

**A REUSABLE APPLICATION FRAMEWORK
FOR CONTEXT-AWARE MOBILE PATIENT
MONITORING SYSTEMS**

MAHMOOD GHALEB MAHMOOD AL-BASHAYREH

**DOCTOR OF PHILOSOPHY
UNIVERSITI UTARA MALAYSIA
2014**

Permission to Use

In presenting this thesis in fulfilment of the requirements for a postgraduate degree from Universiti Utara Malaysia, I agree that the Universiti Library may make it freely available for inspection. I further agree that permission for the copying of this thesis in any manner, in whole or in part, for scholarly purpose may be granted by my supervisor(s) or, in their absence, by the Dean of Awang Had Salleh Graduate School of Arts and Sciences. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to Universiti Utara Malaysia for any scholarly use which may be made of any material from my thesis.

Requests for permission to copy or to make other use of materials in this thesis, in whole or in part, should be addressed to:

Dean of Awang Had Salleh Graduate School of Arts and Sciences
UUM College of Arts and Sciences
Universiti Utara Malaysia
06010 UUM Sintok

Abstrak

Pembangunan Sistem Pemantauan Konteks Sedar Pesakit Mudah Alih (CaMPaMS) menggunakan sensor tanpa wayar adalah sangat kompleks. Untuk mengatasi masalah ini, Rangka Kerja Pemantauan Konteks Sedar Pesakit Mudah Alih (CaMPaMF) telah diperkenalkan sebagai satu teknik yang sesuai untuk meningkatkan kualiti keseluruhan pembangunan dan mengatasi kerumitan pembangunan CaMPaMS. Walaupun terdapat beberapa kajian yang mereka bentuk CaMPaMF yang boleh digunakan semula, masih belum ada lagi kajian yang memfokus kepada bagaimana mereka bentuk dan menilai rangka kerja aplikasi berdasarkan aspek kebolehgunaan semula berganda dan menggunakan pendekatan penilaian kebolehgunaan semula berganda. Tambahan pula, tiada kajian yang mengintegrasikan kesemua keperluan domain CaMPaMS. Oleh itu, tujuan kajian ini adalah untuk mereka bentuk CaMPaMF yang boleh digunakan semula untuk CaMPaMS. Untuk mencapai matlamat ini, dua belas kaedah telah digunakan: kajian literatur, analisis kandungan, matriks konsep, pemodelan ciri, penggunaan pelbagai kes, kajian pakar domain, model yang berasaskan pendekatan senibina, analisis kod statik, pendekatan model kebolehgunaan semula dan prototaip, pengiraan jumlah nilai penggunaan semula, dan kajian pakar perisian. Hasil utama kajian ini adalah CaMPaMF boleh digunakan semula yang direka bentuk dan dinilai agar ia mengandungi pelbagai aspek kebolehgunaan semula. CaMPaMF terdiri daripada model domain yang disahkan oleh doktor pakar runding sebagai pakar domain, model seni bina, model platform bebas, model platform khusus yang disahkan oleh pakar perisian, dan tiga prototaip CaMPaMS untuk memantau pesakit tekanan darah tinggi, sawan, atau penyakit kencing manis, dan pelbagai pendekatan penilaian kebolehgunaan semula. Kajian ini menyumbang kepada badan pengetahuan kejuruteraan perisian, terutamanya dalam bidang mereka bentuk dan menilai rangka kerja aplikasi yang boleh digunakan semula. Penyelidik boleh menggunakan model domain untuk meningkatkan kefahaman tentang kehendak domain CaMPaMS, sekali gus diperluaskan dengan keperluan baharu. Pembangun juga boleh menggunakan semula dan memperluaskan CaMPaMF untuk membangunkan pelbagai CaMPaMS untuk pesakit yang berbeza. Industri perisian juga boleh menggunakan semula CaMPaMF untuk mengurangkan keperluan untuk berunding dengan pakar domain dan mengurangkan masa pembangunan CaMPaMS.

Kata kunci: Rangka kerja aplikasi guna semula, Penilaian kerangka kerja aplikasi kebolehgunaan semula berganda, Aspek kebolehgunaan semula berganda, Sistem pemantauan pesakit mudah alih

Abstract

The development of Context-aware Mobile Patient Monitoring Systems (CaMPaMS) using wireless sensors is very complex. To overcome this problem, the Context-aware Mobile Patient Monitoring Framework (CaMPaMF) was introduced as an ideal reuse technique to enhance the overall development quality and overcome the development complexity of CaMPaMS. While a few studies have designed reusable CaMPaMFs, there has not been enough study looking at how to design and evaluate application frameworks based on multiple reusability aspects and multiple reusability evaluation approaches. Furthermore, there also has not been enough study that integrates the identified domain requirements of CaMPaMS. Therefore, the aim of this research is to design a reusable CaMPaMF for CaMPaMS. To achieve this aim, twelve methods were used: literature search, content analysis, concept matrix, feature modelling, use case assortment, domain expert review, model-driven architecture approach, static code analysis, reusability model approach, prototyping, amount of reuse calculation, and software expert review. The primary outcome of this research is a reusable CaMPaMF designed and evaluated to capture reusability from different aspects. CaMPaMF includes a domain model validated by consultant physicians as domain experts, an architectural model, a platform-independent model, a platform-specific model validated by software expert review, and three CaMPaMS prototypes for monitoring patients with hypertension, epilepsy, or diabetes, and multiple reusability evaluation approaches. This research contributes to the body of software engineering knowledge, particularly in the area of design and evaluation of reusable application frameworks. Researchers can use the domain model to enhance the understanding of CaMPaMS domain requirements, thus extend it with new requirements. Developers can also reuse and extend CaMPaMF to develop various CaMPaMS for different diseases. Software industries can also reuse CaMPaMF to reduce the need to consult domain experts and the time required to build CaMPaMS from scratch, thus reducing the development cost and time.

Keywords: Reusable application framework, Multiple reusability evaluation approaches, Multiple reusability aspects, Mobile patient monitoring systems

Acknowledgement

All thanks and praises are due to Allah, who provides me with the substance, time, health, strength of mind, and patience to engage in this journey to acquire knowledge.

I would like to express my deepest appreciation and gratitude to my supervisor Dr Nor Laily Hashim for her continuous guidance and support from start to finish. I offer a special thank you for her motivation and support in helping me to publish my work. It has been a great pleasure to work under her supervision.

I would like to record special thanks to my father Galeb and my mother Sabah. Words fail to express my appreciation to them and without their unconditional prayers, support, and love I could not have completed, or even started, my study. My Lord, have mercy upon them as they have taught me a lot and to be whom I am today.

Praise be to Allah again, who blessed me with my wife Ola and my son Abdul Rahman. Thank you Ola for your patience, understanding, and for your real trust in my capabilities. Thank you for your continuous motivation, support, and love. Thank you Abdul Rahman for your smile that gave me the strength to keep going no matter what I faced during my study.

I would like also to thank my brothers Malek and Fares as well as my sisters Ala' and Eman. Thank you for your love, support, prayers, and for everything you did for me.

Finally, thank you for all of you for being the reasons to realize this dream. I am indebted to all of you more than you know.

Mahmood Ghaleb Al-Bashayreh

August 2013

Dedication

To my mother Sabah and my father Gheleb

To my dear wife Ola

To my dear son AbdulRahman

To my brothers, Malek & Fares and my sisters Ala' and Eman

Table of Contents

Permission to Use.....	3
Abstrak	4
Abstract	5
Acknowledgement.....	6
Dedication	7
Table of Contents	8
List of Tables.....	13
List of Figures	15
List of Abbreviations.....	16
CHAPTER ONE INTRODUCTION	1
1.1. Overview	1
1.2. Research Background and Motivation	1
1.3. Research Problem.....	8
1.3.1. Statement of Problem.....	10
1.4. Research Questions	10
1.5. Research Objectives	11
1.6. Research Scope	11
1.7. Research Framework.....	12
1.8. Research Significance	16
1.9. Thesis Outline	18
CHAPTER TWO SOFTWARE REUSE AND APPLICATION FRAMEWORKS FOR CAMPAMS	20
2.1. Overview	20
2.2. Reuse-Based Software Engineering	20
2.2.1. Benefits of Software Reuse.....	21
2.2.2. Approaches of Software Reuse	22
2.2.3. Application Framework versus Other Reuse Approaches	24
2.2.4. Evaluation of Software Reuse.....	27
2.3. What Is Software Frameworks?	32
2.4. Development of Software Frameworks	33

2.4.1. Domain Analysis	35
2.4.2. Architectural Design	40
2.4.3. Framework Design and Implementation	42
2.4.4. Framework Testing	46
2.4.5. Framework Documentation.....	46
2.5. CaMPaMS in Biomedical Informatics Domain	47
2.5.1. Biomedical Informatics Domain	47
2.5.2. Context-Aware Mobile Patient Monitoring Systems.....	49
2.6. Software Framework for Biomedical Informatics Domain	55
2.6.1. Reusability of Application Frameworks	55
2.6.2. Domain Requirements for CaMPaMS	56
2.7. Lacks and Gaps Identification Based on Previous Studies	68
2.8. Summary	71
CHAPTER THREE METHODOLOGY	73
3.1. Overview	73
3.2. Design Research.....	73
3.3. Pragmatic Research Paradigm.....	74
3.4. Design Research Methodology	75
3.5. Stage 1: Research Clarification	77
3.5.1. Literature Review Process	77
3.5.2. Lacks and Gaps Identification Process	80
3.6. Stage 2: Descriptive Study 1	81
3.6.1. Domain Analysis Process.....	82
3.7. Stage 3: Prescriptive Study	87
3.7.1. Architectural Design Process	88
3.7.2. Framework Design and Implementation Process.....	88
3.8. Stage 4: Descriptive Study 2	92
3.8.1. Framework Testing and Documentation Process.....	92
3.9. Summary	97
CHAPTER FOUR DOMAIN ANALYSIS.....	98
4.1. Overview	98
4.2. Feature Modelling	98

4.2.1. Anywhere, Anytime Monitoring.....	102
4.2.2. Real-Time Continuous Monitoring.....	102
4.2.3. Unlimited Number of Sensors.....	102
4.2.4. Unlimited Number of Monitoring Applications	103
4.2.5. Context-Aware Monitoring Query.....	103
4.3. Abstract Use Case Modelling	110
4.4. Domain Model Validation.....	112
4.4.1. Authoring Scenarios.....	112
4.4.2. Domain Expert Review	120
4.5. Summary	127
CHAPTER FIVE FRAMEWORK DESIGN AND IMPLEMENTATION.....	128
5.1. Overview	128
5.2. Identify Quality Attributes	128
5.3. Select Architectural Styles	128
5.4. Construct the Architectural Diagram	129
5.4.1. Context Monitoring Layer	131
5.4.2. Context Characterization Layer	134
5.5. PIM Development	136
5.5.1. Hot Spots and Frozen Spots	139
5.5.2. Design Patterns and Design Principles	153
5.5.3. Sequence Diagram	157
5.6. PSM Development	177
5.7. Code Development.....	178
5.7.1. IDataValue Default Implementation	178
5.7.2. IDataValueFactory Default Implementation.....	178
5.7.3. AbstractNotificationEventArgs Default Implementation	181
5.7.4. IPatientProfileRepository Default Implementation	181
5.7.5. IConnectionArgs Default Implementation.....	181
5.7.6. IDataSourceConnectorFactory Default Implementation	181
5.7.7. IDataConverter Default Implementation	181
5.7.8. IDataConverterFactory Default Implementation	182
5.7.9. IThresholdValue Default Implementation	182

