Contents

Robot and targets Poses

```
sawyer = SE3;
sawyer.t = [0 0 0.93];
target1 = SE3;
target1.t = [0.75 -0.35 1.014]
target2 = SE3.rpy([0 0 -0.785]);
target2.t = [1 0 1.014]
target3 = SE3.rpy([0 0 0.586931]);
target3.t = [0.85 0.25 1.014]
```

```
target1 =
         1         0         0      0.75
         0         1         0     -0.35
         0         0         1     1.014
         0         0         0         1


target2 =
    0.7074    0.7068         0         1
   -0.7068    0.7074         0         0
         0         0         1     1.014
         0         0         0         1


target3 =
    0.8326   -0.5538         0      0.85
    0.5538    0.8326         0      0.25
         0         0         1     1.014
         0         0         0         1
```

Part 1: A. Poses of the three targets with the repect to the robot base

frame

```
sawyerTtarget1 = inv(sawyer)*target1
sawyerTtarget2 = inv(sawyer)*target2
sawyerTtarget3 = inv(sawyer)*target3
```

```
sawyerTtarget1 =
         1         0         0      0.75
         0         1         0     -0.35
```

```
         0         0         1     0.084
         0         0         0         1


sawyerTtarget2 =
    0.7074    0.7068         0         1
   -0.7068    0.7074         0         0
         0         0         1     0.084
         0         0         0         1


sawyerTtarget3 =
    0.8326   -0.5538         0      0.85
    0.5538    0.8326         0      0.25
         0         0         1     0.084
         0         0         0         1
```

Part 1: B. The joint variables to grasp the object at each location, ie.

inverse kinematics

```
L(1) = Link('alpha', -pi/2, 'a', 0.081, 'd', 0);
L(2) = Link('alpha', pi/2, 'a', 0, 'd', 0.191, 'offset', pi/2);
L(3) = Link('alpha', -pi/2, 'a', 0, 'd', 0.399);
L(4) = Link('alpha', pi/2, 'a', 0, 'd', -0.1683);
L(5) = Link('alpha', -pi/2, 'a', 0, 'd', 0.3965);
L(6) = Link('alpha', pi/2, 'a', 0, 'd', 0.136);
L(7) = Link('alpha', 0, 'a', 0, 'd', 0.1785);
R1 = SerialLink(L, 'name', "Sawyer");

pose1 = sawyerTtarget1*SE3.Ry(pi/2)*SE3.Rz(-pi/2);
pose2 = sawyerTtarget2*SE3.Ry(pi/2)*SE3.Rz(-pi/2);
pose3 = sawyerTtarget3*SE3.Ry(pi/2)*SE3.Rz(-pi/2);
pose4 = pose1; % discard position
pose4.t = [0.65 0.4 0.084];

q1dwn = R1.ikine(pose1);
% R1.plot(q1dwn);
q1up = q1dwn -[0 pi/6 0 0 0 0 0];
% R1.teach(q1up)

q2dwn = R1.ikine(pose2);
% R1.teach(q2dwn)
q2up = q2dwn -[0 pi/6 0 0 0 0 0];
% R1.teach(q2up)

q3dwn = R1.ikine(pose3);
% R1.teach(q3dwn)
q3up = q3dwn -[0 pi/6 0 0 0 0 0];
% R1.teach(q3up)

q4dwn = R1.ikine(pose4);
% R1.teach(q4dwn);
q4up = q4dwn -[0 pi/6 0 0 0 0 0];
% R1.teach(q4up)
```

- in radians

```
in_radians = array2table([q1dwn; q2dwn; q3dwn;q4dwn], ...
    'VariableNames', {'q1','q2','q3','q4','q5','q6','q7'}, ...
    'RowNames', {'pos1dwn','pos2dwn','pos3dwn','pos4dwn'} )
```

```
in_radians =

  4×7 table

                q1          q2          q3          q4          q5          q6          q7
              ________    _________    ________    _________    ________    ________    ________

    pos1dwn    -0.36642     -0.55917    -0.74016      0.99382    -0.78784     -1.0055    -0.28228
    pos2dwn    0.016076    -0.098902    -0.84517    -0.053642    -0.60174     0.84959    -0.17939
    pos3dwn     0.36526     -0.43363    -0.83871       0.8286    -0.66369    -0.82339    -0.22415
    pos4dwn      1.0891     -0.22987     -1.1957        1.015      -1.262     0.23996     0.87751
```

