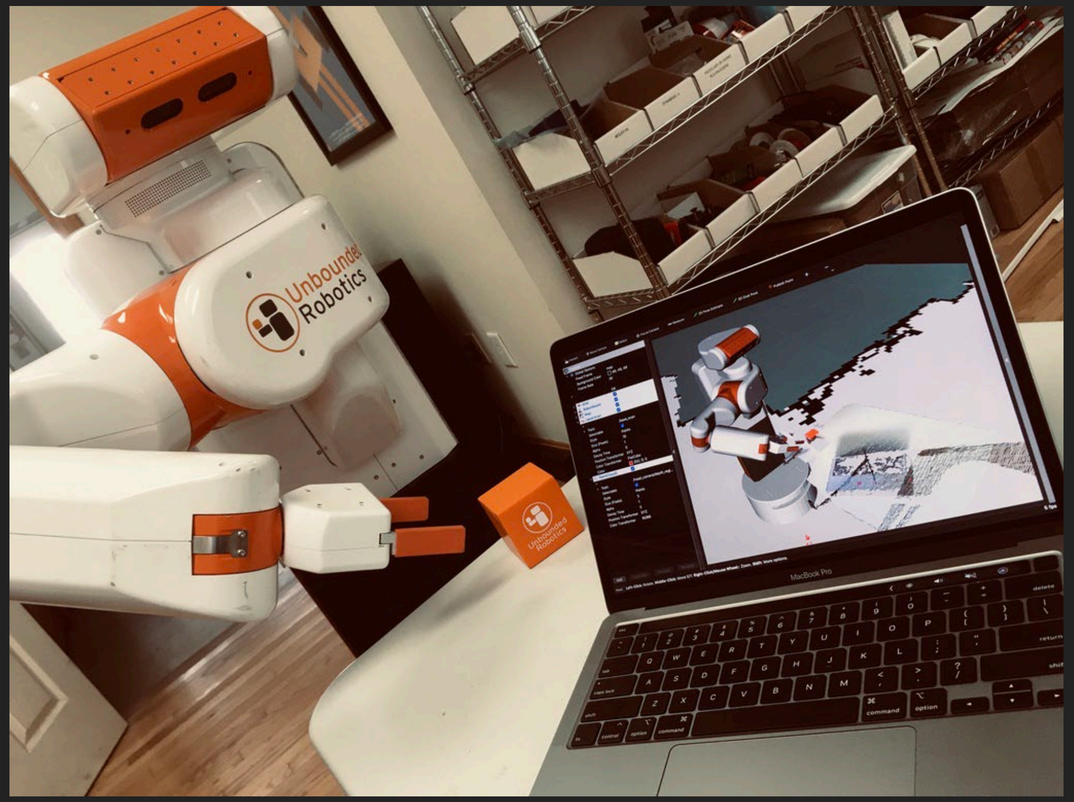
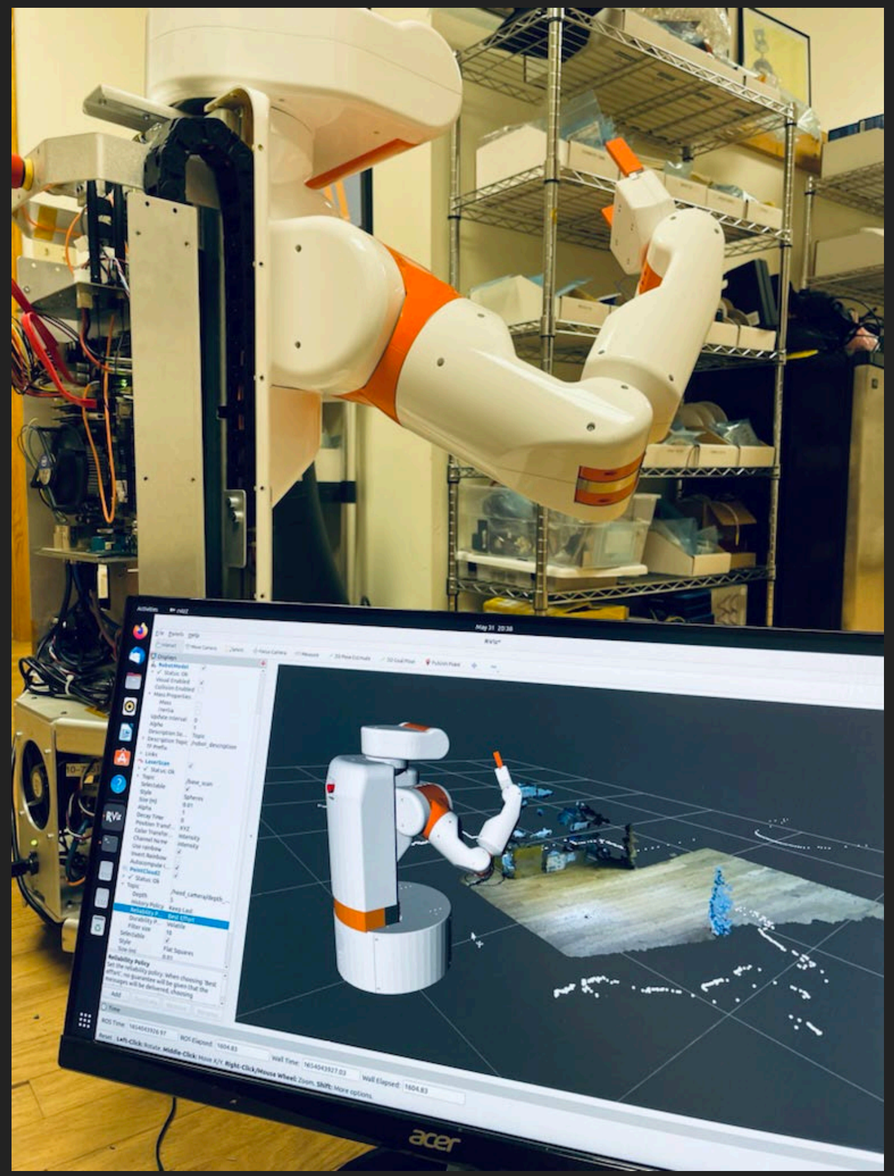
MICHAEL FERGUSON



