

Model-Based Energy Recuperation of Multi-Axis Machines

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The peak power consumption of multi-axis production machinery (e.g. industrial robots) is determined by the forces during acceleration phases of continuous movements. The required high electric currents represent a cost factor in terms of the mains power supply. In this paper a new Modelica-based method is presented to save the mechanical braking energy of production machinery into a local flywheel-based energy recuperation system (ERS) for later utilization. An ERS has twofold advantages: on the one side it reduces the apparent power peaks from the mains power system. On the other side the overall energy consumption can also be reduced therewith. However, a mechanical ERS with a flywheel needs to be controlled in advance, as its internal inertia and the switched magnetic field introduce some dead time in the process. Therefore, the here presented approach uses an interdisciplinary Modelica model of the machinery to compute future power requirements prior execution of new movements. It is assumed that the machine program is known upfront in a textual form. The movement commands must be carried out with the virtual machine model first. The simulation computes the energy demand, according to which the stored amount of energy within the ERS (i.e. the angular velocity of its flywheel) must be controlled. The here computed reference angular velocity signal is put later also to the real controller, where the physical ERS is attached to as an extra motor. This paper presents the methodology along an example of a 3-axis robotic manipulator that is installed in the VDTC building of the Fraunhofer IFF, Magdeburg. This specific example has been used to validate the concept: 12% less power-consumption and 10% less power peaks were achieved during the operation.