5.7.10. IThresholdValueFactory Default Implementation	182
5.7.11. IUnaryEvaluationOperator Default Implementation.....	182
5.7.12. IUnaryEvaluationOperatorFactory Default Implementation	183
5.7.13. IBinaryEvaluationOperator Default Implementation.....	183
5.7.14. IBinaryEvaluationOperatorFactory Default Implementation	183
5.7.15. ISetEvaluationOperator Default Implementation	183
5.7.16. ISetEvaluationOperatorFactory Default Implementation	184
5.7.17. IUnaryQueryElement Default Implementation.....	184
5.7.18. IBinaryQueryElement Default Implementation.....	184
5.7.19. ISetQueryElement Default Implementation.....	184
5.7.20. IContextMonitoringQueryEvaluator Default Implementation.....	184
5.7.21. IContextMonitoringQuery Default Implementation	184
5.7.22. IMonitoringQueryRepository Default Implementation	185
5.8. Summary	185
CHAPTER SIX FRAMEWORK TESTING AND DOCUMENTATION.....	187
6.1. Overview	187
6.2. Framework Design Guidelines Application.....	187
6.3. Framework Reusability Evaluation Using Reusability Model	188
6.3.1. Calculate Values of Metrics	188
6.3.2. Identify Thresholds of Metrics.....	191
6.3.3. Identify Outliers	191
6.3.4. Design Review	191
6.4. Prototyping and Documentation	192
6.4.1. Framework Initialization.....	193
6.4.2. Hypertension CaMPaMS	195
6.5. Amount of Reuse Calculation	206
6.5.1. Reuse Level (RL)	207
6.5.2. Reuse Frequency (RF)	207
6.5.3. Reuse Size and Frequency (RSF).....	208
6.6. Framework Reusability Evaluation Using Software Expert Review	209
6.6.1. Demographic Profiles of Software Experts	209
6.6.2. Frequency of Responses from Software Expert Review Instrument	212

6.7. Summary	215
CHAPTER SEVEN CONCLUSION AND FUTURE WORK	216
7.1. Overview	216
7.2. Research Summary.....	216
7.2.1. Domain Model of CaMPaMS	217
7.2.2. Design of Reusable Application Framework for CaMPaMS.....	217
7.2.3. Application Framework Reusability Evaluation.....	219
7.3. Research Contributions	220
7.3.1. CaMPaMF.....	221
7.3.2. Application Framework Reusability Evaluation Approach.....	225
7.4. Research Limitations.....	228
7.5. Future Research.....	228
References	230
Vita.....	403

List of Tables

Table 2.1 <i>Benefits of Software Reuse</i>	22
Table 2.2 <i>Software Reuse Approaches</i>	23
Table 2.3 <i>The Primary Differences between Application Frameworks and Design Patterns</i>	25
Table 2.4 <i>The Primary Differences between Application Frameworks and Components</i>	26
Table 2.5 <i>The Primary Differences between Application Frameworks and Libraries</i>	26
Table 2.6 <i>Summary of Previous Studies that Support Context-Aware Monitoring ...</i>	61
Table 2.7 <i>Percentages and Proportions of Domain Requirements in Previous Studies that Designed Application Frameworks for PMS</i>	69
Table 2.8 <i>Percentages and Proportions of Sub-Domain Requirements Related to Context Awareness Computing Domain Requirement in Previous Studies that Designed Application Frameworks for PMS</i>	70
Table 3.9 <i>Concept Matrix</i>	81
Table 3.10 <i>Native Mobile Platform Languages</i>	90
Table 4.11 <i>Common Features of CaMPaMF</i>	98
Table 4.12 <i>Common Features of Context-Aware Monitoring Query Feature</i>	99
Table 4.13 <i>Variable Features of Query Alarm Feature</i>	100
Table 4.14 <i>Two Common Dimensions of Alternative Variable Features of the Query Element Feature</i>	100
Table 4.15 <i>Demographic Profiles of Experts</i>	121
Table 4.16 <i>Further Comments from the Experts</i>	127
Table 6.17 <i>Multi-Metric Approach Applied to CaMPaMF</i>	189
Table 6.18 <i>Thresholds of Metrics</i>	191
Table 6.19 <i>Outlier Values of Metrics</i>	192
Table 6.20 <i>Outlier Value Percentage</i>	192
Table 6.21 <i>Reuse Level of CaMPaMS Prototypes</i>	207
Table 6.22 <i>Reuse Frequency of CaMPaMS Prototypes</i>	208
Table 6.23 <i>Reuse Size and Frequency of CaMPaMS Prototypes</i>	209

Table 6.24 <i>Demographic Profiles of Experts</i>	209
Table 6.25 <i>Further Comments from the Software Experts</i>	215

List of Figures

<i>Figure 1.1.</i> Research framework.....	15
<i>Figure 2.2.</i> Application framework reusability model.....	30
<i>Figure 2.3.</i> Diabetes context monitoring queries.....	68
<i>Figure 3.4.</i> Research methodology	76
<i>Figure 4.5.</i> A feature model to design CaMPaMF	101
<i>Figure 4.6.</i> High BP monitoring query	104
<i>Figure 4.7.</i> Abstract use case model	111
<i>Figure 4.8.</i> Experts' specialisation	122
<i>Figure 4.9.</i> Diseases monitored by experts.....	123
<i>Figure 4.10.</i> Experts' ages	124
<i>Figure 4.11.</i> Experts' experience	124
<i>Figure 4.12.</i> Experts' genders.....	125
<i>Figure 5.13.</i> The proposed architecture of the CaMPaMF	130
<i>Figure 5.14.</i> Platform independent model	137
<i>Figure 5.15.</i> Platform specific model	179
<i>Figure 6.16.</i> CaMPaMF initialization process.....	193
<i>Figure 6.17.</i> CaMPaMF dependency graph.....	194
<i>Figure 6.18.</i> Hypertension context monitoring queries	196
<i>Figure 6.19.</i> Software experts' specialisation.....	210
<i>Figure 6.20.</i> Software experts' ages	210
<i>Figure 6.21.</i> Software experts' experience	211
<i>Figure 6.22.</i> Software experts' genders	211
<i>Figure 7.23.</i> Contributions to the software engineering body of knowledge related to software design.....	221

List of Abbreviations

BP	Blood Pressure
BT	Body Temperature
CaMPaMF	Context-aware Mobile Patient Monitoring Framework
CCL	Context Characterization Layer
CIM	Computation Independent Model
CML	Context Monitoring Layer
CaMPaMS	Context-aware Mobile Patient Monitoring Systems
DIP	Dependency Inversion Principle
DRM	Design Research Methodology
ECG	Electrocardiogram
FODA	Feature-Oriented Domain Analysis
HR	Heart Rate
ISP	Interface-Segregation Principle
JMA	Jordan Medical Association
LSP	Liskov Substitution Principle
MDA	Model Driven Architecture
MDD	Model Driven Development
MDRE	Model Driven Requirement Engineering
MPMS	Mobile Patient Monitoring Systems
OCP	Open-Closed Principle
PIM	Platform Independent Model
PMS	Patient Monitoring Systems
PSM	Platform Specific Model
RR	Respiration Rate
SRP	Single Responsibility Principle
UML	Unified Modelling Language
WBS	Wireless Body Sensors
WHO	World Health Organisation

CHAPTER ONE

INTRODUCTION

1.1. Overview

This chapter introduces the research that is presented in this thesis. The research background and motivation is described, followed by a presentation of the research problem, the research questions, and the objectives, scope and framework of the research, along with its significance. Finally, this chapter presents an outline of the whole thesis.

1.2. Research Background and Motivation

Reuse-based software engineering is a development approach that increases the reuse of existing software [1]. Software reuse is one of the fundamental software engineering concepts [2] and one of the most commonly used principles to simplify application development and overcome development complexities. Reusing software reduces the number of software assets that need to be developed and reuses well-tested assets that have been used in many systems with minimal errors. Moreover, software reuse encapsulates the knowledge of specialists [3-5].

According to [6], identifying the aspects that affect software reusability can enhance the knowledge required to build a reusable software components and identify the potential of reusing existing software modules in new a software development. Therefore, it is important to identify the aspects that can affect software reusability.

The contents of
the thesis is for
internal user
only

REFERENCES

- [1] I. Sommerville, *Software Engineering*, 9th ed. Boston, MA: Pearson, 2011.
- [2] M. Fayad, D. S. Hamu, and D. Brugali, "Enterprise Frameworks Characteristics, Criteria, and Challenges," *Communications of the ACM*, vol. 43, pp. 39-46, October 2000.
- [3] J. Sametinger, *Software Engineering with Reusable Components*. Berlin, Germany: Springer, 1997.
- [4] H. Mili, A. Mili, S. Yacoub, and E. Addy, *Reuse-Based Software Engineering: Techniques, Organizations, and Controls*: Wiley, 2001.
- [5] C. W. Krueger, "Software Reuse," *ACM Computing Surveys*, vol. 24, pp. 131-183, 1992.
- [6] J. S. Poulin, "Measuring Software Reusability," in *3rd International Conference on Software Reuse: Advances in Software Reusability*, Rio de Janeiro , Brazil 1994, pp. 126-138
- [7] S. Maggo and C. Gupta, "A Machine Learning Based Efficient Software Reusability Prediction Model for Java Based Object Oriented Software," *International Journal of Information Technology and Computer Science*, vol. 6, pp. 1-13, January 2014.
- [8] F. Taibi, "Reusability of Open-Source Program Code: A Conceptual Model and Empirical Investigation," *ACM SIGSOFT Software Engineering Notes*, vol. 38, pp. 1-5, July 2013.
- [9] K. Cwalina and B. Abrams, *Framework Design Guidelines: Conventions, Idioms, and Patterns for Reusable .Net Libraries*, 2nd ed. Upper Saddle River, NJ: Addison-Wesley, 2009.
- [10] K. Erni and C. Lewerentz, "Applying Design-Metrics to Object-Oriented Frameworks," in *3rd International Software Metrics Symposium*, Berlin, Germany, 1996, pp. 64-74.

