

ROS-I Americas Updates

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SwRI



SwRI Background

- Founded in 1947
- San Antonio, TX
- Independent, not-for-profit
- Applied R&D in Natural Sciences and Engineering
- FY 2022 Revenue: \$798M



SwRI Background

- 1500 acres
- 11 technical divisions
- 2.4 million sq. ft. of laboratories, test facilities
- ~2700 employees

Universities
National Labs

SwRI[®]

Industry

Fundamental
Science

Basic
Research

Applied
Research

Product
Development

Production

SwRI Robotics

- Advanced robotics software
- Custom robotics
- Vehicle autonomy
- Machine vision and perception
- Industrial automation and controls
- System integration



ROS-I 10 Year Montage

<https://www.youtube.com/watch?v=-6yAk05et1Q>



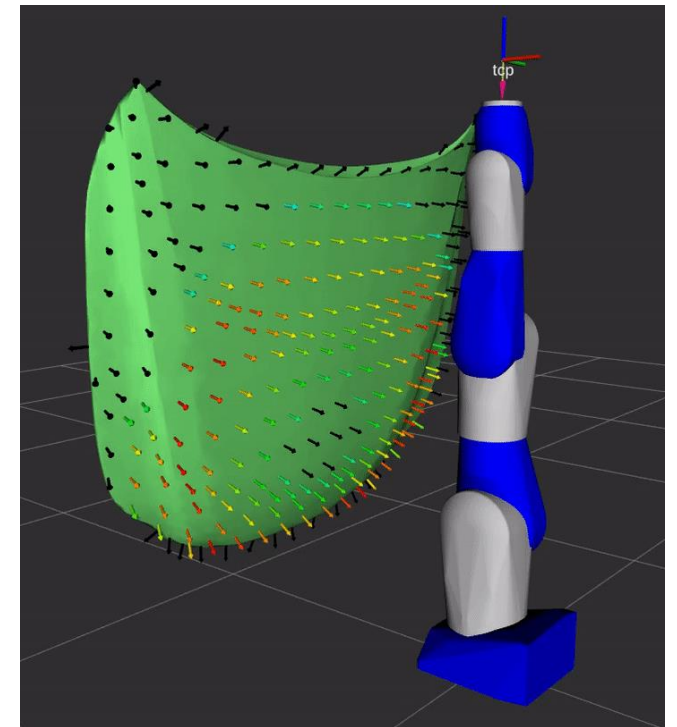
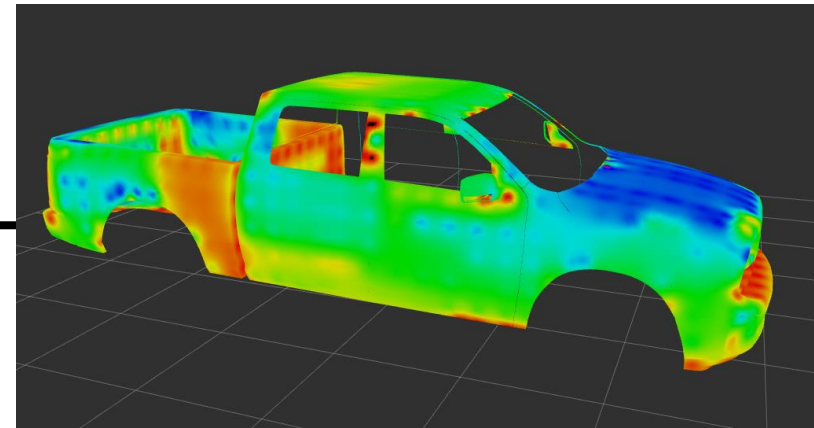
Continue to foster collaboration

- In person conferences, training events, meetups
- Write ups and additional broader reach collaborative initiatives beyond the ROS community
 - American Welding Society
 - Founders' Society of Americas
 - Coaters' Association
 - Remanufacturing Industries Council
 - Manufacturing Innovation Institutes



ROSCon

- New Orleans, USA – October 18-20
- Presented workshop on reachability analysis
 - https://github.com/marip8/reach_roscon_2023
- Focus topics:
 - mobile robotics/autonomy
 - real-time development
 - applications/deployment
- Continued discussion on DDS middleware optimization and debugging



