Robot workspace and semi-algebraic geometry

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ABSTRACT

The workspace of a robot arm is the set of all positions that it can reach. The volume, boundary, and shape of the workspace are major subjects. If the robot arm has many joints and the restrictions of their angles are given, it can be very complicated. Also the number of solutions of inverse kinematics on each sections of the workspace and boundaries given by kinematic singularities are important issues. Especially in the field of collaborative robots, the workspace do a key role. To do a work with robots, we should present safe areas and dangerous areas, and then we could avoid the dangerous movements.

To calculate the workspace and number of solutions, we can use the discriminant and real root classification techniques from semi-algebraic geometry. The forward kinematics can be given in the form of the systems of polynomial equations, and the inverse kinematics can be solved by the elimination. The set of positions that give the real angle solutions is the workspace. Hence the boundaries are given by the discriminant and the number of possible joint conditions are given by the number of real roots. In this talk, we will introduce the algebraic approach to the robot workspace problems, and some calculations of the case of the simple robot arms.