Software Construction

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Software Construction

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Overview

Our research focuses on the development of new and advanced methods, tools, and techniques in the broad area of software construction. Since software engineering is done in software developing organizations, we always try to develop and deliver software engineering support that is applicable under industrial software development conditions. Hence, most of our research projects are performed in close cooperation with industrial partners. Details on the projects can be found in the corresponding section of this report.

Currently we are actively working in the following areas:

- *Metric-based process evaluation and improvement.* Like in other engineering disciplines, measuring is a prerequisite to determine the performance of processes and products. We have started a new project the aims to develop an integrated highly customizable measurement infrastructure.

- *Simulation-based quality assurance of business processes and workflows.* Business processes as well as workflows become more and more an important means to specify and integrate software services and applications. An appropriate validation and verification approach of those models is an open issue but crucial for gaining all the benefits.

- *Advanced use case modeling.* Use case modeling is applied in industry for years to specify functional requirements. But the potentials of this requirements engineering technique are not utilized so far. An advanced modeling approach is needed enabling improved use case based requirements validation as well as use case based automated system testing.

Since appropriate tools are often the door opener to transfer research ideas to practice we are developing dedicated tool support for those areas. Currently we offer the following tools:

- ViPER (Visual Tooling Platform for Model-Based Engineering, www.viper.sc)
- QMetric and BugzillaMetrics (www.qmetric.org)
- NaUTiluS (Narrative Use Case Description Toolkit for Evaluation and Simulation)
- MeDIC (Measure Documentation - Integration and Calculation)

Teaching

In addition to undergraduate courses on Programming and Software Development the group offers on the graduate level the following set of courses focusing on Software Construction and Software Quality Assurance:

- Lecture Software Quality Assurance and Project Management
- Lecture Object-Oriented Software Construction
- Lecture Managing Software Development Projects
- Seminars and Practical Labs

Furthermore we are responsible for the Software Engineering course of the master program Software Systems Engineering at the Thai German Graduate School of Engineering, Bangkok, Thailand.

Research Projects

Model-Based Engineering of Small Embedded & Real-Time Systems

Nyßen, H. Lichter

External cooperation: ABB Corporate Research Center, Ladenburg, Germany

As the history of software engineering unveils, abstraction is the means to face complexity. While the 1970's and 1980's have been strongly based on functional and data abstraction, and while the 1990's and early 2000's have been dominated by object-orientation, model-based software development (MBSD) seems to be the predominant development paradigm of the present and upcoming decade.

Due to its increased capabilities in terms of abstraction, traceability and analyzability, it seems to be the in particular useful to address the very special constraints, being faced in the domain of embedded & real-time systems. However, as current surveys unveil, from a state-of-the-practice viewpoint, model-based software development does not seem to have penetrated the embedded & real-time domain yet. Tracing this back to domain-specific technical, economical and organizational constraints, not being properly reflected by current model-based approaches, it is the goal of this project to introduce modern model-based technology and techniques, being however constraint-adequate.

As only a common, integrated methodology, formed by a systematic and concise method, by profound supporting tools, and by underlying languages, being related via common concepts and principles, allows to unleash the full potential of model-based development, it is the central goal of this project to deliver the latter. Regarding the very special constraints, being additionally faced in the domain of small embedded & real-time systems, the approach should in particular be applicable to a domain, which has been very much elided so far.

Evaluating Business Process Models

A. Ganser, H. Lichter

External cooperation: Osthus GmbH, Aachen

Research in constructing software, in other terms software engineering, already exists for decades and over the years several approaches emerged. Ranging from procedural, functional until object oriented approaches, creating a model of the system to be build is a cornerstone of every approach. But, all software systems, which are modeled and developed with these approaches, deal with single pieces of software or software systems for narrow scopes (metaphor: e.g. for departments in companies). Consequently, one step in abstraction deals with connecting these software systems to workflows. This adds a goal oriented perspective and links several systems together to (e.g.) support departments working together in a static,

but automated way. What remains is the importance of models in a sense of abstractions from the real world. The next step in abstraction adds business goals as a motivation and concerns the whole company or even several companies.

