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In [1]:

```
import pybullet as p
import pybullet_data
import numpy as np
import time
import matplotlib.pyplot as plt
from TurtleBot_FixedTarget import TurtleBot
from TurtleBot_followtrajectory import TurtleBot2
```

pybullet build time: Oct 3 2022 17:04:40

First Case: Fixed Target

In [2]:

```
simulation = False
turtlebot = TurtleBot(simulation)
actions, orientations, poses = turtlebot.main(pose_target= np.array([3,4,0])
```

Position now: [2.98056513 3.96002625 0.03570333], Orientation: [6.87229107e-04 -5.20092493e-03 1.11812165e+00], with orientation error = 0.00013540375740931203, and pose_error: [0.01943487 0.03997375 -0.03570333]

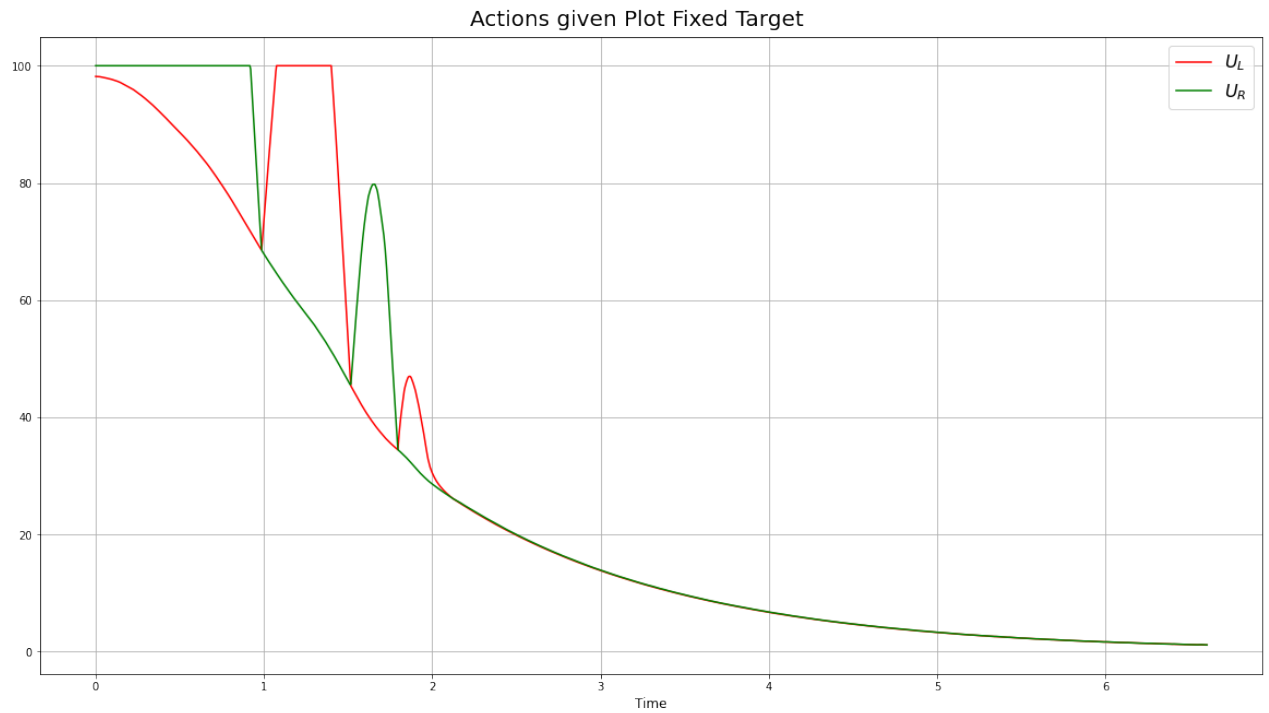
In [3]:

```
t1 = np.arange(0, len(actions)*turtlebot.dt, turtlebot.dt)
```