- [11] R. N. Ferri, R. N. Pratiwadi, L. M. Rivera, M. Shakir, J. J. Snyder, D. W. Thomas, *et al.*, "Software Reuse Metrics for an Industrial Project," in *4th International Software Metrics Symposium*, Albuquerque, NM, 1997, pp. 165-173.
- [12] D. Hristov, O. Hummel, M. Huq, and W. Janjic, "Structuring Software Reusability Metrics for Component-Based Software Development," in *7th International Conference on Software Engineering Advances*, Lisbon, Portugal, 2012, pp. 421-429.
- [13] Fazal-e-Amin, A. K. Mahmood, and A. Oxley, "Reusability Assessment of Open Source Components for Software Product Lines," *International Journal on New Computer Architectures and Their Applications*, vol. 1, pp. 519-533, 2011.
- [14] S. Sagar, N. W. Nerurkar, and A. Sharma, "A Soft Computing Based Approach to Estimate Reusability of Software," *ACM SIGSOFT Software Engineering Notes*, vol. 35, pp. 1-5, July 2010.
- [15] J. Bosch, P. Molin, M. Mattsson, P. Bengtsson, and M. Fayad, "Framework Problems and Experiences," in *Building Application Frameworks: Object-Oriented Foundations of Framework Design*, M. Fayad, D. C. Schmidt, and R. E. Johnson, Eds., ed New York, NY: Wiley, 1999, pp. 55-82.
- [16] R. Binder, *Testing Object-Oriented Systems: Models, Patterns, and Tools* vol. 2. Reading, MA: Addison-Wesley, 2000.
- [17] H. Hasan, "Information Systems Development as a Research Method," *Australasian Journal of Information Systems*, vol. 11, pp. 4-13, 2003.
- [18] W. Frakes and C. Terry, "Software Reuse: Metrics and Models," *ACM Computing Surveys*, vol. 28, pp. 415-435, June 1996.
- [19] P. L. Roden, "An Examination of Stability and Reusability in Highly Iterative Software," Doctor of Philosophy, Computer Science, University of Alabama, Huntsville, AL, 2008.
- [20] W. Zhang and M. Kim, "What Works and What Does Not: An Analysis of Application Frameworks Technology," *Journal of Business Systems, Governance and Ethics*, vol. 1, pp. 15-26, November 2006.

- [21] E. J. Posnak, R. G. Lavender, and H. M. Vin, "An Adaptive Framework for Developing Multimedia Software Components," *Communications of the ACM*, vol. 40, pp. 43 - 47, October 1997.
- [22] J. v. Gorp and J. Bosch, "Role-Based Component Engineering," in *Building Reliable Component-Based Software Systems*, I. Crnkovic and M. Larsson, Eds., ed Boston, MA: Artech House, 2002, pp. 135-154.
- [23] M. Fayad, D. C. Schmidt, and R. E. Johnson, "Application Frameworks," in *Building Application Frameworks: Object-Oriented Foundations of Framework Design*, M. Fayad, D. C. Schmidt, and R. E. Johnson, Eds., ed New York, NY: Wiley, 1999, pp. 3-28.
- [24] M. E. Markiewicz and C. J. P. d. Lucena, "Object Oriented Framework Development," *Crossroads*, vol. 7, pp. 3-9, 2001.
- [25] M. Morisio, D. Romano, and I. Stamelos, "Quality, Productivity and Learning in Framework-Based Development: An Exploratory Case Study," *IEEE Transactions on Software Engineering*, vol. 28, pp. 876-888, September 2002.
- [26] J. Al-Dallal and P. Sorenson, "Reusing Class-Based Test Cases for Testing Object-Oriented Framework Interface Classes," *Journal of Software Maintenance and Evolution: Research and Practice*, vol. 17, pp. 169-196, May/June 2005.
- [27] R. Neumann, S. Günther, and N. Zenker, "Reengineering Deprecated Component Frameworks: A Case Study of the Microsoft Foundation Classes," in *9th International Conference on Business Informatics*, Vienna, Austria, 2009, pp. 737-748.
- [28] M. Mattsson, "Comparison of Three Evaluation Methods for Object-Oriented Framework Evolution," in *Software Evolution and Feedback: Theory and Practice*, N. H. Madhavji, J. C. Fernández-Ramil, and D. E. Perry, Eds., ed West Sussex, UK: Wiley, 2006, pp. 281-312.
- [29] D. Parsons, A. Rashid, A. Telea, and A. Speck, "An Architectural Pattern for Designing Component-Based Application Frameworks," *Software: Practice and Experience*, vol. 36, pp. 157-190, February 2006.

- [30] A. Tevanlinna, J. Taina, and R. Kauppinen, "Product Family Testing: A Survey," *ACM SIGSOFT Software Engineering Notes*, vol. 29, pp. 12-12, March 2004.
- [31] U. Kulesza, V. Alves, A. Garcia, C. J. P. d. Lucena, and P. Borba, "Improving Extensibility of Object-Oriented Frameworks with Aspect-Oriented Programming," in *Reuse of Off-the-Shelf Components*. vol. 4039, M. Morisio, Ed., ed Berlin, Germany: Springer, 2006, pp. 231-245.
- [32] S. P. Lee, S. K. Thin, and H. S. Liu, "Object-Oriented Application Framework on Manufacturing Domain," *Malaysian Journal of Computer Science*, vol. 13, pp. 56-64, June 2000.
- [33] D. C. Schmidt, A. Gokhale, and B. Natarajan, "Leveraging Application Frameworks," *Queue*, vol. 2, pp. 66-75, July/August 2004.
- [34] T. C. Oliveira, P. Alencar, and D. Cowan, "ReuseTool—An Extensible Tool Support for Object-Oriented Framework Reuse," *Journal of System and Software*, vol. 84, pp. 2234–2252, December 2011.
- [35] G. Booch, R. A. Maksimchuk, M. W. Engle, B. J. Young, J. Conallen, and K. A. Houston, *Object-Oriented Analysis and Design with Applications*, 3rd ed. Upper Saddle River, NJ: Addison-Wesley, 2008.
- [36] A. Jatain and S. Goel, "Comparison of Domain Analysis Methods in Software Reuse," *International Journal of Information Technology and Knowledge Management*, vol. 2, pp. 347-352, July/December 2009.
- [37] H. Gomaa, "Reusable Software Requirements and Architectures for Families of Systems," *Journal of System and Software*, vol. 28, pp. 189-202, March 1995.
- [38] M. A. Musen, Y. Shahar, and E. H. Shortliffe, "Clinical Decision-Support Systems," in *Biomedical Informatics: Computer Application in Health Care and Biomedicine*, E. H. Shortliffe and J. J. Cimino, Eds., 3rd ed New York, NY: Springer, 2006, pp. 698-734.
- [39] P. C. Tang and C. J. McDonald, "Electronic Health Record Systems," in *Biomedical Informatics: Computer Applications in Health Care and Biomedicine*, E. H. Shortliffe and J. J. Cimino, Eds., 3rd ed New York, NY: Springer, 2006, pp. 447-473.

- [40] R. M. Gardner and M. M. Shabot, "Patient-Monitoring Systems," in *Biomedical Informatics: Computer Applications in Health Care and Biomedicine*, E. H. Shortliffe and J. J. Cimino, Eds., 3rd ed New York, NY: Springer, 2006, pp. 585-625.
- [41] H. S. Chae, J. F. Cui, J. Park, J. Park, and W. J. Lee, "An Object-Oriented Framework Approach to Flexible Availability Management for Developing Distributed Applications," *Journal of Information Science and Engineering*, vol. 25, pp. 1021-1040, July 2009.
- [42] A. Valerio, G. Succi, and M. Fenaroli, "Domain Analysis and Framework-Based Software Development," *ACM SIGAPP Applied Computing Review*, vol. 5, pp. 4-15, September 1997.
- [43] S. Lee, S. Thin, and H. Liu, "EMAF: An Enterprise Manufacturing Application Framework Integrated Environment," in *Pacific Asia Conference on Information Systems*, Seoul, Korea, 2001, pp. 963-977.
- [44] J. Zhang, D. Levy, S. Chen, and J. Zic, "mBOSS+: A Mobile Web Services Framework," in *IEEE Asia-Pacific Services Computing Conference*, Hangzhou, China, 2010, pp. 91-96
- [45] T. Broens, A. V. Halteren, M. V. Sinderen, and K. Wac, "Towards an Application Framework for Context-Aware m-Health Applications," *International Journal of Internet Protocol Technology*, vol. 2, pp. 109-116, February 2007.
- [46] A. Esposito, L. Tarricone, M. Zappatore, L. Catarinucci, R. Colella, and A. DiBari, "A Framework for Context-Aware Home-Health Monitoring," *International Journal Autonomous and Adaptive Communications Systems*, vol. 3, pp. 75-91, December 2010.
- [47] V. Villarreal, J. Fontecha, R. Hervás, and J. Bravo, "Using and Applying MobiPattern to Design MoMo Framework Modules," in *Ambient Assisted Living*. vol. 6693, J. Bravo, R. Hervás, and V. Villarreal, Eds., ed Berlin, Germany: Springer, 2011, pp. 25-32.

- [48] A. Fortier, G. Rossi, S. E. Gordillo, and C. Challiol, "Dealing with Variability in Context-Aware Mobile Software," *Journal of Systems and Software*, vol. 83, pp. 915-936, June 2010.
- [49] F. Paganelli and D. Giuli, "An Ontology-based System for Context-Aware and Configurable Services to Support Home-Based Continuous Care," *IEEE Transactions on Information Technology in Biomedicine*, vol. 15, pp. 324-333, March 2011.
- [50] D. Zhang, Z. Yu, and C. Chin, "Context-Aware Infrastructure for Personalized Healthcare," in *Personalised Health Management Systems: The Integration of Innovative Sensing, Textile, Information and Communication Technologies*. vol. 117, C. D. Nugent, P. J. McCullagh, E. T. McAdams, and A. Lymberis, Eds., ed Washington, DC: IOS Press, 2005, pp. 154-163.
- [51] S. Kang, J. Lee, H. Jang, Y. Lee, S. Park, and J. Song, "A Scalable and Energy-Efficient Context Monitoring Framework for Mobile Personal Sensor Networks," *IEEE Transactions on Mobile Computing*, vol. 9, pp. 686-702, May 2010.
- [52] M. J. Mitchell, C. Meyers, A. A. Wang, and G. Tyson, "ContextProvider: Context Awareness for Medical Monitoring Applications," in *33rd Annual International Conference IEEE Engineering in Medicine and Biology Society*, Boston, MA, 2011, pp. 5244-5247.
- [53] World Health Organization (WHO), *Global Health Risks: Mortality and Burden of Disease Attributable to Selected Major Risks*. Geneva, Switzerland: World Health Organization, 2009.
- [54] World Health Organization (WHO), *The World Health Report 2008: Primary Health Care: Now More Than Ever*. Geneva, Switzerland: World Health Organization, 2008.
- [55] O. Aziz, B. Lo, A. Darzi, and G. Yang, "Introduction to Body Sensor Networks," in *Body Sensor Networks*, G. Yang, Ed., ed New York, NY: Springer, 2006, pp. 1-39.