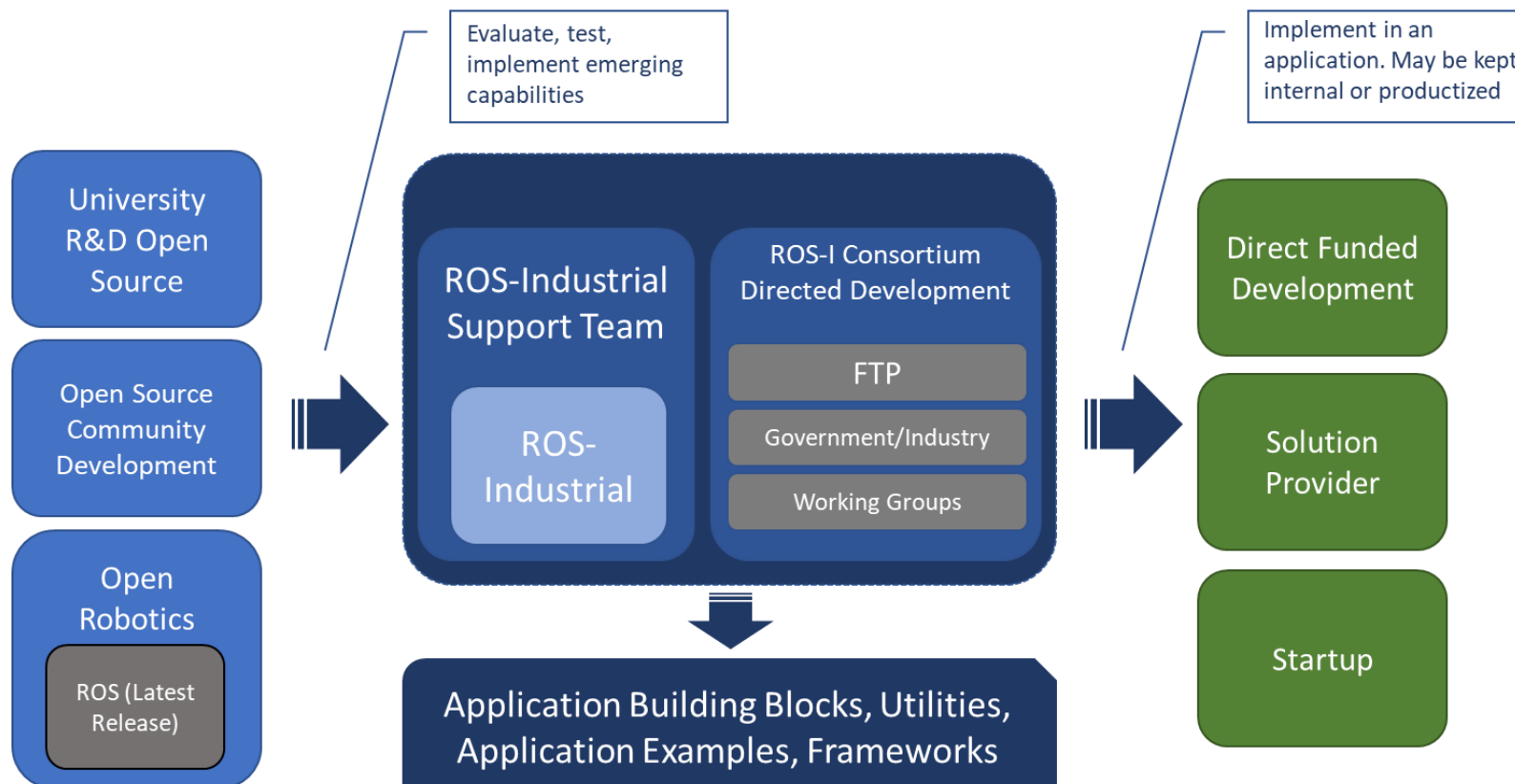
<https://github.com/ros-industrial/reach>

https://github.com/ros-industrial/reach_ros2

Upcoming Events

- Training
 - Typically 3-4 times per year
 - Cover ROS/ROS2 basics, various advanced topics
 - Remote sessions possible
 - Access to training material from all consortia
- ROS-I Americas Annual Meeting
 - March 2024
 - SwRI – San Antonio, TX, USA

How to get capability on the floor

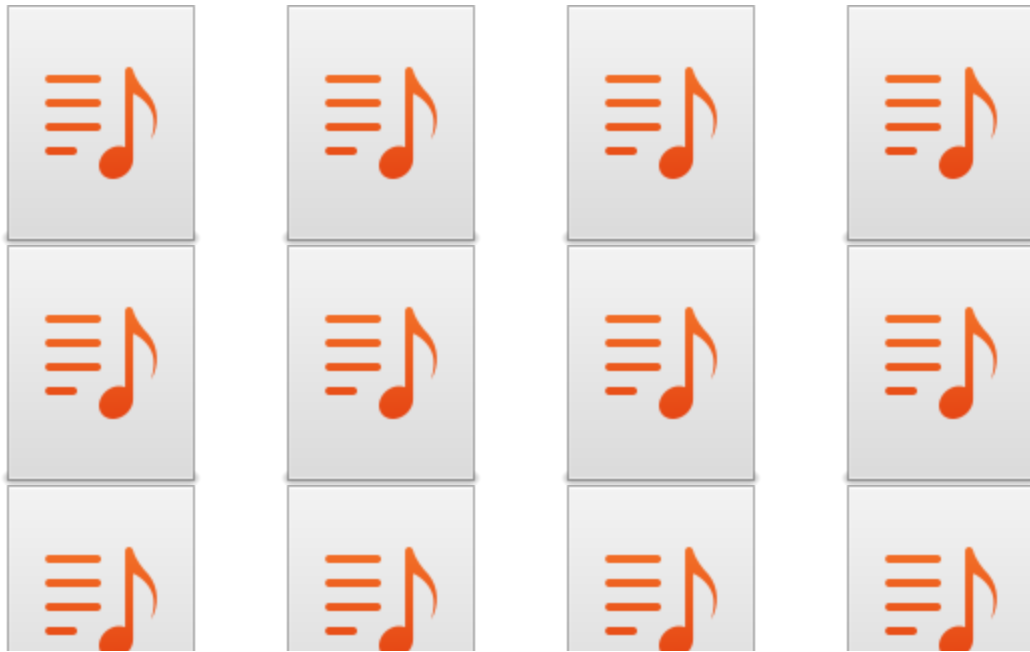


- Continued opportunity to leverage MII network for tech transition
- Many examples of Government/Industry partnerships that refine capabilities
-

