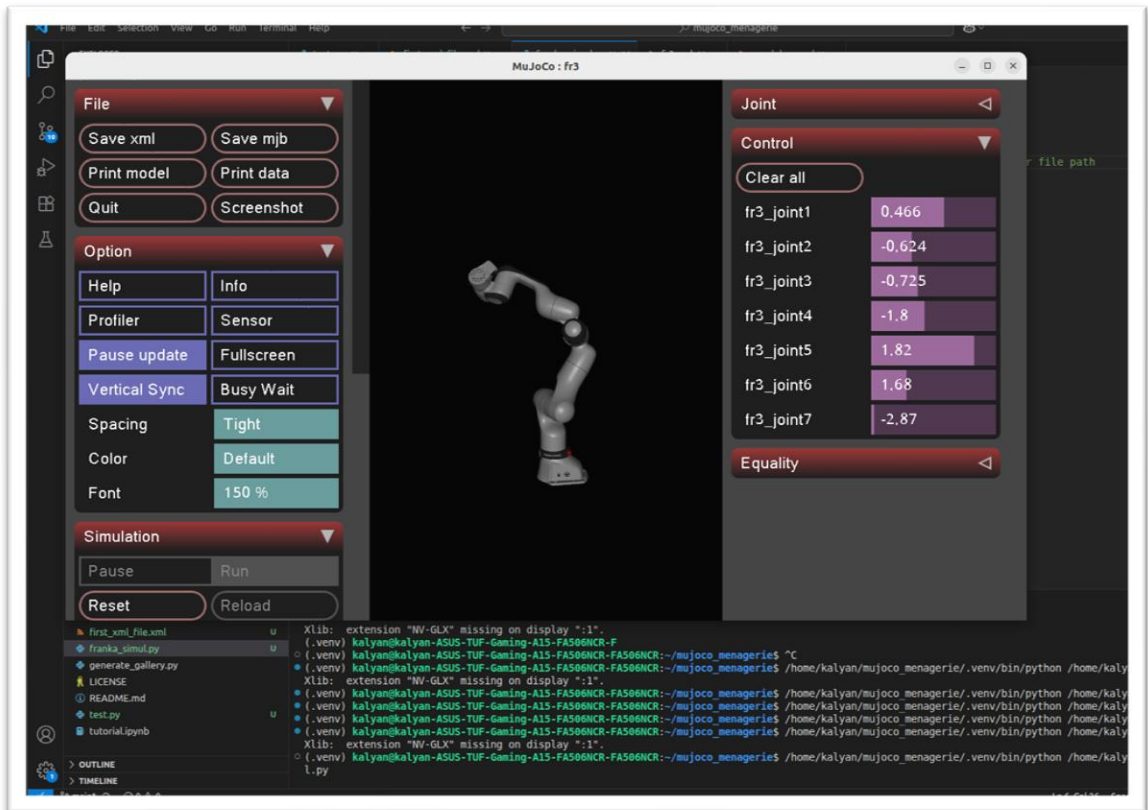


# Introduction to Robotics(ME 639)

## 1. Simulation of Franka Research 3 serial chain manipulator



### Observations:

After Simulating I observed that this robot has 7 degrees of freedom. I changed the value of gravity and observed the following:

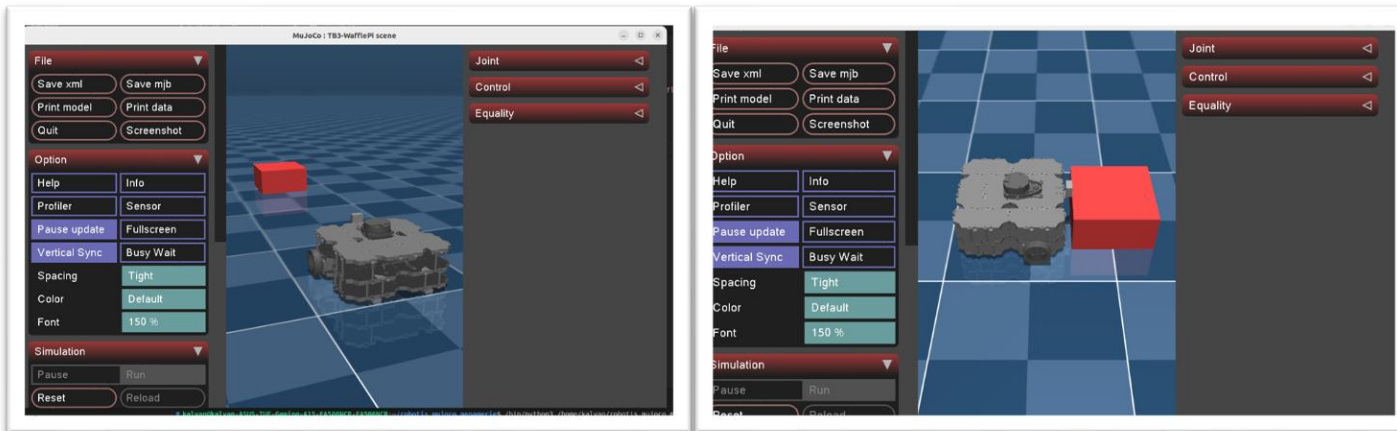
i. Initially the gravity was set to zero so there were no external force already acting on it. The motion of the joints were very smooth and it had no problem maintaining its position even after manipulation.

ii. When I changed the gravity to  $-9.81\text{m/sec}^2$  in the z-direction, initially we observe no change but once manipulated in such a way so that a cantilever position is formed, we observe a little to and fro motion before it became stable in its desired position. On further increasing the gravity, I saw massive SHM and it took more time to become stable.

So, the Amplitude of the SHM was directly proportional to the value of gravity. The system became more unstable and hard to control.

