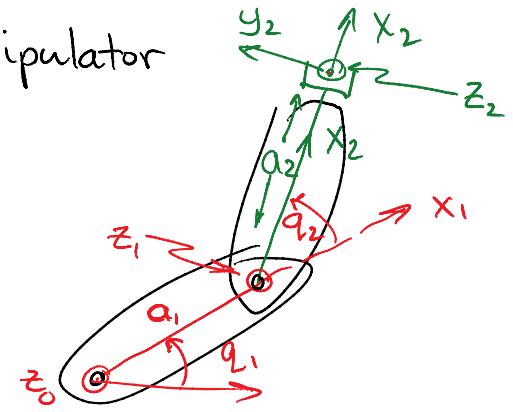
Tuesday, June 12, 2012
3:09 PM

$$^0T_N(q) = {}^0A_1(q_1)\,{}^1A_2(q_2)\cdots{}^{N-1}A_N(q_N) = \prod_{i=1}^{N} {}^{i-1}A_i(q_i)$$

$$^0T_N(q) \in SE(n), \quad n=\{2,3\}$$

Planar example: 2R Planar manipulator



DH param assignment:

- jnt 1 axis $\Rightarrow z_0$
- jnt 2 axis $\Rightarrow z_1$
- $z_1 \parallel z_2 \Rightarrow \alpha_1 = 0$
- common normal between z_0 & z_1 $\Rightarrow a_1 \neq 0$
- Choose some reference direction in Link 2

Link	θ_i	d_i	a_i	α_i	σ_i
1	q_1	0	a_1	0	0
2	q_2	0	a_2	0	0

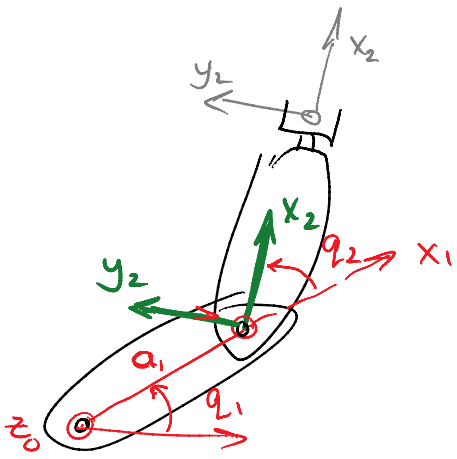
Our choices:

- Origins of {0} & {1} in same plane $\Rightarrow d_1 = 0$
- Choose reference direction for x_2 toward pt. of interest

  (Note: I chose {2} $\ni$ it was a DH tform from {1})
- Choose {2} $\ni$ $d_2 = 0 = \alpha_2$, $a_2 \neq 0$.

Suppose I choose $a_2 = 0$?

Then the origin of {2} moves to coincide with the origin of {1}.

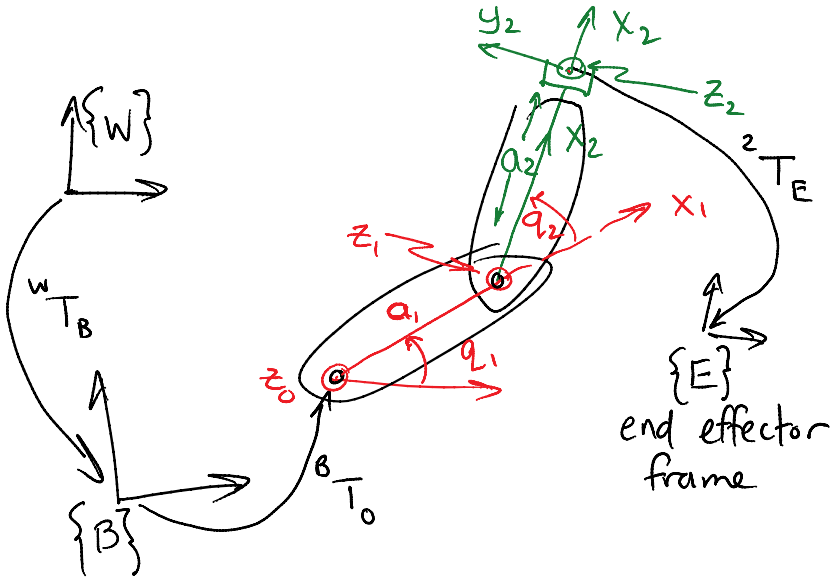


Link	θ_i	d_i	a_i	α_i	σ_i
1	q_1	0	a_1	0	0
2	q_2	0	0	0	0

It would still be convenient to define a frame in the gripper.