MIGRATING A MOBILE MANIPULATOR TO ROS 2

TALK OVERVIEW

- Mobile Manipulation
- What is the UBR-1?
- ROS 1 - > ROS 2: Challenges and Features
- Essential Tools for Mobile Manipulation in ROS 2



UNBOUNDED ROBOTICS UBR-1

- 2013: Co-founder, CTO
- 2014: Company bankrupt
- …
- 2020: Robot appears on Craigslist

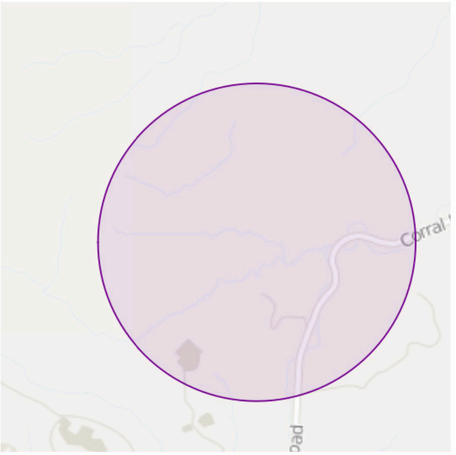
CL stockton > for sale > electronics - by owner

favorite hide flag Posted about 13 hours ago on: 2020-04-25 16:29

Contact Information:

Robot prototype - $5000 (Tracy, CA)

image 1 of 10



condition: **new**

This prototype robot is now for sale.
It worked when it was put in the box and is from a failed robotic company.
They were going to sell them for $50,000 and this prototype is yours for the low price of $5,000.
There may be some spare parts too.
This robot comes with his (her) own storage box.
I believe the lithium battery needs to be recharged at this point.

QR Code Link to This Post

SAVE THE ROBOTS: MORE THAN JUST A BEER NAME

- Updated from Indigo->Melodic
- Melodic->Noetic: Python3
- How hard can it be to go to ROS 2?
- 4 years later - giving this talk!

ROS 1 - > ROS 2

- More than just an API change
  - Different threading models
  - More fully featured (but also more complex/verbose)
  - Some late arriving features (lazy subscribers, etc)
- Many packages took the opportunity to largely re-write/re-architect (ex: Nav2)

UBR-1 ON ROS2 TIMELINE

- Started with ROS 2 Foxy / 20.04
- Ported to Humble / 22.04
- Ported to Iron
- Ported to Jazzy / 24.04

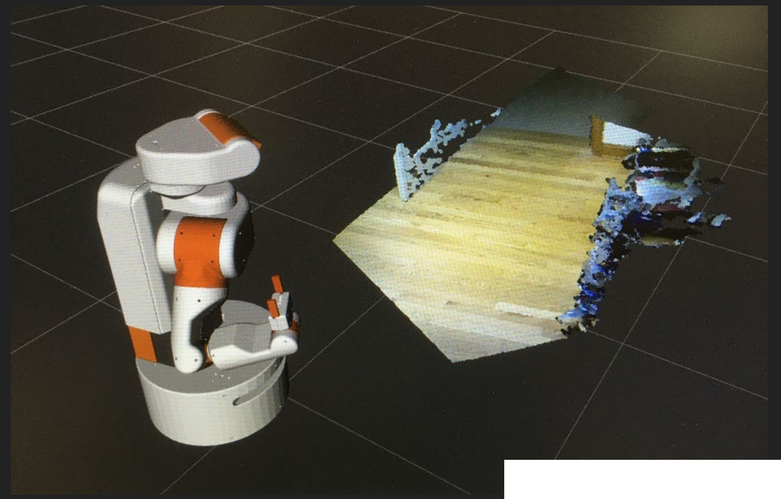
USE DOCKER/ROCKER TO OVERCOME OPERATING SYSTEM MISMATCH

HARDWARE DRIVERS IN ROS2

- Still a bit like the wild west!
  - Some are not merged into mainline - have to find the random fork! Stack Exchange and forums help to find these.
  - Some are not released into Debian packages!
  - Some features still arriving (lazy subscribers)!
- I ended up becoming maintainer of urg_node, openni2_camera packages.

