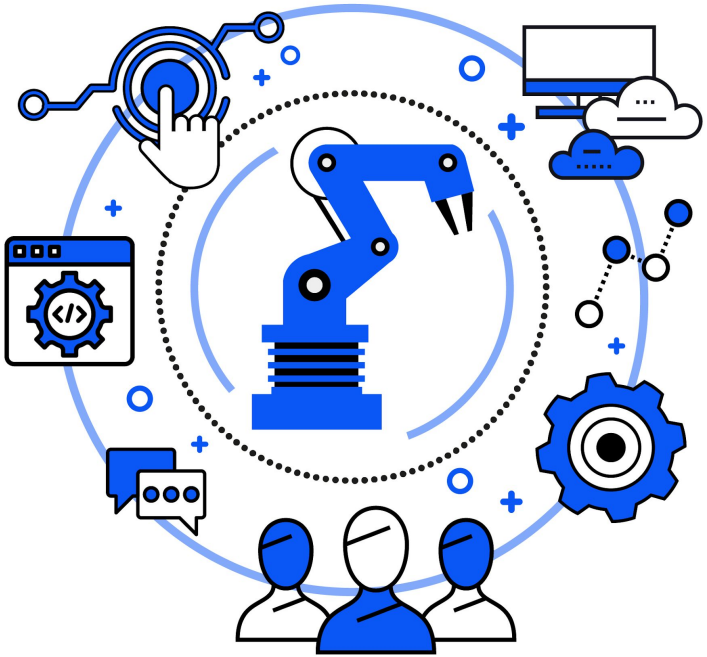


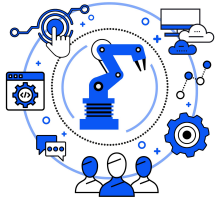
PICKNIK

# Easy Robot Software

## And the MoveIt Setup Assistant 2.0

Dave Coleman, PhD
davetcoleman

*Reducing the Barrier to Entry of Complex Robotic Software: a MoveIt! Case Study*
*David Coleman, Ioan Sucan, Sachin Chitta, Nikolaus Correll*
*Journal of Software Engineering for Robotics, April 2014*



# Outline

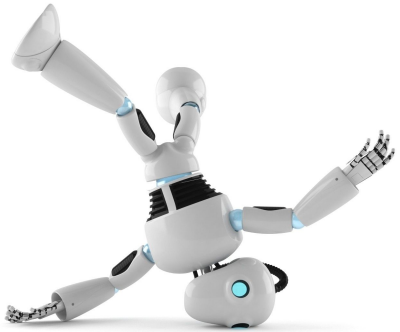
- Unique Challenges To Robot Software
- Why Do We Care?
- The 6 Entry Barrier Design Principles
- The MoveIt Setup Assistant

PICKNIK

PICKNIK

# Building Robot Software Is Hard

So let's all work together :)



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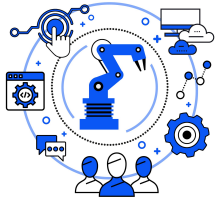
# Unique Challenges Facing Robotic Software

- No single developer can have the necessary **domain knowledge**
- Large variety in **complexity** and scale of robotic platforms.
- Software/hardware interaction with **unstructured real world**.
- Long term desire to **reduce reliance on GUIs**.



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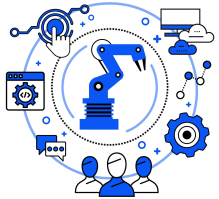
# Barriers to Entry

*The time, effort, and knowledge that a new user must invest in the integration of a software component with an arbitrary robot.*



# Why do we care?

PICKNIK

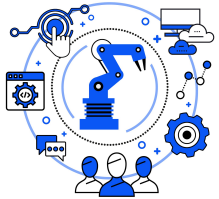
**Larger User Bases = Better Software**

# Why do we care? Larger user bases

PICKNIK

As number of users increases, bugs are identified and fixed faster [2]


[1] H. Bruyninckx, “Open robot control software: the orocos project,” in Robotics and Automation, 2001. Proceedings 2001 ICRA. IEEE International Conference on, vol. 3.
[2] D. C. Schmidt, “Why software reuse has failed and how to make it work for you,”C++ Report, vol. 11, no. 1, p. 1999
[3] D. C. Schmidt and A. Porter, “Leveraging open-source communities to improve the quality & performance of open-source software,” in Proceedings of the 1st Workshop on Open Source Software Engineering, 2001



