ch12_straight_line_rrt

April 27, 2022

0.1 Problem 0: RRT Planner Implementation

Implement the following and ensure the unit tests pass (be sure to read the headers for each function). * `chap12/planner_utilities.py`: * `plan_path(...)` * `find_closest_configuration(...)` * `generate_random_configuration(...)` * `find_shortest_path(...)` * `smooth_path(...)` * `chap12/rrt_straight_line.py`: * `create_rrt_plan(...)`

0.1.1 Hints on implementation

- `np.random.rand()` can be used to calculate a random number between 0 and 1
- Take a good look at `MsgWaypoints`
  - See the documentation for `Waypoint` in `msg_waypoints.py`
  - `tree.connect_to_goal.item(i)` make sure to set and use the `connect_to_goal` property of `MsgWaypoints`. This is used to indicate that this waypoint could be connected to the goal, not that it is the goal waypoint.
    - Note that you do not ever need to add the goal waypoint to the tree structure, you just set
  - Waypoints can be added by either adding a `Waypoint` through `add_waypoint(...)` or through specifying the values of the waypoint through `add(...)`. Waypoint data can be accessed individually or by calling the `get_waypoint(...)` function to extract all of the data for the waypoint
  - `tree.parent.item(i)` will return the parent of the waypoint at index `i`. Make sure to set the parent value appropriately.

0.1.2 Note on the unit tests

There will only be unit tests for `plan_path(...)`, `find_closest_configuration(...)`, `find_shortest_path(...)`, and `smooth_path(...)`.

There will **be no** unit tests for `generate_random_configuration(...)` and `create_rrt_plan(...)`

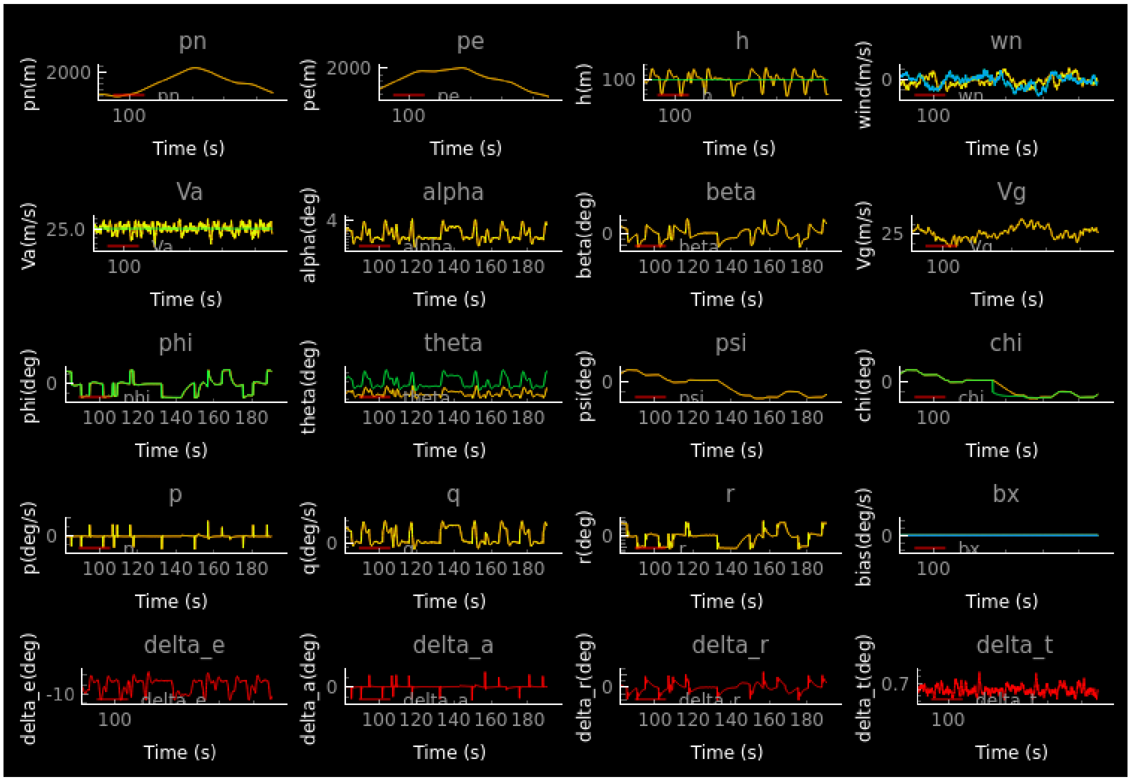
[5]:

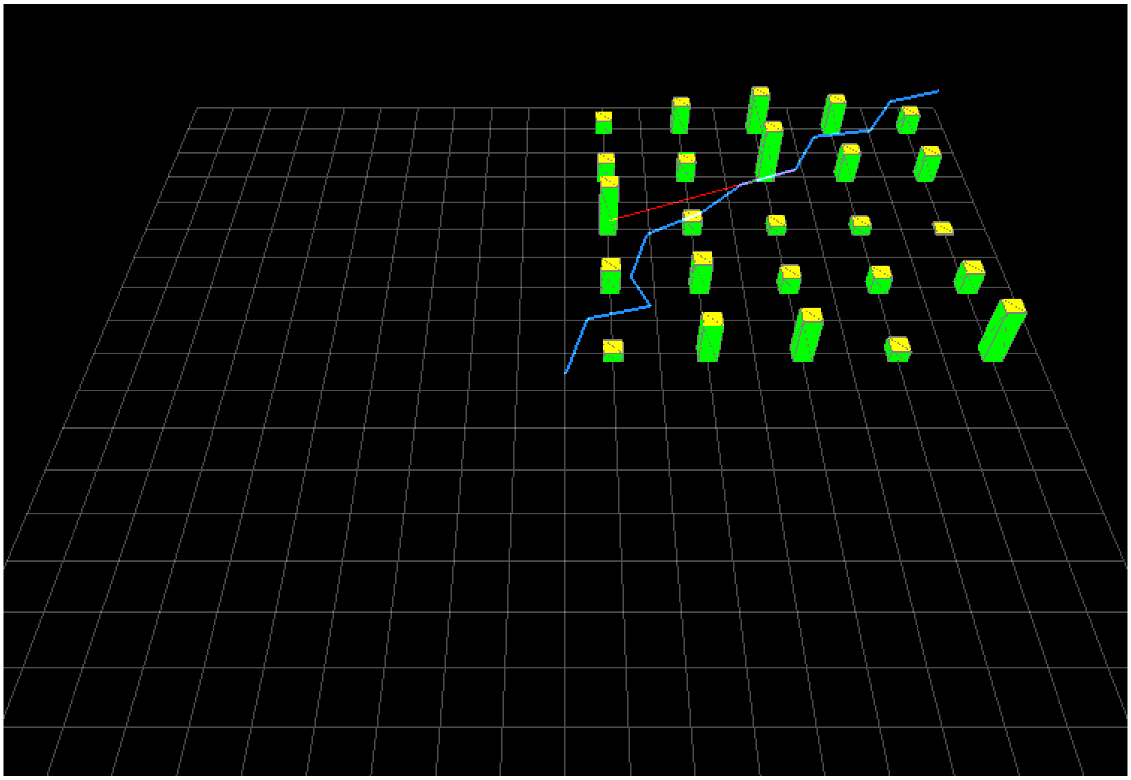
```python
import numpy as np
from mav_sim.chap3.mav_dynamics import DynamicState
from mav_sim.chap12.run_sim import run_sim
from mav_sim.message_types.msg_sim_params import MsgSimParams
from mav_sim.message_types.msg_world_map import MsgWorldMap
from mav_sim.tools.types import NP_MAT
from mav_sim.chap12.world_viewer import WorldViewer
from mav_sim.chap3.data_viewer import DataViewer
from mav_sim.tools.display_figures import display_data_view, display_mav_view

# The viewers need to be initialized once due to restart issues with qtgraph
if 'world_view' not in globals():
    print("Initializing waypoint viewer")
    global world_view
    world_view = WorldViewer()
if 'data_view' not in globals():
    print("Initializing data_view")
    global data_view
    data_view = DataViewer()

# Initialize the simulation parameters
sim_params_default = MsgSimParams(end_time=100., video_name="cha12.avi") # Sim␣
 ↪ending in 10 seconds
state = DynamicState()

# Function for running simulation and displaying results
def run_sim_and_display(end_pose: NP_MAT, sim_params: MsgSimParams =␣
 ↪sim_params_default):
    global world_view
    global data_view
    data_view.reset(sim_params.start_time)
    (world_view, data_view) = run_sim(sim=sim_params, end_pose=end_pose,␣
 ↪init_state=state, world_view=world_view, data_view=data_view)
    display_data_view(data_view)
    display_mav_view(world_view)
```