- [56] M. C. Houston, *Handbook of Hypertension*. Chichester, UK: Wiley-Blackwell, 2009.
- [57] N. M. Kaplan and R. G. Victor, *Kaplan's Clinical Hypertension*, 10th ed. Philadelphia, PA: Lippincott Williams & Wilkins, 2009.
- [58] R. J. McManus, E. P. Bray, J. Mant, R. Holder, S. Greenfield, S. Bryan, *et al.*, "Protocol for a Randomised Controlled Trial of Telemonitoring and Self-Management in the Control of Hypertension: Telemonitoring and Self-Management in Hypertension," *BMC Cardiovascular Disorders*, vol. 9, pp. 1-21, February 2009.
- [59] J. E. Bardram and H. B. Christensen, "Pervasive Computing Support for Hospitals: An overview of the Activity-Based Computing Project," *IEEE Pervasive Computing*, vol. 6, pp. 44-51, January-March 2007.
- [60] S. Sneha and U. Varshney, "Enabling Ubiquitous Patient Monitoring: Model, Decision Protocols, Opportunities And Challenges," *Decision Support Systems*, vol. 46, pp. 606-619, February 2009.
- [61] V. Villarreal, G. Urzaiz, R. Hervas, and J. Bravo, "Monitoring Architecture to Collect Measurement Data and Medical Patient Control through Mobile Devices," in *5th International Symposium on Ubiquitous Computing and Ambient Intelligence*, Riviera Maya, Mexico, 2011.
- [62] Y. Ren, R. W. N. Pazzi, and A. Boukerche, "Monitoring Patients Via a Secure and Mobile Healthcare System," *IEEE Wireless Communications*, vol. 17, pp. 59-65, February 2010.
- [63] C. Liu, Q. Zhu, K. A. Holroyd, and E. K. Seng, "Status and Trends of Mobile-Health Applications for iOS Devices: A Developer's Perspective," *Journal of System and Software*, vol. 84, pp. 2022-2033, November 2011.
- [64] Z. Lv, F. Xia, G. Wu, L. Yao, and Z. Chen, "iCare: A Mobile Health Monitoring System for the Elderly," in *IEEE/ACM International Conference on Green Computing and Communications and International Conference on Cyber, Physical and Social Computing*, Hangzhou, China, 2010, pp. 699-705.

- [65] D. Apiletti, E. Baralis, G. Bruno, and T. Cerquitelli, "Real-Time Analysis of Physiological Data to Support Medical Applications," *IEEE Transactions on Information Technology in Biomedicine*, vol. 13, pp. 313-321, May 2009.
- [66] Y. M. Huang, M. Y. Hsieh, H. C. Chao, S. H. Hung, and J. H. Park, "Pervasive, Secure Access to A Hierarchical Sensor-Based Healthcare Monitoring Architecture in Wireless Heterogeneous Networks," *IEEE Journal on Selected Areas in Communications*, vol. 27, pp. 400-411, May 2009.
- [67] V. G. Koutkias, I. Chouvarda, A. Triantafyllidis, A. Malousi, G. D. Giaglis, and N. Maglaveras, "A Personalized Framework for Medication Treatment Management in Chronic Care," *IEEE Transactions on Information Technology in Biomedicine*, vol. 14, pp. 464-472, March 2010.
- [68] A. Copetti, O. Loques, J. C. B. Leite, T. P. C. Barbosa, and A. C. L. d. Nobrega, "Intelligent Context-Aware Monitoring of Hypertensive Patients," in *3rd International Conference on Pervasive Computing Technologies for Healthcare*, London, UK, 2009, pp. 1-6.
- [69] I. Mohomed, A. Misra, M. Ebling, and W. Jerome, "HARMONI: Context-Aware Filtering of Sensor Data for Continuous Remote Health Monitoring," in *6th Annual IEEE International Conference on Pervasive Computing and Communications*, Hong Kong, China, 2008, pp. 248-251.
- [70] M. G. Al-Bashayreh, N. L. Hashim, and O. T. Khorma, "The Requirements to Enhance the Design of Context-Aware Mobile Patient Monitoring Systems Using Wireless Sensors," in *Context-Aware Systems and Applications*. vol. 109, P. C. Vinh, N. M. Hung, N. T. Tung, and J. Suzuki, Eds., ed Berlin, Germany: Springer, 2013, pp. 62-71.
- [71] F. C. Delicato, I. L. A. Santos, P. F. Pires, A. L. S. Oliveira, T. Batista, and L. Pírmez, "Using Aspects and Dynamic Composition to Provide Context-Aware Adaptation for Mobile Applications," in *ACM Symposium on Applied Computing*, Honolulu, HI, 2009, pp. 456-460.

- [72] C. Bettini, O. Brdiczka, K. Henriksen, J. Indulska, D. Nicklas, A. Ranganathan, *et al.*, "A Survey of Context Modelling and Reasoning Techniques," *Pervasive and Mobile Computing*, vol. 6, pp. 161-180, March 2010.
- [73] J. R. Hoyos, J. GarcíaMolina, and J. A. Botía, "MLContext: A Context-Modeling Language for Context-Aware Systems," *Electronic Communications of the EASST*, vol. 28, pp. 1-14, 2010.
- [74] M. G. Al-Bashayreh, N. L. Hashim, and O. T. Khorma, "Context-Aware Mobile Patient Monitoring Frameworks: A Systematic Review and Research Agenda," *Journal of Software*, vol. 8, pp. 1604-1612, July 2013.
- [75] M. G. Al-Bashayreh, N. L. Hashim, and O. T. Khorma, "Software Frameworks in Biomedical Informatics: A Systematic Review and Research Agenda," *Journal of Software*, 2013.
- [76] N. F. Ahmad, D. B. Hoang, and M. H. Phung, "Robust Preprocessing for Health Care Monitoring Framework," in *11th IEEE International Conference on e-Health Networking, Applications and Services*, Sydney, Australia, 2009, pp. 169-174.
- [77] T. Laakko, J. Leppänen, J. Lähtenmäki, and A. Nummiaho, "Mobile Health and Wellness Application Framework," *Methods of Information in Medicine*, vol. 47, pp. 217-222, 2008.
- [78] J. E. Bardram and T. R. Hansen, "The AWARE Architecture: Supporting Context-Mediated Social Awareness in Mobile Cooperation," in *16th ACM Conference on Computer Supported Cooperative Work*, Chicago, IL, 2004, pp. 192-201.
- [79] M. G. Al-Bashayreh, N. L. Hashim, and O. T. Khorma, "Context-Aware Mobile Patient Monitoring Framework Development: An Architectural Design," *Advanced Science Letter*, vol. 20, pp. 293-297, January 2014.
- [80] G. Arango, "Domain Analysis Methods," in *Software Reusability*, W. Schäfer, R. Prieto-Díaz, and M. Matsumoto, Eds., ed New York, NY: Ellis Horwood, 1994, pp. 17-49.

- [81] E. S. d. Almeida, J. C. C. P. Mascena, A. P. C. Cavalcanti, A. Alvaro, V. C. Garcia, S. R. d. L. Meira, *et al.*, "The Domain Analysis Concept Revisited: A Practical Approach," in *Reuse of Off-the-Shelf Components*. vol. 4039, M. Morisio, Ed., ed Berlin, Germany: Springer, 2006, pp. 43-57.
- [82] M. Acher, A. Cleve, G. Perrouin, P. Heymans, C. Vanbeneden, P. Collet, *et al.*, "On Extracting Feature Models From Product Descriptions," in *6th International Workshop on Variability Modeling of Software-Intensive Systems*, Leipzig, Germany, 2012, pp. 45-54.
- [83] T. Jeon, S. Lee, and H. Seung, "Increasing the Testability of Object-Oriented Frameworks with Built-in Tests," in *Advanced Internet Services and Applications*. vol. 2402, W. Chang, Ed., ed Berlin, Germany: Springer, 2002, pp. 873-881.
- [84] W. Pree, *Design Patterns for Object-Oriented Software Development*. Wokingham, UK: Addison-Wesley, 1995.
- [85] H. A. Schmid, "Framework Design by Systematic Generalization," in *Building Application Frameworks: Object-Oriented Foundations of Framework Design*, M. Fayad, D. C. Schmidt, and R. E. Johnson, Eds., ed New York, NY: Wiley, 1999, pp. 353-378.
- [86] G. Miller, J. McGregor, and M. Major, "Capturing Framework Requirements," in *Building Application Frameworks: Object-Oriented Foundations of Framework Design*, M. Fayad, D. C. Schmidt, and R. E. Johnson, Eds., ed New York, NY: Wiley, 1999, pp. 309-323.
- [87] M. G. Al-Bashayreh, N. L. Hashim, and O. T. Khorma, "Context-Aware Mobile Patient Monitoring Framework Development: A Detailed Design," *IERI Procedia*, vol. 4, pp. 155–167, December 2013.
- [88] M. G. Al-Bashayreh, N. L. Hashim, and O. T. Khorma, "Feature Model to Design Application Framework for Context-aware Mobile Patient Monitoring Systems," in *2nd IEEE International EMBS Conference Biomedical Engineering and Sciences*, Langkawi, Malaysia, 2012, pp. 72-77.

- [89] L. Chung and J. C. S. d. P. Leite, "On non-Functional Requirements in Software Engineering," in *Conceptual Modeling: Foundations and Applications*. vol. 5600, A. T. Borgida, V. K. Chaudhri, P. Giorgini, and E. Yu, Eds., 1st ed New York, NY: Springer, 2009, pp. 363-379.
- [90] A. Kleppe, J. Warmer, and W. Bast, *MDA Explained: The Model Driven Architecture: Practice and Promise*. Boston, MA: Addison Wesley, 2003.
- [91] W. Raghupathi and A. Umar, "Exploring a Model-Driven Architecture (MDA) Approach to Health Care Information Systems Development," *International Journal of Medical Informatics*, vol. 77, pp. 305-314, May 2008.
- [92] P. Bourque, F. Robert, J. M. Lavoie, A. Lee, S. Trudel, and T. C. Lethbridge, "Guide to the Software Engineering Body of Knowledge (SWEBOK) and the Software Engineering Education Knowledge (SEEK) - A Preliminary Mapping," in *10th International Workshop on Software Technology and Engineering Practice*, Québec, Canada, 2004, pp. 8-23.
- [93] G. Cardino, F. Baruchelli, and A. Valerio, "The Evaluation of Framework Reusability," *ACM SIGAPP Applied Computing Review*, vol. 5, pp. 21-27, September 1997.
- [94] G. Sindre, R. Conradi, and E.-A. Karlsson, "The REBOOT Approach to Software Reuse," *Journal of Systems and Software*, vol. 30, pp. 201-212, September 1995.
- [95] G. Caldiera and V. R. Basili, "Identifying and Qualifying Reusable Software Components," *Computer*, vol. 24, pp. 61-70, February 1991.
- [96] ISO, IEC, and IEEE, *Systems and Software Engineering - Vocabulary*. Piscataway, NJ: IEEE Computer Society, 2010.
- [97] E. S. d. Almeida, A. Alvaro, V. C. Garcia, J. C. C. P. Mascena, V. A. d. A. Burégio, L. M. d. Nascimento, *et al.*, *CRUISE: Component Reuse in Software Engineering*. Recife, Brazil: CESAR, 2007.
- [98] L. Chou, J. Sun, and M. Chen, "A New Application Framework for Intelligent Surveillance Sensor Networks," in *3rd International Conference on*

International Information Hiding and Multimedia Signal Processing, Kaohsiung, Taiwan, 2007, pp. 589-591.

