Metacontrol for ROS₂ Systems

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ROS-Industrial Conference
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Autonomous robots

Wizards of ROS: Willow Garage and the Making of the Robot Operating System
How a small band of Silicon Valley engineers started a global robotics revolution
By Evan Ackerman and Eric Guizzo

Team Delft Wins Amazon Picking Challenge
Year two of the Amazon Picking Challenge results in robots that are much, much closer to taking over for humans

Why Robots and Humans Struggled with DARPA's Challenge
Stuttgart 10/12/19
MROS - Carlos Hernandez
Outline

1. Vision
2. Objectives
3. Approach
Vision

Model-driven approach

Self-adaptation exploiting models @runtime

Metacontrol

Design model

Runtime model

re-design

uncertainty

system behavior

mission reqs.

design

control architecture

run-time operation

Runtime model

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Stuttgart 10/12/19
References


- C. Hernandez et al. Meta-control and self awareness for the ux-1 autonomous underwater robot. In Fourth Iberian Robotics Conference, ROBOT’19

MROS: a RobMoSys Integrated Technical Project

- **MROS**: Towards an EU Industrial Digital Platform for Robotics
  - Partners from EU projects ROSIN and OFERA, funded and coached by RobMoSys

- **RobMoSys**: Composable Models and Software for Robotic Systems

- RobMoSys **Model-Driven Approach**

  - Models at Run-time e.g. for self-configuration/adaptation/explanation
  - Automate labor-intensive activities (V&V, code gen., etc.)
  - Correct-by-construction composition
  - Reuse and customization of robotics software assets
  - Guidance by following harmonized interpretation of abstractions

**16:30 Modeling and Tooling for Robotics Software Development**
Dennis Stampfer, HS Ulm

Credit to Huascar Espinoza (CEA-LIST)
Objectives

O1: meta-modeling solution for **reliable** robot skills through **architectural adaptation @runtime** with clear separation of concerns for task, contingency and system handling.

O2: Implementation for the **ROS2 Navigation** in an industrial pilot case.

O3: Demonstrate the value of **ontologies** for reasoning with **models@runtime** in the context of RobMoSys.
Pilots: Navigation

• **ROS2** Navigation stack

• **Two platforms** - varying task requirements: *transport, approaching, exploration*...

• Improved **reliability** and **autonomy**
Impact

- Composable components
- Replaceable components
- Re-usable
- Reliable quality of service
- Standardization of models and interfaces
KPIs

• KPOs: system **availability**, engineering **effort**, **cost** and **time** and platform **evolvability**.

• **KPI 1:** System reliable autonomy level

• **KPI 2:** Effort to develop an autonomous application

• **KPI 3:** Re-usability

• **KPI 4:** Extensibility

• **KPI 5:** Suitability of ontologies for RobMoSys metamodeling
Meta-control

Reasoner

Ontology-based KB

Mode manager and monitor

BT Navigator MROS plugin

 ROS graph for navigation

RobMoSys Task-plot metamodel

MROS TOMASys metamodel

System Modes from micro-ROS

ROS 2 node Life-cycle from http://design.ros2.org
Ontological reasoning

Ontology-based KB

ROS graph for navigation

Metacontrol

Navigation

MROS metamodel

System Modes from micro-ROS

ROS 2 node Life-cycle from http://design.ros2.org

System Modes

System Behaviour

Coord. (BT)

Metacontrol

MROS metamodel

Metacontrol

Navigation

BOSCH

FERA

POLITÉCNICA

TU Delft

Universidad Rey Juan Carlos

RobMoSys Task-plot metamodel

Consortium
MROS and RobMoSys metamodels

Tools for verification and validation

Wed 11:50 ROS Model
Nadia Hammoudeh Garcia, Fraunhofer IPA
To wrap up

**MROS**: Metacontrol for ROS2 systems

- models@runtime to drive
- architectural adaptation for
- reliable autonomy
Thanks!