ICRA2012 Workshop on Software Development and Integration in Robotics (SDIR-VIII)

May 6, 2013 Karlsruhe, Germany

Davide Brugali
University of Bergamo, Italy

Nico Hochgeschwender,
Bonn-Rhein-Sieg University, Germany

Roland Philippsen,
Halmstad University, Sweden
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<th>Time</th>
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<tr>
<td>8.30 – 9.15</td>
<td>Welcome and Introduction</td>
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<tr>
<td>9.15 – 10.00</td>
<td>One for (Almost) All: Using a Modern Programming Language in Robotics</td>
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<td></td>
<td>Dr. Berthold Bäuml, DLR Germany</td>
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<td>10.00 – 10.30</td>
<td>Coffee break</td>
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<tr>
<td>10.30 – 12.30</td>
<td>4 Parallel Interactive sessions</td>
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<td>12.30 – 13.30</td>
<td>Lunch break</td>
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<td>13.30 – 15.30</td>
<td>4 Parallel Interactive sessions</td>
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<td>15.30 – 16.00</td>
<td>Coffee break</td>
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<td>16.00 – 18.00</td>
<td>Open discussion</td>
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Interactive sessions

- **Session 1 : Methodologies and Tools**
  - Development Processes, Components, Patterns, MDE

- **Session 2 : Middlewares**
  - System integration, Concurrent systems, RT systems

- **Session 3 : Software Frameworks**
  - Simulation, Coordination, Prototyping, Sensor calibration

- **Session 4 : Robot Architectures**
  - Software Arch., Control Arch., Integration Arch.
### Morning Session: Methodologies & Tools

<table>
<thead>
<tr>
<th>Presenter</th>
<th>Authors</th>
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<tbody>
<tr>
<td>Mauro Dragone</td>
<td>Mauro Dragone, David Swords, G.M.P. O'Hare</td>
<td>Software Engineering Challenges for Adaptive Robotic Ecologies</td>
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<tr>
<td>Luc Fabresse</td>
<td>Luc Fabresse and Jannik Laval and Noury Bouraqadi</td>
<td>Towards Test-Driven Development for Mobile Robots</td>
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<tr>
<td>?</td>
<td>Sylvain Joyeux and Thomas Roehr</td>
<td>The Single-Purpose Component</td>
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<td>?</td>
<td>Ludwig Naegele, Andreas Angerer, Bruce A. MacDonald</td>
<td>Graphical formalization and automated computing of safety constraints in robotics</td>
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### Morning Session: Middleware

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<tr>
<th>Presenter</th>
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<tbody>
<tr>
<td>Matteo Morelli</td>
<td>M. Morelli and M. Di Natale</td>
<td>Generation of Flow-Preserving Orocos Implementations of Simulink/Scicos Models</td>
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<tr>
<td>Lorenzo Natale</td>
<td>Ali Paikan, Giorgio Metta and Lorenzo Natale</td>
<td>Exploiting data flow ports for coordination of concurrent components</td>
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<tr>
<td>Alexander Ferrein</td>
<td>Tim Niemueller, Gerhard Lakemeyer, Alexander Ferrein</td>
<td>Aspects of Integrating Diverse Software into Robotic Systems</td>
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<tr>
<td>Michael Arndt</td>
<td>Michael Arndt, Max Reichardt, Jochen Hirth, Karsten Berns</td>
<td>Requirements for Interoperability and Seamless Integration of different Robotic Frameworks</td>
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### Morning Session: Software Frameworks

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<tr>
<th>Presenter</th>
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<tr>
<td>Andreas Wortmann</td>
<td>Jan Oliver Ringert and Bernhard Rumpe and Andreas Wortmann</td>
<td>MontiArcAutomaton: Modeling Architecture and Behavior of Robotic Systems</td>
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<tr>
<td>Mi-sook Kim</td>
<td>Mi-sook Kim, Hong Seong Park</td>
<td>OPRos-based RILS(Robot in the Simulation System)</td>
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<tr>
<td>Guillaume Walck</td>
<td>Guillaume Walck, Ugo Cupcic, Toni Oliver Duran and Veronique Perdereau</td>
<td>A Case-Study of ROS Software Re-usability: From Object Manipulation to In-Hand Manipulation</td>
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### Morning Session: Robot Architectures

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<tr>
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<tbody>
<tr>
<td>Arne Nordmann</td>
<td>Arne Nordmann, Alexandre Tuleu and Sebastian Wrede</td>
<td>A Domain-Specific Language and Simulation Architecture for Motor Skill Exploration</td>
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<tr>
<td>Francesco Fiamberti</td>
<td>Francesco Fiamberti, Daniela Micucci and Francesco Tisato</td>
<td>Robotic mapping: an architectural approach</td>
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<td>Marco Frigerio</td>
<td>Marco Frigerio, Claudio Semini and Darwin G. Caldwell. Jonas Buchli</td>
<td>Challenges in the software architecture design for autonomous legged robots</td>
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<tr>
<td>Javier Felip Leon</td>
<td>Angel J. Duran, Javier Felip Leon, Marco Antonelli, Beatriz Leon, Antonio Morales and A. P. del Pobil</td>
<td>The UJI humanoid torso integration architecture</td>
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# IEEE ICRA2013 - 8° SDIR Workshop - Karlsruhe, May 6 2013

## Afternoon - Session 1: Methodologies & Tools

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<tr>
<td>Alexander Nussbaumer</td>
<td>Autonomous Robots: Towards A Founded Assessment of Robustness</td>
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<tr>
<td>Andreas Schierl</td>
<td>Towards Realtime Robot Reactions – Patterns for Modular Device Driver Interfaces</td>
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<td>C-Forge: A Model-Driven Toolchain for Developing Component-Based Robotics Software</td>
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<td>A toolchain for deploying component-based applications on complex service robots</td>
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## Afternoon - Session 2: Middleware

