Implementing RRT-Connect and Goal biased RRT for motion planning and Comparing the performance with Standard RRT.

Video Presentation:
https://drive.google.com/file/d/1mROburGyOG8sWYYiW1FhAI57FzRK3z8j/view?usp=share_link

ENPM 661
Project -5

Team:
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Goal

- To explore different variants of Rapidly Exploring Random Tree search algorithms.
- To implement and understand innovative strategies to make the standard Sample Based Method much more efficient.
- To compare the results of RRT Connect and Goal biased - RRT with Standard RRT.
- Simulating the path planning algorithms on ROS turtlebot in Gazebo environment.

Standard RRT

- RRT path planning is a sampling based motion planning algorithm that uses Rapidly Exploring Random Trees (RRTs) to generate feasible paths for a robot or other agent in a high-dimensional configuration space.
- RRT path planning incrementally builds a tree of possible paths by randomly sampling the configuration space and connecting the samples to the existing tree.

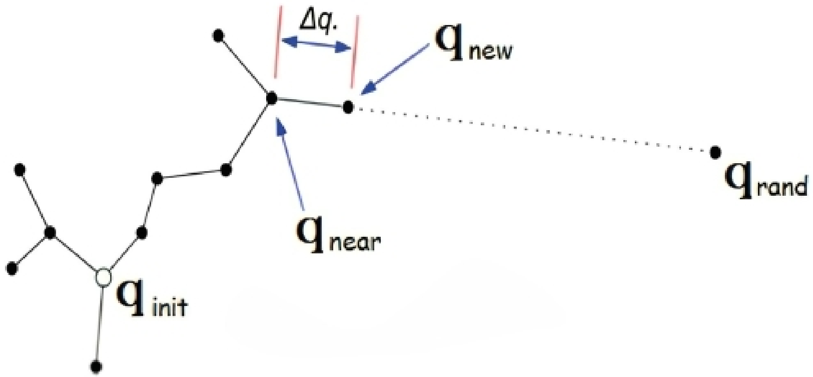
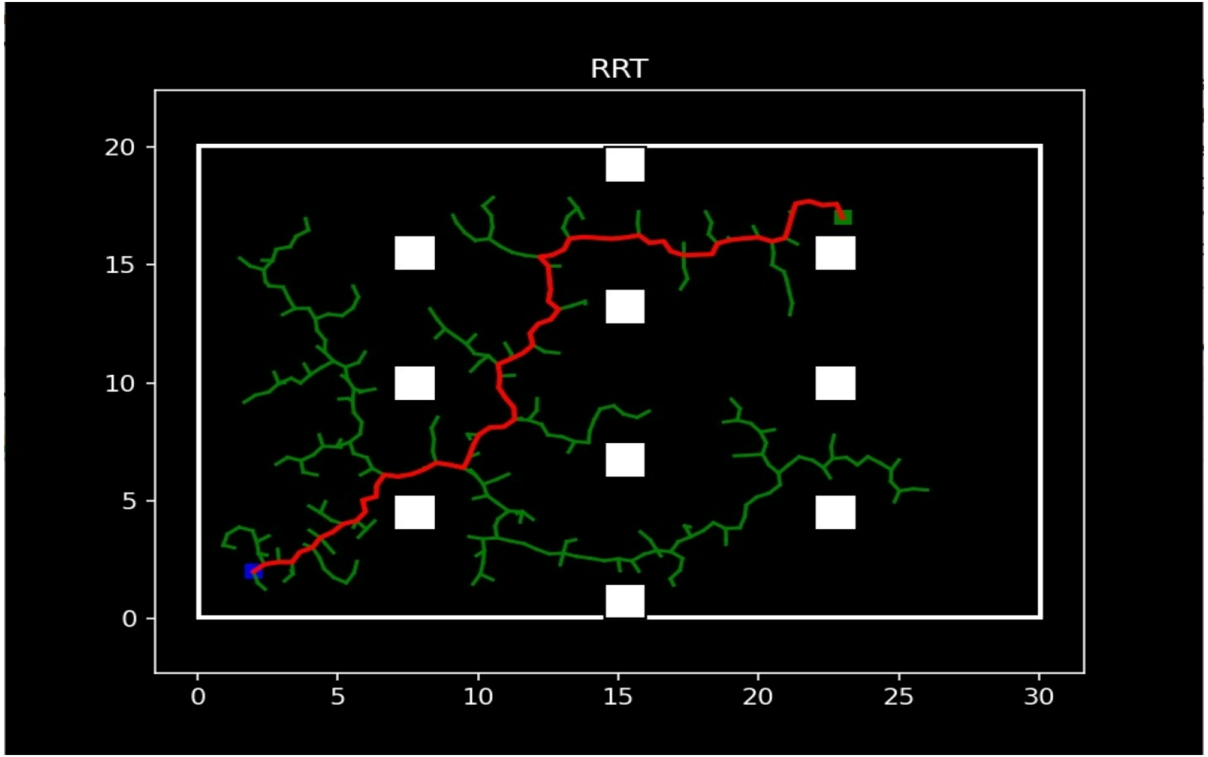