PORTING OPENNI2_CAMERA TO ROS 2

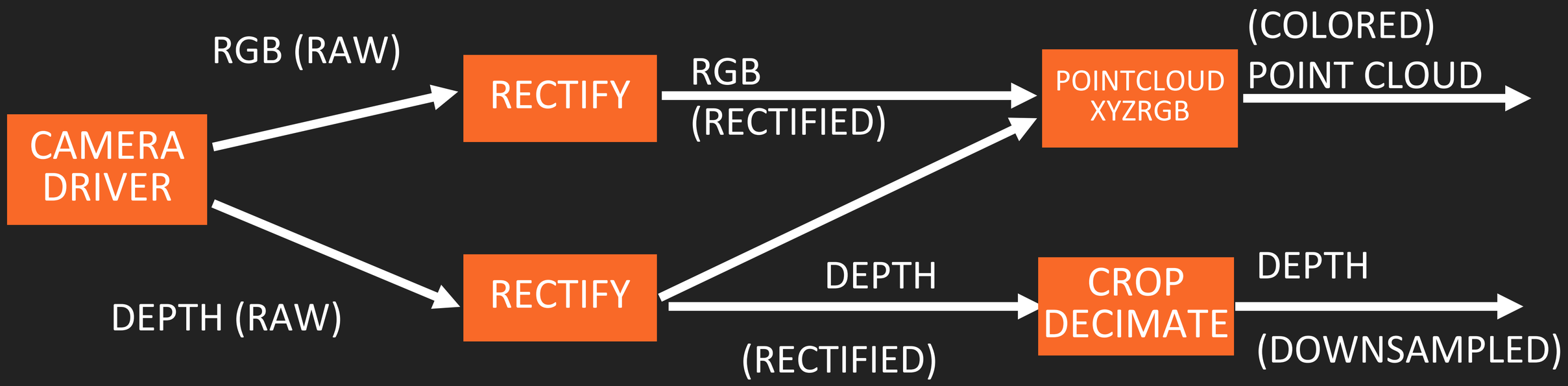
- Nodelets -> Components (well documented)
  - Derived from rclcpp::Node::SharedPtr
  - shared_from_this() limitations
- Lazy subscribers - added in Iron/Jazzy. Workaround with timers.
- openni2_launch still not ported



FULL WRITE UP:

IMAGE PIPELINE

- Transform and preprocess image data
- Proper ROS 2 components (were nodelets in ROS 1)
  - Easier to introspect and debug - same performance boost!

