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Fuzzy Decision Making in Modeling and Control

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The control theory belongs to the most significant and best developed fields in which the fuzzy set theory and some of the related branches are successfully used. One of the specialized mathematical theories which are very near to the control methods is the optimal decision-making theory. In the context of this review, it regards namely the fuzzy control and fuzzy decision-making. The fuzzy set theory became a significant and effective tool for modeling vagueness and uncertainty in general, as well as in specific situations of control of complex real process or decision-making in practical situations in which the uncertainty and vagueness represent their natural components.

The main purpose of the book is to analyze the relation between fuzzy decision-making procedures and the design of fuzzy control systems. The attention is focused on the problems which could be on rather heuristic level formulated as

- analyzing the value of fuzzy decision-making for fuzzy modeling,
- formalization of the influence of fuzzy decision-making for the designing signal-based fuzzy controllers,
- fuzzy design and performance specifications in model-based control,
- design of model-based controllers combined with fuzzy decision modules.

From this point of view, the models of fuzzy control systems are investigated and discussed.

The text of the book is divided into thirteen chapters. The first one, the “*Introduction*” verbally presents the considered situation, the interpretation of the main concepts of the control theory and the motivation of the work.

The following twelve chapters can be grouped in three clusters according to their main orientation. The first cluster is formed by Chapters 2, 3 and 4, namely “*Fuzzy Decision Making*”, “*Fuzzy Decision Functions*” and “*Fuzzy Aggregated Membership Control*”, which are of rather auxiliary character. They introduce the fundamental concepts and exactly formulated starting points for the further explanation. It is also shown there how direct fuzzy controllers can be designed by directly applied fuzzy decision-making.

In the second cluster the main chapters of the book are concentrated. These are Chapters 5–9, namely “*Modeling and Identification*” in which three types of fuzzy models and the fuzzy clustering approach to identification of the controlled system are presented, “*Fuzzy Decision Making for Modeling*” which is focused on the fuzzification and defuzzification of the decision-making procedures, “*Fuzzy Model-Based Control*” oriented to inversion of fuzzy models, adaptive control, compensation of errors, and some other, mostly practically formulated control problems. The remaining two chapters from this cluster “*Performance Criteria*” and “*Model-Based Control with Fuzzy Decision Functions*” continue the presentation of the control systems influenced by the decision-making methods. They deal with such topics like performance and design specification and fuzzy decision making in predictive control or aggregation operators, and some others.

The third group of chapters is formed by Chapters 10–13. Among them “*Derivative-Free Optimization*” and “*Advanced Optimization Issues*” complete the previous chapters by the explanation of some related topics and by discussion of their consequences, and the contents of the remaining two chapters “*Application Example*” and “*Future Development*” are evident from their headings. The book is completed by two appendices devoted to

“*Model-Based Predictive Control*” and “*Nonlinear Internal Model Control*” as well as by a representative list of references (218 items) and the Index.

The referred book contributes to the existing literature on fuzzy control theory in an interesting way. It offers a specific view on the problem, namely on the validity of the fuzzy decision-making methods for the models of control, and it analyzes this topic on a very good level. The text is written without strictly logical formalism (there are no formal definitions, theorems and proofs, but the used mathematics is formally correct). It develops fluently in natural sequence, where only examples and algorithms are graphically stressed. The structure of the chapters and sections is logical and it simplifies the orientation of the reader in the book.

That implies the profile of the probably expected reader who would be a mathematically oriented specialist in control theory with knowledge of the practical problems of eventual applications. An average knowledge of fuzzy sets is assumed, too. But the book can be also useful for a mathematician who is interested in engineering applications as well as for an advanced student wishing to know more about the modern control theory.

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