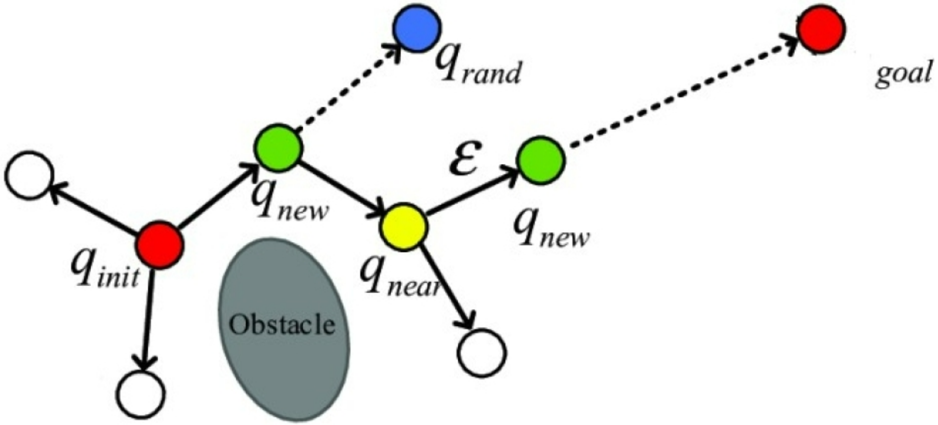
Fig. 1. Mechanism of tree expansion of an RRT

Results



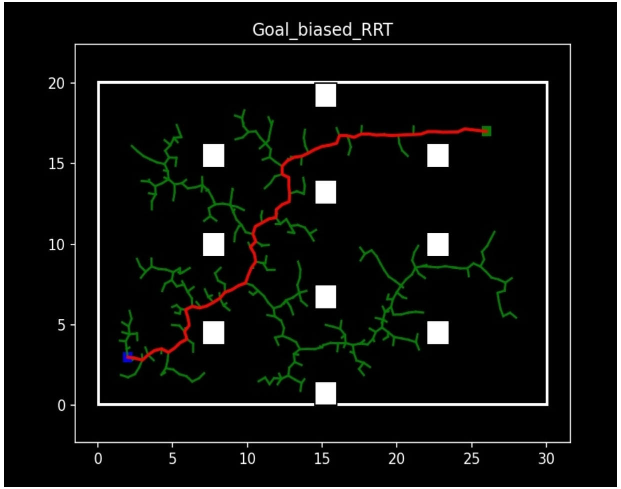
Goal Biased RRT

- Goal Biased RRT is a variant of the RRT algorithm for that incorporates a bias towards the goal configuration when generating random samples.
- The algorithm generates a sample towards the goal configuration rather than at a random point in the configuration space, which can help the algorithm converge more quickly towards a solution.