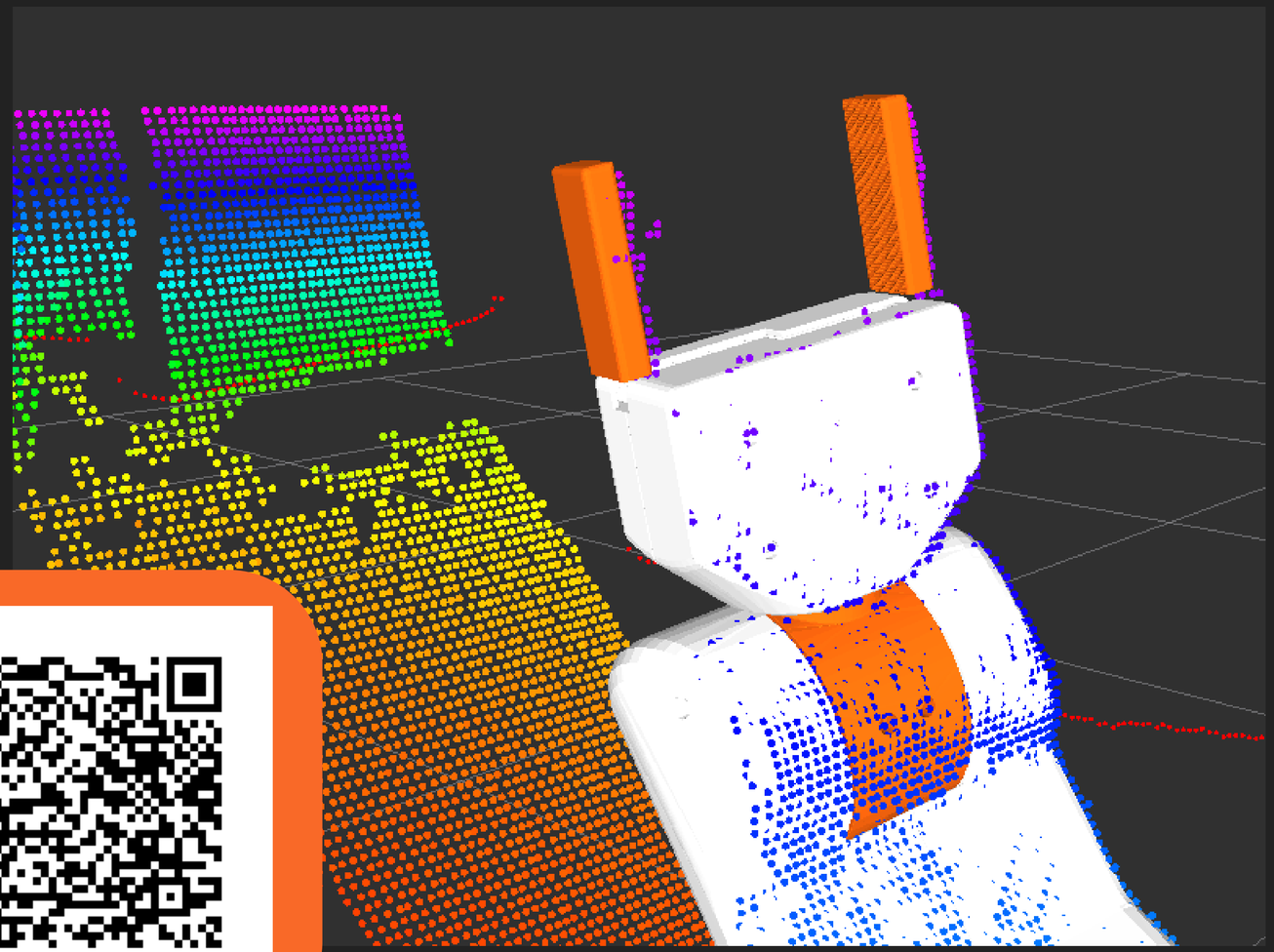


LAUNCH FILES

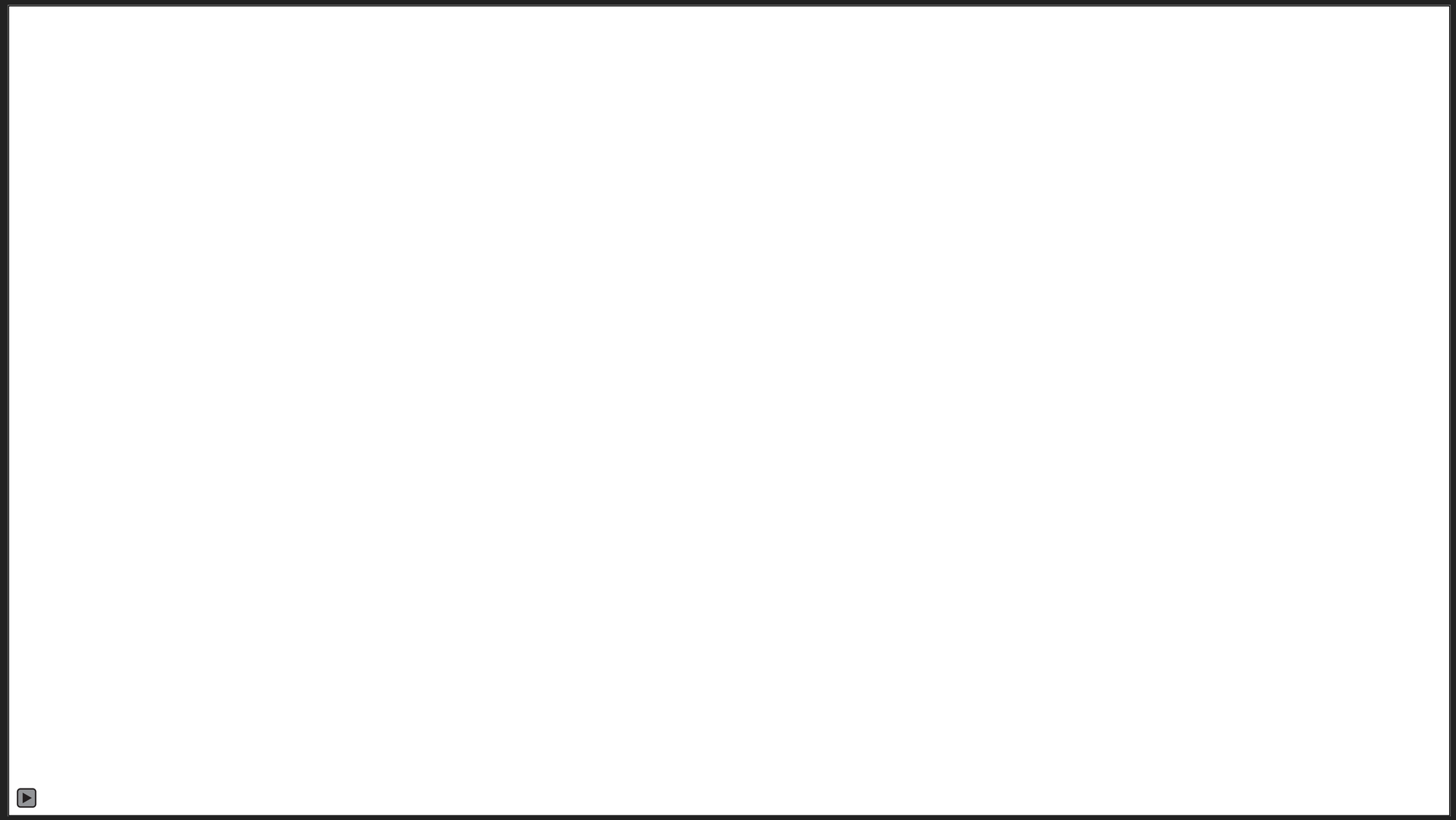
- Python-based launch files:
  - Awesome for complex robots!
  - Can be overly verbose.
  - Somewhat poorly documented…

ESSENTIAL MOBILE MANIPULATION TOOLS: CALIBRATION

- camera_calibration
- robot_calibration
- Update all sorts of API when migrating to ROS 2
  - Parameters had to change format due to XML arrays
  - See ros2_cookbook:



ESSENTIAL MOBILE MANIPULATION TOOLS: CALIBRATION



ESSENTIAL TOOLS: MAPPING AND LOCALIZATION

- Some mapping packages not ported to ROS 2 (slam_karto)
- slam_toolbox does a very good job of mapping
  - Maps are “transient local” (what was “latched” in ROS 1)
  - Had to manually adjust the free_thresh for map to look correct
- Some notes on tuning AMCL on my blog