Focused Technical Projects

- 2 active collaboration opportunities
- Require a member champion
- Send suggestions to your friendly Consortium Manager

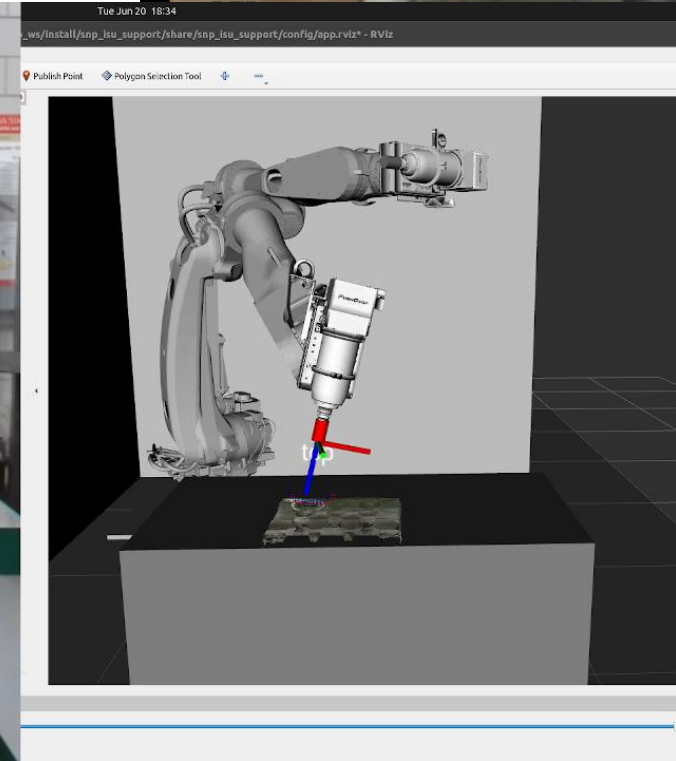
ROS-I FTP Robotic Blending M5



- Reconfigurable Work Flow
- Characterization Based Path Planning for QA
- Improved 3D Segmentation
- Process Optimization
- Response to Human Cues
- Technology Transfer
- Integration and Testing

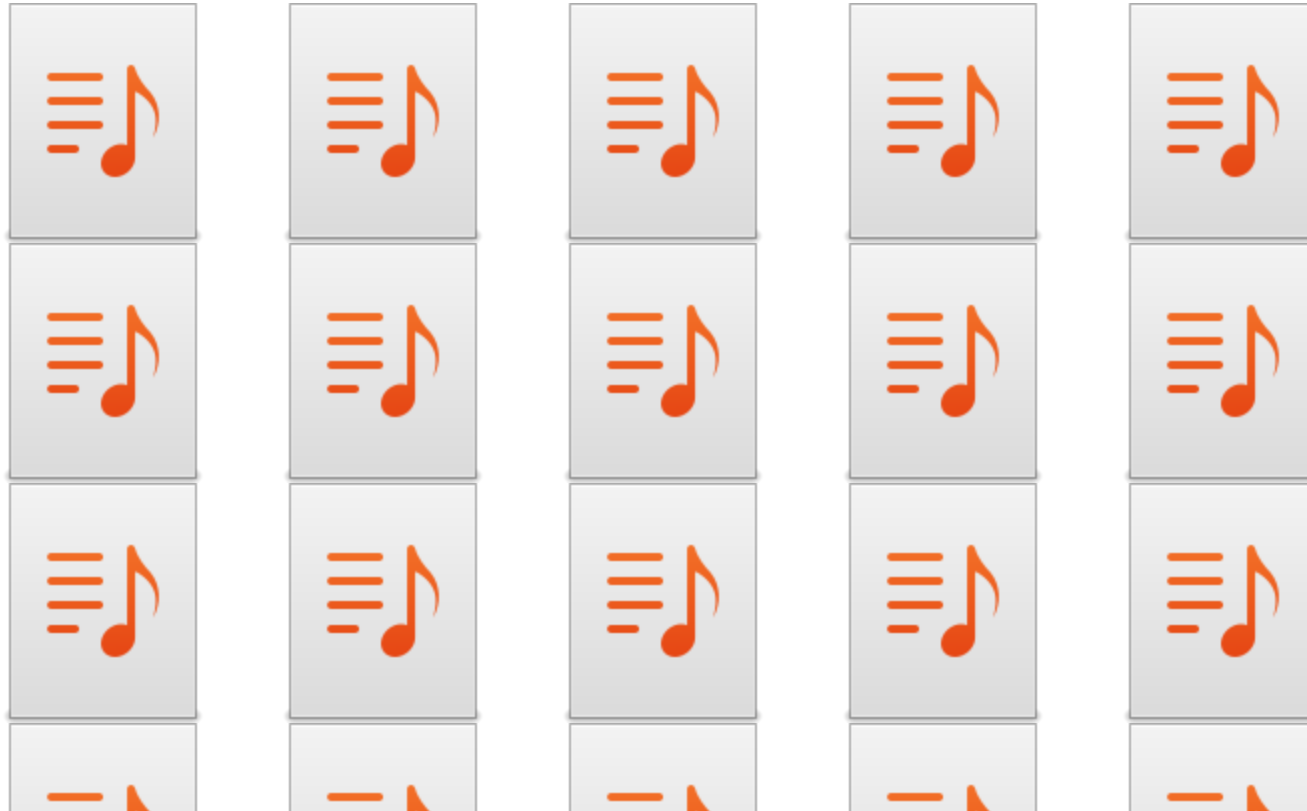
Software Improvements

- Calibration
- Tuning on human drawn boundaries
- Enabling stones



Software Progress

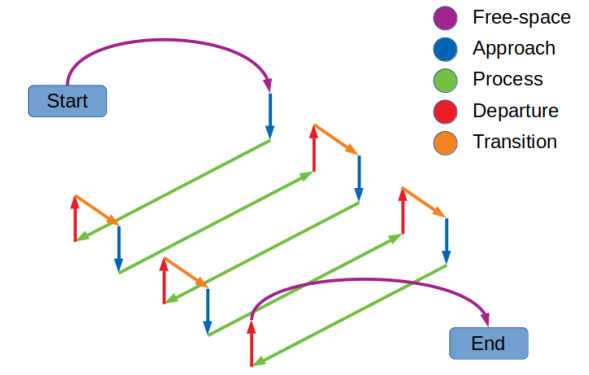
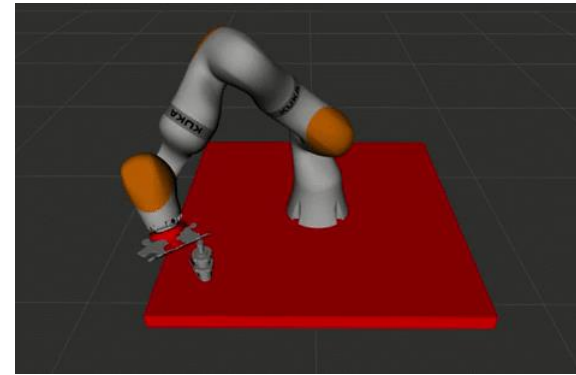
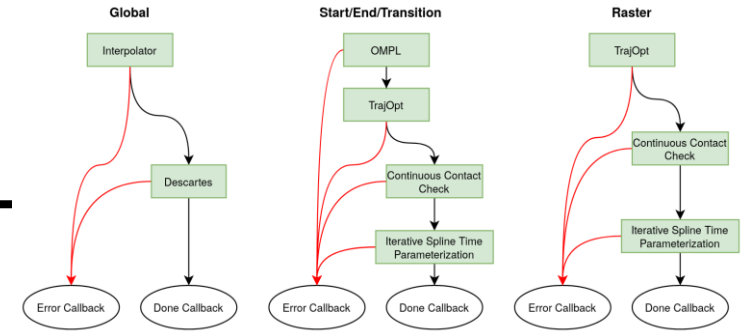
- Drawn Boundary Segmentation



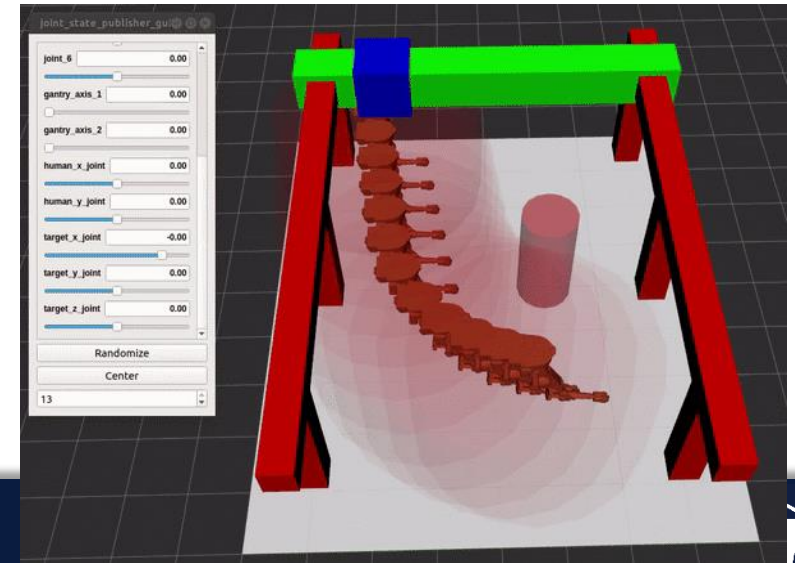
- Final demonstration on production system at end-user 11/2024
- Operator interfaces
- High mix stainless/steel castings

Tesseract

- tesseract
 - Improved code coverage
 - Improved memory allocation/run-time speed
 - Improved collision reporting
- tesseract_planning
 - Planner profile interface refactor
 - Added time parameterization algorithms
 - Plugins for planning task composition
- trajopt
 - Continued port to IFOPT framework for more flexible constraint definition
- tesseract_qt
 - Improved Rviz widgets
 - Added introspection tools (trajectory playbook, state collision evaluation)
- tesseract_ros2
 - Reached parity with ROS1 interface



<https://github.com/tesseract-robotics>



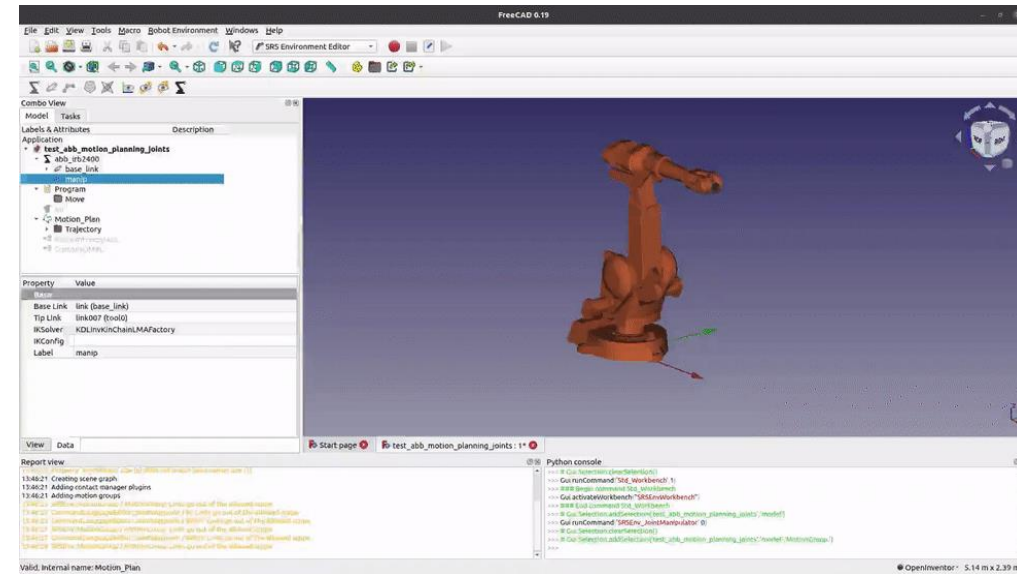
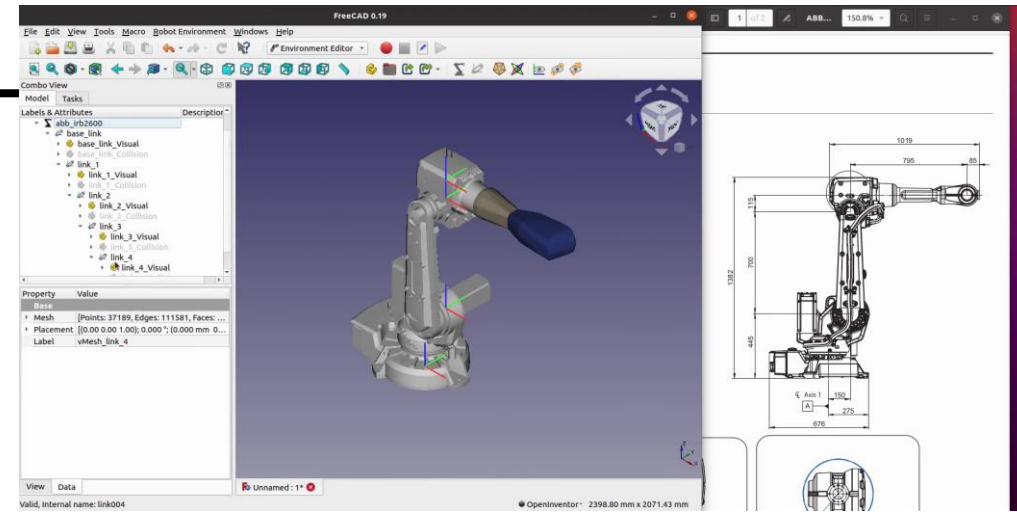
Robot Drivers in ROS 2

- Increased hardware support in ROS 2
 - MotoROS2 (controller native driver)
 - UR ROS 2 in Polyscope 6
 - <https://www.youtube.com/watch?v=MggfbjuHGrU>
 - ABB EGM, ros2_control
 - https://github.com/PickNikRobotics/abb_ros2
 - Kawasaki KHI (potential port via Blending M5 FTP)
- Hardware Interfaces Working Group
 - Standardize interfaces
 - Define requirements
 - Work through compatibility/interoperability roadblocks

SWORD

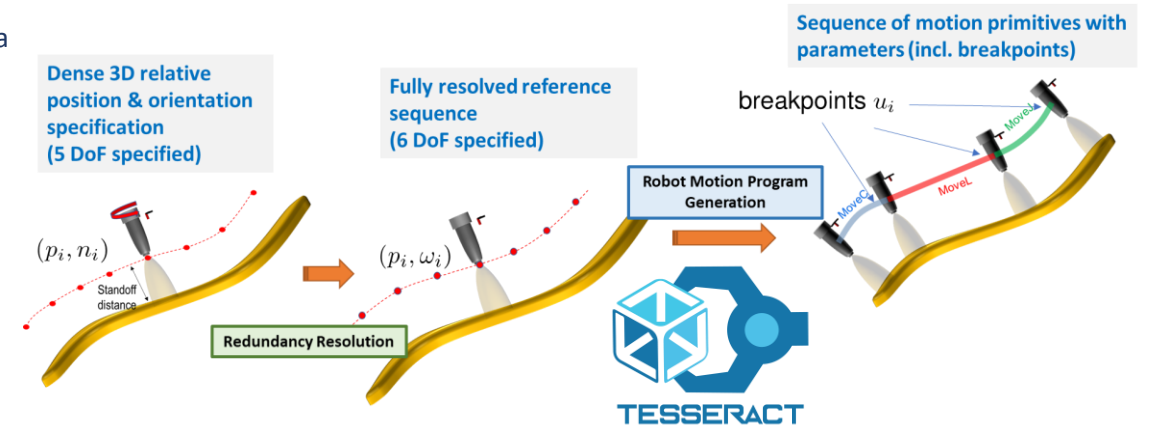


- Leverage ROS-I tools in a CAD-based environment
- Cross-platform (Windows, Linux)
- Current capabilities
 - Create/export robot models (URDF)
 - Create convex hulls for collision models
 - Visualize kinematics
 - Define tool path
 - Perform motion planning with OMPL, Descartes, TrajOpt, etc.
 - Configure custom motion planning pipelines
- Capabilities under development
 - Generate tool paths using mesh and CAD data
 - Motion planning profile wizards
 - Export robot trajectories to deployable format
 - Reach study
- Beta test underway – contact to participate



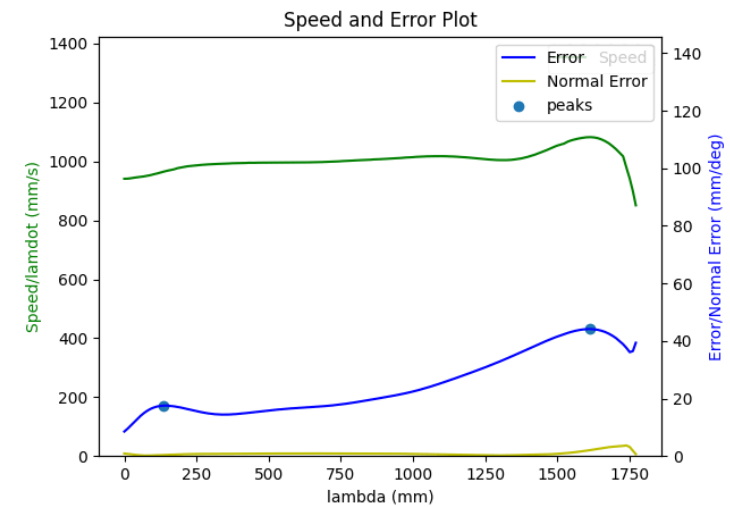
Optimized tool path for tracking accuracy and velocity

- 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



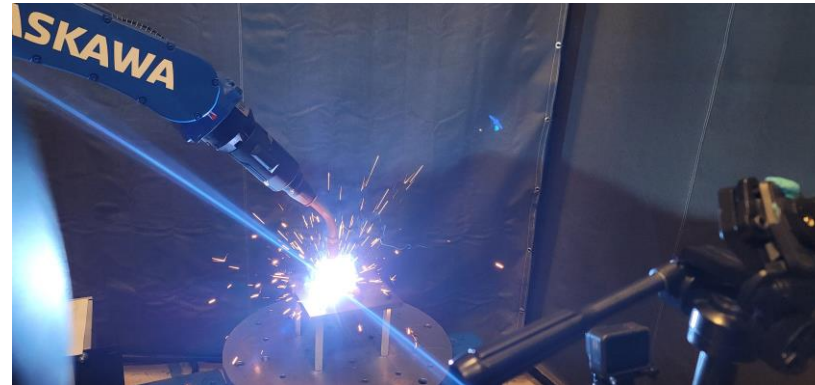
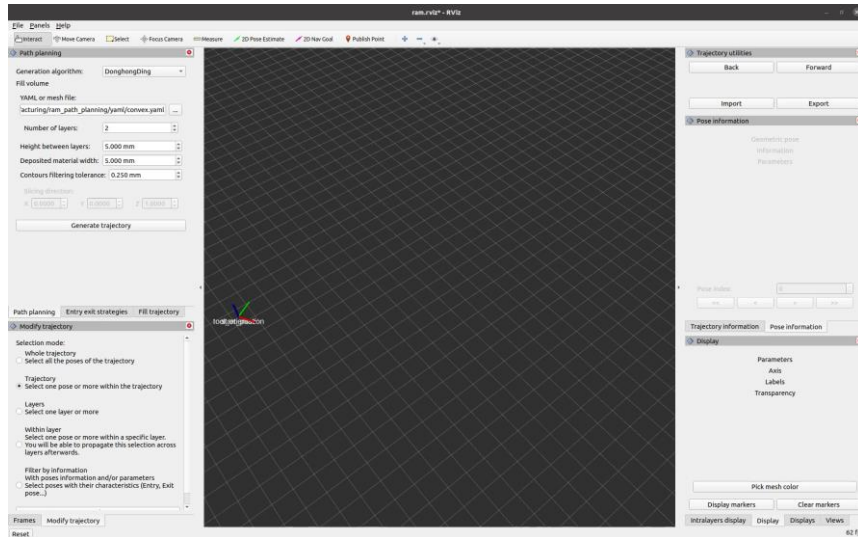
Error Stats	Avg Error (mm)	Max Error (mm)	Min Error (mm)	Std Error (mm)	Avg Angle (rad)	Max Angle (rad)	Min Angle (rad)	Std Angle (rad)
Curve 1	0.0021	0.163	0.00038	0.03	0.0016	0.0061	0.00008	0.0014
Curve 2	0.094	0.436	0.0054	0.073	0.0027	0.0117	0.0005	0.0023

