Homework 1 - Robot Dynamics and Control

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1 Article summary

Supernumerary Robotic Limbs for Human Body Support [1]
F. Parietti and H.H. Asada

The journal paper introduces a new wearable device to support a person in dangerous and repetitive tasks, such as, carrying heavy loads in a working environment. Motivation boils down to the fact that there are several activities which is still not easily to be replaced by robots due to the slow learning rate of complex tasks. Therefore, a new device, called *Supernumerary Robotic Limbs* SRL, is proposed and it is characterized as a wearable robot to maximize the human performance. Additionally, a studying of body support stability is presented by take in consideration the stiffness matrix evaluation.

The SRL system illustrated in Fig. 1 consist on: two robotics limbs; a harness to protect the hip bone; and a control unit. The device provides support to the user without constraining its motion with the help of the three links: one prismatic joint and two revolute joints, consequently, three degrees of freedom (DOFs). According to kinematic arrangements of manipulators in [2], the SRL system is observed to be a system with two RRP robot.

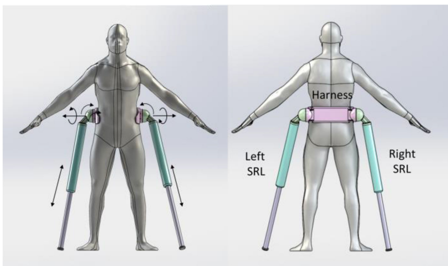

Figure 1: Design concept of SRL.

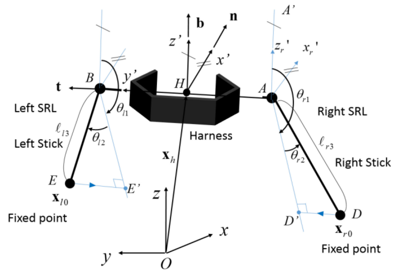

Figure 2: Schematic of the SRL system.

In order to study the support stability, the forward kinematic is presented, in additional, the differentiation of its equation results in Jacobian Matrix. Some assumptions are made by the authors, such as, massless of the SRL links and center of the mass equivalent to the center of the human body in combination with the harness.

The authors conclude the work by provind the SRL design works weel. A prototype was built and tested in diferent working environments. Additionally two control techniques presented and demostrated sucess to stabilize the body support:

- Null-space stabilization using Hessian;
- Joint servo stiffness control based on the Jacobian.

References

[1] F. Parietti and H. H. Asada, "Supernumerary robotic limbs for human body support.," *IEEE Trans. Robotics*, vol. 32, no. 2, pp. 301–311, 2016.

[2] M. W. Spong, S. Hutchinson, M. Vidyasagar, *et al.*, *Robot modeling and control*, vol. 3. Wiley New York, 2006.

2 Question 2

The figure shows two planar manipulators of the RP and PR types. For each, write Matlab code that displays the reachable workspace for a given set of parameters. Show the shape of the reachable workspaces for the following parameter values: $l_1 = l_2 = 1$, $\delta = 0.2$, $d = 0.2$, $h = 0.5$ and $D = 0.75$.

RP robot: The range of motion of the prismatic link is $0 \leq q_2 \leq D$. The range of motion of the revolute joint is limited by interference between the first link and the ground and between the end effector and the ground.

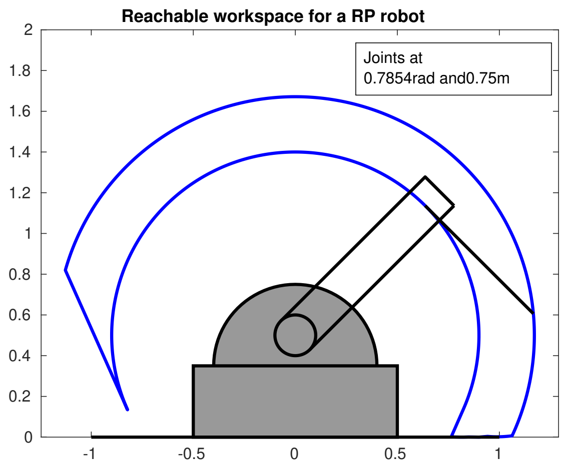

Figure 3: Reachable Workspace.

PR robot: The range of motion of the prismatic link is $0 \leq q_1 \leq D$. The range of motion of the revolute joint is limited only by intereference between the end effector and the ground

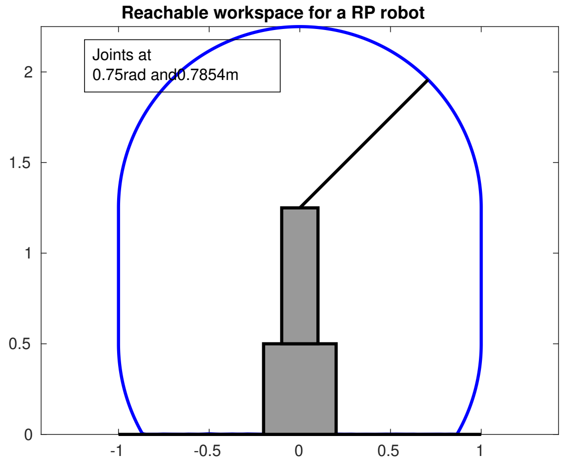

Figure 4: Reachable Workspace

3 Code Instruction

- Download the code (**MAINroboticsHW1.m**) attached in the email.
- Alternatively, the code is avaliable at `https://github.com/EriveltonGualter/MCE747-Robot-Dynamics-and-Control` after submission deadline.
- Run MAINroboticsHW1.m