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Tine Lefebvre · Herman Bruyninckx · Joris De Schutter

Nonlinear Kalman Filtering for Force-Controlled Robot Tasks

With 86 Figures and 10 Tables

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Foreword

At the dawn of the new millennium, robotics is undergoing a major transformation in scope and dimension. From a largely dominant industrial focus, robotics is rapidly expanding into the challenges of unstructured environments. Interacting with, assisting, serving, and exploring with humans, the emerging robots will increasingly touch people and their lives.

The goal of the new series of Springer Tracts in Advanced Robotics (STAR) is to bring, in a timely fashion, the latest advances and developments in robotics on the basis of their significance and quality. It is our hope that the wider dissemination of research developments will stimulate more exchanges and collaborations among the research community and contribute to further advancement of this rapidly growing field.

The monograph written by Tine Lefebvre, Herman Bruyninckx and Joris De Schutter is focused on how to achieve more robot autonomy by means of reliable processing skills. The latest developments in the areas of contact modelling, nonlinear parameter estimation and task plan optimisation for improved estimation accuracy are discussed. Kalman filtering techniques are applied to identify the contact state based on force sensing between a grasped object and the environment. The potential of the work is to be found not only for industrial robot operation in space, sub-sea or nuclear scenarios, but also for service robots operating in unstructured environments co-habited by humans where autonomous compliant tasks require active sensing.

Remarkably, the doctoral thesis at the basis of this monograph was a finalist for the Fourth EURON Georges Giralt PhD Award devoted to the best PhD thesis in Robotics in Europe. A fine addition to the series!

Naples, Italy,
June 2005

Bruno Siciliano
STAR Editor

Preface

During the last decades, a number of “smart machines” entered our homes: washing machines, vacuum cleaners, entertainment pet robots, . . . This makes us dream about the next generation of service robots which take over household chores. However, several major difficulties have yet to be overcome before this dream can come true. One of these difficulties is to make contact in a safe and controlled way with inaccurately positioned objects.

More robot autonomy can only be achieved by reliable sensor processing skills. This book describes the latest developments in the areas of contact modelling, nonlinear parameter estimation and task plan optimisation for improved estimation accuracy. The obtained autonomy is indispensable for the execution of tasks with inaccurately known objects and for tasks in environments that do not allow a precise positioning of the objects. Application areas include industrial robot operation in space, sub-sea or nuclear environments. The same research is relevant for service robots operating in environments that have been designed for humans and where even simple tasks require a lot of sensing.

Meise, Leuven, Belgium,
March 2005

*Tine Lefebvre
Herman Bruyninckx
Joris De Schutter*

No book, however small, is produced without the help of others. This monograph is the result of four years of PhD research at the Division of Production Engineering, Machine Design & Automation (PMA), Department of Mechanical Engineering, Katholieke Universiteit Leuven, Belgium. I am grateful to all people who contributed to this work. I would like to give a special

word of thanks to my supervisors Joris De Schutter and Herman Bruyninckx for offering me support and guidance and at the same time giving me the freedom to choose my research niche. Also many thanks to the Fund for Scientific Research Flanders for providing a fellowship for this research. Last but not least, I am indebted to my parents who always encouraged and supported me to study something in which I was interested.

Meise, Belgium,
March 2005

Tine Lefebvre

Contents

1	Introduction	1
1.1	Introduction	1
1.2	Autonomous Compliant Motion	4
1.3	Recursive State Estimation for Nonlinear Systems	7
1.4	Overview of this Work	8
2	Literature Survey: Autonomous Compliant Motion	11
2.1	Introduction	11
2.2	Force Control	12
2.3	Parameter Estimation and CF Recognition	12
2.3.1	Estimation of the Geometrical Parameters	13
2.3.2	CF Recognition	14
2.3.3	Estimation in this Work	17
2.4	Fine-Motion Planning Under Uncertainty	17
2.4.1	Task Skeletons	18
2.4.2	Planning in Configuration Space	18
2.4.3	Planning in Contact Space	19
2.4.4	Learning Task Plans	20
2.4.5	Active Sensing	22
2.4.6	Planning in this Work	23
2.5	Conclusions	23
3	Literature Survey: Bayesian Probability Theory	25
3.1	Introduction	25
3.2	Bayesian Versus Classical Statistics	26
3.3	Bayesian Filtering	30
3.3.1	Bayesian Filtering Theory	31
3.3.2	Bayesian Filtering in this Work	33
3.4	Hypothesis Testing	34
3.4.1	General Hypothesis Testing	35
3.4.2	Model Selection for Switching Models	35
3.4.3	Likelihood for Parameterised Models	37
3.4.4	Hypothesis Testing in this Work	40

