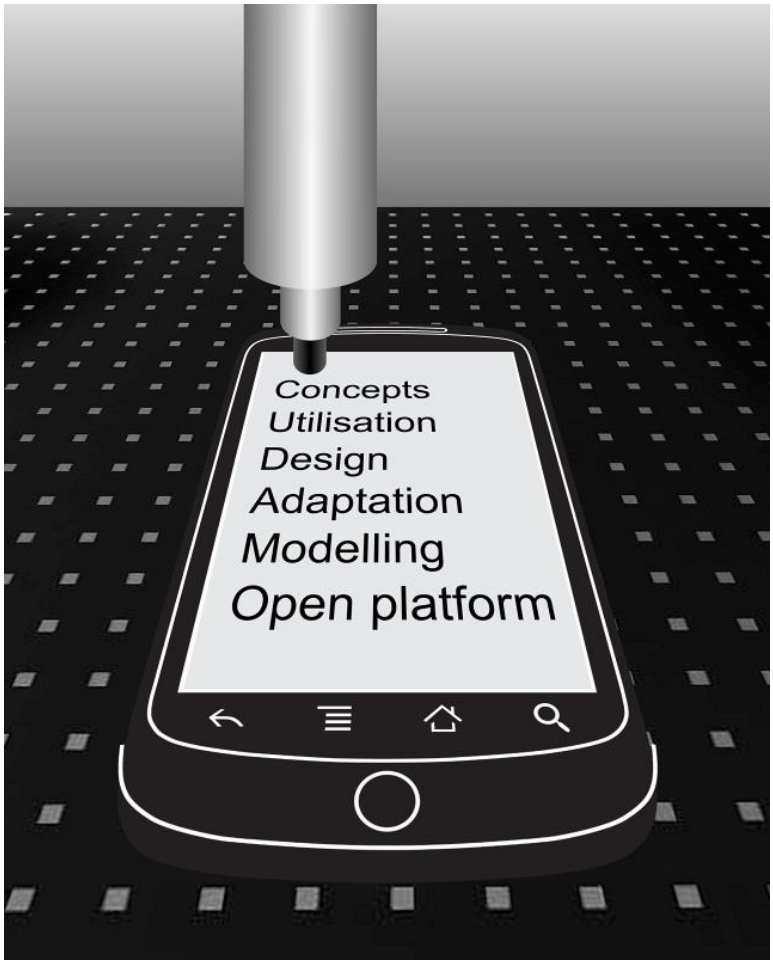
Matti Vuori & Antti Jääskeläinen, 21.10.2014

RATA

RATA project final report for Tampere University of Technology sub project



Contents

1. Introduction

This is the final report from Tampere University of Technology (TUT) for the project Robot Aided Test Automation (RATA), funded by Tekes (decision 4029/12, project officer Jouko Salo) and TUT.

The research topic in the project was robot aided software testing. A short summary on the topic is in the slide set Robot assisted testing (if you are not reading a PDF version of this report, the slide set is available at the publication page of the project at https://wiki.tut.fi/RATA/PublicationsAndDownloads).

The project was executed as a collaboration project where other parties had their individual projects. The other parties in RATA were Intel, OptoFidelity and VTT. The project was executed between 29.06.2012 and 30.06.2014.

The project web site is at https://wiki.tut.fi/RATA.

This report looks into the collaboration project from the perspective of TUT, department of pervasive computing, which had a role of research institution in the project, based on our experience of test automation systems and especially model-based testing.

2. Project execution

2.1 Execution and content

The project had the following main areas:

- Research on test modelling on robot testing context. Main results were reference test models to be used in the development and as guidance for test modellers.
- Building of test adaptation for robot testing. Main results were an adaptation system for test robots.
- Research on design principles for robot-based systems. Main results were several reports on the design issues.
- Design and implementation of Otero – Open Test Robot Platform. Main results were a published platform built around open source components.

More on the results in later chapters.

Also, at the beginning of the project we did a patent study to check that there are no obstacles to releasing the results to industry. None such were found, although it is advisable to repeat the study if some party would like to produce commercial solutions specifically to the USA market.

