Questions:

We are trying to lift the soda cup vertically upwards by 0.5 meters.

In this experiment, we try to do the said task in two ways:

1. Incrementally lift the soda can by taking small steps.
2. Directly try to lift the soda can to the desired position in one time-step.

Applying these two methods involves the following changes in the delta_x:
In the 1st method, delta_x moves 0.01 in the z-position, and we iterate for 50 steps until we have reached 0.5m in the z-direction.
In the 2nd method, delta_x moves 0.5 m directly.

We observe that , when we move the arm incrementally with a small step size (0.01), the arm moves perfectly in the vertical direction.

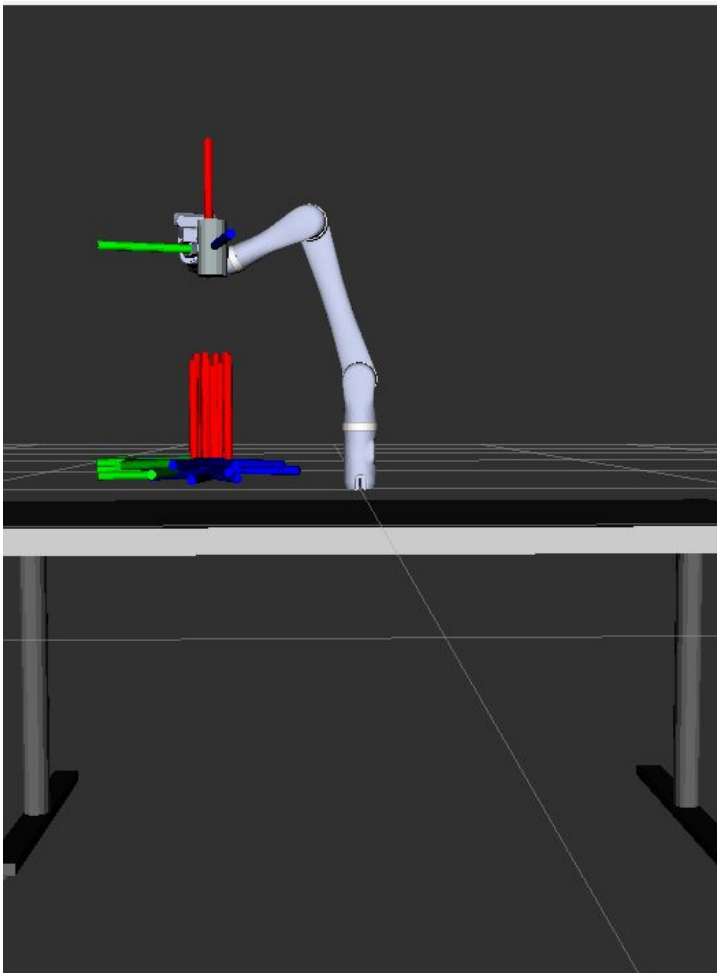

Fig 1.

However, when we try to lift the arm directly to 0.5m in the z-direction, the final position of the arm is not the desired position, but the arm moves in somewhat diagonal direction.

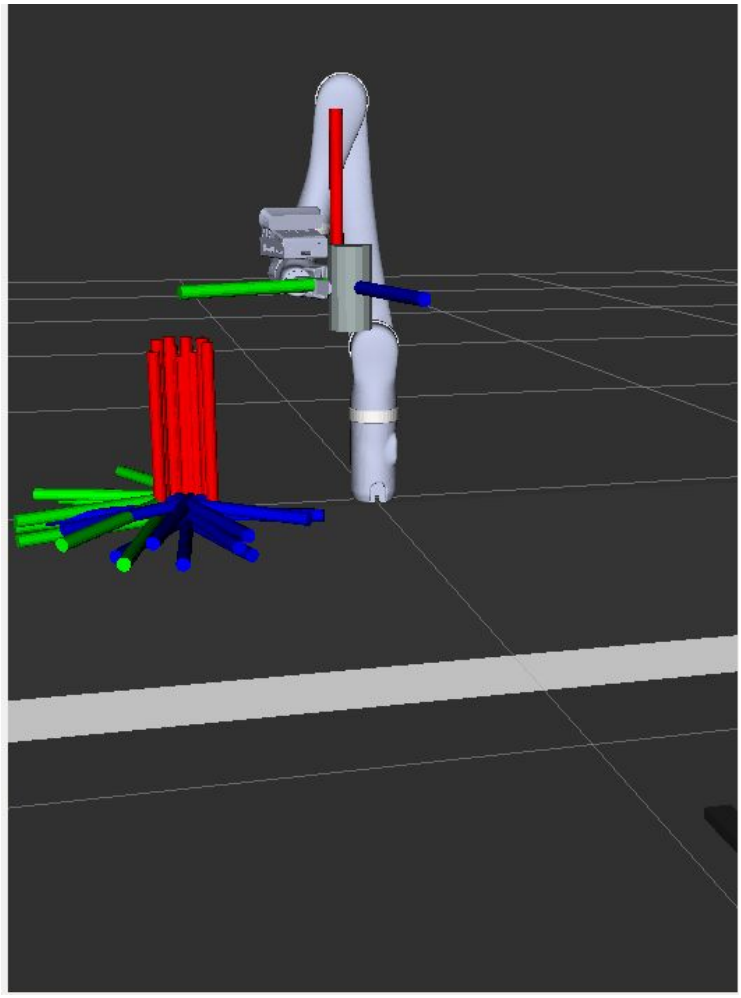

Fig 2.

This is due to the following reasons :

1. In the 1st method, we try to move in the z-direction (upwards) by 0.01. When we move we also update the q (configuration) of the robot.
2. In the next iteration, we recompute the jacobian using the updated q, and again try to move by 0.01 units in the upward direction. This process is repeated.
3. Thus, in the iterative method, we recompute q, and use updated jacobian to move to the next stage. By doing this incrementally, we ensure that the robot arm does not go out of the desired trajectory.
4. In the 2nd method, we compute the jacobian of the starting configuration q, (robot holding the soda can on the table) and then apply the delta_x vector directly. In this method, as the robots arm is moving from the starting configuration, the jacobian of q also changes, but this is not used to update the configuration space.
5. Thus, the robot arm keeps moving in the direction it got from the starting configuration space, without considering its current configuration space (q) and the goal value
6. This behaviour shows us that the update equation delta_q = jacobian_pseudo_inverse(q)*delta_x should be used for each change in configuration q, and not just between the start and the end state.