[2]:

```python
# Final point definition
world_map = MsgWorldMap()
end_pose = np.array([[world_map.city_width], [world_map.city_width], [-100]])

# Run the simulation
run_sim_and_display(end_pose=end_pose)
```

```
planning…
msg_waypoints::add() new point,  [[2000.]
 [2000.]
 [-100.]] , is nearly equal to prev point,  [[2000.]
 [2000.]
 [-100.]] , so not adding the waypoint
msg_waypoints::add() new point,  [[2000.]
 [2000.]
 [-100.]] , is nearly equal to prev point,  [[2000.]
 [2000.]
 [-100.]] , so not adding the waypoint
msg_waypoints::add() new point,  [[2000.]
 [2000.]
 [-100.]] , is nearly equal to prev point,  [[2000.]
 [2000.]
 [-100.]] , so not adding the waypoint
…done planning.
planning…
msg_waypoints::add() new point,  [[   0.]
 [   0.]
 [-100.]] , is nearly equal to prev point,  [[   0.]
 [   0.]
 [-100.]] , so not adding the waypoint
msg_waypoints::add() new point,  [[   0.]
 [   0.]
 [-100.]] , is nearly equal to prev point,  [[   0.]
 [   0.]
 [-100.]] , so not adding the waypoint
msg_waypoints::add() new point,  [[   0.]
 [   0.]
 [-100.]] , is nearly equal to prev point,  [[   0.]
 [   0.]
 [-100.]] , so not adding the waypoint
…done planning.
```