ESSENTIAL MOBILE MANIPULATION TOOLS: NAVIGATION

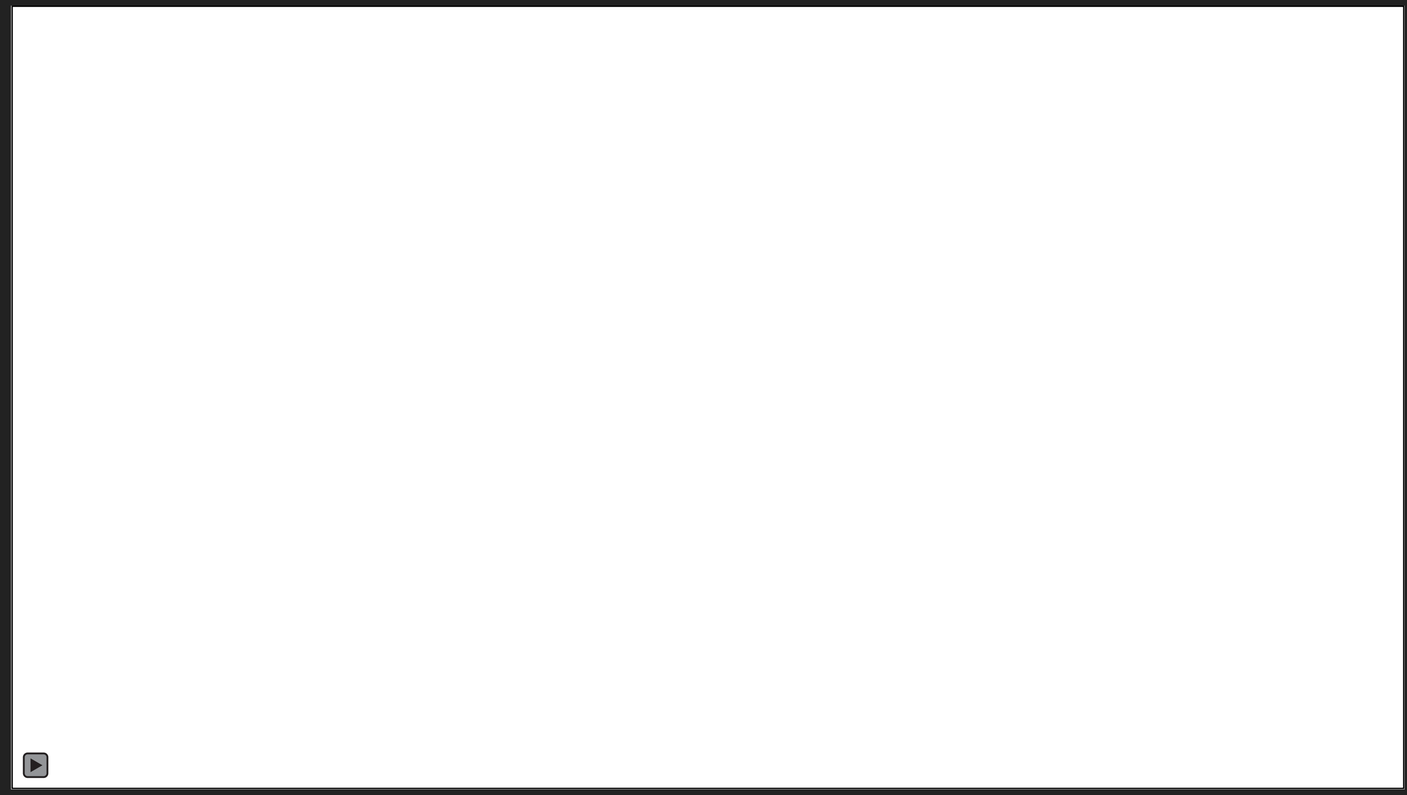
- Nav2 is a major rewrite of the ROS 1 Navigation Stack
- Behavior Trees allows changing the behavior of what used to be move_base
  - No longer just plan, control, recover
  - Newly added features like auto docking (See Steve Macenksi's talk at 4:40)

NAVIGATION: CUSTOM CONTROLLERS

- UBR-1 uses graceful_controller, porting to ROS 2 involved:
  - Changes to how parameters are defined, since they used to be loaded via XML arrays.
  - Updates for different controller API.
- Fairly straight forward - and new controller has less code thanks to external components like goal checker (leads to less code duplication between controllers).

