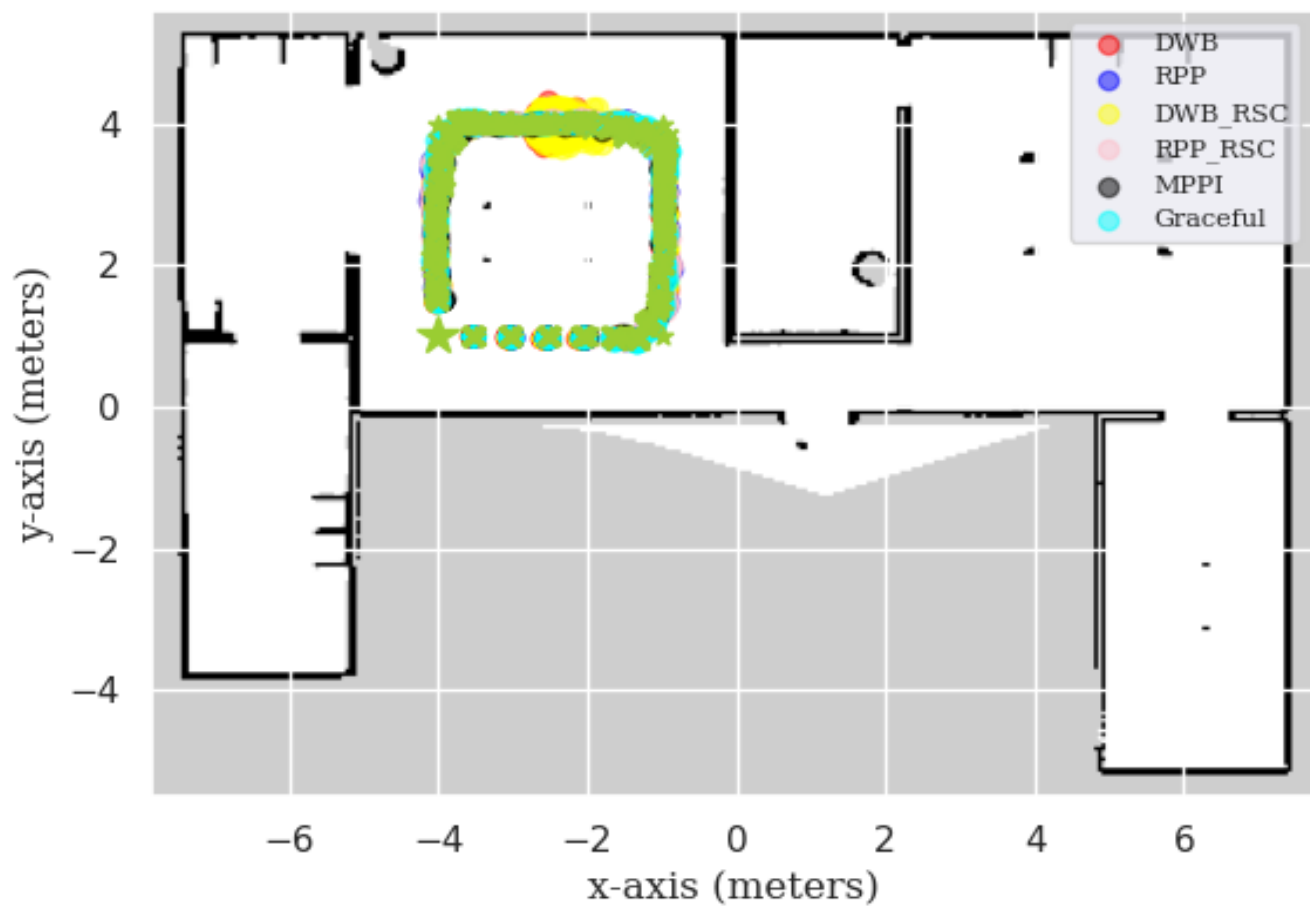
-Global planner: NavFn

Traveled path

-Trajectory type: square\_3

x Global planner path \* Waypoints ★ Initial pose



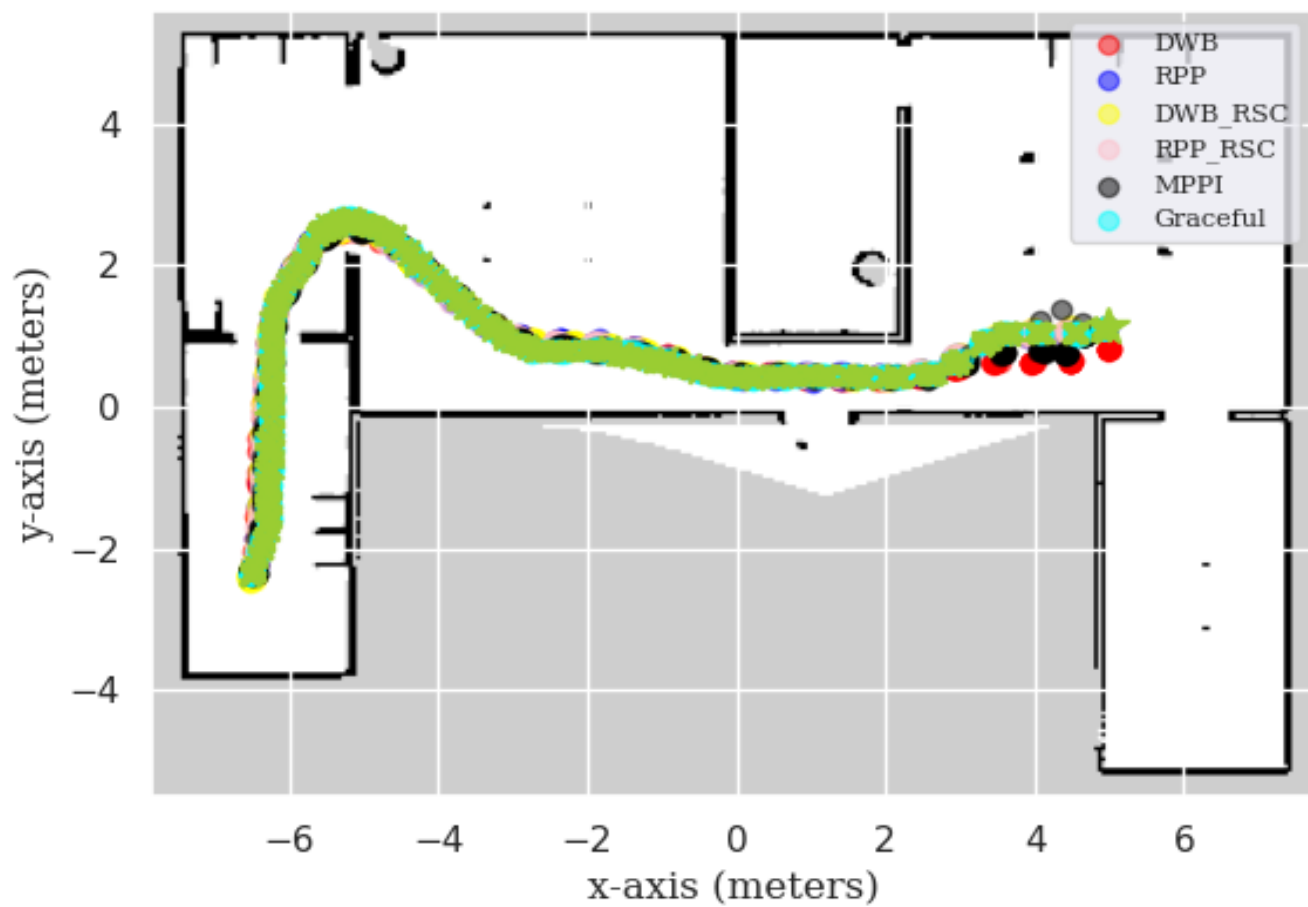


