

Bringing ROS to the factory floor: the ROS-Industrial initiative



Why ROS-Industrial?
 push industrial robotics from PREPROGRAMMED motions to PERCEPTION in the loop & DYNAMICALLY GENERATED trajectories
 plus debugging/visualization/simulation tools, hw independence, ...

How?
 starting from the intuition of a Research Engineer to two Consortia of over 30 members!

ROS in industrial products & settings

Robot vision2 - motion controller using ROS
<http://www.rosindustrial.com>
 cROS used as the middleware to "glue" the modules of a factory processing plant in Italy
JRobotics

ROS on AGV operating at a major car manufacturing plant in Germany
 Via Intermedien, rosgate.com/intermed

RIC-Americas Launches

25 people from 14 organizations
 ROS-Industrial project backed by a Consortium comprising 10 Community w/ financial and managerial support

RIC-Europe Launches

Community Meetings x4

(Example topics)
 Join us today during the Bids of a Feather session!

Growth

31 members in the two consortia as of Sept 30, 2015
rosindustrial.org

19th Annual Robotics Industry Forum

Focused Technical Projects

Standing the community on their feet, bottom-up approach with the industrial "contracted area", top-down one

It's training time!

training sessions held regularly at SAE (USA) and IIR (Germany) offer outreach events: see the ROS-Industrial Conference at IIR, part of the Consortia's mission

current FTP proposals & candidate topics

CAD to ROS Workbench
 - ROS 1.0.4 release with 2D support (right-click) - 2D image display, tool selection, camera control, etc. - 2D view control (Page for Robot in 2D view)
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cROS on PLCs **ROS w/ OPC-UA**

ROS-it: We've been busy!

Ecosystem

Technical

2011 2012 2013 2014 2015 2016

First ROS-I Demonstration

- PRR pick & place performed with mechanical hardware
- Cooperative effort between SwRI, Southern Motors, & Willow Garage
- Demonstrated software portability

Robot Support

- ABB, Adapt, FANUC, Motoman, Universal
- Maintained by SwRI, TU Delft, Fraunhofer IPA
- Future additions:
 - KUKA, Epson, Stäubli, Rognar (BlueWorkforce)

Dual Arm Interfaces

- Dual arm Motoman SDAI OF (Fraunhofer IPA & Motoman)
- Dual arm UR - Hilgendorf (SwRI & NIST)

Calibration Toolbox

- General purpose calibration library (SwRI & NIST)
- Addressed:
 - Robot to camera (fixed)
 - Robot to camera (arm mounted)
 - Camera to camera (tranny)
- Latest additions:
 - Streamlined kinematic/estimation calibration
 - Templates for common use cases

Mobile Manipulator

- Developed mobile manipulation platform for order fulfillment
- Standardized platform (Euler)

Path Planning

- Develop path planners for industrial application
- Repeatable
- Scalable
- Common sense plans
- Descartes semi-constrained cartesian path-planner
- Resurrected STOMP-planner

IO Network Support

- ROS support for CANOpen devices (Fraunhofer IPA)
- Support for device profile for drives and motion control
- Integrated in the ros-control framework
- `joint_state_controller`
- `joint_trajectory_controller`
- `position_controllers`
- `velocity_controllers`
- ROS ProfNet coming soon

Scan & Plan

- Use 3D sensors to scan objects and intelligent planner to perform operations
- Utilizes multiple core technologies



ROSCon 2015



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Plus intermediaries, integrators and many more!

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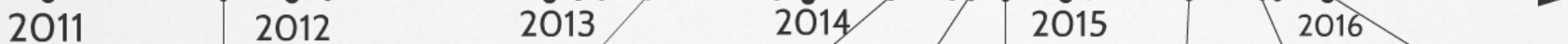
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- ROS 1.0 release with C/C++ based plugins, codebases
- Proposals for ROS 2.0 with Python and C++ based plugins, codebases
- ROS 2.0 release with C/C++ based plugins, codebases
- ROS 2.0 release with C/C++ based plugins, codebases

cROS on PLCs **ROS w/ OPC-UA**

- Industry 4.0 use of ROS integration through OPC-UA
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Ecosystem