# Why do we care? Larger user bases

PICKNIK

More users involved in quality assurance, documentation, and support [3]

[1] H. Bruyninckx, “Open robot control software: the orocos project,” in Robotics and Automation, 2001. Proceedings 2001 ICRA. IEEE International Conference on, vol. 3.
[2] D. C. Schmidt, “Why software reuse has failed and how to make it work for you,”C++ Report, vol. 11, no. 1, p. 1999
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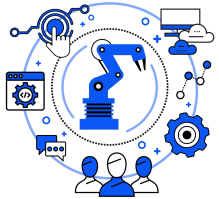

# Why do we care? Larger user bases

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New feature contributions increase (weaker correlation) [2]

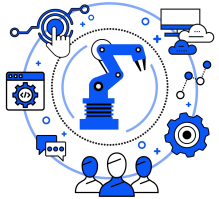

[1] H. Bruyninckx, “Open robot control software: the orocos project,” in Robotics and Automation, 2001. Proceedings 2001 ICRA. IEEE International Conference on, vol. 3.
[2] D. C. Schmidt, “Why software reuse has failed and how to make it work for you,”C++ Report, vol. 11, no. 1, p. 1999
[3] D. C. Schmidt and A. Porter, “Leveraging open-source communities to improve the quality & performance of open-source software,” in Proceedings of the 1st Workshop on Open Source Software Engineering, 2001

# Why do we care? Larger user bases

PICKNIK

Critical mass of skilled contributors has been shown to make open source projects successful [1]

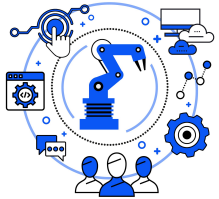
[1] H. Bruyninckx, “Open robot control software: the orocos project,” in Robotics and Automation, 2001. Proceedings 2001 ICRA. IEEE International Conference on, vol. 3.
[2] D. C. Schmidt, “Why software reuse has failed and how to make it work for you,”C++ Report, vol. 11, no. 1, p. 1999
[3] D. C. Schmidt and A. Porter, “Leveraging open-source communities to improve the quality & performance of open-source software,” in Proceedings of the 1st Workshop on Open Source Software Engineering, 2001



PICKNIK

# Why do we care?
# Education / Hiring / Innovation.

Increase number of creative minds working on today's robotic challenge



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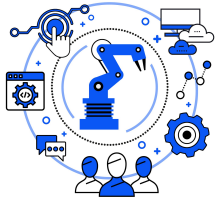
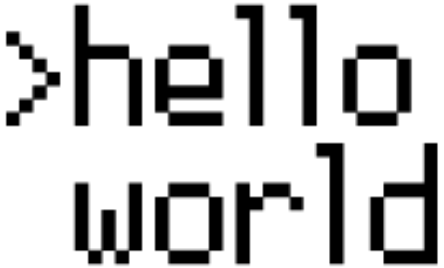
# The 6 Entry Barrier Design Principles



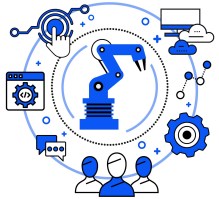
# The 6 Entry Barrier Design Principles

## Immediacy




Minimize the amount of time to accomplish the most basic task.

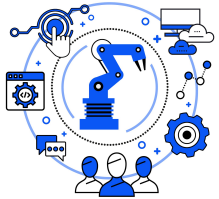
- Quick start demo
- Cursory feedback to new user that software is worth investing in
- Combat the paradox of the active user



# Paradox of the Active User

*Users never read manuals*

*The paradox is that the users would actually save time in the long run if they learned more about the system before attempting to use it, but these studies showed that in reality people do not tend to invest time upfront into learning a new system.*