In [4]:

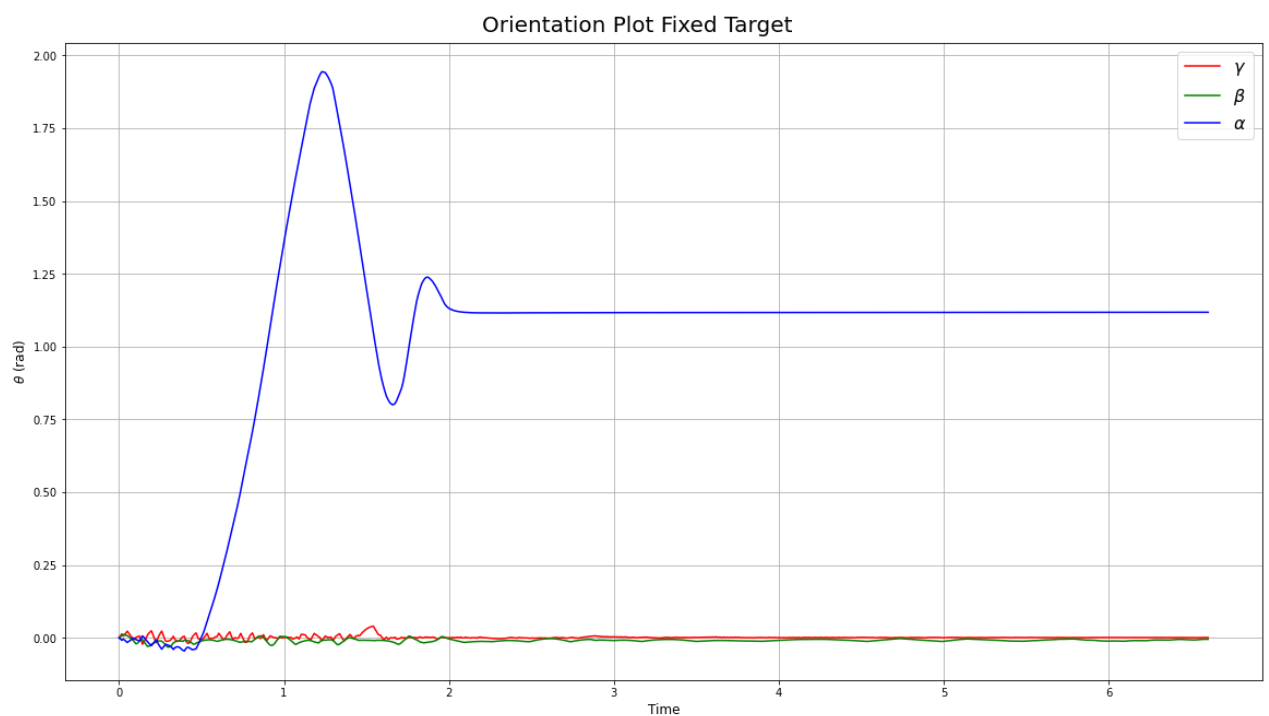
```
fig, ax = plt.subplots(figsize=(16,9), constrained_layout=True)

ax.plot(t1, actions[:,0], c='r', label='$U_L$')
ax.plot(t1, actions[:,1], c='g', label='$U_R$')
ax.set_xlabel("Time", fontsize=12)
ax.legend(loc='upper right', fontsize = 16)
fig.suptitle("Actions given Plot Fixed Target", fontsize = 20)
plt.grid()
plt.show()
```



```
In [5]: fig, ax = plt.subplots(figsize=(16,9), constrained_layout=True)

ax.plot(t1, orientations[:,0], c='r', label='$\\gamma$')
ax.plot(t1, orientations[:,1], c='g', label='$\\beta$')
ax.plot(t1, orientations[:,2], c='b', label='$\\alpha$')
ax.set_xlabel("Time", fontsize=12)
ax.set_ylabel("$\\theta$ (rad)", fontsize=12)
ax.legend(loc='upper right', fontsize = 16)
fig.suptitle("Orientation Plot Fixed Target", fontsize = 20)
plt.grid()
plt.show()
```