-Global planner: smac\_planner

Traveled path

-Trajectory type: single\_goal\_0

x Global planner path \* Waypoints ★ Initial pose

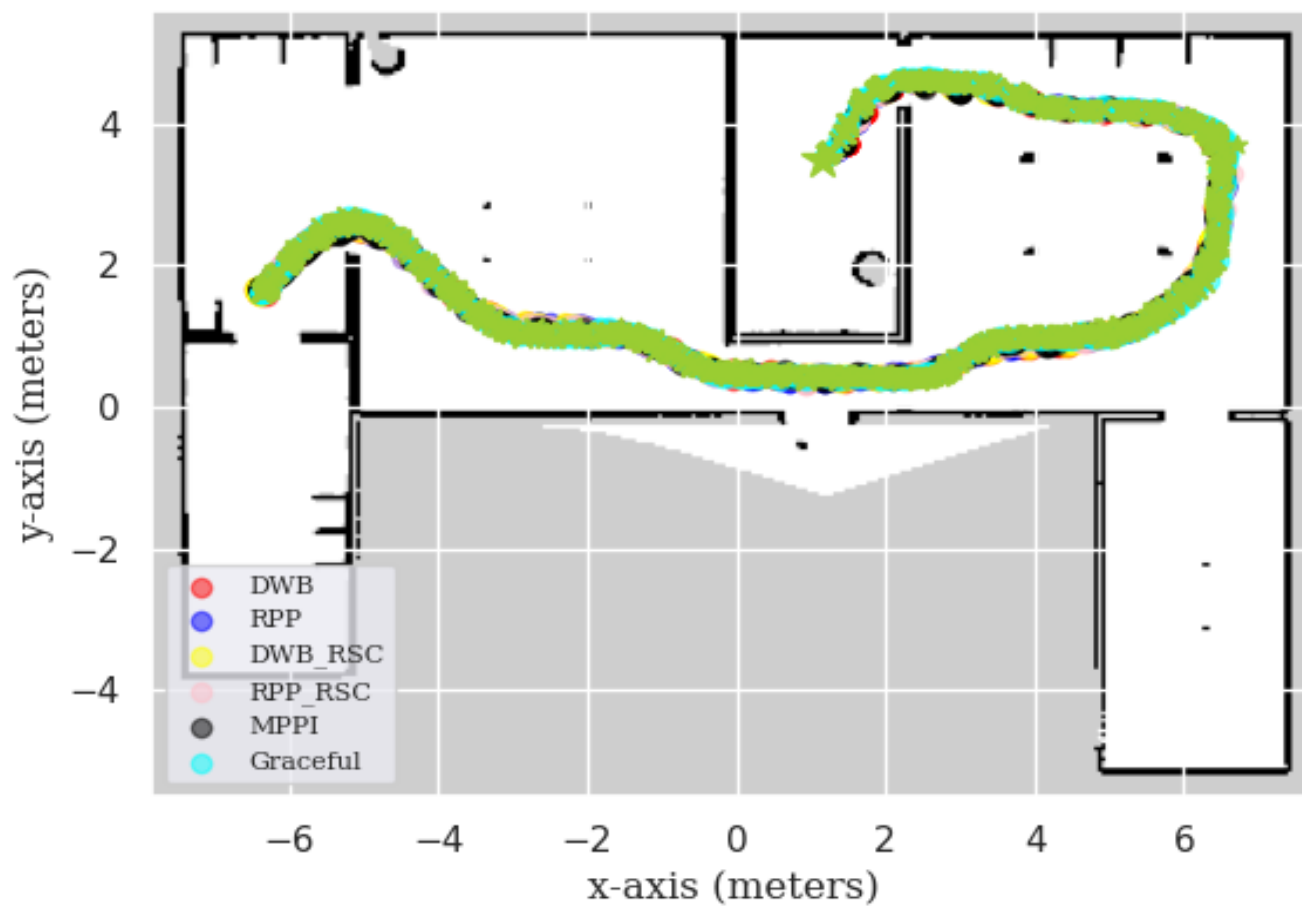


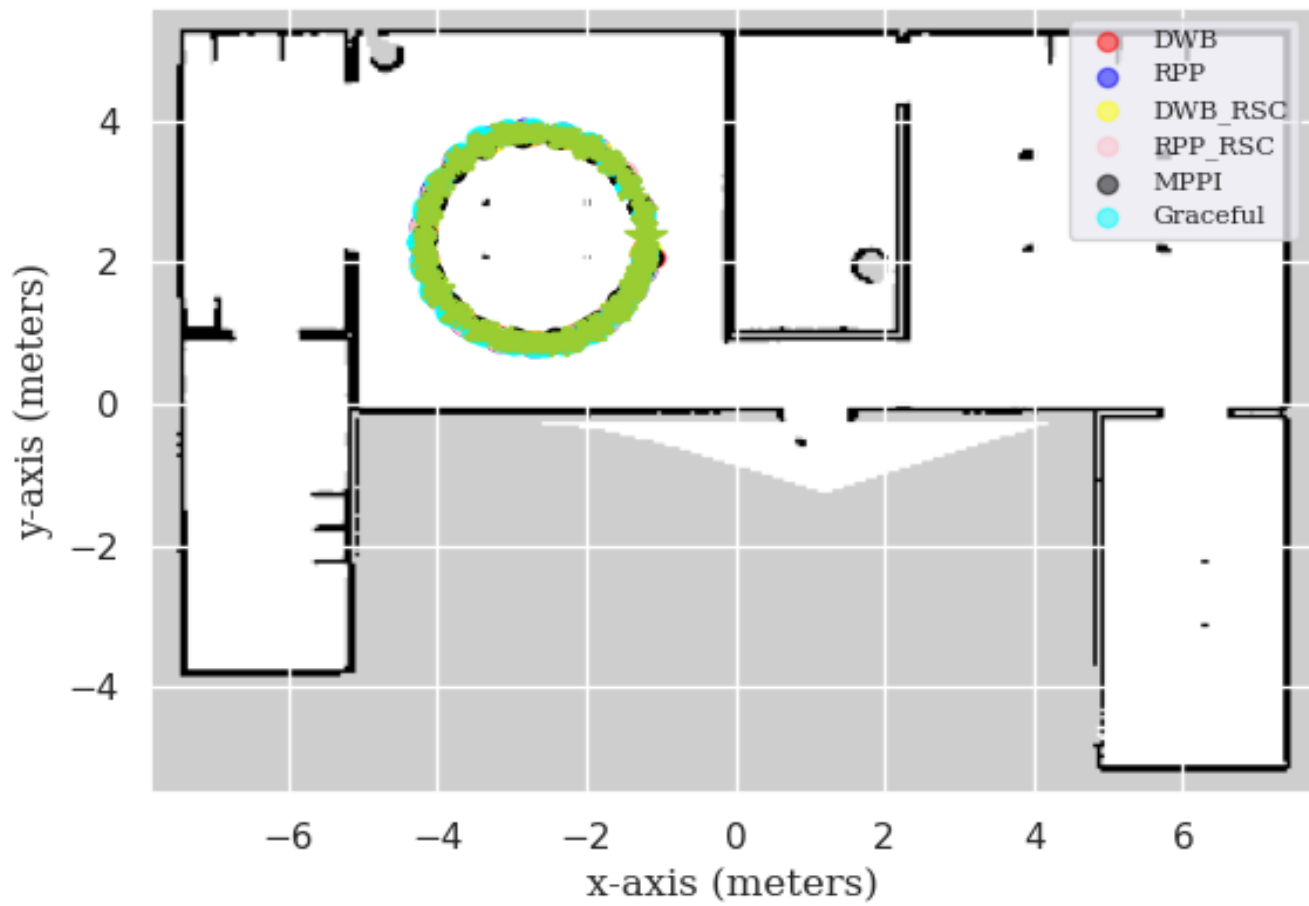