<https://arminstitute.org/projects/optimized-robot-motion-program-for-tracking-complex-geometric-paths/>



Open Additive Framework

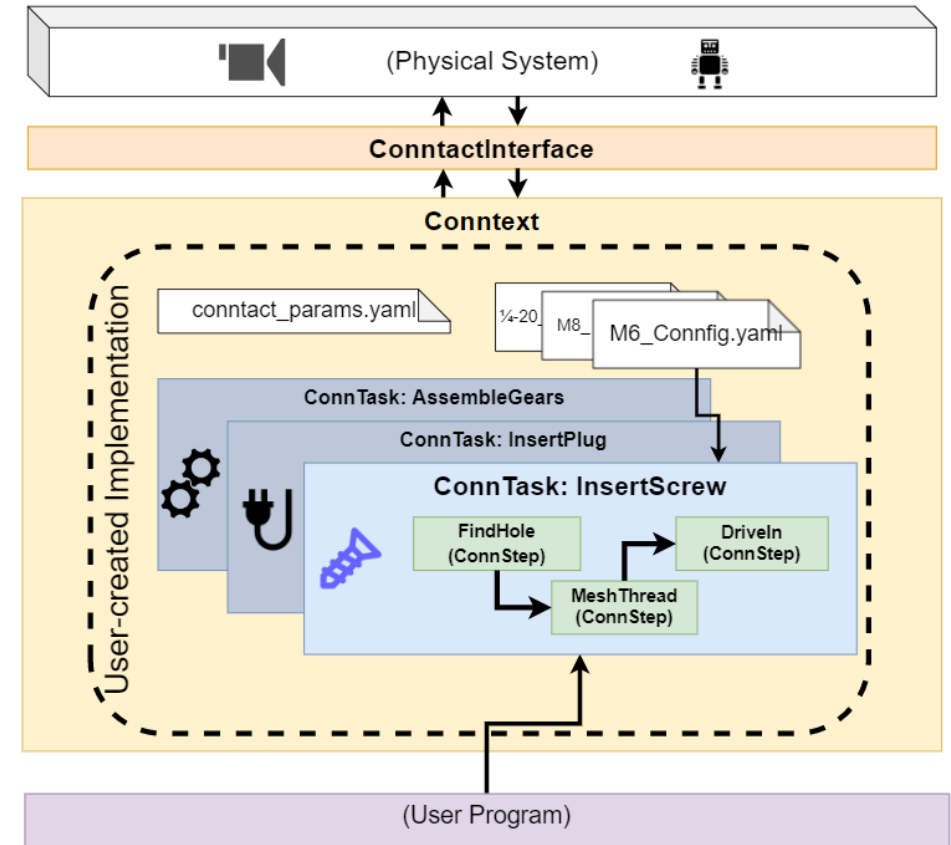
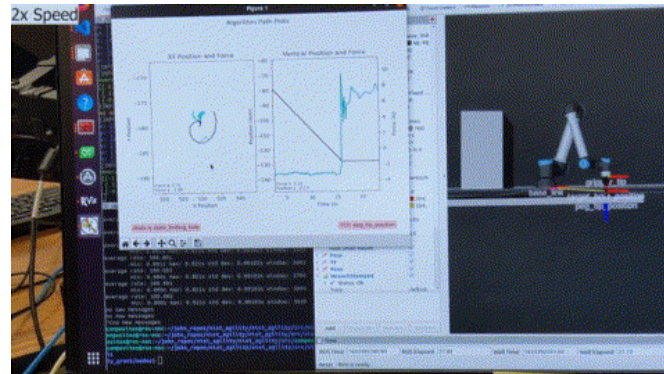
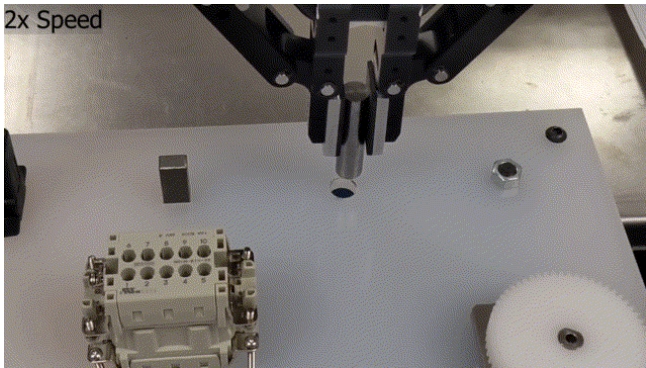
- Open Flexible Additive Framework
- Merging of computational physics-bases analysis with planning



