ROS-Industrial Developer Meeting

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ROS-Industrial Consortium Program Manager

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2023 KO

Agenda

- 9:00 – Welcome
- 9:10 – Overview of what went down in '22
- 9:30 – Plans for '23
- 9:45 – Open Discussion/Forum

Key highlights

- Kicked off an Interfaces Working Group
  - Documenting semantics to be accounted for in interfaces
  - Understanding approaches for driver development to date/practices
  - Seeking to create new/update REPs, provide tools where needed
- New repositories/capabilities – Reach, Descartes Light, Redundancy Resolution
- Provided a full open repo for Scan-N-Plan – leverage for training
- Full ConnTact application
- Updated labs and advanced topics in training to ROS 2
- A lot of Tesseract updates!

Technical Themes

- Simplified snap shot of the core themes that ROS-I pursues
- Overtime and with the rise of ROS 2 a formal roadmap was set aside as best practices developed
- Currently working to accelerate resources in the 4 themes while responding to member/user feedback
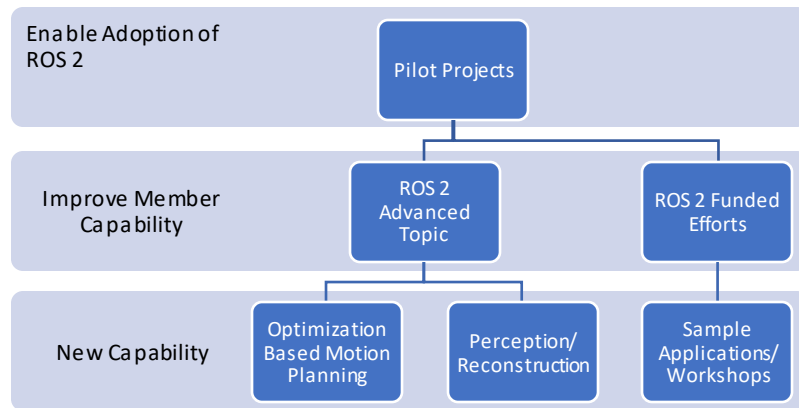
Strategy for Development

MoveIt

Environment Layer (MoveIt, Tesseract, Dart, etc.)

TESSERACT

Messages, Topics

ROS 1 / ROS 2 / Middleware Layer

DART
Dynamic Animation and Robotics Toolkit

DRAKE
MODEL-BASED DESIGN AND
VERIFICATION FOR ROBOTICS

Build ROS1 or ROS2, these are independent
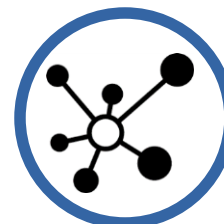
Independent of ROS

Collision Detection
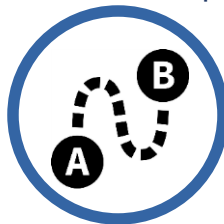
Motion Planners

Kinematic Solvers

Connectivity Structure

Continue to support deployed end-user ROS1 systems with new capabilities as they are developed even if for a ROS2 solution

How to get capability on the floor

University R&D Open Source

Open Source Community Development

Open Robotics
ROS (Latest Release)

Evaluate, test, implement emerging capabilities

ROS-Industrial Support Team
ROS-Industrial

ROS-I Consortium Directed Development
FTP
Government/Industry
Working Groups

Application Building Blocks, Utilities, Application Examples, Frameworks

Implement in an application. May be kept internal or productized

Direct Funded Development

Solution Provider

Startup

- Continued opportunity to leverage MII network for tech transition
- Many examples of Government/Industry partnerships that refine capabilities
- Startups can leverage for de-risking/scaling

Delivering new products


Modular/Scalable RTX System
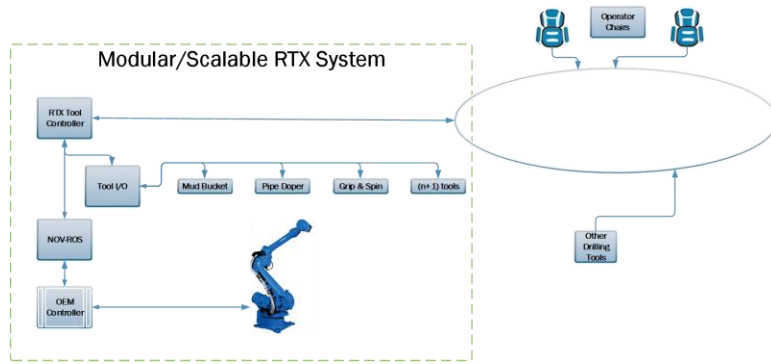
NOV RTX Productized