-Global planner: smac\_planner

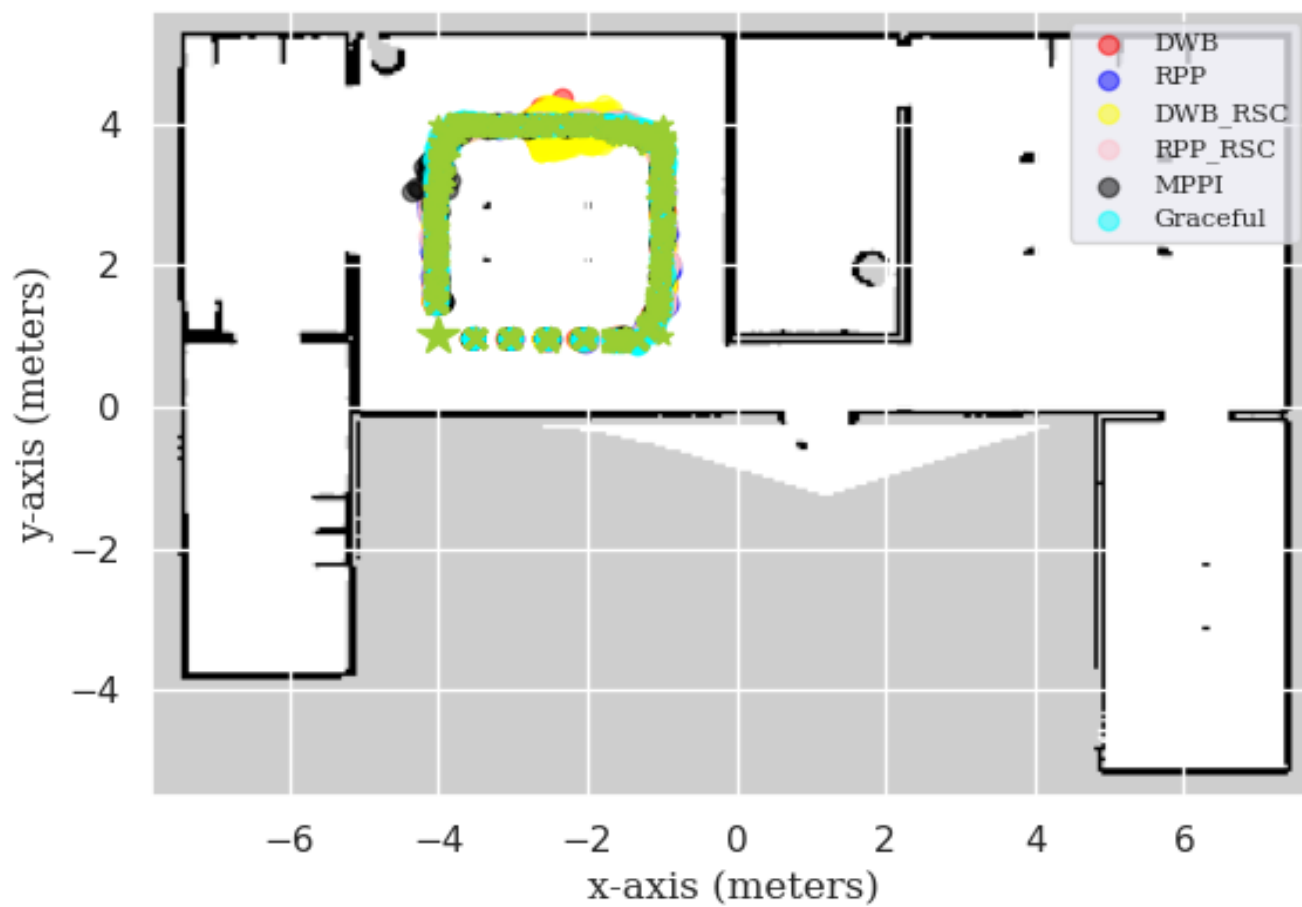
Traveled path

-Trajectory type: waypoints\_1

x Global planner path \* Waypoints ★ Initial pose

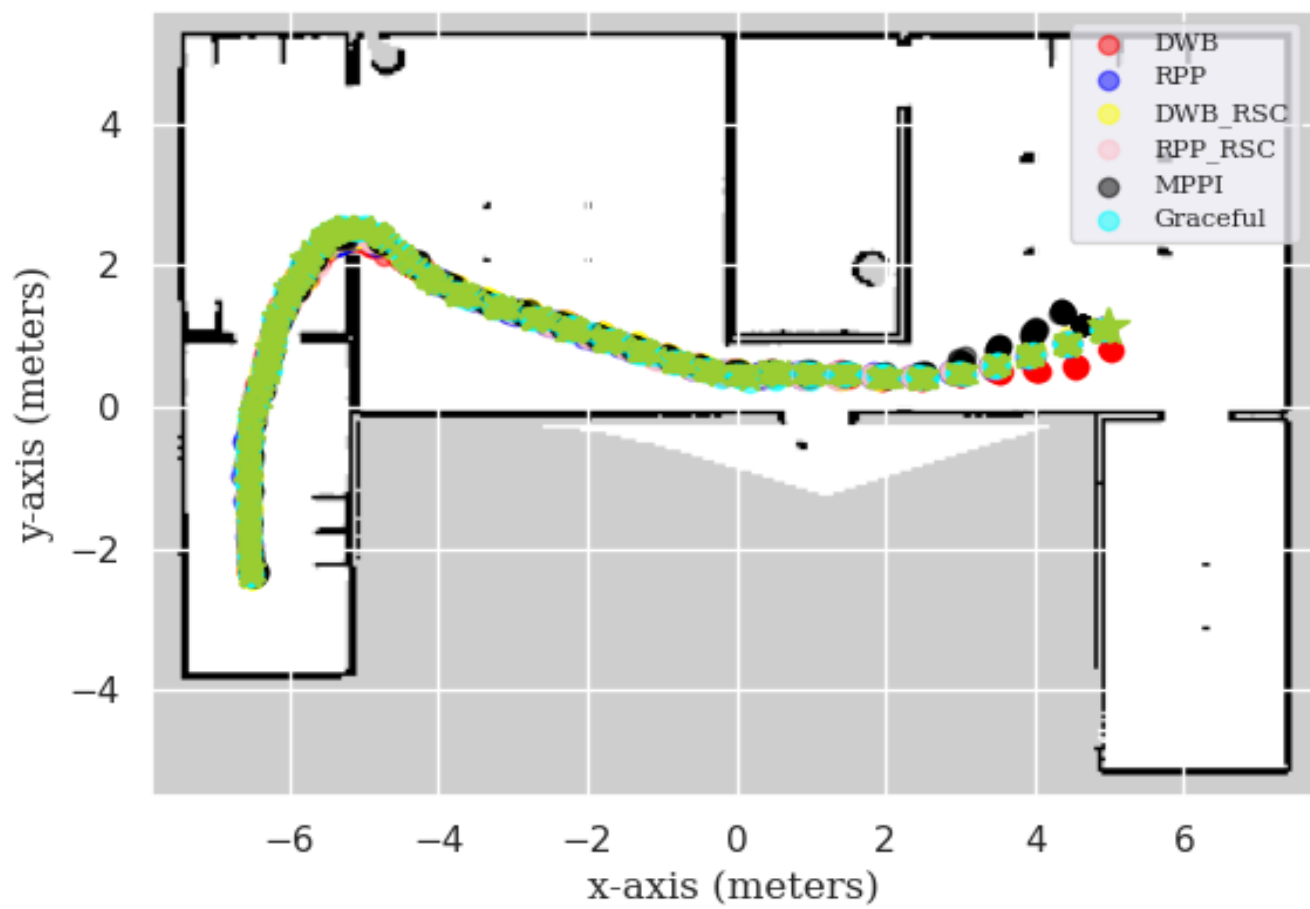