Technical

First ROS-1 Demonstration

- ROS 1.0 plan performed with industrial hardware
- Cooperative effort between SwRI, Sabana Motors, & Willow Garage
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Robot Support

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- General purpose calibration library (SwRI & NIST)
- Additions:
 - Robot to camera (fixed)
 - Robot to camera (arm mounted)
 - Camera to camera (inertial)
- Latest additions:
 - Standardized intrinsic/extrinsic calibration
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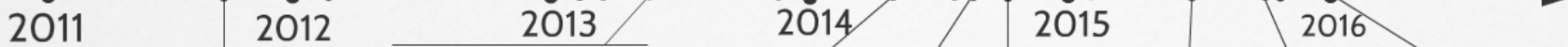
CAD to ROS Workbench

- ROS 1.0 release with ROS2 target topics, feedback
- Presentations on work with the ROS2 migration team, ROS2 plan
- ROS2 release with ROS2 target topics, feedback
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- Industry 4.0 use the ROS migration through ROS2
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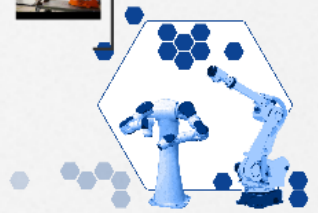
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January 18-20, 2012
Orlando World Center Marriott
Orlando, Florida USA

► Update Robots for Mobility: Innovative Design, Control, & Design

1/18/2012

Professor of Robotics, Carnegie Mellon University

► How Good is the New IIR Study on Robotics & Job Creation?

1/19/2012

CEO, IIR, former governing body member, co-chaired by Mark Warner, US to International Federation of Robotics

► ROS-Industrial - Accelerating Research to Applications

[Shaun Edwards](#)

Senior Research Engineer, Southwest Research Institute®

► 2012 Research Funding Opportunities for Innovative Robotics Research

1/19/2012

Head of Office, U.S. State Department, Office of Science & Technology

► An Update on the Obama Administration's National Robotics Initiative

1/19/2012

Office of Science and Technology Policy, OSTP

► An Update on the New Robot Safety Standards

1/19/2012

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(Example topics)

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current FTP proposals & candidate topics

CAD to ROS Workbench

- ROS 1.0 release with C/C++ based plugins, codebase 1.0
- Presentations on work with the ROS-Industrial Consortium: 3rd year update
- Update on the ROS-Industrial Consortium: the new year, the new members
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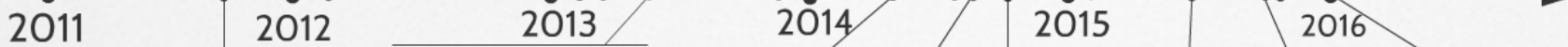
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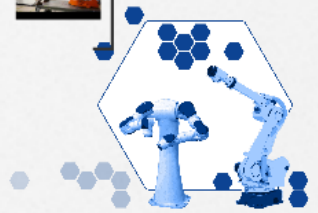
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- Integrated in the ros-control framework
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ROSCon 2015



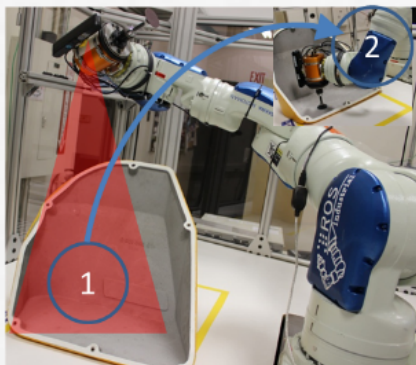
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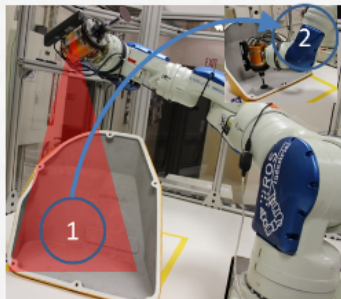
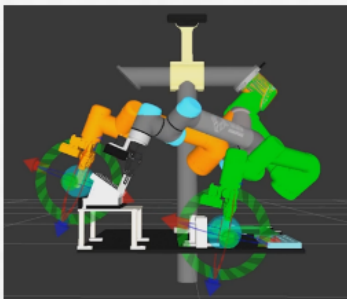
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reduce unnecessary parallel
by sharing infrastructure c
(which is not your core

Focused Technical Projects

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reduce unnecessary parallel work by sharing infrastructure costs (which is not your core IP!)

