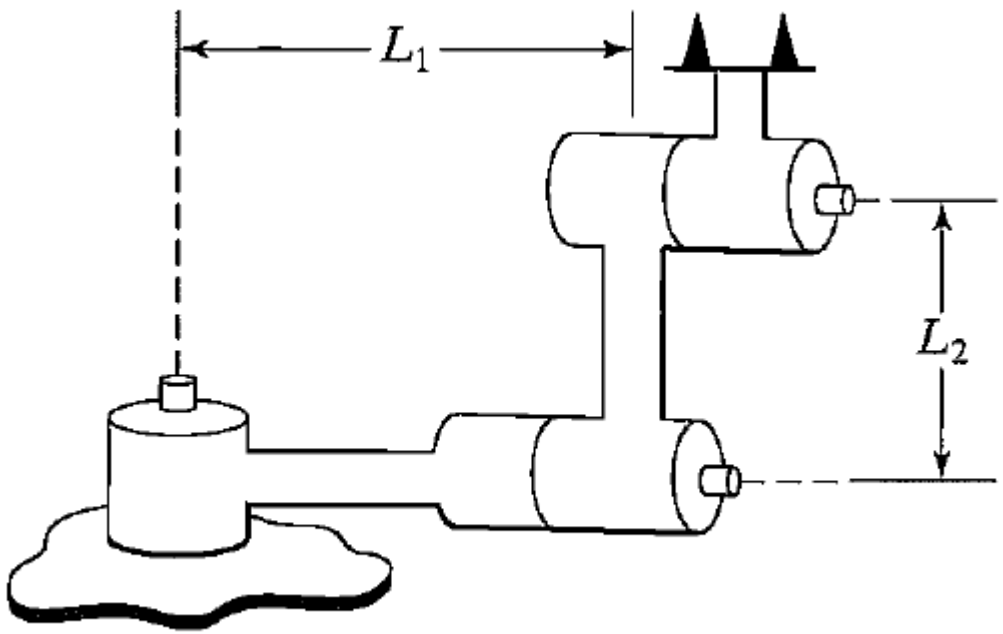
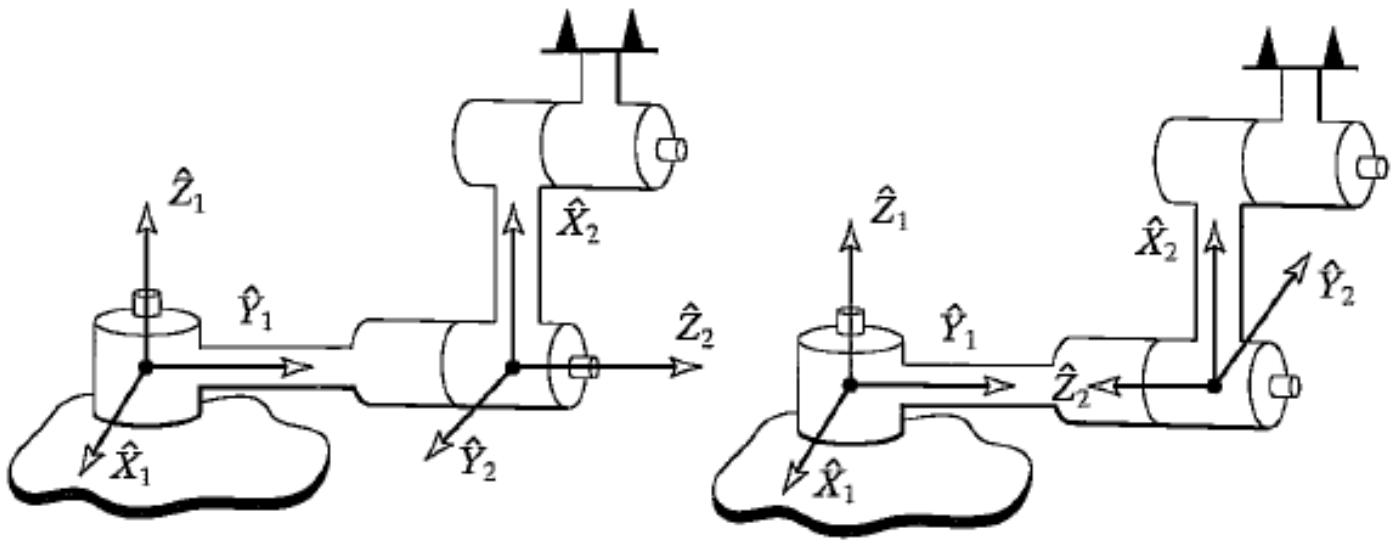

