

Springer Series in Advanced Manufacturing

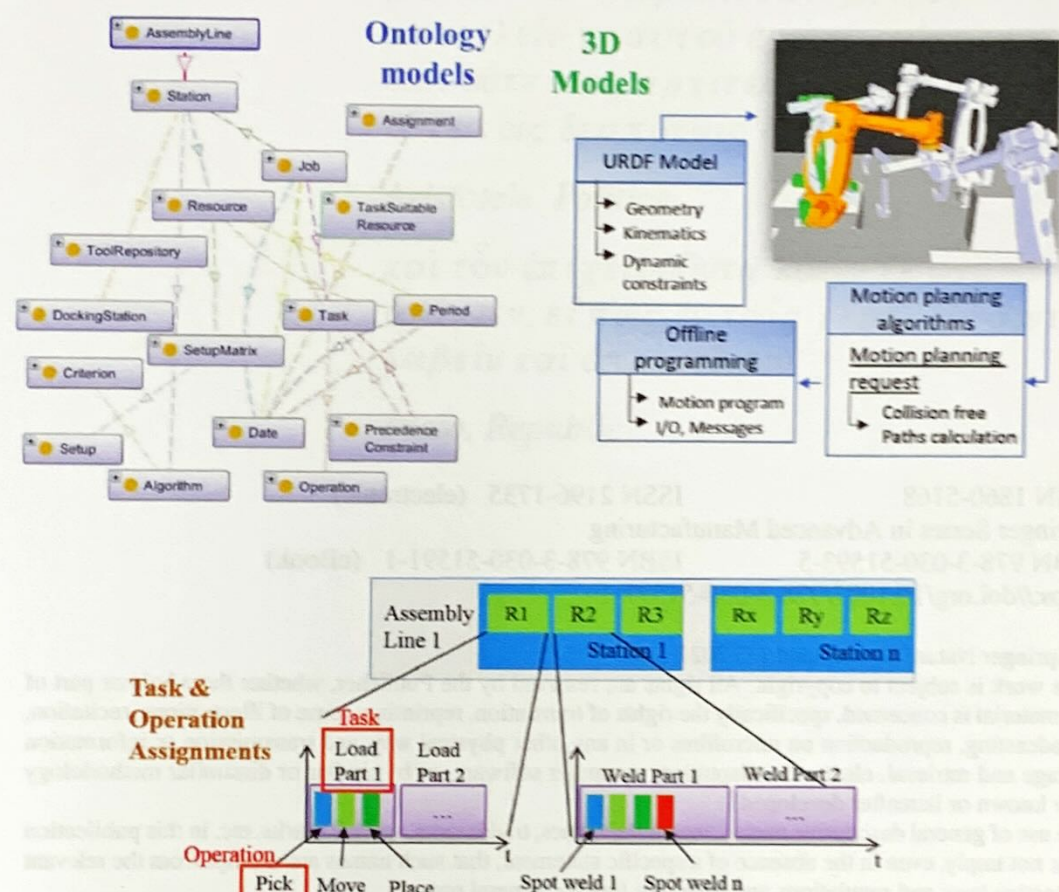
Sotiris Makris

Cooperating Robots for Flexible Manufacturing

 Springer

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Preface

This book is the derivation of my research work at the Laboratory for Manufacturing Systems and Automation, University of Patras in Greece. It is based on close interaction with both industry and research colleagues. There have been many great ideas conceived over these years of research on the topic of cooperating robots for flexible manufacturing. This book writing is an effort to share these experiences with a broader audience in a format that is concise enough to summarize many different concepts but also provides adequate detail and references to allow those interested to follow similar a direction.

This book aims to consolidate the content of discussions and experiences with experts, practitioners and engineers in manufacturing systems. With the great variety of manufacturing systems, we had the opportunity to study a noteworthy set of methods and tools have been produced. The aim of the book is sharing this experience with academia and industry practitioners hoping to contribute to improving manufacturing practice. While there is a plethora of books detailed enough to teach principles of robotics, this book offers a unique opportunity to dive into the practical aspects of implementing real-world complex robotic applications.