- [99] E. Gamma, R. Helm, R. Johnson, and J. M. Vlissides, *Design Patterns: Elements of Reusable Object-Oriented Software*. Reading, MA: Addison-Wesley, 1995.
- [100] D. C. Schmidt and F. Buschmann, "Patterns, Frameworks, and Middleware: Their Synergistic Relationships," in *25th International Conference on Software Engineering*, Portland, OR, 2003, pp. 694-704.
- [101] G. Polancic, R. V. Horvat, and I. Rozman, "Improving Object-Oriented Frameworks by Considering the Characteristics of Constituent Elements," *Journal of Information Science and Engineering*, vol. 25, pp. 1067-1085, July 2009.
- [102] I. Crnkovic, B. Hnich, T. Jonsson, and Z. Kiziltan, "Basic Concepts in CBSE," in *Building Reliable Component-Based Software Systems*, I. Crnkovic and M. Larsson, Eds., ed Norwood, MA: Artech House, 2002, pp. 3-22.
- [103] P. Clements, F. Bachmann, L. Bass, D. Garlan, J. Ivers, R. Little, *et al.*, *Documenting Software Architectures: Views and Beyond*, 2nd ed. Upper Saddle River, NJ: Addison-Wesley, 2011.
- [104] R. E. Johnson, "Components, Frameworks, Patterns," *ACM SIGSOFT Software Engineering Notes*, vol. 22, pp. 10-17, May 1997.
- [105] C. Szyperski, *Component Software: Beyond Object-Oriented Programming*, 2nd ed. New York, NY: Addison-Wesley, 2011.
- [106] D. Ranjan and A. K. Tripathi, "Variability-Based Models for Testability Analysis of Frameworks," *Journal of Software Engineering and Applications*, vol. 3, pp. 455-459, May 2010.
- [107] G. Larsen, "Designing Component-Based Frameworks Using Patterns in the UML," *Communications of the ACM*, vol. 42, pp. 38-45, October 1999.
- [108] G. Froehlich, H. J. Hoover, L. Liu, and P. Sorenson, "Hooking into Object-Oriented Application Frameworks," in *19th International Conference on Software Engineering*, Boston, MA, 1997, pp. 491-501.

- [109] A. Sutcliffe and G. Papamargaritis, "Applying the Domain Theory to Design for Reuse," *BT Technology Journal*, vol. 22, pp. 104-115, April 2004.
- [110] J. A. McCall, P. K. Richards, and G. F. Walters, *Factors in Software Quality* vol. 1. Rome, NY: US Rome Air Development Center, 1977.
- [111] J.-M. Morel and J. Faget, "The REBOOT Environment," in *2nd International Workshop on Software Reusability*, 1993, pp. 80-88.
- [112] A. Rosel and K. Erni, "Experiences with the Semantic Graphics Framework," in *Implementing Application Frameworks: Object-Oriented Frameworks at Work*, M. E. Fayad, D. C. Schmidt, and R. E. Johnson, Eds., ed New York, NY: Wiley, 1999, pp. 629-658.
- [113] R. P. E. Esilva and E. C. Freiburger, "Metrics to Evaluate the Use of Object Oriented Frameworks," *Computer Journal*, vol. 52, pp. 288-304, 2009.
- [114] H. Washizaki, H. Yamamoto, and Y. Fukazawa, "A Metrics Suite for Measuring Reusability of Software Components," in *9th International Software Metrics Symposium*, Sydney, Australia, 2003, pp. 211-223.
- [115] M. Lanza and R. Marinescu, *Object-Oriented Metrics in Practice: Using Software Metrics to Characterize, Evaluate, and Improve the Design of Object-Oriented Systems*. Berlin, Germany: Springer, 2006.
- [116] D. Soni, R. Shrivastava, and M. Kumar, "A Framework for Validation of Object-Oriented Design Metrics," *International Journal of Computer Science and Information Security*, vol. 6, pp. 46-52, December 2009.
- [117] T. Stahl, M. Völter, J. Bettin, A. Haase, and S. Helsen, *Model-Driven Software Development: Technology, Engineering, Management*. Hoboken, NJ: Wiley, 2006.
- [118] Wikipedia. (2014, April). *Eclipse*. Available: [http://en.wikipedia.org/wiki/Eclipse_\(software\)](http://en.wikipedia.org/wiki/Eclipse_(software))
- [119] Wikipedia. (2014, April). *Java Platform*. Available: http://en.wikipedia.org/wiki/Java_platform

- [120] Wikipedia. (2014, April). *.NET Framework*. Available: http://en.wikipedia.org/wiki/.NET_Framework
- [121] S. Lopes, A. Tavares, J. Monteiro, and C. Silva, "Instantiation of a Classification System Framework that Facilitates Reuse," *Journal of Software*, vol. 2, pp. 57-69, October 2007.
- [122] J. v. Gorp and J. Bosch, "Design, Implementation and Evolution of Object Oriented Frameworks: Concepts and Guidelines," *Software: Practice and Experience*, vol. 31, pp. 277-300, 2001.
- [123] S. Srinivasan, "Design Patterns in Object-Oriented Frameworks," *Computer*, vol. 32, pp. 24-32, January 1999.
- [124] T. C. Shan and W. W. Hua, "Taxonomy of Java Web Application Frameworks " in *IEEE International Conference on e-Business Engineering*, Shanghai, China, 2006, pp. 378-385.
- [125] W. Pree, "Essential Framework Design Patterns," *Object Magazine*, vol. 7, pp. 34-37, 1997.
- [126] H. A. Schmid, "Systematic Framework Design by Generalization," *Communications of the ACM*, vol. 40, pp. 48-51, October 1997.
- [127] H. Mili, M. Fayad, D. Brugali, D. Hamu, and D. Dori, "Enterprise Frameworks: Issues and Research Directions," *Software: Practice and Experience*, vol. 32, pp. 801-831, 2002.
- [128] S. Demeyer, T. D. Meijler, O. Nierstrasz, and P. Steyaert, "Design Guidelines for 'Tailorable' Frameworks," *Communications of the ACM*, vol. 40, pp. 60-64, October 1997.
- [129] J. M. Neighbors, "Draco: A Method for Engineering Reusable Software Systems," in *Software Reusability*. vol. 1, T. Biggerstaff and A. Perlis, Eds., ed New York, NY: ACM Press, 1989, pp. 295-319.
- [130] K. Czarnecki and U. Eisenecker, *Generative Programming: Methods, Tools, and Applications*. Boston, MA: Addison Wesley, 2000.

- [131] A. Sturm, D. Dori, and O. Shehory, "The Application-Based Domain Analysis Approach and its Object-Process Methodology Implementation," *International Journal of Software Engineering and Knowledge Engineering*, vol. 18, pp. 1115-1142, December 2008.
- [132] N. S. Gill and P. Tomar, "Modified Development Process of Component-Based Software Engineering," *ACM SIGSOFT Software Engineering Notes*, vol. 35, pp. 1-6, 2010.
- [133] A. v. Deursen and P. Klint, "Domain-Specific Language Design Requires Feature Descriptions," *Journal of Computing and Information Technology*, vol. 10, pp. 1-17, 2002.
- [134] R. S. Pressman, *Software Engineering: A Practitioner's Approach*, 7th ed. Boston, MA: McGraw Hill, 2010.
- [135] IEEE, "IEEE Standard for Information Technology - System and Software Life Cycle Processes - Reuse Processes," ed. New York, NY: IEEE Computer Society, 2010, pp. 1-51.
- [136] G. Succi, A. Valerio, T. Vernazza, M. Fenaroli, and P. Predonzani, "Framework Extraction with Domain Analysis," *ACM Computing Surveys*, vol. 32, p. 12, March 2000.
- [137] R. Prieto-Díaz, "Historical Overview," in *Software Reusability*, W. Schäfer, R. Prieto-Díaz, and M. Matsumoto, Eds., ed New York, NY: Ellis Horwood, 1994, p. 160.
- [138] M. Aksit, F. Marcelloni, and B. Tekinerdogan, "Developing Object-Oriented Frameworks Using Domain Models," *ACM Computing Surveys*, vol. 32, March 2000.
- [139] B. Berenbach, D. Paulish, J. Kazmeier, and A. Rudorfer, *Software & Systems Requirements Engineering: In Practice*. New York, NY: McGraw-Hill, 2009.
- [140] K. Czarnecki, S. Helsen, and U. Eisenecker, "Formalizing Cardinality-Based Feature Models and their Specialization," *Software Process: Improvement and Practice*, vol. 10, pp. 7-29, March 2005.

- [141] K. C. Kang, S. G. Cohen, J. A. Hess, W. E. Novak, and A. S. Peterson, "Feature-Oriented Domain Analysis (FODA) Feasibility Study," Software Engineering Institute, Pittsburgh, PA, Technical Report CMU/SEI90TR021, November 1990.
- [142] C. Kästner, T. Thüm, G. Saake, J. Feigenspan, T. Leich, F. Wielgorz, *et al.*, "FeatureIDE: A Tool Framework for Feature-Oriented Software Development," in *31st International Conference Software Engineering*, Vancouver, BC, 2009, pp. 611–614.
- [143] M. Acher, P. Collet, F. Fleurey, P. Lahire, S. Moisan, and J. Rigault, "Modeling Context and Dynamic Adaptations with Feature Models," in *4th International Workshop Models*, Denver, colo, 2009, pp. 89-98.
- [144] L. Bass, P. Clements, and R. Kazman, *Software Architecture in Practice*, 3rd ed. Upper Saddle River, NJ: Addison-Wesley, 2013.
- [145] L. Bass, R. Nord, W. Wood, D. Zubrow, and I. Ozkaya, "Analysis of Architecture Evaluation Data," *Journal of Systems and Software*, vol. 81, pp. 1443-1455, 2008.
- [146] F. Buschmann, R. Meunier, H. Rohnert, P. Sommerlad, and M. Stal, *Pattern-Oriented Software Architecture: A System of Patterns* vol. 1st. Chichester, UK: Wiley, 1996.
- [147] F. Buschmann, K. Henney, and D. C. Schmidt, *Pattern-Oriented Software Architecture: A Pattern Language for Distributed Computing* vol. 4th. Chichester, UK: Wiley, 2007.
- [148] M. Kircher and P. Jain, *Pattern-Oriented Software Architecture: Patterns for Resource Management* vol. 3rd. Chichester, UK: Wiley, 2004.
- [149] D. C. Schmidt, M. Stal, H. Rohnert, and F. Buschmann, *Pattern-Oriented Software Architecture: Patterns for Concurrent and Networked Objects* vol. 2nd. Chichester, UK: Wiley, 2000.
- [150] M. Shaw and D. Garlan, *Software Architecture: Perspectives on an Emerging Discipline*. Upper Saddle River, NJ: Prentice Hall, 1996.

