

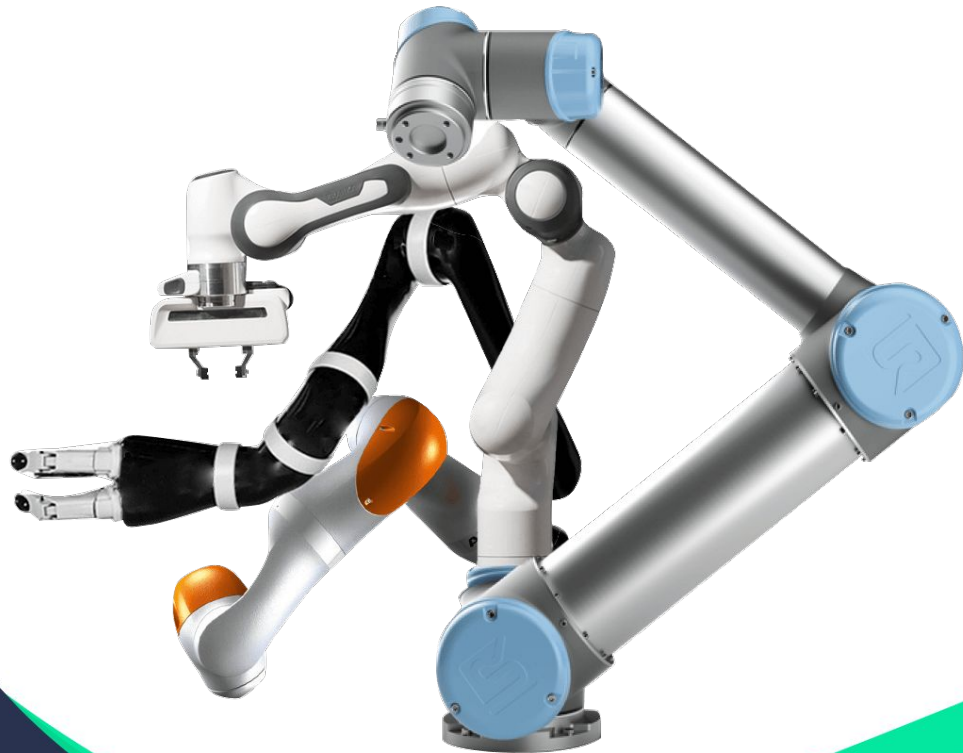


An Affordance-Driven, Human-in-the-Loop Perception Framework

SBIR Phase II Progress Update

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Movelt Studio Developer Platform