Path Planner Optimization and Planning Request Adptr.	Robotic Blending	CMM- Enabled Robotic Routing
Minimize cycle time for pick & place applications.	Macro-scan simple work pieces and plan tool paths	Scan the perimeter of legacy tooling; auto-gen paths
Complete	Complete	April Install

(examples of the first FTPs)

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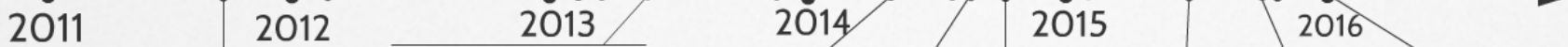
cROS on PLCs **ROS w/ OPC-UA**

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ROS-I: We've been busy!

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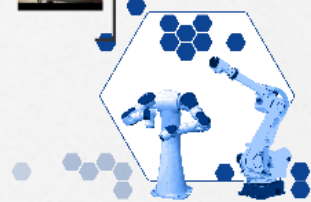
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ROSCon 2015



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ROS-I Conference,
Fraunhofer IPA, June 26,
2014



IAS-13 Workshop:
ROS-Industrial in
European
Research Projects,
July 15, 2014

RIC-EU Kickoff,
June 27, 2014

ROS trainings at
IPA,
October 2014,
March 2015



Roadmapping
Workshop
at European
Robotics
Forum, Lyon,
March 20
2013

ICRA / ROSCon
in Karlsruhe /
Stuttgart,
Germany, M
2013





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- training sessions held regularly at SwRI (USA) and IPA (Germany)
- other **outreach** events, like the ROS-Industrial Conference at IPA
- part of the Consortia's mission

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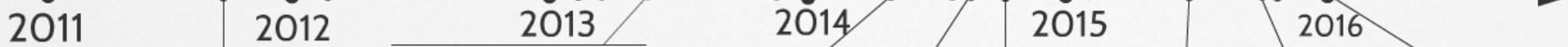
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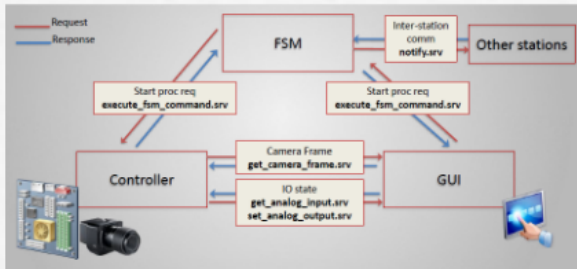
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IT+Robotics

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 **Fraunhofer**
IPA

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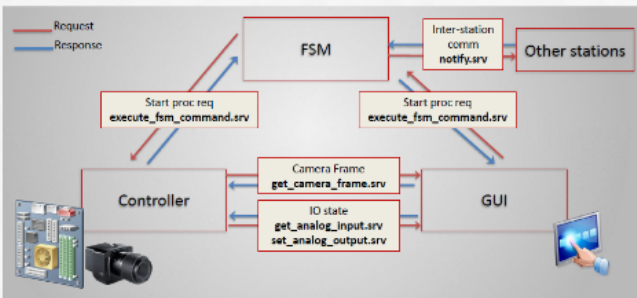


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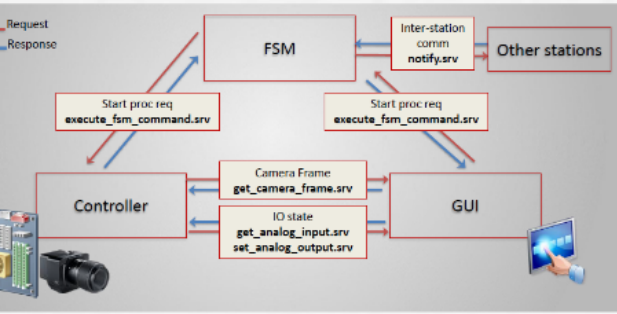
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Project Features 2/2