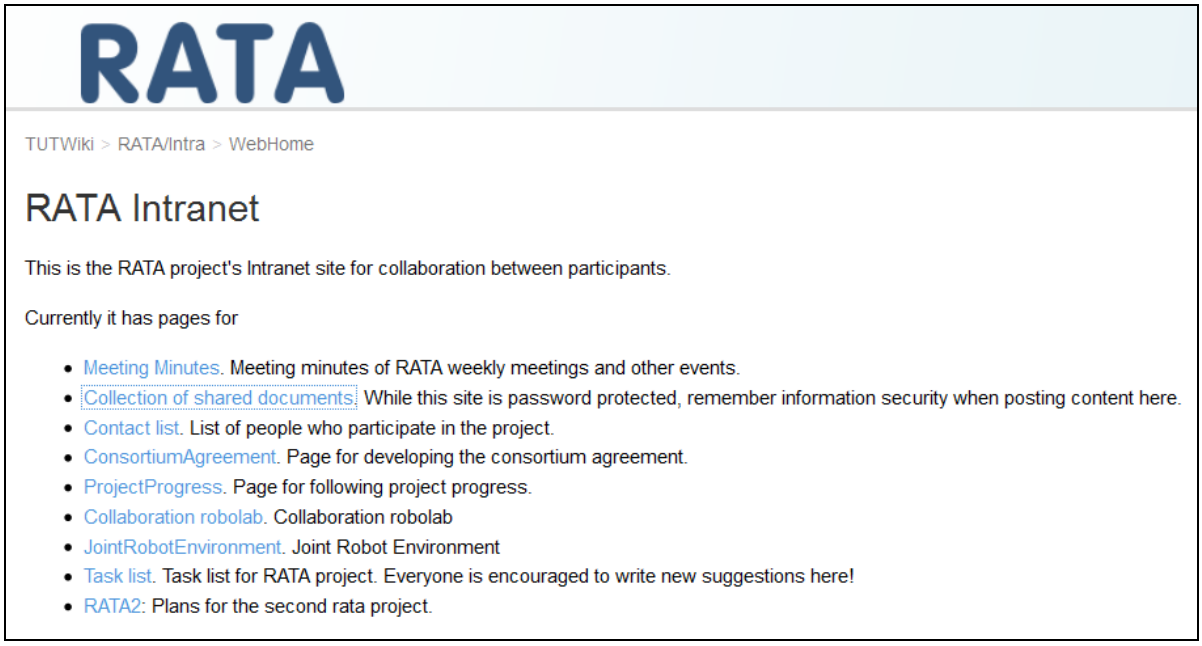
2.2 Resources and collaboration

TUT's personnel in the project included:

- Management: Professor Hannu-Matti Järvinen.
- Project manager: Antti Jääskeläinen.
- Researchers: Antti Jääskeläinen, Osku Reinikainen, Heikki Virtanen and Matti Vuori.
- Original project planning: Matti Vuori & Mika Katara (currently working at Intel).

The RATA consortium had a steering group. Members: Hannu-Matti Järvinen (TUT), Veli-Pekka Vatula (Intel), Ville Könönen (VTT), Pertti Aimonen (OptoFidelity), and Jouko Salo (Tekes).

All RATA subprojects were coordinated by Intel, first by Jussi Niutanen and later Tommi Toropainen. Coordination was done using weekly physical or telco meetings (the tool used was Microsoft Lync provided by Intel). The lifecycle mode of the project was agile, based mostly on an agreed short term task list. The project had an intranet site (under TUT's Wiki) which was used for sharing task lists and documents. The coordinator and sub project managers also participated in the steering group meetings.



The project had a confidential intranet at TUT's Wiki, which proved easy and efficient.

The main collaboration parties were obviously the other parties of the project.

During the period, TUT had another research project ATAC (http://atac.testautomation.fi/) that targeted testing of complex software systems. RATA had a lot of synergy with that project. VTT also participated in that project.

In the research of robot based test systems, there is a clear need for using test robots. OptoFidelity provided robot systems for TUT and they were used locally at OptoFidelity, and remotely using remote operation facilities developed at OptoFidelity.

2.3 Possible problems and changes to original plans

There were some changes to the original plans, and we think that the changes were overall positive for the project.

- Originally, the patent study (or freedom to operate study) was planned to be done by a consultant, but we decided that this kind of task would be better done internally, because we could more flexibly utilize our substance knowledge and also better share the results between parties. Therefore, Matti Vuori did the study.
- The original goal was to develop a test system for Intel during the project, but due to changes in the circumstances, it was felt that the practical public outcome of the project could be a framework that the whole Finnish industry could use. Therefore, the focus was moved to the development of the Otero platform.
- At first it was planned that TUT's TEMA tool set (http://tema.cs.tut.fi/) would provide a user interface for test design, but it was found that Intel's fMBT tool (http://01.org/fmbt/) was more suitable for the task. Later, a goal was formed that the resulting test execution systems should be adaptable to any test design or test modelling tool, because companies' needs vary widely in this regard.
- There was a plan to empirically compare robot-assisted and traditional instrumented test automation, but this turned out unnecessary, as we were able to form an understanding about the issues without that.

3. Summary of project results

3.1 Generic understanding of robot assisted testing

Robot assisted testing was a new area for TUT and is such for most of the practitioners and researchers of testing. The project produced general information about the paradigm.

The following TUT documents are available:

- Matti Vuori. 2013. Robot assisted testing. Tampere University of Technology. Slideset. 16 p.
- Matti Vuori. 2013. About the applicability and benefits of robot assisted testing. RATA project report. Tampere University of Technology. 10 p.

3.2 Otero – Open Test Robot Platform

Otero is an open specification and open source platform developed for the developers of test robot systems, especially for those who would like to build a low end system to enable them to practise test robotics and plan for a professional system acquisition. It is also a tool for test education and training and for researchers working in this area. The platform is currently software only, but we give some guidance about its adaptation to inexpensive robots.

See https://wiki.tut.fi/RATA/OteroShortDescription for a high level document of the platform. In it we describe the general ideas of the platform in order to make the possible users and developers understand what it is all about – what it offers and contains. Detailed descriptions of the platform architecture and the APIs are provided in separate documents.