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<tr>
<td>Elena Ceseracciu, Daniele Domenichelli, Paul Fitzpatrick, Giorgio Metta, Lorenzo Natale, Ali Paikan</td>
<td>A middle way for robotics middleware</td>
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<tr>
<td>Michael Fritscher, Robin Hess, Klaus Schilling</td>
<td>Introducing a robust multitasking operating system for real-time demands</td>
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<tr>
<td>Renato. Samperio</td>
<td>Generic component-based middleware for a peer-to-peer flexible robot architecture</td>
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<tr>
<td>Tobias Hammer and Berthold Baeuml</td>
<td>Raw Performance of Robotic Software Middleware: A Comparison and aRDx’s New Realtime Communication Layer</td>
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## Afternoon - Session 3: Software Frameworks

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<tr>
<td>Ulrik P. Schultz</td>
<td>Unity: A Unified Software/Hardware Framework for Rapid Prototyping of Experimental Robot Controllers using FPGAs</td>
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<tr>
<td>Dominick Vanthienen</td>
<td>Software framework for robot application development: a constraint-based task programming approach</td>
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<td>A Library for Event-Processing and Adaptable Component Interactions in Autonomous Robot Software</td>
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<tr>
<td>Matteo Matteucci</td>
<td>A General Framework for Mobile Robot Pose Tracking and Multi Sensors Self-Calibration</td>
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## Afternoon - Session 4: Robot Architectures

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<tr>
<td>Nicolas Gobillot</td>
<td>A Component-Based Navigation-Guidance-Control Design Pattern for Mobile Robots</td>
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<td>Kamilo Melo</td>
<td>Open Modular Snake Robot Software Architecture</td>
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<td>Noureddine Ouadah</td>
<td>Modular &amp; Reusable Embedded Control Architecture: case of a car-like robot</td>
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<tr>
<td>Roger Esteller Curto</td>
<td>ViSeLab: Visual Servoing Laboratory: Interchangeable components for creating experiments</td>
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Objectives

Structure and formalize

- the robot development process
- for advanced mobile manipulators

and provide

- functional libraries,
- tools,
- and models,

which help to significantly accelerate the development process.
Advanced Mobile Manipulators

Interoperable hardware and software components through harmonisation of the sw/hw device layer

Deliverables D1.xx
Functional Libraries

- 3D Perception
  BRICS_3D
  2nd Research Camp
  2011

- Mobile Manipulation
  BRICS_MM
  1st Research Camp
  2010

- Control and Coordination
  BRICS_CC
  3rd Research Camp
  2011

- Robust Navigation
  BRICS_RN
  4th Research Camp
  2012

Development of Mobile Manipulation Applications
Integration of BRICS results
5th Research Camp
2012

Deliverables D3.xx
Model-driven Engineering Toolchain

**BRIDE : BRICS Integrated Development Environment**
- A MDE environment for system design and code generation

Deliverables D4.xx and D8.xx

IEEE ICRA2013 - 8° SDIR Workshop - Karlsruhe, May 6 2013
Education, Research, Industry Showcases

Research
- Path planning
- Perception
- Control
- ...

Transfer of research results into applications / demonstrations to support:
- Easy usage of scientific results
- Extend existing systems
- Built upon others work (avoid „not invented here“)

Deliverables D5.xx

**Fraunhofer**
Institut Produktionstechnik und Automatisierung

**University of Applied Sciences Bonn-Rhein-Sieg**
Guidelines for Robust Autonomy

Threats to robustness
- Variable time delay
- Package loss
- Block outs

Deliverables D6.xx
Software Flexibility:

the ease with which a system or component can be modified for use in applications or environments other than those for which it was specifically designed.

*IEEE Standard Glossary of Software Engineering Terminology*

- Approach ➔ Software Product Line Engineering
- Tool ➔ Variability Analysis and Resolution Plugin (VARP)

*Deliverables D7.xx*
Component-based Development Process

- This lack of architecture in ROS libraries makes them much easier to integrate into other platforms.
Component-based Development Process

“No object is an island”

*Kent Beck, Ward Cunningham*

“No component is an island”

*BRICS*

“Architectural constraints should be explicit”

*BRICS*
Component-based Development Process

Component A
Component B
Component C
Component D
Component E3
Component F3

Different implementations of the same functionality
Component-based Development Process

- Component A
- Component B
- Component C
- Component D
- Component E3
- Component F3

Constraints
- requires
- excludes
Component-based Development Process

Component A
- mandatory

Component B

Component C

Component D
- optional

Component E3

Component F3

Constraints
- mandatory
- optional
Component-based Development Process

Constraints
• mutually exclusive
Component-based Development Process

- **Variation points**
- **Variants**
- **Constraints**

**Component**
- **A** mandatory
- **B** alternative
- **C** optional
- **D**
- **E3** requires
- **F3**
Capturing Variability in Robotic Systems
Capturing Variability in Robotic Systems
Capturing Variability in Robotic Systems

Software Product Line

Product 1

Product 2
Variability Modeling with Feature Diagrams

Constraint:
- MarkerBased \textbf{REQUIRES} (Camera \textbf{AND} Marker Detection Algorithm)
Announcement

SIMPAR 2014
SIMULATION, MODELING, and PROGRAMMING for AUTONOMOUS ROBOTS

Bergamo, Italy, October/November 2014