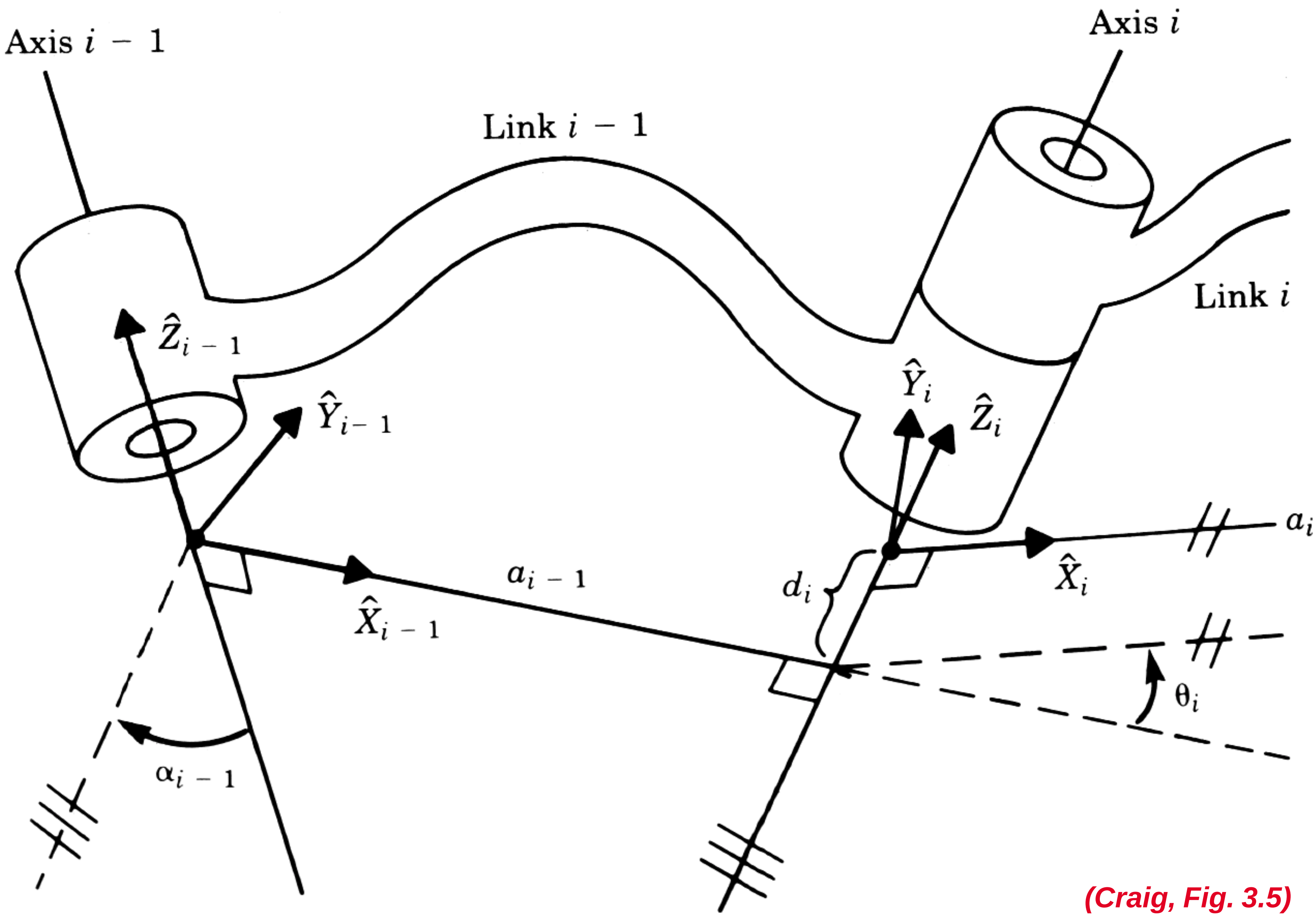
General coordinate frame assignments

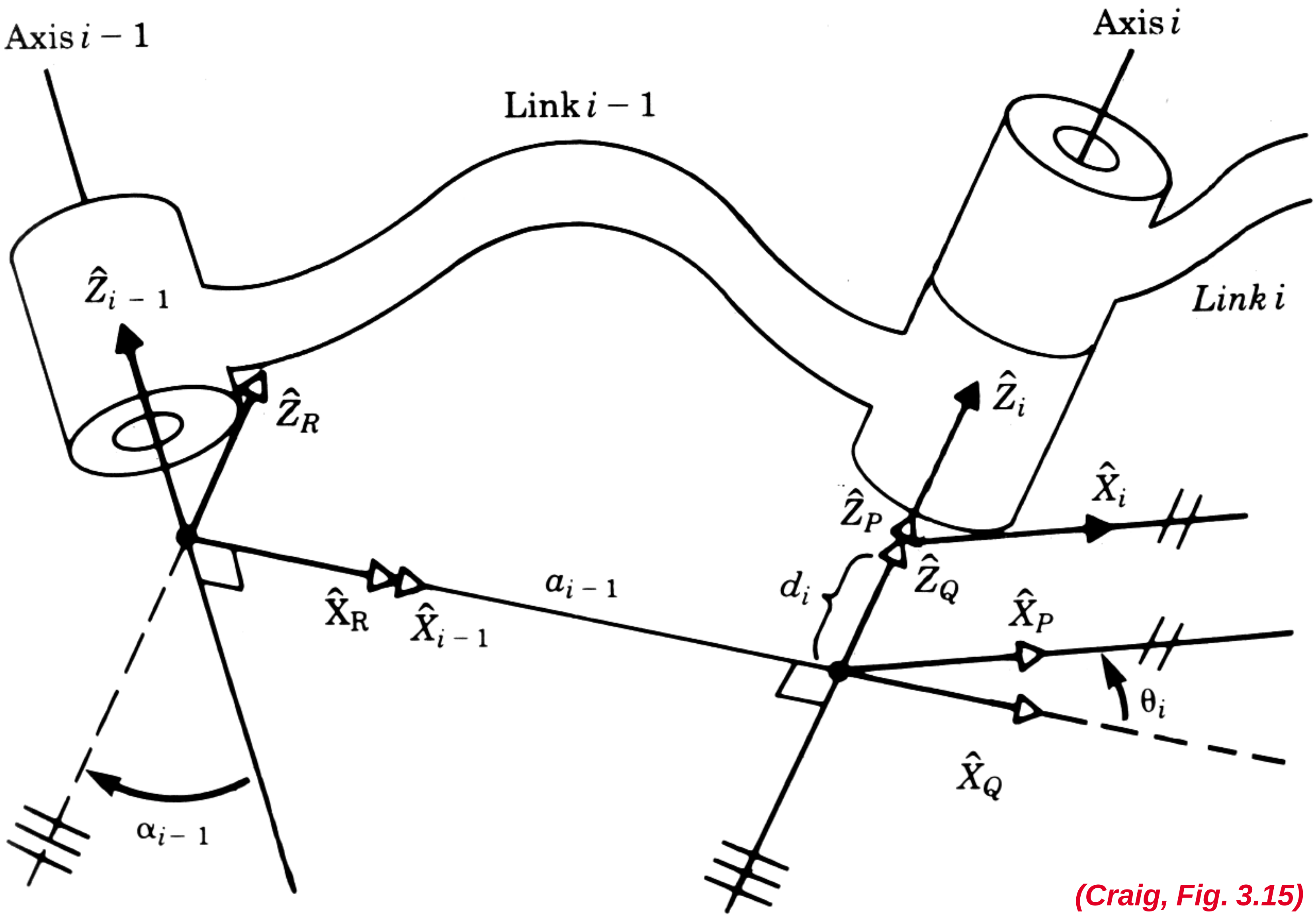


(Craig, Fig. 3.5)

a_i = the distance from Z_i to Z_{i+1} measured along X_i;
α_i = the angle between $\hat{Z}_i$ and $\hat{Z}_{i+1}$ measured about $\hat{X}_i$;
d_i = the distance from $\hat{X}_{i-1}$ to $\hat{X}_i$ measured along $\hat{Z}_i$; and
θ_i = the angle between $\hat{X}_{i-1}$ and $\hat{X}_i$ measured about $\hat{Z}_i$.

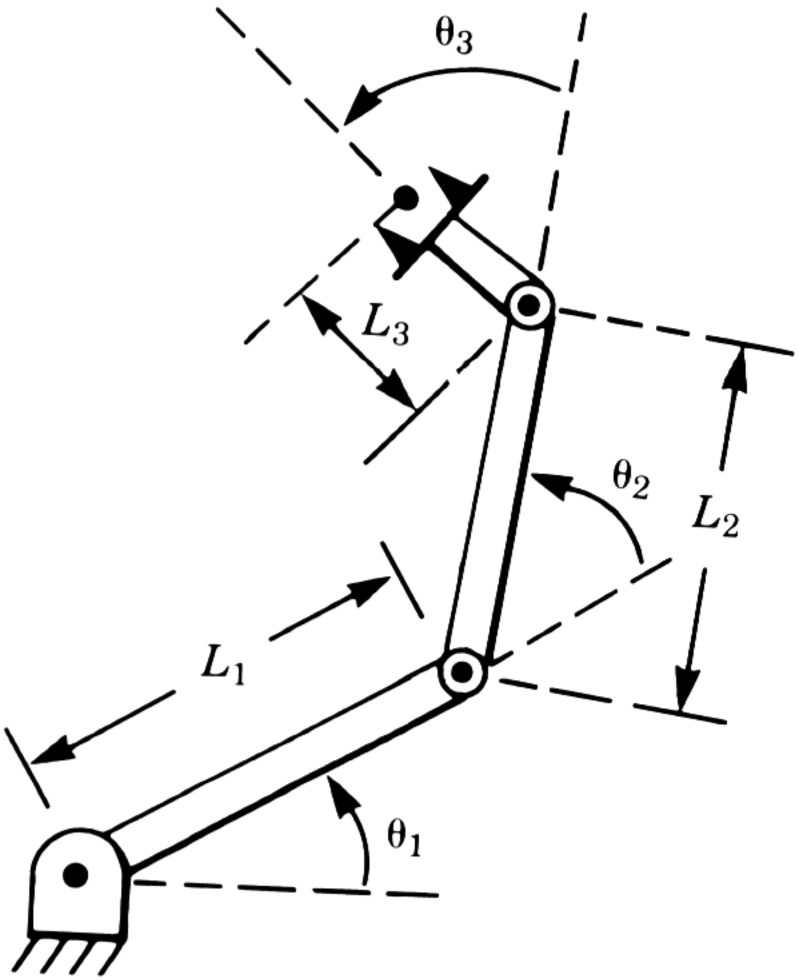
1. Identify the joint axes and imagine (or draw) infinite lines along them. For steps 2 through 5 below, consider two of these neighboring lines (at axes i and $i+1$).
2. Identify the common perpendicular between them, or point of intersection. At the point of intersection, or at the point where the common perpendicular meets the ith axis, assign the link frame origin.
3. Assign the $\hat{Z}_i$ axis pointing along the ith joint axis.
4. Assign the $\hat{X}_i$ axis pointing along the common perpendicular, or if the axes intersect, assign $\hat{X}_i$ to be normal to the plane containing the two axes.
5. Assign the $\hat{Y}_i$ axis to complete a right-hand coordinate system.
6. Assign $\{0\}$ to match $\{1\}$ when the first joint variable is zero. For $\{N\}$ choose an origin location and $\hat{X}_N$ direction freely, but generally so as to cause as many linkage parameters as possible to become zero.