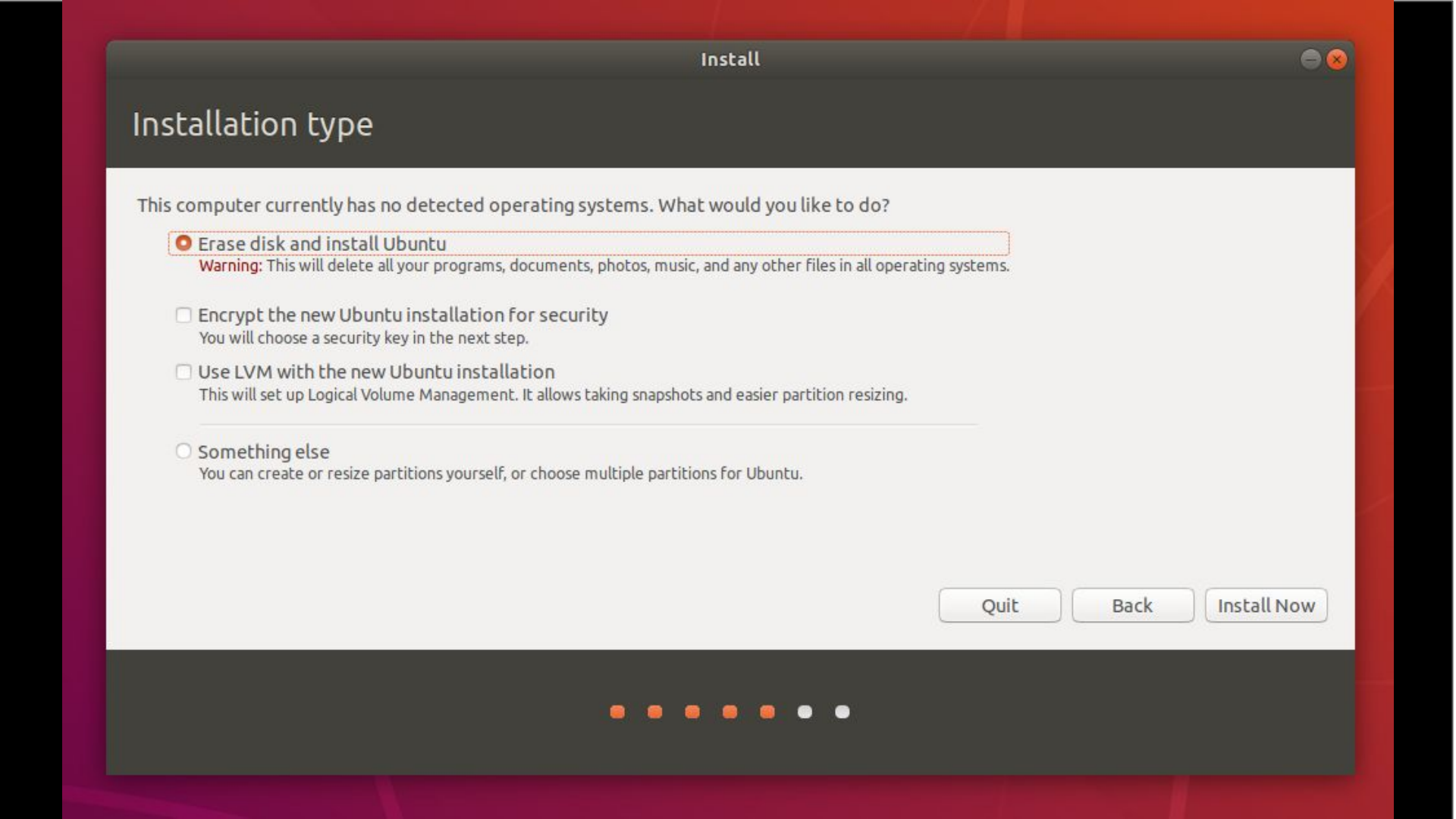


# The 6 Entry Barrier Design Principles

## Transparency

Configuration steps are performed automatically for the user while at the same time being as visible as possible

- Understand what parameters are specific to their robot
- "layered" approach of quick initial setup while allowing later customization as needed


Install
Installation type
This computer currently has no detected operating systems. What would you like to do?
Erase disk and install Ubuntu
Warning: This will delete all your programs, documents, photos, music, and any other files in all operating systems.
Encrypt the new Ubuntu installation for security
You will choose a security key in the next step.
Use LVM with the new Ubuntu installation
This will set up Logical Volume Management. It allows taking snapshots and easier partition resizing.
Something else
You can create or resize partitions yourself, or choose multiple partitions for Ubuntu.
Quit
Back
Install Now

# The 6 Entry Barrier Design Principles

## Reconfigurable

The automatically generated parameters and default values for the initial setup of a robot should be easy for the user to modify at a later time.

