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. 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 are aiming to develop an integrated highly customizable measurement infrastructure.
- *Goal-based Process Improvement*. Different reference models (e.g. CMMI, SPICE, COBIT) are used by organizations to improve their software processes. A systematic and objective approach is developed to decide which reference models, parts of reference models, or combinations of them are best suited for the intended improvement.
- *Interactive Use Case based Prototyping*. Prototyping is an accepted technique to evaluate complex system behavior. Since prototypes are typically created manually prototyping may be time consuming. We develop a generative approach to automatically create interactive prototypes from use case based requirements specifications.
- *Reusing Domain Engineered Artifacts for Code Generation.* Model driven engineering uses certain diagrams to foster code generation. But these diagrams are rarely reused.; overcoming this is one goals of this project

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)
- OpenUMF (Use Case based Requirements Modeling Framework)
- MeDIC (Measure Documentation - Integration and Calculation)
- MoCCa (Model Composition and Combination Vault)

Teaching

We offer on the graduate level the following courses:

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

Furthermore we are responsible for the Software Engineering course of the master program Software Systems Engineering at TGGS, Bangkok, Thailand.

In 2010 Matthias Vianden (Software Quality Assurance) and Andreas Ganser (Beginners Course in Computer Science) were nominated in the category for best “teaching support” at the CS’s Open Day in December. Furthermore Simona Jeners (Pricope) successfully presented her research project and won a prize in the “One Minute Madness” session.

Research Projects

Reusing Domain Engineered Artifacts for Code Generation

A. Ganser, H. Lichter

Software development has undergone several changes over decades and evolved from manual typing up source code to (partially) generating source code from diagrams. However, some of the motivating motives remained constant over time. One of which is the urge to reduce time necessary for developing a system. This is because development will remain a partially manual executed task as long as no way for completely generating software is found. Another motivation is the need for a certain quality which can be guaranteed upfront, if some parts of the system are generated from diagrams.

These and more motivating aspects have been extensively developed in the industries and largely discussed in science until model driven architecture (MDA), and model driven engineering (MDE) emerged. Both address the above mentioned aspects and comprise of several methods which include a domain specific modeling (DSM). This methodology brings about figures which maps the objects under consideration to models. Among these models are class diagrams as know from UML which are called domain models in these contexts.

While both approaches take these domain models as inputs for code generation, only MDE includes reuse in DSM. But this reuse remains rather rudimentary. Taking a closer look at model repositories one might suppose that these repositories are meant to store models so they can be reused rather easily in different projects. But the goals for these tools are totally different! All the available repositories (by and large) only consider versioning, migration, transformation, conflict detection, merging and search. This means, models are not related to each other, there is barely a description of models, no examples are present how the models could be used or no interfaces are defined which point to the most important aspects that could help reusing a particular model.

The goal of this research project is to bolster model reuse by providing interfaces attaching descriptions and providing examples. Furthermore, models should not be treated as in an isolated world, but related to each other, knowing not only that these models worked out together but even how they did. These relationships cross borders and overcome the usual reuse obstacles and unleash the full power of previously modeled knowledge.

Goal-based Process Improvement

S. Jeners, H. Lichter

External cooperation: Generali Informatik Services, Aachen

Nowadays, the software market is expanding and clients are requesting better, faster, and cheaper software products. One important impact factor to project success is the quality of the

applied IT-processes. Hence, more and more organizations are obligated to identify, structure, and improve their processes systematically. There is a variety of reference models known as maturity-, process- and quality-models as well as standards, norms, etc. that can be used. Organizations have to decide which of these models they want to use. The adoption of multiple RMs allows an organization to exploit synergy effects between them. On the one hand organizations can address co-coordinately different and common areas. On the other hand the weaknesses of a single RM can be overcome by the strengths of others.