Derivation of homogeneous transform

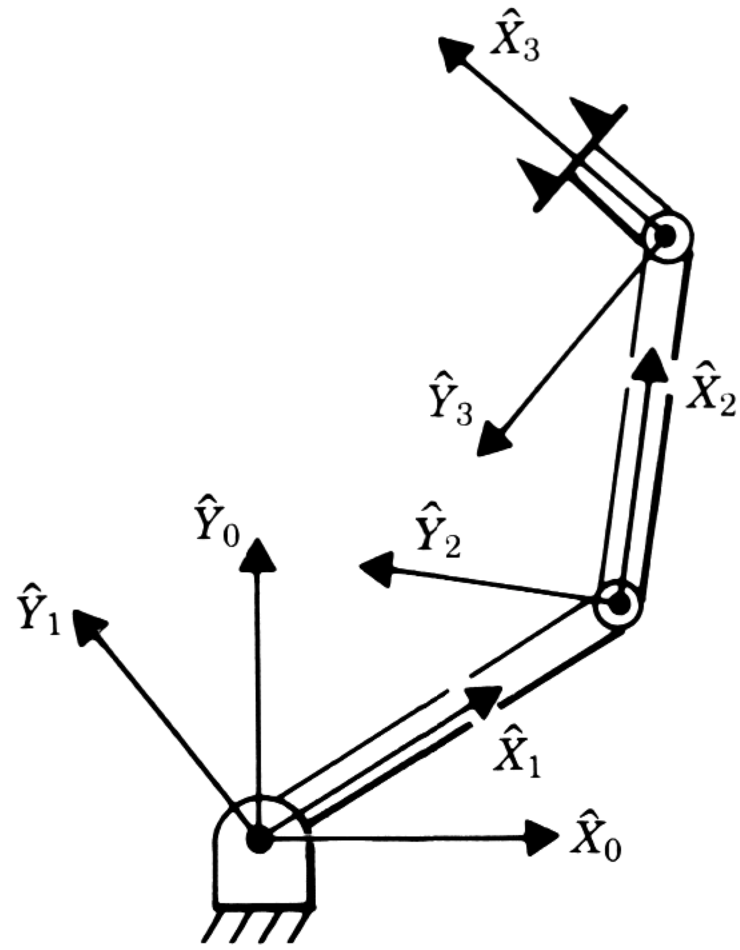


(Craig, Fig. 3.15)

Planar manipulator



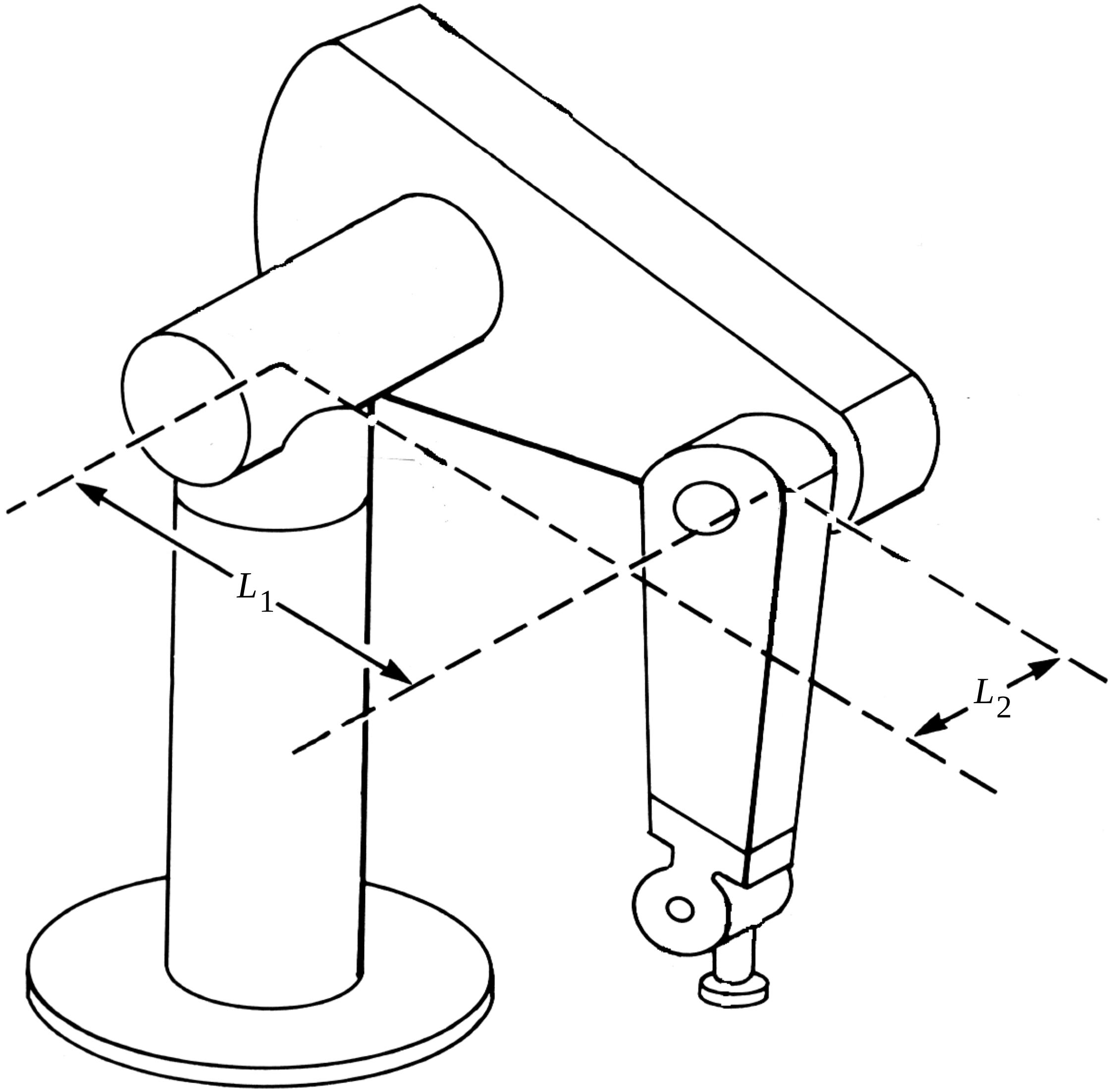
(Craig, Fig. 3.6)



(Craig, Fig. 3.7)