The term "Cooperating robots" in this book refers to robots that either cooperate between themselves or cooperate with people. The book investigates aspects of cooperation towards implementing flexible manufacturing systems. Therefore, manufacturing systems are the main driver behind the discussion on implementing such robotic systems.

Numerous methods have been proposed to design and to operate manufacturing systems. This book aims to introduce a novel set of methods for designing and operating manufacturing systems consisting of cooperating robots. Many methods are available in the literature on designing or operating robotized manufacturing systems when the main priority is efficiency and robustness; the essential element of these robotized manufacturing systems is the need for flexibility.

Initially, the concept of a manufacturing system will be briefly introduced, followed by aspects of flexibility. Following the key aspects of robotic systems will be introduced while the discussion will be streamlined towards implementing systems of cooperating robots towards flexible manufacturing systems. Aspects of designing such systems, such as considering material flow, logistics, processing

times, shop floor footprint and design of flexible handling systems, are going to be discussed. Additionally, key issues in operating such systems involve decision making, autonomy, cooperation, communication, task scheduling, motion generation and distribution of control at the control level of different devices among others.

The book consolidates knowledge published in papers with co-authors; however, it introduces several novel concepts that have not been published before. It presents a number of chapters in the form of technical papers discussing industrial challenges and approaches taken. These chapters are organized in four major parts. Part I introduces the topics of cooperating robots in two dimensions. On the one hand, there are the topics of robots cooperating among themselves, and on the other hand, there are the aspects of robots cooperating with humans. Part II includes aspects of robot to robot cooperation. Part III elaborated aspects of collaborative robotics, namely humans cooperating with robots. Part IV summarizes with an outlook for the future.

I would like to thank the European Commission for the financial support in my research over the years. Thanks to a number of funding programs, namely the Factories of the Future program and the Robotics initiative it has been possible to facilitate this work in cooperation with the European industry and realize the journey towards implementing the vision discussed throughout this book. Moreover, I am grateful for a number of leading European manufacturing companies for the great cooperation, namely Daimler, PSA, FCA, Volvo, Ford, Bic Violex, Electrolux, Comau, Prima Industrie, Siemens, Festo and Pilz. I have enjoyed extensive and fruitful conversations over the years.

My very good friends and associates in our Laboratory for Manufacturing Systems and Automation, in the University of Patras, have been invaluable in both performing research activities and also achieving this first edition of the manuscript. Special thanks to the colleague and friend, Dr. George Michalos for his persistence and hard work in many fronts and for sharing the vision for researching the issues of cooperating robots in industry.

In addition, I am grateful for the support and good cooperation with Professor Dimitris Mourtzis from the manufacturing systems group in LMS, Dr. Kosmas Alexopoulos from the software development group in LMS and Professor Panagiotis Stavropoulos from the manufacturing processes group in LMS.

I would like to thank the great team I had the opportunity to cooperate with over the years, in the Laboratory for Manufacturing Systems and Automation, in the University of Patras. They have been a great help in developing these topics, and I am grateful for their passion and commitment; Niki Kousi, Panagiotis Karagiannis, Panagiotis Aivaliotis, Apostolis Papavasileiou, Dionisis Andronas, Christos Gkournelos, Stereos Matthaiakis, Andreas Sardelis, Konstantinos Dimoulas, Nikolaos Nikolakis, Charalampos Kouros, Spyros Koukas, Plato Sipsas, Evangelos Xanthakis, Dr. Loukas Renztos, Dr. Konstantinos Efthymiou and Dr. Panagiota Tsarouchi have greatly contributed to the work behind the actual manuscript over the years. There are many others not being mentioned, and I would like to thank them all.

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Finally, I would like to greatly and warmly thank my wife, Sophia, for the tolerance and support over the years as well as my children, John and Dimitra, wishing them a bright future.

