Assignment-1

Deepak Gadhave
23110110

Task-1: Launch MuJoCo inside ROS 2 using mujoco_ros

There are a few libraries to launch MuJoCo using ROS 2 like MoveIt and Woolfrey. The tasks were carried out without the use of ROS 2 but I tried setting up the mujoco_ros2 repository by Woolfrey.

Code

This code can be used to launch the required model by making changes in the example.py file:

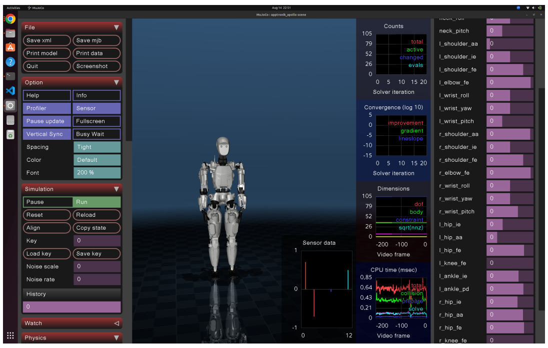
```
ros2 launch mujoco_ros2 example.py
```

Later to directly load the GUI without the use of ROS 2 we can use the following code and drag and drop the .xml file of the required model.

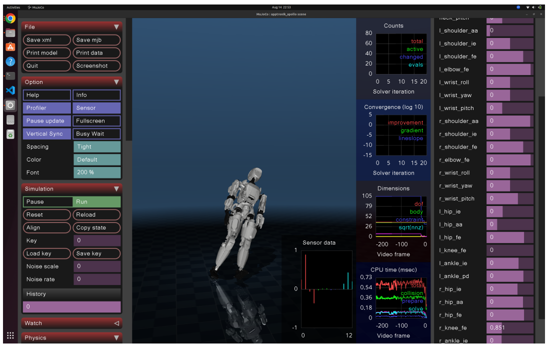
```
python3 -m mujoco.viewer
```

Images

Example: Apollo Apptronik Humanoid robot



(a) Launching Apptronik Apollo

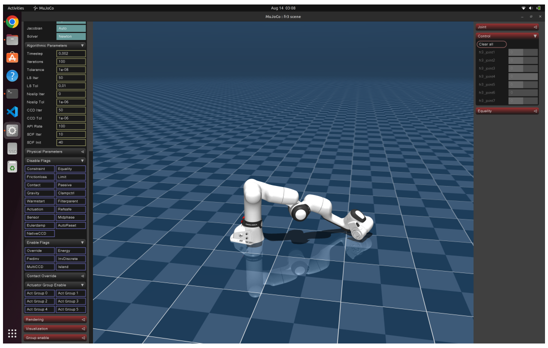


(b) Changing joint value to make the humanoid fall

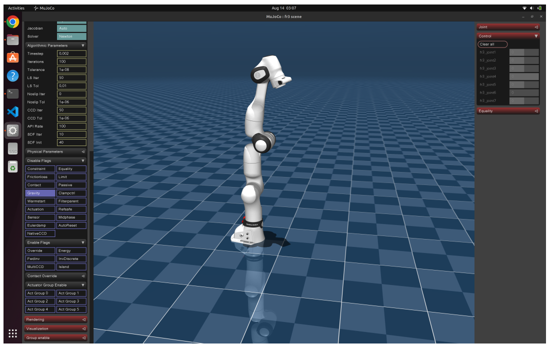
Task-2 Simulate Franka Research 3 serial chain manipulator

Here we checked the difference in the states of the manipulator when gravity is on and when it is off. We also need to disable the actuator controls to see the behaviour.

