Research Grants for PhD students from the China Scholarship Council

DESIGN FOR ENERGY EFFICIENCY OF ROBOT MANIPULATORS

Global energy usage has grown by the factor of 26,5 per capita over the past 200 years [1]. With increasing concerns over this excessive consumption of energy, new optimal methods of machine design must be developed. Therefore, the European Union, several non-governmental organizations and the economy have set the goal to significantly increase the efficiency of the used resources in areas, such as transportation, energy production and industry within the next years [1].

The synthesis of mechanisms with minimum effort motions is one of the most promising areas. In the mechanism design, the reduction of the energy consumption can be reached in different ways. In static mode of operation, an efficient solution is the balancing of gravitational forces of mechanical systems, which leads to the minimization of actuating torques [3]-[11].

However, with the increase of the accelerations of moving links, the inertia forces become important and the balancing of gravitational forces in dynamic operation cannot be optimal. In this context, another problem has been formulated: to find such a distribution of movable masses or shapes of links, which allows the minimization of input torques of the actuators in dynamic mode of operation [12]-[17].

The cancellation or reduction of the dynamic loads on the actuators is a new challenge for industrial robotics.

The aim of the proposed research project is to develop a new design technique to reduce the power consumption of actuators of robot manipulators. To achieve the aim, the prescribed variable speed of the input links should be used. The movement of the input links by the prescribed velocity, defined from the constancy of the kinetic energy in the robot manipulator, will cancel the input torque due to the inertial effects. The originality of this approach lies in the fact that the robot manipulator is designed according to traditional methods and the cancellation of the actuating torques is only achieved by means of optimal motion control of the input links. To increase the effectiveness of the proposed solution, the control based on the prescribed variable speed of the input links can be combined with the optimal redistribution of the masses of moving links. The efficiency of the suggested solution will be illustrated via numerical simulations and experimental tests.

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