In [6]:

```
fig, ax = plt.subplots(figsize=(16,9), constrained_layout=True)

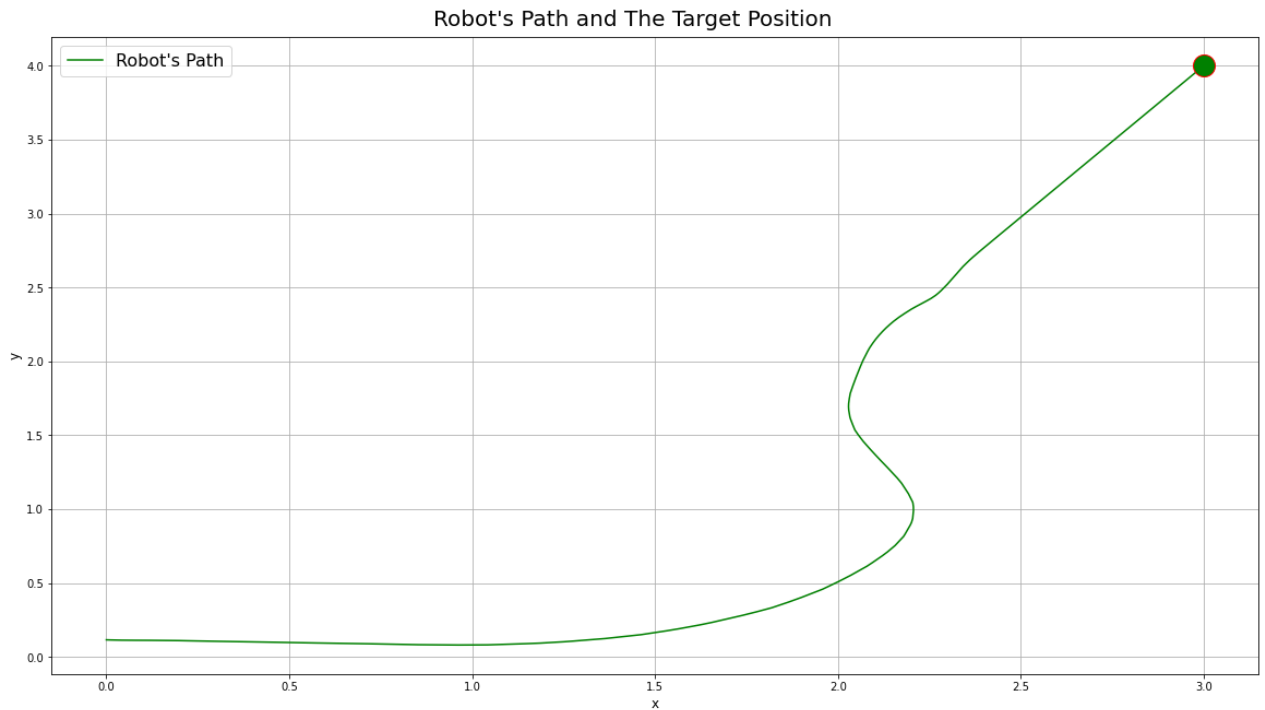
ax.plot(t1, poses[:,0], c='r', label='$x$')
ax.plot(t1, poses[:,1], c='g', label='$y$')
ax.plot(t1, poses[:,2], c='b', label='$z$')
ax.set_xlabel("Time", fontsize=12)
ax.legend(loc='upper left', fontsize = 16)
fig.suptitle("Position Plot Fixed Target", fontsize = 20)
plt.grid()
plt.show()
```



