MoveIt

Workshop 2019 Macau

Sponsored by aws PICKNIK ROBOTICS

MoveIt

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Sponsored by aws PICKNIK ROBOTICS

Thanks to our current maintainers!

Robert Haschke	CITEC, Bielefeld University
Michael Görner	University of Hamburg
Isaac IY Saito	Plus One Robotics
Ian McMahon	Toyota Research Institute
Gijs van der Hoorn	Delft Univ. of Tech / ROS-I
Jorge Nicho	SwRI / ROS-I
Bence Magyar	Heriot-Watt University
Mike Lautman	PickNik Robotics
Jon Binney	Iron Ox
Henning Kayser	PickNik Robotics
Bryce Willey	Realtime Robotics
Mark Moll	PickNik Robotics
Dave Coleman	PickNik Robotics

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Thanks to our many contributors!

Original Team

Sachin Chitta	Kinema Systems
Ioan Sucan	Google X
Dave Hershburger	Kinema Systems
Acorn Pooley	SRI International

Core Contributors

Michael Ferguson	Independent Consultant
Zak Kingston	Rice University
Felix von Drigalski	OMRON SINIC X Corporation
Simon Schmeißer	isys vision
William Baker	Houston Mechatronics
Andy Zelenak	PickNik Robotics
Mohmmad El khzragy	TUM
Kei Okada	JSK Lab, Univ of Tokyo
Martin Günther	DFKI
Shingo Kitagawa	JSK Lab, Univ of Tokyo
Yan Yu	Intel
Víctor Mayoral	Acutronic Robotics
Anas Mchichou	Acutronic Robotics
Levi Armstrong	SwRI / ROS-I

Organizing Committee for MoveIt Workshop

Rob Coleman

Tahnee Foley

Dave Coleman

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Schedule

- *9:00* **Welcome**
  - *Invited Talks*
- *10:00* **Coffee / Tea Break 1**
  - *Invited Talks*
- *12:30* **Lunch**
  - *Panel Discussion*
  - *Group Roadmapping*
- *15:00* **Coffee / Tea Break 2**
  - *Hands on With Task Constructor*
  - *Lightning Rounds*
- **17:00 End of Workshop**

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Prep for later today

- If you have a lightning talk, please sign up and send us your PDF:
  - Sign Up: shorturl.at/dxDL9
  - Send Slides to: mike@picknik.ai

- For the optional hands-on section, pre-install MoveIt Melodic (18.04):

```
sudo apt-get install ros-melodic-moveit
git clone https://github.com/ubi-agni/moveit_task_constructor.git -b tutorial
git clone https://github.com/ros-planning/panda_moveit_config.git -b melodic-devel
```

See also **https://moveit.ros.org/install/**

- Wifi: Sheraton_Conference
  - CT9R4JQP

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Previously At ROSCon 2019

- Introducing MoveIt Grasps, a manipulation framework
  - *Mike Lautman*
- Flexible Framework for Quantitative Reachability Analysis
  - *Michael Ripperger*
- Reactive Jogger for Teleoperation and Contact Tasks
  - *Andy Zelenak, Robert G. Reid, Mitch Pryor*
- cartesian_controllers: Motion, Force and Compliance Control for Robotic Manipulators
  - *Stefan Scherzinger, Arne Rönnau*
- OpenVINO™ Acceleration for Intelligent Robot
  - *Sharron LIU, Yu YAN*
- Safety Certified ROS-native Industrial Manipulator
  - *Christian Henkel*

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Why a MoveIt Workshop?

An informal day of presentations, panel discussions, and hands-on training of latest MoveIt features.

The intended audience are primarily experienced and advanced users of MoveIt

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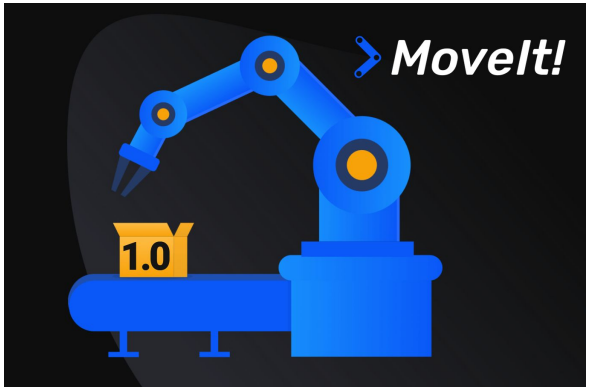
MoveIt is 8 years old!