A Few Other Useful Frames

- The world frame {W} is fixed.
- Perhaps define a base from {B}
  ${}^{W}T_{B} \neq$ constant
- Choose ${}^{B}T_{0}$ as is convenient.



$${}^{W}T_{T} = {}^{W}T_{B}\,{}^{B}T_{0}\,{}^{0}A_{1}(q_1)\,{}^{1}A_{2}(q_2)\,{}^{2}T_{E}$$

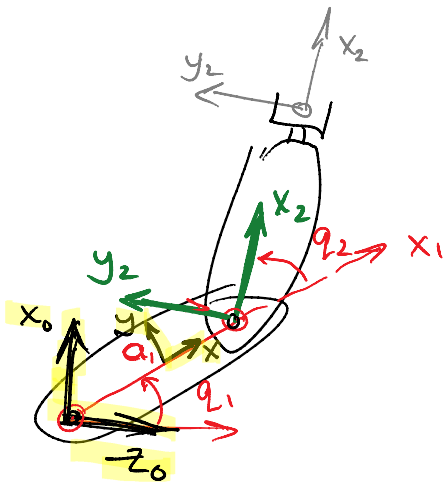
$^{I}T = {}^{I}T_B \; {}^{B}T_0 \; A_1(q_1) \; A_2(q_2) \; {}^{2}T_E$

is convenient.

- ${}^{0}T_B$ is usually constant.
- Choose ${}^{2}T_E$ for convenience
  ${}^{2}T_E$ is usually constant.

Suppose you wanted to label the axes differently, so DH conventions are not satisfied.

Then just design the t'forms you want. For example...



$$R_y(q_1)\, T_z(a_1/2)\, R_y(-\pi/2)\, R_x(-\pi/2)\, T_x(a_1/2)\, R_z(q_2) \cdots$$

Planar example on page 141-142.

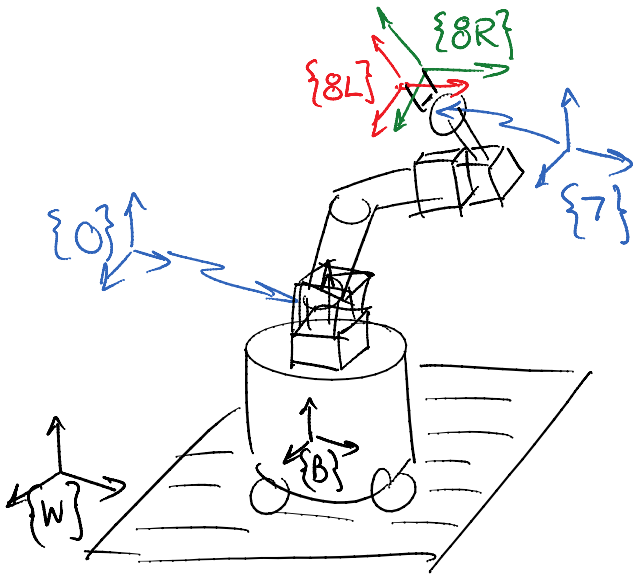
Puma 560 example on pages 143-146.

Define D-H parameters for a 3D robot.

Consider the modular Schunk Arm on a mobile base.

Kinematic Characteristics

- Mobile Base
- 7 revolute joints
- 1 prismatic joint
  (the gripper joint)



Determine the full forward kinematic model from the World frame to the fingertips.

${}^{W}T_{B}(x,y,\theta)$ — position & orientation of the robot's base.

${}^{B}_{\ }T_{0}$ — constant t'form from {B} to {0}

{0} — the base frame of the arm.

{7} — the final frame of the arm

{8L}, {8R} — the frames at the finger tips

DH frame assignment procedure:

Identify $z_0, z_1, \cdots z_7, z_{8L}, z_{8R}$

Identify joint types: prismatic or revolute

Construct $x_0, x_1, \cdots, x_{8L}, x_{8R}$ from $x_{j+1} = z_j \times z_{j+1}$

Determine DH parameters.

Other frame assignment methods

- Exponential map