PUMA 560 Robot

PUMA 560 Robot



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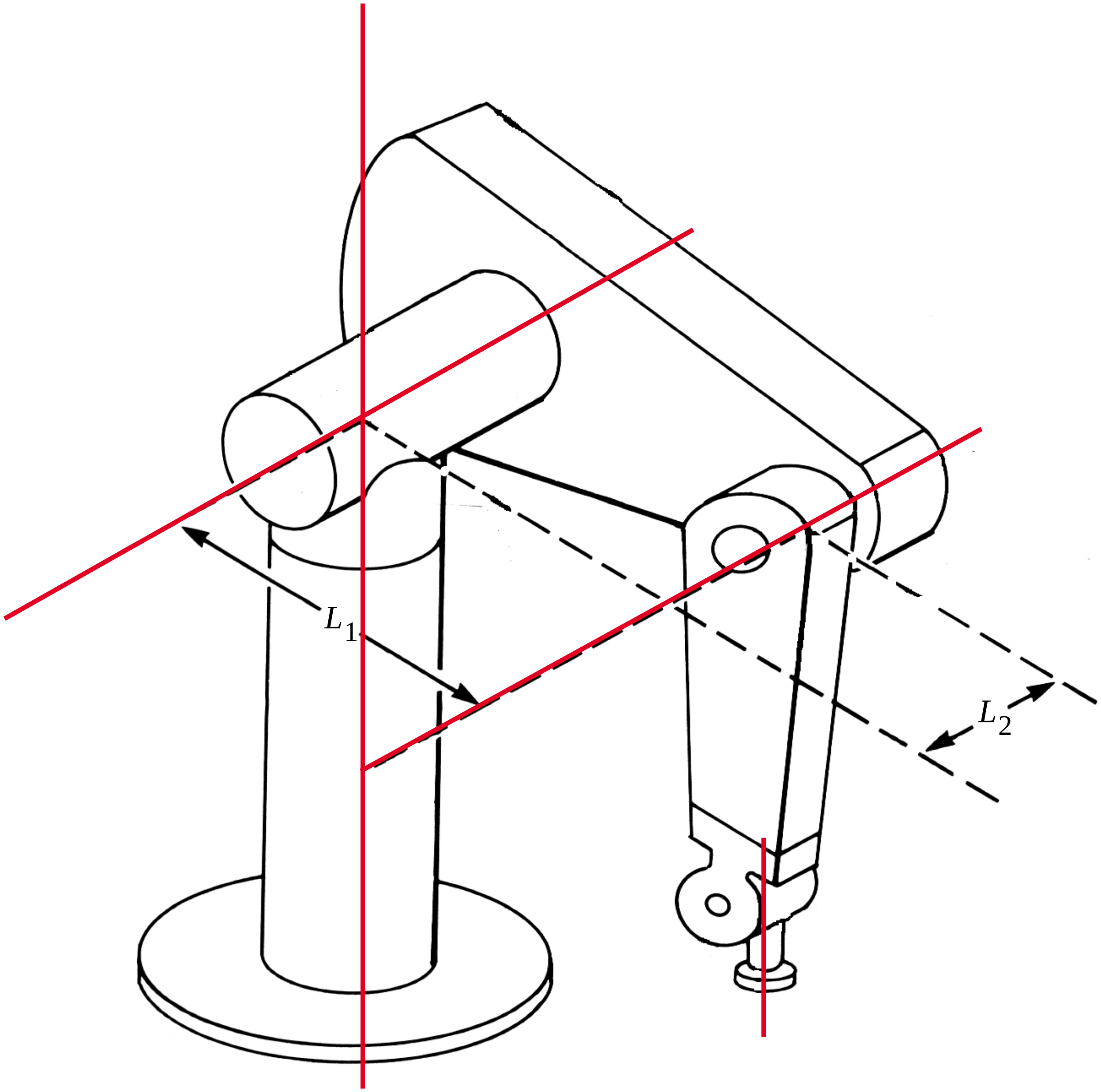

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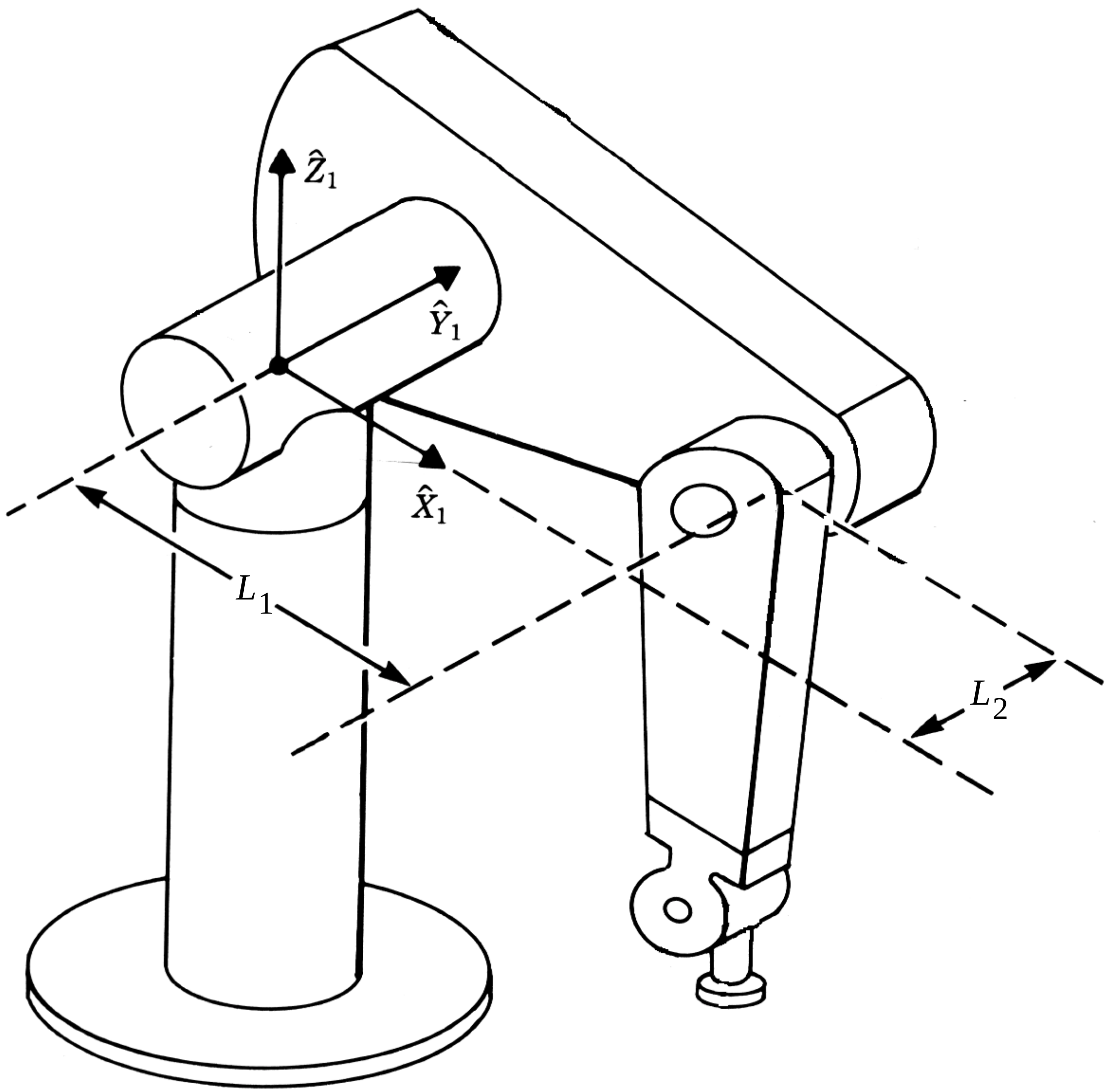

