Toward open-source robotics:

ROS use case in industrial and mobile robotics

Nikola Knežević, University of Belgrade, School of Electrical Engineering
David Seničić, Htec, Belgrade
Kosta Jovanović, University of Belgrade, School of Electrical Engineering

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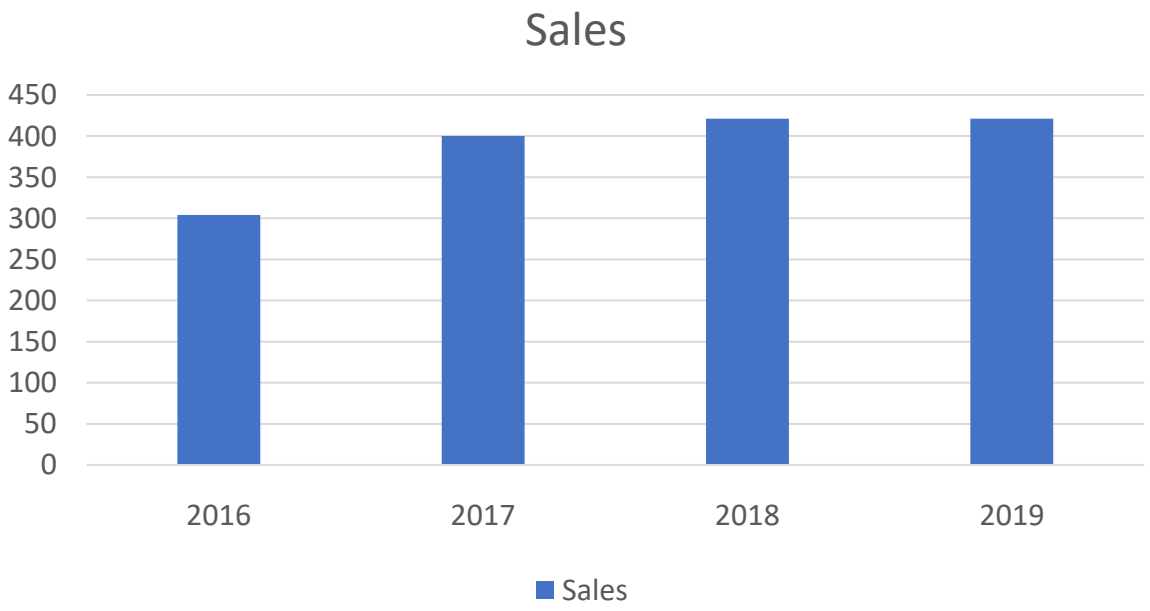
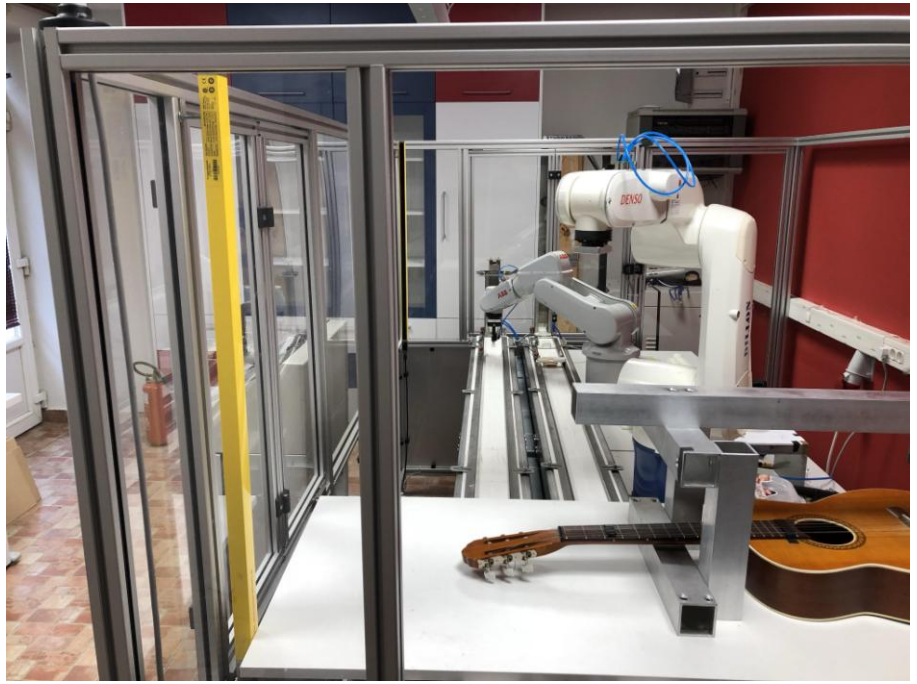
Introduction