Stable version 1.0 released this year



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Open Letter to MoveIt! Community

davetcoleman Nov '18

An Open Letter to the MoveIt! Community

Dave Coleman
8 Nov 2018

Dear MoveIt Community,

I'm writing to make some changes to the direction of MoveIt! - let's shake things up, try new things, and be less conservative in making improvements. I'm doing this because I really care about the role of open source robotics in the years to come. I envision a future where everyone has access to the economic prosperity of robotic manipulators.

A few weeks ago I attended an open source conference where I led a discussion session I titled "Stability vs Growth: Breaking API". I presented to the audience of diverse projects a problem I believe we've been struggling with in our ROS and MoveIt! community: stagnation and irrelevance. After speaking with many attendees, I came away with the belief that our now 7 year old project is stuck, making only minor incremental progress since Willow Garage shuttered its doors in 2013. Meanwhile, the robotics world has raced forward.

There are many reasons I believe MoveIt! is facing this innovator's dilemma, and I want to outline some of them here with the public declaration that we at PickNik intend to change this, with your help. We see an exciting future for MoveIt!, and we believe we can transform it from a stagnant open source project, to a globally recognized platform that enables organizations of all sizes to leverage robotics for their applications. Before I outline the solution, I want to clearly state some major parts of the problem:

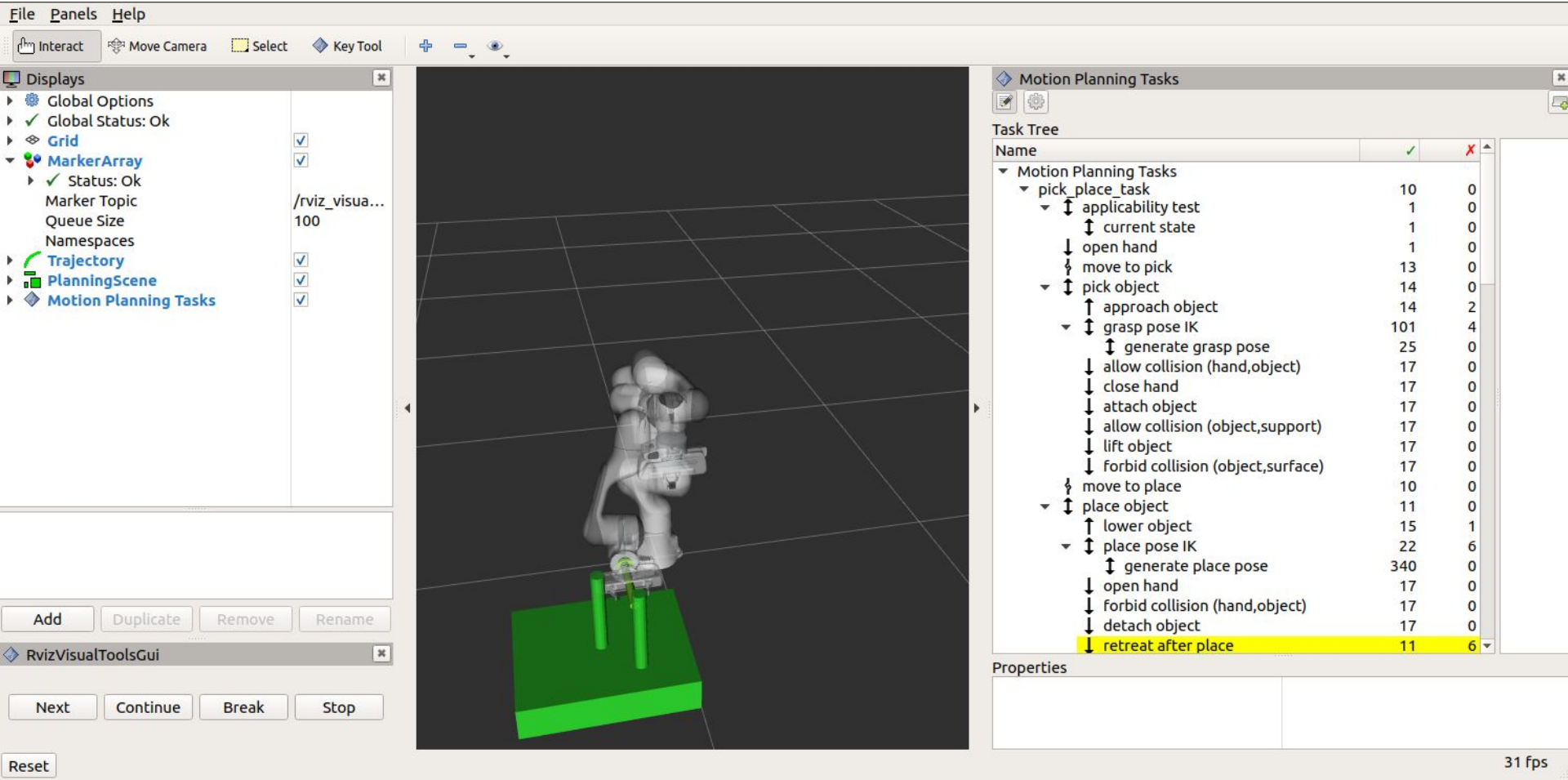
Lack of Major Versions

MoveIt! has not yet officially been declared 1.0, yet we maintainers typically take the stance that API