- [151] J. Kim, S. Park, and V. Sugumaran, "DRAMA: A Framework for Domain Requirements Analysis and Modeling Architectures in Software Product Lines," *Journal of Systems and Software*, vol. 81, pp. 37-55, January 2008.
- [152] F. Buschmann, K. Henney, and D. C. Schmidt, *Pattern-Oriented Software Architecture: On Patterns and Pattern Languages* vol. 5th. Chichester, UK: Wiley, 2007.
- [153] D. Garlan and M. Shaw, "An Introduction to Software Architecture," in *Advances in Software Engineering and Knowledge Engineering*, V. Ambriola and G. Tortora, Eds., ed River Edge, NJ: World Scientific, 1993, pp. 1-40.
- [154] I. Gorton, *Essential Software Architecture* Berlin, Germany: Springer 2006.
- [155] OMG. (2014, March). *MDA - The Architecture of Choice for a Changing World*. Available: <http://www.omg.org/mda/>
- [156] B. Selic, "The Pragmatics of Model-Driven Development " *IEEE Software*, vol. 20, pp. 19 - 25 2003.
- [157] OMG, "Mda Guide Version 1.0.1," omg/2003-06-01, June 2003.
- [158] D. Gašević, D. Djurić, and V. Devedžić, *Model Driven Engineering and Ontology Development*, 2nd ed. New York, NY: Springer, 2009.
- [159] S. Miller, K. Scott, A. Uhl, and D. Weise, *MDA Distilled: Principles of Model-Driven Architecture*. Boston, MA: Addison-Wesley, 2004.
- [160] X. Chen, *Developing Application Frameworks in .NET*. Berkeley, CA: Apress, 2004.
- [161] R. C. Martin, *Agile Software Development: Principles, Patterns, and Practices*. Upper Saddle River, NJ: Prentice Hall, 2003.
- [162] B. Hailpern and P. Tarr, "Model-Driven Development: The Good, the Bad, and the Ugly," *IBM Systems Journal*, vol. 45, pp. 451-461, July 2006.
- [163] V. M. Jones, A. v. Halteren, D. Konstantas, I. Widya, and R. Bults, "An Application of Augmented MDA for the Extended Healthcare Enterprise," *International Journal of Business Process Integration and Management*, vol. 2, pp. 215–229, 2007.

- [164] J. Al-Dallal, "Estimating the Coverage of the Framework Application Reusable Cluster-Based Test Cases," *Information and Software Technology*, vol. 50, pp. 595-604, May 2008.
- [165] R. E. Johnson and V. F. Russo, "Reusing Object-Oriented Designs," University of Illinois, Urbana, IL, Technical Report UIUCDS91-1696, May 1991.
- [166] R. Baskerville and A. T. Wood-Harper, "Diversity in Information Systems Action Research Methods," *European Journal of Information Systems*, vol. 7, pp. 90-107, June 1998.
- [167] A. Mouttham, L. Peyton, B. Eze, and A. E. Saddik, "Event-Driven Data Integration for Personal Health Monitoring," *Journal of Emerging Technologies in Web Intelligence*, vol. 1, pp. 110-118, November 2009.
- [168] A. Rocha, A. Martins, J. C. F. Junior, M. N. K. Boulos, M. E. Vicente, R. Feld, *et al.*, "Innovations in Health Care Services: The CAALYX System," *International Journal of Medical Informatics*, vol. 82, pp. 307–320, November 2013.
- [169] V. Villarreal, J. Fontecha, R. Hervas, and J. Bravo, "An Architecture to Development a Ambient Assisted Living Applications: A Study Case in Diabetes," in *5th International Symposium Ubiquitous Computing and Ambient Intelligence*, Riviera Maya, Mexico, 2011.
- [170] E. Coiera, *Guide to Health Informatics*, 2nd ed. London, UK: Arnold, 2003.
- [171] E. H. Shortliffe and M. S. Blois, "The Computer Meets Medicine and Biology: Emergence of a Discipline," in *Biomedical Informatics: Computer Application in Health Care and Biomedicine*, E. H. Shortliffe and J. J. Cimino, Eds., 3rd ed New York, NY: Springer, 2006, pp. 3-45.
- [172] E. H. Shortliffe, "The Science of Biomedical Computing," *Informatics for Health and Social Care*, vol. 9, pp. 185-193, July/December 1984.
- [173] J. D. Myers, "Medical Education in the Information Age," in *Symposium on Medical Informatics*, Washington, DC, 1986.

- [174] D. A. B. Lindberg, "NLM Long Range Plan," US National Library of Medicine, Bethesda, MD, Panel Report Z 675.M4 N2782L 1986, January 2002.
- [175] H. R. Warner, "Medical Informatics: A Real Discipline?," *Journal of the American Medical Informatics Association*, vol. 2, pp. 207-214, July/August 1995.
- [176] R. A. Greenes and E. H. Shortliffe, "Medical Informatics: An Emerging Academic Discipline and Institutional Priority," *JAMA*, vol. 263, pp. 1114-1120, February 1990.
- [177] M. F. Collen, "The Origins of Informatics," *Journal of the American Medical Informatics Association*, vol. 1, pp. 91-107, March/April 1994.
- [178] D. Mascareñas, E. Flynn, C. Farrar, G. Park, and M. Todd, "A Mobile Host Approach for Wireless Powering and Interrogation of Structural Health Monitoring Sensor Networks," *IEEE Sensors Journal*, vol. 9, pp. 1719-1726, December 2009.
- [179] G. Wiederhold and E. H. Shortliffe, "System Design and Engineering in Health Care," in *Biomedical Informatics: Computer Applications in Health Care and Biomedicine*, E. H. Shortliffe and J. J. Cimino, Eds., 3rd ed New York, NY: Springer, 2006, pp. 233-262.
- [180] E. S. Nahm, "Innovations in Patient-Monitoring Systems," *American Nurse Today*, vol. 4, pp. 29-30, November/December 2009.
- [181] T. Bratan and M. Clarke, "Optimum Design of Remote Patient Monitoring Systems," in *28th IEEE EMBS Annual International Conference*, New York, NY, 2006, pp. 6465-6468.
- [182] B. Lin, B. Lin, N. Chou, F. Chong, and S. Chen, "RTWPMS: A Real-Time Wireless Physiological Monitoring System," *IEEE Transactions on Information Technology in Biomedicine*, vol. 10, pp. 647-656, October 2006.
- [183] L. D. Hudson, "Monitoring of Critically Ill Patients: Conference Summary," *Respir Care*, vol. 30, pp. 628-636, 1985.

- [184] E. Jovanov, A. O. Lords, D. Raskovic, P. G. Cox, R. Adhami, and F. Andrasik, "Stress Monitoring Using a Distributed Wireless Intelligent Sensor System," *IEEE Engineering in Medicine and Biology Magazine*, vol. 22, pp. 49-55, May/June 2003.
- [185] R. S. H. Istepanian, E. Jovanov, and Y. T. Zhang, "Guest Editorial Introduction to the Special Section on M-Health: Beyond Seamless Mobility and Global Wireless Health-Care Connectivity," *IEEE Transactions on Information Technology in Biomedicine*, vol. 8, pp. 405-414, December 2004.
- [186] W. M. Omar and A. Taleb-Bendiab, "E-Health Support Services Based on Service-Oriented Architecture," *IT Professional*, vol. 8, pp. 35-41, 2006.
- [187] M. Trudel, J. A. Cafazzo, M. Hamill, W. Igharas, K. Tallevi, P. Picton, *et al.*, "A Mobile Phone Based Remote Patient Monitoring System for Chronic Disease Management," in *Building Sustainable Health Systems*, vol. 129, K. A. Kuhn, J. R. Warren, and T.-Y. Leong, Eds., ed Washington, DC: IOS Press, 2007, pp. 167-171.
- [188] V. Jones, A. v. Halteren, N. Dokovsky, G. Koprinkov, J. Peuscher, R. Bults, *et al.*, "Mobihealth: Mobile Services for Health Professionals," in *M-Health: Emerging Mobile Health Systems*, R. S. H. Istepanian, S. Laxminarayan, and C. S. Pattichis, Eds., ed New York, NY: Springer, 2006, pp. 237-246.
- [189] A. B. Waluyo, W. Yeoh, I. Pek, Y. Yong, and X. Chen, "MobiSense: Mobile Body Sensor Network for Ambulatory Monitoring," *ACM Transactions on Embedded Computing Systems*, vol. 10, August 2010.
- [190] J. Shen, D. Shih, H. Chiang, and S. Lin, "A Mobile Physiological Monitoring System for Patient Transport," *Journal of High Speed Networks*, vol. 16, pp. 51-68, January 2007.
- [191] H. Mei, B. v. Beijnum, P. Pawar, I. Widya, and H. Hermens, "A*-Based Task Assignment Algorithm for Context-Aware Mobile Patient Monitoring Systems," in *15th IEEE International Conference on Embedded and Real-Time Computing Systems and Applications*, Beijing, China, 2009, pp. 245-254.

- [192] E. J. Ko, H. J. Lee, and J. W. Lee, "Ontology-Based Context Modeling and Reasoning for U-HealthCare," *IEICE Transactions on Information and Systems*, vol. E90-D, pp. 1262-1270, August 2007.
- [193] A. V. Halteren, R. Bults, K. Wac, D. Konstantas, I. Widya, N. Dokovsky, *et al.*, "Mobile Patient Monitoring: The MobiHealth System," *Journal on Information Technology in Healthcare*, vol. 2, pp. 365–373, 2004.
- [194] I. Mohomed, A. Misra, M. Ebling, and W. Jerome, "Context-Aware and Personalized Event Filtering for Low-Overhead Continuous Remote Health Monitoring," in *9th IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks*, Newport Beach, CA, 2008, pp. 1-8.
- [195] J. Sriram, M. Shin, D. Kotz, A. Rajan, M. Sastry, and M. Yarvis, "Challenges in Data Quality Assurance in Pervasive Health Monitoring Systems," in *Future of Trust in Computing*, D. Gawrock, H. Reimer, A. Sadeghi, and C. Vishik, Eds., ed Berlin, Germany: Vieweg+Teubner, 2009, pp. 129-142.
- [196] ZigBee Alliance. (2008, July). *ZigBee Specification*. Available: <http://www.zigbee.org>
- [197] J. Espina, T. Falck, and O. Mühlens, "Network Topologies, Communication Protocols, and Standards," in *Body Sensor Networks*, G. Yang, Ed., ed New York, NY: Springer, 2006, pp. 145-182.
- [198] J. A. Gutierrez, M. Naeve, E. Callaway, M. Bourgeois, V. Milter, and B. Heile, "IEEE 802. 75.4: A Developing Standard for Low-Power Low-Cost Wireless Personal Area Networks," in *IEEE Network* vol. 15, ed, 2001, pp. 12-19.
- [199] C. Hofmann, C. Weigand, and J. Bernhard, "Wireless Medical Sensor Network With Zigbee," in *5th International Conference on Electronics, Hardware, Wireless and Optical Communications*, Madrid, Spain, 2006, pp. 12-15.
- [200] E. Mattila, I. Korhonen, and N. Saranummi, "Mobile and Personal Health and Wellness Management Systems," in *Pervasive Computing in Healthcare*, J. E. Bardram, A. Mihailidis, and D. Wan, Eds., ed Boca Raton, FL: CRC Press, 2007, pp. 105-134.