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Sotiris Makris

Part I

1. Introduction to Cooperating Robots and Flexible Manufacturing	1
1.1 Overview	2
1.2 Cooperating Robots for Flexible Manufacturing	3
1.2.1 Flexible Production Systems with Cooperating Robots	7
1.2.2 Efficiency Aspects of Cooperating Robots Technology	32
1.3 Human-Robot Collaboration	14
1.3.1 Safe Human-Robot Cooperative Assembly Operations	16
1.3.2 Efficiency Aspects in Human-Robot Collaboration	22
1.4 Technology Perspective	26
1.4.1 Robotic Perception of Shop Floor Process and Human	27
1.4.2 Task Planning and Communication for Shop Floor Reconfiguration	28
1.4.3 Facility and Workload Modeling	29
References	30

Part II Cooperating Robots: Robot-Robot Cooperation

2. Flexible Cooperating Robots for Reconfigurable Shop Floor	33
2.1 Introduction	35
2.1.1 Mixed Assembly Line	36
2.1.2 Flexible Assembly Systems	37
2.1.3 Illustrative Industrial Example	39
2.2 Approach for Controlling Flexible Assembly Systems with Cooperating Robots	41
2.2.1 High Level Control Logic	44
2.2.2 Low Level Control Logic	50
References	54

Contents

Part I

1	Introduction to Cooperating Robots and Flexible Manufacturing	3
1.1	Overview	3
1.2	Cooperating Robots for Flexible Manufacturing	5
1.2.1	Flexible Production Systems with Cooperating Robots	7
1.2.2	Efficiency Aspects of Cooperating Robots Technology	12
1.3	Human-Robot Collaboration	14
1.3.1	Safe Human-Robot Cooperative Assembly Operations	16
1.3.2	Efficiency Aspects in Human-Robot Collaboration	22
1.4	Technology Perspective	26
1.4.1	Robotic Perception of Shop Floor, Process and Human	27
1.4.2	Task Planning and Communication for Shop Floor Reconfiguration	28
1.4.3	Facility and Workload Modeling	29
	References	30

Part II Cooperating Robots: Robot-Robot Cooperation

2	Flexible Cooperating Robots for Reconfigurable Shop Floor	35
2.1	Introduction	35
2.1.1	Fixed Assembly Line	36
2.1.2	Flexible Assembly Systems	37
2.1.3	Illustrative Industrial Example	39
2.2	Approach for Controlling Flexible Assembly Systems with Cooperating Robots	41
2.2.1	Unit Level Control Logic	44
2.2.2	Line Level Control Logic	50

2.2.3	Service Oriented Approach for System Integration and Communication	56
2.3	Real World Implementation of the Robotic Cell	70
2.4	Discussion	72
	References	73
3	On the Coordination of Multiple Cooperating Robots in Flexible Assembly Systems Using Mobile Robots	75
3.1	Introduction	75
3.1.1	Manufacturing System Integration and Control	75
3.1.2	Mobile Robots and Manipulators	78
3.2	Approach	80
3.2.1	Data Model	80
3.2.2	Decision Making Triggering and Resource Negotiation Mechanisms	81
3.2.3	Integration and Communication Architecture	83
3.2.4	Mobile Robot Control Services	87
3.2.5	Execution Software System Implementation	88
3.3	Case Study	89
3.4	Discussion	91
	References	92
4	Cooperating Dexterous Robotic Resources	95
4.1	Introduction	95
4.2	Robot to Robot Cooperation	97
4.3	Robotic Perception	99
4.3.1	Training of Vision Algorithm for Object Detection	99
4.3.2	Calibration of the Vision System	100
4.3.3	Region of Interest (RoI) Identification	101
4.3.4	Hybrid 3D Vision Algorithm	102
4.3.5	Machine Learning Method	103
4.4	Dexterous Manipulation	103
4.4.1	Design of the Gripper	104
4.4.2	Implementation	107
4.5	High Speed Handling	109
4.5.1	Motion Analysis	109
4.5.2	Grasping Mechanism	109
4.5.3	Rotating Mechanism	110
4.5.4	Constraints	110
4.5.5	Integration and Networking	111
4.5.6	Hardware and Software Implementation	111
4.5.7	Use Case from Consumer Goods Industry	114
4.6	Discussion	118
	References	118