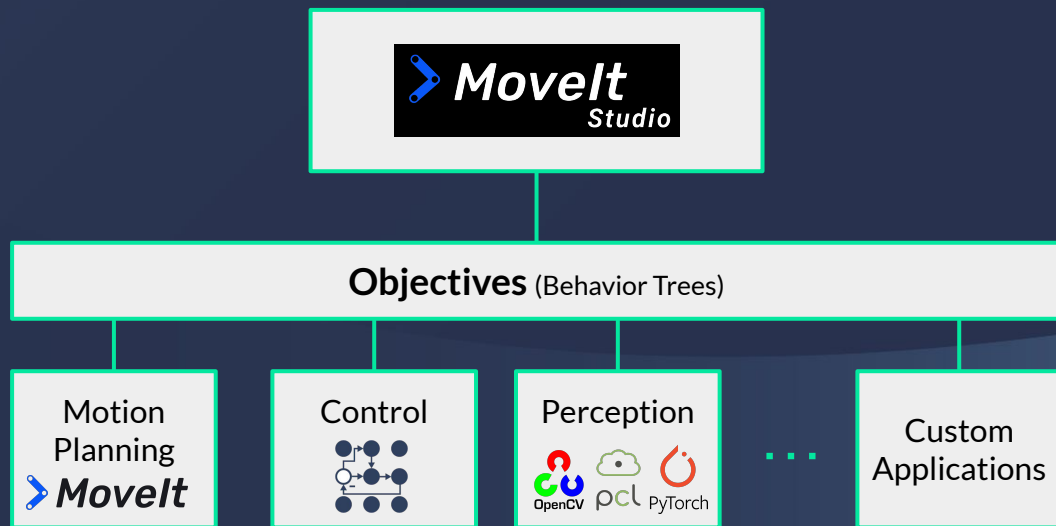




Introduction to MoveIt Studio

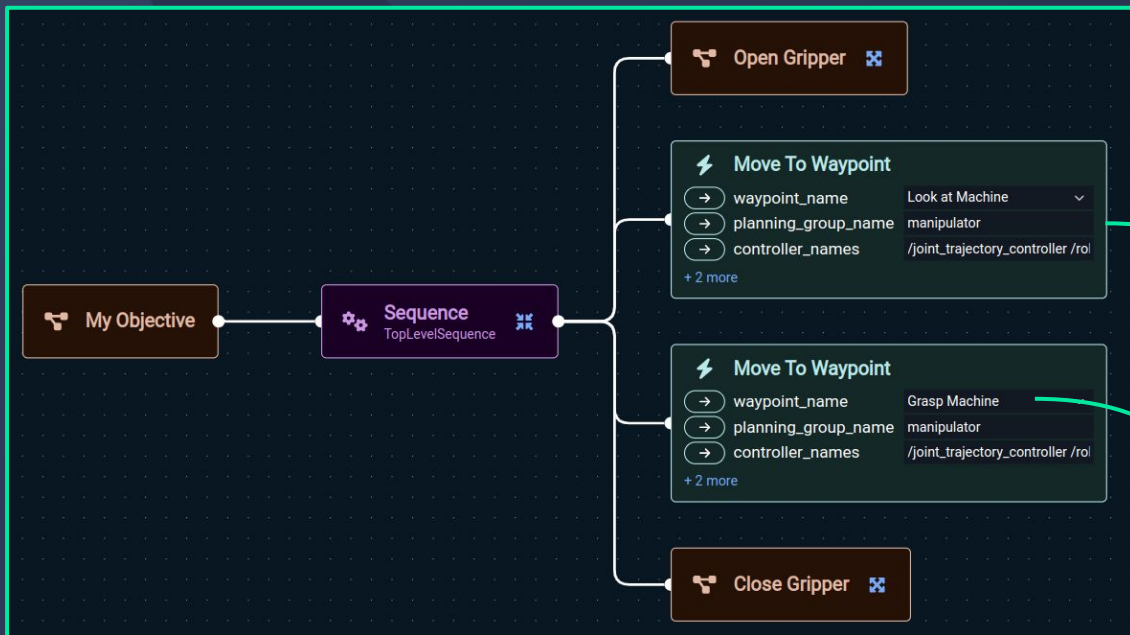


- **Graphical tools and SDK**
Enables developing robot autonomy and remote operation applications
- **Behavior Tree execution engine**
Manages state of **Objectives** representing different “skills” for your robot
- **Connected to ROS 2 ecosystem**
Extensively uses standard tools including **MoveIt** and **ros2_control**
Integrate custom code as ROS 2 packages





Movelt Studio Jargon 101



Objective

A Behavior Tree representing a complete "task".

Behavior

An individual behavior tree node that performs a specific "skill".

Waypoint

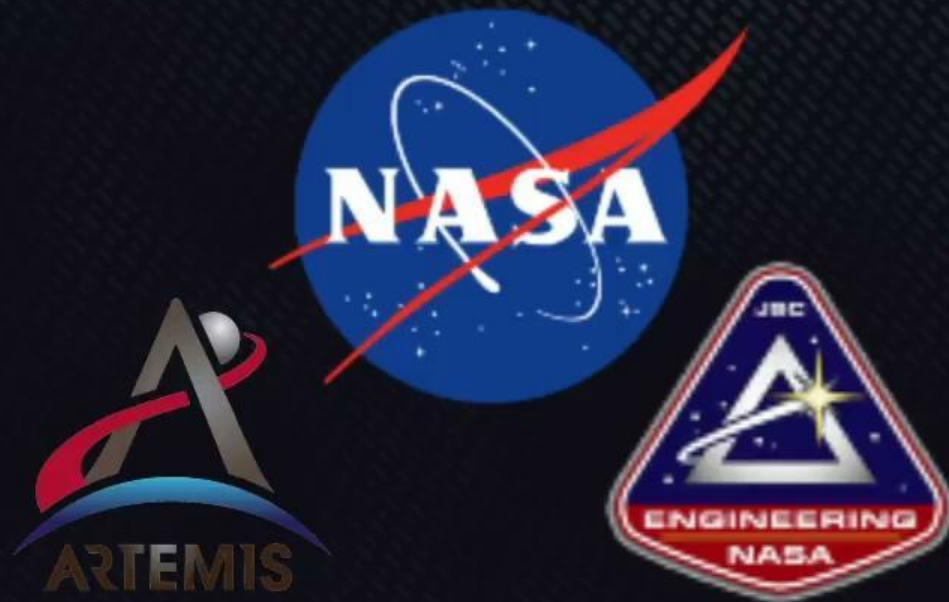
A named joint state that can be saved and used in Objectives.