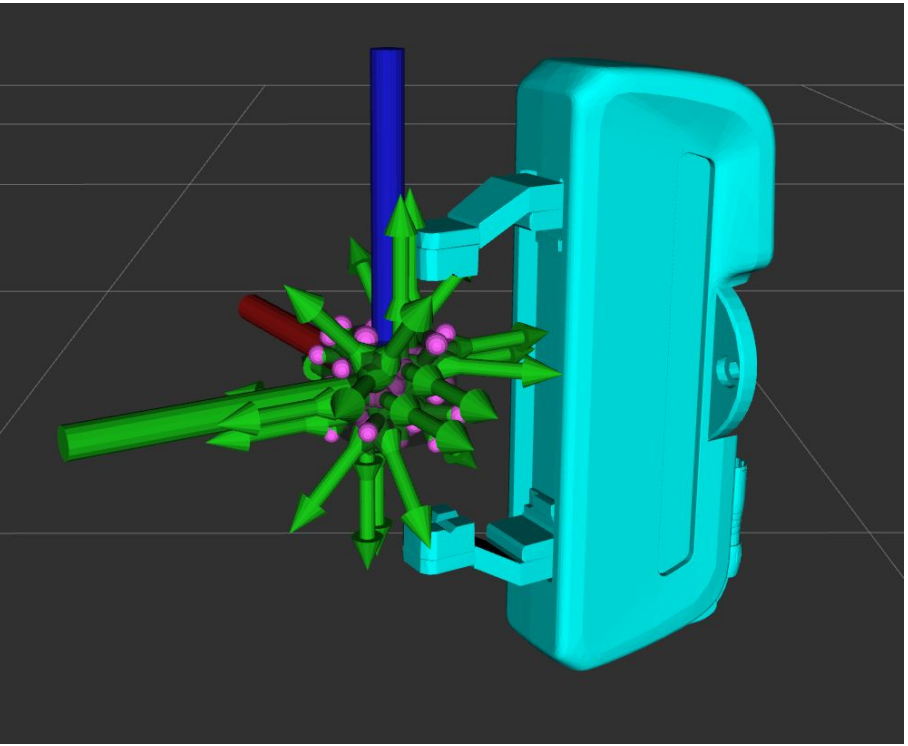
Key New Features In MoveIt Ecosystem

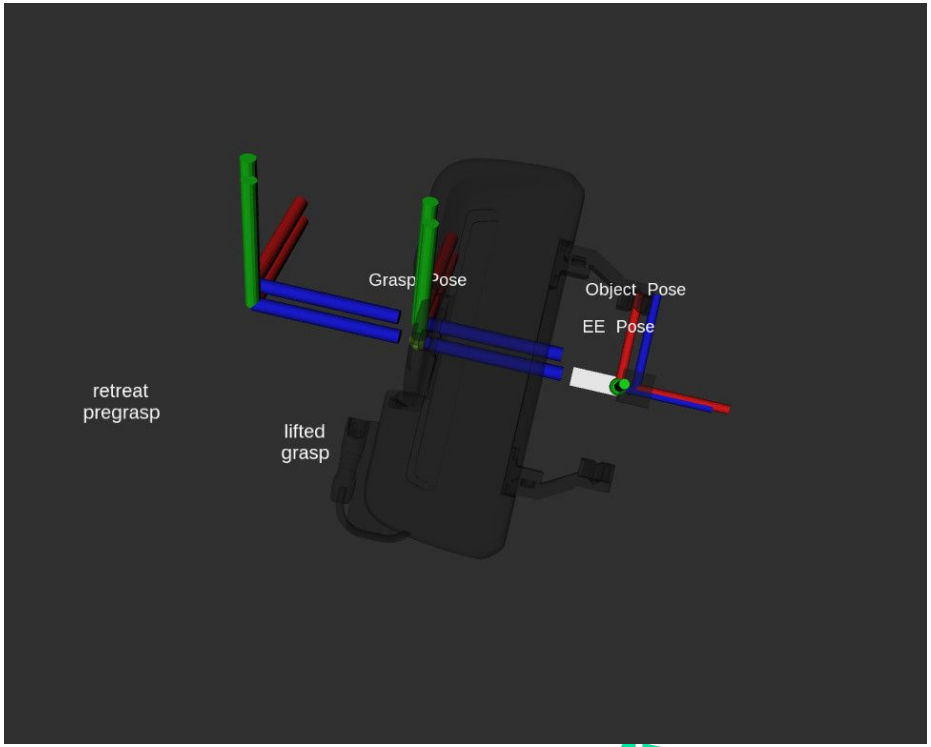
- **MoveIt Task Constructor**
  - *Task Planning*
  - *Robert Haschke, Michael Görner*
- **MoveIt Grasps**
  - *Geometric-based grasp generation*
  - *Mike Lautman, Dave Coleman*
- **MoveIt Cpp**
  - *Advanced API for performance*
  - *Henning Kayser*
- **MoveIt JogArm**
  - *Realtime teleoperation planner*
  - *Andy Zelenak*
- **CHOMP Planning Adapter**
  - *Post-proccessing of OMPL-generated plans*