- [201] J. Pan, S. Li, and Z. Wu, "Towards a Novel In-Community Healthcare Monitoring System Over Wireless Sensor Networks," in *3rd International Conference on Internet Computing in Science and Engineering*, Harbin, China, 2008, pp. 160-165.
- [202] N. Oliver, F. FloresMangas, and R. d. Oliveira, "Towards Wearable Physiological Monitoring on a Mobile Phone," in *Mobile Health Solutions for Biomedical Application*, P. Olla and J. Tan, Eds., ed Hershey, PA: IGI Global, 2009, pp. 208-243.
- [203] E. Jovanov, A. Milenkovic, C. Otto, and P. C. d. Groen, "A Wireless Body Area Network of Intelligent Motion Sensors for Computer Assisted Physical Rehabilitation," *Journal of NeuroEngineering and Rehabilitation*, vol. 2, March 2005.
- [204] M. T. Arredondo, S. Guilleín, I. Peinado, and G. Fico, "Scenarios for the Interaction Between Personal Health Systems and Chronic Patients," in *Wearable Monitoring Systems*, A. Bonfiglio and D. D. Rossi, Eds., ed New York, NY: Springer, 2011, pp. 253-276.
- [205] F. Meneses and A. Moreira, "Technology Enablers for Context-Aware Healthcare Applications," in *Mobile Health Solutions for Biomedical Applications*, P. Olla and J. Tan, Eds., ed Hershey, PA: Information Science Reference, 2009, pp. 260-269.
- [206] I. Martínez, J. Escayola, M. Martínez-Espronedada, L. Serrano, J. D. Trigo, S. Led, *et al.*, "Standard-Based Middleware Platform for Medical Sensor Networks and u-Health," in *17th International Conference on Computer Communications and Networks*, US Virgin Islands, VI, 2008, pp. 714-719.
- [207] U. Varshney, "A Framework for Supporting Emergency Messages in Wireless Patient Monitoring," *Decision Support Systems*, vol. 45, pp. 981-996, November 2008.
- [208] M. Galarraga, L. Serrano, I. Martínez, and P. d. Toledo, "Review of the ISO/IEEE X73-POCMDC Standard for Medical Device Interoperability," in *Medical and Care Compunetics 3*. vol. 121, L. Bos, L. Roa, K. Yogesan, B.

- O'Connell, A. Marsh, and B. Blobel, Eds., ed Washington, DC: IOS Press, 2006, pp. 242 - 256.
- [209] A. K. Dey, "Understanding and Using Context," *Personal Ubiquitous Computing*, vol. 5, pp. 4-7, 2001.
- [210] B. N. Schilit and M. M. Theimer, "Disseminating Active Map Information to Mobile Hosts," *IEEE Network*, vol. 8, pp. 22 - 32, September/October 1994.
- [211] T. Gu, H. K. Pung, and D. Zhang, "Toward an OSGi-Based Infrastructure for Context-Aware Applications," *IEEE Pervasive Computing*, vol. 3, pp. 66-74, October/December 2004.
- [212] R. Hervás, J. Bravo, and J. Fontecha, "A Context Model Based on Ontological Languages: A Proposal for Information Visualization," *Journal of Universal Computer Science*, vol. 16, pp. 1539-1555, August 2010.
- [213] D. Zhang, B. Adipat, and Y. Mowafi, "User-Centered Context-Aware Mobile Applications—The Next Generation of Personal Mobile Computing," *Communications of the Association for Information Systems*, vol. 24, pp. 27-46, January 2009.
- [214] D. Preuveneers, K. Victor, Y. Vanrompay, P. Rigole, M. K. Pinheiro, and Y. Berbers, "Context-Aware Adaptation in an Ecology of Applications," in *Context-aware Mobile and Ubiquitous Computing for Enhanced Usability: Adaptive Technologies and Application*, D. Stojanovic, Ed., ed Hershey, PA: Inform. Science Reference, 2009, pp. 1-25.
- [215] J. P. A. Almeida, M. Iacob, H. Jonkers, and D. Quartel, "Model-Driven Development of Context-Aware Services," in *Distributed Applications and Interoperable Systems*, F. Eliassen and A. Montresor, Eds., ed Birlin, Germany: Springer, 2006, pp. 213-227.
- [216] F. Paganelli and D. Giuli, "An Ontology-Based Context Model for Home Health Monitoring and Alerting in Chronic Patient Care Networks," in *21st International Conference on Advanced Information Networking and Applications Workshops*, Ontario, Canada 2007, pp. 838-845.

- [217] S. W. Loke, "Context-Aware Artifacts: Two Development Approaches," *IEEE Pervasive Computing*, vol. 5, pp. 48-53, April/June 2006.
- [218] N. Kara and O. A. Dragoi, "Reasoning with Contextual Data in Telehealth Applications," in *3rd IEEE International Conference on Wireless and Mobile Computing, Networking and Communications*, White Plains, NY, 2007, pp. 69-76.
- [219] M. J. v. Sinderen, A. T. v. Halteren, M. Wegdam, H. B. Meeuwissen, and E. H. Eertink, "Supporting Context-Aware Mobile Applications: An Infrastructure Approach," *IEEE Communications Magazine*, vol. 44, pp. 96-104, September 2006.
- [220] R. Ashford, P. Moore, B. Hu, M. Jackson, and J. Wan, "Translational Research and Context in Health Monitoring Systems," in *4th IEEE International Conference on Complex, Intelligent and Software Intensive Systems*, Kraków, Poland, 2010, pp. 81-86.
- [221] P. Vajirkar, S. Singh, and Y. Lee, "Context-Aware Data Mining Framework for Wireless Medical Application," in *Database and Expert Systems Applications*, vol. 2736, V. Marík, W. Retschitzegger, and O. Štěpánková, Eds., ed Berlin, Germany: Springer, 2003, pp. 381-391.
- [222] N. BriconSouf and C. R. Newman, "Context Awareness in Health Care: A Review," *International Journal of Medical Informatics*, vol. 76, pp. 2-12, January 2007.
- [223] A. K. Dey, G. D. Abowd, and D. Salber, "A Conceptual Framework and a Toolkit for Supporting the Rapid Prototyping of Context-Aware Applications," *Human-Computer Interaction*, vol. 16, pp. 97-166, December 2001.
- [224] N. Roy, G. Pallapa, and S. K. Das, "An Ontology-Driven Ambiguous Contexts Mediation Framework for Smart Healthcare Applications," in *International Conference on Pervasive Technologies Related to Assistive Environments*, Athens, Greece, 2008, pp. 1-8.

- [225] D. S. Hamu, "Enterprise Frameworks," in *Building Application Frameworks: Object-Oriented Foundations of Framework Design*, M. Fayad, D. C. Schmidt, and R. E. Johnson, Eds., ed New York, NY: Wiley, 1999, pp. 83-86.
- [226] A. B. Waluyo, I. Pek, X. Chen, and W. Yeoh, "Design and Evaluation of Lightweight Middleware for Personal Wireless Body Area Network," *Personal and Ubiquitous Computing*, vol. 13, pp. 509-525, April 2009.
- [227] N. Roy, T. Gu, and S. K. Das, "Supporting Pervasive Computing Applications with Active Context Fusion and Semantic Context Delivery," *Pervasive and Mobile Computing*, vol. 6, pp. 21-42, February 2010.
- [228] M. D. Rodríguez and J. Favela, "Assessing the SALSA Architecture for Developing Agent-Based Ambient Computing Applications," *Science of Computer Programming*, vol. 77, pp. 46-65, January 2012.
- [229] J. Lewandowski, H. E. Arochena, R. N. G. Naguib, and K. Chao, "A Portable Framework Design to Support User Context-Aware Augmented Reality Applications," in *3rd International Conference on Games and Virtual Worlds for Serious Applications*, Athens, Greece, 2011, pp. 144-147.
- [230] N. F. Ahmad and D. B. Hoang, "Assistive Health Care Monitoring Framework Using Active Database Approach," in *4th IADIS International Conference e-Health*, Algarve, Portugal, 2009, pp. 19-26.
- [231] C. Orwat, A. Graefe, and T. Faulwasser, "Towards Pervasive Computing in Health Care – A Literature Review," *BMC Medical Informatics and Decision Making*, vol. 8, pp. 26-45, June 2008.
- [232] U. Varshney, "Managing Wireless Health Monitoring for Patients with Disabilities," *IT Professional*, vol. 8, pp. 12-16, November/December 2006.
- [233] P. Kulkarni and Y. Ozturk, "mPHASiS: Mobile Patient Healthcare and Sensor Information System," *Journal of Network and Computer Applications*, vol. 34, pp. 402-417, January 2011.
- [234] F. Balagtas-Fernandez, M. Tafelmayer, and H. Hussmann, "Mobia Modeler: Easing the Creation Process of Mobile Applications for Non-Technical Users,"

in *15th International Conference on Intelligent User Interfaces*, Hong Kong, China, 2010, pp. 269-272.

- [235] R. F. LeBlond, R. L. DeGowin, and D. D. Brown, *DeGowin's Diagnostic Examination*, 9th ed. New York, NY: McGraw-Hill Medical, 2009.
- [236] S. F. Smith and D. Duell, *Clinical Nursing Skills: Nursing Process Model, Basic to Advanced Skills*, 3rd ed. Englewood, NJ: Appleton & Lange, 1992.
- [237] F. Paganelli, E. Spinicci, and D. Giuli, "ERMHAN: A Context-Aware Service Platform to Support Continuous Care Networks for Home-Based Assistance," *International Journal of Telemedicine and Applications*, vol. 2008, January 2008.
- [238] P. D. Haghghi, B. Gillick, S. Krishnaswamy, M. M. Gaber, and A. Zaslavsky, "Mobile Visualization for Sensory Data Stream Mining," in *2nd International Workshop on Knowledge Discovery from Sensor Data*, Las Vegas, NV, 2008, pp. 85-92.
- [239] American Heart Association. (2012, July). *Understand Your Risk for High Blood Pressure*. Available: http://www.heart.org/HEARTORG/Conditions/HighBloodPressure/UnderstandYourRiskforHighBloodPressure/Understand-Your-Risk-for-High-Blood-Pressure_UCM_002052_Article.jsp
- [240] M. H. Ellestad, *Stress Testing: Principles and Practice*, 5th ed. New York, NY: Oxford University Press, 2003.
- [241] R. L. Bloom, "A Case-Based Approach to Teaching Evidence-Based Practice and Motor Speech Disorders," *Contemporary Issues in Communication Science and Disorders*, vol. 37, pp. 123-130, 2010.
- [242] V. Villarreal, J. Laguna, S. López, J. Fontecha, C. Fuentes, R. Hervás, *et al.*, "A Proposal for Mobile Diabetes Self-Control: Towards a Patient Monitoring Framework," in *Distributed Computing, Artificial Intelligence, Bioinformatics, Soft Computing, and Ambient Assisted Living*. vol. 5518, J. Cabestany, I. Rojas, and G. J. Caparrós, Eds., ed Berlin, Germany: Springer, 2009, pp. 869-876.