Hence, business process modeling enlarges the perspective with business goals and mainly adds the aspects of agile business processes and business goals. This sounds like documentation at first but committing to business processes actually burden engineers with severe architectural constrains. Moreover, demands emerged which want to have these business processes automated. As a consequence, business processes are required to be flawless in many different ways.

On the one side, a lot of research has been undertaken in the field of metrics for business process models. On the other side, a lot of quality models exist on a very high level of abstraction. But, only very few researchers ventured to establish a link between metrics and models. This is due to the gap perceived small but actually it is immense.

So, the initial questions are: What can we do with the metrics invent so far? What do the numbers mean with respect to a given quality model? Which metrics are missing? And, combined with simulations on business process models - which information we can glean? And, finally, is there interesting information derivable from historical information of models?

These simple questions turn out to be challenging since lot of the foundations are still missing.


Methodical and Tool Support for Advanced Use Case Modelling

V. Hoffmann, H. Lichter

Use cases are a widely accepted technique for the elicitation and specification of functional requirements. In practice use cases often consist of two parts: an overview diagram which depicts the relations between the single use cases and a set of more or less detailed textual descriptions of the behaviour encapsulated by the single use cases. One of the major advantages of use case related techniques is the informal structure of the textual behaviour descriptions, which makes them a good means for communication especially between developers and customers.

This informality is at the same time their biggest drawback. Hence, it is impossible to keep track of model completeness as well as of consistency of the textual descriptions themselves and between textual descriptions and other requirement documents especially the use case overview diagrams automatically. To overcome those issues we defined a formal meta-model for textual use case descriptions. This meta-model only affects the structure of textual behaviour descriptions, but does not restrict the language that can be used to describe the behaviour itself.

Thus on the one hand the enriched descriptions remain simple enough to be usable as a communication means and on the other hand the application of the formal model enables tool support which leads more sophisticated, consistent use case descriptions.
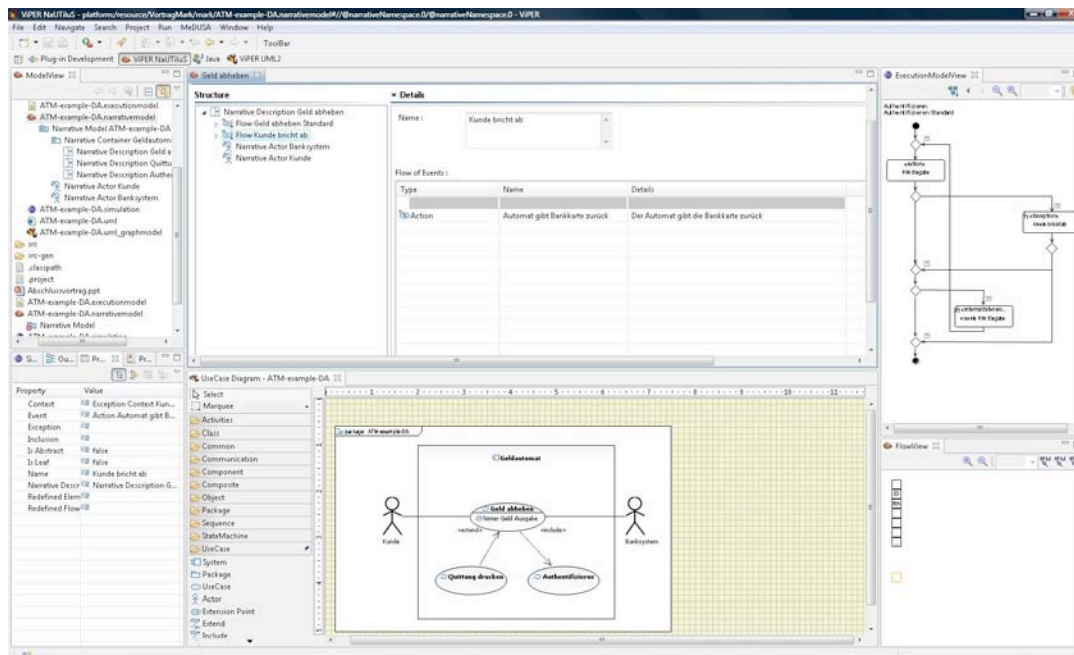
During the last year we created ViPER-NaUTiluS. ViPER-NaUTiluS adds integrated tool support for specifying, editing and analysing of enriched use case descriptions to the ViPER-IDE. Furthermore the NaUTiluS framework includes a use case simulator for the specified behaviour descriptions. Thus NaUTiluS enables prototyping of the system behaviour very early in the development process.