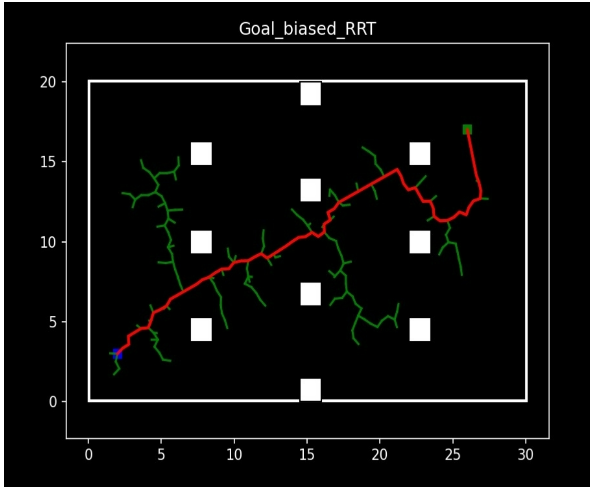


Results

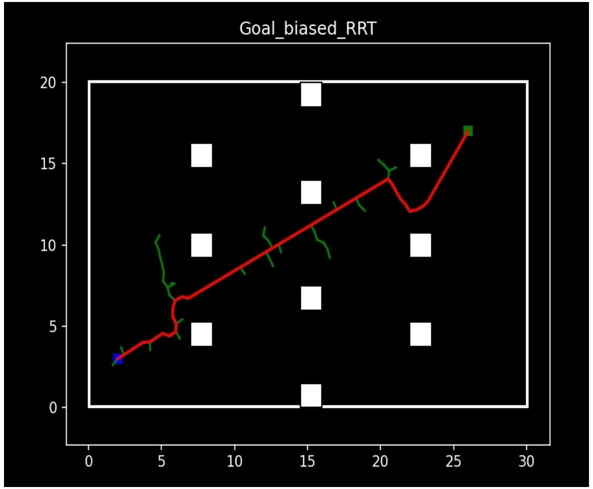
Bias=0



Bias=0.5

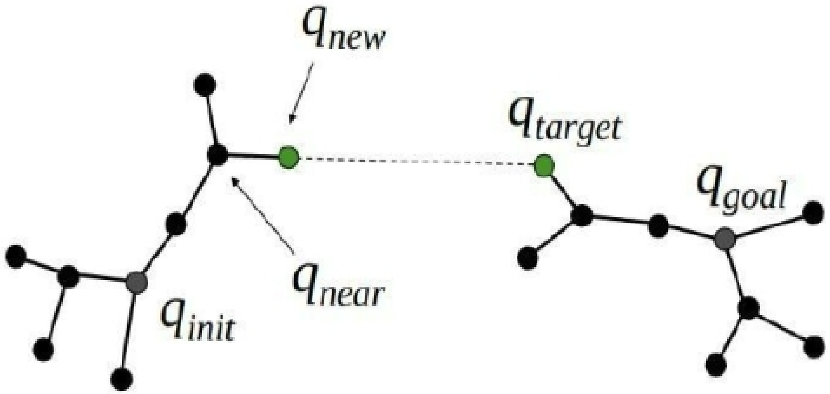


Bias =0.9

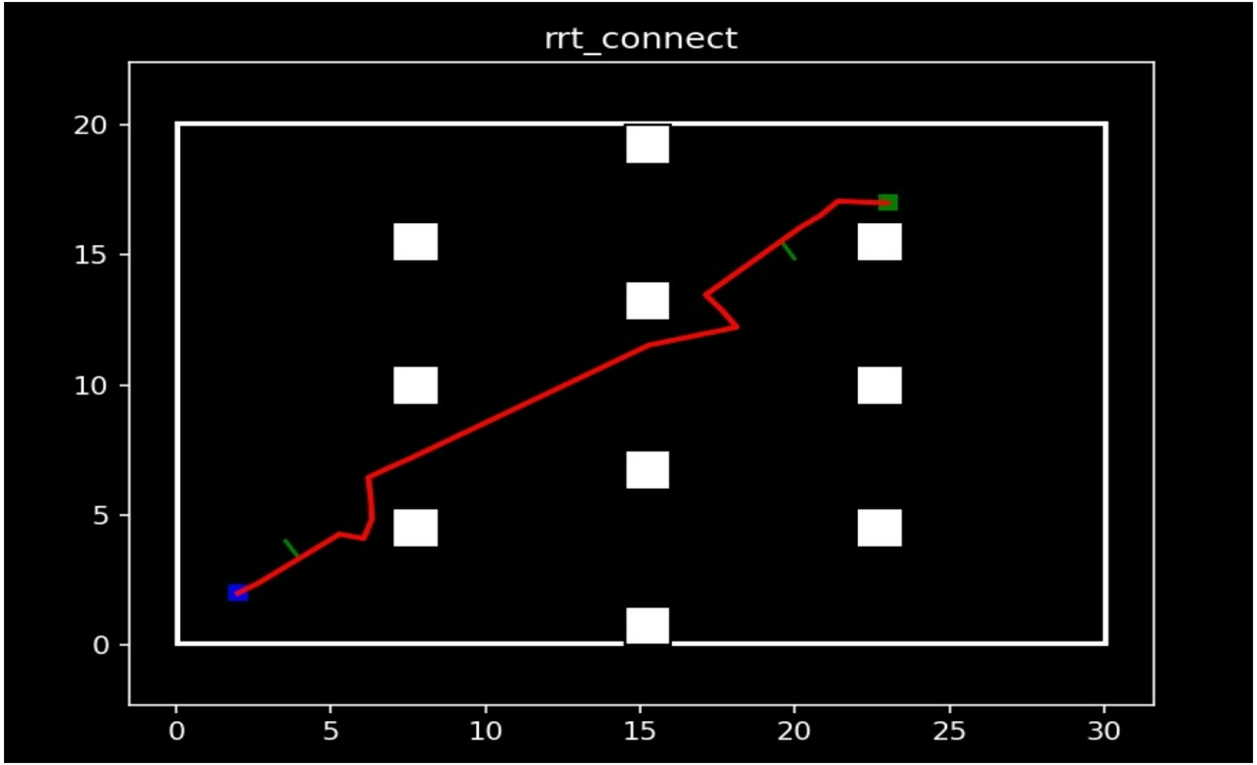


RRT-Connect

RRT-Connect builds two RRTs, one from the start configuration and one from the goal configuration, and attempts to connect them in alternating fashion until a path is found between the start and goal configurations.