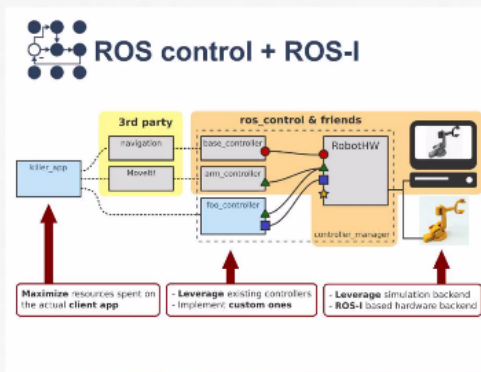
<http://youtu.be/Qc3z7FCwHw>

ROS-I Community Meeting

Amazon Picking Challenge
(Competition by Amazon)
- Dejan Pangercic -
Deepfield Robotics (Bosch)

Kuka LBR iiwa

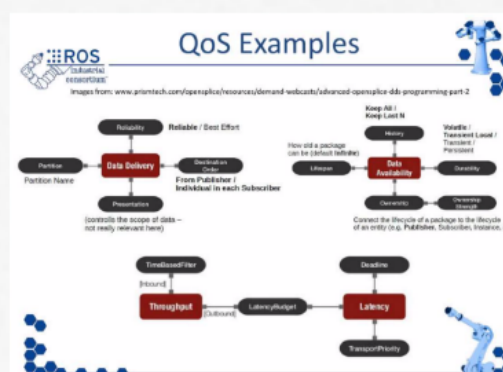
- The Kuka LBR iiwa is an
 - exciting innovation in collaborative industrial robotics
 - enable automation in many new application areas



Comparative study raw image

<http://youtu.be/BxImEMMFnc>

<http://youtu.be/vSMAtq-2Zt>



(Example topics)

Join us today during the Birds of a Feather session!

Bringing ROS to the factory floor: the ROS-Industrial initiative



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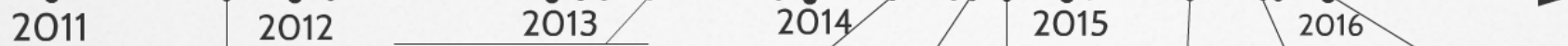
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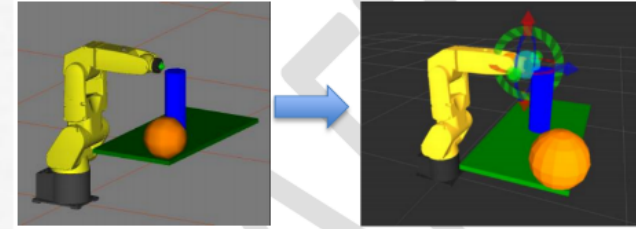


ROSCon 2015



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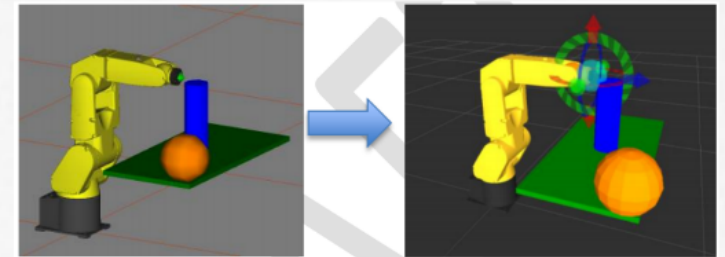
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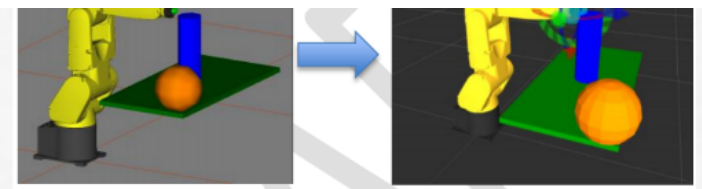
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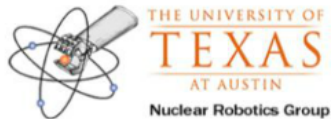
BLUEWORKFORCE



