MCE4101
Robotic Engineering

Assignment 4

Due: 9 Sept 2021

Todsarad T 6114215

Narong Aphiratsakun, D.Eng

Assumption University

Faculty of Engineering

Assignment 4

Q1 RRR with no offset configuration.

a. Let $\alpha_2 = 3$ and $\alpha_3 = 5$, $d_1 = 2$, obtain the possible values of θ_1, θ_2 and θ_3 for point (7.75,1.95, 1.8). Compute with using Atan2 function.

b. Draw (by hand) the following configurations of RRR, specify arm up and arm down configuration.

Hint: there should be 2 set of values of θ_1 ,θ_2 and θ_3.

Attach your code with answers.

Q2 Obtain DH table and check both sets of answer from Q1 by using fkine function in MATLAB. Attached your code, answer, and plot the position of robot.

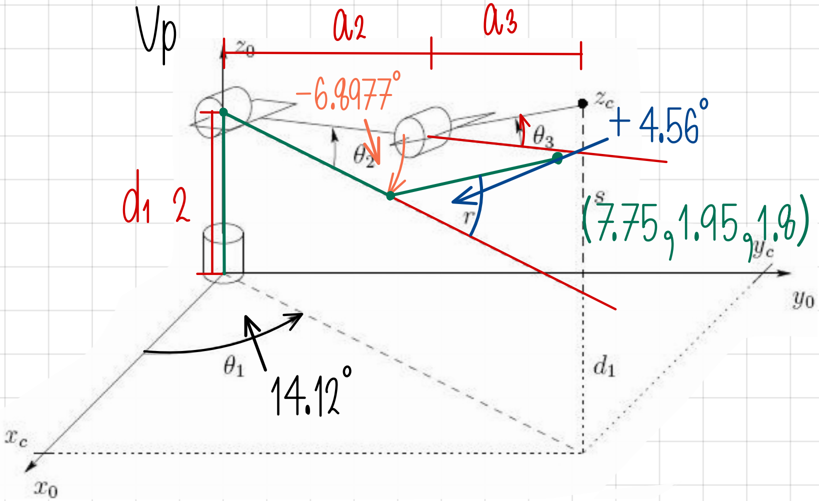
Q1 and Q2

$$D = \frac{X_c^2 + Y_c^2 + (Z_c - d_1)^2 - a_2^2 - a_3^2}{2a_2a_3}$$

$$= \frac{(7.75)^2 + (1.95)^2 + (1.8-2)^2 - 3^2 - 5^2}{2(3\times5)}$$

$$= 0.9968$$

	Z	Z	X	X
Links	θ	d	a	α
1	θ_1^*	d_1	0	90°
2	θ_2^*	0	a_2	0
3	θ_3^*	0	a_3	0



$$\theta_3 = \mathrm{Atan2}(D, \pm\sqrt{1-D^2})$$

$$= \tan^{-1}2d\left(\frac{\pm\sqrt{1-0.9968^2}}{0.9968}\right)$$

$$= \pm 4.56^\circ$$

at $\theta_3 = +4.56^\circ$

$$\theta_2 = \mathrm{Atan2}(\sqrt{X_c^2+Y_c^2}, Z_c - d_1) - \mathrm{Atan2}(a_2 + a_3\cos\theta_3, a_3\sin\theta_3)$$

$$= \tan^{-1}2d((1.8-2), \sqrt{(7.75)^2+(1.95)^2}) - \tan^{-1}2d(5\sin 4.56, 3+5\cos 4.56)$$

$$= -6.8977^\circ$$

at $\theta_3 = -4.56^\circ$

$$\theta_2 = \mathrm{Atan2}(\sqrt{X_c^2+Y_c^2}, Z_c - d_1) - \mathrm{Atan2}(a_2 + a_3\cos\theta_3, a_3\sin\theta_3)$$

$$= \tan^{-1}2d((1.8-2), \sqrt{(7.75)^2+(1.95)^2}) - \tan^{-1}2d(5\sin(-4.56), 3+5\cos(-4.56))$$