Results

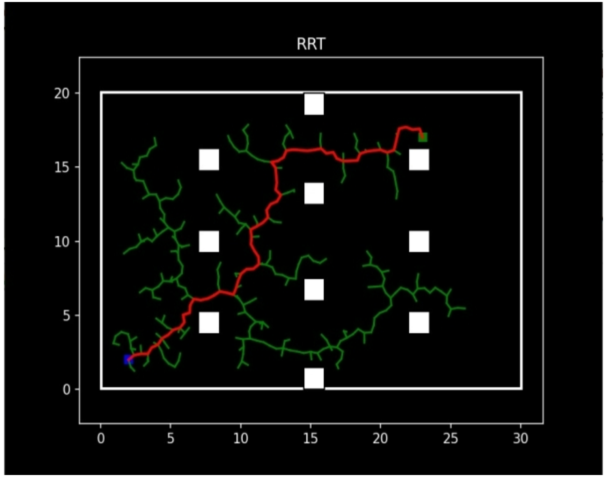


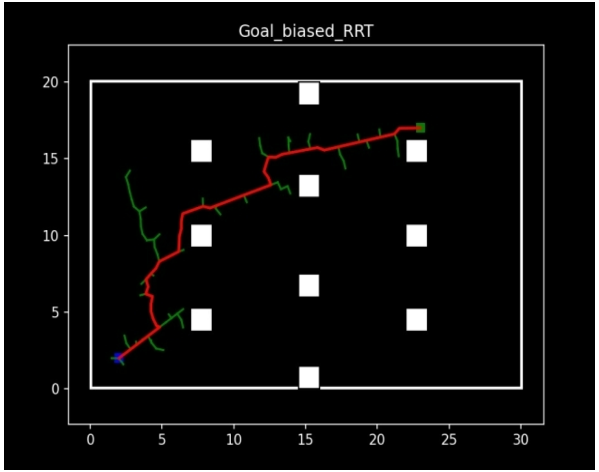
Comparing Results

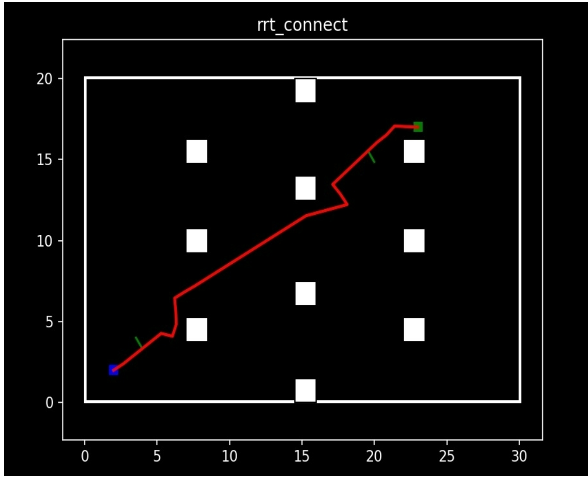
Time taken=0.85s

Time taken=0.23s

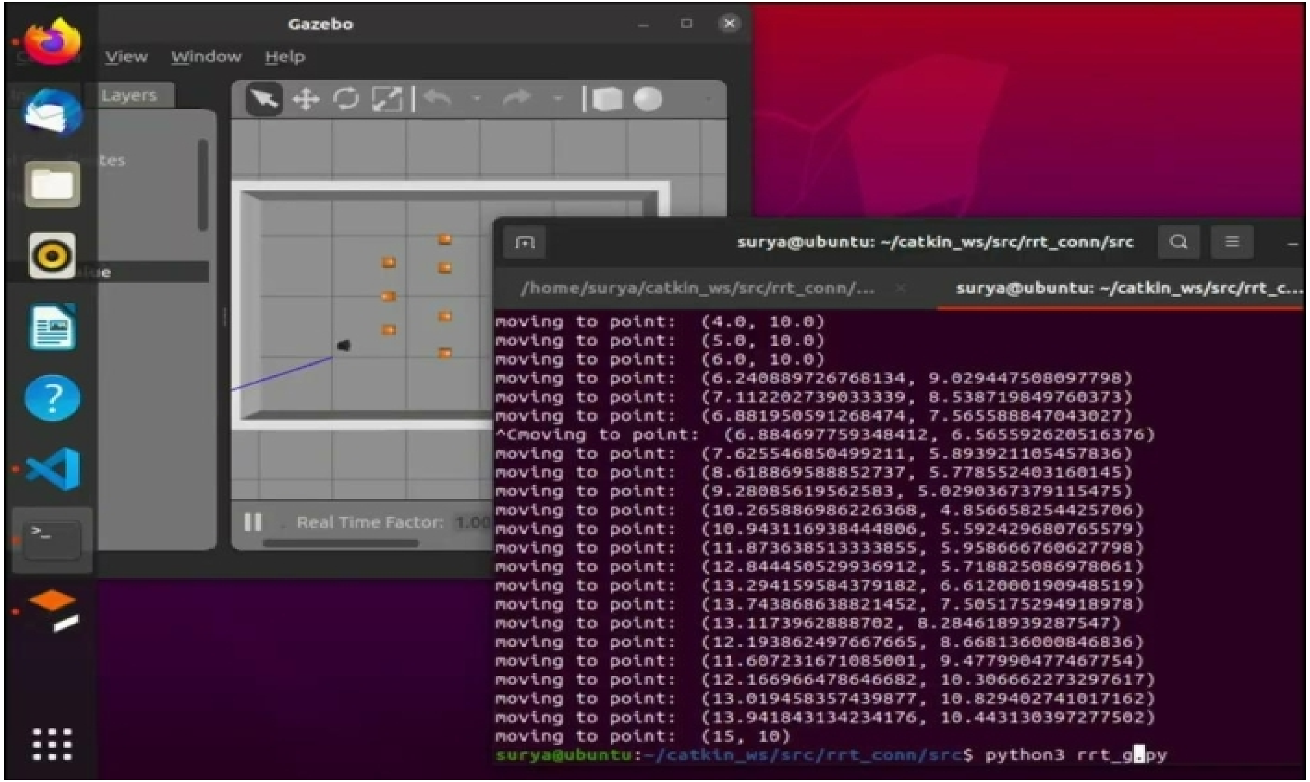
Time taken=0.07s





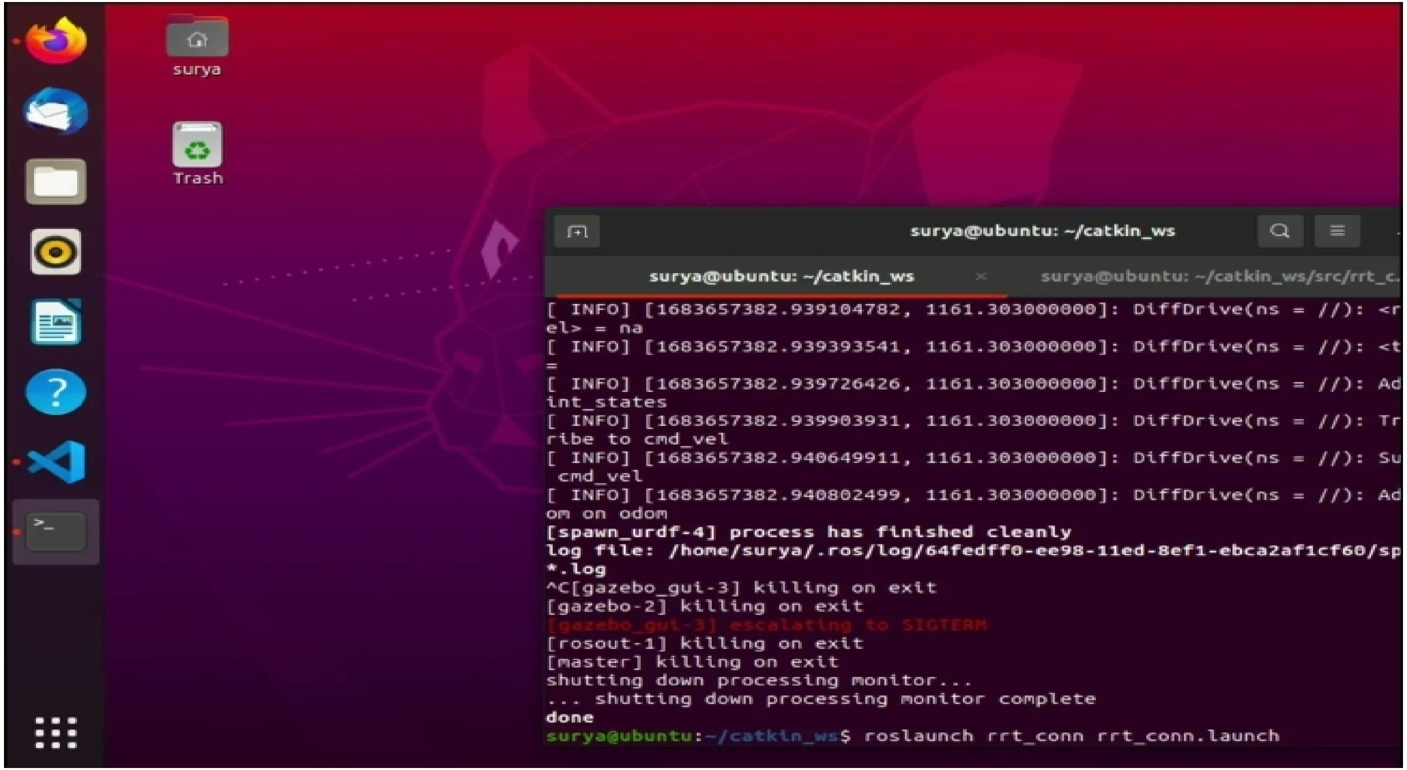


RRT visualization in Gazebo


Gazebo
View
Window
Help
Layers
Real Time Factor: 1.00
surya@ubuntu: ~/catkin_ws/src/rrt_conn/src
/home/surya/catkin_ws/src/rrt_conn/...
surya@ubuntu: ~/catkin_ws/src/rrt_c...

```
moving to point:  (4.0, 10.0)
moving to point:  (5.0, 10.0)
moving to point:  (6.0, 10.0)
moving to point:  (6.240889726768134, 9.029447508097798)
moving to point:  (7.112202739033339, 8.538719849760373)
moving to point:  (6.881950591268474, 7.565588847043027)
^Cmoving to point:  (6.884697759348412, 6.565592620516376)
moving to point:  (7.625546850499211, 5.893921105457836)
moving to point:  (8.618869588852737, 5.778552403160145)
moving to point:  (9.28085619562583, 5.029036737911 5475)