The aim of this project is to develop a model based approach that provides an objective and semiautomatic selection of improvement practices of multiple RMs that best fit to an organization. To select the best suited practices the organizations' internal processes, wishes, problems, environment etc. have to be considered. The selected practices have to address the improvement potentials of the internal processes and the organizations' wishes. These are reflected by the goals of the organization. The selected practices should also be evaluated and filtered according to their return on investment. According to goals and on this analysis improvement practices can be selected that are extracted from similar or standalone practices from a build-in repository of all considered RMs. For an efficient implementation of the RMs, the traces between the improvement practices and their corresponding RM' practices and the dependencies between the improvement practices are also given. For efficient adoption and further selection of improvement practices, the implementation of the improvement practices should be continuously monitored considering the given goals.

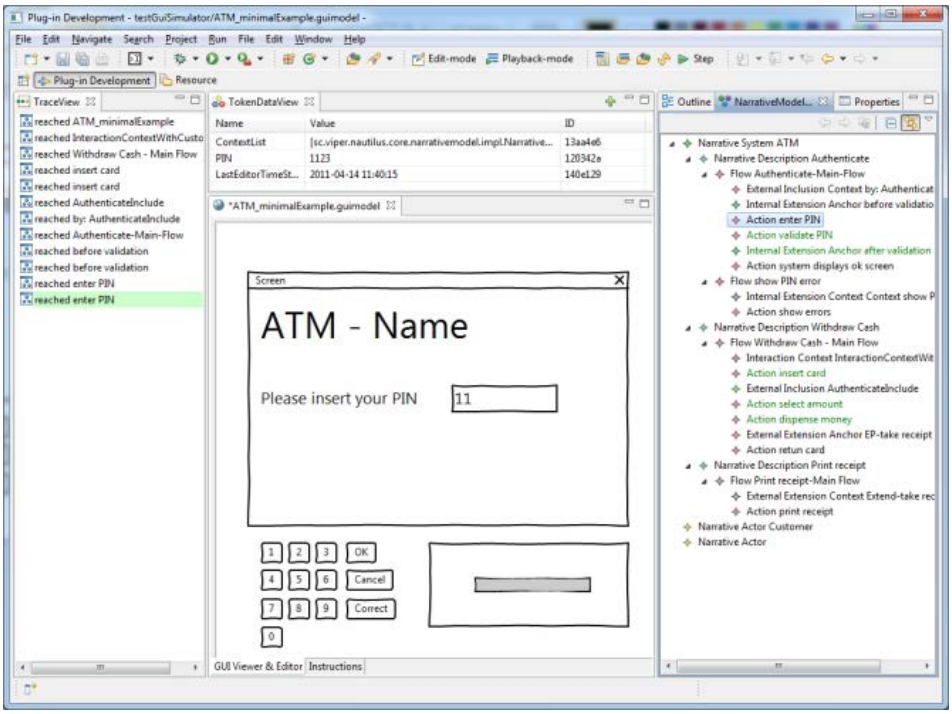
Interactive Use Case based Prototyping

V. Hoffmann, H. Lichter

Prototyping is a widely accepted technique to evaluate complex system behavior. Prototypes are especially helpful to analyze use cases that many stakeholders find complicated due to their abstractness and fragmentation. Nowadays prototypes are typically created manually and they are not directly connected to other requirements specification documents. Thus their development is expensive and often of sync with corresponding requirements specifications. Therefore we have devised a generative approach to derive interactive prototypes automatically from a use case based requirements specification.

Our approach is based on an integrated requirements model that combines functional use case models with user interface prototypes and domain concept models. Additionally we have defined a formal token-flow based execution semantic for this model.

Based on this requirements model we have created a fully automated transformation approach that is able to generate interactive behavior prototypes. The simulation runs are performed on UI mockups derived from user interface prototypes. This enables non technical stakeholders to experience the behavior in a simple intuitive fashion and can additionally be used as basis for feasibility studies. Because of a specific structure of our generation approach we are moreover able to use the simulation proactively during requirements modeling.



During the last year we developed an integrated tool support called OpenUMF for the specification of all perspectives of the requirements model based on ViPER technology. Additionally we developed an integrated simulation environment that is able to generate and execute interactive prototypes from our requirements model. The generation approach is implemented in a flexible way such that it can be used to generate prototypes for only partially complete models. Thus the prototypes can be used for requirements inspections as well as proactively during requirements modeling.