- Industrial robot sales





Introduction

- Service robots
  - Robots in homes
  - Robots in hotels
  - Robots in hospitals
- Major challenges :
  - Dealing with unstructured human environment
  - Localization
  - Navigation
  - Each robot product has its own software!

Introduction

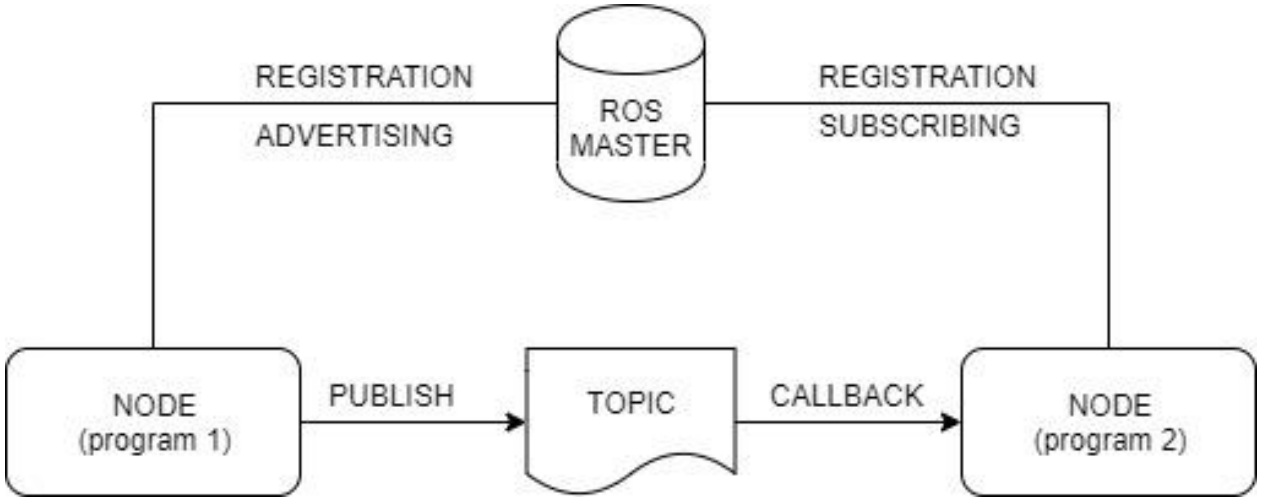
- Obstacles for robot integration
  - A small number of highly educated staff.
  - A high cost of robotic equipment
  - Closed and expensive software and hardware

Introduction

- Robot Operating System (ROS)
  - Meta Operating System for robots – framework.
  - It provides many libraries and tools for easy and fast development of robotic applications.
  - Open-source
  - Modular and reusable