In [7]:

```
fig, ax = plt.subplots(figsize=(16,9), constrained_layout=True)

ax.plot(poses[:,0], poses[:,1], c='g', label="Robot's Path")
ax.plot([3],[4],marker="o", markersize=20, markeredgecolor="red", markerfacecolor="white")
ax.set_xlabel("x", fontsize=12)
ax.set_ylabel("y", fontsize=12)
ax.legend(loc='upper left', fontsize = 16)
fig.suptitle("Robot's Path and The Target Position", fontsize = 20)
plt.grid()
plt.show()
```



Second Case: Follow Trajectory

In [8]:

```
x = np.arange(0.1, 2*np.pi, 1./(2*240.))
y = np.sin(x)
z = np.zeros(len(x))
pose_targets = np.array([x,y,z]).T.reshape(len(x),1,3)

turtlebot2 = TurtleBot2(simulation)
acts, orients, pose = turtlebot2.main(pose_targets=pose_targets, Kp=80)
```

Position now: [6.11022555 -0.16874203 0.03612028], Orientation: [0.00119 19 -0.01396615 0.7716552], with orientation error = 0.001258883918031087 3, and pose_error: [0.17102445 0.16680672 -0.03612028]

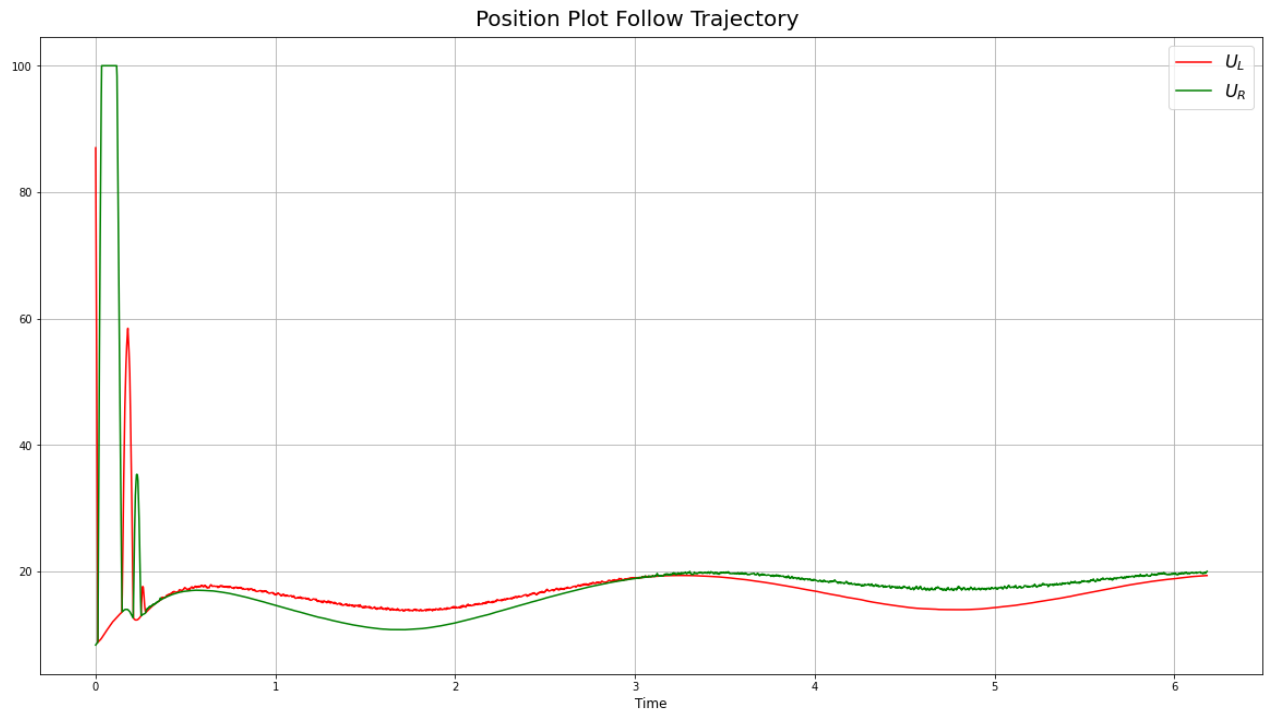
In [9]:

```
t2 = np.arange(0, len(x)*1./(2*240.), 1./(2*240.))
```