3.5	Information Measures	40
3.5.1	Entropy	41
3.5.2	Covariance Matrix	42
3.5.3	Entropy Versus Covariance Matrix	44
3.5.4	Information Measures in this Work	45
3.6	Optimisation Under Uncertainty	45
3.6.1	Markov Decision Process	46
3.6.2	Partially Observable Markov Decision Process	47
3.6.3	Task Planning for Compliant Motion	48
3.7	Conclusions	48
4	Kalman Filters for Nonlinear Systems	51
4.1	Introduction	51
4.2	The Linear Regression Kalman Filter	55
4.2.1	Process Update	55
4.2.2	Measurement Update	56
4.2.3	The UKF, CDF and DD1 Filters	58
4.3	Consistency and Information Content of the Estimates	59
4.4	Nonlinear Process Models	61
4.4.1	The (Iterated) Extended Kalman Filter	61
4.4.2	The Linear Regression Kalman Filter	62
4.4.3	Extra Process Model Uncertainty	62
4.4.4	Examples	62
4.4.5	Conclusion: The Process Update	66
4.5	Nonlinear Measurement Models	66
4.5.1	The Extended Kalman Filter	66
4.5.2	The Iterated Extended Kalman Filter	67
4.5.3	The Linear Regression Kalman Filter	68
4.5.4	Extra Measurement Model Uncertainty	68
4.5.5	Examples	69
4.5.6	Conclusion: The Measurement Update	74
4.6	Conclusions	75
5	The Non-Minimal State Kalman Filter	77
5.1	Introduction	77
5.2	The Non-Minimal State Kalman Filter for Static Systems	78
5.2.1	Analytical Posterior Pdf	78
5.2.2	Retrieving an Estimate for the Original State $\mathbf{x}$	80
5.2.3	Prior Information	82
5.2.4	Example	83
5.3	The Non-Minimal State Kalman Filter for Dynamic Systems ..	87
5.3.1	Analytical Posterior Pdf	87
5.3.2	Retrieving an Estimate for the Original State $\mathbf{x}$	89
5.3.3	Experiment	90
5.4	Conclusions	93

6	Contact Modelling	95
6.1	Introduction	95
6.2	Problem Statement and Definitions	96
6.3	Contact Modelling	100
6.3.1	Closure Equations	100
6.3.2	Twist and Wrench Equations	101
6.3.3	Effect of Friction	101
6.4	Modelling Based on a Library of Elementary CFs	102
6.4.1	Multiple-Contact CFs	102
6.4.2	Polyhedral CFs	103
6.4.3	Non-Minimal Contact Descriptions	105
6.5	Polyhedral Elementary CFs	105
6.5.1	Vertex-Face CF	105
6.5.2	Edge-Edge CF	107
6.5.3	Face-Vertex CF	109
6.6	Non-Polyhedral Elementary CFs	111
6.6.1	Vertex-Cylinder CF	111
6.6.2	Ball-Face CF	114
6.6.3	Ball-Cylinder CF	115
6.7	Examples	116
6.8	Conclusions	119
7	Geometrical Parameter Estimation and CF Recognition	121
7.1	Introduction	121
7.2	Measurement Models	122
7.2.1	Twist and Wrench Measurement Models	122
7.2.2	Closure Versus Twist Measurement Equations	123
7.2.3	Uncertainty on the Models	124
7.3	Geometrical Parameter Estimation in a CF	125
7.3.1	Implicit Measurement Equations	125
7.3.2	Kalman Filter Estimators	126
7.3.3	Non-Minimal Contact Description	130
7.3.4	Accuracy Limitation	130
7.3.5	Partial Observation	132
7.4	Detection of CF Transitions and CF Recognition	133
7.4.1	Detection of CF Transitions	133
7.4.2	Detection of Transient Control Behaviour	134
7.4.3	Recognising the CF	134
7.4.4	Propagation of Geometrical Parameter Estimates	135
7.5	Conclusions and Future Work	136
8	Experiment: A Cube-In-Corner Assembly	139
8.1	Introduction	139
8.2	Experiment Description	139
8.3	IEKF Results for Small Uncertainties	141
8.4	IEKF Results for Large Uncertainties	149
8.5	NMSKF Results for Large Uncertainties	150
8.6	Conclusions	164

9	Task Planning with Active Sensing	165
9.1	Introduction	165
9.2	Measurement Information	167
9.2.1	Measure of Information	168
9.2.2	Information in a Single Measurement	169
9.2.3	CF-Observable Parameter Space	171
9.3	General Active Sensing Task Plan	173
9.3.1	Optimisation Problem	174
9.3.2	Decoupling of the Optimisation Problem	174
9.3.3	Transition Motion	177
9.4	CF Sequence	180
9.4.1	Optimisation Solution	181
9.4.2	Example	183
9.5	Active Sensing Motion	190
9.5.1	Heuristic Solution	190
9.5.2	Solution by Optimisation	191
9.5.3	Example	193
9.6	Task Execution and Online Re-planning	196
9.7	Conclusions	197
10	General Conclusions	199
10.1	Main Topics	199
10.2	Limitations and Future Work	203
10.3	Fast Model Building: A New Research Direction	204
A	The Linear Regression Kalman Filter	205
A.1	Statistical Linear Regression	205
A.2	The LRKF Process Update	206
A.3	The LRKF Measurement Update	208
B	The Non-Minimal State Kalman Filter	211
B.1	The NMSKF for Static Systems	211
B.2	The NMSKF for Dynamic Systems	213
C	Frame Transformations	219
D	Kalman Filtering for Non-Minimal Measurement Models	223
E	Partial Observation with the Kalman Filter	227
F	A NMSKF Linearizing State for the Geometrical Parameter Estimation	231
F.1	Choice of a Linearizing State $\mathbf{x}'$	231
F.2	Details for a Vertex-Face CF	232

G	CF-Observable Parameter Space for Twist and Pose Measurements	235
G.1	The Matrix $\mathbf{H}_k$ Defines the Space of Observed Parameter Directions	236
G.2	CF-Observable Parameter Space for All Twists at One Pose	237
G.3	CF-Observable Parameter Space for All Twists at All Poses	238
G.4	Multiple-Contact CFs	238
	References	241
	Index	259
	Symbols, Definitions and Abbreviations	261