ROS tools and Packages

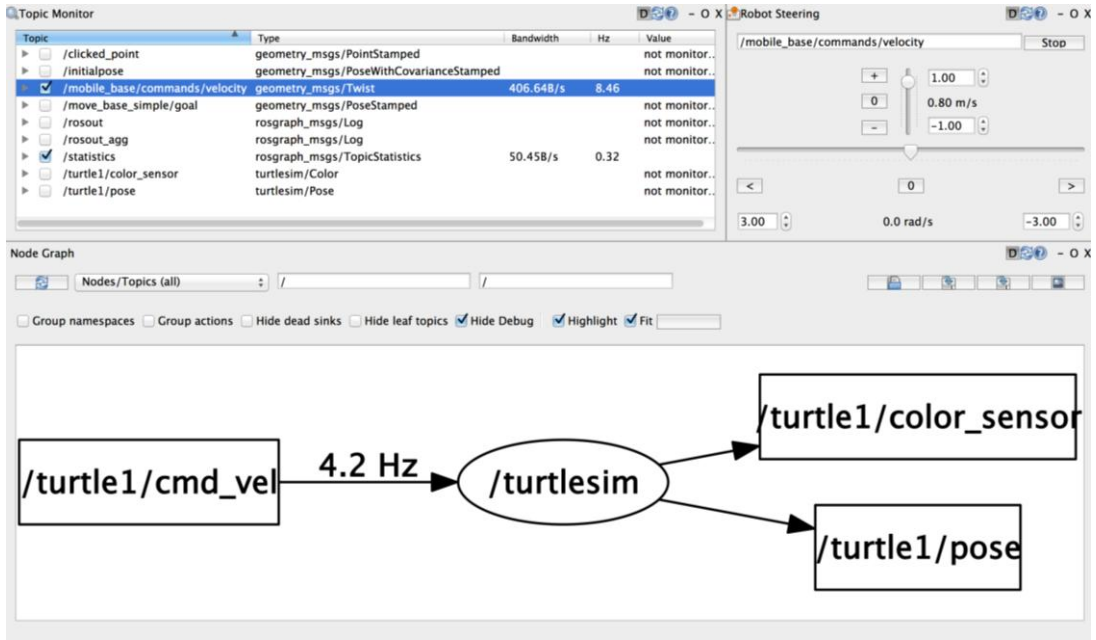
- ROS infrastructure



  - Allows using different programming languages:
    - C++, Python, Lisp, Java, R and other

ROS tools and Packages

- ROS tools
  - Tools for visualization.
  - Tools for debugging.
  - Tools for simulation.



ROS tools and Packages

- ROS packages
  - All ROS software is organized in packages.
  - A package can contain nodes, libraries, config files, third-party software or anything else that constitutes a useful module.
  - The main goal of organizing software in packages is to prove easy-to-consume and reusable software.
  - All robot drivers are organized as ROS packages.