Model-based Test Generation for Web Applications

T. Sattaya-aphitan, H. Lichter

External cooperation: TOT Public Company Limited, Bangkok

Nowadays many organizations are using web applications for e-business/e-commerce purpose. Hence, it is important to ensure the required quality of web applications before distributing them. In contrasts to traditional software, there are many aspects of web applications that are different from traditional software. First, web applications typically implement a 3-tier-architecture comprising web browser, web server and database tier. The tiers are communicating by stateless protocols such as HTTP request and HTTP response. Second, each tier is implemented using a diversity of programming languages. The web browser tier is often realized using HTML, JavaScript, CCS and so on. The web server tier is implemented in JSP, PHP, ASP, JavaBean and so on. Finally, languages and technologies like Oracle, MSSQL, MySQL, etc. are used to implement the database tier. Third, web pages are often generated from prior dynamic web pages which depend on their previous inputs and server's states (session). Event handler: interactions between web browsers with users.

There are many published approaches to test Web application: First, the manual/experience-based testing approach is based on individual tester's experience. Second, the model-based testing approach abstracts the Web application Under Test (WUT) into a formal model such as a Control Flow Graph (CFG), an Event Flow Graph (EFG), an Event Interaction Graph (EIG), a System Dependency Graph (SDG), or Finite State Machine (FSM) and model checking technique. Third, the specification-based testing approach generates test cases from UML diagrams such as activity diagram, use case diagram, sequence diagram, collaboration diagram and state chart diagram. However, none of these approaches reflects the whole behavior of web applications. In our research, we focus on a model-based testing approach using structural analysis methods, called white–box testing. The goal is to formalize a testing approach which takes special care of web application behaviors. The proposed approach analyzes WUT's source code and generates the following outputs: test cases, test setup and test oracle. The generation procedure ensures that there are no duplicated and no un-executable test cases. In additional, our proposed approach introduces a novel coverage metric called "Content coverage". The generated test cases ensure 100% content coverage of the WUT. However, not only test cases are generated. The approach will guide testers to setup test environment before running the test cases (e.g. selecting input data and parameters needed to run the tests). Furthermore the approach aims to produce expected results which can be automatically compared to the actual program execution.

Metric-Based Project and Process Management

M. Vianden, H. Lichter

External cooperation: Generali Informatik Services, Aachen

It is commonly known, that projects management greatly benefit by the application of metrics. However, research shows that it is demanding to find the right metrics; 58% of all project managers and 50% of all senior managers find it difficult to collect, analyze, and use the right metrics. On the one hand, metric frameworks like GQM help to derive metrics from abstract goals for the project. On the other hand, defining measures just for one project (in a multi project organization with a lot of similar projects) is costly and ineffective. Hence, it is wise to reuse metric experience (metric definitions, evaluations, and models) as all experience can and should be reused.

Although considerable research has been devoted to the modeling of metrics and metric frameworks, rather less attention has been paid to investigating how the results of this research (metric meta models, metric frameworks, and metric experience bases) can lead to a sound concept for metric reuse. Therefore, the aim of this project is to develop such a concept for metric reuse. The concept should be enriched by metric processes which include metric reuse as well as dedicated tool support for metric documentation, metric reuse and metric calculation.