L_1
L_2

$a_i = the\ distance\ from\ \hat{Z}_i\ to\ \hat{Z}_{i+1}\ measured\ along\ \hat{X}_i;$

$\alpha_i = the\ angle\ from\ \hat{Z}_i\ to\ \hat{Z}_{i+1}\ measured\ about\ \hat{X}_i;$

$d_i = the\ distance\ from\ \hat{X}_{i-1}\ to\ \hat{X}_i\ measured\ along\ \hat{Z}_i;$ and

$\theta_i = the\ angle\ from\ \hat{X}_{i-1}\ to\ \hat{X}_i\ measured\ about\ \hat{Z}_i.$



$a_1 = 0$ $a_2 = L_2$

$\alpha_1 = -90°$ $\alpha_2 = 0$ $\theta_2 = -90°$

$d_1 = 0$ $d_2 = L_1$

$a_1 = 0$ $a_2 = L_2$

$\alpha_1 = 90°$ $\alpha_2 = 0$ $\theta_2 = 90°$

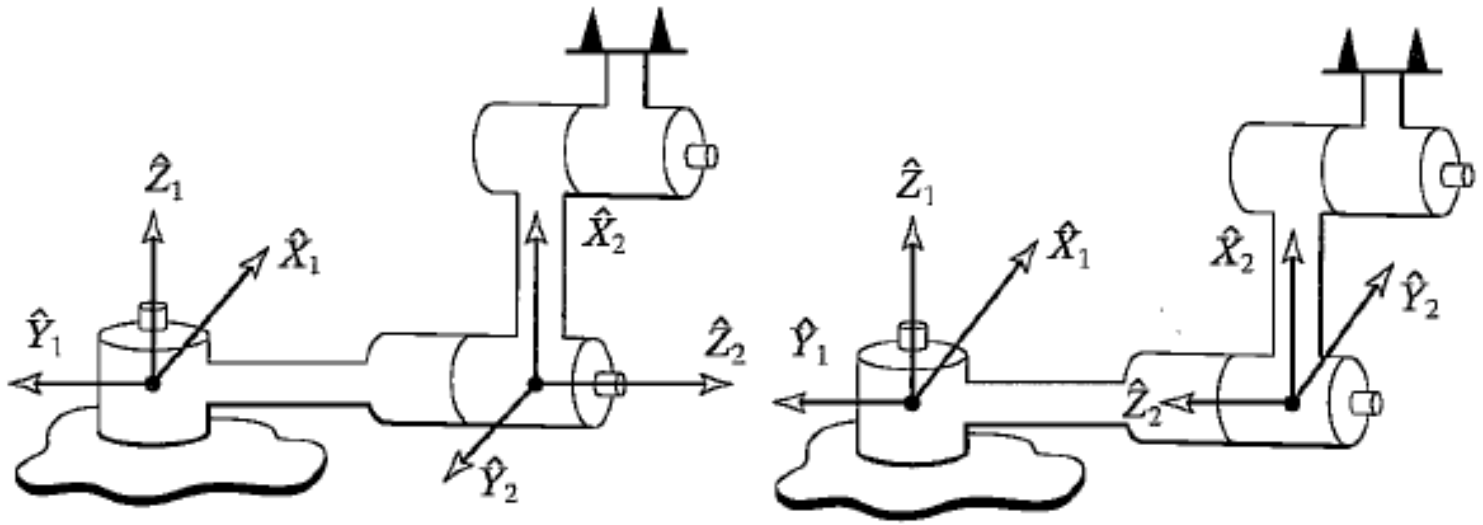
$d_1 = 0$ $d_2 = -L_1$

$a_i = the\ distance\ from\ \hat{Z}_i\ to\ \hat{Z}_{i+1}\ measured\ along\ \hat{X}_i;$

$\alpha_i = the\ angle\ from\ \hat{Z}_i\ to\ \hat{Z}_{i+1}\ measured\ about\ \hat{X}_i;$