moving to point:  (10.265886986226368, 4.856658254425706)
moving to point:  (10.943116938444806, 5.592429680765579)
moving to point:  (11.873638513333855, 5.958666760627798)
moving to point:  (12.844450529936912, 5.718825086978061)
moving to point:  (13.294159584379182, 6.612000190948519)
moving to point:  (13.743868638821452, 7.505175294918978)
moving to point:  (13.1173962888702, 8.284618939287547)
moving to point:  (12.193862497667665, 8.668136000846836)
moving to point:  (11.607231671085001, 9.477990477467754)
moving to point:  (12.166966478646682, 10.306662273297617)
moving to point:  (13.019458357439877, 10.829402741017162)
moving to point:  (13.941843134234176, 10.443130397277502)
moving to point:  (15, 10)
surya@ubuntu:~/catkin_ws/src/rrt_conn/src$ python3 rrt_g.py
```

Goal-Biased-RRT visualization in Gazebo


surya
Trash
surya@ubuntu: ~/catkin_ws
surya@ubuntu: ~/catkin_ws
surya@ubuntu: ~/catkin_ws/src/rrt_c

```
[ INFO] [1683657382.939104782, 1161.303000000]: DiffDrive(ns = //): <r
el> = na
[ INFO] [1683657382.939393541, 1161.303000000]: DiffDrive(ns = //): <t
=
[ INFO] [1683657382.939726426, 1161.303000000]: DiffDrive(ns = //): Ad
int_states
[ INFO] [1683657382.939903931, 1161.303000000]: DiffDrive(ns = //): Tr
ribe to cmd_vel
[ INFO] [1683657382.940649911, 1161.303000000]: DiffDrive(ns = //): Su
 cmd_vel
[ INFO] [1683657382.940802499, 1161.303000000]: DiffDrive(ns = //): Ad
om on odom
[spawn_urdf-4] process has finished cleanly
log file: /home/surya/.ros/log/64fedff0-ee98-11ed-8ef1-ebca2af1cf60/sp
*.log
^C[gazebo_gui-3] killing on exit
[gazebo-2] killing on exit
[gazebo_gui-3] escalating to SIGTERM
[rosout-1] killing on exit
[master] killing on exit
shutting down processing monitor...
... shutting down processing monitor complete
done
surya@ubuntu:~/catkin_ws$ roslaunch rrt_conn rrt_conn.launch
```

RRT-Connect visualization in Gazebo

Thank You

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