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Controller Tuning by Means of Evolutionary Multiobjective Optimization:

a Holistic Multiobjective Optimization Design Procedure

PhD dissertation by:
Gilberto Reynoso Meza

Supervisors:
Dr. F. Xavier Blasco Ferragud and Dr. Javier Sanchís Saez



Instituto Universitario de Automática e Informática Industrial
Universitat Politècnica de València

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Abstract

This thesis is devoted to Multiobjective Optimization Design (MOOD) procedures for controller tuning applications, by means of Evolutionary Multiobjective Optimization (EMO). With such purpose, developments on tools, procedures and guidelines to facilitate this process have been realized.

This thesis is divided in four parts. The first part, namely **Fundamentals**, is devoted on the one hand, to cover the theoretical background required for this Thesis; on the other hand, it provides a state of the art review on current applications of MOOD for controller tuning.

The second part, **Preliminary contributions on controller tuning**, states early contributions using the MOOD procedure for controller tuning, identifying gaps on methodologies and tools used in this procedure. The contribution within this part is to identify the gaps between the three fundamental steps of the MOOD procedure: problem definition, search and decision making. These gaps are the basis for the developments presented in parts III and IV.

The third part, **Contributions on MOOD tools**, is devoted to improve the tools used in Part II. Although applications on the scope of this thesis are related to controller tuning, such improvements can also be used in other engineering fields. The first contribution regards the decision making process, where tools and guidelines for design concepts comparison in m -dimensional Pareto fronts are stated. The second contribution focuses on amending the gap between search process and decision making. With this in mind, a mechanism for preference inclusion within the evolutionary process is developed. With this it is possible to calculate pertinent approximations of the Pareto front; furthermore, it allows to deal efficiently with many-objective and constrained optimization instances.

Finally, in the fourth part, **Final contributions on controller tuning**, a stochastic sampling procedure for proportional-integral-derivative (PID) controllers is proposed, to guarantee that (1) any sampled controller will stabilize the closed loop and (2) any stabilizing controller could be sampled. Afterwards, two control engineering benchmarks are solved using this sampling strategy, the MOOD guidelines highlighted through this Thesis for multivariable controller tuning and the tools developed in Part III.