

Contents

List of Figures	xv
List of Tables	xx
CHAPTER 1 Introduction	1
1.1 Motivation	3
1.2 Problem statement	5
1.3 Thesis goals	6
1.4 Thesis approach	7
1.5 Research methodology	9
1.6 Thesis context	10
1.7 Outline of this thesis	11
CHAPTER 2 Background	13
2.1 Human-Computer Interaction	14
2.1.1 Design methodologies	14
2.1.2 Interaction Modalities	16
2.1.3 Multimodal interaction	18
2.1.4 Analysis and discussion	20
2.2 Context-Aware Computing	20
2.2.1 Context of use	22
2.2.2 Context sensing	24
2.2.3 Context models	25
2.2.4 Context-Awareness as enabler for Autonomic Computing .	26
2.2.5 Reinforcement Learning	28
2.2.6 Analysis and discussion	29

2.3 Considerate Computing	30
2.3.1 Receiving and managing interruptions	33
2.3.2 Contextual factors that influence interruption	34
2.3.3 Cognitive aspects of interruptions	36
2.3.4 Analysis and discussion	37
2.4 Conclusions	38
CHAPTER 3 State of the Art	39
3.1 Analysis criteria	40
3.2 Context-Aware User Interfaces	45
3.2.1 Analysis and discussion	52
3.3 Attentive User Interfaces	55
3.3.1 Analysis and discussion	61
3.4 Non-Intrusive Ubiquitous Computing	64
3.4.1 Analysis and discussion	69
3.5 Discussion of previous systems	73
3.5.1 Characteristics of our proposal	73
3.6 Conclusions	75
CHAPTER 4 Overview of the Proposal	77
4.1 Point of view	79
4.2 Main building blocks	81
4.3 Systems' infrastructure	89
4.4 Evaluation of our approach	93
4.5 Conclusions	96
CHAPTER 5 A Framework for Interaction Obtrusiveness Adaptation	99
5.1 User-centered design method overview	101
5.1.1 Why a modeling approach?	101
5.1.2 Steps of the user-centered design process	104
5.2 Obtrusiveness requirements definition	106
5.2.1 User interviews and observations	107
5.2.2 Persona definition	108
5.2.3 Services and obtrusiveness definition	111
5.3 Modeling	113

5.3.1	Obtrusiveness modeling	113
5.3.2	Context modeling	118
5.3.3	Interaction variability modeling	122
5.3.4	Concrete interaction modeling	128
5.4	Simulation	132
5.4.1	Requirements for the evaluation	133
5.4.2	Fast-prototyping for interaction obtrusiveness adaptation .	134
5.4.3	Models refinement	139
5.5	Discussion of our design method	140
5.6	Conclusions	143
CHAPTER 6 Self-Regulating Interactions Through Models at Runtime		145
6.1	System implementation	147
6.1.1	Glue code generation	149
6.2	The self-regulating system	163
6.3	AdaptIO: an infrastructure for adapting interaction obtrusiveness	168
6.3.1	The Autonomic Infrastructure	169
6.4	Deployment of the infrastructure	180
6.4.1	Server Side Subsystem	181
6.4.2	Client side subsystem: managed systems	182
6.5	Applying AdaptIO to non-adaptive services	186
6.6	Scalability evaluation	188
6.7	Conclusions	191
CHAPTER 7 Exploiting the User Feedback		193
7.1	Characterization of the obtrusiveness adaptation	195
7.2	The reinforcement learning strategy	198
7.2.1	Applying RL to our approach	199
7.2.2	Obtaining the Feedback	200
7.2.3	Running the Reinforcement Learning algorithm	201
7.2.4	Adjusting an obtrusiveness level	203
7.2.5	An application example	204
7.3	The customization interfaces for end-users	206
7.3.1	Obtrusiveness Personalization interface	209

7.3.2	User Situation Specification interface	214
7.4	Reinforcement evaluation	219
7.4.1	Case study description	220
7.4.2	Evaluation procedure and results	221
7.5	Conclusions	222
CHAPTER 8 Validation of the proposal		225
8.1	Smart Home case study	228
8.1.1	Design of the case study	228
8.1.2	Applying our design method	229
8.1.3	Evaluating the design method	238
8.1.4	Simulating the design	244
8.2	Adaptive Notifications case study	249
8.2.1	Design of the case study	250
8.2.2	Evaluating the User Experience	251
8.2.3	Evaluating the customization interfaces	256
8.3	Experiences applying our approach	260
8.3.1	User Routine Tasks: Smart Hotel	260
8.3.2	Smart Library	263
8.3.3	HomeCare	265
8.4	Discussion of the results	267
8.4.1	Benefits obtained	267
8.4.2	Limitations detected	269
8.5	Conclusions	270
CHAPTER 9 Conclusions and Future Work		271
9.1	Contributions	272
9.2	Publications	273
9.2.1	Relevance of the publications	276
9.3	Projects codirected	279
9.4	Future work	279
9.5	Final remarks	281
Appendix		282
APPENDIX A Metamodels & Tool Support		283

A.1	The AdaptIO modeling language	284
A.1.1	The persona model metamodel	286
A.1.2	The obtrusiveness model metamodel	287
A.1.3	The feature model metamodel	289
A.1.4	The context model metamodel	297
A.1.5	The Android components metamodel	299
A.1.6	Relationships between metamodels	300
A.2	Model-based validation	301
A.2.1	Constraints on models	302
A.2.2	Reasoning on feature models with FAMA	303
APPENDIX B	Adaptive Notifications case study & Evaluation Instruments	307
B.1	Adaptive Notifications case study	307
B.1.1	Applying our design method	307
B.2	Instruments used in the evaluations	315
B.2.1	Usability evaluation of the design method	316
B.2.2	User satisfaction evaluation	320
B.2.3	User experience evaluation	324
B.2.4	Customization interfaces evaluation	326
Bibliography		329