  - *Raghavender Sahdev*
- **Iterative Cubic Spline Algorithm**
  - *Smoother trajectory generation*
  - *Ken Anderson*
- **Time-Optimal Trajectory Parameterization**
  - *Follow path within bounds on accelerations & velocities*
  - *Michael Ferguson, Henning Kaiser*
- **Named Frames on Collision Objects**
  - *Subframes for placing objects*
  - *Felix von Drigalski*

MoveIt Task Constructor



MoveIt Grasps





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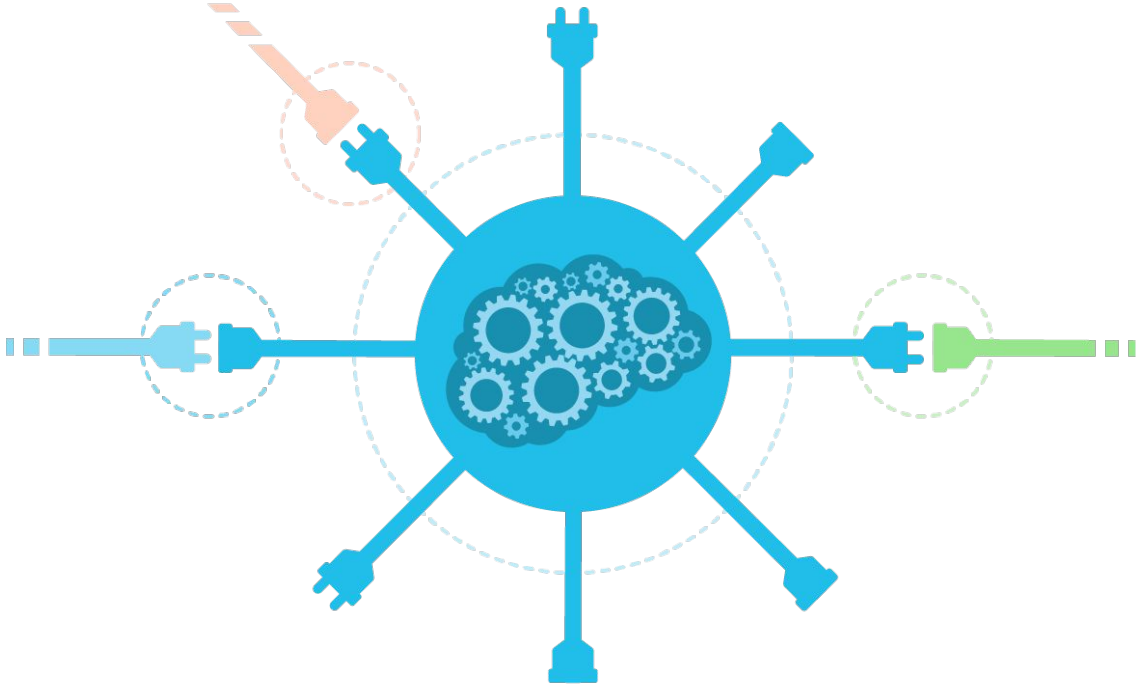
MoveIt Cpp Interface