5	Cooperative Manipulation—The Case of Dual Arm Robots	123
5.1	Introduction	123
5.2	State of the Art Solutions	124
5.3	Approach	125
5.4	Industrial Relevance and Examples	126
5.4.1	Heavy Part Grasping with a Dual Arm Robot	127
5.4.2	Parts Grasping and Screwing Processes	127
5.5	Discussion	129
	References	131
6	An Approach for Validating the Behavior of Autonomous Robots in a Virtual Environment	133
6.1	Introduction	133
6.1.1	Virtual Commissioning and Simulation Tools	135
6.2	Virtual Resources Modeling	136
6.2.1	Services of Robotic Resources	136
6.2.2	Data Model	138
6.2.3	Ontology	138
6.2.4	Simulation Tool	139
6.3	Illustrative Virtual Validation Example	140
6.3.1	Actual Assembly Cell	140
6.3.2	Virtual Assembly Cell	142
6.4	Discussion	143
	References	144
7	Physically Interacting Cooperating Robots for Material Transfer	145
7.1	Introduction	145
7.2	Approach	146
7.3	Implementation	148
7.4	Industrial Example	155
7.5	Discussion	157
	References	158
8	Generating Motion of Cooperating Robots—The Dual Arm Case	159
8.1	Introduction	159
8.2	Related Work	161
8.3	Approach	162
8.4	Industrial Example	168
8.5	Discussion	172
	References	173

9	Physics Based Modeling and Simulation of Robot Arms	175
9.1	Introduction	175
9.2	Approach	178
9.2.1	Physical-Based Simulation Modeling	179
9.2.2	Numerical Estimation Method	182
9.2.3	Identification Procedure	183
9.3	Industrial Examples	185
9.3.1	Single Robot Operation—Implementation	185
9.3.2	Experiments and Results	186
9.3.3	Cooperating Robot Concept—Implementation	189
9.3.4	Mechanical Structure Model	195
9.3.5	Gearbox Model	196
9.4	Full Robot Models	197
9.5	Discussion	201
	References	202
10	Vision Guided Robots. Calibration and Motion Correction	205
10.1	Introduction	205
10.2	Calculating 3D Coordinates Using Stereo Vision	207
10.2.1	Stereo Triangulation Principle	208
10.2.2	The Correspondence Problem	209
10.2.3	Physical Setup for Stereo Triangulation	210
10.2.4	Images Capturing	212
10.2.5	Images Un-Distortion and Rectification	212
10.2.6	Image Features Correspondence	214
10.3	Calibration of Camera and Robot Base Frames	215
10.3.1	Identification of Parameters	217
10.3.2	Physical Setup for Calibrating Camera Frame and Robot Base Frame	219
10.3.3	Accuracy Aspects	219
10.4	Robot Path Correction	221
10.5	Discussion	222
	References	222
11	Cooperating Robots for Smart and Autonomous Intralogistics	223
11.1	Introduction	223
11.2	Approach	225
11.2.1	Shared Data Repository	227
11.2.2	Decisional Level	228
11.2.3	Execution Control Level	233
11.2.4	Physical Level	234
11.3	Implementation	235
11.4	Industrial Example	237
11.4.1	Discrete Event Simulation (DES)	238
11.5	Discussion	242
	References	243

12 Robots for Material Removal Processes	245
12.1 Introduction	245
12.2 Approach	246
12.2.1 Case Study	247
12.3 Discussion	251
References	252
 Part III Cooperating Robots: Human-Robot Collaboration	
13 Workplace Generation for Human-Robot Collaboration	255
13.1 Introduction	255
13.2 State-of-the-Art Solutions	256
13.3 Approach	256
13.3.1 Multiple Criteria Evaluation	258
13.4 Industrial Example	263
13.5 Discussion	266
References	267
14 Dynamic Safety Zones in Human Robot Collaboration	271
14.1 Introduction	271
14.2 Approach	272
14.2.1 Virtual Safety Zones' Configuration	272
14.2.2 Real Time Human Robot Distance Monitoring—Static Virtual Zones	274
14.2.3 Dynamically Switching Safety Zones	277
14.3 Implementation	280
14.3.1 Real Time Human Robot Distance Monitoring—Static Virtual Zones	280
14.3.2 Dynamically Switching Safety Zones	281
14.4 Industrial Example	282
14.4.1 Real Time Human Robot Distance Monitoring—Static Virtual Zones	282
14.4.2 Dynamically Switching Safety Zones	283
14.5 Discussion	285
References	286
15 Seamless Human-Robot Interaction	289
15.1 Introduction	289
15.2 HRI Functionalities for the Programming Phase	290
15.2.1 User Calibration	290
15.2.2 Programming Phase	291
15.3 HRI Functionalities for the Execution Phase	293
15.3.1 Assembly Process Information	293
15.3.2 Robot Motion and Workspace Visualization	293
15.3.3 Visual Alerts	295
15.3.4 Assembly Status Reporting	295