FLEXTRONICS X



JOHN DEERE



SIEMENS



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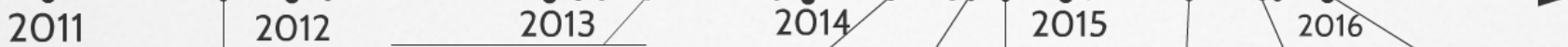
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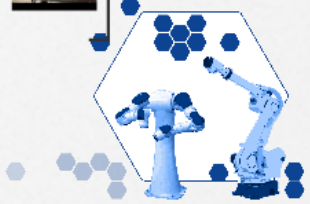
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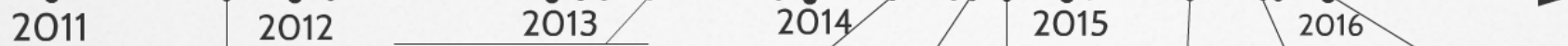
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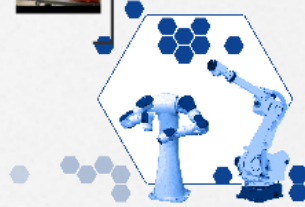
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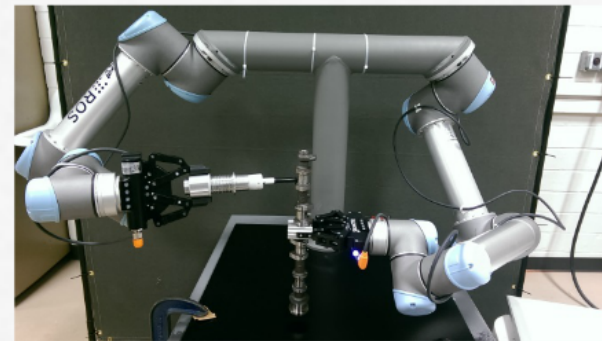
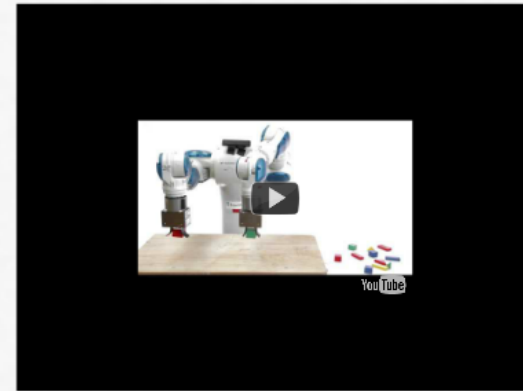
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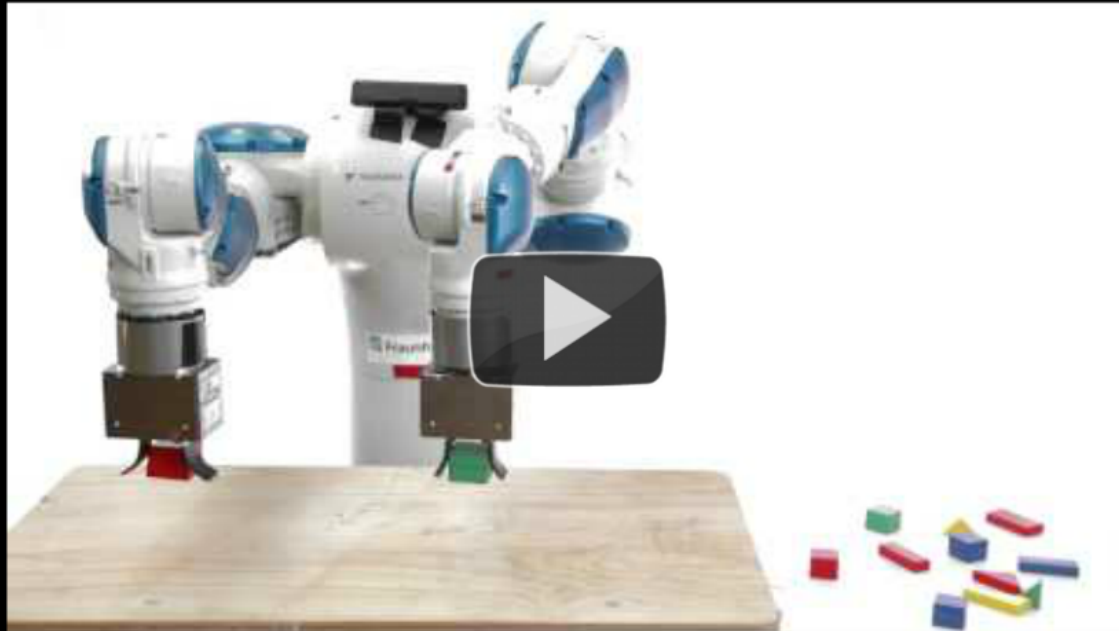
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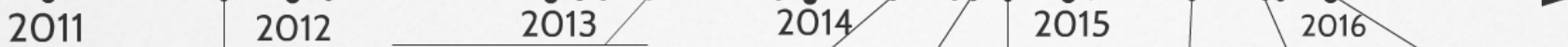
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ROSCon 2015