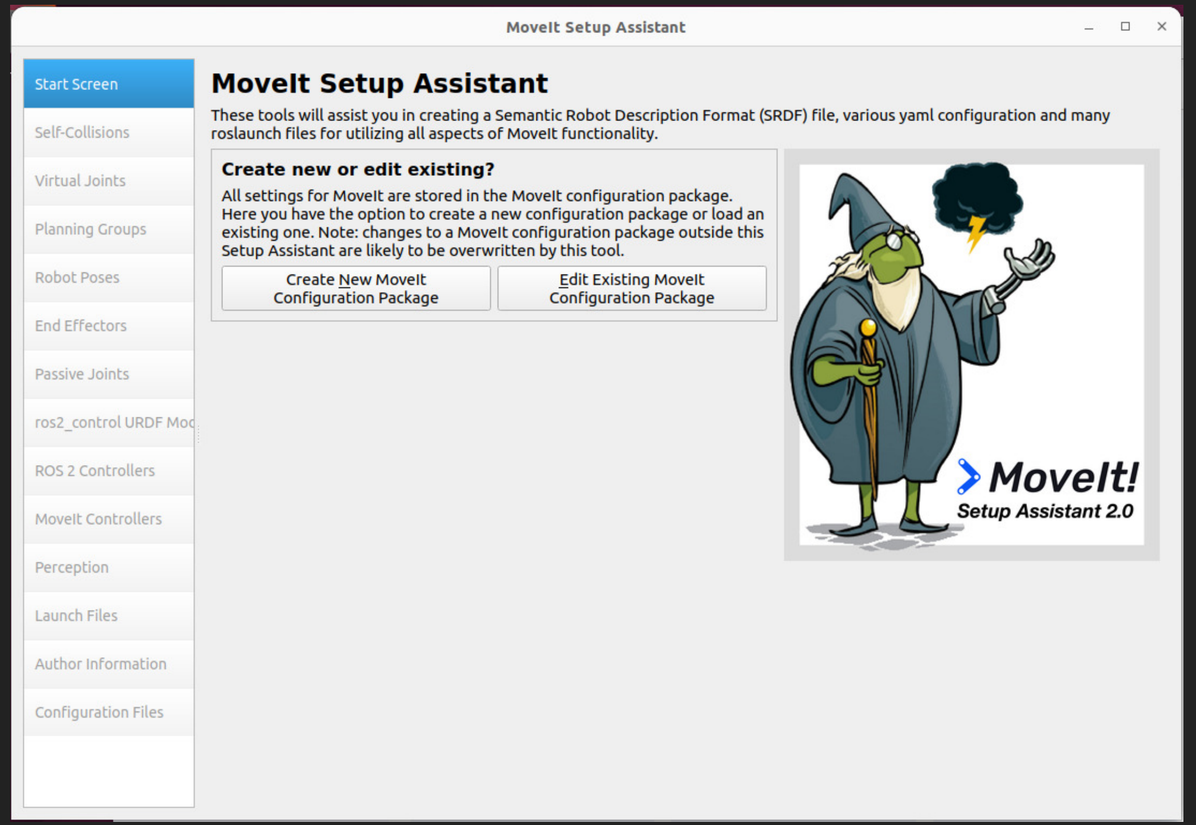
NAVIGATION: CUSTOM COSTMAP LAYERS

- Mobile manipulator wants to tilt head up and down while navigating in order to get better field of view from sensors
- Timing isn’t always perfectly aligned - need to find the ground plane and remove it for better performance

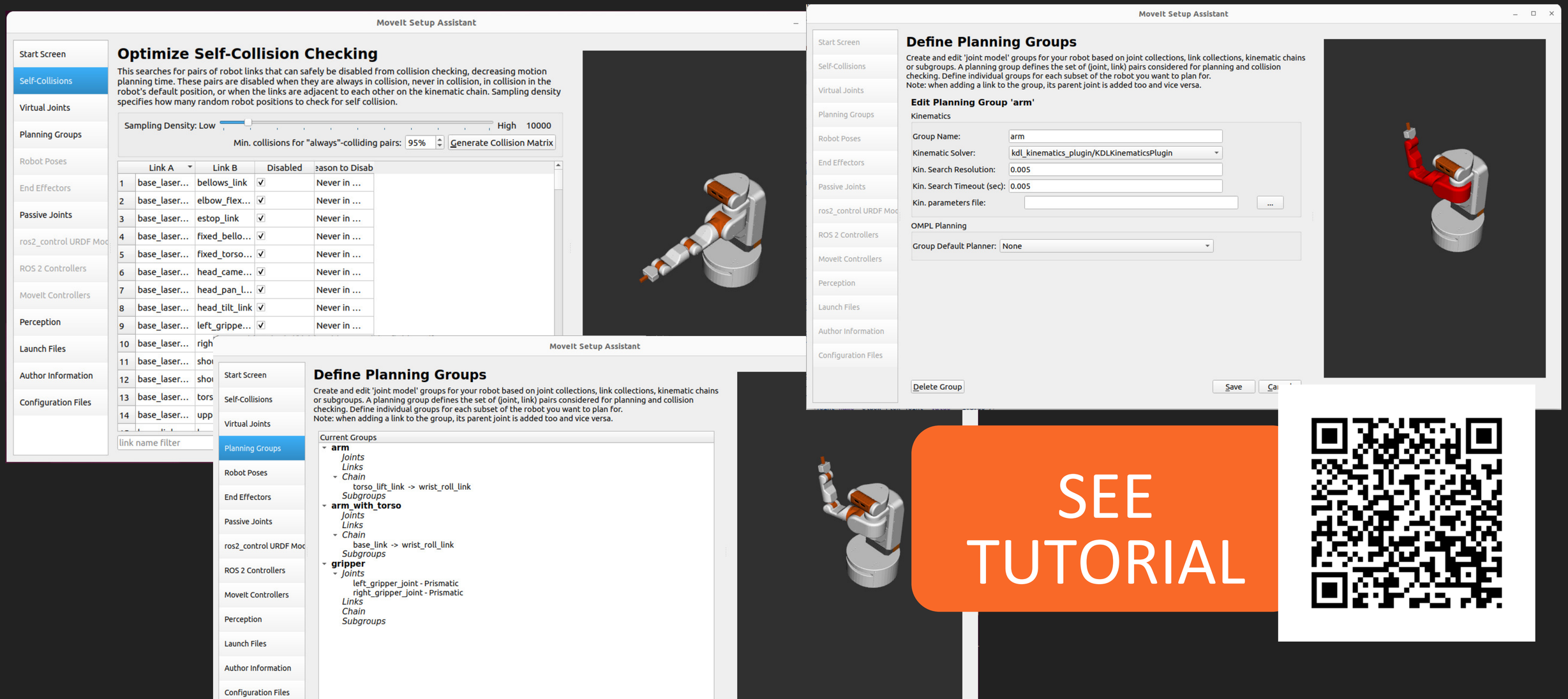


ESSENTIAL MOBILE MANIPULATION TOOLS: MANIPULATION

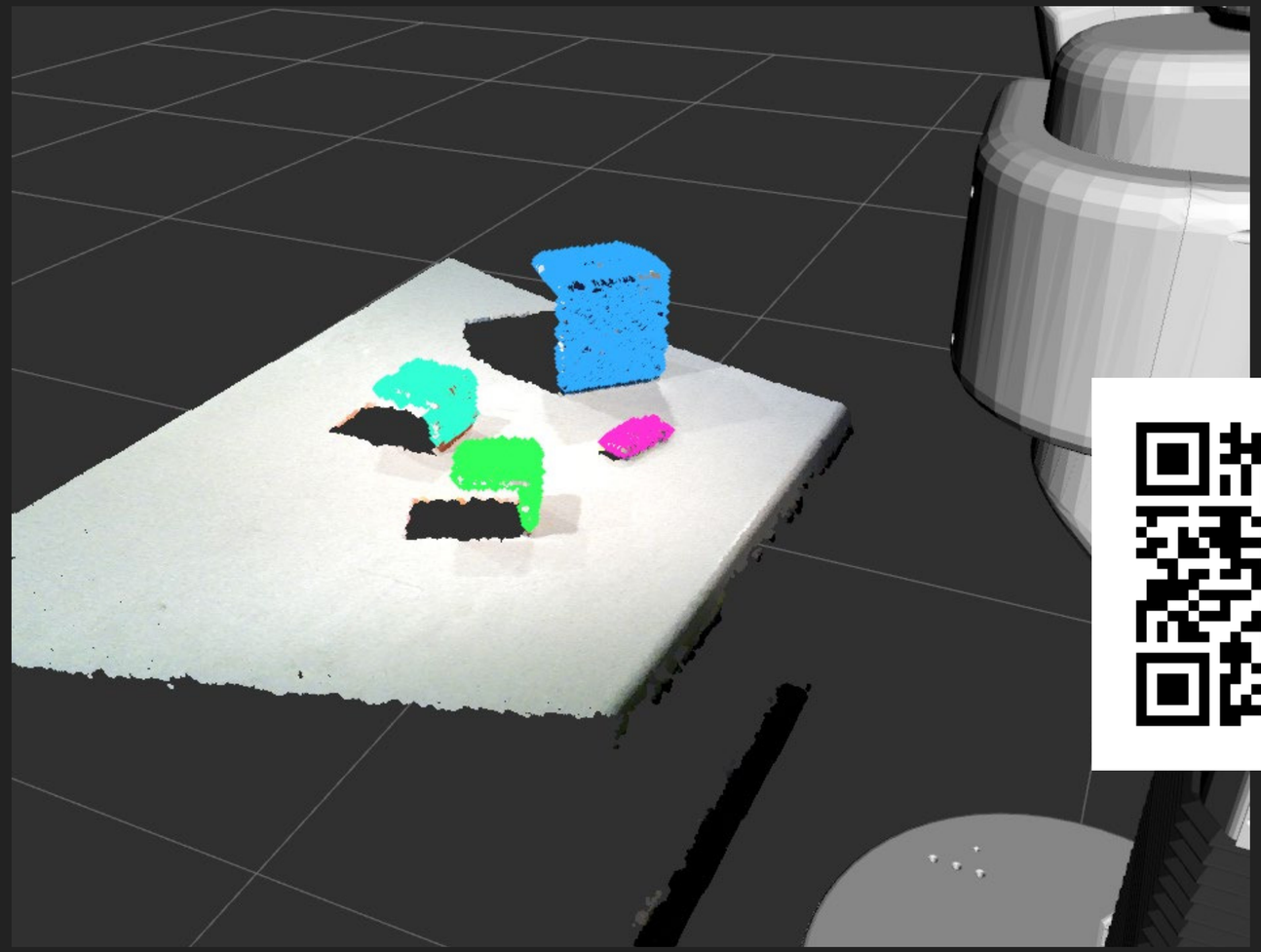
- MoveIt2 - heavy changes to API from ROS 1
- Pick & Place => MTC
- Setup Assistant now available!