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MoveIt JogArm

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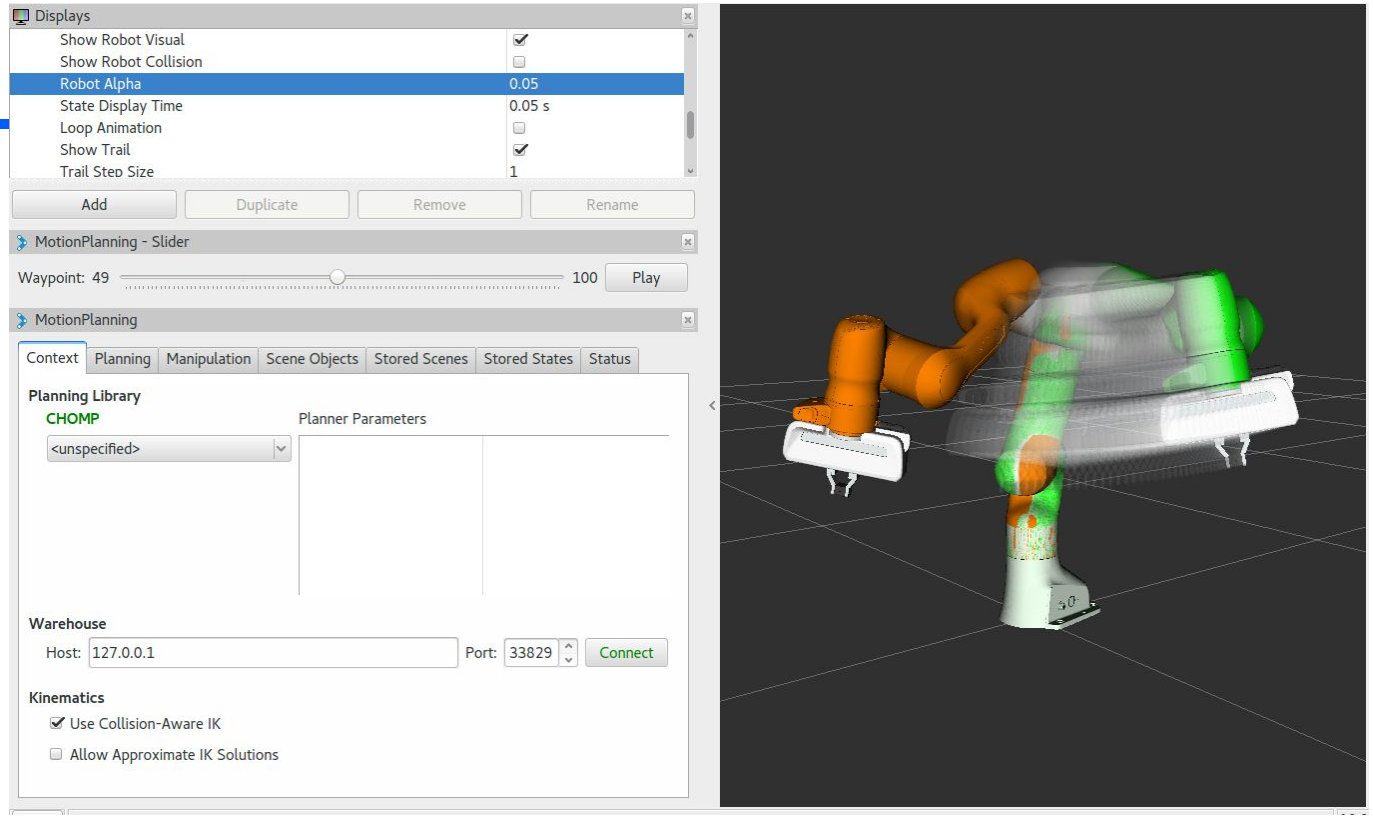
CHOMP