The platform was designed in close team work with Intel, OptoFidelity and VTT. The main document was authored by Antti Jääskeläinen (TUT), Matti Vuori (TUT), Kimmo Jokinen (OptoFidelity), Tommi Toropainen (Intel), Heikki Virtanen (TUT), Arttu Lämsä (VTT), and Miska Seppänen (VTT).

3.3 Guidance for developers of robot assisted test systems

The development of robot assisted systems requires a very wide variety of competences. For that reason we published reports that describe the issues.

The following TUT reports are available:

- Matti Vuori. 2013. Robot assisted test system concepts and their main characteristics. RATA project report. Tampere University of Technology. 5 p.
- Matti Vuori. 2013. Elements of robot assisted test systems. RATA project report. Tampere University of Technology. 9 p.
- Matti Vuori. 2013. Remote robot testing system review checklist. Tampere University of Technology. 2 p.
- Matti Vuori. 2013. Locating the defects from robot test run observations – or where is the problem?. RATA project report. Tampere University of Technology. 4 p.
- Matti Vuori. 2013. About metrics and reporting in model-based robot assisted functional testing. RATA project report. Tampere University of Technology. 10 p.

3.4 Practical information on adaptation of testing robots

One very practical issue at the beginning of the project was that adaptation was needed from the test execution system to a robot that uses a mobile device. For that, research was done resulting in a master's thesis:

- Osku Reinikainen. 2014. Developing Device Adaptation for Model-Based Testing. Tampere University of Technology. 45 p.

Excerpt from its abstract:

"The implementation of the interface needs tools and image processing as a technical basis. Regarding the image processing, text recognition as well as the image and pattern recognition are dealt with because they are needed for the verification of the system state. Interfaces that are part of the tools are dealt with because the interface is implemented on them. These include [Intel's] fMBT (free Model-Based Testing) and [OptoFidelity's] TnT (Touch and Test). fMBT is a model-based testing system and TnT is OptoFidelity's robotic testing system. Other tools include Android interface, AAL (Adapter Action Language), and Tesserac. Android interface can control system which contains Android mobile operating system. AAL is modeling language used by fMBT and Tesseract is OCR (Optical Character Recognition) engine used by fMBT.

Interesting cases of the implementation are dealt with in more detail. The implementation is divided to functionalities of general, fMBT-version and TnT-version. Testing of the interface is dealt after these implementation problems. A few models were made to Google's Gmail, Calendar, Google+ and Hangouts programs by using interface. These models were used for debugging of the programs and with their help logical mistakes of the interface were resolved.

As a result, the fMBT version of the interface has been made to work and the TnT version has executed preliminary tests. The interface can be used with models and it is easy to change to another version."

3.5 Practical guidance on test modelling in the context of robot assisted testing

Model-based testing is seen as a good method for developing tests for robot-assisted testing. Therefore, emphasis was placed in the analysis of this area to see how the generic principles are applied in this context.

The following reports and quality assurance tools were produced:

- Matti Vuori. 2013. Architecture of models in testing – how models of various abstraction levels relate to each other. RATA project report. Tampere University of Technology. 10 p.
- Matti Vuori, Antti Jääskeläinen & Heikki Virtanen. 2012. fMBT AAL modelling style guide. Tampere University of Technology.
- Matti Vuori. 2012. Notes on reviewing test models. Tampere University of Technology.

4. Utilisation of the results

4.1 Dissemination of the competences and new information during the project

The project had a public web site and reports were published on it during the whole project. The site will be available after the project. The publication page is at https://wiki.tut.fi/RATA/PublicationsAndDownloads.

During the project, training was provided for the project parties and some other companies in the area about test modelling for robot assisted testing. The role of TUT in the training was to reflect on general principles of model-based testing and how they affect practical modelling. Training materials are available at the publication page.

RATA disseminated its results in Testiautomaatiopäivä (Test Automation Day) in June 2014, arranged by TUT. See http://www.cs.tut.fi/tapahtumat/testiautomaatio14/.

4.2 Views into utilisation of the results

For testing research, the project provided an opportunity to learn about issues in testing that are important in non-robot testing too, such as identifying objects in user interfaces with image recognition and optical character recognition. This will help researchers in the development of new generation test systems.

As an education institute, TUT gained competence to start teaching robot assisted testing. The first course (in seminar form) is planned for spring 2015.

4.3 Indirect effects of the project on other organisations and the society

Robot assisted testing is seen as an important tool for many companies, including the industries that develop safety-critical systems and any mobile systems. This is due to the unique characteristics of the robot assisted system where it needs no instrumentation in the system under test and can work around many inherent deficiencies in testability often seen in mobile platforms.

The Otero platform and produced reports give possibilities for companies to learn about robot assisted testing. The platform in particular is seen as an inexpensive way to do proof-of-concept trials of robot assisted testing and training of testers before committing to industrial-grade commercial systems. The platform would still need adaptation for available low-cost robot hardware, however.

The research added to the diversity of Finnish testing culture, which will build a basis for later innovations in testing tool business, practices in companies and research that supports those.