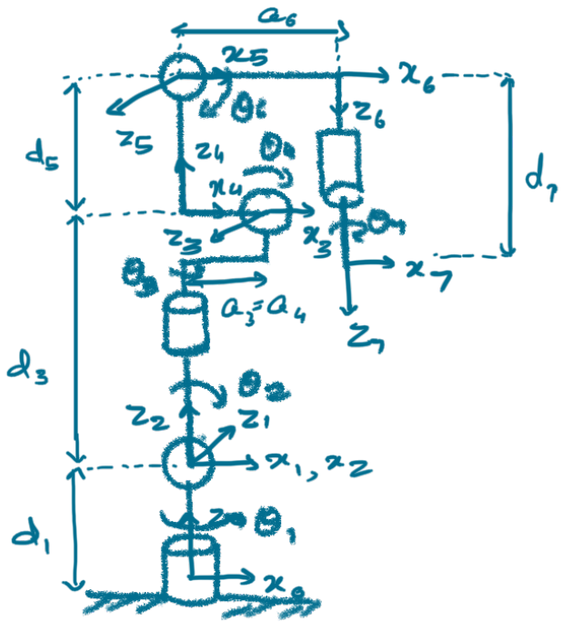
Pgrel ab 4

(1)



$d_1 = 0.333\,m$

$d_3 = 0.316\,m$

$a_3 = a_4 = 0.0825\,m$

$d_5 = 0.384\,m$

$d_6 = 0.088\,m$

$d_7 = 0.21\,m$

DH Table ($\theta_5^* = 0$)

Link	a_i	α_i	d_i	θ_i
1	0	-90	d_1	θ_1^*
2	0	90	0	θ_2^*
3	a_3	90	d_3	θ_3^*
4	$-a_4$	-90	0	θ_6^*
5	0	90	d_5	0
6	a_6	90	0	θ_6^*
7	0	0	d_7	$\theta_7^* - 45°$

1. First we get $T_1^0, T_2^1, T_3^2 \dots T_7^6$
2. Obtain $T_1^0, T_2^0, T_3^0 \dots T_7^0$ using post multiplication
3. initialize some config $q_0 = [q_0^1\ q_0^2 \dots q_0^7]$
4. Set goal config q_f
5. Set 1 obstacle for simplicity. Choose position in base frame. say $\vec{P}$
6. Assume distance of influence of obstacle $= \rho_0$
7. Assume attracting field of strength for each joint
8. Assume repulsive field of strength for each joint
9. Assume step size for each joint
9. initialise $q = q_0 \quad i = 0$

10. for each q in T:

if $\|q^i - q_f\| \geq$ tolerance & iter < max iter

get $o_i(q)$ from T_i^0

get $o_i(q_f)$ from T_i^0

$F_{att_i}(q) = -\zeta_i (o_i(q) - o_i(q_f))$

if $|\vec{p} - o_i(q) - \text{reading}_{obstacle}| > \rho_0$:

$F_{rep_i}(q) = 0$

else:

$$F_{rep_i}(q) = \eta_i \left[\frac{1}{\rho(o_i(q)} - \frac{1}{\rho_0}\right] \frac{1 \cdot \nabla \rho(o_i(q))}{\rho_0^2(o_i(q))}$$

note if object is convex,

$$\nabla \rho(o_i(q)) = \frac{o_i(q) - b}{\|o_i(q) - b\|}$$

$F_i(q) = F_{att_i}(q) + F_{rep_i}(q)$

$\tau_i(q) = J_v^T F_i(q)$

$q^{i+1} \leftarrow q^i + \alpha^i \frac{\tau_i(q)}{\|\tau_i(q)\|}$

$i \leftarrow i + 1$

else:

return q_0

Note: The Attractive force at each origin is based on the parabolic well potential.

(2) The parameters are: ρ_0, ζ_i, η_i & α_i

- ρ_0: dist of influence of obstacle
- ζ_i: attractive field strength of joint i
- η_i: repulsive field strength of joint i
- α_i: step size in gradient descent

→ If we consider increasing ρ_0, the likelihood of arm colliding with obstacle will decrease. But if ρ_0 is low, the arm

collision with obstacle will be more likely.

③ For testing the above method, the following preliminary tests can be considered:

① choosing map with obstacle dimensions very smaller than link dimensions

② map with dense number of obstacles

③ map with obstacles forming a narrow passage for arm to configure into.

④ choosing low attractive field strength & high repulsive field strength for joints closer to the base of the arm. At the same time choosing a higher attractive field strength & low repulsive field strength for the end effector.