Congratulations! You passed!

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1. It's more useful to visualize the manipulability ellipsoid using the body Jacobian than the space Jacobian, since the body Jacobian measures linear velocities at the origin of the end-effector frame, which has a more intuitive meaning than the linear velocity at the origin of the space frame. If the robot has n joints, then the body Jacobian J_b is $6 \times n$. We can break J_b into two sub-Jacobians, the angular and linear Jacobians:

$$J_b = \begin{bmatrix} J_{b\omega} \\ J_{bv} \end{bmatrix}.$$

What is the dimension of $J_{bv}J_{bv}^{\mathrm{T}}$, which is used to generate the linear component of the manipulability ellipsoid?

1 / 1 point

- (●) 3×3
- ( ) 6×6
- ( ) $n \times n$

Correct
The linear component of a twist is 3-dimensional.

2. Consider a robot with a full rank Jacobian as it approaches a singular configuration. As it approaches a singular configuration, what happens to the manipulability ellipsoid? Select all that apply.

1 / 1 point

- [x] The length of one principal axis approaches zero.

Correct

- [ ] The length of one principal axis approaches infinity.
- [x] The interior "volume" of the ellipsoid approaches zero.

Correct

- [ ] The interior "volume" of the ellipsoid approaches infinity.

3. Consider a robot with a full rank Jacobian as it approaches a singular configuration. As it approaches the singular configuration, what happens to the force ellipsoid? Select all that apply.

1 / 1 point

- [ ] The length of one principal axis approaches zero.
- [x] The length of one principal axis approaches infinity.

Correct
At a singularity, the robot can resist wrenches in some direction with zero joint forces and torques.

- [ ] The interior "volume" of the ellipsoid approaches zero.
- [x] The interior "volume" of the ellipsoid approaches infinity.

Correct
At least one principal axis approaches infinity while the others are nonzero, so the volume approaches infinity.