- Typically chosen to work with the largest number of robots
- Not optimal for any robot
- Varying applications require different configurations

# The 6 Entry Barrier Design Principles

PICKNIK

## Intuitive

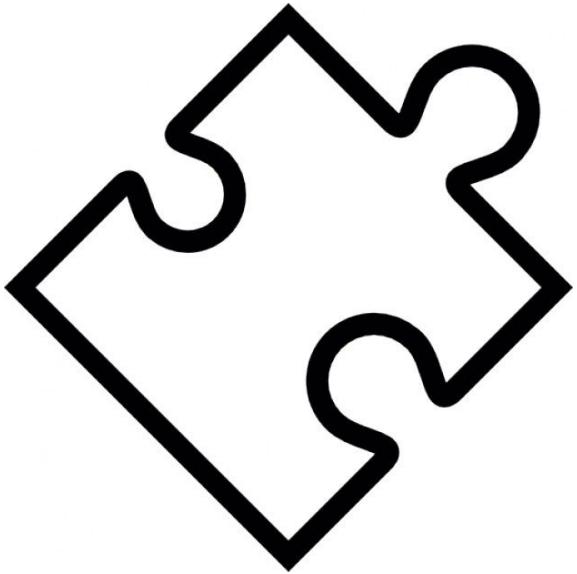
The need to read accompanied documentation, and the amount of required documentation, should be minimized.

- Follow standard design patterns
- Provide interface context clues
- Ideally an interface does not require additional documentation

# The 6 Entry Barrier Design Principles

PICKNIK

## Extensible



The user should be enabled to customize as many components and behaviors as possible within the reasonable scope of the software.

- Makes the software far more powerful and re-usable for varying use cases
- Plugin interface

# The 6 Entry Barrier Design Principles

PICKNIK

## Documented

The amount of reference material explaining how to use the software should be maximized for as many aspects and user levels as possible.

- No software is intuitive enough to not require documentation
- Different types of documentation are required for different types of users
  - Developers vs end-users

# The 6 Entry Barrier Design Principles

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## Documented

ROS.org

About | Support | Discussion Forum | Service Status | Q&A answers.ros.org

Search: Submit

Documentation | Browse Software | News | Download

### dataspeed_pds

indigo | kinetic | melodic

Documentation Status

***dataspeed_pds***: *dataspeed_pds_can* | *dataspeed_pds_msgs* | *dataspeed_pds_scripts*

## Package Summary

✔ Released ✔ Continuous Integration ✔ Documented

Interface to the Dataspeed Inc. Power Distribution System (PDS)

- Maintainer status: developed
- Maintainer: Kevin Hallenbeck <khallenbeck AT dataspeedinc DOT com>, Eric Myllyoja <emyllyoja AT dataspeedinc DOT com>
- Author: Kevin Hallenbeck <khallenbeck AT dataspeedinc DOT com>, Eric Myllyoja <emyllyoja AT dataspeedinc DOT com>
- License: BSD
- External website: http://dataspeedinc.com
- Bug / feature tracker: https://bitbucket.org/dataspeedinc/dataspeed_pds/issues
- Source: hg https://bitbucket.org/DataspeedInc/dataspeed_pds (branch: default)

**Package Links**
dataspeed_pds website
FAQ
Changelog
Change List
Reviews
**Dependencies (4)**
**Jenkins jobs (11)**

Wiki
Distributions
ROS/Installation
ROS/Tutorials
RecentChanges
dataspeed_pds

Page
Immutable Page
Info
Attachments
More Actions:

User
Login

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Wiki: dataspeed_pds (last edited 2018-07-02 18:43:10 by KevinHallenbeck)

Brought to you by: Open Source Robotics Foundation

dataspeed_pds

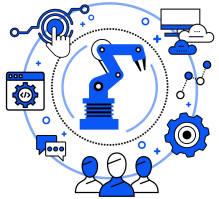
Overview
Source
Commits
Branches
Pull requests
Pipelines
Issues
Downloads

Dataspeed Inc. / Power Distribution / dataspeed_pds / Source

### Source

default | dataspeed_pds /

| | | |
|---|---|---|
| dataspeed_pds | | |
| dataspeed_pds_can | | |
| dataspeed_pds_lcm | | |
| dataspeed_pds_msgs | | |
| dataspeed_pds_rqt | | |
| dataspeed_pds_scripts | | |
| .hgignore | 377 B | 2017-07-26 |
| .hgtags | 282 B | 2018-06-29 |
| LICENSE | 1.6 KB | 2018-04-12 |
| bitbucket-pipelines.yml | 2.4 KB | 2018-06-28 |
| dataspeed_pds.rosinstall | 327 B | 2017-07-26 |



