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Motion Planning and Simulation Design of a Redundant Robot for Sheet Metal Bending Processes

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Abstract : Industry 4.0 is a vision of integrated industry implemented by artificial intelligent computing, software, and Internet technologies. The main goal of industry 4.0 is to deal with the difficulty owing to competitive pressures in the marketplace. For today's manufacturing factories, the type of production is changed from mass production (high quantity production with low product variety) to medium quantity-high variety production. To offer flexibility, better quality control, and improved productivity, robot manipulators are used to combine material processing, material handling, and part positioning systems into an integrated manufacturing system. To implement the automated system for sheet metal bending operations, motion planning of a 7-degrees of freedom (DOF) robot is studied in this paper. A virtual reality (VR) environment of a bending cell, which consists of the robot and a bending machine, is established using the virtual robot experimentation platform (V-REP) simulator. For sheet metal bending operations, the robot only needs six DOFs for the pick-and-place or tracking tasks. Therefore, this 7 DOF robot has more DOFs than the required to execute a specified task; it can be called a redundant robot. Therefore, this robot has kinematic redundancies to deal with the task-priority problems. For redundant robots, Pseudo-inverse of the Jacobian is the most popular motion planning method, but the pseudo-inverse methods usually lead to a kind of chaotic motion with unpredictable arm configurations as the Jacobian matrix lose ranks. To overcome the above problem, we proposed a method to formulate the motion planning problems as optimization problem. Moreover, a genetic algorithm (GA) based method is proposed to deal with motion planning of the redundant robot. Simulation results validate the proposed method feasible for motion planning of the redundant robot in an automated sheet-metal bending operations.

Keywords : redundant robot, motion planning, genetic algorithm, obstacle avoidance
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