

## Humanoid Robotics - Locomotion and whole-body control (SS 2025)

Exercise Sheet No. 2

due June 5th, 2025

### 2.1 – Reem-C’s center of mass

Write a program that

- reads all segment masses and segment center of mass locations of Reem-C
- calculates the total mass of the robot and prints it out
- calculates the total center of mass of the robot as a function of its joint angles and prints it out.
- computes the distance of his center of mass to the center of the pelvis segment (x, y, z, distance) and prints it out.

Apply this program to the data set given in the attachment. You can play this data via

```
roslaunch sampleMotion
```

Visualize the total center of mass and the center of the pelvis segment for the entire motion. Prepare a video or live demo of this visualization, the results of the printouts as well as all your relevant code.

### 2.2 – Center of pressure

Write a program that computes the center of pressure location based on the measurements of the force torque sensors, and prints out x,y coordinates of the COP. All relevant parameters can be found in the Reem-C model.

Apply this program to the data set given in the attachment.

Visualize the center of pressure for the entire motion.

Prepare a video or live demo of this visualization, the results of the printouts as well as all your relevant code.

### 2.3 – Zero moment point

Write a program that computes the zero moment point from the motion of the robot following the three approaches discussed in the class and prints them out:

1. exact computation of ZMP taking all contributions into account

2. simplified computation of ZMP taking only translations of segments into account
3. even more simplified computation of the ZMP approximating the robot by a single mass point. Assume here that this mass point (total mass of the robot) is aligned with the pelvis motion of the robot.

Apply this program to the data set given in the attachment.

Visualize all three computations of the ZMP for the entire motion - preferably also showing the COP from the last exercise.

Prepare a video or live demo of this visualization, the results of the printouts as well as all your relevant code.