$d_i = the\ distance\ from\ \hat{X}_{i-1}\ to\ \hat{X}_i\ measured\ along\ \hat{Z}_i;$ and

$\theta_i = the\ angle\ from\ \hat{X}_{i-1}\ to\ \hat{X}_i\ measured\ about\ \hat{Z}_i.$



$a_1 = 0$ $a_2 = L_2$

$\alpha_1 = 90°$ $\alpha_2 = 0$ $\theta_2 = 90°$

$d_1 = 0$ $d_2 = L_1$

$a_1 = 0$ $a_2 = L_2$

$\alpha_1 = -90°$ $\alpha_2 = 0$ $\theta_2 = -90°$

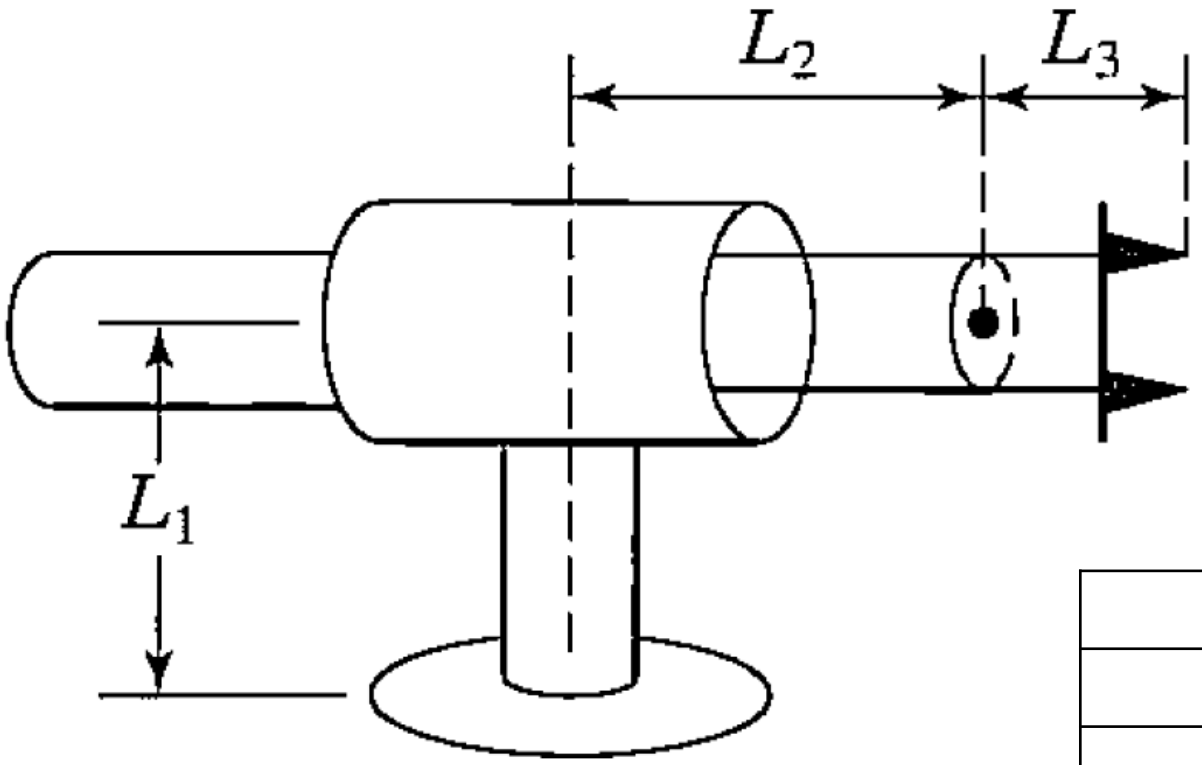
$d_1 = 0$ $d_2 = -L_1$

$a_{i-1} =$ *The distance from* $\hat{Z}_{i-1}$ *to* $\hat{Z}_i$ *measured along* $\hat{X}_{i-1}$;