-Global planner: ThetaStar

-Trajectory type: single\_goal\_0

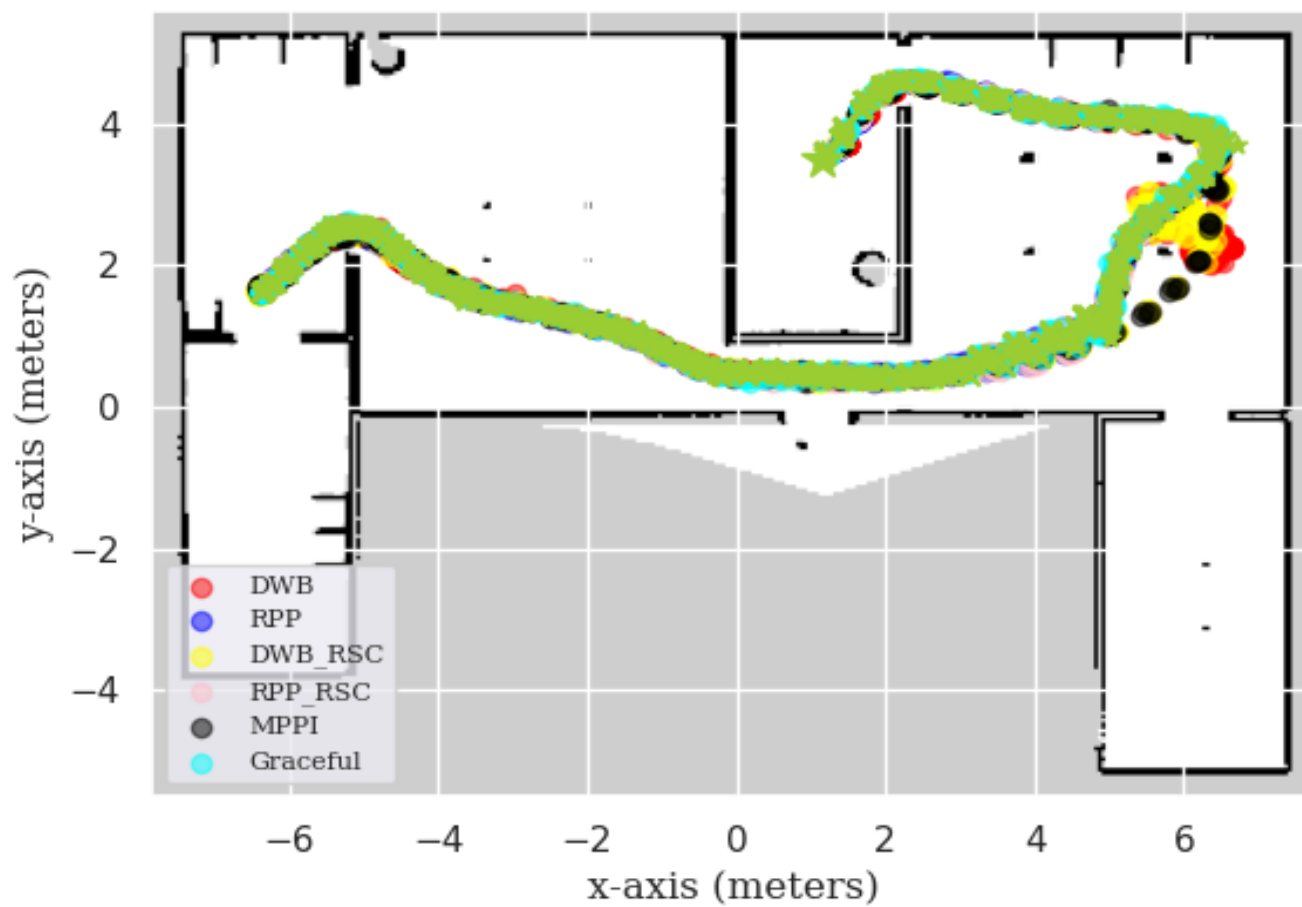


-Global planner: ThetaStar

Traveled path

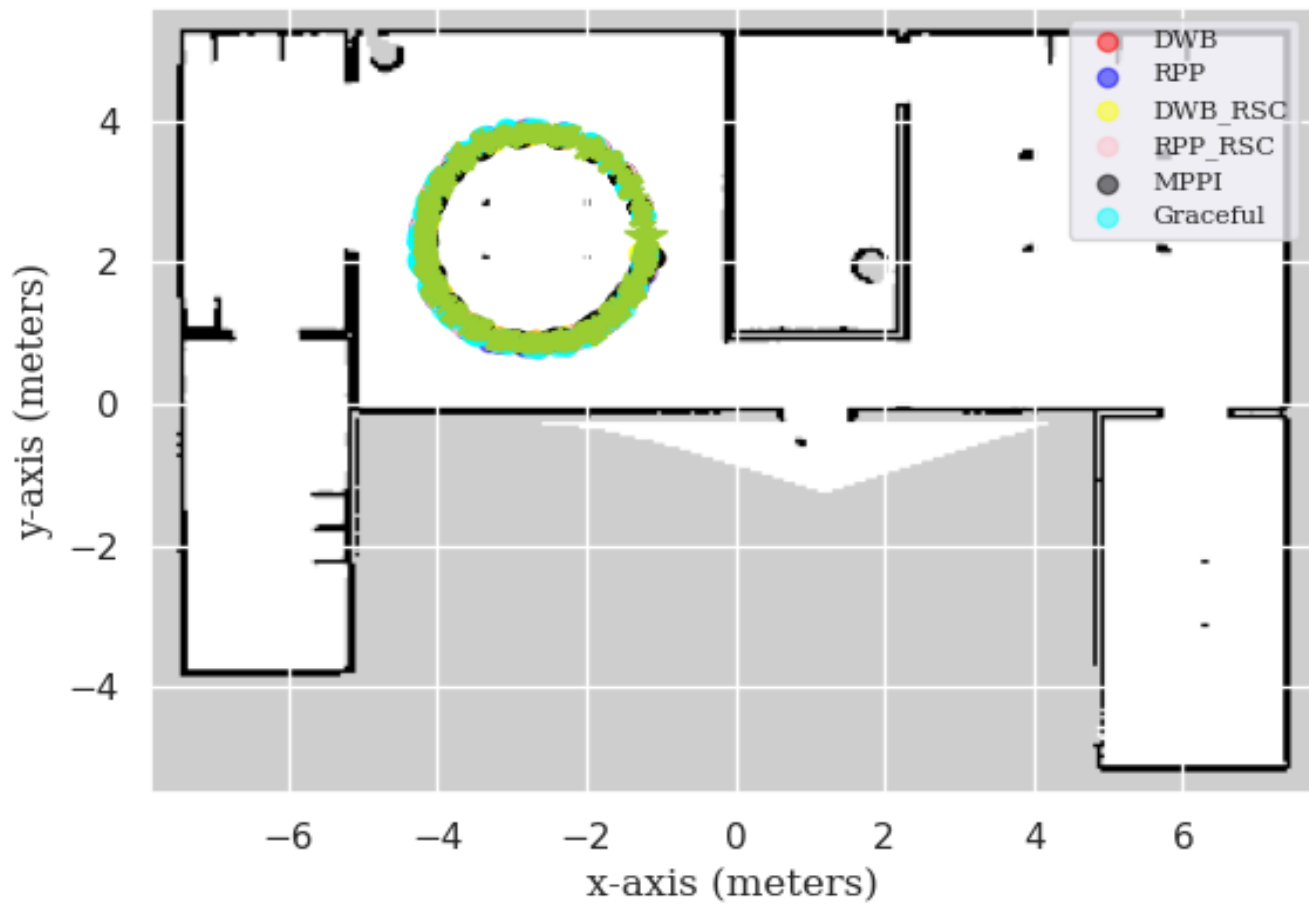