- [243] W. M. Wang, C. F. Cheung, W. B. Lee, and S. K. Kwok, "Knowledge-Based Treatment Planning for Adolescent Early Intervention of Mental Healthcare: A Hybrid Case-Based Reasoning Approach," *Expert Systems*, vol. 24, pp. 232-251, September 2007.
- [244] L. Blessing and A. Chakrabarti, *DRM, a Design Research Methodology*. London, UK: Springer, 2009.
- [245] C. M. Eckert, P. J. Clarkson, and M. K. Stacey, "The Spiral of Applied Research: A Methodological View on Integrated Design Research," in *14th International Conference on Engineering Design*, Stockholm, Sweden, 2003, pp. 19-21.
- [246] R. Chow and W. Jonas, "Beyond Dualisms in Methodology: An Integrative Design Research Medium "MAPS" and some Reflections," in *Design Research Society Conference*, Sheffield, UK, 2008, pp. 1-18.
- [247] M. L. Markus, A. Majchrzak, and L. Gasser, "A Design Theory for Systems that Support Emergent Knowledge Processes," *MIS Quarterly*, vol. 26, pp. 179-212, September 2002.
- [248] S. T. March and G. F. Smith, "Design and Natural Science Research on Information Technology," *Decision Support Systems*, vol. 15, pp. 251-266, December 1995.
- [249] H. A. Simon, *The Sciences of the Artificial*, 3rd ed. London, UK: MIT Press, 1996.
- [250] R. Cole, S. Purao, M. Rossi, and M. Sein, "Being Proactive: Where Action Research Meets Design Research," in *26th International Conference on Information Systems*, Las Vegas, NV, 2005, pp. 325-336.
- [251] S. Dagtas, Y. Natchetoi, H. Wu, and A. Shapiro, "An Integrated Wireless Sensing and Mobile Processing Architecture for Assisted Living and Healthcare Applications," in *International Workshop on Systems and Networking Support for Healthcare and Assisted Living Environments*, San Juan, CA, 2007, pp. 70-72.
- [252] A. R. Hevner, S. T. March, J. Park, and S. Ram, "Design Science in Information Systems Research," *MIS Quarterly*, vol. 28, pp. 75-105, March 2004.

- [253] R. Wieringa, "Design Science as Nested Problem Solving," in *4th International Conference on Design Science Research in Information Systems and Technology*, Malvern, PA, 2009.
- [254] V. K. Vaishnavi and William Kuechler Jr., *Design Science Research Methods and Patterns: Innovating Information and Communication Technology*. Boca Raton, FL: Auerbach Publications, 2008.
- [255] J. R. Venable, "The Role of Theory and Theorising in Design Science Research," in *International Conference on Design Science Research in Information Systems and Technology*, Claremont, CA, 2006, pp. 1-18.
- [256] S. Easterbrook, J. Singer, M. Storey, and D. Damian, "Selecting Empirical Methods for Software Engineering Research," in *Guide to Advanced Empirical Software Engineering*, F. Shull, J. Singer, and D. I. K. Sjøberg, Eds., ed London, UK: Springer, 2008, pp. 285-311.
- [257] W. James and G. B. Gunn, *Pragmatism and other Writings*. New York, NY: Penguin Books, 2000.
- [258] R. B. Johnson and A. J. Onwuegbuzie, "Mixed Methods Research: A Research Paradigm Whose Time Has Come," *Educational Researcher*, vol. 33, pp. 14-26, October 2004.
- [259] J. Brannen, "Mixing Methods: The Entry of Qualitative and Quantitative Approaches into the Research Process," *International Journal of Social Research Methodology*, vol. 8, pp. 173-184, July 2005.
- [260] M. G. Al-Bashayreh, N. L. Hashim, and O. T. Khorma, "Towards Successful Design of Context-aware Application Frameworks to Develop Mobile Patient Monitoring Systems Using Wireless Sensors," in *3rd IEEE Conference Open System*, Kuala Lumpur, Malaysia, 2012, pp. 1-6.
- [261] M. G. Al-Bashayreh, N. L. Hashim, and O. T. Khorma, "A Survey on Success Factors to Design Context-aware Frameworks to Develop Mobile Patient Monitoring Systems," in *3rd IEEE Conference on Open Systems*, Kuala Lumpur, Malaysia, 2012, pp. 1-6.

- [262] M. G. Al-Bashayreh, N. L. Hashim, and O. T. Khorma, "A Survey on Success Factors to Design Application Frameworks to Develop Mobile Patient Monitoring Systems," in *2nd IEEE International EMBS Conference Biomedical Engineering and Sciences*, Langkawi, Malaysia, 2012, pp. 57-62.
- [263] J. V. Brocke, A. Simons, B. Niehaves, K. Riemer, R. Plattfaut, and A. Cleven, "Reconstructing the Giant: On the Importance of Rigour in Documenting the Literature Search Process," in *17th European Conference on Information Systems*, Verona, Italy, 2009, pp. 2206-2217.
- [264] S. Elo and H. Kyngäs, "The Qualitative Content Analysis Process," *Journal of Advanced Nursing*, vol. 62, pp. 107-115, November 2008.
- [265] J. Webster and R. T. Watson, "Analyzing the Past to Prepare for the Future: Writing a Literature Review," *MIS Quarterly*, vol. 26, pp. xiii-xxiii, June 2002.
- [266] M. Aksit, B. Tekinerdogan, F. Marcelloni, and L. Bergmans, "Deriving Frameworks from Domain Knowledge," in *Building Application Frameworks: Object-Oriented Foundations of Framework Design*, M. Fayad, D. C. Schmidt, and R. E. Johnson, Eds., ed New York, NY: Wiley, 1999, pp. 169-198.
- [267] M. Antkiewicz and K. Czarnecki, "FeaturePlugin: Feature Modeling Plug-In for Eclipse," in *Eclipse Technology eXchange (ETX) Workshop*, Vancouver, BC, 2004, pp. 67-72.
- [268] J. Kim, M. Kim, and S. Park, "Goal and Scenario Based Domain Requirements Analysis Environment," *Journal of Systems and Software*, vol. 79, pp. 926-938, July 2006.
- [269] K. Weidenhaupt, K. Pohl, M. Jarke, and P. Haumer, "Scenarios in System Development: Current Practice," *IEEE Software*, vol. 15, pp. 34-45, March/April 1998.
- [270] Brazilian Society of Cardiology, "IV Guideline for Ambulatory Blood Pressure Monitoring / II Guideline for Home Blood Pressure Monitoring," *Arquivos Brasileiros de Cardiologia*, vol. 85, pp. 1-18, February 2005.
- [271] H. W. Rodbard, L. Blonde, S. S. Braithwaite, E. M. Brett, R. H. Cobin, Y. Handelsman, *et al.*, "American Association of Clinical Endocrinologists Medical

- Guidelines for Clinical Practice for the Management of Diabetes Mellitus," *Endocrine Practice*, vol. 13, pp. 1-68, May/June 2007.
- [272] D. Matthews, N. Meston, P. Dyson, J. Shaw, L. King, and A. Pal, *Diabetes: An Overview*. Oxford, UK: Oxford, 2008.
- [273] US National Library of Medicine. (2011, July). *Hypoglycemia*. Available: <http://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0001423/>
- [274] H. Batteram, H. Benz, T. Broens, P. D. Costa, H. Eertink, L. F. Pires, *et al.*, "AWARENESS Scope and Scenarios," Freeband AWARENESS Enschede, Netherlands AWARENESS/D1.1v2, June 2005.
- [275] R. Huis, H. Hermens, and M. Vollenbroek-Hutten, "Tools and Methods for Reliable Measurement of Sensory Input Information: State of the Art and First Selection of Parameters," Freeband AWARENESS AWARENESS/D4.1, November 2004.
- [276] K. H. E. Kroemer, H. J. Kroemer, and K. E. Kroemer-Elbert, "Exercise and Work," in *Engineering Physiology*, K. H. E. Kroemer, H. J. Kroemer, and K. E. Kroemer-Elbert, Eds., 4th ed Berlin, Germany: Springer, 2010, pp. 173-198.
- [277] A. Bertolino, G. D. Angelis, A. D. Sandro, and A. Sabetta, "Is My Model Right? Let me Ask the Expert," *Journal of System and Software*, vol. 84, pp. 1089-1099, July 2011.
- [278] M. Moon, K. Yeom, and H. S. Chae, "An Approach to Developing Domain Requirements as a Core Asset Based on Commonality and Variability Analysis in a Product Line," *IEEE Transactions on Software Engineering*, vol. 31, pp. 551-569, July 2005.
- [279] K. E. Wiegers, *Software Requirements*, 2 ed. Redmond, WA: Microsoft Press, 2003.
- [280] Sparx Systems. (2014, January). *Enterprise Architect*. Available: <http://www.sparxsystems.com/products/ea/index.html>
- [281] Sparx Systems, "MDA Overview," 2007.

- [282] D. S. Frankel, *Model Driven Architecture: Applying MDA to Enterprise Computing*. New York, NY: Wiley, 2003.
- [283] M. H. Lutz and P. A. Laplante, "C# and the .NET Framework: Ready for Real Time?," *IEEE Software*, vol. 20, pp. 74-80, Jan/Feb 2003.
- [284] A. Davies, *Async in C# 5.0*. Sebastopol, CA: O'Reilly, 2012.
- [285] S. Olson, J. Hunter, B. Horgen, and K. Goers, *Professional Cross-Platform Mobile Development in C#*. Indianapolis, IN: Wiley, 2012.
- [286] G. Shackles, *Mobile Development with C#*, 1st ed. Sebastopol, CA: O'Reilly, 2012.
- [287] Xamarin. (2014, April). *Mono*. Available: <http://www.mono-project.com>
- [288] Simple Injector. (2014, April). *Simple Injector*. Available: <http://simpleinjector.codeplex.com/>
- [289] E. Skorve and M. Aanestad, "Bootstrapping Revisited: Opening the Black Box of Organizational Implementation," in *Scandinavian Information Systems Research*. vol. 60, K. Kautz and P. A. Nielsen, Eds., ed Berlin, Germany: Springer, 2010, pp. 111-126.
- [290] M. Seemann, *Dependency Injection in .NET*. Shelter Island, NY: Manning, 2012.
- [291] M. Gousset. (2013). *Use Code Maps to Understand Code Relationships*. Available: <http://visualstudiomagazine.com/articles/2013/04/25/use-code-maps-to-understand-code-relationships.aspx>
- [292] Microsoft. (2014, June). *Visual Studio Code Metrics Viewer 2013*. Available: <http://visualstudiogallery.msdn.microsoft.com/03de6710-4573-460c-aded-96588572dc19>
- [293] C. Driver and S. Clarke, "An Application Framework for Mobile, Context-Aware Trails," *Pervasive and Mobile Computing*, vol. 4, pp. 719-736, October 2008.

- [294] P. Devanbu, S. Karstu, W. Melo, and W. Thomas, "Analytical and Empirical Evaluation of Software Reuse Metrics," presented at the 18th International Conference on Software Engineering, Berlin, Germany, 1996.
- [295] Microsoft, *Enterprise Solution Patterns Using Microsoft .NET*. Redmond, WA: Microsoft, 2003.
- [296] J. Bishop, *C# 3.0 Design Patterns*. Sebastopol, CA: O'Reilly, 2008.
- [297] R. E. Johnson and B. Foote, "Designing Reusable Classes," *Journal of Object-Oriented Programming*, vol. 1, pp. 22-35, June/July 1988.
- [298] P. Coad and E. Yourdon, *Object-Oriented Design*. Englewood Cliffs, NJ: Yourdon Press, 1991.
- [299] S. R. Chidamber and C. F. Kemerer, "A Metrics Suite for Object Oriented Design," *IEEE Transactions on Software Engineering*, vol. 20, pp. 476-493, June 1994.
- [300] G. Booch, *Object Oriented Design: With Applications*. Redwood City, CA: Pearson, 1991.
- [301] T. Korson and J. D. McGregor, "Understanding Object-Oriented: A Unifying Paradigm," *Communications of the ACM*, vol. 33, pp. 40-60, September 1990.
- [302] M. F. Kilian, "A Note on Type Composition and Reusability," *ACM SIGPLAN OOPS Messenger*, vol. 2, pp. 24-32, July 1991.