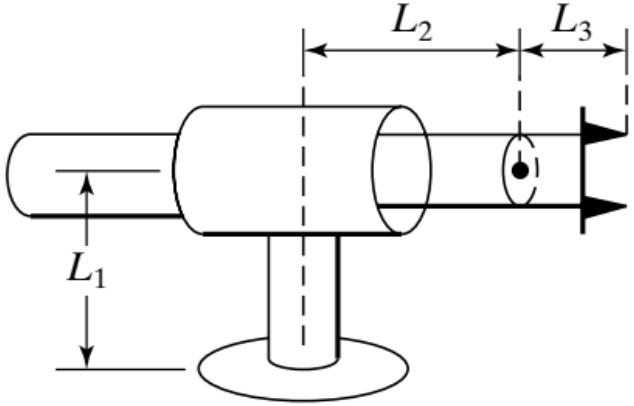
$\alpha_{i-1} =$ *The angle from* $\hat{Z}_{i-1}$ *to* $\hat{Z}_i$ *measured along* $\hat{X}_{i-1}$;

$d_i =$ *The distance from* $\hat{X}_{i-1}$ *to* X_i *measured along* $\hat{Z}_i$;

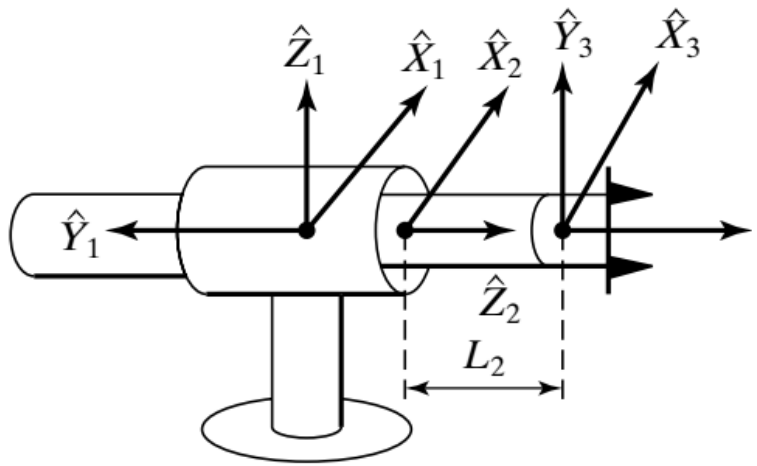
$\theta_i =$ *The angle from* $\hat{X}_{i-1}$ *to* X_i *measured along* $\hat{Z}_i$;



i	$\propto_{i-1}$	a_{i-1}	d_i	θ_i
1	0	0	L1	$\theta 1$
2	90	0	D2	0
3	0	0	L2	$\theta 3$
4	0	0	L3	0



(a)



(b)

i	α_{i-1}	a_{i-1}	d_i	θ_i
1	0	0	0	θ_1
2	90°	0	d_2	0
3	0	0	L_2	θ_3

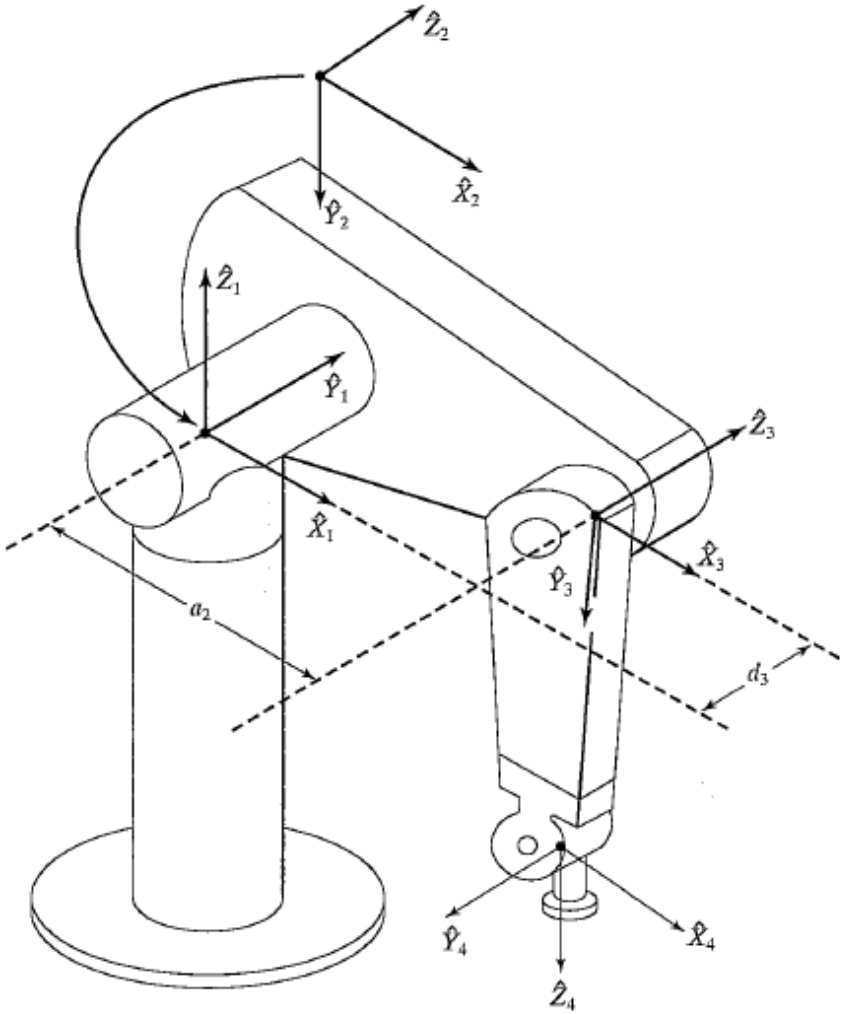
a_{i-1} = The distance from $\hat{Z}_{i-1}$ to $\hat{Z}_i$ measured along $\hat{X}_{i-1}$;