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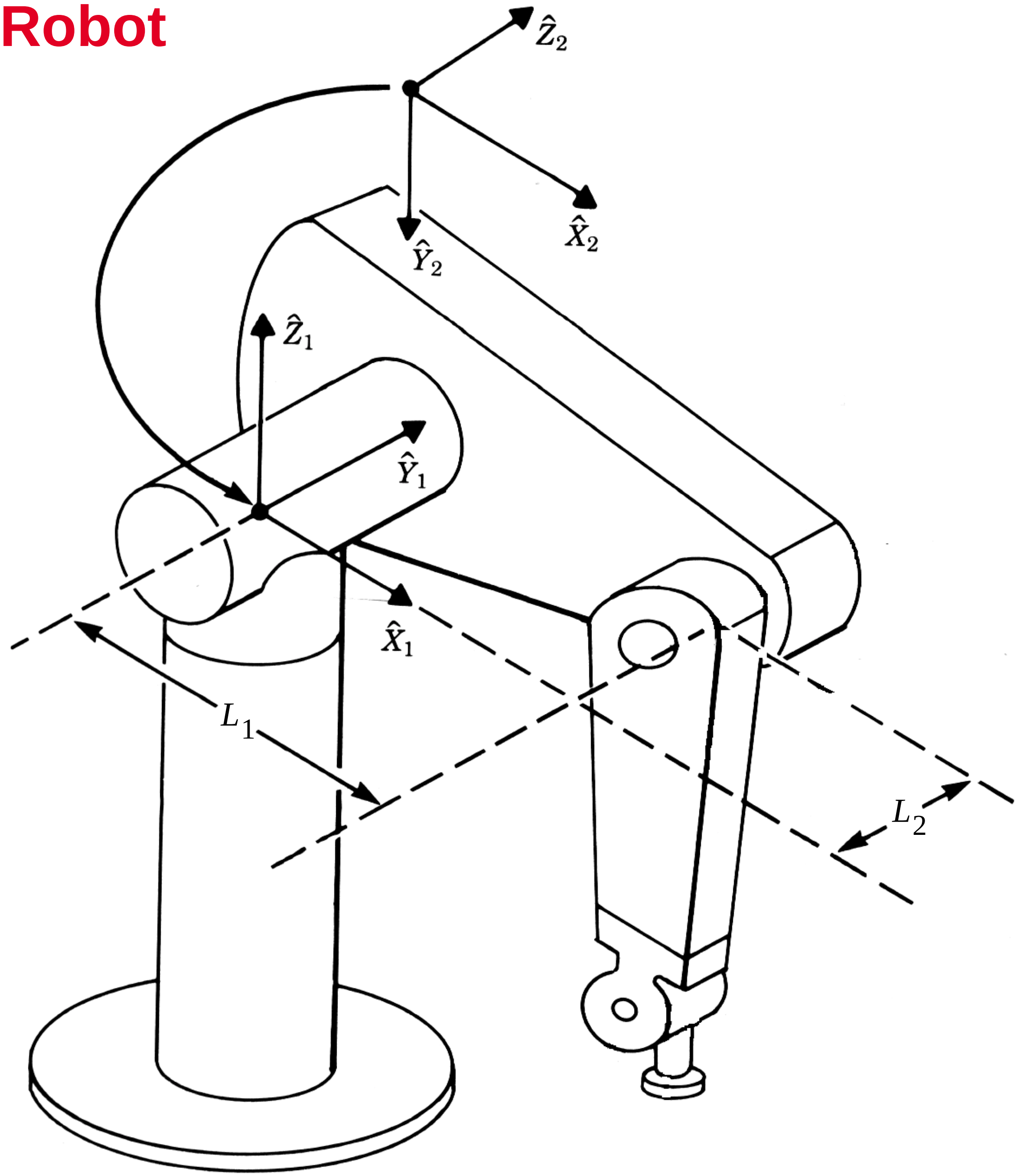

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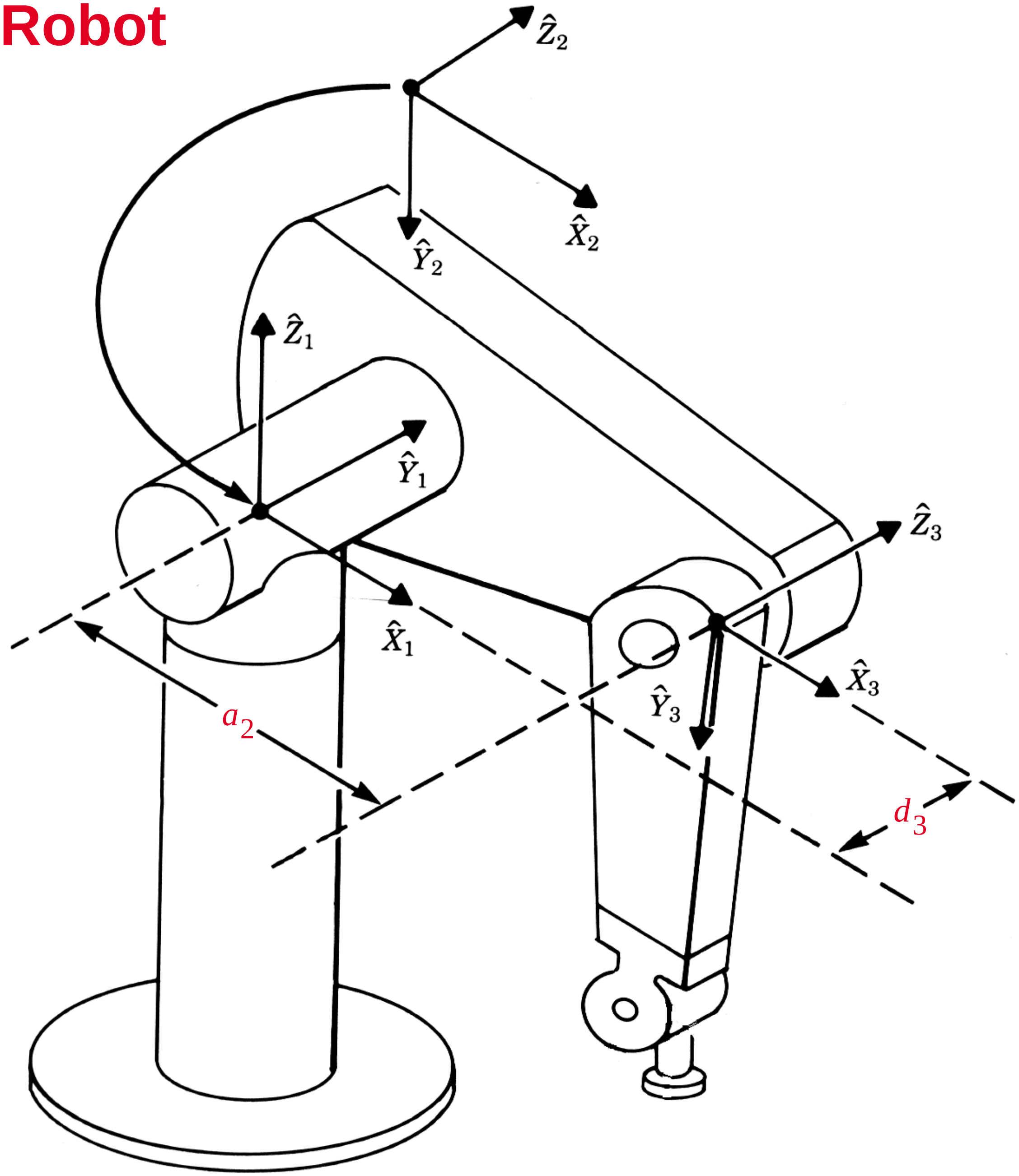

