Design of Multiobjective Robust Controllers Using Genetic Algorithm

Alberto Herreros López
University of Valladolid (DISA)
(albher@eis.uva.es)
Spain, 2000

Abstract

This work studies the multiobjective control design and robust multiobjective control design using multiobjective genetic algorithms (GAs).

Modern control theory transforms control design problems into optimization problems. In many cases, control objectives are multiple and problems are formulated as multiobjective optimizations, whose solutions are not unique. The objectives to be optimized are measured by the norms of different closed-loop transfer functions. There are different mix control methods to optimize some norm combinations, for example the $\mathcal{H}_2/\mathcal{H}_\infty$ or the $\mathcal{L}_1/\frac{\mathcal{H}_2}{\mathcal{H}_\infty}$. However, these optimizations are not convex and are very difficult to solve. The controllers obtained with these methods have a big order and it is impossible to fix the controller structure or constraints in their parameters. In many cases, these methods obtain a superior limit as the problem solution, for example, the linear matrix inequation (LMI) methods.

The principal contributions of this work are the following:

- The formulation of multiobjective control as a function vector optimization with respect to the controller parameters, whose structure has been chosen a priori.
- The formulation of robust multiobjective control as a function vector min-max optimization between the controller parameters, whose structure has been chosen a priori, and the uncertainty parameters.
- A general study of the multiobjective genetic algorithms.
- The creation of two new multiobjective GAs, the MRCD (multiobjective robust control design) genetic algorithm and the MRCD min-max. They have operators to solve the problems formulated.
- The evaluation of these algorithms with respect to test functions, and with respect to algorithms based on LMIs that solve classic mix control problems.
- The formulation of a general PID tuning as a multiobjective optimization problem. The MRCD algorithm application to solve it in SISO and MIMO plants.
- The design of multiobjective controllers (with the MRCD algorithm) and robust multiobjective controllers (with the MRCD min-max algorithm) in an industrial plant, comparing the results.