ROS tools and Packages

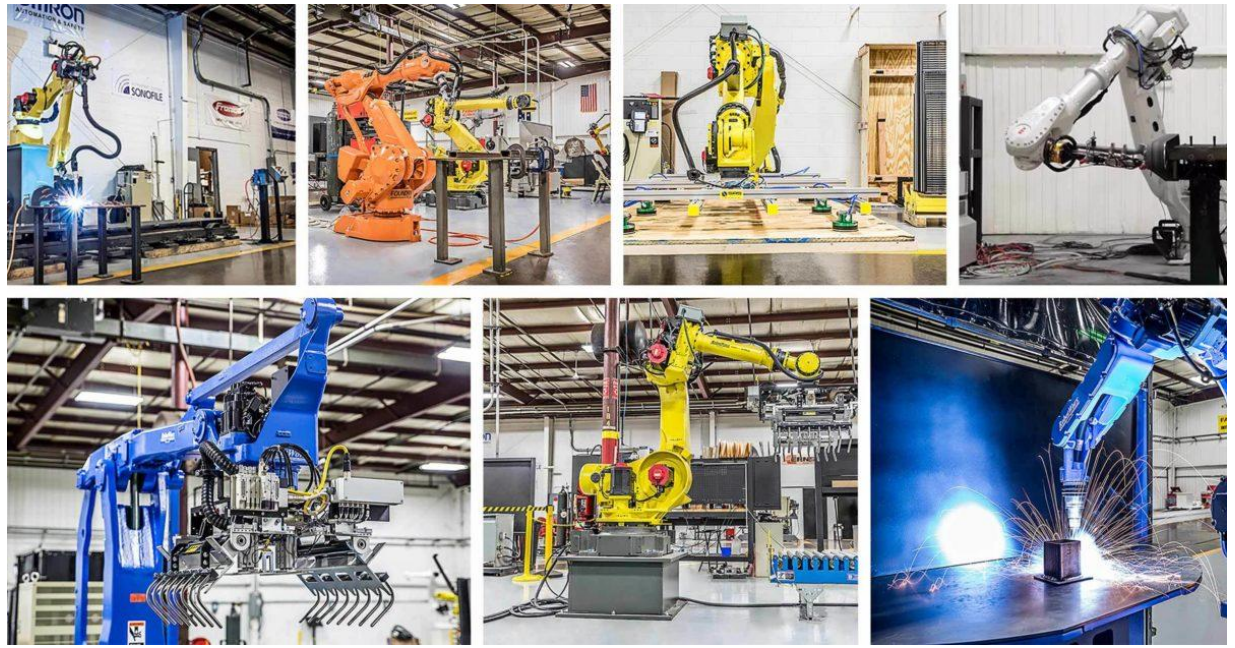
- ROS packages

Industrial robots ROS package	Mobile robots ROS package
ros_control	*move_base*
tf	*navigation*
safety_limiter	*robot_pose_ekf*
moveit	*gmapping*
pcl	
vision_opencv	
openai_ros	

Industrial robot use case

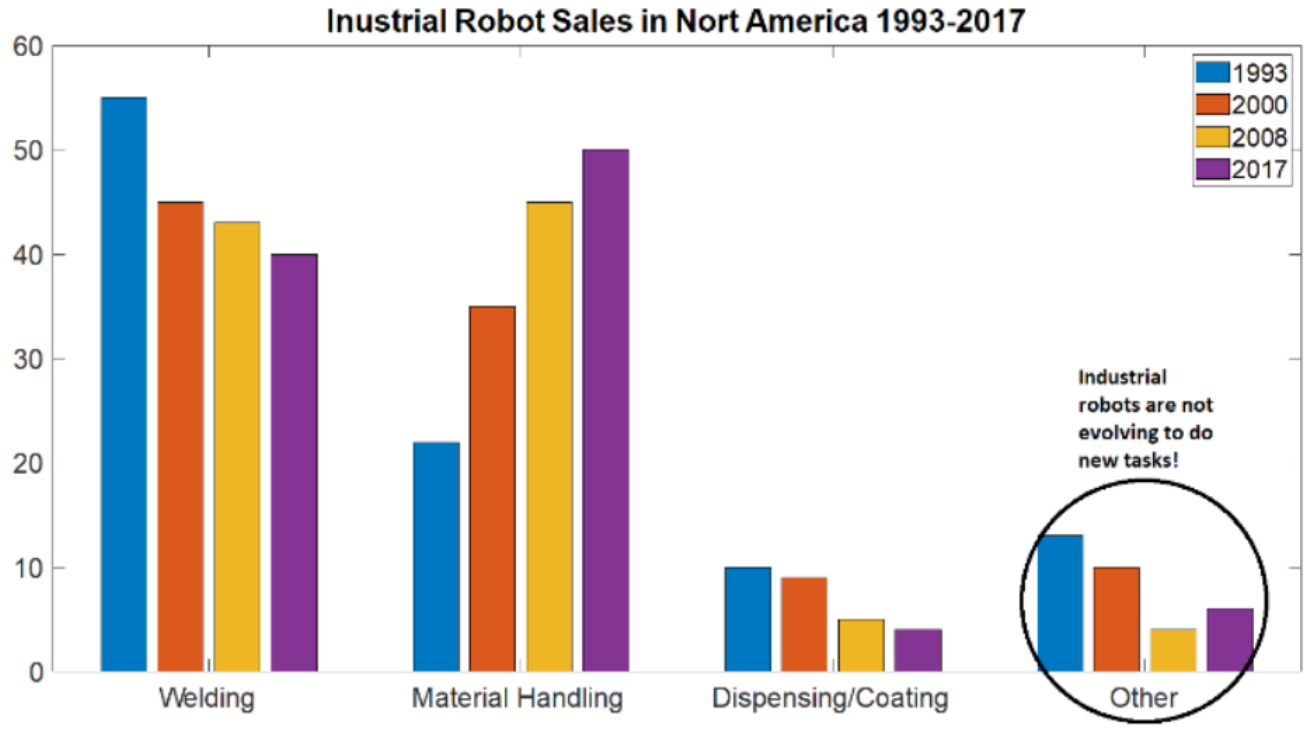
- Problems:
  - Robotics solutions are implemented using the framework provided by manufactures.
  - Programs were mainly made per client specification.
- Provided solution:
  - ROS Industrial (ROS-I) –

