

Lecture 1 Supplemental Notes: Robotics Terminology

1. Manipulator – a multi-link arm.
2. Configuration – a specification of all points, geometrically, on a robot.
3. Configuration Space – the set of all possible configurations.
4. Kinematics – Geometric relationship of motion, e.g., from joint angles to end effector position and orientation.
5. Degrees of Freedom (DOFs) – Independent rotational or translational directions of motion that are presently possible.
6. Revolute Joint – A rotational DOF.
7. Prismatic Joint – A translational DOF.
8. Pitch, theta, θ – Rotation about y axis.
9. Roll, phi, ϕ – Rotation about x axis.
10. Yaw, psi, ψ – Rotation about z axis.

11. Joint Variables, q – DOF for joints. e.g.,

$$q = \begin{bmatrix} x \\ y \\ z \\ \phi \\ \theta \\ \psi \end{bmatrix} \quad \text{or perhaps:} \quad q = \begin{bmatrix} \theta_1 \\ \theta_2 \end{bmatrix}, \text{ depending on the robot configuration.}$$

12. Joint Space – The set of all possible joint variable combinations.

13. State Space – The set of all combinations of geometry AND dynamics, i.e., positions and velocities, that are possible.
14. Dynamics – Relationships between forces and motions, e.g., Newton's Laws.
15. End Effector – The point(s) of the robot (and most typically, of a robot manipulator) designed to interact with the environment, e.g., a tool tip.
16. Workspace – The set of all points reachable by the end effector.
17. Reachable Workspace – See above definition for "Workspace".
18. Dextrous Workspace – The set of all points that the end effector can reach at any, arbitrary orientation (e.g., roll, pitch, yaw in 3D space; or just angle for 2D robot).
19. Kinematic Redundancy – When multiple joint solutions exist to put an end effector at a particular position and orientation.
20. Forward Kinematics – Mapping from joint geometry to end effector geometry. One unique forward kinematic mapping exists, always.
21. Inverse Kinematics – Mapping from end effector to joint geometry. There may be multiple solutions (i.e., kinematically redundant). There may be no solution (i.e., kinematically infeasible).
22. Singularity – Loss of an independent DOF (i.e., direction of instantaneous motion) of the end effector. [To be discussed at length in future lectures!]
23. The Jacobian – A matrix representation of the velocity relationships between joint DOFs and end effector DOFs, for a given geometry.
24. Accuracy – How close to a desired target one can get (i.e., mean error with respect to a goal).
25. Repeatability – How closely repeated trials are to one another (i.e., variance in error).