Opening a Door

INTRA-VEHICULAR ROBOTICS (IVR) LOGISTICS DEMONSTRATION

ROBOTIC MOVEMENT OF CARGO TRANSFER BAGS FROM A HATCH TO A STOWAGE AREA.



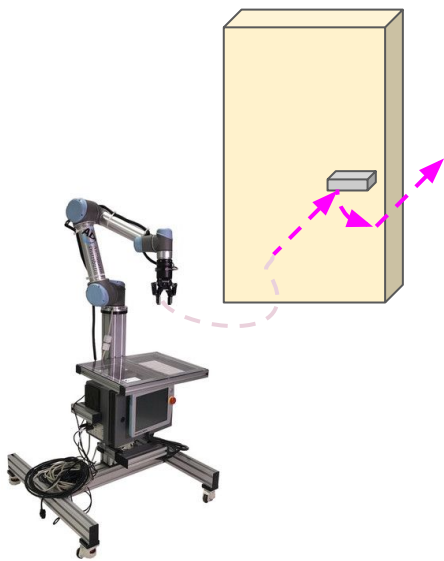
NASA JSC ENGINEERING IMETRO FACILITY

Phase I Recap / Phase II Progress



What is “Affordance-Driven” and “Human-in-the-Loop” to us?

Affordances on objects can guide task and motion planning for (semi-)autonomous systems.



Manipulation task: e.g., Door opening



Inspection task: e.g., Hatch seal inspection



Phase I Recap

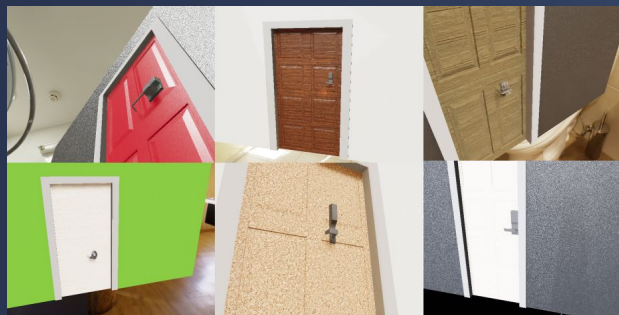
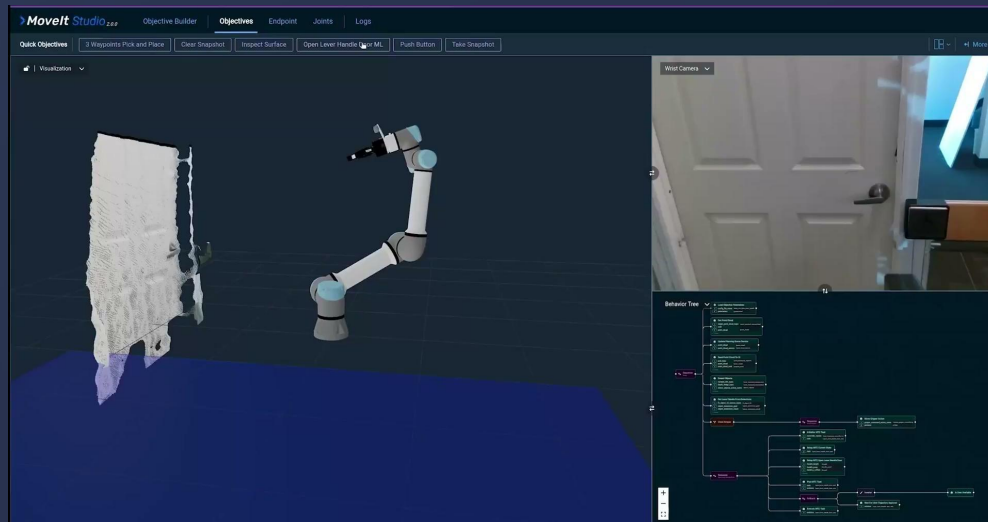


