

Report

Task 1:

FK: $R_z(q_0) * T_z(a_1) * R_x(q_1) * T_y(a_2) * T_y(q_2)$

Task 2:

IK: $q_0 = \text{atan2}(\text{goal.x}, \text{goal.y})$

$Q_1 = \text{atan2}(\text{goal.z} - a_1, \sqrt{\text{goal.x}^2 + \text{goal.y}^2})$

$Q_2 = \text{distance between goal and 2}^{\text{nd}} \text{ joint}$

Robot have 0 or 2 solutions

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

Clasical aproach:

$x: (a_2 + q_2) \sin(q_0) \cos(q_1)$

$y: (a_2 + q_2) \cos(q_0) \cos(q_1)$

$z: a_1 + (a_2 + q_2) \sin(q_1)$

$$J = \begin{bmatrix} \frac{dx}{dq_0} & \frac{dx}{dq_1} & \frac{dx}{dq_2} \\ \frac{dy}{dq_0} & \frac{dy}{dq_1} & \frac{dy}{dq_2} \\ \frac{dz}{dq_0} & \frac{dz}{dq_1} & \frac{dz}{dq_2} \end{bmatrix} = \begin{bmatrix} R_0^0 & R_1^0 & R_2^0 \end{bmatrix}$$

$$= \begin{bmatrix} -(a_2 + q_2) \cos(q_0) \cos(q_1), & (a_2 + q_2) \sin(q_0) \sin(q_1), & -\sin(q_0) \cos(q_1) \\ -(a_2 + q_2) \sin(q_0) \cos(q_1), & -(a_2 + q_2) \sin(q_1) \cos(q_0), & \cos(q_0) \cos(q_1) \\ 0, & (a_2 + q_2) \cos(q_1), & \sin(q_1) \\ 0, & \cos(q_0), & 0 \\ 0, & \sin(q_0), & 0 \\ 1, & 0, & 0 \end{bmatrix}$$

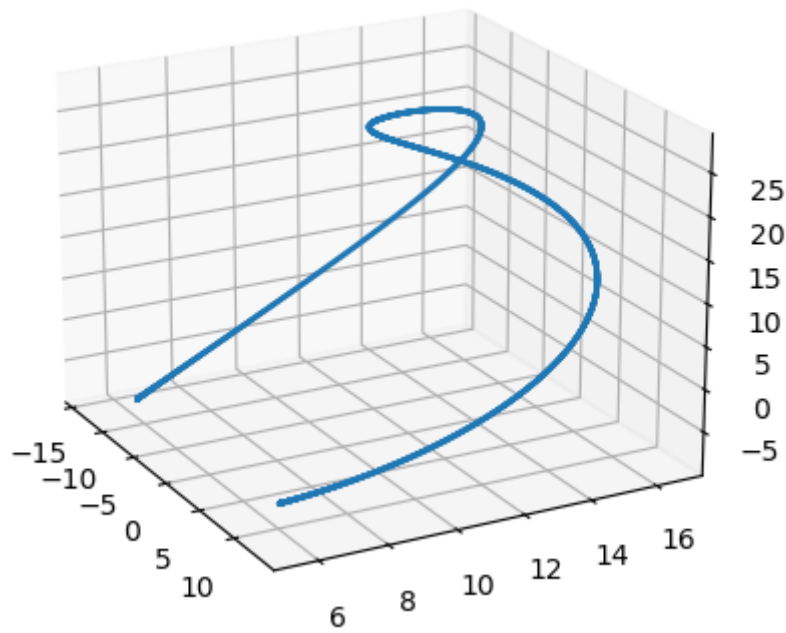
Task 4:

analysing Jacobian for singularities is finding dependent rows

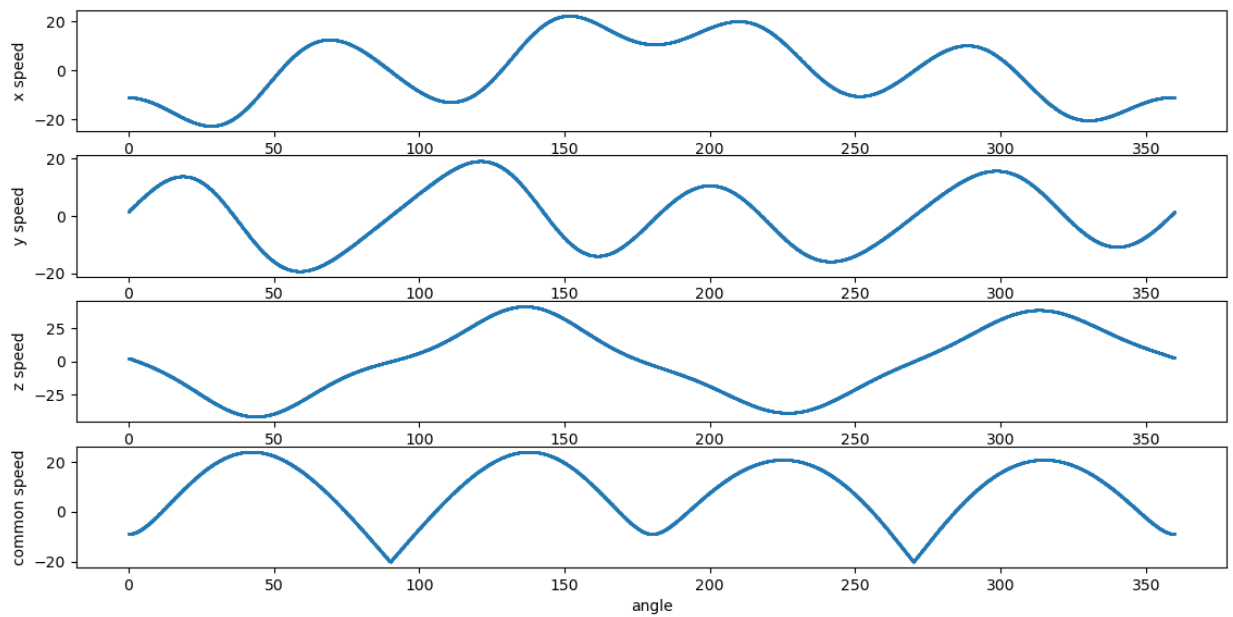
I use for it python function `rref`. If some of rows are dependent on other function return that row as zeros row

Task 5:

Graphics:



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



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