In [10]:

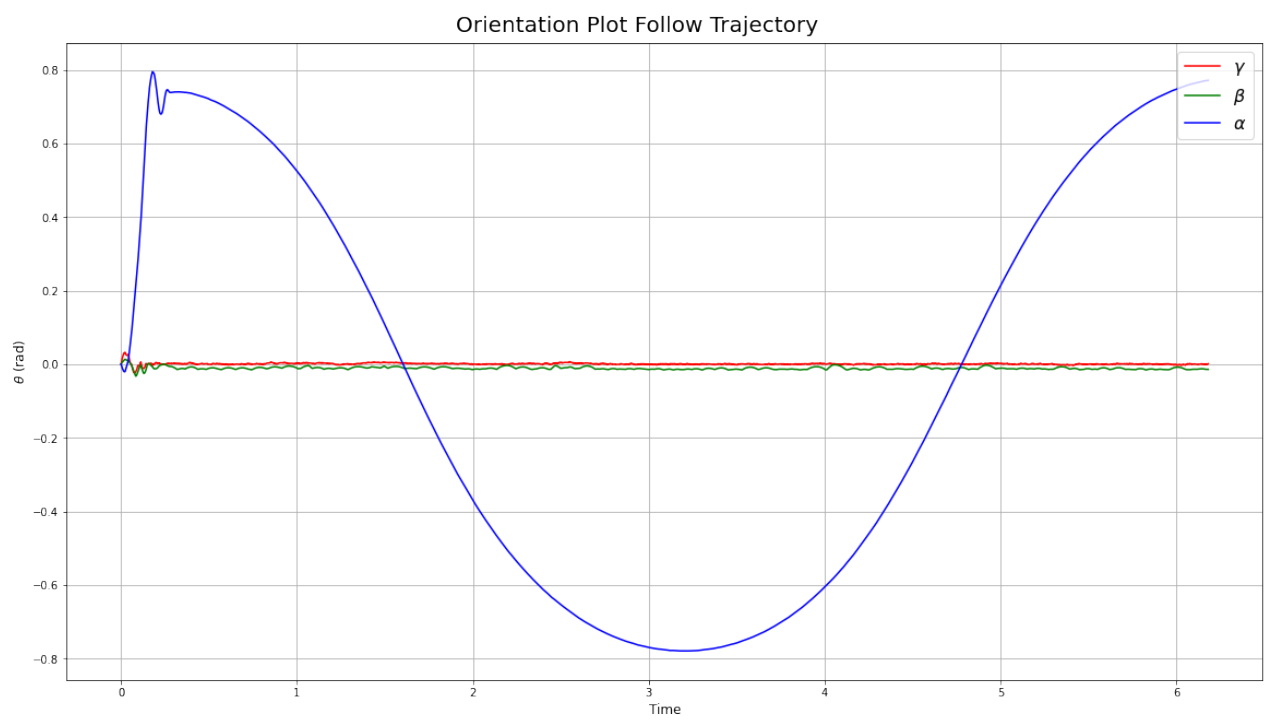
```
fig, ax = plt.subplots(figsize=(16,9), constrained_layout=True)

ax.plot(t2, acts[:,0], c='r', label='$U_L$')
ax.plot(t2, acts[:,1], c='g', label='$U_R$')
ax.set_xlabel("Time", fontsize=12)
ax.legend(loc='upper right', fontsize = 16)
fig.suptitle("Position Plot Follow Trajectory", fontsize = 20)
plt.grid()
plt.show()
```