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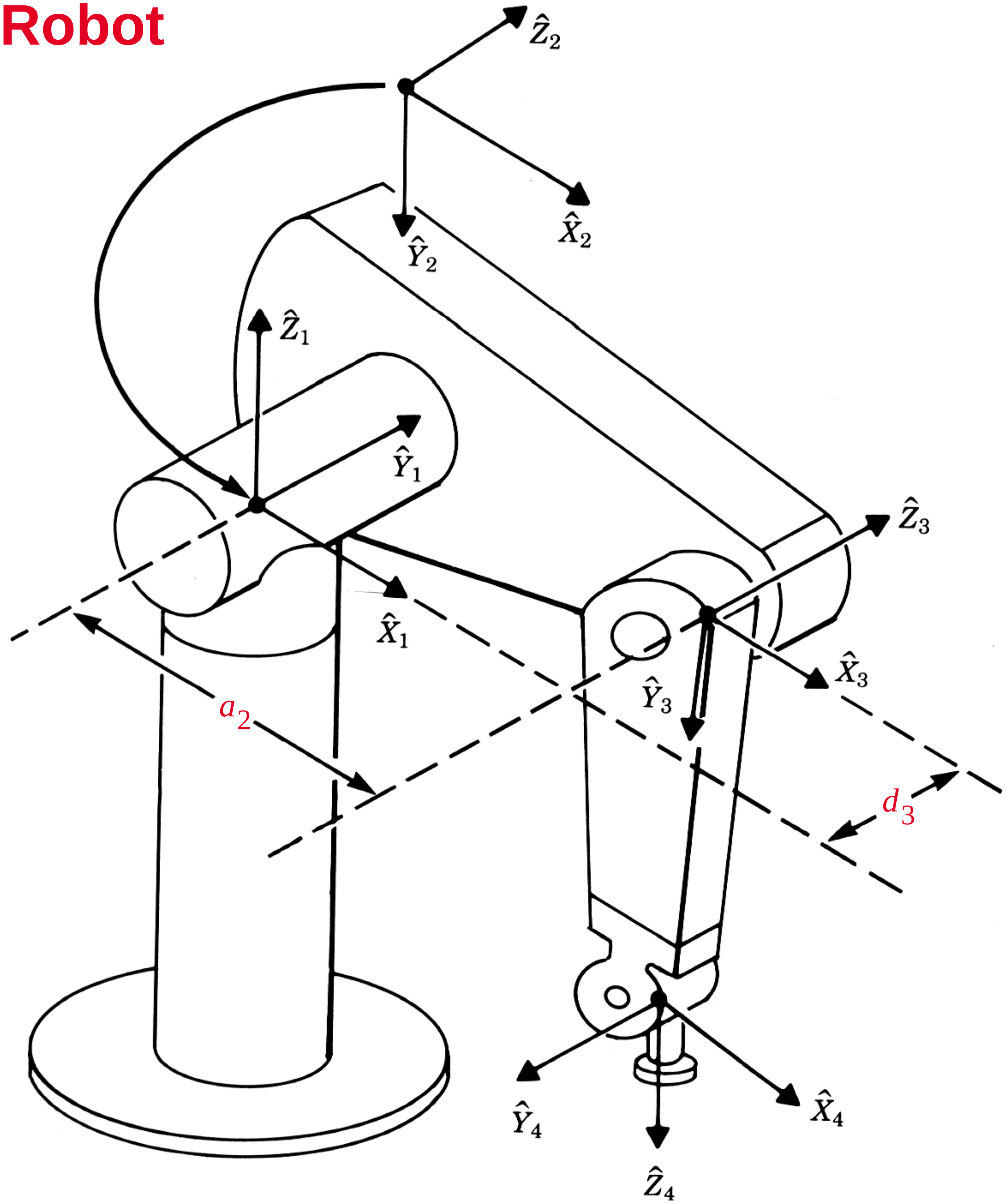