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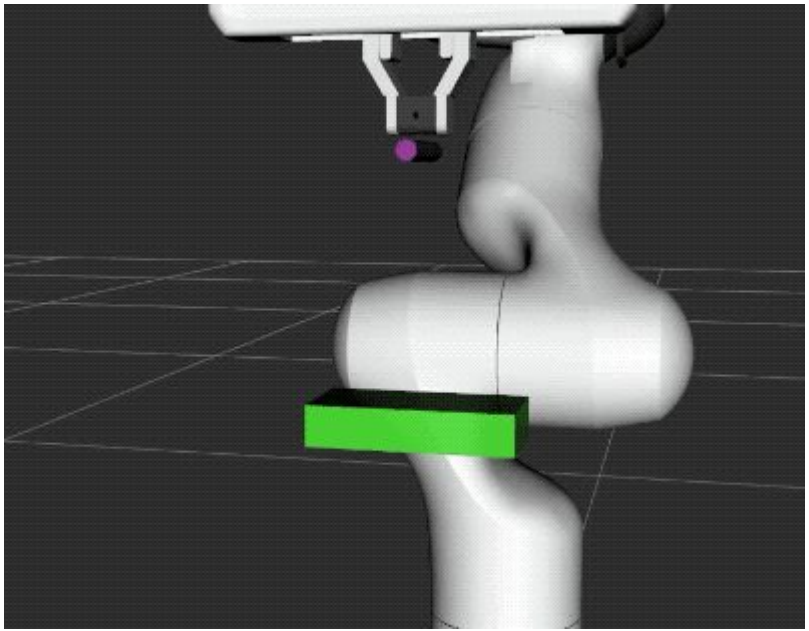
Named Frames on Collision Objects



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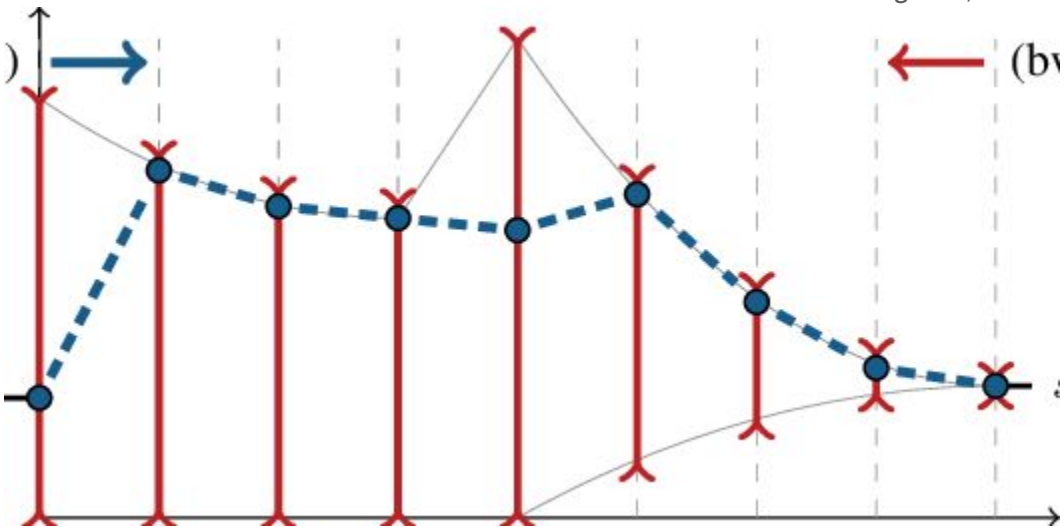
Time Parameterization

