Optimization of a Micro Fluidic Component Using a Parallel Evolutionary Algorithm and Simulation Based on Discrete Element Methods

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Abstract

In most cases, application of the powerful evolutionary optimizing method is limited to tasks which can manage with short simulation runtimes, e.g. less than one minute. More precise simulations like discrete element methods require much more time of up to 20 minutes and more. This can be solved by a parallelization of the optimization process. The parallel version of our optimization tool GADO (Genetic Algorithm for Design Optimization) based on structured populations scales linearly with the number of involved processors and, thus, enables us to handle optimization based on time-consuming simulation.

This paper introduces the parallelization in brief and describes the optimization task. The micro fluidic component is a micro structured polymeric film of 80 µm thickness, which works as an actuator plate and can be used e.g. for tactile arrays. By varying the structures of the film, the mechanical behavior can be affected. The main optimization goals are a great deflection at a given working pressure and a limited tension of the film in order to achieve a long life time of the device. This is a highly multimodal problem and it requires chromosomes of dynamic length, as the optimal number of structures is one of the optimization parameters and itself depends on the geometry of the structures on hand.

The obtained results are very promising and show that manual designs can be outdone in both performance and durability.

1 Introduction

Industrial application of micro systems requires short development times as well as reliable designs of high quality comparable to the state of the art in micro elec-