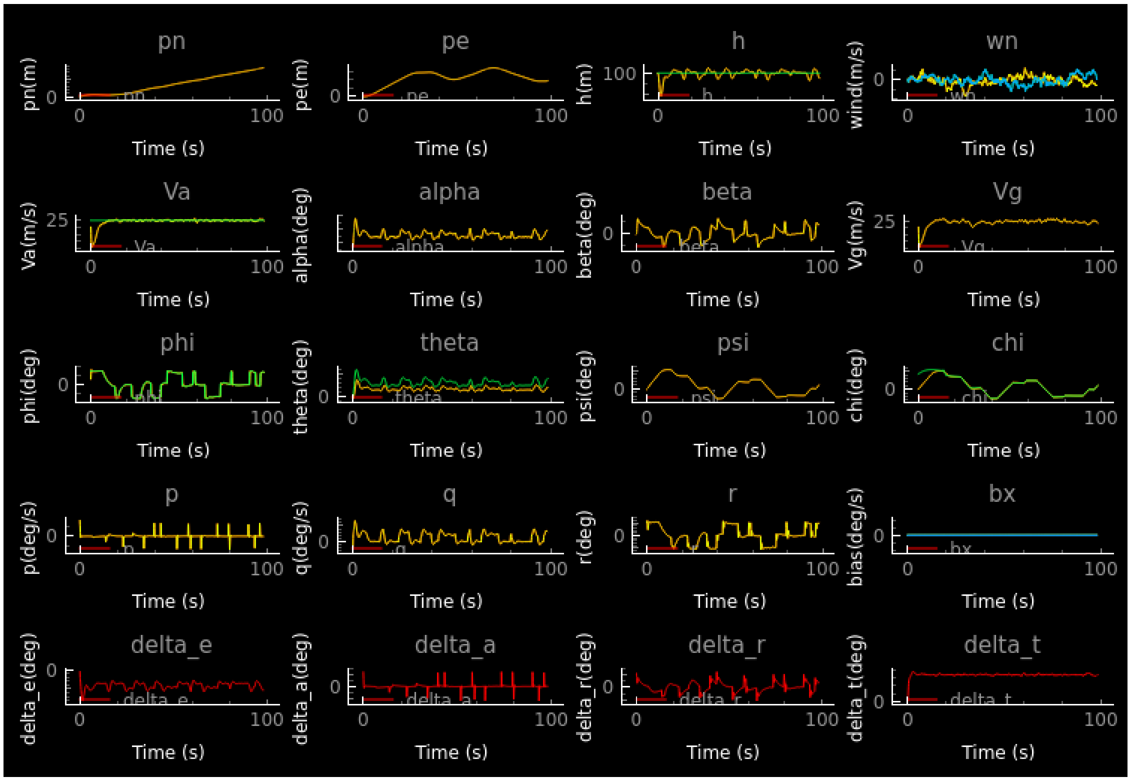


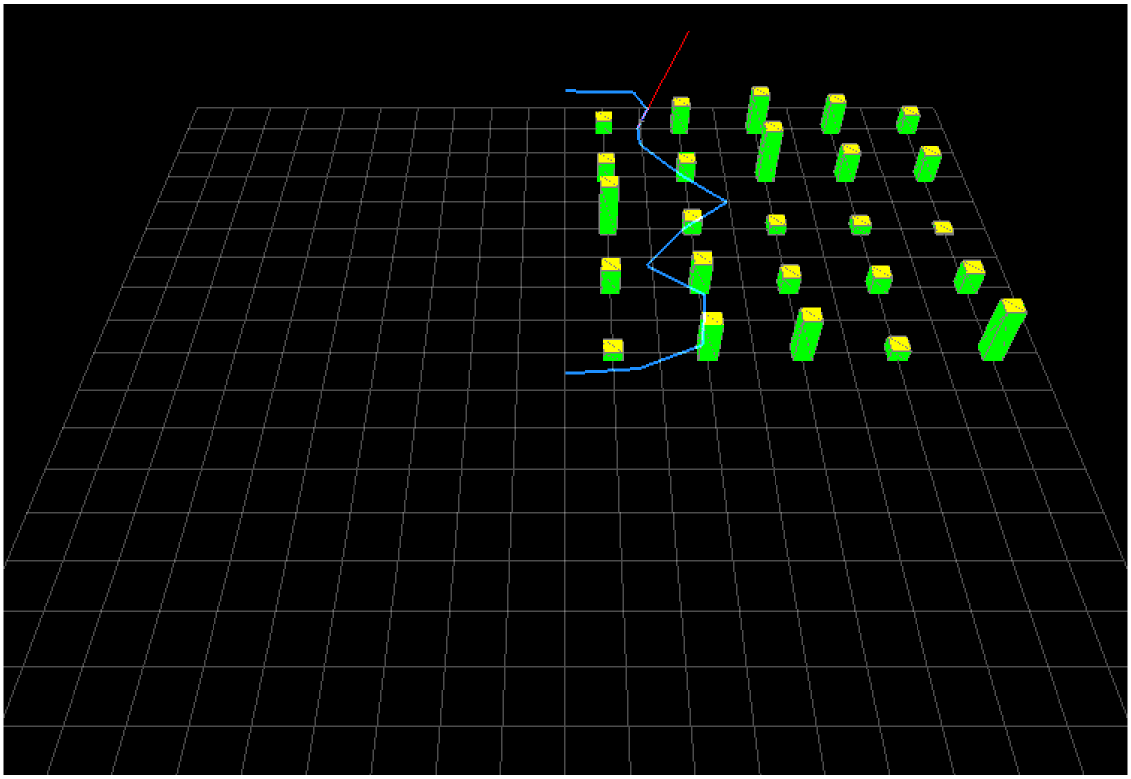
0.2 Problem 1: Top Left Corner

Rerun the simulation with the following changes: * Have the end pose be the top left corner (instead of top-right as defined above). * Adjust the sim time so that the UAV makes it only part of the way to the end pose, but does have sufficient time to be on the path.

[6]:
```
# Final point definition
world_map = MsgWorldMap()
end_pose = np.array([[world_map.city_width], [0], [-100]])

# Run the simulation
run_sim_and_display(end_pose=end_pose)
```

```
planning…
msg_waypoints::add() new point,  [[2000.]
 [   0.]
 [-100.]] , is nearly equal to prev point,  [[2000.]
 [   0.]
 [-100.]] , so not adding the waypoint
msg_waypoints::add() new point,  [[2000.]
 [   0.]
 [-100.]] , is nearly equal to prev point,  [[2000.]
 [    0.]
 [-100.]] , so not adding the waypoint
msg_waypoints::add() new point,  [[2000.]
 [    0.]
 [-100.]] , is nearly equal to prev point,  [[2000.]
 [    0.]
 [-100.]] , so not adding the waypoint
…done planning.
```





0.3 Simple code checking

The following code does not need to change. It should just be used as a sanity check so that you know the code is implemented properly. The output should not have any lines reading `Failed test!` If it does, then write an explanation of why those failed tests are okay. For example, you may describe that the function is testing a fringe case where the value changes at $\pi/2$. Your function behaves well up to the boundary, but perhaps struggles with some points that are numerically on / close to the boundary.

0.3.1 Reasoning for results not being perfect on the unit tests

(For each unit test that failed, write a brief explanation of why it is okay that it failed)

[7]:

```
from mav_sim.unit_tests.ch12_straight_line_rrt_test import run_tests
run_tests()
# If you want to run a specific test
# run_tests(<the_test_number>)
```

```
Starting plan_path test
Starting find_closest_configuration test
Starting find_shortest_path test
Starting smooth_path test
End of test
```

[ ]: