Accelerating Industry Adoption of ROS2 based Technology in Asia Pacific

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The Advanced Remanufacturing Technology Centre (ARTC)

Leading Public-Private Partnership Research Centre in SE Asia

Officially Opened on 28th January 2015

- **Mission – To Develop and Deploy Advanced Manufacturing Solutions and Upskill Workforce, to Drive Local Industry Competitiveness**
- **Bridging the gap between Research and Industry**
- **Co-Create and Value Capture with Industry through the Implementation of Solutions**

The ROS-Industrial Membership Ecosystem

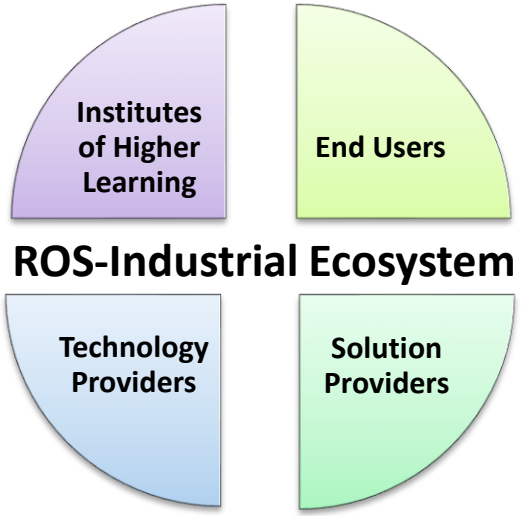
A Global Consortium with regional presence:

Fraunhofer IPA

Fraunhofer IPA, Germany

Southwest Research Institute, Texas

A*STAR ARTC, Singapore



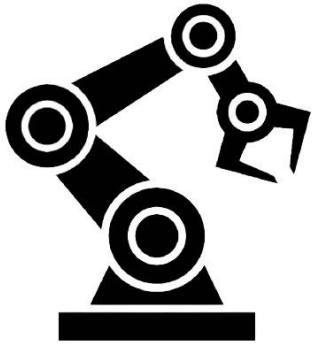
2 new members in Asia Pacific…

KYOCERA

Infineon

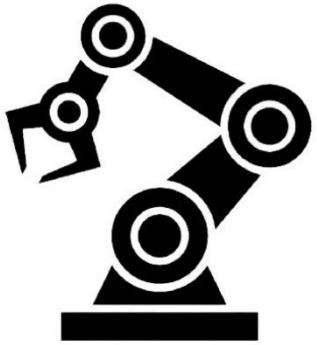
Joining >80 members Globally

The Vision and Mission of ROS-Industrial AP



Vision

An internationally acclaimed default partner in Asia Pacific for Open Source robotics

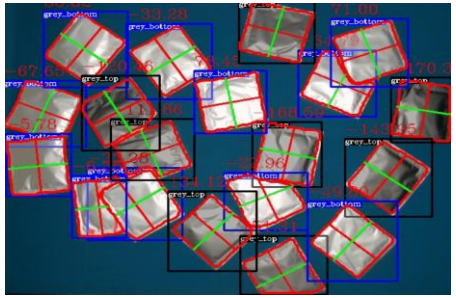


Mission

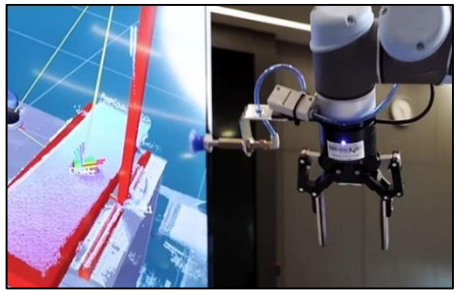
To develop and deploy ROS2 native technologies to support the international ROS community and Singapore's robotics ecosystem partners in their accelerated adoption of Open Source robotics

ROS2 Development Programme

Technology Focus



Perception



Manipulation

Software Quality

Motivation

- **Accelerating adoption of robotics through ROS**
- Ease of installation, setup and deployment
- Flexible and upgradeable to new state of the art algorithms, dynamically support different hardware architectures
- Industry-ready ROS 2 packaging – this includes following formal R&D processes and deliver automated software testing for maintainability

Sponsor

Managed by Advanced Remanufacturing and Technology Centre ARTC

Robotics Empowering People NATIONAL ROBOTICS PROGRAMME

Perception – ROS2 easy_perception_deployment (epd)

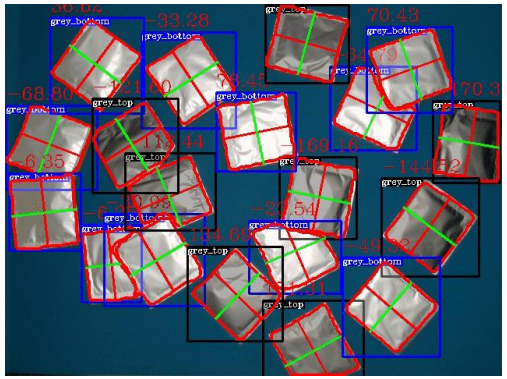
Motivation

A ROS 2 package that provides object vision capabilities that is easy to configure and deploy, with support for state-of-the-art machine learning algorithms

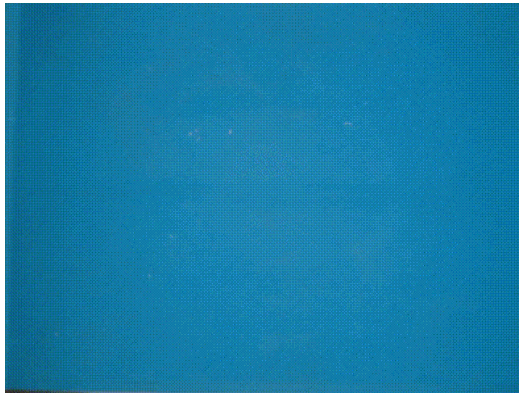
Key Features

Permissively Licensed and Open Source.

Reduces time needed in training and deploying robotic vision systems by use of **transfer-learning**.



Reduces knowledge barrier with the use of **GUI** to guide users. Targeted mainly at **users with little or no programming background**.



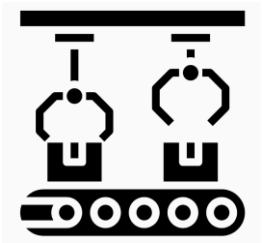
Relies on **open-standard ONNX AI models**. Removes overreliance on any one given Machine Learning library (Eg. Tensorflow, PyTorch, MXNet).

ROS 2 package **formally tested**

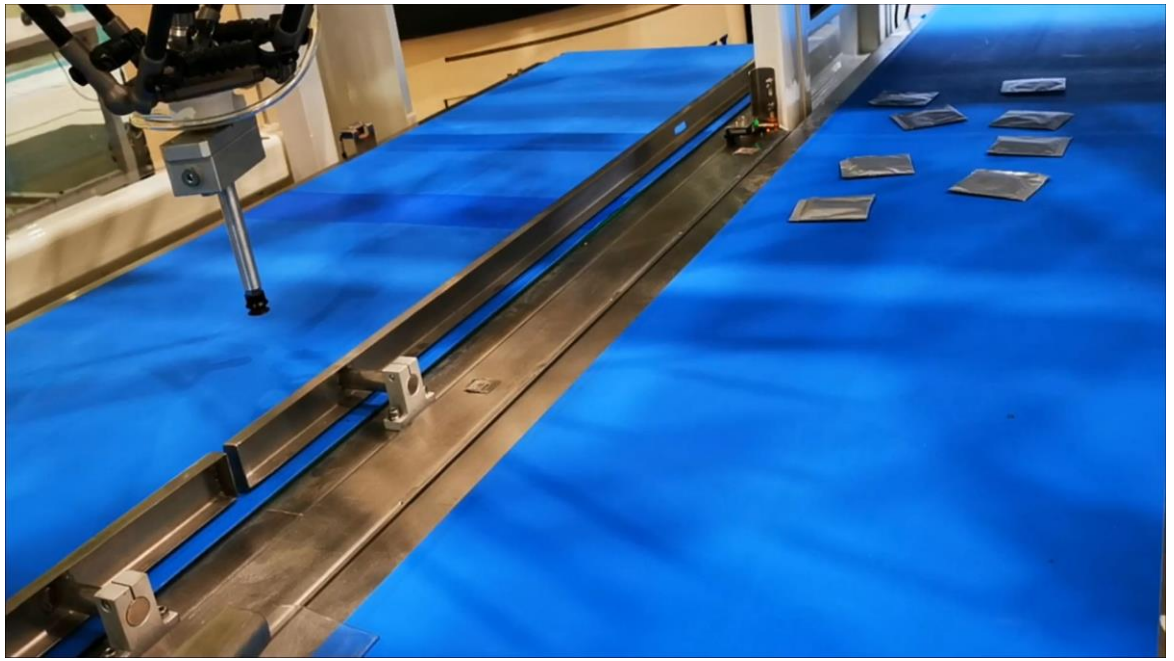
Perception (epd) – Use Case

EPD Configuration: ROS2 Foxy, Precision Level 3, Object Localization, operating at 2 FPS

Use Case Description: Industrial Conveyor Tracking and Automated Picking.



ROS 2-based conveyor belt picking



EPD runs a **deep-learning model** as a ROS2 inference engine which outputs object information in the form of **custom ROS2 messages** that caters to common Computer Vision demands.

Customizable Use-case Configurations :

I. Classification
II. Counting
III. Color-Matching
IV. Localization/Measurement
V. Tracking

Perception (epd) – Release Candidate

Download

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

License

License Apache 2.0

- Business friendly license that can be leveraged to create proprietary and commercial solutions

Quality

CI passing | codecov 88% | docs passing

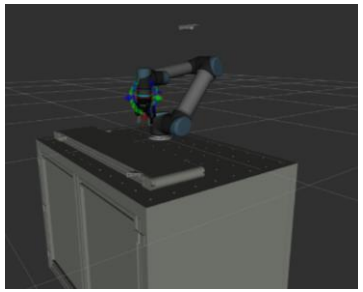
- Comprehensive code coverage of unit tests
- Complete support documents in place
- No static analysis warnings
- No dynamic analysis warnings

EPD

Manipulation – ROS2 easy_manipulation_deployment(emd)

Motivation

An easy to use ROS 2 manipulation package that provide a fast and flexible pipeline for pick and place tasks that can support a variety of grippers

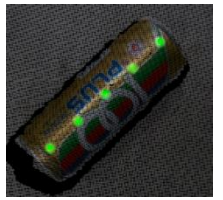


Key Features

Workcell Builder - **Quick and intuitive GUI** for users to create a representation of the elements in a workcell

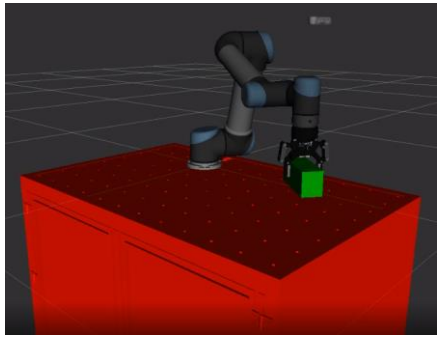
Grasp Planner – **Modular and flexible grasp planner** that generates an end effector specific pose from a perception output and **can flexibly** plan for **different end-effector architectures**

5-Finger Gripper



Suction Cup Array

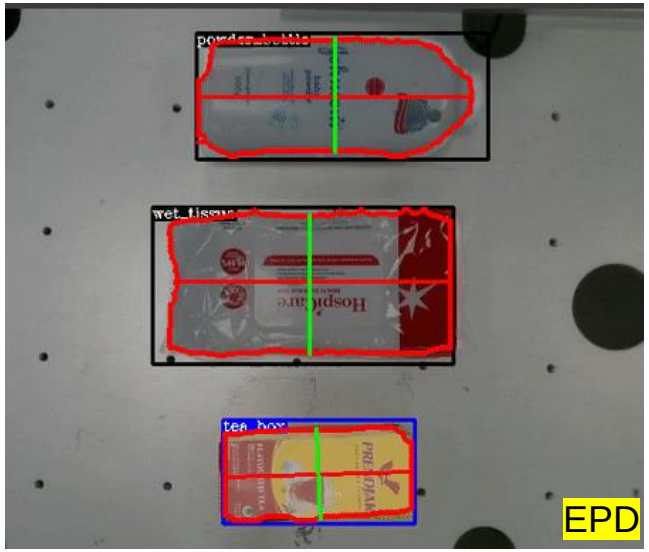
Grasp Execution - Robust and dynamic path planning process to **navigate robot** to the object for grasp while accounting for workcell/user safety

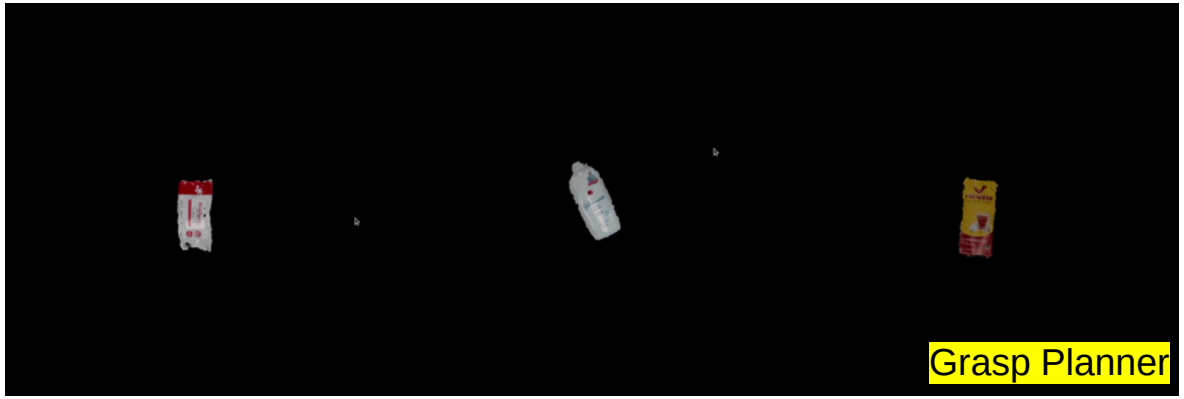


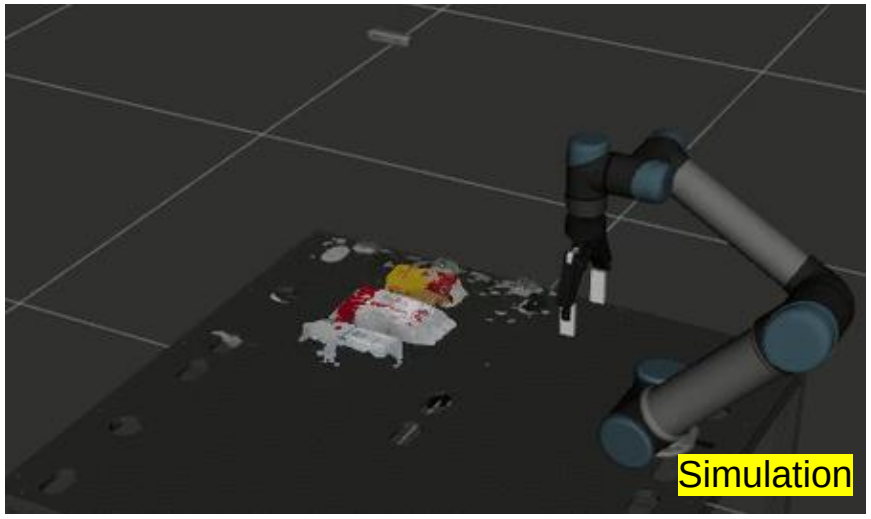
ROS 2 package **formally tested**

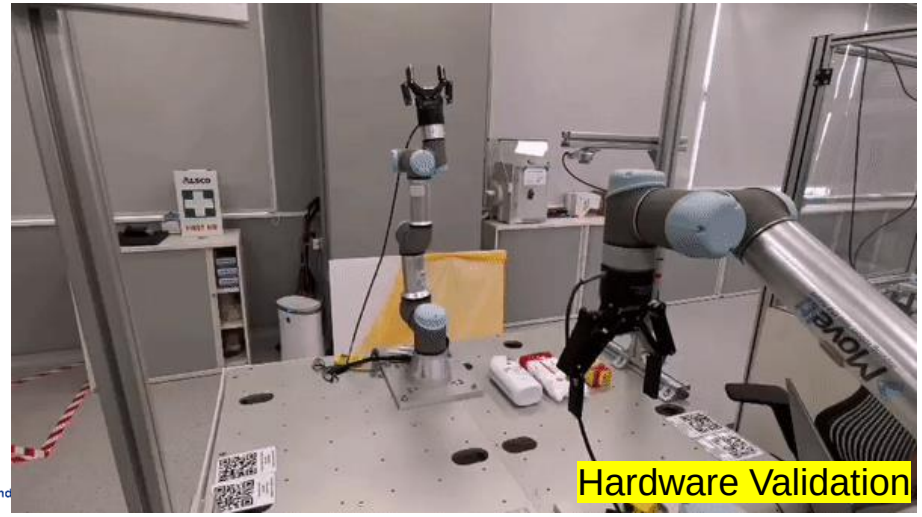
Manipulation(emd) – Full Pipeline Established

End-To-End EPD-EMD Pipeline testing has been successfully demonstrated





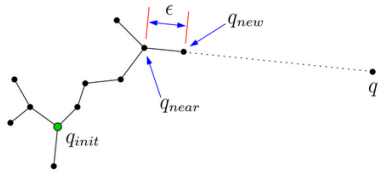




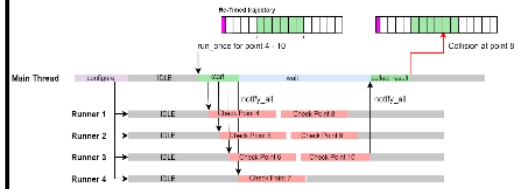
Manipulation(emd) – Dynamic Safety

Safety Zone

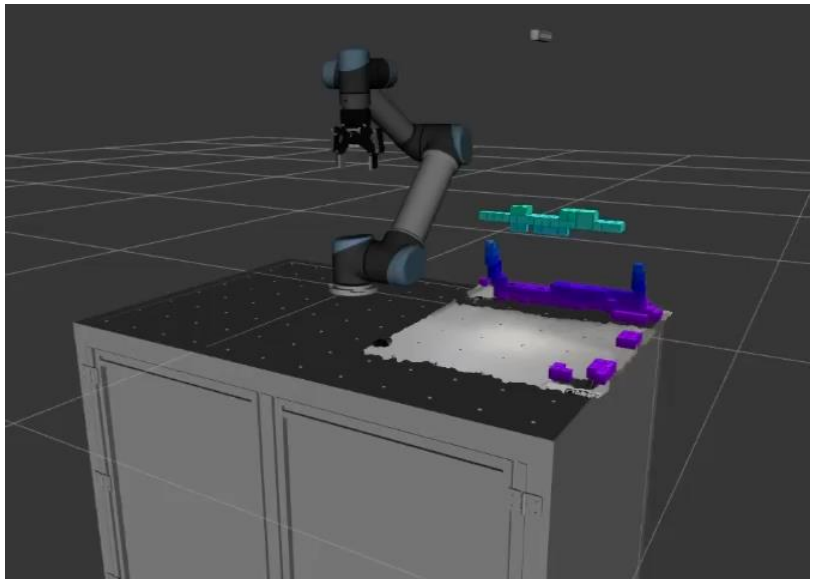
Replanner



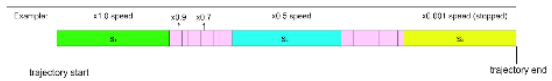
Multithreaded Collision Checker



Dynamics Safety



Next Point Publisher Speed Scaling



Manipulation (emd) – Use Cases

Potential industry implementation:

I. Handling in High-Mix Low-Volume FMCG industry

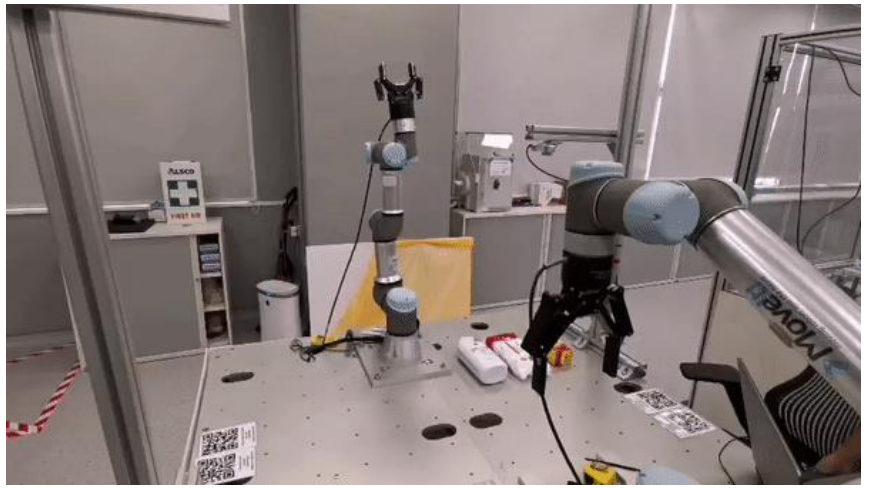
II. Handling in Manufacturing environment

III. Machine Tending Automation

IV. Labeling Automation

V. Many other more !

Finger Gripper



Suction Cup

Manipulation (emd) – Release Candidate

Download

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

License

- Business friendly license that can be leveraged to create proprietary and commercial solutions

Quality

- Increasing unit tests coverage for workcell builder
- Complete support documents in place
- No static analysis warnings
- No dynamic analysis warnings

EMD

Towards Automated Industry-grade Quality

REP-2004 – Global Community Alignment

- **5 quality levels**
- **7 categories** with process expectations and metrics used to determine the quality level of a package.

ROS-Industrial industrial_ci

- Tools for **automated software testing** and **continuous integration**.
- **Tutorials** for implementing industrial_ci and achieving quality levels.

ROS-Industrial Quality Tier Badges for industrial_ci

One-stop hosted service for

- **End-user** to determine whether a package is suitable for your project.
- **Maintainers** ensure package quality assurance consistency.

ROS Quality Badges

Commit /
Pull Request

Source Code

Developers

```
projectionTransform.block<3, 1>(
  0,
  3) = -1.f * (projectionTransform.block<
pcl::transformPointCloud(*(this->cloud),
this->affine_matrix = projectionTransfor
pcl::getMinMax3D(*(this->cloud_projected
const Eigen::Vector3f meanDiagonal = 0.5
  (this->maxPoint.getVector3fMap() + thi
Eigen::Quaternionf bboxQuaternion(this->
```

Feedback

Software Testing
Industrial ci / ROS Buildfarm

Repository Maintenance

Git Hook
(Github Application)