-Trajectory type: waypoints\_1

x Global planner path \* Waypoints ★ Initial pose



-Global planner: ThetaStar

-Trajectory type: circle\_2



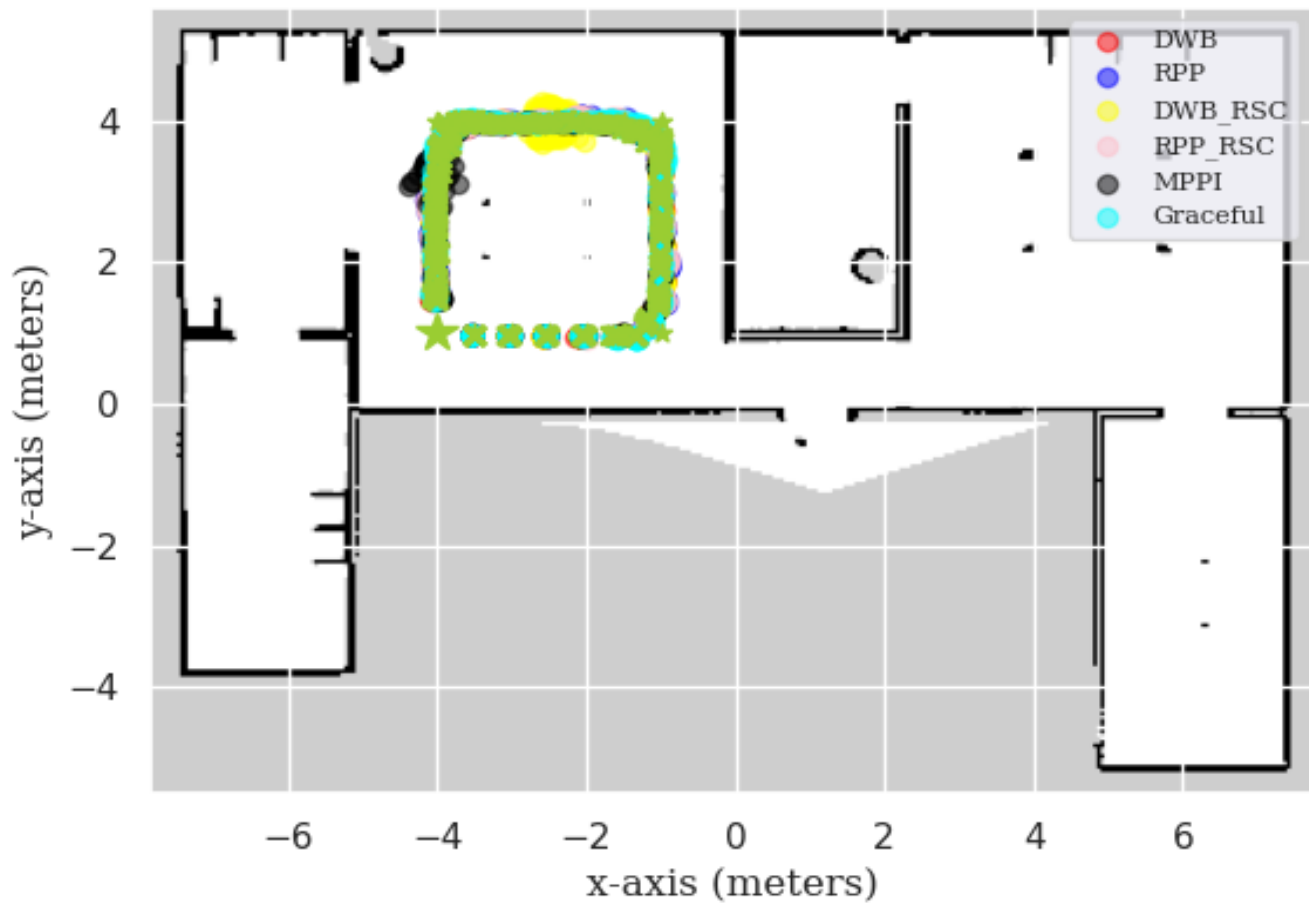
-Global planner: ThetaStar

