# Topology optimization of industrial robots considering system-level performance

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## Abstract

Topology optimization has been popularly applied for the lightweight design of industrial robots. Due to very large amount of computation resource required for the system-level optimization of a robot, it is a common practice that topology optimization is separately performed on each part of a robot. However, a robot consisting of part-level optimized parts cannot be ensured to show optimized performances in the system level. This is because it is difficult to properly divide the system resource into part levels to set the part-level constraints. For example, if the total mass of a robot is constrained in a system-level optimization and the system stiffness is the design objective, it is impossible to know in the stage of the problem formulation how the total mass should be divided into each parts to have maximized system stiffness. The objective of this investigation is to present an optimization method that can find a system-level optimized design by using part-level topology optimizations. In order to obtain a solution close to the system-level optimized one, it is important to make the intersected design space of part-level optimizations as close as possible to the design space of the system-level optimization by finding proper set of constraints for part-level optimizations. In this research, a metamodel is constructed for each part to build the relation between the stiffness and the mass of the part. The proper set of mass constraints for part-level optimizations is determined by solving the system-level optimization problem which is formulated by using the part-level metamodels. The proposed optimization method is applied for the design of a painting robot which consists of 6 serially connected parts.