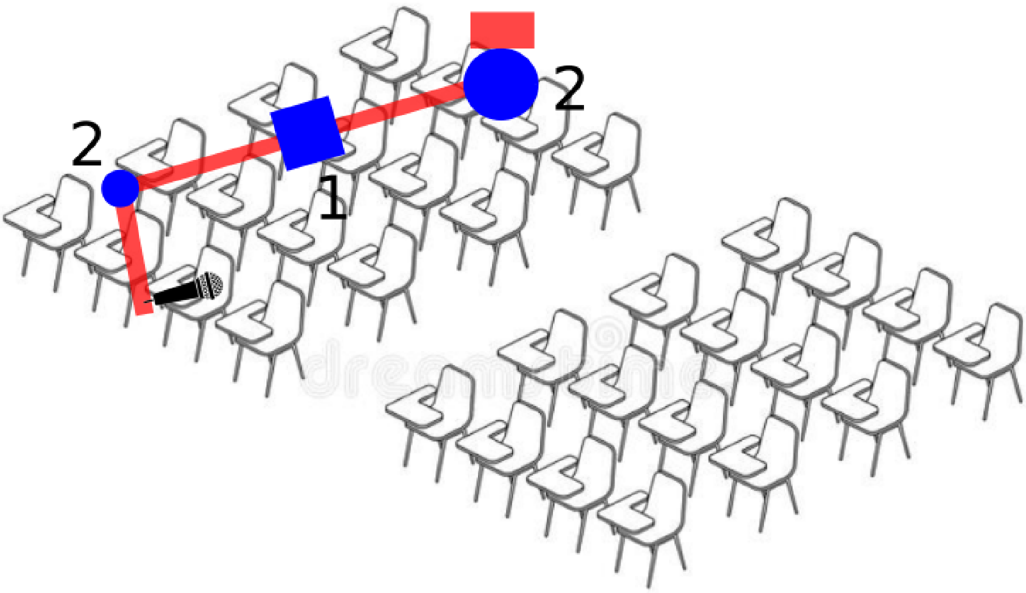
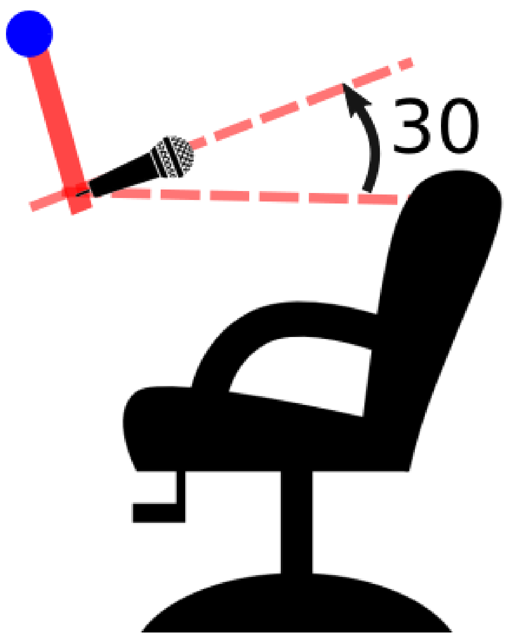
Final Project Assignment:Giraff robot for question handling in conferences



Handing a microphone to random people that want to ask questions after a talk, can be a duly task, and we want to automatize it. The assignment for the final project is to design a “giraff” robot that is able to place a microphone in front of a person in a small theater/conference room.
The robot is located in the middle of the room and attached to the ceiling. The room is 4 m high and the robot should be able to reach 1 m high locations in a 5x12 meters area.
The robot should have 5 degrees of freedom: a spherical joint at the base (2 revolute joints with intersecting axes), one prismatic joint that is able to achieve a long extension and 2 revolute joints to properly orient the microphone (not necessarily with intersecting axes).
We want to be able to locate the microphone at any point in the 5x5 conference room, with a certain pitch orientation (30 deg) with respect to the horizontal (the task is 4D), to allow people to talk comfortably in the microphone.



You can exploit the
redundancy (1 DoF) to minimize a secondary task of your choice (e.g. stay close to a certain default configuration). The project can be decomposed in the following (incremental) steps:

1) build the URDF model of the robot choosing the links lengths and conveniently placing 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.
6) plan a polynomial trajectory (in the task space) to move from a homing configuration $\mathbf{q}_{home}$ to a given end-effector configuration/orientation $\mathbf{p}_{des}$ + $\boldsymbol{\theta}_{des.}$
4) write an inverse-dynamics (computed torque) control action in the task space to linearize the system and achieve a tracking of the task.
5) Set the PD gains of the Cartesian controller implemented on the linearized system to achieve a settling time of 7s without overshoot.
6) In the null-space of the task minimize the distance with respect to a given configuation $\mathbf{q}_0$ of your choice.
7) Simulate the robot to reach the location $\mathbf{p}_{des}$ **=[1, 2, 1]** from the homing configuration $\mathbf{q}_{home}$ **=[0,0,0,0]**. The frame definition is as follows:
8) draw up a report of the activities to send us before the exam for evaluation