Traveled path

-Trajectory type: square\_3

x Global planner path \* Waypoints ★ Initial pose



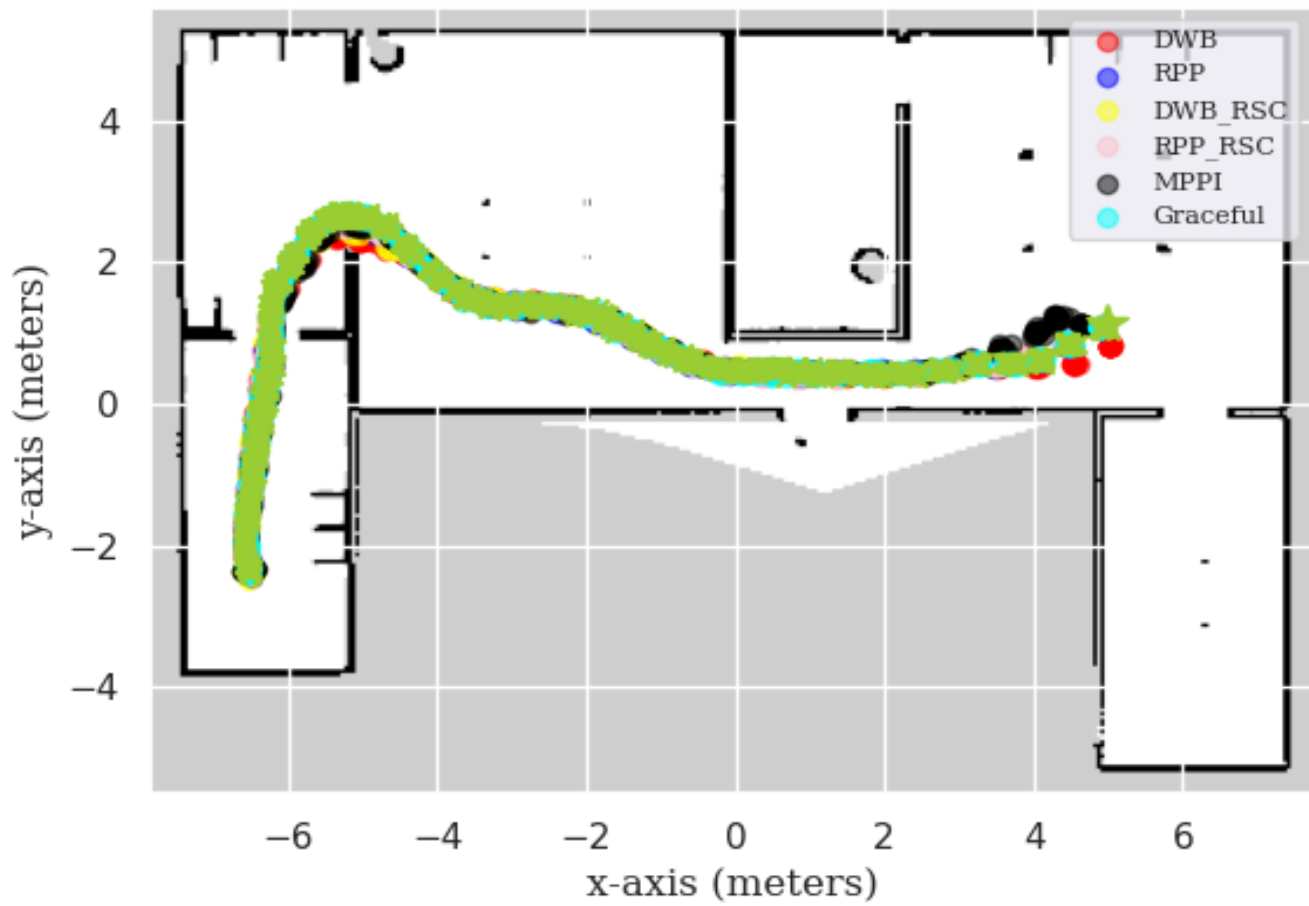


-Global planner: Lattice

Traveled path

-Trajectory type: single\_goal\_0