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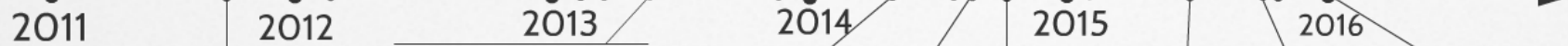
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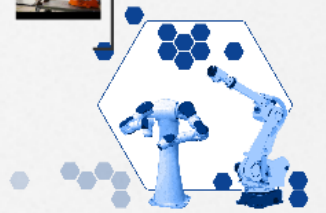
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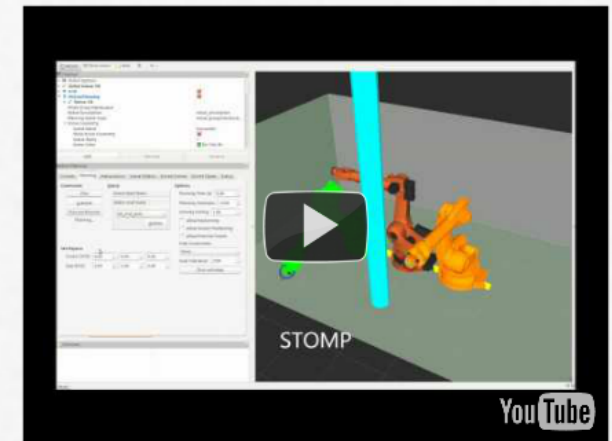
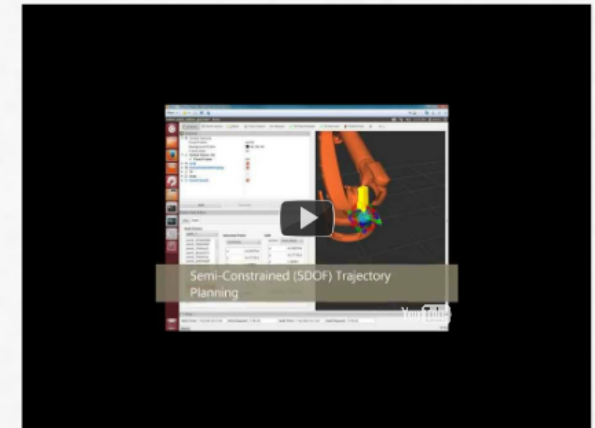


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The screenshot displays a ROS-based trajectory planning interface. On the left, a tree view shows the robot's structure, including 'Global Systems', 'Fixed Frame', 'Background Color', 'Frame Rate', 'Global Status: OK', 'Fixed Frame', 'Limb', 'RobotPose6DOFDisplay', 'TS', 'Axis', and 'Point Cloud'. The main 3D view shows an orange robotic arm with a yellow arrow pointing to a target point. A table below the 3D view shows the 'Both Points' table:

Joint	Selected Point	End	Free Move
joint_343b0d00			
joint_f952ed07			
joint_14f6e017	-0.200750	-0.200750	
joint_8e200111		-0.217383	
joint_1f8e0111	-0.217383		
joint_5d00e0d1		1.284917	

A large play button is overlaid on the 3D view. At the bottom, a 'You Tube' logo is visible.

Semi-Constrained (5DOF) Trajectory Planning

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RIC-Americas Launches

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Community Meetings x4

(Example topics)

Join us today during the Birds of a Feather session!