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## 2. Simulation of TurtleBot Waffle Pi



Simulating the bot with an initial force in the x direction and then making it collide with an immovable object .

### Observations:

After Simulating I observed that this robot has 2 wheels that can be manipulated.

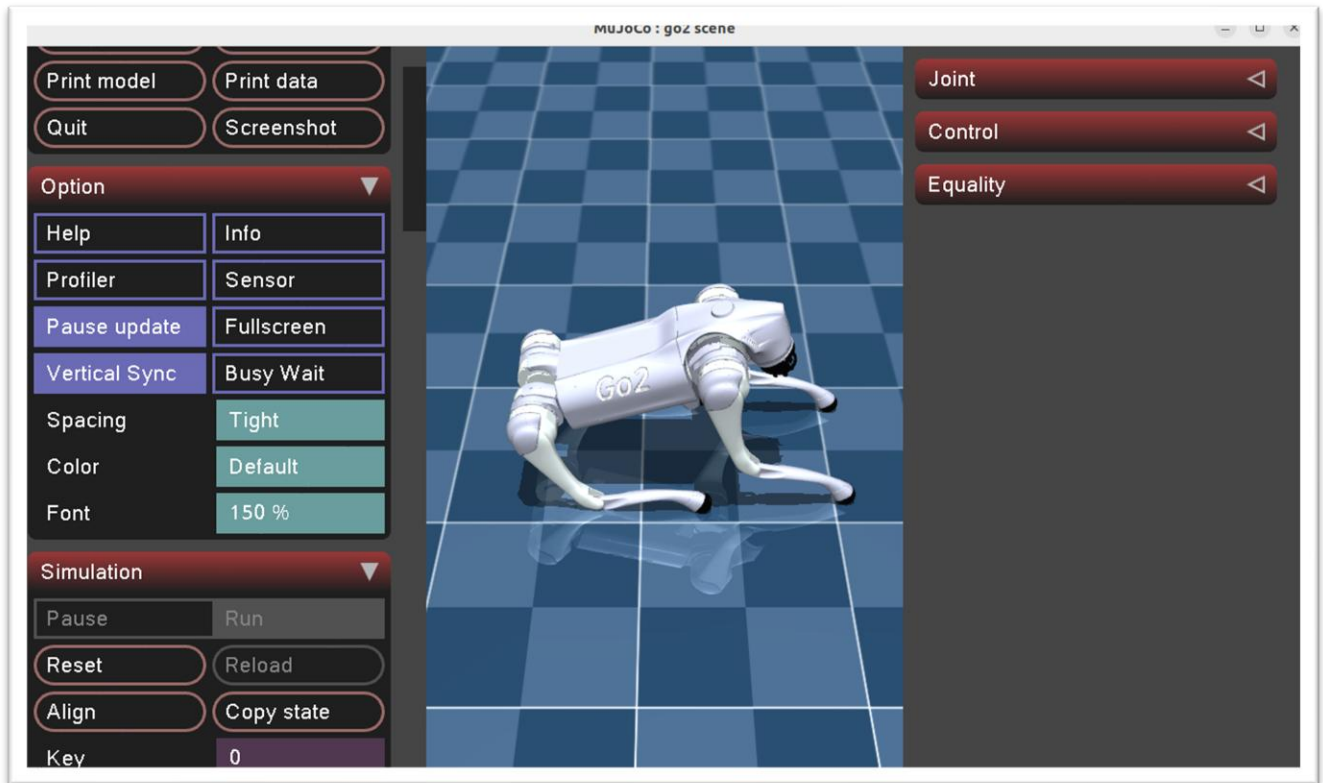
i. Initially I controlled it with the controllers and it worked as expected, but when I added an external force, in the x direction, it went on rolling in the direction of force. A very minimal force also made it roll and move forward or backward.

ii. Then I applied a force in the y direction and for a small force, due to the available friction on plane, the bot was steady and did not move. It started to drift once I gave enough force to overcome the frictional force.

iii. Lastly I gave a force in the x-direction and made it collide with an immovable wall. In case of no gravity, it took off after collision and with gravity on, it collided and stopped instantly.

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## 3. Simulation of Unitree Go2 EDU quadruped



### Observations:

After Simulating I observed that this is a quadruped robot with multiple degrees of freedom. It has 4 legs, and individually each have 3 degrees of freedom. In addition there was a hip joint and a head.

i. Initially I controlled it with the controllers and it worked as expected. Initially gravity was turned on so it was forced to sit down as shown in the picture.

ii. I tried turning off gravity, but that would just not work after I moved a part. It caused the whole bot to go fly in the reaction force direction.

iii. When I tried turning on gravity in the simulation software the robot sat down. But once I modified the .xml file and wrote the value of gravity and simulate, the bot will tuple backwards. So I didn't quite understand why but my hypothesis is, when updating the file, it might be taking from the COG, but in the software, the gravitational vector is throughout the space.

## **4. Problems I faced and solutions I found**

1. The major problem was that I had a lower hard disk space and I had to partition my windows to Ubuntu and then learning about the new OS. I solved it by watching YouTube tutorials, asking chat gpt, and by the help of a few TA students and friends.
2. There were no good MuJoCo python tutorials available. So I had to take the help from Chat Gpt to write the code and explain how it works.
3. First I was confused about the .xml file, which one to open because I was opening just the model, but it would fall down endlessly. So then by experimenting I understood that the scene file should be executed for the correct interpretation.
4. I prompted chatgpt to make an inverted pendulum code for both python and mujoco but both of the files when I tried to run had some sort of error in the output while executing. Both the files ran but I did not get the desired output. I could not edit the code much as I do not have the expertise of a PID controller. Once I have the required knowledge I'll surely apply that to make it work.