Images



(a) State of FR3 with gravity "ON"



(b) State of FR3 with gravity "OFF"

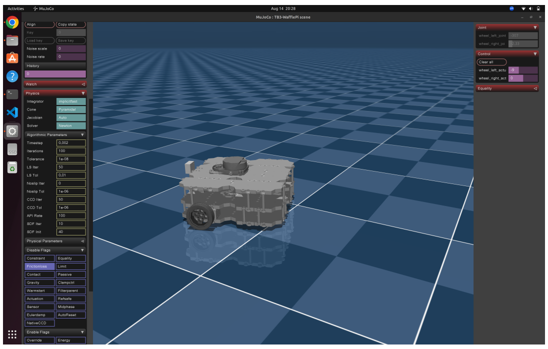
Task-3: Simulate TurtleBot Waffle pi differential drive robot

Moved the robot by controlling the actuator, i.e. the motors at its 2 wheels.

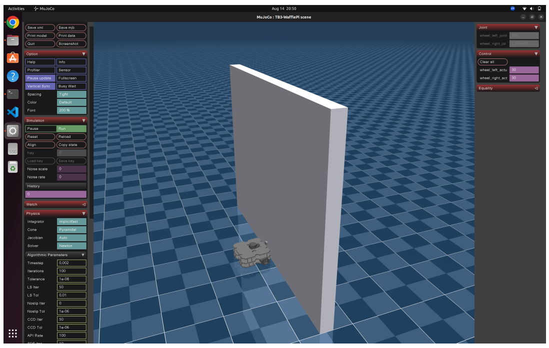
1. In the first case, I changed the motor control of its left wheel and I was able to observe slip in certain sections while it was going in a circle.

2. In the second case, I added a wall and collided the turtlebot head-on with the wall.

Images



(a) Slip and drift observed at wheels



(b) Collision with wall to observe physical behaviour

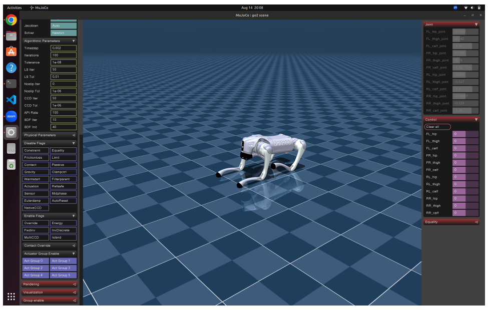
Task-4: Simulate Unitree Go 2 EDU quadruped

1. First 2 images below, show that the quadruped robot is stable even if gravity is "ON" or "OFF".

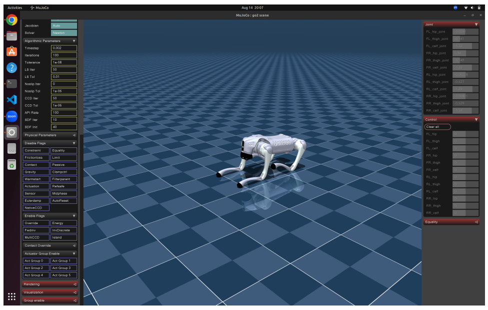
2. 3rd image shows the contact forces of the quadruped with the ground in the MuJoCo GUI.

3. 4th & 5th images show the state of the quadruped at its joint limits and the values of the limits of each joint in rads respectively.

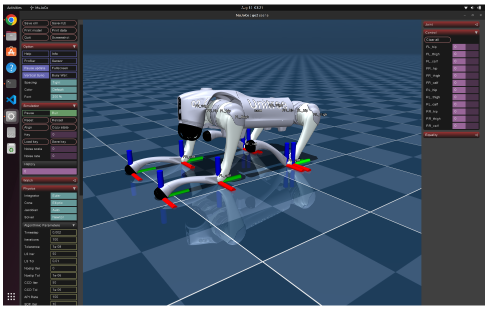
Images



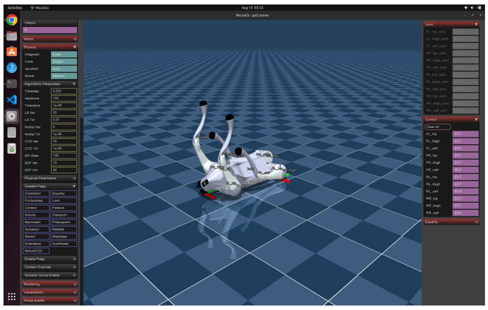
(a) Quadruped with gravity "ON"



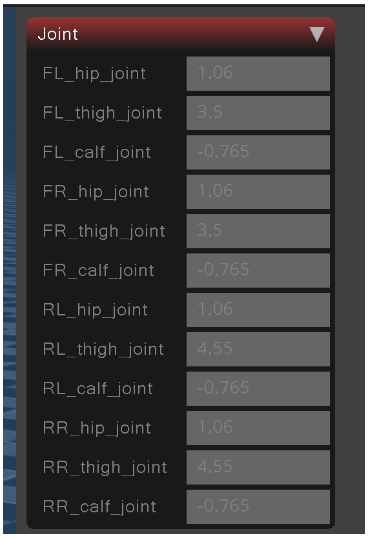
(b) Quadruped with gravity "OFF"



(c) Contact forces of the robot with ground



(d) State of the robot at joint limits

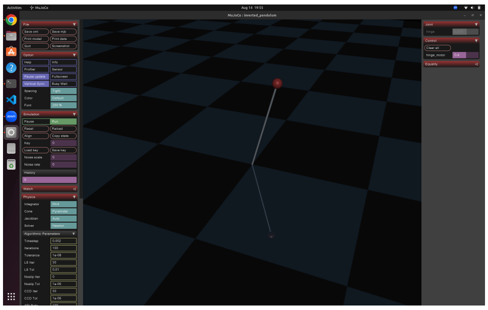


(e) Joint limit values

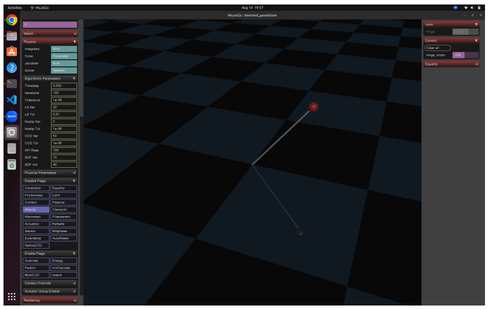
Task-5: Simulate simple inverted pendulum

Observed the behaviour the inverted pendulum under gravity by changing the joint values, i.e. varying the initial conditions. Under gravity it falls to the ground after giving some initial condition.

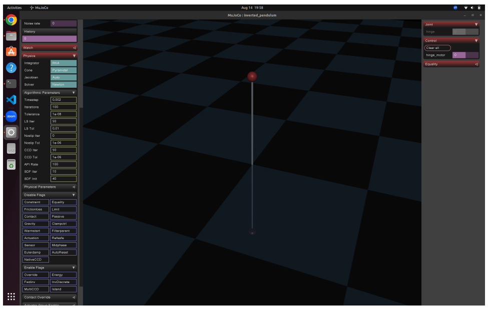
Images



(a) Inverted Pendulum with gravity "ON" and changing joint value



(b) Inverted Pendulum with gravity "OFF" and changing joint value



(c) State of the inverted pendulum without changing joint value

Challenges faced and how they were fixed

1. mujoco_ros2: Tasks were carried out directly using the MuJoCo GUI and not using ROS 2. I tried using the repository by Woolfrey to launch MuJoCo using ROS 2 but it needed other commands to control the joints.

```
ros2 topic pub /joint_commands std_msgs/msg/Float64MultiArray "{data: [1.0, -1.0]}"
```

2. Controlling the robot joints: It is challenging to adjust the joint values or control the robot as we can control it using a slider only which does not allow for precise control. Using python scripts and ROS 2 we might be able to control it precisely.

References

- MuJoCo Documentation MuJoCo Official Documentation.

- OpenAI. ChatGPT conversation.
- GitHub Repository. mujoco_ros2 on GitHub.