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A new and efficient algorithm for the inverse kinematics of a general serial $6R$ manipulator.

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Summary: We present a new and very efficient algorithm to compute the inverse kinematics of a general $6R$ serial kinematic chain. The main idea is to make use of classical multidimensional geometry to structure the problem and to use the geometric information before starting the elimination process. For the geometric pre-processing we utilize the Study model of Euclidean displacements, sometimes called kinematic image, which identifies a displacement with a point on a six-dimensional quadric S_6^2 in seven-dimensional projective space P^7. The $6R$-chain is broken up in the middle to form two open $3R$-chains. The kinematic image of a $3R$-chain turns out to be a Segre manifold consisting of a one-parameter set of 3-spaces. The intersection of two Segre manifolds and S_6^2 yields 16 points which are the kinematic images representing the 16 solutions of the inverse kinematics. Algebraically this procedure means that we have to solve a system of seven linear equations and one resultant to arrive at the univariate 16 degree polynomial. From this step in the algorithm we get two out of the six joint angles, and the remaining four angles are obtained straight forwardly by solving the inverse kinematics of two $2R$-chains.

MSC:

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53A17 Differential geometric aspects in kinematics

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Study representation; kinematic mapping; Segre manifold

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