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# Intelligent and Allied Approaches to Hybrid Systems Modelling

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# Intelligent and Allied Approaches to Hybrid Systems Modeling

## Multi-chapter book

*Eds.: Florin Ionescu and Dan Stefanoiu*

**Abstract**

*Recently, there is a tremendously increasing interest in interdisciplinary applications that arise complex problems impossible to solve by only using the instruments of one single scientific field or technology. Such problems are related to modeling of systems that encompass a collection of sub-systems with different structures and natures synergistically working together in order to achieve some goal. We refer to this system to as a "hybrid system".*

*Perhaps one of the most actual class of problems relies on the use of internet, where agents with different natures (humans, program routines or peripheral devices (printers, cameras, robot manipulators, etc.)) can constitute in an ad hoc manner a system aiming to reach for a preset goal (e.g. find the cheapest flying ticket, provide a video picture of an inaccessible mountain peak, etc.). Another applications involve the use of robots and flexible manufacturing lines, operating with various machines. Some robots are endowed with artificial vision and must be able to perform an accurate pattern recognition of objects to manipulate. Sometimes not only the shape of the object has to be recognized, but also its nature. In Mechatronics or Avionics – two newly developed fields – the concept of hybrid system is fundamental. Here, sub-systems from Mechanics, Electronics, Automatic Control, Computer Science and Aeronautics are usually combined together in a functional unit in charge with a specified task.*

*The aforementioned examples (and many others) are in close interaction with the modern concept of "allied technologies" that refers to the integration of knowledge from different fields in a single product. But this integration (that actually constitute in itself a hybrid) is a difficult task, which requires intelligent approaches. The field of Artificial Intelligence seems to be a very permissive and suitable framework for solving problems related to hybrid systems modeling and design, because here meet together several sciences from mathematics and physics to medicine and psychology.*

*The multi-chapter book proposed to be published cannot encompass the whole panoply of allied technologies that exist nowadays, but rather aims to present some advanced and recent theories and applications regarding the hybrid systems modeling. Thus, the reader will find interesting connections between fields like: System Theory, System Identification, Automatic Control, Robotics, Image Processing, Data/Image Compression, Neuronal Modeling, Multi-Agent Systems, Fuzzy Sets and Measures, Genetic Algorithms, Artificial Intelligence, Evolutionary searching techniques.*

*The Editors*

# Intelligent and Allied Approaches to Hybrid Systems Modeling

**Multi-chapter book**

*Editors: Florin Ionescu and Dan Stefanoiu*

## Table of contents


**Foreword**

*The Editors*

**Chapter 1. From Discrete Event to Hybrid Dynamic Systems** ..... 1

*Virginia Ecaterina OLTEAN (Romania)*

1.1. Introduction and Motivation ..... 2
1.2. The Supervision of Discrete Event Systems - An Introductory ..... 4
*1.2.1. The supervision of discrete event systems – An Introductory*.. 4
*1.2.2. Closed loop behavior of a supervised process*..... 6
*1.2.3. The controllability concept and existence conditions of a supervisor*..... 6
*1.2.4. The algorithm of Kumar for supervisor synthesis*..... 7
*1.2.5. An extension to the supervised control of discrete event systems* ..... 11
*1.2.6. Observation, observability and some complexity issues* ..... 14
1.3. A Class of Hybrid Supervision Systems..... 17
*1.3.1. Structure and behaviour of a hybrid control system*..... 18
*1.3.2. The control problem*..... 23
1.4. Concluding Remarks..... 31
References ..... 34