- **Iterative Cubic Spline Algorithm**
  - *Smoother trajectory generation*
  - *Ken Anderson*
- **Time-Optimal Trajectory Parameterization**
  - *Follow path within bounds on accelerations & velocities*
  - *Michael Ferguson, Henning Kaiser*



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Optimizations Based On Levi's Work

- **TrajOpt**
  - *Optimization-based motion planner*
  - *Levi Armstrong, Omid Heidari*
- **Bullet Collision Checker**
  - *Alternative motion planner*
    Jens Petit
- **Unified Collision Environment for Speedup**
  - *Combine robot and environment into one scene*
  - *Jens Petit*
- **Speedups with Eigen::Isometry3d**
  - *Faster linear algebra operations*

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Other Improvements

- Faster Inverse Kinematics Solvers
  - *Robert Haschke*
- Windows Support
  - *Special build rules from Microsoft*
- New Inverse Kinematic Solvers
  - *KDL, IKFast, LMA*
- Easier Quick Start in the Setup Assistant
  - *Setup for Gazebo and ros_control*
- Better Benchmarking Suite
  - *Improved statistics, comparisons, simplification*
- Improved quality of Cartesian paths
  - *Jump threshold*
- FCL shape cache thread-local for speedup
  - *Faster collision checking*
- Improved Rviz motion planning plugin
  - *Better user interfaces*
- Constraint approximation databases
  - *Speedup planning in difficult regions*
- Realtime Robotics RapidPlan Integration
  - *Plugin for FPGA-based collision checking*

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A Feature-Rich Ecosystem

Global Planners
- OMPL
- SBPL

Local Planners
- CHOMP
- STOMP
- TrajOpt

Cartesian Planners
- RobotState
- Descartes
- JogArm
- PilzIndustrial Motion

Inverse Kinematic Solvers
- KDL
- IKFast
- TrackIK
- LMA
- BioIK

Grasping Libraries
- MoveIt Grasps
- Grasp Pose Detection (GPD)
- Intel OpenVino

Collision Checking
- Fast Collision Library (FCL)
- Bullet

Perception / Octomap
- Depth Images
- Point Clouds

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Documentation!

FRANKA EMIKA

Getting Started
MoveIt Quickstart in RViz
Move Group C++ Interface
Move Group Python Interface
MoveIt Commander Scripting
Robot Model and Robot State
Planning Scene
Planning Scene ROS API
Motion Planning API
Motion Planning Pipeline
Creating Moveit Plugins
Visualizing Collisions
Time Parameterization
Planning with Approximated Constraint Manifolds
Pick and Place
MoveIt Grasps
MoveIt Task Constructor
Subframes

MoveIt Setup Assistant
URDF and SRDF
Low Level Controllers
Perception Pipeline Tutorial
IKFast Kinematics Solver
TRAC-IK Kinematics Solver
Kinematics Configuration
Custom Constraint Samplers
OMPL Planner
CHOMP Planner
STOMP Planner
TrajOpt Planner
Planning Adapter Tutorials
Joystick Control Teleoperation
Arm Jogging in Real-Time
Benchmarking
Integration/Unit Tests

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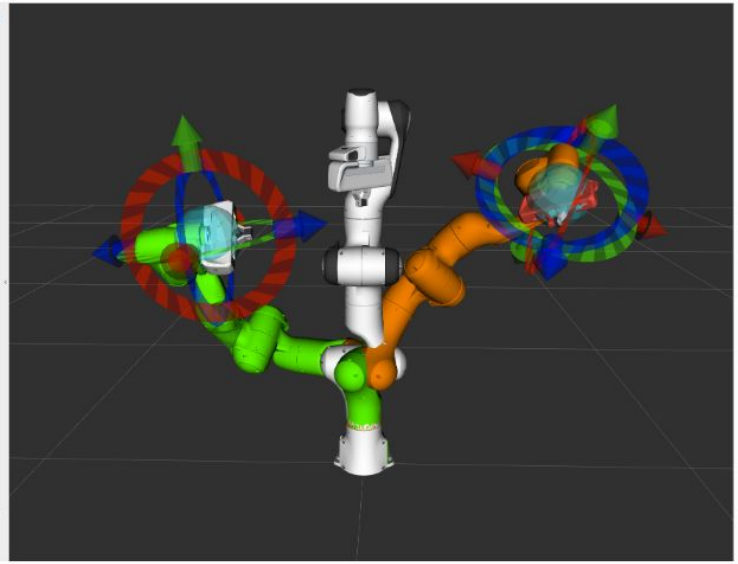
Tutorials Version: Master

This is the latest version, which is actively developed. For beginners, we recommmend the stable Melodic tutorials. If you are still running a Kinetic release, please use the Kinetic tutorials.