Introduced ML based perception to existing manipulation tasks

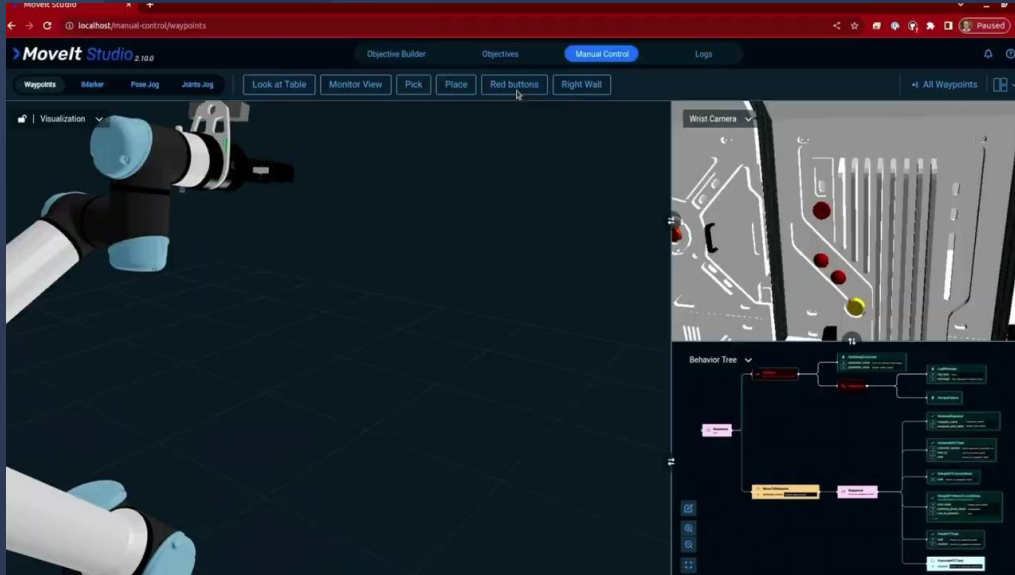
- Replaces user clicks with object detections from trained models.

Explored synthetic data generation from simulation

- Developed ROS 2 control interface to NVIDIA Isaac Sim.
- Developed basic pipeline for synthetic data generation with NVIDIA Omniverse Replicator API.



Phase II Progress: Commercialization of ML Efforts



ROS 2 Action Server

User's Object
Segmentation
Model

Contract:
ROS 2 action
definition

"Find Masked
Objects" Behavior

MoveIt Studio Objective

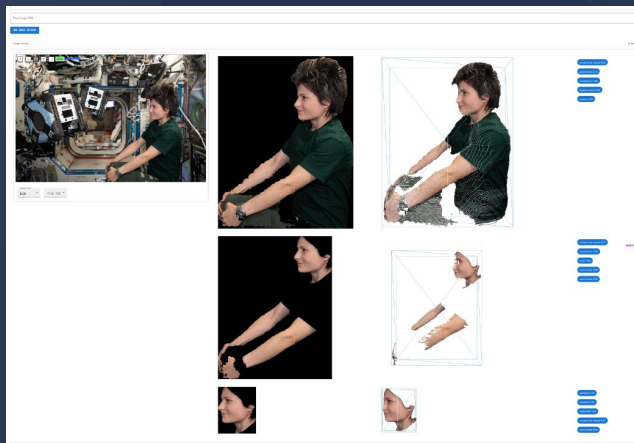


Phase II Progress: Foundation Models for Human Prompting



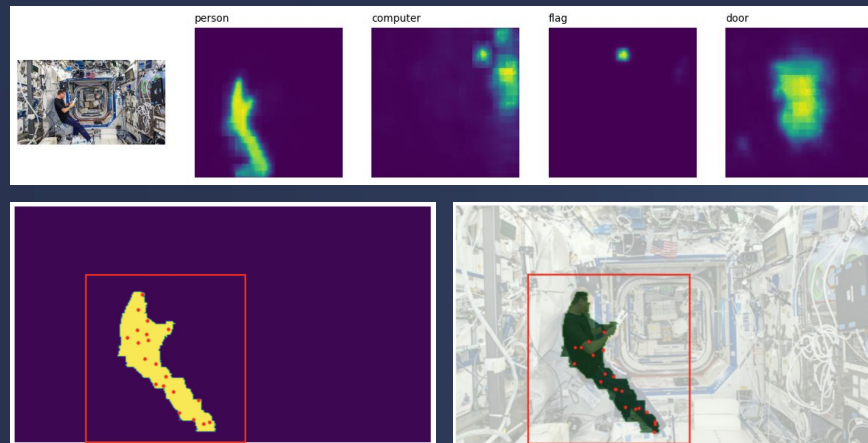
Segment Anything Model (SAM)

Accepts user prompts as collections of points, bounding boxes, or a combination of both.