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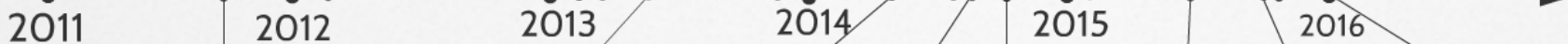
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Ecosystem

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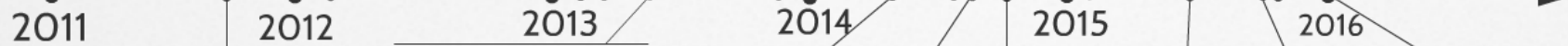
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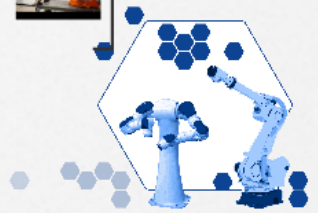
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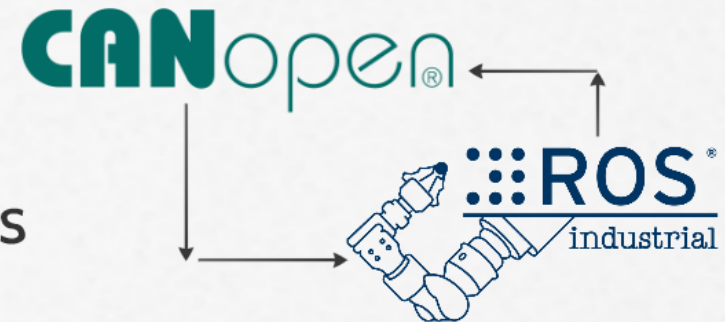


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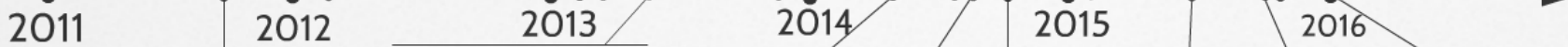
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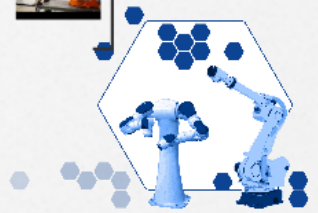
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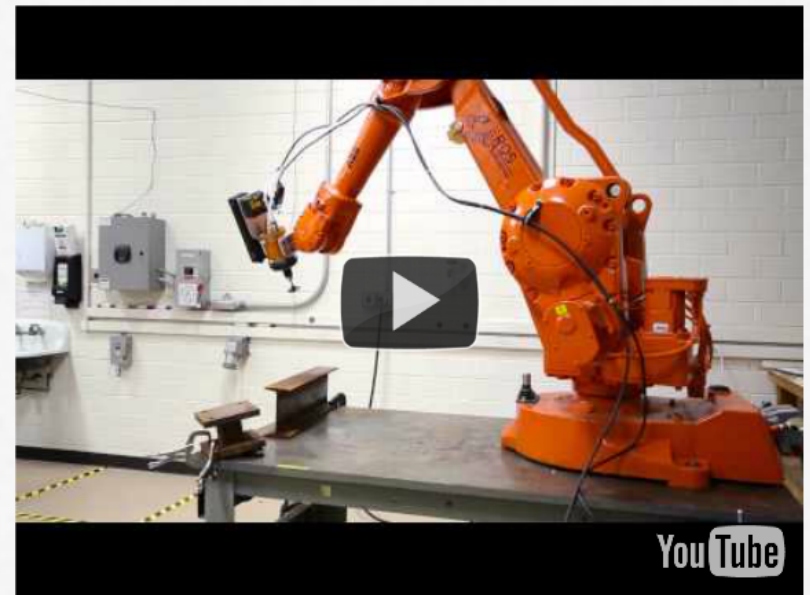


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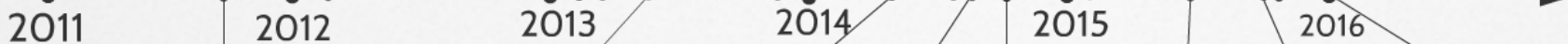
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