GUI-Supported Test Case Generation based on Rich Use Case Models

M.Obaid, H.Lichter

Although UML notational diagrams are a good means to model use cases on an abstract level, natural language descriptions that capture these use cases are still necessary and widely used for requirements. The aggregation of these both UML diagrams and the detailed descriptions form the complete use case model. Various current tools are available that support attaching more details into use case models and allow behaviour specifications of use cases with natural language descriptions. While some research work has been done to form high quality use case models that capture such descriptions (which are less readable or less practical for later phases use), other approaches were based on using limited semantically processed natural language phrases, but they still have usability problems and did not manage to reach the needed level of the practical use. Having such a usable high quality use case model is beneficial to represent what the future system will do and how it will behave, it does not only facilitate the next development phases, but also gives the possibility to have more beneficial features. Three of more important features are System Tests, Simulation, and Architecture. This research project will focus on the generation of system test cases out of such enhanced use case models.

The research focus is of two main phases, the first is allowing the addition of needed testing information into semantically-processed flows of events descriptions of use cases, which will

form quality use case scenarios of various possible system functionality traces (simulation traces) that can be visual in a tabular format, and the other research phase is to allow a usable graphical visualization of test traces (based on the simulation traces). Such graph would be more convenient for practical use if having a Bi-relationship with the previously mentioned tabular traces records. The tester has then a flexible ability to choose graphically and easily a trace to generate its test case or many test cases at the same time if wanted.

In summarized words, an enhanced use case meta-model has to be developed recursively, that will capture functionality traces with testing information. A corresponding tool support is additionally needed on two levels, the modelling level so that the automated generation of test cases at such early stage will be more accomplishing to its purpose when it is based on such solid, standardized, and fair data-containing modelling of the requirements available, and the graphical step-wise test cases generation based on a suitable criteria selection approach as well as the selection possibility for the tester himself.

Process Assessment based on Software Repository Data

H. Schackmann, H. Lichter

External cooperation: Kisters AG, Aachen

The development of a large portfolio of software projects raises several managerial challenges, like balancing resource allocation between different projects, and aligning development processes to the standards of the organization. Hence the project status and process quality characteristics, like planning precision or problem resolution speed, must be monitored continuously in order to identify development process weaknesses, and assess process improvements. Collecting the required data by regularly project status reporting can be expensive and intrusive, and furthermore ignores the past history of a process. This motivates mining data from routinely collected repositories like change request management (CRM) systems.

However existing CRM tools provide only a number of fixed metric evaluations and are limited in their adaptability. In order to support a flexible approach for the evaluation of metrics on CRM data, the tool BugzillaMetrics was developed at our group. It is based on declarative metric specifications. This enables concentrating the main effort on the model of the metric, not on its implementation. Moreover the core of BugzillaMetrics is a generic metric evaluation algorithm that is adaptable to different change request management and version control systems. Currently adapters for Mantis, CVS, and Subversion are available. These tools have been made available open source in the QMetric tool suite. Further on the QMetric tool suite was extended by support for the definition of quality assessment models, and their automatic evaluation. Quality assessment models leverage the evaluation results of the software metric to the level of the quality characteristics of interest for the user. The tools had been evaluated in case studies targeted at the evaluation of quality characteristics within a project portfolio of open source projects, as well as in an industrial context.