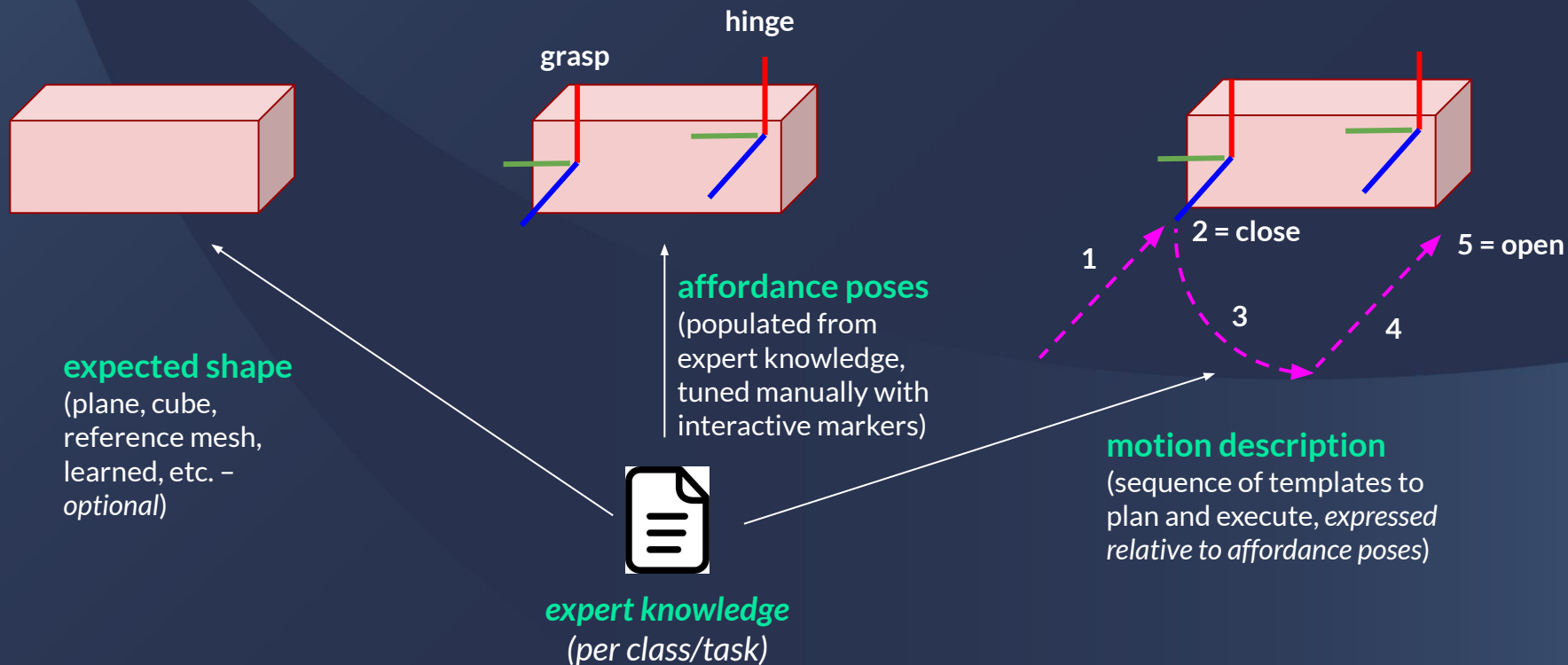
SAM + CLIP

Prompts can come from multimodal vision + language models, enabling user input in natural language.





Phase II Progress: Objects → Affordances → Motion Plans



Towards Astrobees





Towards Astrobee



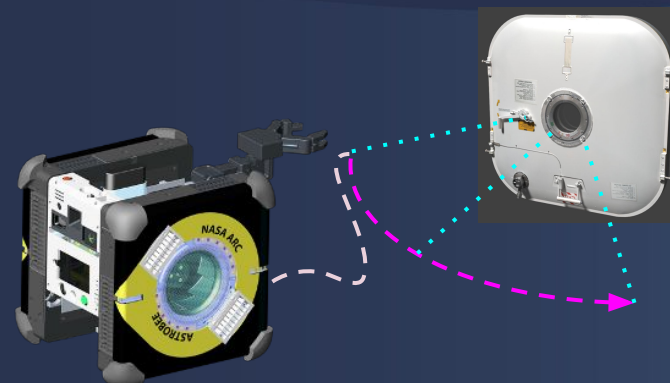
Stand up MoveIt Studio configuration for simulated Astrobee

- MoveIt Studio exclusively uses ROS 2: can assist with porting components to ROS 2, or alternatively use the ROS 1 Bridge.
- Create new Behaviors that wrap around the Astrobee command API for base/arm motion.

ML based affordance detection for IVR related inspection tasks

Aiming for hardware experiments

- Phase II targeted to culminate with 3-DOF experiment in the Ames Granite Lab.
- Submitted proposal to CASIS to conduct ISS experiments.



Thank You!