- modular and scalable system that can be put on any rig network

- Framework for all path planning and collision avoidance is NOV-ROS

- Prototype integration of scene awareness and people detection into RTX system

- Productization of all end effectors nearly complete

- Roadmap for other functions/end effectors ongoing

NOV Keynote from RICA 2022 Annual Meeting:
https://youtu.be/WQZJnv5BR48?list=PLXUpEXjGC63weFXogyQrAOS45a62nVM8L

Teaching Application
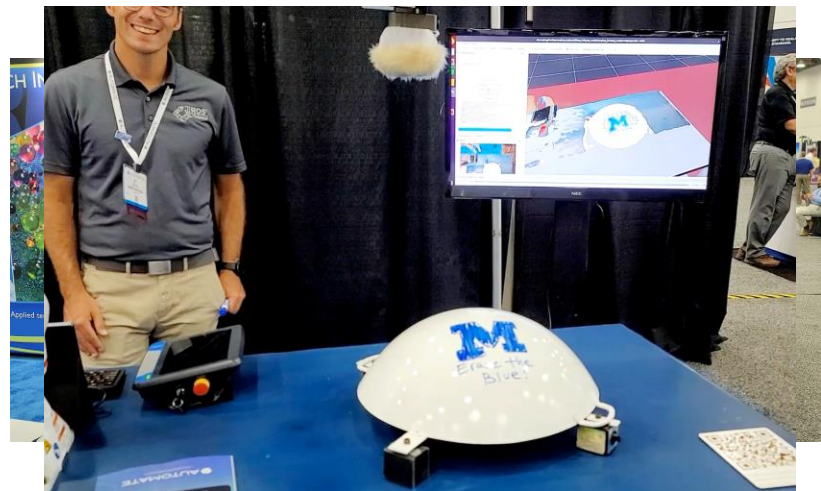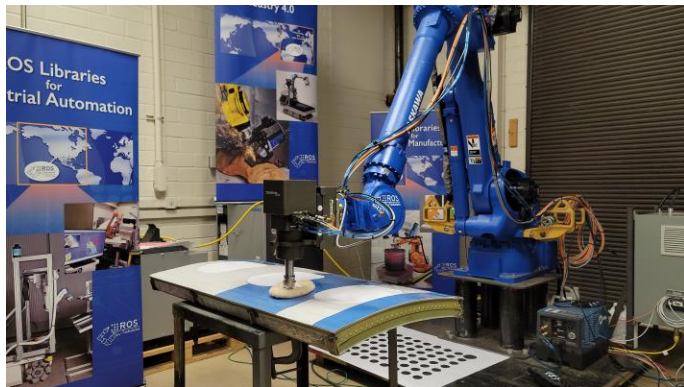
https://github.com/ros-industrial-consortium/scan_n_plan_workshop

Developers' Meeting Overview: https://youtu.be/GgTxvIaekjE

Tesseract Updates

- In '22 moved to its own Github org: https://github.com/tesseract-robotics
- Tesseract Planning Refactoring in process
  - 1.0 release in next six months
    - Tesseract Planning Refactor
    - Full Boost Serialization
    - Full Plugin Support
    - Code Coverage > 90%
      - tesseract
        - Complete
      - tesseract_planning
        - In-Work
    - Complete SRDF Editor

- Extracting functionality that applies to broader community
  - boost_plugin_loader
- A collection of Qt Widgets and Data Models for a variety of Tesseract Components (All Under Active Development)
  - Scene Graph
  - Scene State
  - Allowed Collision Matrix
  - Kinematic Groups
  - Kinematic States
  - Tool Center Points
  - Command History… and many more