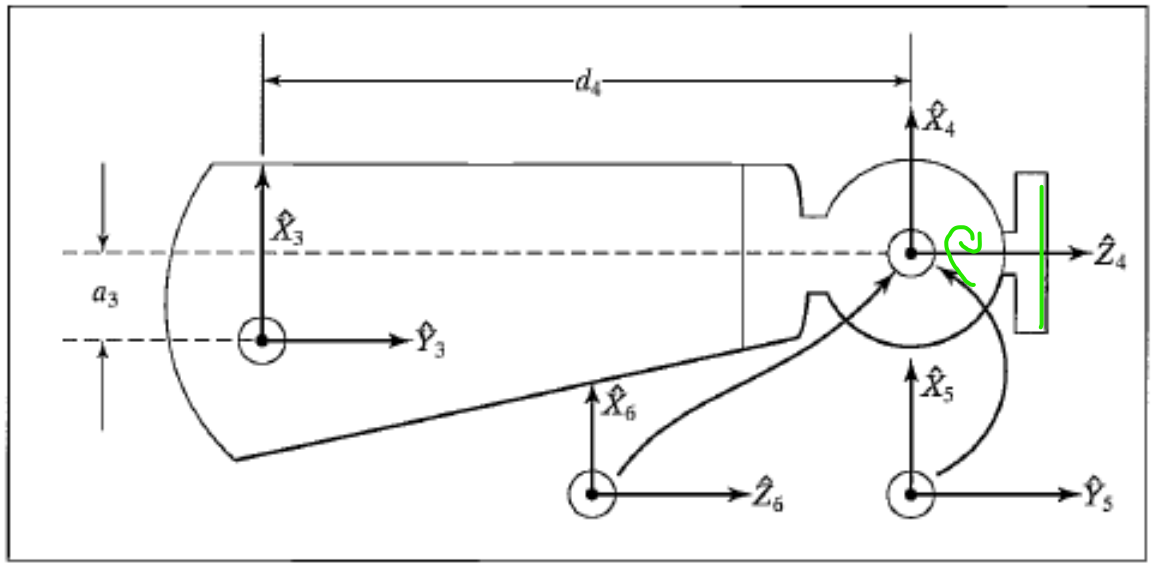
α_{i-1} = The angle from $\hat{Z}_{i-1}$ to $\hat{Z}_i$ measured along $\hat{X}_{i-1}$;