$$= -3.9971^\circ$$

$$\theta_1 = \mathrm{Atan2}(X_c, Y_c)$$

$$\theta_1 = \tan^{-1}2d(7.75, 1.95)$$

$$= 14.12^\circ$$

Assignment4Q1.m* | Assignment4Q2.m

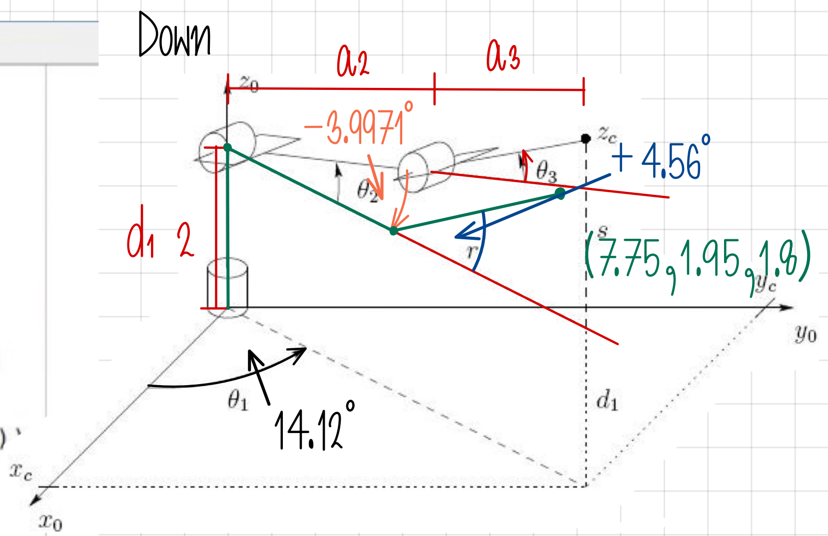
```matlab
%%RRR with no offset
d1 = 2; a2 = 3; a3 = 5 ;
Xc = 7.75; Yc = 1.95; Zc = 1.8;
r = sqrt(Xc^2+Yc^2)
s = Zc - d1
D = (Xc^2+Yc^2+(Zc-d1)^2-a2^2-a3^2)/(2*a2*a3)

th3 = atan2d((sqrt(1-D^2)),D) %%tan = tang in rad %tand = tang in degree
th2_UP = atan2d(Zc-d1, sqrt(r)) - atan2d(a3*sind(th3), a2+a3*cosd(th3))
th2_DOWN = atan2d(Zc-d1, sqrt(r)) - atan2(a3*sind(-th3), a2+a3*cosd(-th3))
th1 = atan2d(Yc,Xc)

%%For Checking
th1 = 0; th2 = 0; th3 = 0;
d1 = 2; a2 = 3; a3 = 5;
%RRR
%%L = link([alpha A theta D])
L1 = link([pi/2 0 th1 d1,  0]); %%0 is revolute (and default), 1 is prismatic
L2 = link([0 a2 th2 0, 0]);
L3 = link([0 a3 th3 0, 0]);
RRR = robot({L1 L2 L3});
%UP
th1_rad = deg2rad(14.12);
th2_rad = deg2rad(-6.897);
th3_rad = deg2rad(4.5609);

%DOWN
%th1_rad = deg2rad(14.12);
%th2_rad = deg2rad(-6.897);
%th3_rad = deg2rad(-3.9971);

RRR_PP = fkine(RRR,[th1_rad th2_rad th3_rad])
Pend = RRR_PP*[th1;th2;th3;1]
plot(RRR,[th1 th2 th3])
```



Assignment 4

Q3 RRP with no offset configuration.

a. Given $d_1 = 2$ and $\alpha_2 = 3$, Obtain the possible values of θ_1, θ_2 and d_3 for point (7.75,1.95, 1.8). Compute with using Atan2 function.

b. Draw the following configurations of RRP, specify arm up and arm down configuration.

Hint: there should be 2 set of values of θ_1 ,θ_2 and d_3.

Attach your code with answers.

Q4 Obtain DH table and check both sets of answer from Q3 by using fkine function in MATLAB. Attached your code, answer, and plot the position of robot.

Q_3 and Q_4

$$d_3 = \sqrt{x_c^2+y_c^2+(z_c-d_1)^2} - a_2$$

$$= \sqrt{(7.75)^2+(1.95)^2+(1.8-2)^2} - 3$$

$$= 4.9941$$

$$r = \sqrt{x_c^2+y_c^2} = \sqrt{(7.75)^2+(1.95)^2} = 7.9916$$

$$s = z_c - d_1 = 1.8 - 2 = -0.2$$

$$\theta_2 = \mathrm{Atan2}(\sqrt{x_c^2+y_c^2},\, z_c-d_1) = \mathrm{Atan2}(r,s)$$

$$= \tan^{-1}2d(-0.2,\, 7.9916)$$

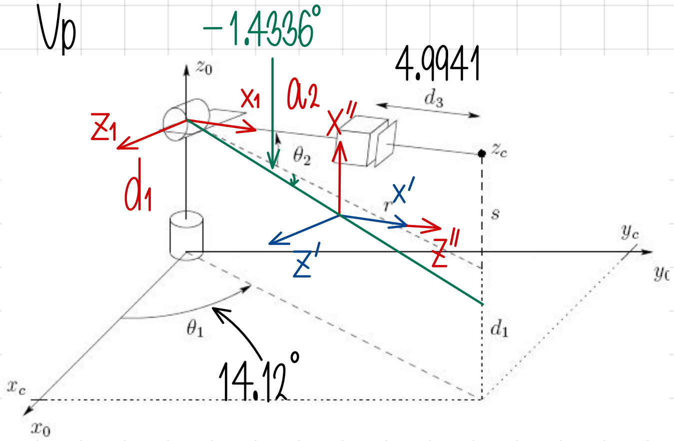
$$= -1.4336^\circ$$

$$\theta_1 = \tan^{-1}2d(7.75, 1.95)$$

$$= 14.12^\circ$$

	Z	Z	X	X
Links	θ	d	a	α
1	θ_1^*	d_1	0	90°
2	θ_2^*	0	a_2	90°
3	90°	0	0	90°
4	0	d_3^*	0	0

Up



Down

nment4Q1.m | Assignment4Q2.m | +

```
%%RRP with no offset d = 0
d1 = 2; a2 = 3;
Xc = 7.75; Yc = 1.95; Zc = 1.8;
r = sqrt(Xc^2+Yc^2)
s = Zc-d1
d3 = sqrt(r^2+s^2)-a2
th2 = atan2d(s,r)
th1 = atan2d(Yc,Xc)

%RRP
%%L = link([alpha A theta D])
L1 = link([pi/2 0 0 d1, 0]); %%0 is revolute (and default), 1 is prismatic
L2 = link([pi/2 a2 0 0, 0]);
L23 = link([pi/2 0 pi/2 0,0]); %dummy link
L3 = link([0 0 0 1, 1]);
RRPRobot = robot({L1 L2 L23 L3});

%%For Checking
%UP
th1 = deg2rad(14.1232);
th2 = deg2rad(-1.4336);
d3 = 4.9941;
%DOWN
%th1 = deg2rad(14.1232);
%th2 = deg2rad(1.4336);
%d3 = 4.9941;

RRP_FK = fkine(RRPRobot,[th1 th2 pi/2 d3])
RRP_Pend= RRP_FK*[0;0;0;1]
plot(RRR,[th1 th2 0 d3])
```