［様式－学 5］

Abstract of Main Thesis

Title of Thesis

ENERGY SAVING CONTROL METHODS FOR ROBOTS WITH ELASTIC ELEMENTS

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Abstract on the Content of the Applicant's Thesis

The importance of saving energy had increased due to limitation of environmental resources. In robotics, energy-saving methods become interesting research topics in science as well as in technology. It seems that regeneration of energy or transfer between potential energy and kinetic energy is easily utilized for periodic robot motions in order to save energy. In practice, however, the motions of multi-joint robots become chaotic when each joint has elasticity. Therefore, the implementation of periodic robot motions is difficult and new control methods are necessary. This dissertation proposes energy-saving methods for periodic robot motions by effectively utilizing elastic elements.

The first part of this dissertation proposes a new energy saving control method for multi-joint robots to generate quasi-passive periodic motions, which requires less actuator torque. Elasticity adaptive control and delay-feedback control (DFC) are simultaneously used which can adaptively adjust desired robot motion in real time without using any parameters of the robot system. Numerical simulations and experimental results demonstrate its effectiveness.

The second part of this dissertation explores a new inertia adaptive control method in which a mass is moved in order to change the moment of inertia and change the desired motion cycle with constant elastic elements. The convergence to desired periodic motions is mathematically proven and the performance of the proposed method is demonstrated by several simulation results.

The third part of this dissertation treats more practical cases that an energy-saving method is applied to SCARA type robots which are widely used in factories. An energy saving control method is proposed by using elastic adaptation and adaptive viscosity compensation. Particularly, the effectiveness of non-diagonal elements of the elastic matrix is considered. It is mathematically proven that robot motion controlled by the proposed method converges to the desired periodic motion. Several simulation results demonstrate the effectiveness and the robustness of the proposed methods.