

Contents

EDITORIAL FOREWORD	x
PREFACE	xi
CHAPTER 1	1
BASIC CONCEPTS AND TOOLS	1
1.1. Modeling and simulation: What is it?	1
1.2. Validity, credibility, tractability and verification	3
1.3. System state and causal systems	7
1.4. Classification of dynamical systems	8
1.5. Discrete and continuous simulation	10
1.6. Evolution of simulation software	10
1.6.1. Control and simulation language CSL	11
1.6.2. Strategies of discrete event execution	14
1.6.3. GPSS	15
1.6.4. SIMULA67	18
1.6.5. DYNAMO and System Dynamics software.....	20
1.6.6. SPICE.....	21
1.6.7. DEVS: Discrete event system specification	22
1.6.8. DYMOLA	24
1.6.9. Chronology of M&S Software development.....	25
1.6.10. Distributed simulation	30
1.6.11. High Level Architecture (HLA).....	31
CHAPTER 2	35
CONTINUOUS SIMULATION	35
2.1. Introduction	35
2.2. Ordinary differential equations and models of concentrated parameter systems.....	37
2.3. Continuous simulation with analog computers	39
2.4. Numerical methods for ordinary differential equations (ODE).....	40
2.4.1. Runge-Kutta methods.....	41
2.4.2. Richardson approximations	42
2.4.3. Predictor-Corrector methods	42
2.4.4. Stiff equations	44
2.4.5. Example of continuous simulation using ODEs.....	45
2.5. Signal flow graphs.....	50
2.6. Bond graphs	53
2.7. Alternative modeling tools and dynamic uncertainty.....	56
2.8. Distributed parameter systems	57
2.9. System dynamics.....	59
2.10. Galactic simulations and the <i>N</i> -body problem	62

CHAPTER 3.....	67
DISCRETE AND COMBINED SIMULATION – EXAMPLE OF PASION IMPLEMENTATION	67
3.1. Are discrete models valid?	67
3.1.1. The discrete time and discrete events	68
3.1.2. Semidiscrete events	72
3.2. PASION – PSM++ simulation system	75
3.2.1. PASION – PSM++ summary	75
3.2.2. Getting started	79
3.2.3. Processes and events	80
3.2.4. Permanently active processes	81
3.2.5. State and conditional events	82
3.2.6. PASION code generators	85
3.3. Queuing Model Generator QMG	86
3.3.1. QMG blocks	87
3.3.2. Example of a QMG model	90
3.3.3. The SVOP procedure	95
3.3.4. PASION animators	96
3.3.5. Another QMG example : manufacturing system model	98
3.4. Complex system simulator of PASION	103
3.4.1. What is Complexity?	103
3.4.2. CSS module of PASION system	104
3.4.3. Model coupling	106
3.4.4. Example	108
CHAPTER 4.....	111
DIFFERENTIAL INCLUSIONS IN MODELING AND SIMULATION ...	111
4.1. Differential inclusions	111
4.2. Possible applications	115
4.3. Differential inclusion solver (DIS)	116
4.4. Application in uncertainty treatment	124
4.5. Uncertain future and differential inclusions	131
4.6. Conclusions and future research	137
CHAPTER 5.....	139
FLUID DYNAMICS – SIMULATING OSCILLATING GAS FLOW	139
5.1. Computational fluid dynamics	139
5.2. Numerical problems	141
5.3. The simulation tool	142
5.4. Examples	143
5.5. Oscillating gas flow	146
5.6. Two-dimensional fluid-dynamics models are invalid	150
5.7. Conclusions	152

CHAPTER 6.....	155
SIMULATING PHENOMENA OF GENERAL RELATIVITY.....	155
6.1. Some basic concepts.....	156
6.2. The simulation tool and model time.....	161
6.3. Simulation experiments.....	163
6.3.1. Relativistic orbit.....	163
6.3.2. Light signals.....	164
6.3.3. 3D light cones.....	165
6.3.4. Time distortion.....	166
6.3.5. Approaching a black hole.....	167
6.3.6. Image distortion – gravitational lens.....	168
6.3.7. Rotating black hole.....	170
CHAPTER 7.....	173
INTERACTIONS BETWEEN HOSTILE HIERARCHICAL STRUCTURES: SIMULATION OF THE STRUGGLE BETWEEN TERRORIST AND ANTI-TERRORIST ORGANIZATIONS.....	173
7.1. Introduction.....	173
7.2. The model.....	176
7.3. Structures.....	177
7.4. The tool and the model implementation.....	180
7.5. Simulation experiments.....	183
7.6. Conclusions.....	188
CHAPTER 8.....	189
ON A METRIC STRUCTURE IN THE SPACE OF DYNAMIC SYSTEM MODELS.....	189
8.1. DEVS.....	190
8.2. Definitions.....	190
8.3. Distance between models.....	192
8.4. Examples.....	194
8.5. Conclusions.....	198
CHAPTER 9.....	199
SIMULATION OPTIMIZATION: A CASE STUDY OF A PARALLEL OPTIMIZATION ALGORITHM.....	199
9.1. Introduction.....	199
9.2. Problem statement.....	201
9.3. Simulation experiment.....	203
9.4. Conclusions.....	208
REFERENCES.....	211
INDEX.....	221