Write Up: <https://rosindustrial.org/news/2022/8/23/an-open-framework-for-additive-manufacturing> Video: <https://youtu.be/rxkLyYaazII>

Agility in advanced assembly applications

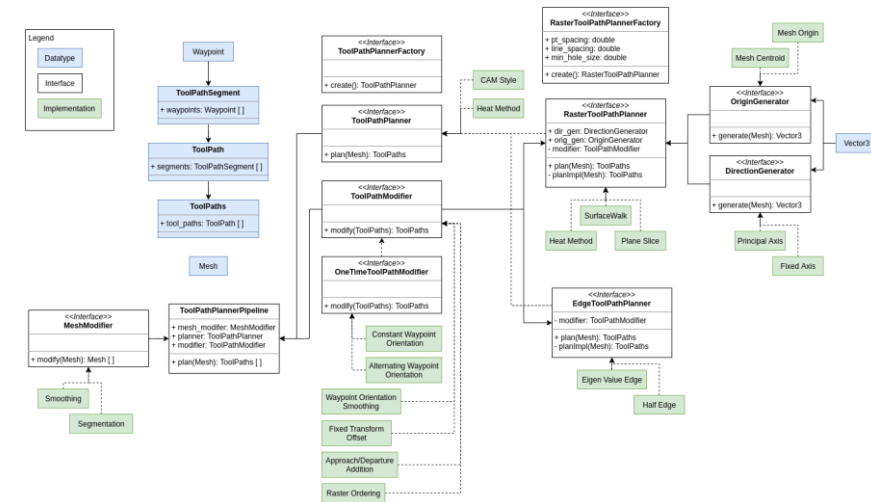
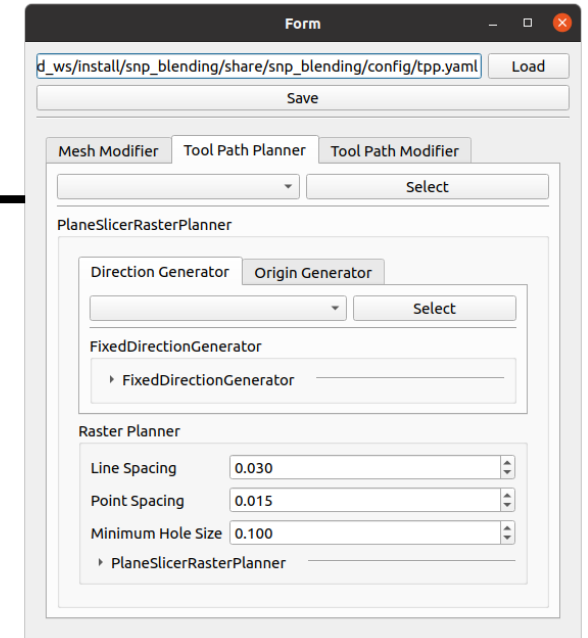
- The ConnTact Assembly Framework
 - Ability to enable researchers to simply implement and test learning algorithms to test extensibility
 - Supported by NIST and the Agility Working Group



<https://github.com/swri-robotics/ConnTact>

Looking Forward

- Lower barrier to entry/improved usability
 - More GUI interfaces
 - More Python wrappers
 - More binary distributions
 - Expanded Windows compatibility
- ROS 1 to ROS 2 Port Considerations
 - Deliberate design effort
 - Improved documentation
 - Separation of ROS interfaces from core code to support ROS1/2, other frameworks
- On-going ports
 - REACH (complete, community contributed ROS2 port)
 - noether (on-going)
 - industrial_calibration (on-going)



Resources

- ROS-Industrial
 - Home: rosindustrial.org
 - Documentation: wiki.ros.org/industrial
 - Code:
 - <https://github.com/ros-industrial>
 - <https://github.com/ros-industrial-consortium>
 - Training: http://ros-industrial.github.io/industrial_training/
 - ROSin: <http://rosin-project.eu/>
- Upcoming Events (<https://rosindustrial.org/events-summary/>)
- SwRI
 - <https://robotics.swri.org>
 - [YouTube Industrial Robotics Playlist](#)

Thank You

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