Advances in Industrial Automation Leveraging ROS-Industrial and Open Source Tools

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Southwest Research Institute

- Non-Profit
- Applied R&D
- Established: 1947
- Campus: 1,200 acres (5 km²)
- Staff: 2,700
- Revenue: $592M
- Diverse Engineering, R&D
Robotics and Automation Engineering

Machine Vision and Perception

Custom Robotics

Industrial Automation and Controls

System Integration

Advanced Robotic Software
Presentation Overview

• Needs & Opportunities
• Advanced Software for Industrial Robots
• Applications in Industry
• Moving Forward
Industrial Robotics Market

Interesting 2015 Statistics:
• 253,748 robots sold – highest ever recorded
• China now biggest market with 27% of the supply
• Estimated 12% growth per year in units through 2019

Interesting RIA North America 2016 Statistics:
• 10% growth in units ordered over 2015
• Automotive market strong
• Strong growth in assembly applications

Source: IFR Statistics
The Opportunities/Industry Needs

- General Industry
  - One-off tasks
  - Uncertain object pose
  - High mix
  - Uncertain geometry
  - Intuitive programming
  - Auto-generated paths
  - Robots move to the job
  - Shared workspace with humans

- Aerospace Specifically
  - Advanced processes that require precision
  - Improved worker safety and well-being
  - High value components, dynamic environments, and variable part mixes

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<th>Topics</th>
<th>Current</th>
<th>Future</th>
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<td>Programming</td>
<td>Manual, High Skilled Programmers, Time Consuming</td>
<td>Automated by Machine</td>
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<td>Adaptation</td>
<td>Human in the Loop, Can’t Adapt to As-Built Condition</td>
<td>Dynamic Per Part Based on As Built Condition</td>
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<td>Process</td>
<td>Fixed Parameters</td>
<td>Sensor Driven</td>
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<td>Inspection</td>
<td>Post Process, No Feedback</td>
<td>In-Process Drives Adaptation Creates Digital Thread</td>
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Advanced Software Capabilities Needed!

- Research Robotics
  - Reinvention of the Wheel
  - Little Commonality
  - Short Lifespan
  - Inability to Compare Results

“We’ve automated all the easy stuff”

**ROS**

ROS Solves These

- Open source (BSD)
- Created by Willow Garage
- Maintained by Open Source Robotics Foundation (OSRF)

**ROS-Industrial** is an extension of ROS with a focus on enabling advanced capabilities for industrial robots
ROS: Robot Operating System

- Open source (BSD)
- Established to keep robotics researchers from “re-inventing the wheel”
- Maintained by OSRF – 10 years strong!
- Reusable software components
- >1,000,000 users downloaded/mo. ¹

ROS: Robot Operating System – Notable Users

- BMW
- ClearPath Robotics
- Erle Robotics
- Fetch Robotics
- Intermodalics
- PAL Robotics
- Rethink Robotics
- Savioke
- SwRI
- Willow Garage
- Yujin Robot
2017: ROS-Industrial Consortium
Global Members
What Can ROS-I Do?
Robotic Blending
A Stepping Stone to Intelligent Agility

Opportunity: 73% ROI based on overall part processing area efficiency improvements via reduction in variable labor
Automated Painting for Aerospace
An Application

- Automated spray paint processes
  - Reduce emissions (regulation)
  - Reduce exposure (personnel)
  - Reduce cost (materials)
  - Increase quality (consistency)

- Challenges
  - Unconstrained location
  - “Random” part order
  - Real time processing
  - Moving parts
Solution: Automated Painting

- 3D Sensing (ROS/OpenNI)
- 3D Processing (ROS/PCL)
- Process based path planning (SwRI)
- Robot IK solvers (ROS/MoveIt!)
- Robot workcell visualization (ROS/Rviz)
- Distributed system (ROS/Core)
- Data acquisition/playback (ROS/bag)
InkJet Printing Aircraft

- Develop and Test Unique Inkjet Technology For Large Complex Surfaces
- Demonstrate Inkjet Technology on Aircraft Application Using Large Scale Robots
- Simulated Demonstration Rotary Bell Painting on LR System Robot leveraging ROS-based path planning
3D Printing/Additive Manufacturing

- Leverage the Perception and Path Planning Capabilities and Tools within ROS-I to drive adaptable 3D Printing

Large Scale 3D Printing with Mobile Robots!


New ROS Additive Manufacturing Package
http://wiki.ros.org/ros_additive_manufacturing
Advanced Automation for Agile Aerospace Applications (A5)

- Intelligent Framework, Adaptable to Many Processes
- Hardware Agnostic
- Initial Pilot: Sanding for Paint Prep, Composite Repair, NDI
- High Value to Sustainment Community
Moving Forward

Member Value Through Collaboration
- Voice of Industry
- Roadmap Driven
- Prioritization of Effort
- Realization and Demonstration of Industry relevant Capability
Newest Institute in Robotics

Some objectives of the new institute:
• Supporting advanced robotics capabilities for manufacturing
• Standardizing interfaces for cross-platform compatibility
• Modularizing and scaling components to larger systems
• Enabling a collaborative development environment
• Developing the workforce through training curriculum and hands-on classes
• Transferring technology via open-source license
• Providing affordability for small and medium enterprises

http://www.arminstitute.org/
Resources

- ROS-Industrial
  - Home: https://www.rosindustrial.org
  - Documentation: https://wiki.ros.org/industrial
  - Code: https://github.com/ros-industrial
  - Training: https://rosindustrial.org/training
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