**Chapter 2. Modeling and Parameter Estimation for Inherently Unstable Dynamic Systems** ..... 1

*Jitendra R. RAOL (India), Gopalaratnam GIRIJA (India)*

2.1. Introduction ..... 2
2.2. Motivation ..... 2
2.3. Identification Aspects of Augmented Systems ..... 4
*2.3.1. Identifiability Issues for Closed Loop Systems* ..... 5
*2.3.2. Co-linearity and Its Detection* ..... 6
2.4. Mixed Estimation (ME) ..... 8
*2.4.1. Numerical Validation of ME Method* ..... 9
*2.4.2. Examples* ..... 10
2.5. Parameter Estimation of Unstable System (without Augmentation) . 19
*2.5.1. Extended Kalman Filtering and UD Factorization* ..... 20
*2.5.2. UD Factorization Filtering* ..... 21
*2.5.3. Numerical Validation* ..... 23
*2.5.4. Eigenvalue Transformation Method* ..... 24
*2.5.5. Numerical Validation* ..... 26
2.6. Factorization Filtering Mixed Estimation Method ..... 32
*2.6.1. Recursive Mixed Estimation in UD Filter* ..... 32
*2.6.2. Numerical Simulation Results* ..... 34
2.7. Asymptotic and Generalization Theory of Stabilized Output Error Methods ..... 39
*2.7.1. Output Error Method* ..... 40
*2.7.2. Equation Error Method (EEM)* ..... 40
*2.7.3. Stabilized Output Error Methods (SOEM)* ..... 41
*2.7.4. Theory of SOEM* ..... 42
*2.7.5. Intuitive Explanation of SOME* ..... 47
*2.7.6. Generalization of Total Least Squares Method (TLSM)* ..... 48
*2.7.7. Numerical Validation of SOME* ..... 49
*2.7.8. Numerical Validation of EEM* ..... 55
2.8. Concluding Remarks ..... 56
References ..... 56

**Chapter 3. FIR Neuron modelling** ..... 1

*Claudia Lidia BADEA (Austria)*

3.1. Mathematical Models of a Neuron ..... 2
*3.1.1. The biological neuron* ..... 2
*3.1.2. The artificial neuron* ..... 3
3.1.3. *The FIR neuron* ..... 5
3.2. Theoretical Background ..... 7
3.2.1. *Equations in algebra of convolutions* ..... 8
3.2.2. *Fundamental theorems* ..... 9
3.3. Generalised FIR Neuron ..... 11
3.4. Linear Differential Operators with constant Coefficients ..... 13
3.4.1. *Malgrange-Ehrenpreis theorem* ..... 13
3.4.2. *Hörmander-Lojasiewicz theorem* ..... 15
3.5. Computation of Weight Functions ..... 15
3.5.1. *Rules* ..... 15
3.5.2. *Simple weight functions* ..... 17
3.5.3. *Particular types of weight functions* ..... 18
3.5.4. *Weight functions of type A* ..... 19
3.5.5. *Weight functions of type B* ..... 20
3.5.6. *Weight functions of type C* ..... 22
3.5.7. *Weight functions of type D* ..... 23
3.5.8. *Weight functions of type E* ..... 23
3.5.9. *FIR models with weak and strong delay kernels* ..... 24
3.6. Concluding Remarks ..... 25
References ..... 25

**Chapter 4. Visual Conveyor Tracking** ..... 1

*Theodor BORANGIU (Romania), Florin IONESCU (Germany)*

4.1. Modeling conveyors with belt variables ..... 2
4.1.1. *The special class of belt variables* ..... 2
4.1.2. *The logical mechanism "Conveyor Belt Windows" and emergency routines* ..... 7
4.1.3. *Robot locations, frames and belt-relative movements planned by vision* ..... 9

4.1.4. *Case study: picking on-the-fly an imposed type and number of parts. Error analysis and experimental results.* ..... 13
4.2. Tracking conveyors as $m \leq 3$ Cartesian axis robots ..... 21
4.2.1. *Multitasking control for robot cooperation* ..... 21
4.2.2. *Dynamically altering belt locations for collision-free object picking-on-the-fly* ..... 32
4.3. Conditioning conveyor tracking by multiple belt synchronization ..... 52
*4.3.1. Flexible part feeding using multiple belt-conveyor devices* ..... 52
*4.3.2. Multitasking robot-vision control of multiple belt – feeders* ..... 56
4.4. Concluding Remarks ..... 61
References ..... 61

**Chapter 5. State of Art, Evolution and Trends of Image Compression Models** ..... 1

*Radu DOBRESCU (Romania)*

5.1. A Review of the Evolution in Image Compression ..... 2
5.1.1. *Basic principles* ..... 2
5.1.2. *JPEG: DCT-based image coding standard* ..... 3
*5.1.3. MPEG: audio and video compression standards* ..... 6
5.1.4. *Image compression using Wavelet Transform* ..... 9
5.1.5. *Image Compression using Neural Networks* ..... 14
5.2. Lossless Techniques for Grayscale Images Compression ..... 16
5.2.1. *Lossless Image Compression Based on Sequential 1Universal Source Coding* ..... 17
*5.2.2. Context Tree Modeling* ..... 17
*5.2.3. Methods for Serializing and Context Building* ..... 25
*5.2.4. Prediction* ..... 29
5.3. Progressive Compression Algorithms for 3-D Graphic ..... 33
5.3.1. *Basic principles* ..... 33
5.3.2. *Background of the 3-D graphic representation* ..... 34
5.3.3. *A new procedure for crunching triangle meshes* ..... 35
*5.3.4. Embedded coding for 3-D graphic model simplification* ..... 37
5.3.5. *Novel progressive coding algorithm* ..... 39
*5.3.6. Numerical results* ..... 42