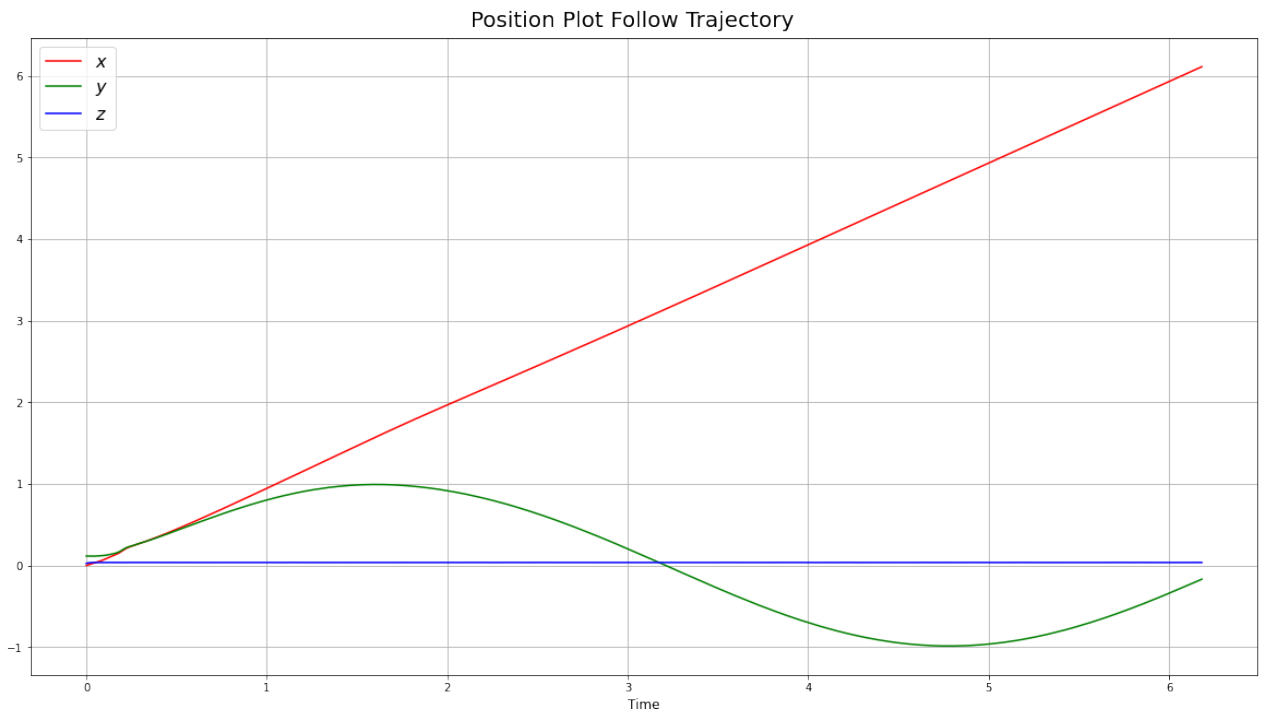
```
In [11]: fig, ax = plt.subplots(figsize=(16,9), constrained_layout=True)

ax.plot(t2, orients[:,0], c='r', label='$\\gamma$')
ax.plot(t2, orients[:,1], c='g', label='$\\beta$')
ax.plot(t2, orients[:,2], c='b', label='$\\alpha$')
ax.set_xlabel("Time", fontsize=12)
ax.set_ylabel("$\\theta$ (rad)", fontsize=12)
ax.legend(loc='upper right', fontsize = 16)
fig.suptitle("Orientation Plot Follow Trajectory", fontsize = 20)
plt.grid()
plt.show()
```



