Final Project Assignment: Giraffe robot for Q&A sessions at talks

Handing a microphone to people from the audience wanting to ask questions can be a dull task, so we want to automate it.

1 Assignement Description

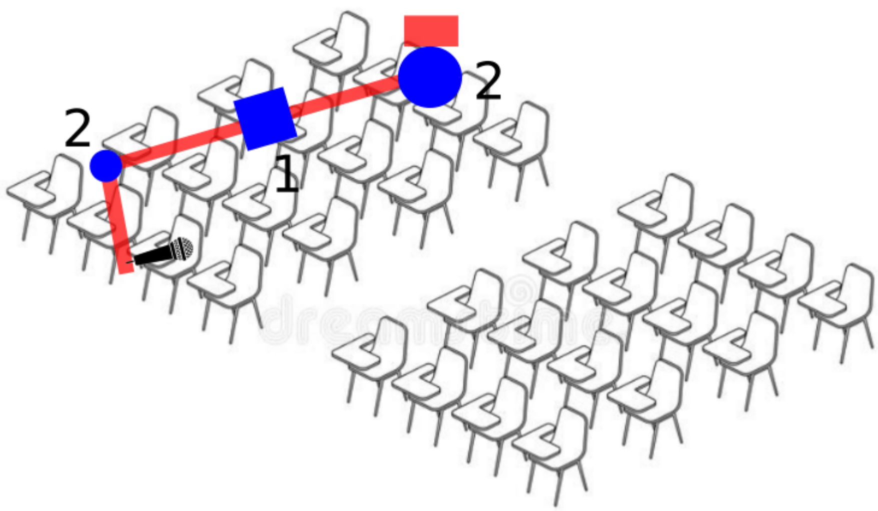

Figure 1: image

The assignment for the final project is to design a *giraffe robot* that places a microphone in front of a person sitting inside a small theater/conference room.

The robot is attached to the ceiling of the room, located in the middle.

The room is 4 m high and the robot should be able to reach 1 m high locations in a 5×12 meter area. The robot should have 5 degrees of freedom:

- 1 spherical joint at the base (2 revolute joints with intersecting axes)
- 1 prismatic joint able to achieve a long extension
- 2 revolute joints to properly orient the microphone (not necessarily with intersecting axes).

We want to locate the microphone at any point in the 5×12 conference room, with a specific pitch orientation ($30\,\text{deg}$) with respect to the horizontal (the task is 4D), so people can talk comfortably in front of the microphone.

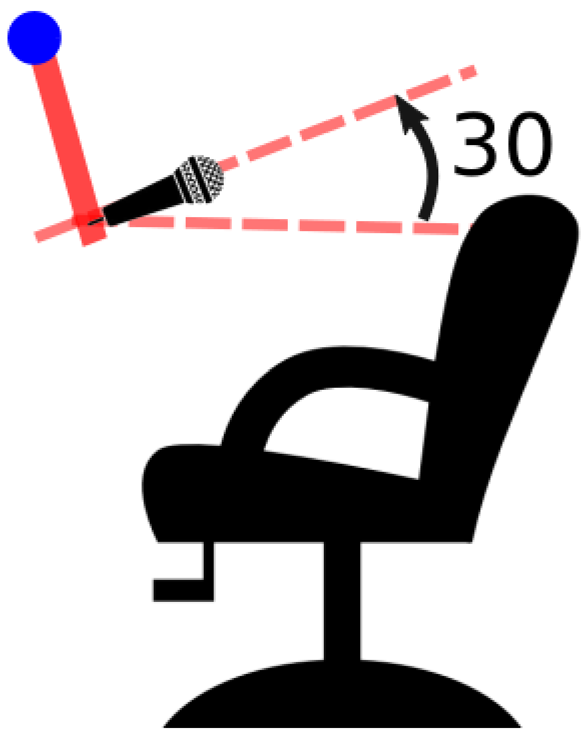

Figure 2: Side view of the chair

You can exploit the redundancy (1 DoF) to minimize a secondary task of your choice (e.g. stay close to a certain default configuration).

2 Workplan

The project can be decomposed in the following (incremental) steps:

1. build the URDF model of the robot choosing the link dimensions and where to place the frames.
2. compute the forward kinematics (position/orientation) and differential kinematics (Jacobian) of of the end-effector.

3. use Pinocchio library's RNEA native function to create a simulator of the motion of the robot.
4. plan a polynomial trajectory (in the task space) to move from a homing configuration $\mathbf{q}_{\text{home}}$ to a given end-effector configuration/orientation $\mathbf{p}_{\text{des}} + \boldsymbol{\theta}_{\text{des}}$.
5. Write an inverse-dynamics (computed torque) control action in the task space to linearize the system and achieve a tracking of the task.
6. Set the PD gains of the Cartesian controller implemented on the linearized system to achieve a settling time of 7 s without overshoot.
7. In the null-space of the task, minimize the distance with respect to a given configuation $\mathbf{q}_0$ of your choice.
8. Simulate the robot to reach the location $\mathbf{p}_{\text{des}} = [1, 2, 1]$ from the homing configuration $\mathbf{q}_{\text{home}} = [0, 0, 0, 0]$. The frame definition is shown in Figure 2.
9. draw up a report of the activities to send us before the exam for evaluation

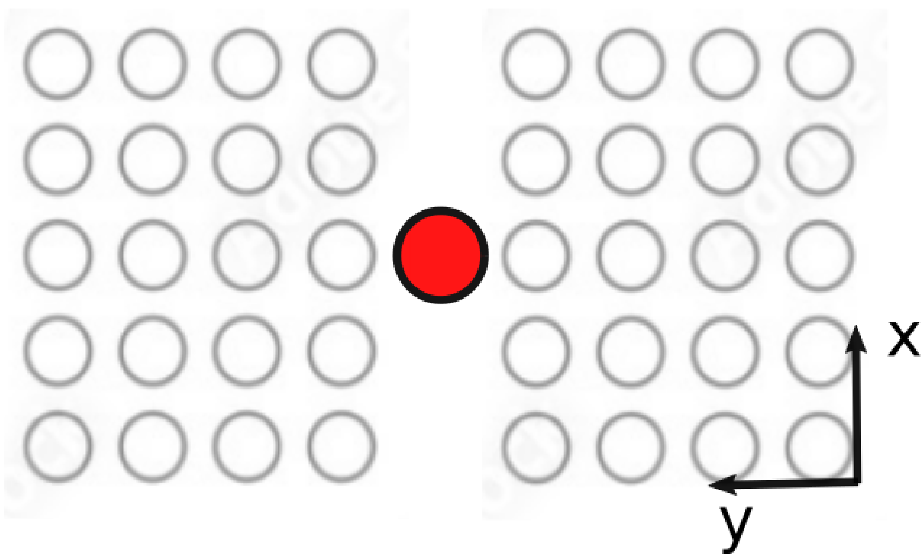

Figure 3: Top view of the room