MoveIt Tutorials

These tutorials will quickly get you, and your robot, using the MoveIt Motion Planning Framework.



MoveIt

INSTALL DOCS ABOUT CONTRIBUTE BLOG GET INVOLVED

Announcement World MoveIt Day 2019 is November 20th!

Moving robots into the future

Easy-to-use robotics manipulation platform for developing applications, evaluating designs, and building integrated products

WATCH OUR MONTAGE GET STARTED

Latest: Melodic / Ubuntu 18.04

INSTALL FROM DEBIAN

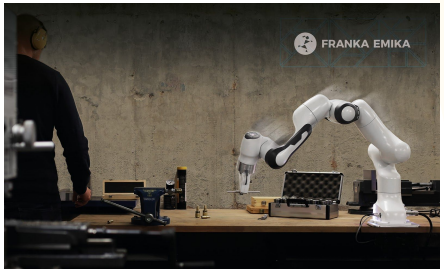
Version: 1.0.0

Install from Source | View on Github

ROS

A Hardened Motion Planning Platform

arm_navigation → MoveIt! → MoveIt! → MoveIt2



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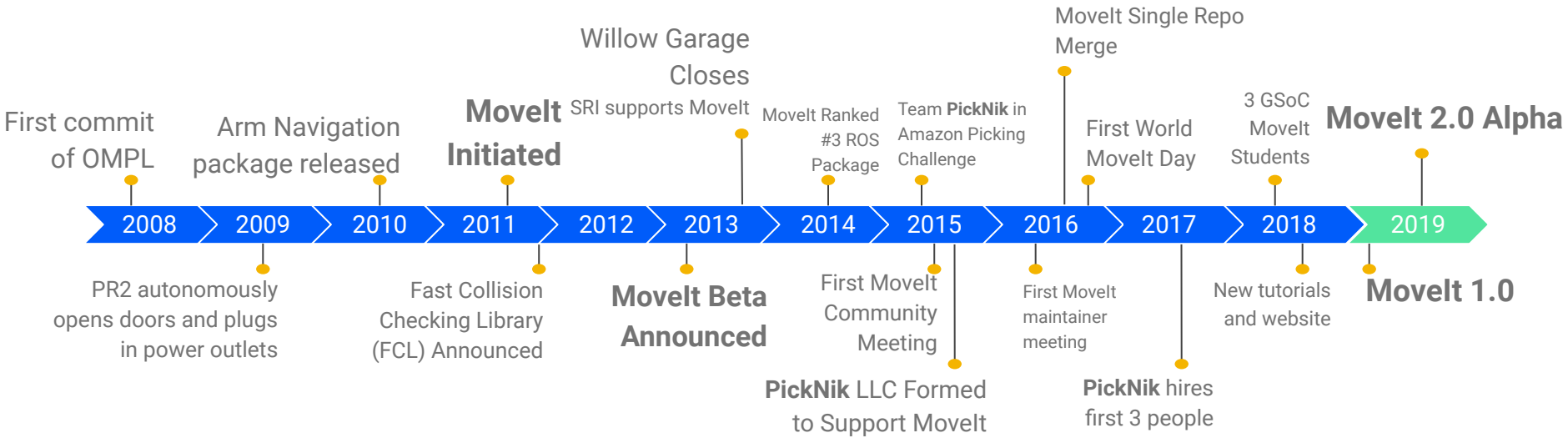
Timeline



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152 Robots integrated to work with MoveIt

23,662 Downloads per month of moveit_core

542 Academic citations of MoveIt

109,880 Unique users to moveit.ros.org in 2019

4200 Members of Discourse, MoveIt's Discussion Forum

482 Github users have starred the MoveIt project

177 Github code contributors to MoveIt

13 International locations participated in World MoveIt Day 2018

310 In-person participants of World MoveIt Day 2018