Complete Update Presentation Here

Agility in advanced assembly applications

- **The ConnTact Assembly Framework**
  - Ability to enable researches to simply implement and test learning algorithms to test extensibility
  - Supported by NIST and the Agility Working Group

https://github.com/swri-robotics/ConnTact
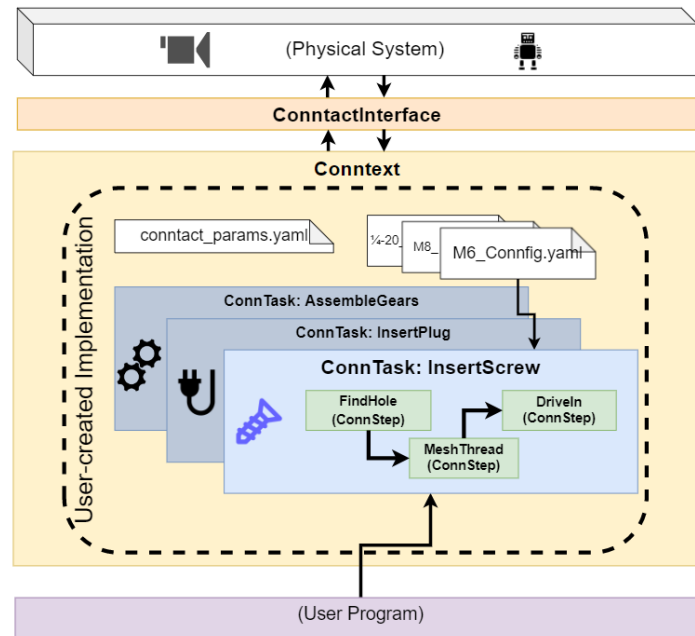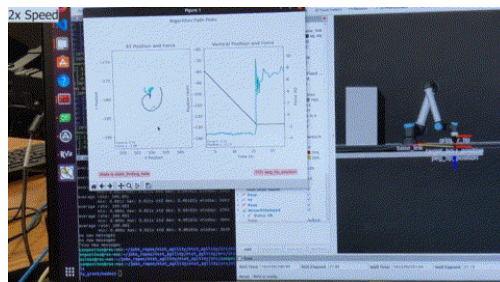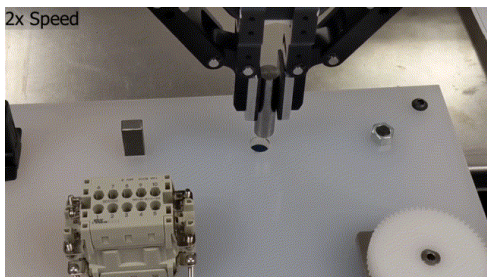
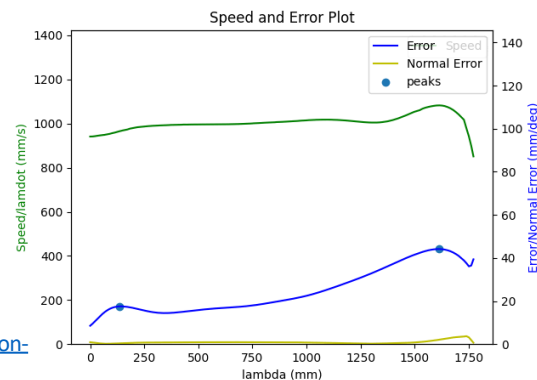# Optimized tool path for tracking accuracy and velocity

- ARM Institute project led by Rensselaer Polytechnic Institute (RPI) with GE, SwRI, and Yaskawa
  - Realized through pose optimization with redundancy resolution
  - Greedy motion primitive fitting (MoveL to MoveC)
  - Adjust blending zones and waypoint position based on trajectory error
  - Outputs for consumption into motion planner – plug-in to Tesseract
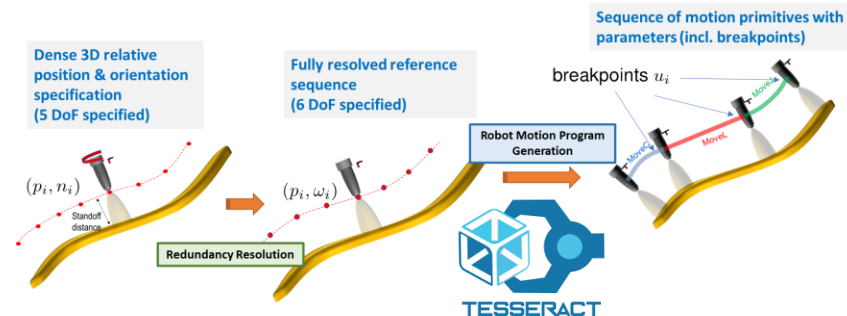
Error Stats	Avg Error (mm)	Max Error (mm)	Min Error (mm)	Std Error (mm)	Avg Angle (rad)	Max Angle (rad)	Min Angle (rad)	Std Angle (rad)
Curve 1	0.0021	**0.163**	0.00038	0.03	0.0016	0.0061	0.00008	0.0014
Curve 2	0.094	**0.436**	0.0054	0.073	0.0027	0.0117	0.0005	0.0023

https://arminstitute.org/projects/optimized-robot-motion-program-for-tracking-complex-geometric-paths/   https://github.com/swri-robotics/RPI-Tesseract-Motion-Planning/tree/master