5.4. Fractal Image Compression ..... 45
*5.4.1. A brief history* ..... 45
5.4.2. *Basic principles* ..... 45
5.4.3. *Using self-similarity in image compression* ..... 49
*5.4.4. Using fractal techniques in image coding* ..... 51
*5.4.5. A comparison between fractal and vector quantization compression techniques* ..... 53
5.5. Concluding Remarks ..... 54
References ..... 55

**Chapter 6. Fuzzy-statistical reasoning in faults diagnosis** ..... 1

*Dan STEFANOIU (Romania), Florin IONESCU (Germany)*

6.1. Introduction ..... 2
6.2. The Fuzzy-Statistical Reasoning Method ..... 5
6.2.1. *Method overview* ..... 5
6.2.2. *Vibration data acquisition and pre-processing* ..... 6
6.2.3. *The fuzzy-statistical model* ..... 15
6.3. Simulation Results and Discussion ..... 40
*6.3.1. The testing platform* ..... 40
6.3.2. *Initial simulation parameters* ..... 42
6.3.3. *Comparative discussion on simulation results* ..... 42
6.4. Concluding Remarks ..... 43
References ..... 53

**Chapter 7. Fuzzy modeling of multi-agent systems dynamics** ..... 1

*Dan STEFANOIU (Romania), Douglas NORRIE (Canada)*

7.1. Introduction and Basic Definitions ..... 2
7.2. Main Hypotheses and Problem Statements ..... 4
7.3. Planning by Ambiguity Minimization ..... 6
7.3.1. *Constructing a possibility tree of MAS states* ..... 6
7.3.2. *Constructing the family of possible plans* ..... 9

*7.3.3. Constructing possibility distributions for tree nodes* ..... 10
*7.3.4. Constructing consonant bodies of evidence for nodes* ..... 14
*7.3.5. Identifying the main sources of ambiguity* ..... 16
*7.3.6. Specifying the characteristic parameters of a plan* ..... 20
7.3.7. *Constructing the ambiguity measures* ..... 20
7.3.8. *Selecting the least ambiguous plan* ..... 28
7.4. Providing the Initial Data ..... 38
7.4.1. *Setting the clustering numbers* ..... 38
7.4.2. *Setting the non-temporal costs* ..... 40
7.4.3. *Setting the time costs* ..... 41
7.5. Simulation Results ..... 42
7.5.1. *General description of application* ..... 42
7.5.2. *Analysis of results and computational complexity performance* ..... 47
7.6. Concluding Remarks ..... 57
Appendix A: Proofs of theorems ..... 58
Appendix B: Inference algorithms providing the initial data in AMM ..... 61
References ..... 67

**Chapter 8. Structural theory of linear systems** ..... 1

*Florin STRATULAT (Romania ),Florin IONESCU (Germany)*

8.1. Structural theory..... 2
*8.1.1 Controllability* ..... 2
*8.1.2* Observability ..... 3
*8.1.3 The structural decomposition* ..... 4
*8.1.4 Control low allocability* ..... 5
*8.1.5 State estimators* ..... 6
*8.1.6 System's stabilization. Elementary synthesis* ..... 8
8.2.Examples ..... 12
*8.2.1 Structural properties* ..... 12
*8.2.2 Allocability* ..... 21
*8.2.3 System's stabilization. Elementary synthesis* ..... 33
References ..... 53

# Chapter 1. From discrete event to hybrid dynamical systems

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*Classic dynamical systems, modelled by differential or difference equations, have continuous state space and time-driven evolution. Discrete Event Systems (DES) have discrete state space and are basically asynchronous, that is their evolution is not governed by a clock, but by the occurrence, at possible irregular intervals, of discrete events. Hybrid dynamical systems result from the integration of time-driven dynamics with event-driven dynamics. The evolution of a hybrid system can be viewed as a discrete sequence of locations, each one having an associated continuous-time evolution law; thus, the global evolution is discrete, while the local evolutions are described by differential equations. The study and understanding of hybrid systems require special approaches, very often obtained as more or less efficient extensions and mixtures of methods and concepts inherited from the classic systems theory - such as variable structure systems - or from the DES theory, respectively. The chapter firstly discusses some aspects concerning the control theory of logical DES, initiated by Ramadge and Wonham. A supervision approach for hybrid systems, belonging to a class of models already classic in the literature, is presented next, followed by a final section dedicated to concluding remarks.*