  The framework that should work on all industrial robots regardless of size and type of the controller.
  - Modular and reusable software solution provide fast application development.



Industrial robot use case

- Usage of industrial robots in the past 20 years:



Industrial robot use case

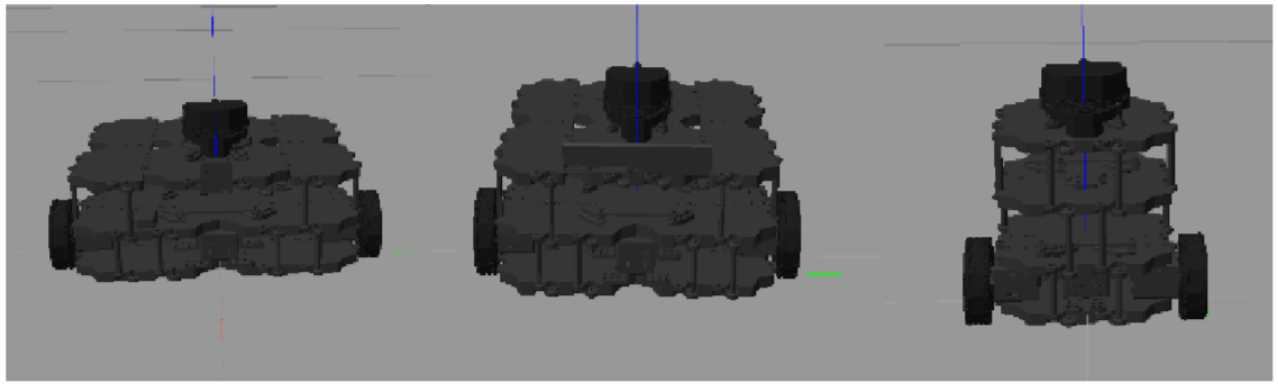
- Implementation
  - ROS in the industry is presented through many H2020 projects (ROS-IN, RAMPup,ReconCell …)
  - RAMPup – Developing modules for industrial implementation of common industrial tasks screwing, gripping, gluing, peg-in-hole and others.
  - Main users and testers will be SME which have small batches, 50 – 1000 units per batch, where reprogramming of industrial robot is weekly required.
  - Easy to use modules and safe tools and software is mandatory.

Industrial robot use case

- Implementation of a RAMPup peg-in-hole problem
  - Collaboration between the School of Electrical Engineering and one of the RAMPup consortium companies.
  - Force-based insertion of an object.
  - Tasks:
    - Creating plug-and-play modules that provides force-based insertion.
    - Module should be agnostic toward type of robot and force-torque sensor.
    - Simulation should be available begore testing on real robot in work cell.
    - End user can program and modify robot's task combining modular software.
  - Equipment:
    - Kuka Agilus KR10
    - Force - torque sensors: Robotiq FT300, Optoforce HEX-E, ATI Dleta SI 330-30
  - Video demonstration

Mobile robot use case

- Motivation
  - Autonomous Mobile Robots – course at the School of Electrical Engineering.
  - Learning basic ROS concepts.
  - Introducing control techniques for mobile robots, localization and navigation.
- Equipment – TurtelBot3 is a mobile robot develops as an educational platform for learning ROS and autonomous mobile robot basic principles.