Improving Large Volume Motion Planning

- Extra degrees of freedom in large robots like rail systems or mobile bases increase work volume

- Intros challenges in process planning; the limitation of the "useful" motion of a robotic system that is constrained by the application at hand

- The new improvements in process planning allow for branching "depth first" searches, which will quickly find a solution for every position in the trajectory, instead of search "breadth first" to find the optimal configuration at each pose
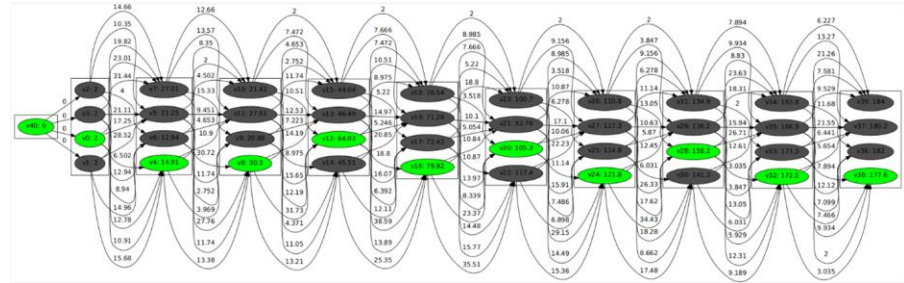
Full Dijkstra graph find the optimal path throught he graph by exploring every edge

Typical rail based system with large volume

https://github.com/swri-robotics/descartes_light

Quantitative Robot Reach Analysis

Updates on the Reach Repository - The REACH repository is a tool that allows users to visualize and quantitatively evaluate the reach capability of a robot system at a given base position for a given workpiece. See the ROSCon 2019 presentation and video for a more detailed explanation of the reach study concept and approach.
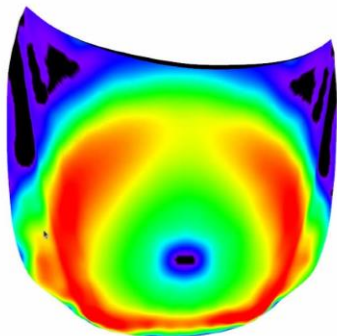
Heat map for reachability – coming soon!
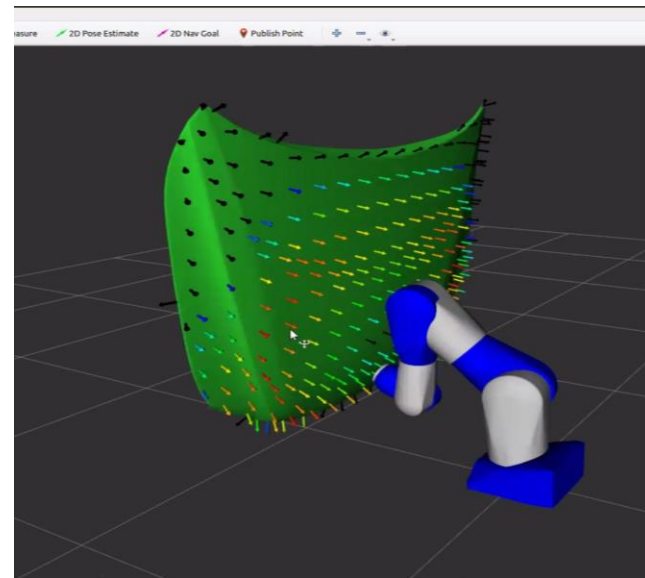
Heat map scoring of waypoints on a mesh – pose quality – new metrics! – available now!

https://github.com/ros-industrial/reach

Training for 2023

- Planning three training events
  - Feb 2023 – registration opening soon!, San Antonio
    - Advanced Topic: Motion Planning Pipeline
  - July 2023 – Seeking a member host site
    - If interested in hosting a training, contact Matt Robinson, RIC Americas PM
  - October 2023 – San Antonio, TX
    - Advanced Topic: TBD – please submit suggestions
- Will offer a single virtual only training – timing TBD.
  - Feedback was hybrid was not working for the students online
  - Will bring more lab exercises to Day 3 in ROS 2
- Bite Size Learning – recorded educational on a smaller topic – targeting 3-6 minutes in length – stay tuned
  - Submit topics to Matt Robinson, RIC Americas PM