Other Activities

- Member of the international program committee, 3rd International Workshop on Formal Methods and Agile Methods, Limerick, Ireland, June 20 -24, 2011, *H. Lichter*
- Member of the international program committee, 26th Annual ACM Symposium on Applied Computing, Software Engineering Track, Tai Chung, Taiwan, March 21-25, 2011, *H. Lichter*
- Member of the international program committee, 5th IEEE International Conference on Secure Software Integration and Reliability Engineering, Jeju Island, June 27-29, 2011 *H. Lichter*
- Member of the program committee, Software Engineering 2011, Karlsruhe, February 27 – March 2, 2011, *H. Lichter*
- Member of the international program committee, IEEE ICCCSIT, 4th International Conference on Computer Science and Information Technology, Chengda, China, June 10-12, 2011, *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 Lehre and Service-Lehre, *H. Lichter*
- Member of the examination board of Computer Science, *H. Lichter*
- Member of workgroup "Zusammenarbeit Hochschule und Industrie", GFFT, Gesellschaft zur Förderung des Forschungstransfers, *H. Lichter*
- Member of the PhD defense committee M. Funk, TU Eindhoven, *H. Lichter*
- Member of the board of management AFST, Association for Social Technologies e.V., Aachen, *H. Lichter*
- Organization and member of workgroup "Messen und Bewerten", REGINA e.V., *H. Lichter, M. Vianden, S. Jeners (Pricope), A. Ganser*
- Organization of the Beginner's Course in Computer Science 2011, *H. Lichter, A. Ganser, S. Jeners (Pricope)*
- Member of Beginner's Course Task Force, 2011, *A. Ganser*
- Member of Computer Science Faculty Committee, 2011, *A. Ganser*
- Member of RWTH Aachen University Scientific Staff Committee, 2011, *A. Ganser*
- Member of Steering Committee Computational Science Center RWTH, 2011, *A. Ganser*
- Member of Steering Committee ZLW/IMA, 2011, *A. Ganser*
- Member of workgroup "Qualität von textuellen Anforderungen", GI, Gesellschaft für Informatik – Fachgruppe Requirements Engineering , *V. Hoffmann*

Talks and Publications

Talks

H. Lichter: Current Topics in SE from a Research and Industry Perspective, NECTEC National Electronics and Computer Technology Center, Bangkok, July 28, 2011.

H. Lichter: Metrics and Models, NECTEC National Electronics and Computer Technology Center, Bangkok, July 28, 2011.

S. Pricope: A Model Based Integration Approach for Reference Models. Second Proceedings of 12th International Conference on Product Focused Software Development and Process Improvement, Torre Canne, Italy, June 22, 2011.

S. Jeners: Efficient Adoption and Assessment of Multiple Reference Models. 5th IFIP TC2 Central and Eastern European Conference on Software Engineering Techniques (CEE-SET'2011), Debrecen, Hungary, August 26, 2011.

V. Hoffmann: Towards an integrated tool supported use case engineering approach. 17th International Conference on Requirements Engineering: Foundation for Software Quality, REFSQ 2011, Essen, March 31, 2011.

Publications

J. Ludewig, H. Lichter (2011): Softwarequalität und wie man sie erkennt - Mit Anspruch. iX kompakt 1/2011 Softwarequalität, Magazin für professionelle Informationstechnik, 112-114, ISSN 0935-9680, Heise Zeitschriften Verlag, Hannover.

J. Ludewig, H. Lichter (2011): Dokumentation in der Softwareentwicklung - Gut festhalten. iX kompakt 1/2011 Softwarequalität, Magazin für professionelle Informationstechnik, 126-130, ISSN 0935-9680, Heise Zeitschriften Verlag, Hannover.

V. Hoffmann, H. Lichter (2011): Towards an integrated tool supported use case engineering approach. 17th International Conference on Requirements Engineering: Foundation for Software Quality, REFSQ 2011, Essen, March 28-31.

S. Pricope, H. Lichter (2011): A Model Based Integration Approach for Reference Models. Second Proceedings of 12th International Conference on Product Focused Software Development and Process Improvement, Danilo Caivano et al., Torre Canne, Italy, June 20-22, ACM, New York, NY, USA, SBN: 978-1-4503-0783-3, pp 6-9.

S. Jeners, H. Lichter, C. G. Rosenkranz (2011): Efficient Adoption and Assessment of Multiple Reference Models. 5th IFIP TC2 Central and Eastern European Conference on Software Engineering Techniques (CEE-SET'2011), Debrecen, Hungary, August 25-26.

H. Lichter, A. Demaria, A. Phurahong (2011): A Requirement Study of Project Intelligence in Siemens IT Solutions and Services. Proceedings of 15th International Computer Science and Engineering Conference, ICSEC 2011, Bangkok, Thailand, Sept. 7-9, pp 79-84.