TELE-OPERATED CONTROLLERS REACHABILITY SPACE FOR A GIVEN LINK'S LENGTH

DYAVA RAMA

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NOTE:

This is still undergoing to get more results and willing to write paper on this.
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Abstract

This work discusses modeling of reachability workspace two 6 DOF teleoperation controller robots. The first step of modeling a controller robot by its Denavit-Hartenberg parameters. It requires assigning proper coordinates for each link and finding their exact dimensions. In this work we will develop the direct kinematics and workspace representations for two controllers: Mantra surgical robot. The calculated workspace helps to surgeon to manipulation the controllers in certain workspace. After finding the D-H parameters and creating Transformation Matrices, MATLAB programming is used to represent their workspaces.

Introduction

The main idea of having teleoperated robots for industrial applications is to reduce human risk in dangerous environments, reduce the amount of physical/manual labor performed by employees, and to get the job done more efficiently. Teleoperated robots are easy to operate, cost effective and very useful. Teleoperated robots are usually smaller than typical robots in dimension, they have a very minimal footprint and utilitarian design. Industrial automation is just starting to make the most out of teleoperated robots recently, However, the world has been seeing teleoperated robots in action in the medical sector for quite some time now; needless to say, the military forces were the other first adopters in this field.
Teleoperated robots are designed to receive simple commands from a human operator and execute the command as instructed. Teleoperated robots are different from fully automated robots in a sense that they can be switched between autonomous and user operated at any time, reducing the workload on the human operator, while also giving the operator the option of making on the spot adjustments or complete a task on their own. Teleoperated robots give you the best of both worlds, automation and self reliance, as well as the ability for a user to instantly connect to the robot and control the

Capability space of controller

Calculation of controller's workspace is very important for surgeon to constraint his/her motions. The aim is to figure out the reachability of controller and this helps to enrich the controllers further.

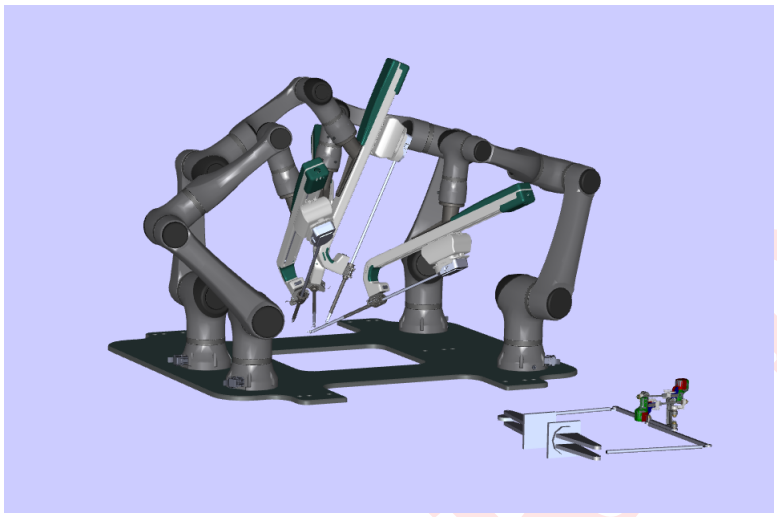

Figure 1: 3D model of tele-operated Mantra Surgical robot

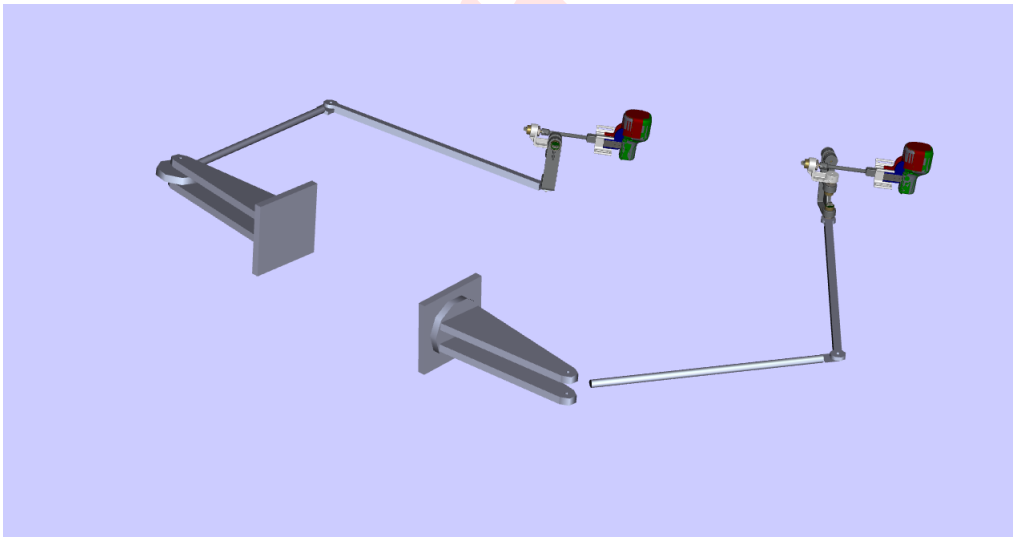

Figure 2: 3D model of Mantra Surgical robotic controller

Visualization of the Workspace

The below figure is given in XY plane, where Z-axis is the height of the controllers/manipulators base. X-axis is the distance towards the operator and Y-axis distance is the perpendicular distance from the operator.

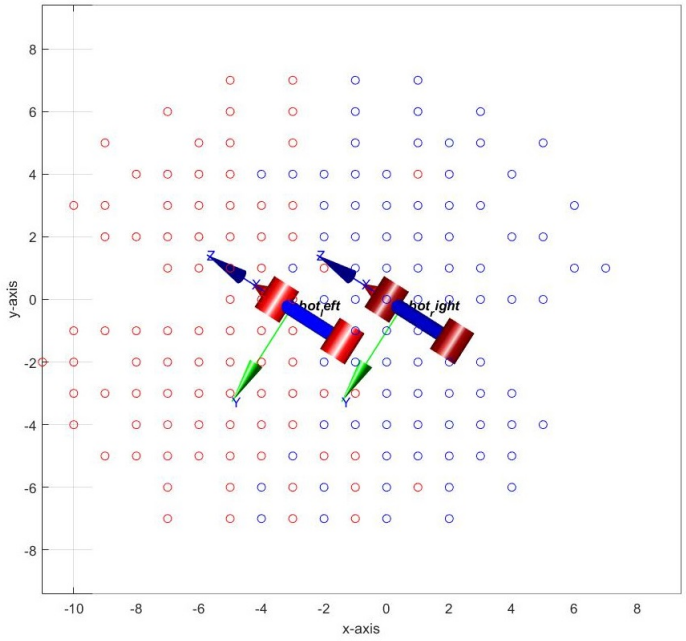

Figure 3: Simulation Results

The blue and red circle dots are represented the reachability points for the right and left controllers respectively.

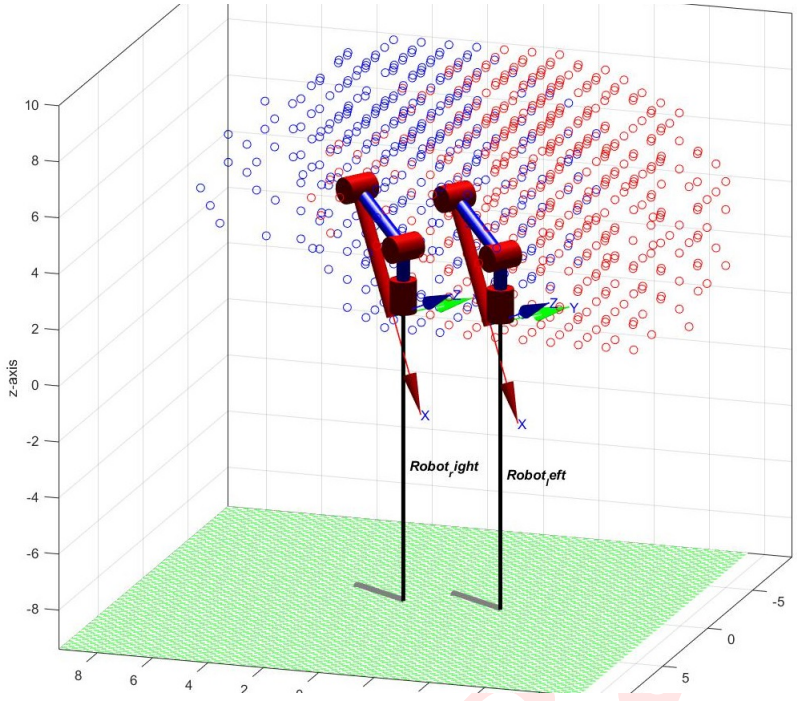

Figure 4: Back view of the assumed system

The assumed approximate base points for right and left respectively.

$$P_{right} = [0 \quad 0 \quad 1.5] \qquad P_{left} = [-3.5083 \quad 0 \quad 1.5]$$

The assumed system D-H parameters for our controller as following

$a1 = 0.001; \qquad alpha1 = pi/2; \qquad d1 = 1.71338;$

$a2 = 2.94; \qquad alpha2 = 0; \qquad d2 = 0;$

$a3 = L_3; \qquad alpha3 = -pi/2; \qquad d3 = 0.;$

To plot the workspace in square cuboid, we can also plot in different length. Here in the below figure $length(L) = 5$.

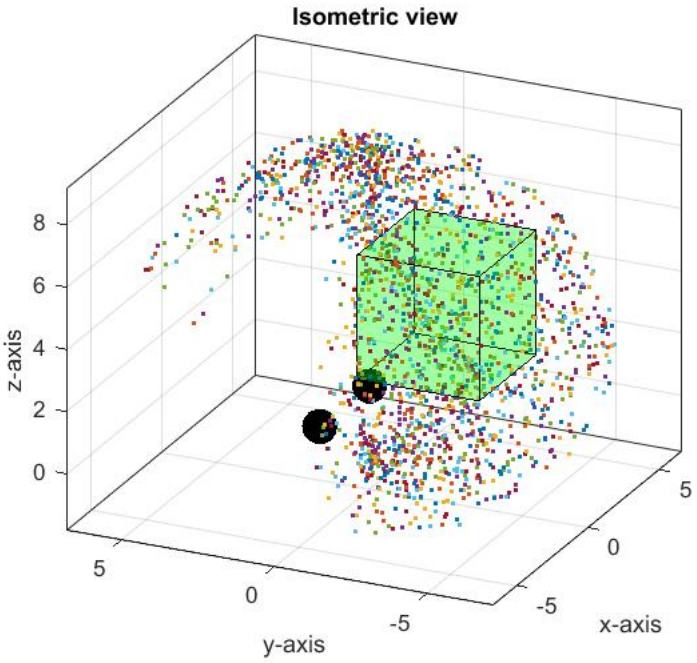

Figure 5: Simulation Results

To plot the workspace in rectangular cuboid, we can also plot in different length, width and height. Here in the below figure $length(L) = 5.1$, $width(w) = 3.5$ and $height(h) = 3.5$

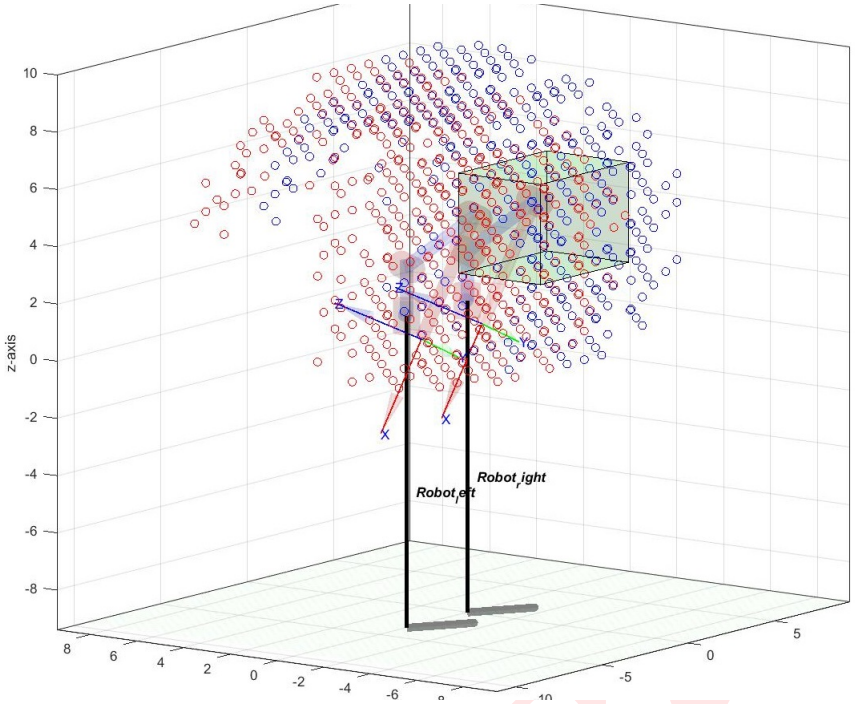

Figure 6: Simulation Results