Metric-Based Project and Process Management

M. Vianden, H. Lichter

External cooperation: Generali Informatik Services, Aachen

Solid and well engineered processes are the basement of successful software development projects. The outer constraints for project businesses however are constantly changing, so the processes need to adjust. Also processes should be continuously mined for improvements. The key questions are, if the underlying processes need some adjustments and if so, what parts of the processes need to change.

To answer the first question, it is inevitable to constantly measure the projects and their results - the products. Therefore the Research Group Software Construction is developing a metric based quality model for software developing processes in close cooperation with Generali Deutschland Informatik Services. Applying this model should allow to assess and to improve the underlying processes. Using this knowledge another goal is to incrementally build a repository of process-adjustments that are in accordance with established models such as CMMI or SixSigma. This repository can then be mined using dedicated metrics and other input parameters to support the optimization of the processes and by that answering the second question above.

Other Activities

- Member of the international program committee, 24th Annual ACM Symposium on Applied Computing Software Engineering Track Honolulu, March 8-12. 2009, *H. Lichter*

- Member of the international program committee, International Workshop on Formal Methods plus Agile Methods in Software Engineering, Rio de Janeiro, December 8 -11, 2009, *H. Lichter*

- Member of the international program committee, Software Engineering (SE) Track at the 24th Annual ACM Symposium on Applied Computing (SAC 2009), Honolulu, March 8-12, 2009, *H. Lichter*

- Member of the program committee, 3rd IEEE International Conference on Secure Software Integration and Reliability Engineering Shanghai, China, July-8-10, 2009 *H. Lichter*

- Member of the program committee, Software Engineering 2009, Kaiserslautern, March 2-6, 2009, *H. Lichter*

- Industry Seminar Software Quality and Testing, Bangkok, Sept. 23, 2009, *H. Lichter*

- Reviewer for dpunkt-Verlag Heidelberg and computing reviews, *H. Lichter*

- Organization of the Computer Science Department's mentors program, *H. Lichter*

- Member of the Computer Science Department's committee for Service-Lehre, *H. Lichter*

- Member of the examination board of Computational Material Science, *H. Lichter*

- Member of the examination board of Bachelor Computer Science, *H. Lichter*

- Member of the selection committee of professorships Software Engineering and Parallel Programming, *H. Lichter*

- Reviewer for PhD thesis A. Vehreschild, *H. Lichter*

- Organization of the Beginner's Course in Computer Science 2009, *H. Lichter, V. Hoffmann*

- Presentation of MeDUSA and the ViPER Tool Support, ABB Alzenau, October 29, 2008, *Alexander Nyßen*

- QMetric Tool presentation, 31th International Conference on Software Engineering (ICSE'09). Vancouver, Canada, May 16-24, 2009, H. Schackmann.

Talks and Publications

Talks

H. Schackmann: *Comparison of Process Quality Characteristics Based on Change Request Data.* International Conferences IWSM 2008, Metrikon 2008, and Mensura 2008 Munich, Germany, November 18-19, 2008.

A. Ganser: *A Server Side SOA Meta Model for Assigning Aspect Services.* Workshop on Modeling Security (MODSEC08) held as part of the 2008 International Conference on Model Driven Engineering Languages and Systems (MODELS), Toulouse, France, September 28, 2008.

A. Nyßen: *Model-Based Construction of Embedded & Real-Time Software - A Methodology for Small Devices.* Informatik-Oberseminar, January 28, 2009.

H. Schackmann: *Process Assessment by Evaluating Configuration and Change Request Management Systems.* Warm Up Workshop For ACM/IEEE ICSE 2010, Cape Town, South Africa, April 01 - 03, 2009.