Workshop

- Seeking to set up a Scan-N-Plan workshop

- Held a workshop as part of ROSCon 2021 virtual

- Seeking a hands on opportunity with hardware and students to get into all the facets of a working system

- Current locations considered:
  - Columbus, OH
  - Pittsburgh, PA
  - Other? – interested in hosting? Ping the PM!
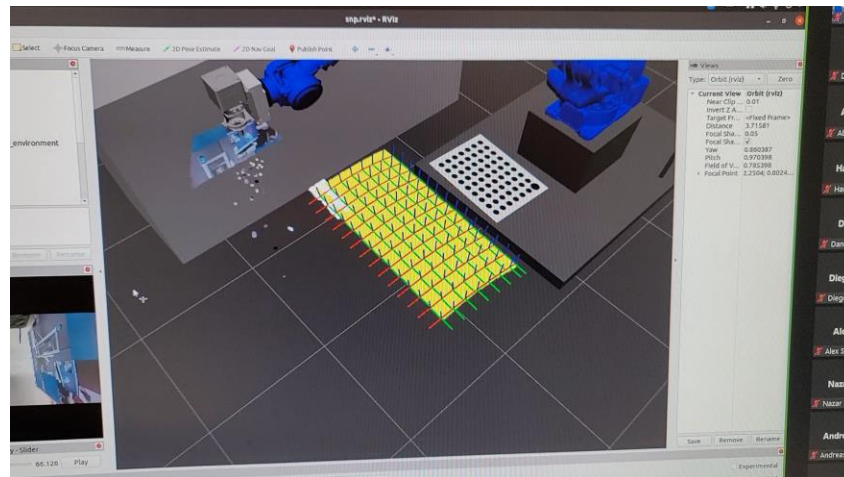
ROSCon 2023

- ROSCon 2023 will be in New Orleans in October!

- Will propose a workshop

- These are larger group workshops, but we will seek to have hardware for testing and step through an application of interest
  - Submit suggestions for something of interest

Robotic Blending M5

- Champion: Steel Founders' Society of America
- Targeting an end-user site
- Team comprised of
  - Yaskawa
  - PushCorp
  - Iowa State
  - EWI
  - ARIS Technology
- Mid 2023 foundry demonstration
  - Merging work from Godel plus recent Scan-N-Plan collaborative workshops
  - ROS 2
  - Multiple replications on hardware

Based on: https://github.com/ros-industrial-consortium/scan_n_plan_workshop

Supporting the community

- ROS 2 Technical Steering Committee (TSC)
  - Represent industry/consortium for core ROS 2 topics/roadmap etc
  - Garner support for working groups that are important to industry

- (Hardware) Interfaces Working Group
  - Working group to identify interfaces that include the semantics
  - Identify industrial standards that have good references
  - Open to everyone: https://discourse.ros.org/t/hardware-interfaces-working-group-recurring-meeting/24847/1

- Acting on Roadmapping from Industry Members & Broader Industry
  - Inform future capability development & tools to support adoption

Thank You!

- Provide feedback
- Seek out ways to collaborate
- Engage your supplier/partners on ROS use
- Reach out if you need help

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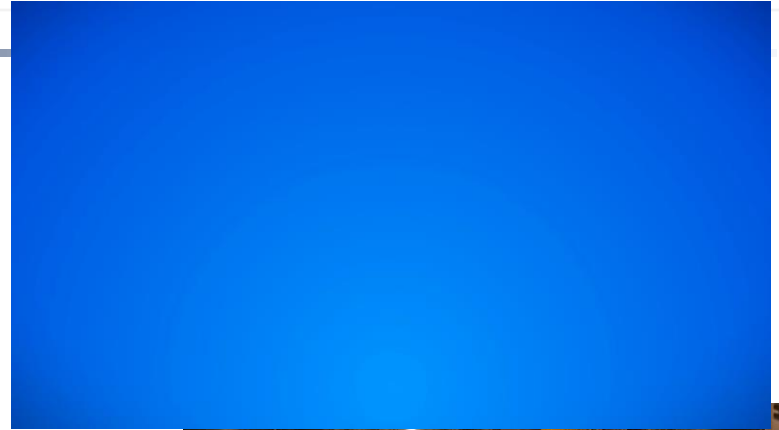
Open Forum

- What can we work on?

- What capability is missing?

- Where can documentation be better?