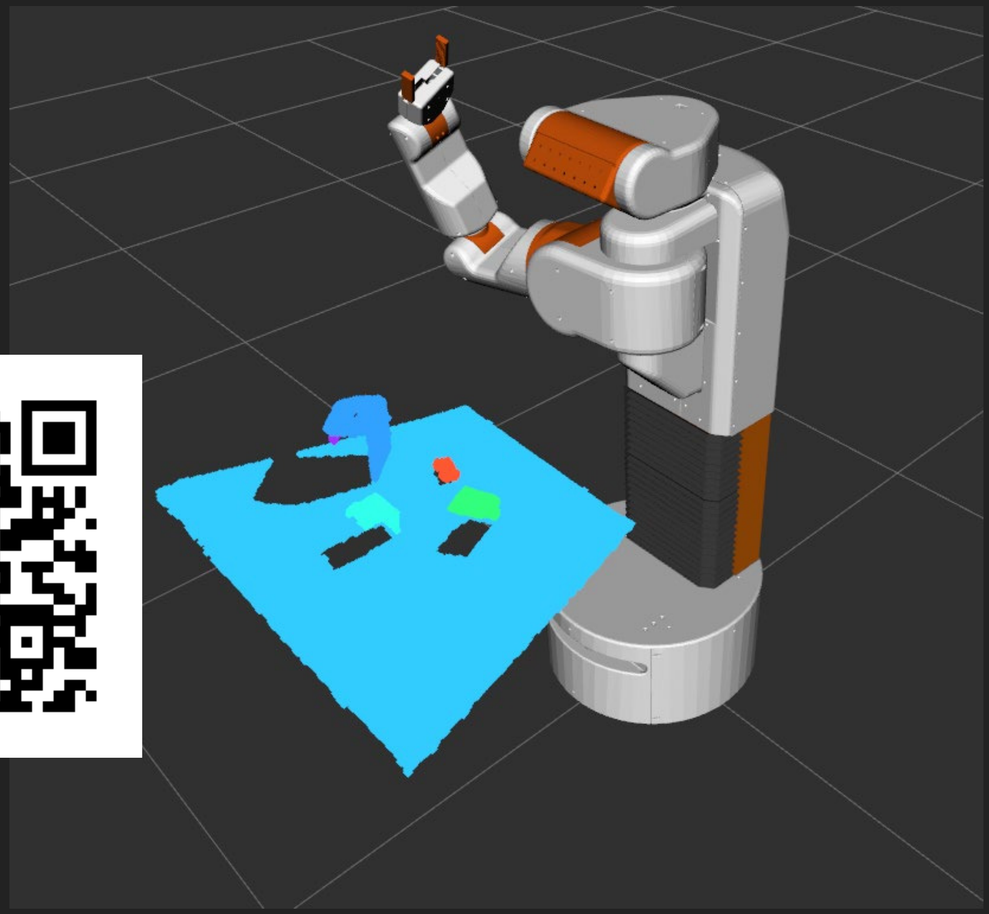


ESSENTIAL TOOLS: MOVEIT SETUP ASSISTANT



ESSENTIAL TOOLS: SIMPLE GRASPING





ESSENTIAL MOBILE MANIPULATION TOOLS: MOVEIT2

ROS 2: CONTINUED STRUGGLES

- QoS and DDS Reliability
  - Maybe Zenoh? Help test it!
- Documentation is scattered/sparse

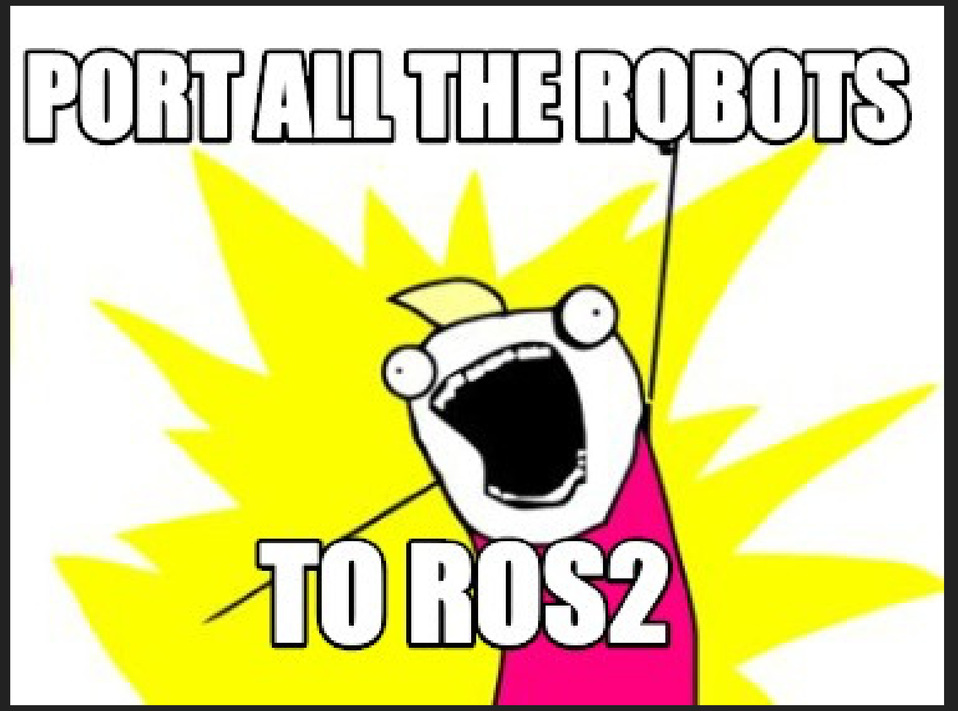
ros2_cookbook Public

Pin | Unwatch 21 | Fork 93 | Star 816

- Client Libraries
  - rclcpp API
    - Logging
    - Nodes and Components
    - Parameters
    - Point Clouds
    - Time
    - TF2
    - Workarounds
  - rclpy API
    - Nodes
    - Parameters
    - Time
    - TF2
- ros2launch
  - Python-Based Launch Files
  - Making a Launch File Executable
  - Loading Parameters From a File

FUTURE WORK

- UBR-1 MoveIt2 Blog Post: Posted Now!
- UBR-1 on Jazzy: In Progress
- New Gazebo Simulation
- Actual mobile AND manipulation AT THE SAME TIME



RESOURCES

http://www.robotandchisel.com/roscon24

Michael Ferguson