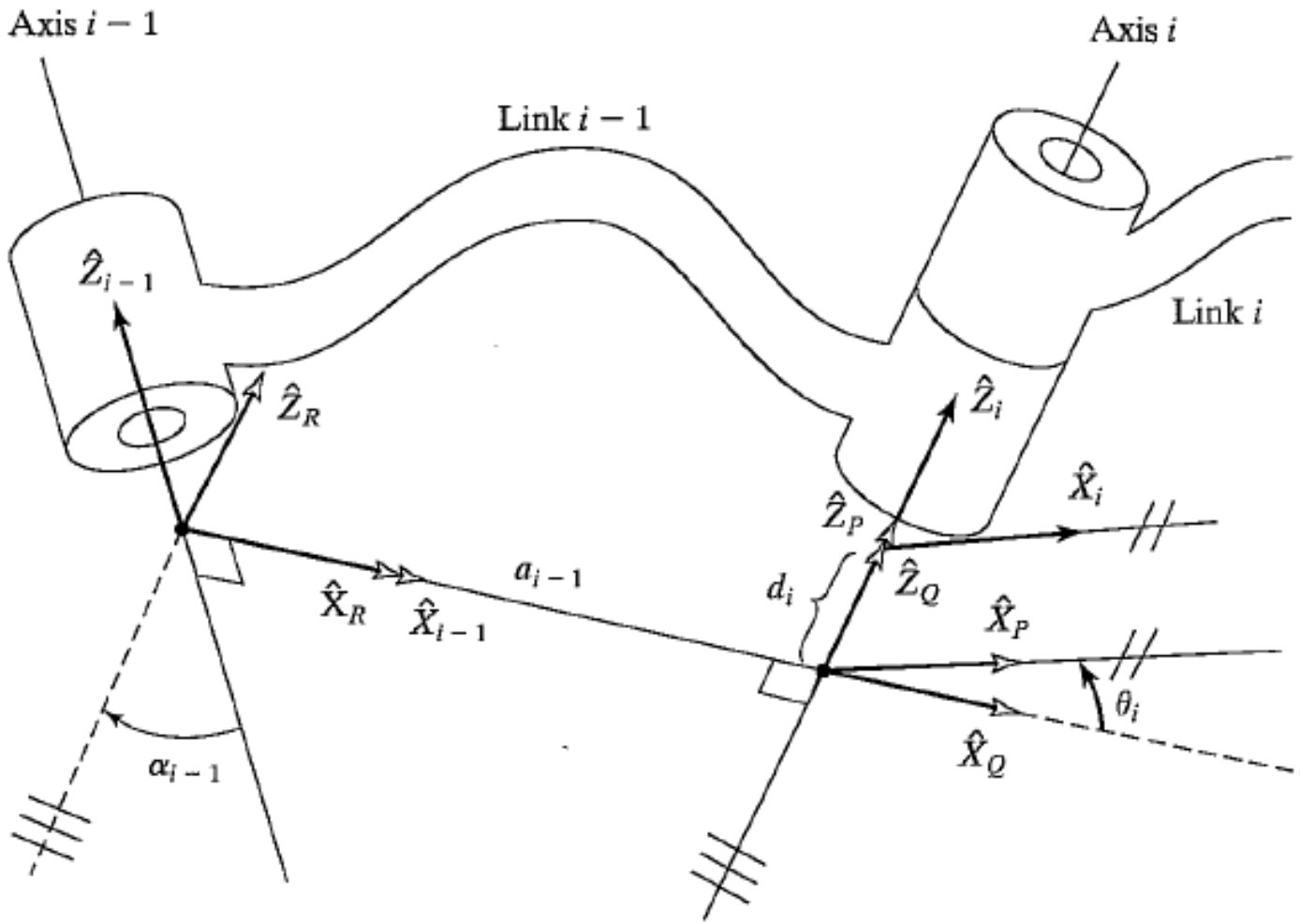
d_i = The distance from $\hat{X}_{i-1}$ to X_i measured along $\hat{Z}_i$;

θ_i = The angle from $\hat{X}_{i-1}$ to X_i measured along $\hat{Z}_i$;

i	$\alpha_i - 1$	$a_i - 1$	d_i	θi
1	0	0	0	θ_1
2	-90	0	0	θ_2
3	0	a_2	d_3	θ_3
4	-90	a_3	d_4	θ_4
5	90	0	0	θ_5
6	-90	0	0	θ_6






Axis $i-1$
Axis i
Link $i-1$
Link i
$\hat{Z}_{i-1}$
$\hat{Z}_R$
$\hat{Z}_i$
$\hat{Z}_P$
$\hat{Z}_Q$
$\hat{X}_i$
$\hat{X}_R$
$\hat{X}_{i-1}$
$\hat{X}_P$
$\hat{X}_Q$
a_{i-1}
d_i
θ_i
α_{i-1}