M. Vianden: *Werkzeugunterstützung für iterative Modernisierungsprozesse,* Workshop on Software Reengineering WSR 2009, Bad Honnef, May 04-06, 2009.

H. Schackmann: *Evaluating Process Quality in GNOME based on Change Request Data.* 6th IEEE Working Conference on Mining Software Repositories (MSR'09). Vancouver, Canada, May 16-17, 2009.

S. Pricope: *Towards a Metric Based Approach to Evaluate SCAMPI Appraisals.* 10th International Conference PROFES 2009, Oulu, Finland, June 15-17.

H. Lichter: *Software Process Improvement – An Overview,* NECTEC, Bangkok, September 19.

Publications

H. Schackmann, H. Lichter (2008): *Comparison of Process Quality Characteristics Based on Change Request Data.* In Dumke, R.R.; Braungarten, R.; Büren, G.; Abran, A.; Cuadrado-Callego, J. (Eds.) International Conferences IWSM 2008, Metrikon 2008, and Mensura 2008 Munich, Germany, November 18-19, 2008. Proceedings. LNCS 5338, Springer-Verlag Berlin Heidelberg. ISBN: 978-3-540-89402-5, pp 127-140.

A. Ganser, S. Hurtz, H. Lichter (2008): *A Server Side SOA Meta Model for Assigning Aspect Services.* In Proceedings of the Workshop on Modeling Security (MODSEC08) held as part of the 2008 International Conference on Model Driven Engineering Languages and Systems (MODELS), Toulouse, France, September 28, 2008. ISSN 1613-0073 Vol-413.

A. Nyßen (2009): *Model-Based Construction of Embedded & Real-Time Software - A Methodology for Small Devices.* Aachener Informatik Berichte, AIB 2009-03, ISSN 0935–3232, RWTH Aachen University, Department of Computer Science.

H. Schackmann, H. Lichter (2009): *Process Assessment by Evaluating Configuration and Change Request Management Systems.* In Proc. of the Warm Up Workshop For ACM/IEEE ICSE 2010 (Cape Town, South Africa, April 01 - 03, 2009). N. Medvidovic and T. Tamai, Eds. WUP '09. ACM, New York, NY, pp 37-40.

C. Weidmann, V, Hoffmann, H. Lichter (2009): *Einsatz und Nutzen von Use Cases - Ergebnisse einer empirischen Untersuchung.* Softwaretechnik-Trends, Band 29, Heft 2, May 2009, ISSN 0720-8928, pp 62 -67.

M. Vianden, F. Berretz, T. Rötschke (2009): *Werkzeugunterstützung für iterative Modernisierungsprozesse.* Workshop on Software Reengineering WSR 2009, Bad Honnef, May 04-06, 2009. Softwaretechnik-Trends, Band 29 Heft 2, ISSN 0720-8928.

H. Schackmann, M. Jansen, C. Lischkowitz, H. Lichter (2009): *QMetric - A Metric Tool Suite for the Evaluation of Software Process Data.* In Companion Volume of the 31th International Conference on Software Engineering (ICSE'09). Vancouver, Canada, May 16-24, 2009, pp 415-416.

H. Schackmann, H. Lichter (2009): *Evaluating Process Quality in GNOME based on Change Request Data.* 6th IEEE Working Conference on Mining Software Repositories (MSR'09). Vancouver, Canada, May 16-17, 2009, pp 95-98.

S. Pricope, H. Lichter (2009): *Towards a Metric Based Approach to Evaluate SCAMPI Appraisals.* In Bomarius F. et al. (eds) Product Focused Software Development and Process Improvement, 10th International Conference PROFES 2009, Oulu, Finland, June 15-17, Lecture Notes in Business Information Processing, vol 32, Springer, pp 261-174.

V. Hoffmann, H. Lichter, A. Nyßen, A. Walter (2009): *Towards the Integration of UML- and textual Use Case Modeling.* In Journal of Object Technology, vol. 8, no. 3, May-June 2009, pp 85-100.