ARM Leveraging of ROS for its projects

ARM Institute

Arnold Kravitz
ARM Institute
Chief Technical Officer
727 686 2702
arnie.kravitz@arminstitute.org
We are a 300 strong consortium of the leading Robotic OEM’s, Manufacturers, Integrators, Tier 1 research Universities innovators, GOV departments and the DOD

Nature
- Public-private partnership

Vision
- A future where people and robots work together to respond to our nation’s greatest challenges and to develop and produce the world’s most desired products.

Method:
Invigorate US industry by investing in:
1. Robotic manufacturing technology
   - Often enhanced with AI
   - Fabricate, finish, assemble, inspect
   - Scan/map/model/ repair defects, maintain
   - Handle material, tend machines, fetch, kit, store, pack / unpack, load /un-load
2. Education & workforce Development
3. Developing an eco system

~ $36M on 30 projects in 2020
Pushing technology across the innovation gap

**MRL 4:** Capability to produce the technology in a *laboratory environment*

**MRL 5:** Capability to produce prototype components in a *production relevant environment*

**MRL 6:** Capability to produce a prototype system or subsystem in a *production relevant environment*

**MRL 7:** Capability to produce systems, subsystems, or components in a *production representative environment*
Developing technology to support market portfolios

1. **Pliant Material handling and Assembly robots**
   - Fabricate, finish, assemble, inspect, Logistics
   - 3D multi-ply composite woven structures
   - Cut, sew, drape, manipulate, align, bond, visual servo

2. **Automotive/Aerospace/Electronics**
   - Fabricate, finish, assemble, inspect, Logistics
   - Composites and Metal structures and skins
   - Coatings

3. **Factory logistics robots** (Fetch, hold, and clean inspect)

"Research was sponsored by the Office of the Secretary of Defense and was accomplished under Agreement Number W911NF-17-00004. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the official policies, either expressed or implied, of the Office of the Secretary of Defense or the U.S. Government. The U.S. Government is authorized to reproduce and distribute reprints for Government purposes notwithstanding any copyright notation herein."
4. **Heavy industry – material finishing projects (7)**

- Grinding (1)
- Sanding (2)
- Polishing (1)
- Surface treatment (cold working) (1)
- Thermal surface treatment (1)

*Research was sponsored by the Office of the Secretary of Defense and was accomplished under Agreement Number W911NF-17-3-0004. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the official policies, either expressed or implied, of the Office of the Secretary of Defense or the U.S. Government. The U.S. Government is authorized to reproduce and distribute reprints for Government purposes notwithstanding any copyright notation herein.*
Results matter: >33% of completed projects are transitioning and most of them used ROS.

152 Projects proposed
15 closed

80 Projects Managed
9 planned for transition
1 in commercial use

48 Completed
6 transitioning

**Transitioned and in Commercial Use (1)**

1. **ARM-TEC-20-NI-F-01: Agile Laboratory Robot for COVID-19 qPCR Testing**

**Transitioned and undergoing TRL 8-9 investment (6)**

1. **Safe Autonomy Features in the Edge (SAFE), Safety project: Real-time Inference for Autonomous mobility**
2. **Vision-based Cleaning of Complex Structures with a Lightweight Compliant Arm, Snake robot**
3. **Adv. Robotic Grinding System for Metal Parts, Passive Track & Trace with Semantic Segmentation Grind Chamfer large gears splines**
4. **Advanced Control for Robotic Surface Treatment, deburring to accommodate batch-to-batch variations.**
5. **Systematic Robotics Application Assessment Methods and Tools for Decision-making,**
   - **Private consulting group evaluating a derisking tool for commercial use.**
6. **Collaborative Robotic Sanding of Aircraft Panels, robotic sanding tech for sanding Nacelle's**

**Firm Plans (9)**

1. **Collaborative Composite Sheet Layups for Complex Geometry of Small Plies**
2. **Seamless Multi-Robot, Multi-Machine Interoperability**
3. **Open Source Teach Pendant Programming Environment**
4. **Bot Couture: Robotic Clothing Manufacturing**
   - **Transition to major garment manufacture reshoring in San Francisco**
5. **Mobile Autonomous Coating Application for Aircraft Sustainment**
6. **Interoperability and Orchestration of Autonomous Mobile Robots (IO-AMRs),**
   - **COVID 19 mobile disinfecting robot for use in occupied areas currently Aero Sustainment Autonomous Masking**
7. **Flexible Drilling System (FDS)**
8. **Virtual Part Repair Programming for Robotic Thermal Spray Applications**
ARM Invests in key technologies, that combine to form numerous manufacturing processes, that make disruptive products in high lift markets.

1) Technologies are used by many Processes.  2) Processes are used in many Markets.
ARM has identified the 13 most urgent and important technologies whose development will have the greatest impact invigorating the US industrial base through the adoption of manufacturing robots enhanced with AI.
Examples of ROS Modules used on programs

- ROS IPA Coverage Planner
- ROS Navigation and move
- ROS Swarm Control Stack
- ROS MoveIT
- Ros GraspIT
- ROS A5 Software
- ROS Smach-task-level architecture for rapidly creating complex robot behavior
- ROS Noether - geo constrained path planning
- ROS Descarte – path planning
- ROS Gmapping - 2d SLAM
- ROS 1/DDS bridge
- ROS-I/MTConnect bridge
- ROS Middleware Wrapper (RMW) layer
- Gazebo
Examples of ARM Projects using ROS

• ARM-17-01-F-14-Passive Object Tracking via Multi-Spectra Robotic Sensor Fusion Package & Semantic Segmentation
  • Multi-Spectra Sensor Fusion system through tracking algorithm on ROS

• ARM-TEC-20-01-F-17-, Interoperability and Orchestration of Autonomous Mobile Robots (IO-AMRs)
  • Software libraries (in ROS) for AMR interoperability
  • Plug&Play connectivity to AMRs with ROS support,
  • Compatibility through open APIs to open ROS modules such as visualizers

• ARM-TEC-20-02-F-05, LM MAID, Mobile Autonomous Industrial Disinfector.
  • Motion planning algorithms and software to handle positioning
Examples of ARM Projects using ROS

• ARM-TEC-20-02-F-07-Qinetiq: Developing Autonomous Mobile Capability for Room Disinfecting Robots to Automate the Treatment of Multiple Separate Rooms and Spaces in the fight against COVID-19 and other Viruses
  • Motion planning algorithms and software to handle positioning
• ARM-TEC-18-01-F-03-UTRC/RPI, Advanced Control of Robotic Surface Treatments
  • 1. ROS node that subscribes to a single point cloud coming from the depth sensor and publishes voxel occupancy grid and textured mesh;
  • 2. ROS node that subscribes to multiple point clouds of a static ply and ground truth camera pose, then publishes textured polygon mesh;
  • 3. ROS node that subscribes to multiple point clouds of a static ply, infers the pose of the camera, then publishes textured polygon mesh;
  • 4. ROS node that subscribes as above but of an initial static ply to learn the appearance then subsequently flexing ply and published the continuously updated polygon mesh and texture
Summary

• ROS shrinks the time to market by providing; a trusted, “well understood”, library of very useful packages, nodes, dashboards, and development-modeling and risk-reduction tools.

• If one desires to stay closed source, one could develop the prototype or pathfinders using ROS and then re-code the final de-risked product to maintain a closed source state.

• Many of the Projects we sponsor use ROS by choice and propose it as discriminator for reducing development risk schedule and development cost.

ROS is driving the democratization of Industrial Robotics