- in degrees

```
in_degrees = array2table(rad2deg([q1dwn; q2dwn; q3dwn;q4dwn]), ...
    'VariableNames', {'q1','q2','q3','q4','q5','q6','q7'}, ...
    'RowNames', {'pos1dwn','pos2dwn','pos3dwn','pos4dwn'} )
```

```
in_degrees =

  4×7 table

                q1          q2          q3          q4          q5          q6          q7
              ________    ________    ________    ________    ________    ________    ________

    pos1dwn    -20.994     -32.038     -42.408      56.942     -45.14     -57.609     -16.173
    pos2dwn    0.92109     -5.6667     -48.424     -3.0735     -34.477      48.678     -10.278
    pos3dwn     20.928     -24.845     -48.055      47.475     -38.026     -47.177     -12.843
    pos4dwn       62.4      -13.17     -68.511      58.157     -72.305      13.749      50.277
```

Part 1: C.The Jacobian matrix at each location using the joint variables

```
disp("Jacobian for target1")
R1.jacob0(q1dwn)
disp("Jacobian for target2")
R1.jacob0(q2dwn)
disp("Jacobian for target3")
R1.jacob0(q3dwn)
disp("Jacobian for target4")
R1.jacob0(q4dwn)
```

```
Jacobian for target1

ans =

    0.3500    0.0784    0.2394   -0.2878    0.1148   -0.0000         0
```

```
    0.7500   -0.0301    0.2550   -0.0895    0.0280   -0.1714         0
    0.0000   -0.7446   -0.2111   -0.3892    0.1651   -0.0497         0
    0.0000    0.3583    0.7914    0.5985    0.5357   -0.0000    1.0000
   -0.0000    0.9336   -0.3037    0.5612   -0.8110    0.2785    0.0000
    1.0000    0.0000    0.5305   -0.5717   -0.2352   -0.9604   -0.0000

Jacobian for target2

ans =

    0.0000    0.0840    0.0203   -0.1182    0.0071   -0.1241         0
    1.0000    0.0014    0.0075   -0.3937    0.1516   -0.1242         0
   -0.0000   -0.9189   -0.2061   -0.3616   -0.1159   -0.0319         0
    0.0000   -0.0161    0.9950    0.0632    0.9894    0.1261    0.7074
    0.0000    0.9999    0.0160    0.6647    0.0560    0.1262   -0.7068
    1.0000    0.0000    0.0987   -0.7444    0.1340   -0.9840    0.0000

Jacobian for target3

ans =

   -0.2500    0.0785    0.0093   -0.1201    0.0493    0.0964         0
    0.8500    0.0300    0.2828   -0.3360    0.1061   -0.1449         0
    0.0000   -0.8022   -0.2369   -0.3758    0.1482   -0.0397         0
   -0.0000   -0.3572    0.8476    0.0531    0.9620   -0.1231    0.8326
   -0.0000    0.9340    0.3241    0.7360   -0.2190    0.1851    0.5538
    1.0000    0.0000    0.4202   -0.6749   -0.1630   -0.9750   -0.0000

Jacobian for target4

ans =

   -0.4000    0.0389    0.0179   -0.0972   -0.0323   -0.0000         0
    0.6500    0.0744    0.1402   -0.5468    0.0518   -0.1141         0
    0.0000   -0.5746   -0.5664   -0.1915   -0.1287    0.1373         0
   -0.0000   -0.8862    0.4511   -0.2264    0.9713   -0.0000    1.0000
   -0.0000    0.4633    0.8629    0.3576    0.1519   -0.7691   -0.0000
    1.0000    0.0000    0.2278   -0.9060   -0.1828   -0.6391   -0.0000
```

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