x Global planner path \* Waypoints ★ Initial pose



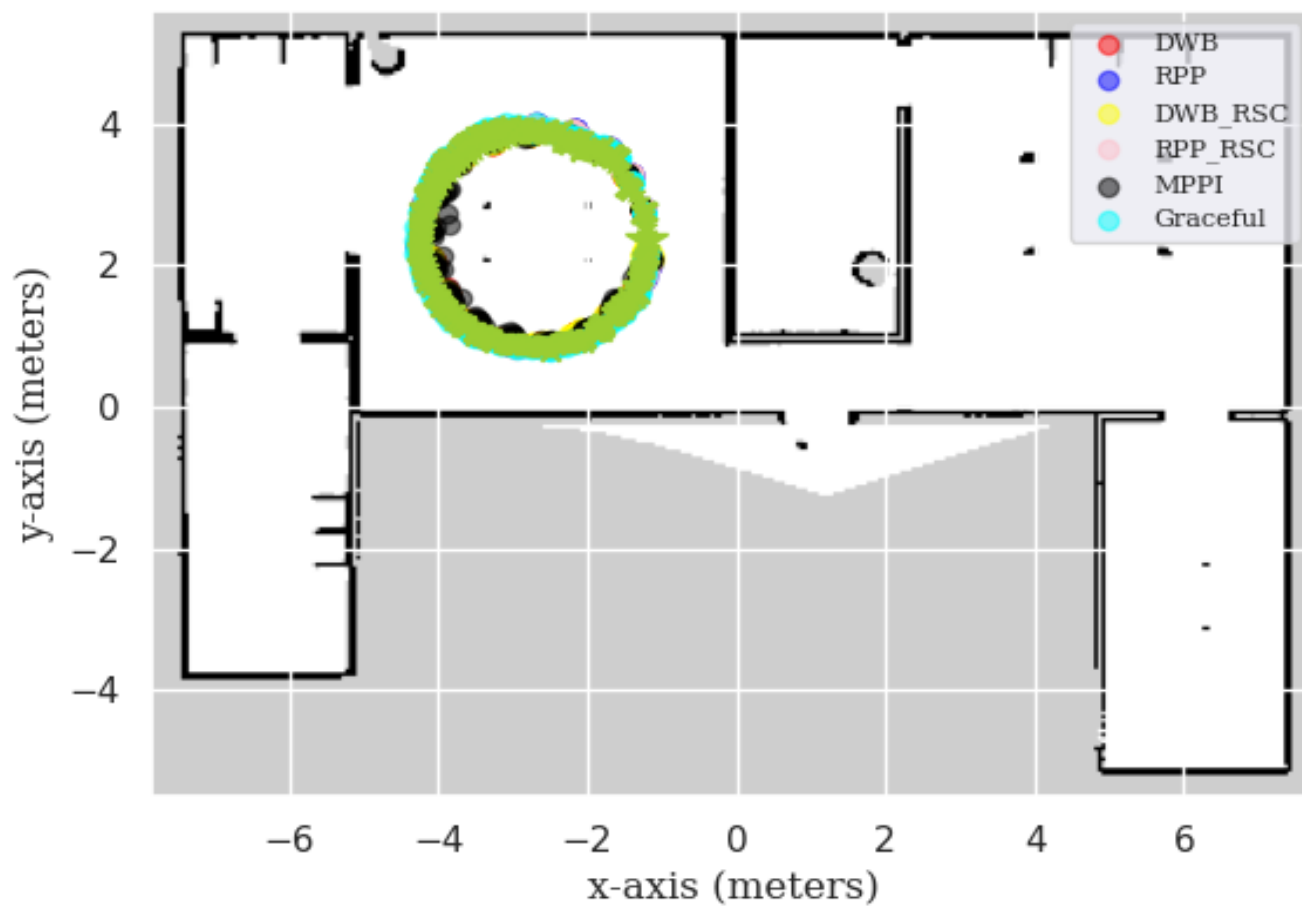
**-Global planner: Lattice**

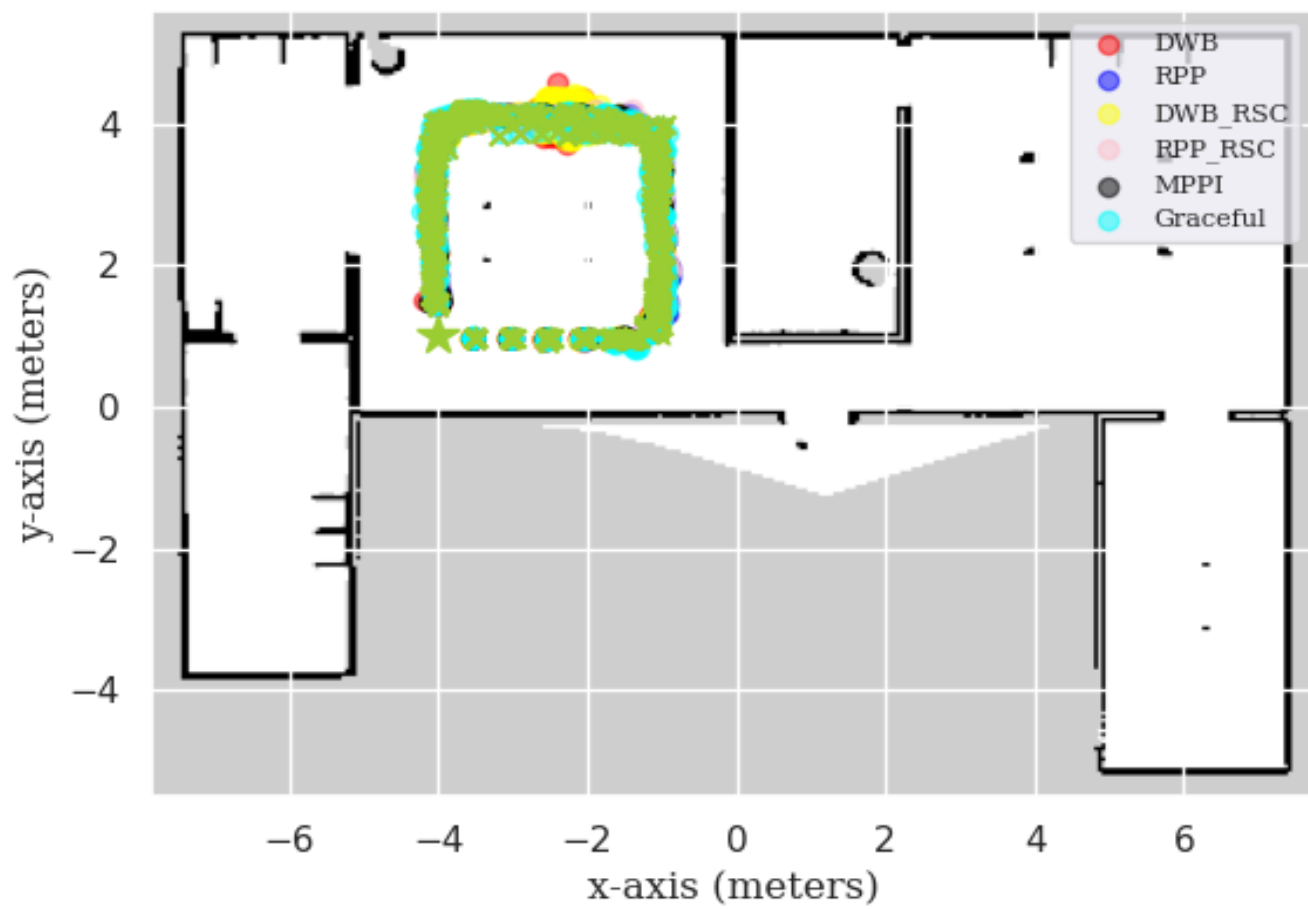
Traveled path

**-Trajectory type: waypoints\_1**

x Global planner path \* Waypoints ★ Initial pose

x Global planner path   \* Waypoints   ★ Initial pose





## Failure report

Recorded log messages of navigation nodes, if any message is recorded