Transformation Matrix:

Link Twist

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & C\alpha_{i-1} & -S\alpha_{i-1} & 0 \\ 0 & S\alpha_{i-1} & C\alpha_{i-1} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Link Length

$$\begin{bmatrix} 1 & 0 & 0 & a_{i-1} \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

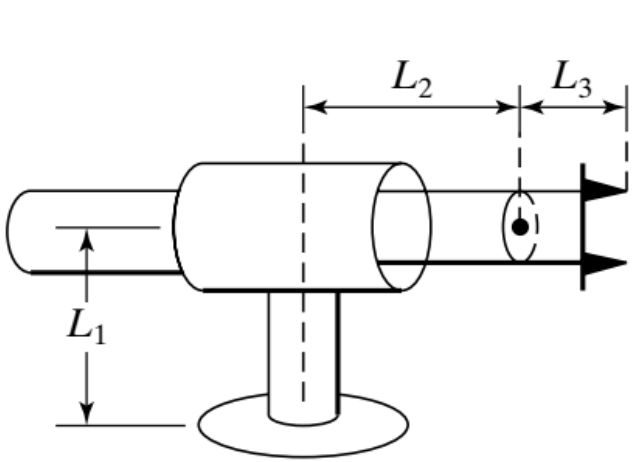
Joint Angle

$$\begin{bmatrix} C\theta_i & -S\theta_i & 0 & 0 \\ S\theta_i & C\theta_i & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

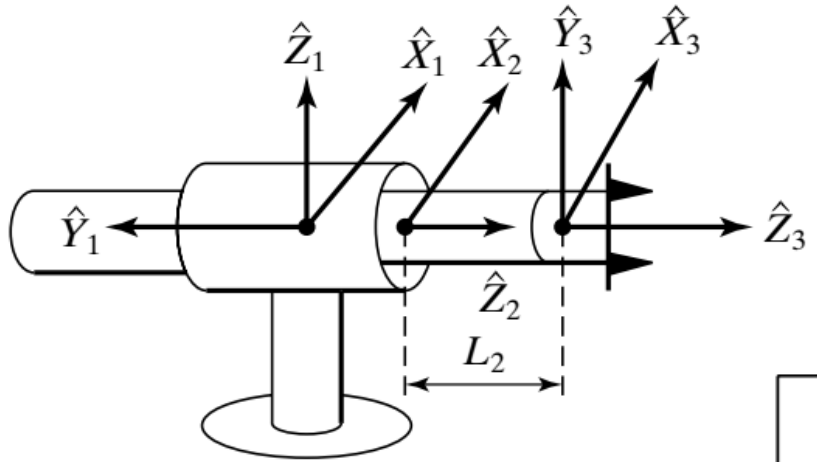
Joint Offset

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & d_i \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$ {}^{i-1}_{i}T = \begin{bmatrix} c\theta_i & -s\theta_i & 0 & a_{i-1} \\ s\theta_i c\alpha_{i-1} & c\theta_i c\alpha_{i-1} & -s\alpha_{i-1} & -s\alpha_{i-1} d_i \\ s\theta_i s\alpha_{i-1} & c\theta_i s\alpha_{i-1} & c\alpha_{i-1} & c\alpha_{i-1} d_i \\ 0 & 0 & 0 & 1 \end{bmatrix}. $$



(a)



(b)

$$
{}^{i-1}_{i}T = \begin{bmatrix} c\theta_i & -s\theta_i & 0 & a_{i-1} \\ s\theta_i c\alpha_{i-1} & c\theta_i c\alpha_{i-1} & -s\alpha_{i-1} & -s\alpha_{i-1} d_i \\ s\theta_i s\alpha_{i-1} & c\theta_i s\alpha_{i-1} & c\alpha_{i-1} & c\alpha_{i-1} d_i \\ 0 & 0 & 0 & 1 \end{bmatrix}.
$$

i	α_{i-1}	a_{i-1}	d_i	θ_i
1	0	0	0	θ_1
2	90°	0	d_2	0
3	0	0	L_2	θ_3