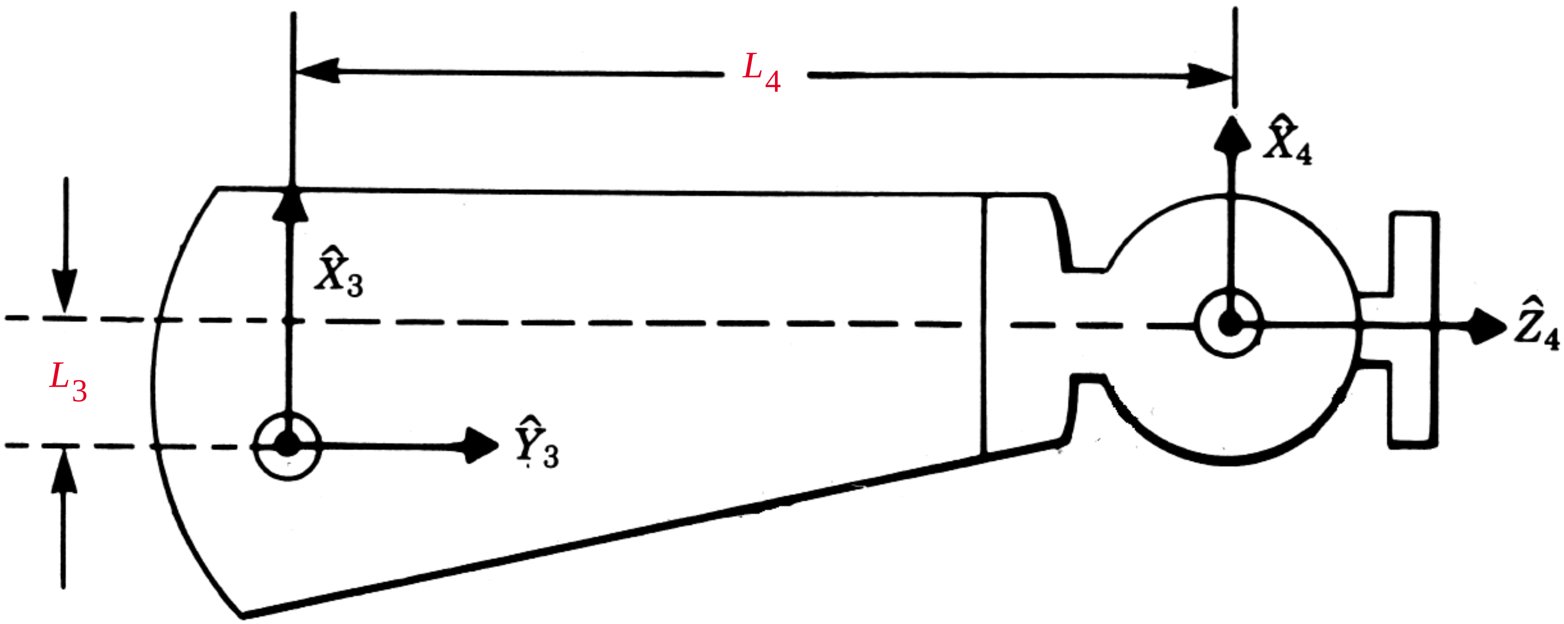
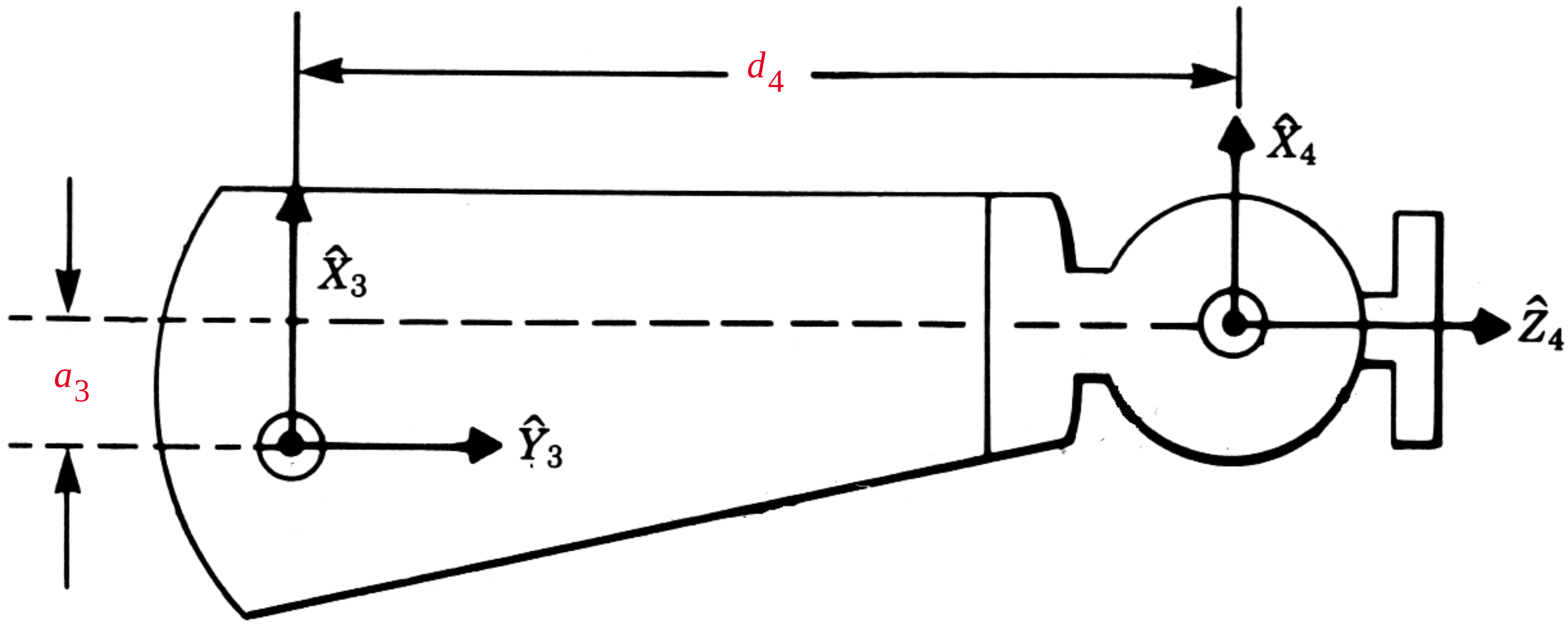


