Preface

Ongoing advances in science and engineering enable mankind to design and operate increasingly sophisticated systems. Both their design and operation require the understanding of the system and its interaction with the environment. This necessitates the formalisation of the knowledge about the system by models. A major issue is what kind of model is best suited for a given task.

This book is about the supervision of continuous dynamical systems. Such systems are typically described by differential equations. However, this does not automatically mean that differential equations are proper models for solving supervision tasks. Instead, this book and recent approaches in literature show that supervision tasks do in general not require the use of such precise models as differential equations. This is of interest because uncertainties, typically occurring in supervision, make the use of precise models very difficult. Alternative approaches therefore use less precise models such as discrete–event descriptions to solve supervision tasks on a higher level of abstraction.

Discrete–event descriptions in form of automata are one of the key elements of this book. To reach this higher level of abstraction, uncertainties by quantisation are introduced on purpose, taking into account a loss of precision. This is one of the main difference to other approaches. When using numerical models like transfer functions or differential equations, uncertainties make the analysis more difficult. Not so here, where the system is described on a qualitative level on which uncertainties are naturally incorporated.

The book presents a new way to describe systems for supervision. Preparing this book I learned that the key to solve supervision problems is simplicity. The main difficulty is to find the right compromise between including and neglecting details. The experience shows that neglecting dynamics and causality by restricting models to a set of rules and purely qualitative assessments of the system is often one step too far because the dynamical properties of a system have to represented in sufficient detail. On the other hand numerical models are usually far to complicated if uncertainties are taken into account. The book suggests a compromise: the quantised systems approach.

Quantisation of signals leads the way towards simplicity, from continuous–variable to discrete signals and systems. Accordingly, the theory on quantised

system has to combine continuous and discrete systems theories. Thus, the book serves also as a bridge between these two theories taking a step towards closing the gap between them. Furthermore, as the quantised system is a special class of hybrid systems, the book is an interesting element also for this line of current research.

Besides a profound study on quantised systems and a collection of new results in this field, the book includes many new results in automata theory, a field of discrete–event systems theory. The complete solutions to the state observation and fault diagnostic problems for stochastic automata and automata networks are firstly presented here in form of a monograph. The results are accompanied by new studies on the observability and diagnosability of such systems.

However, the book is not only dedicated to a modern theory but due to my engineering background also has a focus on practical applications. The application of the methods to a chemical plant is described in detail. Further applications are outlined at the end of the book. Many examples throughout the text illustrate the theoretical concepts. A two–tank system is used as running example more than 20 times to help the reader understanding the results and to give an idea of what the theory is for.

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