Optmization of Robot Paths for Remote-Laser-Welding

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A new promising technology, robot based Remote-Laser-Welding (RLW), has been established in industries, saving time and money by reducing auxiliary process time to a minimum. While fast beam guidance by scanner optics is state of the art, robot based Remote-Laser-Welding systems without scanners can additionally improve costs of investment and maintenance. However, RLW leads to new requirements for motion planning. In the present work we consider the kinematic properties of robots with 6 rotation joints and describe an approach for optimization of robot motion due to given geometric and differential constraints (i.e. constraints on velocity and orientation of the robot end-effector during welding, and limits on velocities and accelerations during the overall workcycle). We consider the non-academic, highly nonlinear model of a commercially available robot with 6 rotation joints and discuss several objectives for optimal motion with regard to RLW. Given equations of robot motion in matrix form, we shall utilize the freedom in position and orientation of the robot end-effector during RLW and express the solution space for our optimization task explicitly using computation of Moore-Penrose pseudoinverses of matrices with polynomial entries. We use computer algebra system Maple to perform these calculations and to derive formulae and procedures for numerical optimization by the method of steepest descent. Finally, the computational examples will be presented.

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