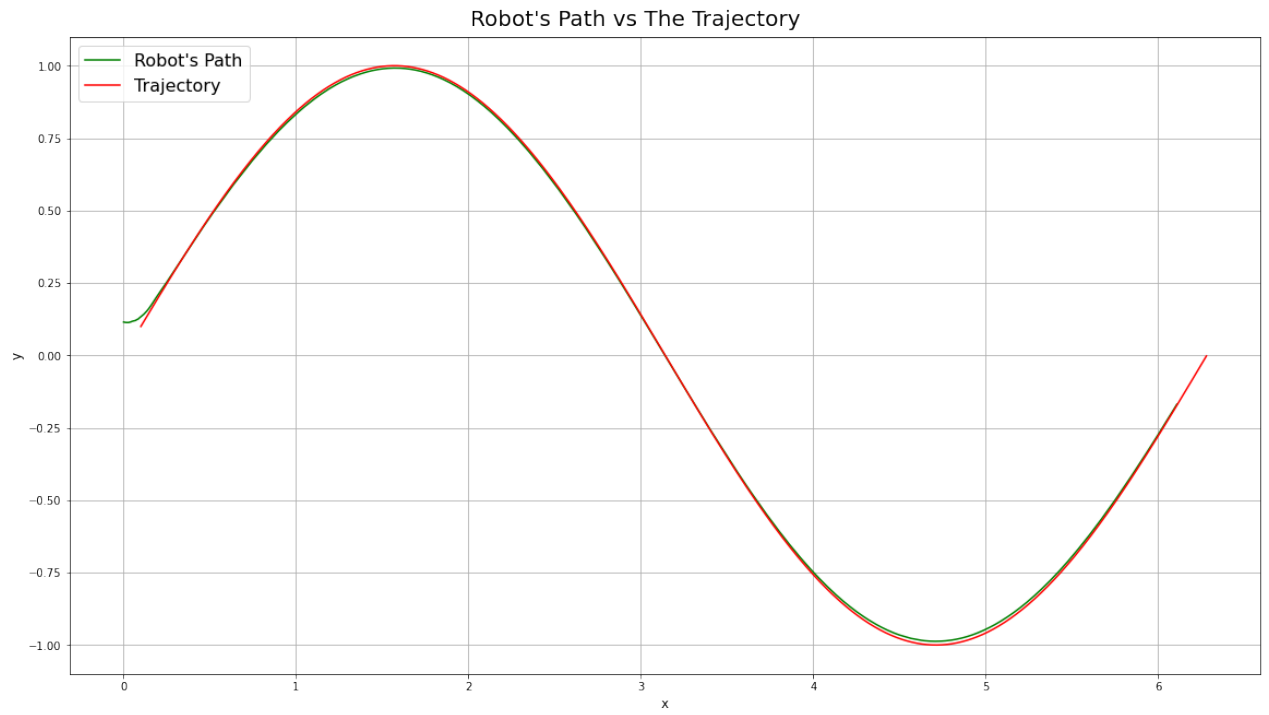
```
In [12]: fig, ax = plt.subplots(figsize=(16,9), constrained_layout=True)

ax.plot(t2, pose[:,0], c='r', label='$x$')
ax.plot(t2, pose[:,1], c='g', label='$y$')
ax.plot(t2, pose[:,2], c='b', label='$z$')
ax.set_xlabel("Time", fontsize=12)
ax.legend(loc='upper left', fontsize = 16)
fig.suptitle("Position Plot Follow Trajectory", fontsize = 20)
plt.grid()
plt.show()
```



```
In [13]: fig, ax = plt.subplots(figsize=(16,9), constrained_layout=True)

ax.plot(pose[:,0], pose[:,1], c='g', label="Robot's Path")
ax.plot(x,y, c="r", label="Trajectory")
ax.set_xlabel("x", fontsize=12)
ax.set_ylabel("y", fontsize=12)
ax.legend(loc='upper left', fontsize = 16)
fig.suptitle("Robot's Path vs The Trajectory", fontsize = 20)
plt.grid()
plt.show()
```



In []: