NEW YORK UNIVERSITY TANDON SCHOOL OF ENGINEERING
Department of Mechanical and Aerospace Engineering

Foundations of Robotics (ROB-GY 6003)

Homework Assignment | Chapter 3

Homework Problems: 3.1, 3.4 (regard $\{S\}$ as $\{0\}$, and $\{T\}$ as $\{3\}$), 3.8, 3.12, 3.16, 3.17

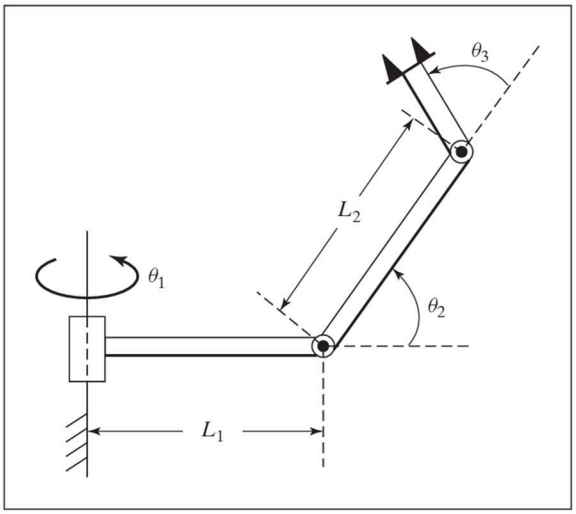


FIGURE 3.29: The $3R$ nonplanar arm (Exercise 3.3).

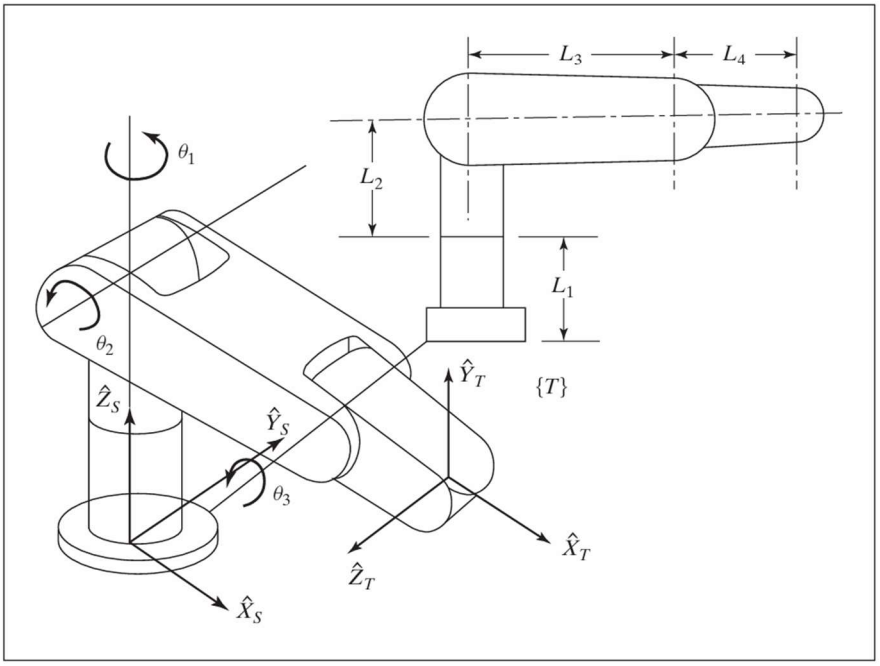
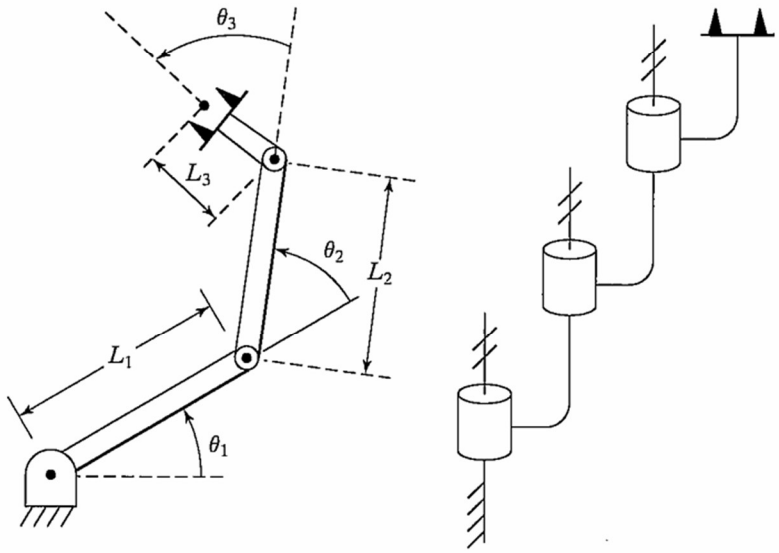


FIGURE 3.30: Two views of a $3R$ manipulator (Exercise 3.4).

EXAMPLE 3.3

Figure 3.6(a) shows a three-link planar arm. Because all three joints are revolute, this manipulator is sometimes called an ***RRR*** (or ***3R***) **mechanism**. Fig. 3.6(b) is a schematic representation of the same manipulator. Note the double hash marks



(a) (b)

3.1 [15] Compute the kinematics of the planar arm from Example 3.3.

3.4 [22] The arm with three degrees of freedom shown in Fig. 3.30 has joints 1 and 2 perpendicular, and joints 2 and 3 parallel. As pictured, all joints are at their zero location. Note that the positive sense of the joint angle is indicated. Assign link frames {0} through {3} for this arm—that is, sketch the arm, showing the attachment of the frames. Then derive the transformation matrices ${}^0_1T$, ${}^1_2T$, and ${}^2_3T$.

3.8 [13] In Fig. 3.31, the location of the tool, ${}^{W}_{T}T$, is not accurately known. Using force control, the robot feels around with the tool tip until it inserts it into the

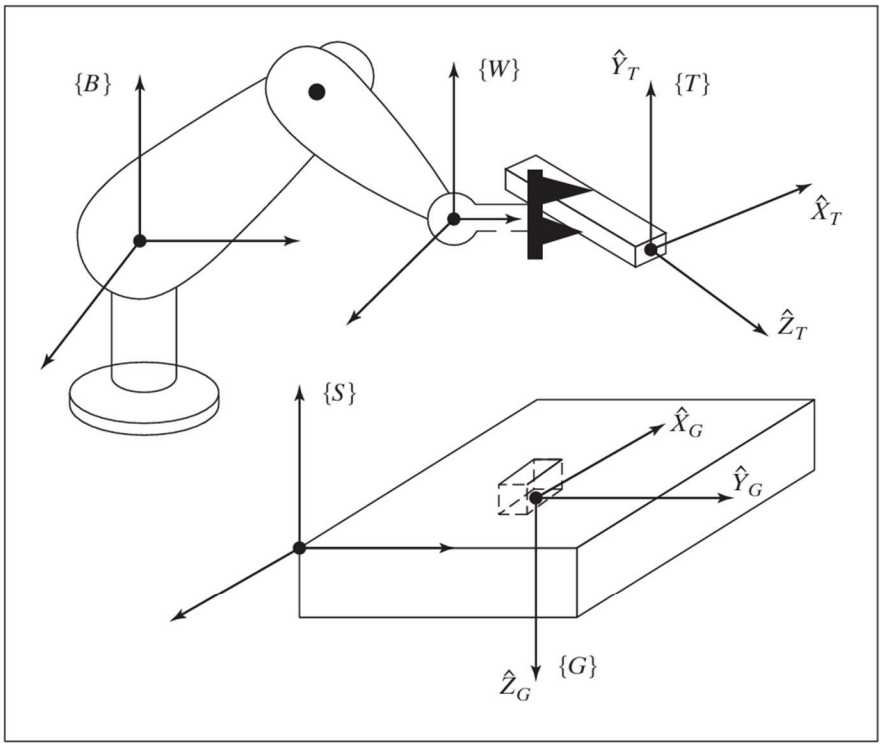


FIGURE 3.31: Determination of the tool frame (Exercise 3.8).

socket (or Goal) at location ${}^{S}_{G}T$. Once in this "calibration" configuration (in which $\{G\}$ and $\{T\}$ are coincident), the position of the robot, ${}^{B}_{W}T$, is figured out by reading the joint angle sensors and computing the kinematics. Assuming ${}^{B}_{S}T$ and ${}^{S}_{G}T$ are known, give the transform equation to compute the unknown tool frame, ${}^{W}_{T}T$.

3.12 [08] Can an arbitrary rigid-body transformation always be expressed with four parameters (a, α, d, θ) in the form of equation (3.6)?

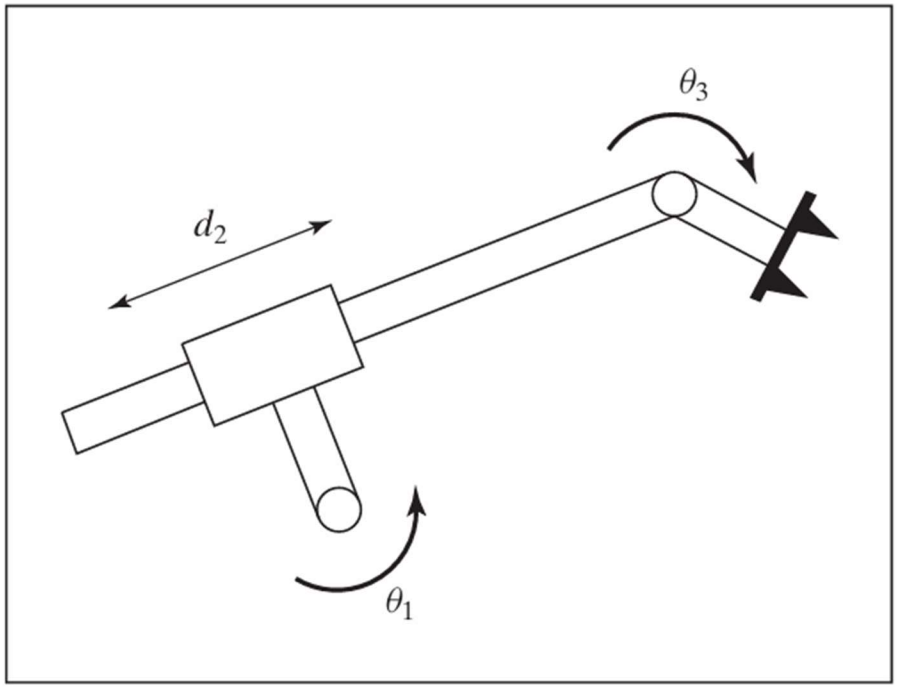


FIGURE 3.36: *RPR* planar robot (Exercise 3.16).

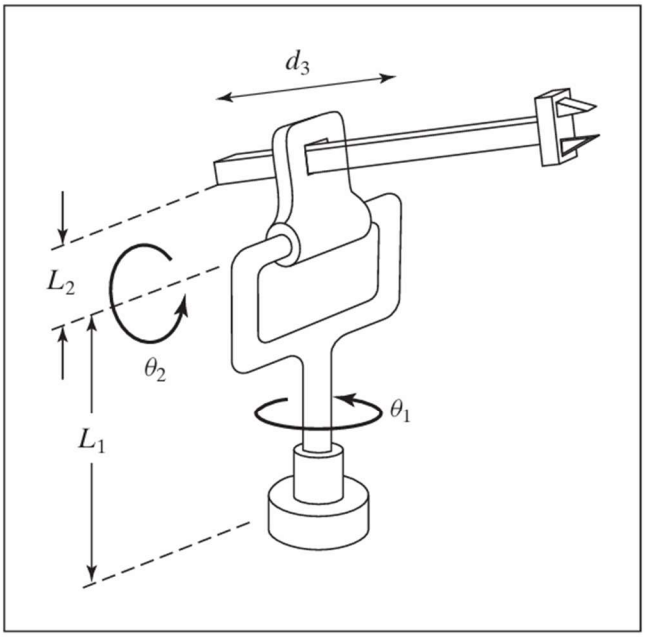


FIGURE 3.37: Three-link *RRP* manipulator (Exercise 3.17).

3.16 [15] Assign link frames to the RPR planar robot shown in Fig. 3.36, and give the linkage parameters.

3.17 [15] Show the attachment of link frames on the three-link robot shown in Fig. 3.37.