

Glossary

acceleration-level Mathematical formulations working with the change in joint speeds with respect to time. Integrating accelerations twice provides displacements. See position-level and velocity-level.

analytical methods Purely mathematical methods that do not require iteration.

closed-form - A problem formulation that does not require iteration for its solution.

conservative motion - A path where both the end-effector and the joints repeatedly follow their same respective trajectories.

degrees of freedom The number of independent variables in the system. Each joint in a serial robot represents a degree of freedom.

dexterity - A measure of the robot's ability to follow complex paths.

direct search A method of solving problems numerically using sets of trial solutions to guide a search. The search is direct because it does not explicitly evaluate derivatives.

dynamic model - A mathematical model describing the motions of the robot and the forces that cause them.

end-effector space - A fixed coordinate system referenced to the base of the robot.

end-effector The robot's last link. The robot uses the end-effector to accomplish a task. The end-effector may be holding a tool, or the end-effector itself may be a tool. The end-effector is loosely comparable to a human's hand.

equality constraint A restriction that requires the displacement or motion of the robot to equal a specified value. Equality constraints specify the position and orientation of the robot's end-effector.

error function The error function assigns a single value that represents the difference between the desired and actual values of one or several dependent variables.

fully constrained robot A robot with as many independent joints as there are equality constraints on the placement of the end-effector.

inequality constraint A restriction that limits the value of a dependent or independent variable. Inequality constraints limit the robot's joint travels (joint limits), joint speeds (speed limits), and torques, (torque limits).

inverse kinematics The inverse kinematics problem is to find the robot's joint displacements given position and orientation constraints on the robot's end-effector.

iteration - Repeatedly applying a series of operations to progressively advance towards a solution.

Jacobian - The matrix of first-order partial derivatives. For robots, the Jacobian relates the end-effector velocity the joint speeds.

joint space - A coordinate system used to describe the state of the robot in terms of it's joint states. Inverse kinematics may also be thought of as a mapping from end-effector space to joint space.

kinematic influence coefficients - These coefficients describe the total influence the N input joints have on the motion of the robot and allow a direct statement of the complex and coupled nonlinear differential equations controlling the response of the system.

LaGrange multipliers A mathematical technique for transforming equality constraints into performance criteria, thus expressing a constrained problem as an unconstrained problem.

linearly dependent A correspondence between quantities or functions that can be described by simply adding, subtracting, or multiplying a scalar.

normalize - Scaling a number of factors so that they will be of similar magnitudes.

numerical methods Iterative methods of solving problems on a computer. Numerical methods may have an analytical basis or they may involve heuristics.

optimization Calculating the independent variables in a function so as to generate the best function value for a given set of conditions. Optimization usually involves maximizing or minimizing a function.

performance criterion Measures based on kinematic and dynamic models of the robot useful for evaluating the state of the robot.

plant description A kinematic and dynamic model of the robot.

position-level Mathematical formulations working with the joint displacements. See acceleration-level and velocity-level.

pseudoinverse - A simple method of inverting a matrix that is not square. As commonly applied to redundant robots, the pseudoinverse minimizes the two-norm of the joint speeds.

redundancy More independent variables than constraints.

resolved-rate - An extremely simple inverse kinematics method at the velocity-level.

scale - Changing magnitude by linear operation, i.e. multiplying by a scalar.

self-motion The robot's ability to move its intermediate links while holding the placement of the end-effector constant.

serial robot A serial robot is a single chain of joints connected by links.

singularity A position in the robot's workspace where one or more joints no longer represent independent controlling variables. Commonly used to indicate a position where a particular mathematical formulation fails.

two-norm The square root of the sum of the squares. The magnitude of a vector.

velocity-level Mathematical formulations working with the joint speeds. Integrating the joint speeds once provides the displacements. See acceleration-level and position-level.