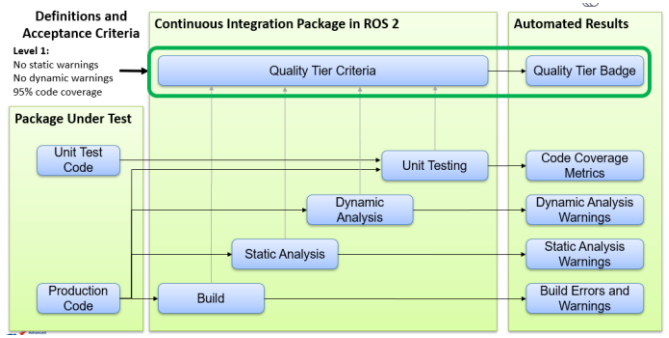
review

Quality Badges & Dashboard GUI

Quality Level 1

Using Codacy as an example

Test Results / Metadata / Reviews



Projects On Robotics Middleware Framework (RMF)

1) Physical Trial Project

- ROS-Industrial AP collaborate with industry partners to deploy RMF physical trial **to enable scalable and autonomous operations for facilities management**

2) Focused Technical Project (FTP)

- ROS-Industrial AP Consortium members collaborate **to develop enhancements required to adopt RMF for manufacturing industry**

Project Outcomes:

- **Connectivity** to brownfield systems
- **Interoperability** between robots and edge devices
- Task and fleet **scheduling**
- Enterprise **Integration**
- Performance **Benchmarking**
- **Optimized** task allocation
- Automatic retreat for battery charging
- **Single dashboard** for different brands of robots

Significant portions of project will be **Open Sourced**

Image Source: roboticsandautomationnews.com

ROS bootcamp and ROS2 Trainings updates

A 5-day boot camp was held in **March** for **16 Singapore Poly students** to get them started in ROS, and the event ended with a competition between the students on **autonomous navigation of turtlebot** thru a tricky maze!

A 3-day training workshop was curated and delivered to ROS-Industrial AP consortium members in **March** on **ROS 2 basics**, **EPD** and **EMD**.

13 participants from **7 companies** participated, provided them with an in-depth technical explanation of the **working principles** for each of the packages

Register for the Next Upcoming Training (Scan the QR code)

- ROS-Industrial Developer training is taking place 13th - 16th Sep
- ROS-Industrial Developer's meeting is taking place 14th Sep

For any enquiries related to our current or upcoming trainings, e-mail us at ros-i_asia@artc.a-star.edu.sg

Future ROS 2 Training Packages

ROS2 Basics
Middleware, DDS, Unified API
ROS2 Structure, computation

Navigation2

Navigation2
Mapping, Simulation of mobile robot thru Gazebo and SLAM, Integration of sub-systems

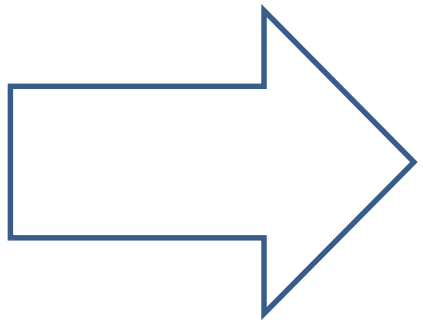
Easy_Perception_Depolyment(EPD)
Object detection, classification, tracking and accurate positioning module,

Easy_Manipulation_Depolyment(EMD)
Flexible and fast grasping library for multiple types of end effectors with integrated collision avoidance capability

Bootcamps for Students

ROS-I Members Training

Public Training



Physical Platform

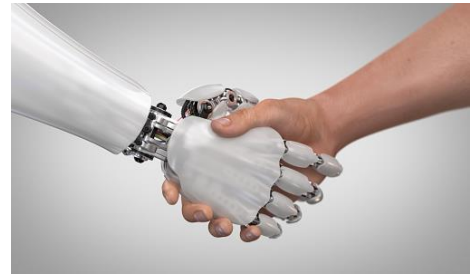
Digital platform - Via AWS Robomarker, EC2 computing environment

Key focus for year 2022

- Continuing the effort on accelerating **industry adoption** and **implementation** of **ROS2 modules**

- Focused Technical Project on **Mobile Manipulation** applicatio

- Continuing the effort on **ROS outreach** and support **Robotics Initiatives** for Asia Pacific



Thank you!