Mobile robot use case

- Course implementation
  - Introduction to ROS concepts.
  - Learning control algorithm for TurtleBot3.
  - Detecting obstacles and walls using a LIDAR sensor.
  - Using Extended Kalman Filter with LIDAR data to improve localization.
- Video demonstration of TurtleBot3 performing Simultaneous Localization And Mapping - Link

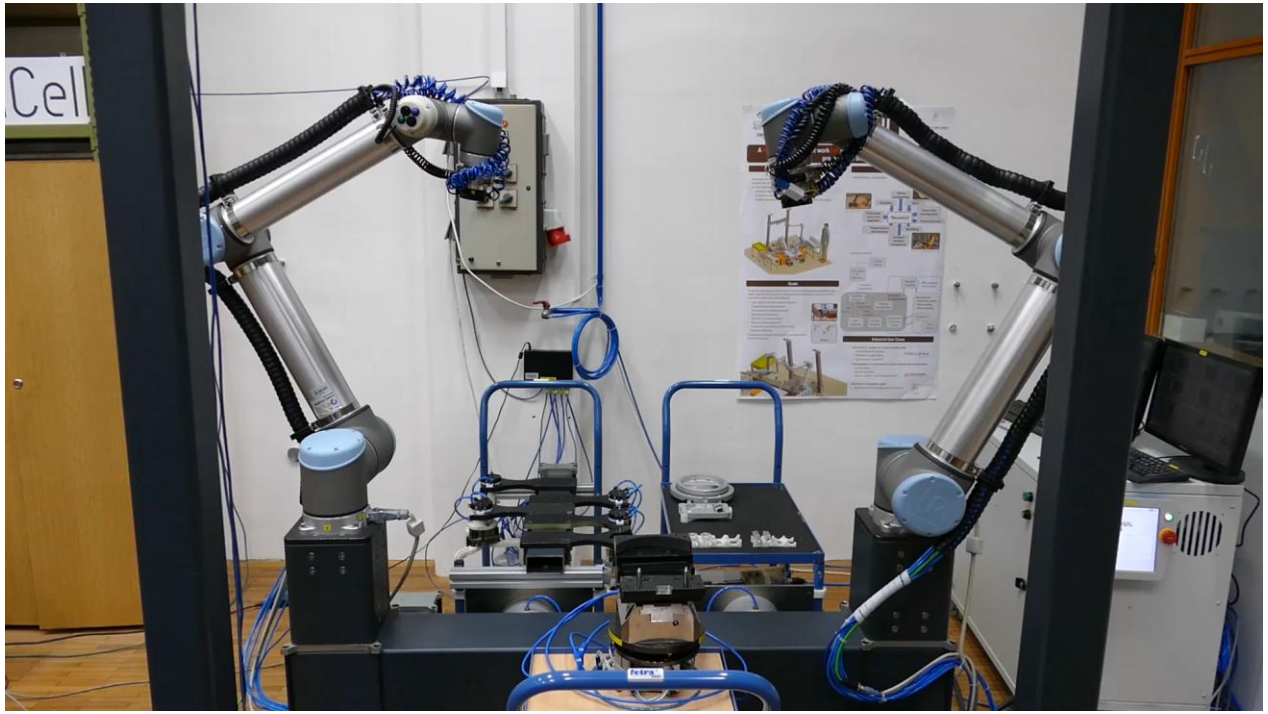
ReconCell

- ReconCell proposes to develop a widely autonomous robotic workcell that will allow very short, self-adaptable and affordable changeovers under the conditions demanded and based on end-user needs.
- Reconfigurable Assembly of Airport Signalization Lights using Collaborative Robots
  - Collaboration between IVAMAX company and School of Electrical Engineering with Institute Jožef Stefan (project coordinator)
  - Grant agreement ID: 680431

ReconCell

ReconCell

- Two types of the aluminum casing.
- Two types of transparent prisms.
- Silicon sealant.
- One robotic cell.
- Two collaborative robots.



Conclusion

- Although ROS is not on as advanced as commercial software solutions, the ROS community is making efforts to introduce open-source concepts into the field of robotics.
- Two examples presented in this paper are showing that ROS can be used in both industrial and mobile robot examples.
- Developing new ROS2 will provide real-time features that bring ROS closer to commercial software.

Thank you for your attention !!!

Question ?