15.3.5	Running Task Information	296
15.3.6	Production Line Data	297
15.4	System Architecture—Control System	297
15.4.1	Control System Without Digital Twin	298
15.5	Industrial Example	301
15.6	Discussion	303
	References	305
16	Gesture-Based Interaction of Humans with Dual Arm Robot	309
16.1	Introduction	309
16.2	Approach	311
16.3	Industrial Example	314
16.3.1	High Level Commands for Programming	314
16.3.2	High Level Commands for Interaction During Execution	315
16.4	Discussion	316
	References	317
17	Synthesis of Data from Multiple Sensors and Wearables for Human-Robot Collaboration	321
17.1	Introduction	321
17.2	Approach	323
17.2.1	Requirements	323
17.2.2	Design	324
17.3	Implementation	325
17.3.1	Perception	325
17.3.2	Intelligent Multimodal Interfaces	327
17.3.3	Safety	329
17.3.4	Integration and Communication Architecture	332
17.4	Industrial Example	333
17.5	Discussion	335
	References	337
18	Virtual Reality for Programming Cooperating Robots Based on Human Motion Mimicking	339
18.1	Introduction	339
18.2	State-of-the-Art Solutions	340
18.3	Approach	340
18.3.1	Hierarchical Model for Programming	340
18.3.2	Human Motion Data Capturing and Processing	343
18.3.3	Human Motion Data Fitting	344
18.3.4	Motion Identification and Classification	345
18.3.5	Human Robot Frames Transformation	345
18.3.6	System Implementation	347
18.4	Industrial Example	348
18.4.1	Cable Handling Use Case	348

18.4.2	Results	349
18.5	Discussion	351
	References	351
19	Mobile Dual Arm Robots in Cooperation with Humans	355
19.1	Introduction	355
19.2	Approach	356
19.2.1	Mobility in Resource Level	357
19.2.2	Mobility in Product Level	358
19.2.3	Shopfloor Virtual Representation—Digital World Model	359
19.2.4	Real Time Robot Behavior Adaptation	363
19.3	Implementation	365
19.4	Industrial Example	366
19.4.1	Current State—Manual Assembly	366
19.4.2	Hybrid Production Paradigm	367
19.5	Discussion	370
19.6	Conclusions and Ongoing Research	371
	References	372
20	Allocation of Manufacturing Tasks to Humans and Robots	373
20.1	Introduction	373
20.2	Related Work	374
20.3	Approach	375
20.4	Industrial Example	376
20.5	Discussion	378
	References	379
21	Sensoreless Detection of Robot Collision with Humans	381
21.1	Introduction	381
21.2	Approach	382
21.2.1	Task 1: Monitoring and Filtering of Robot's Current and Position Signals	385
21.2.2	Task 2: Prediction of Nominal Industrial Robot's Current Signals	386
21.2.3	Task 3: Inverse Dynamic Modelling	387
21.2.4	Task 4: Simulation and Prediction of Nominal Current Signals	387
21.3	Industrial Example	392
21.3.1	Implementation	392
21.3.2	Data Collection and Filtering—Implementation	392
21.3.3	Robot Modelling and Simulation	393
21.3.4	Implementation of Supervised NN for Prediction Improvement	394
21.3.5	Safety Conditions Determination and Safe Mode	394
21.3.6	Integration and Communication Architecture	395

21.3.7 Experiments and Results	395
21.4 Conclusions	400
References	400

Part IV Epilogue

22 Epilogue and Outlook	405
22.1 Emerging Technology	406
22.2 Social and Ethical Aspects	407
22.3 The Need for Life-Long Education and the Teaching Factory ...	408
References	408