(Craig, Fig. 3.19)

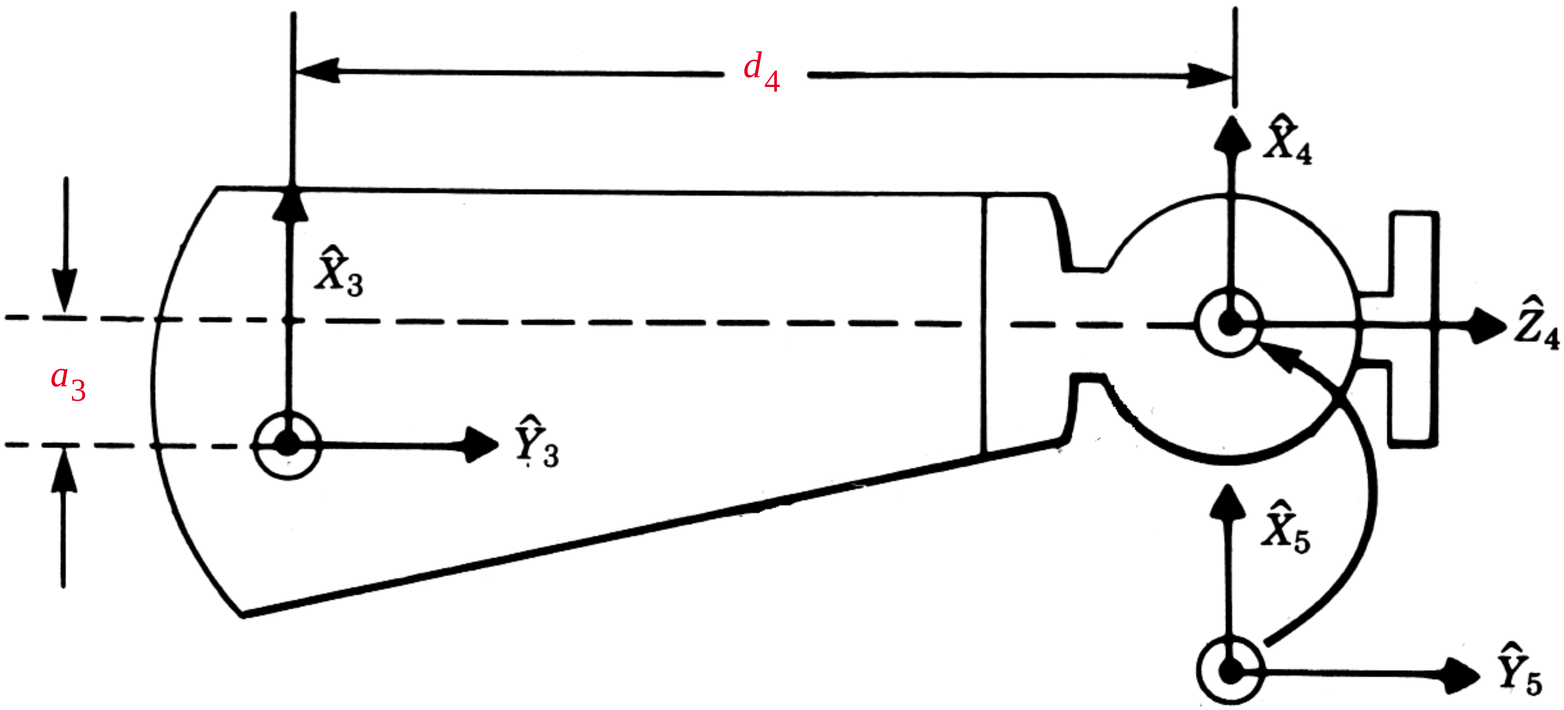
PUMA 560 Robot: Last three joints



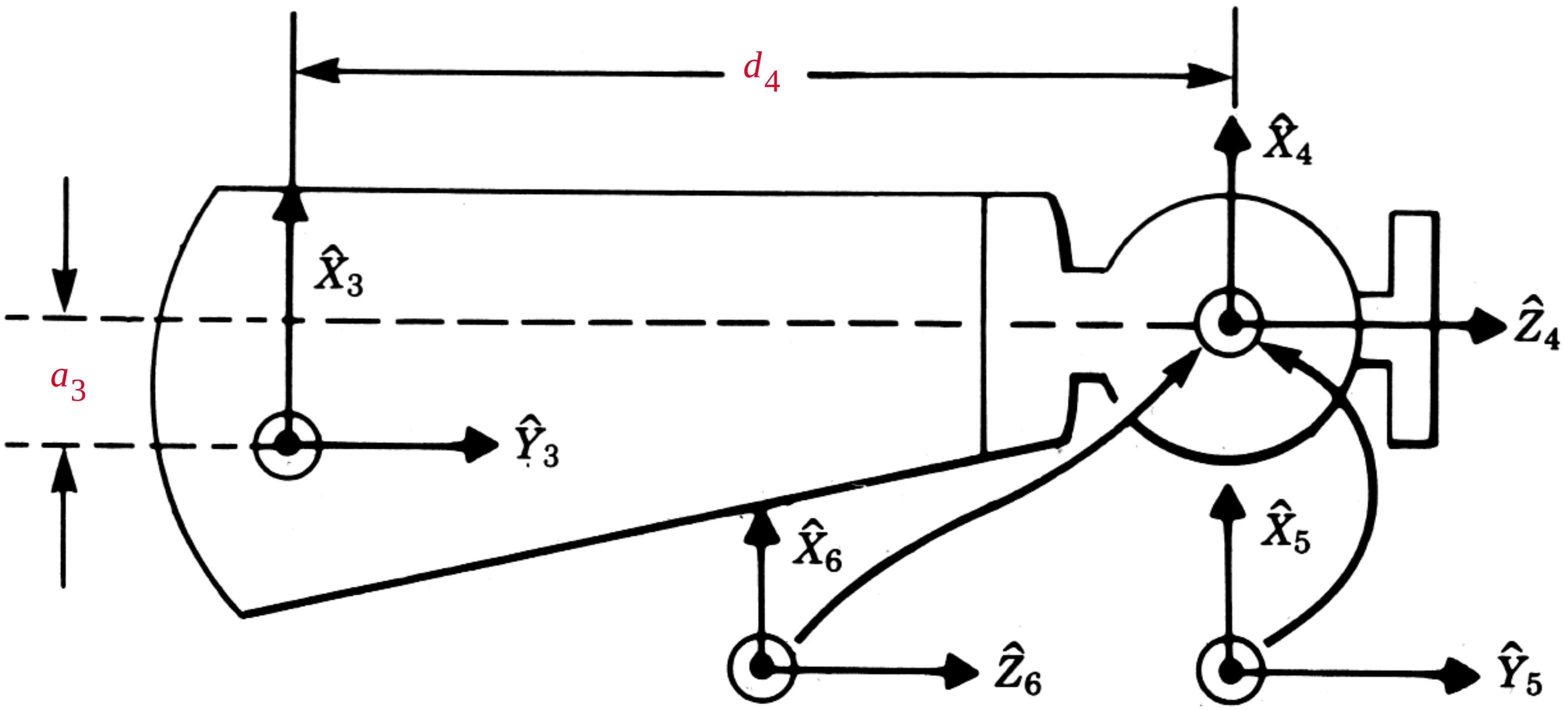
PUMA 560 Robot: Last three joints



PUMA 560 Robot: Last three joints



PUMA 560 Robot: Last three joints



(Craig, Fig. 3.20)