Report

Task 1:

FK: Rz(q0)*Tz(a1)*Rx(q1)*Ty(a2)*Ty(q2)

Task 2:

IK: q0 = atan2(goal.x, goal.y)

Q1 = atan2(goal.z-a1, $\sqrt{goal.x^2 + goal.y^2}$)

Q2 = distance between goal and 2nd joint

Robot have 0 or 2 solutions

Task 3: jacobian computing for geametrical and numerical aproaches given in code

Clasical aproach:

*x: (a2 + q2)sq0*cq1*
*y: (a2 + q2)cq0*cq1*
z: a1 + (a2 + q2)sq1

$$J = \begin{matrix} \frac{dx}{dq0} & \frac{dx}{dq1} & \frac{dx}{dq2} \\ \frac{dy}{dq0} & \frac{dy}{dq1} & \frac{dy}{dq2} \\ \frac{dz}{dq0} & \frac{dz}{dq1} & \frac{dz}{dq2} \\ R_0^0 & R_1^0 & R_2^0 \end{matrix} =$$

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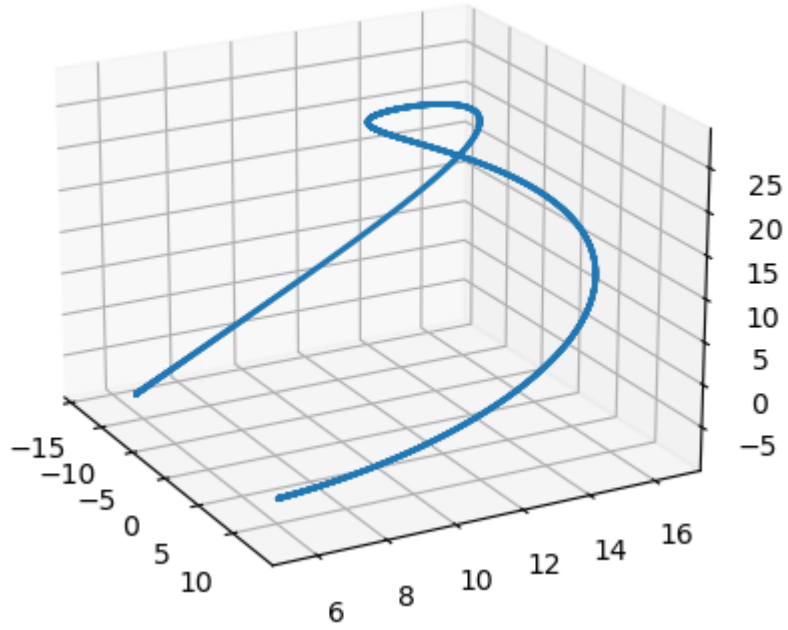
= [-(a2 + q2)*cos(q0)*cos(q1),(a2 + q2)*sin(q0)*sin(q1), -sin(q0)*cos(q1)],
[-(a2 + q2)*sin(q0)*cos(q1), -(a2 + q2)*sin(q1)*cos(q0),  cos(q0)*cos(q1)],
[                         0,          (a2 + q2)*cos(q1),          sin(q1)],
[                         0,                  cos(q0),                0],
[                         0,                  sin(q0),                0],
[                         1,                        0,                0]
```

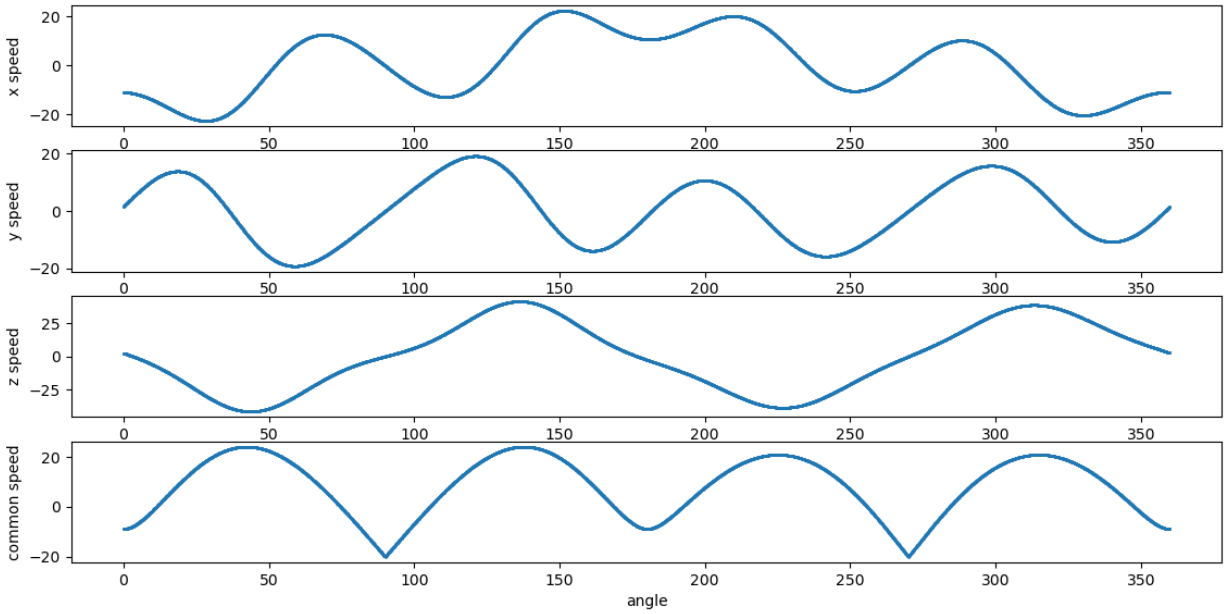
Task 4:
analysing Jacobian for singularities is finding dependent rows

I use for it python function rref. If some of rows are dependent on other function return that row as zeros row

Task 5:
Graphics:



That graphic represent position of endefector during spinning all joints by the given functions



That graphic represent linear velocity for each variable and common speed that calculating on formula $\sqrt{x^2 + y^2 + z^2}$

Github link: https://github.com/EriKarasik/HW2RO