Modelling a robot arm

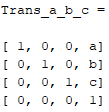
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1. ***Kinematic model of a robot***

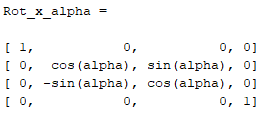
Robots have 2 types of joints : a) Translational

b) Rotational

Translational moves can be described as



Rotational moves around some axis can be describe as



Kinematic analysis of a robot includes two aspects:

1. Forward kinematic (FK)
2. Inverse kinematic (IK)
   1. ***Forward kinematics***

Given: geometry parameters of the links and variables of the joints

Find: the location and pose of end-effector in a given reference frame

The relationship can be derived using Denavit – Hartenberg convention

The joint diagram is shown in Figure 1

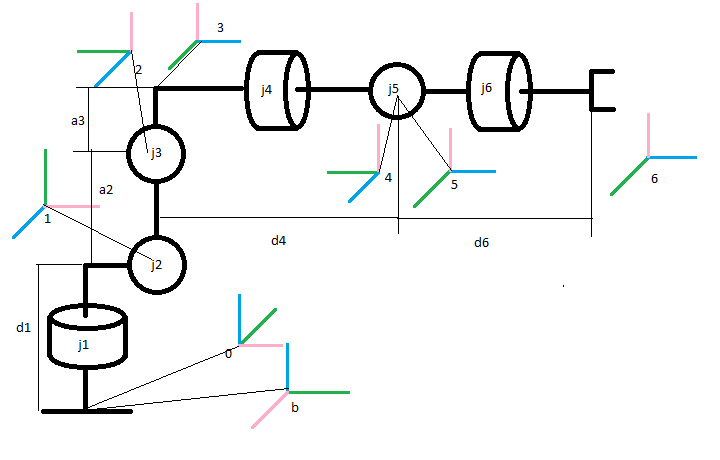


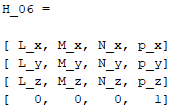
Figure 1. Joint diagram

DH parameters are given in Table 1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| i | Theta | d | a | alpha | Theta\_min | Theta\_max |
| 1 | q1 | d1 | a1 | 90 | -170 | 170 |
| 2 | q2 | 0 | a2 | 0 | -190 | 45 |
| 3 | q3 – 90 | 0 | a3 | 90 | -120 | 156 |
| 4 | q4 | d4 | 0 | -90 | -185 | 185 |
| 5 | q5 | 0 | 0 | 90 | -120 | 120 |
| 6 | q6 | d6 | 0 | 0 | -350 | 350 |

Table 1. DH parameters

H\_06 = H\_01 \* H\_12 \* H\_23 \* H\_34 \* H\_45 \* H\_56



P – position L, M, N – orthogonal vectors

* 1. ***Inverse kinematics***

We try to decouple problem into two simpler problems:

1. Inverse position kinematics
2. Inverse orientation kinematics

Our plan:

1. Find position of the intersection of the wrist axes
2. Find orientation of the wrist

Wrist position can be found as:

w\_x = p\_x – d\_6 \* N\_x

w\_y = p\_y – d\_6 \* N\_y

w\_z = p\_z – d\_6 \* N\_z

We have 2 solution for q1:

q\_11 = atan2(w\_y, w\_x)

q\_12 = atan2(w\_y, w\_x) + pi

and that why we have a group of q2 and q3

q\_21 = alpha + beta

q\_31 = 1/2 \* pi - sigma + gamma

q\_22 = alpha - beta

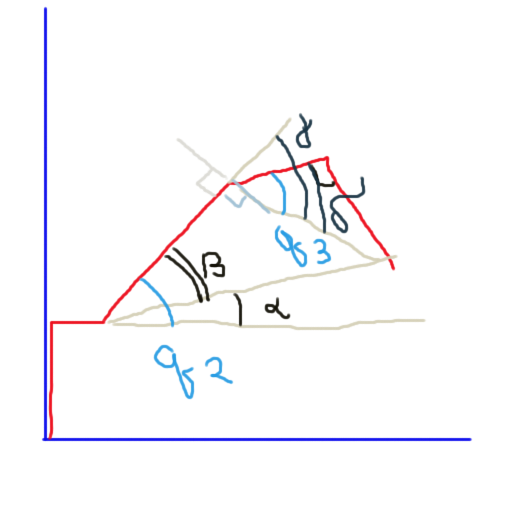
q\_32 = -3/2 \* pi + sigma + gamma

q\_23 = pi - alpha - beta

q\_33 = -3/2 \* pi + sigma + gamma

q\_24 = pi - alpha + beta

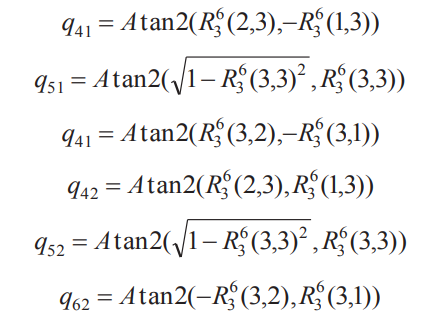
q\_34 = 1/2 \* pi - sigma + gamma



Inverse orientation kinematics

R\_03 can be obtain from H\_01, H\_12, H\_23





I definitely understand this stuff