MoveIt

PICKNIK

# MoveIt Setup Assistant

# Quick Setup of MoveIt

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MoveIt! Setup Assistant

- Start
- Self-Collisions
- Virtual Joints
- Planning Groups
- Robot Poses
- End Effectors
- Passive Joints
- 3D Perception
- Simulation
- ROS Control
- Author Information
- Configuration Files

## MoveIt! Setup Assistant

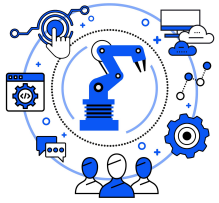
These tools will assist you in creating a Semantic Robot Description Format (SRDF) file, various yaml configuration and many roslaunch files for utilizing all aspects of MoveIt! functionality.

**Create new or edit existing?**

All settings for MoveIt! are stored in the MoveIt! configuration package. Here you have the option to create a new configuration package or load an existing one. Note: changes to a MoveIt! configuration package outside this Setup Assistant are likely to be overwritten by this tool.

Create New MoveIt Configuration Package

Edit Existing MoveIt Configuration Package



# Optimize Collision Checking

PICKNIK

MoveIt! Setup Assistant

- Start
- Self-Collisions
- Virtual Joints
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## Optimize Self-Collision Checking

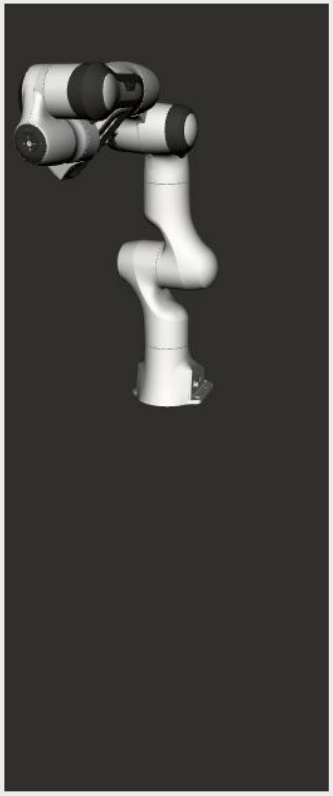
This searches for pairs of robot links that can safely be disabled from collision checking, decreasing motion planning time. These pairs are disabled when they are always in collision, never in collision, in collision in the robot's default position, or when the links are adjacent to each other on the kinematic chain. Sampling density specifies how many random robot positions to check for self collision.

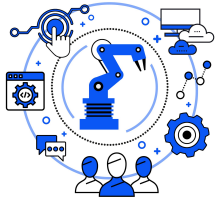
Sampling Density: Low — High 100000

Min. collisions for "always"-colliding pairs: 95% Generate Collision Matrix

| | panda_link0 | panda_link1 | panda_link2 | panda_link3 | panda_link4 | panda_link5 | panda_link6 | panda_link7 | panda_hand | panda_leftfinger | panda_rightfinger |
|---|---|---|---|---|---|---|---|---|---|---|---|
| panda_link0 | | ☑ | ☑ | ☑ | ☑ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| panda_link1 | ☑ | | ☑ | ☑ | ☑ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| panda_link2 | ☑ | ☑ | | ☑ | ☑ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| panda_link3 | ☑ | ☑ | ☑ | | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ |
| panda_link4 | ☑ | ☑ | ☑ | ☑ | | ☑ | ☑ | ☑ | ☑ | ☑ | ☑ |
| panda_link5 | ☐ | ☐ | ☐ | ☑ | ☑ | | ☑ | ☑ | ☑ | ☐ | ☐ |
| panda_link6 | ☐ | ☐ | ☐ | ☑ | ☑ | ☑ | | ☑ | ☑ | ☑ | ☑ |
| panda_link7 | ☐ | ☐ | ☐ | ☑ | ☑ | ☑ | ☑ | | ☑ | ☑ | ☑ |
| panda_hand | ☐ | ☐ | ☐ | ☑ | ☑ | ☑ | ☑ | ☑ | | ☑ | ☑ |

link name filter — ○ linear view ◉ matrix view — Revert





# Specify Metadata

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- Planning Groups
- Robot Poses
- End Effectors
- Passive Joints
- Virtual Joints

MoveIt! Setup Assistant

Start
Self-Collisions
Virtual Joints
Planning Groups
Robot Poses
End Effectors
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ROS Control
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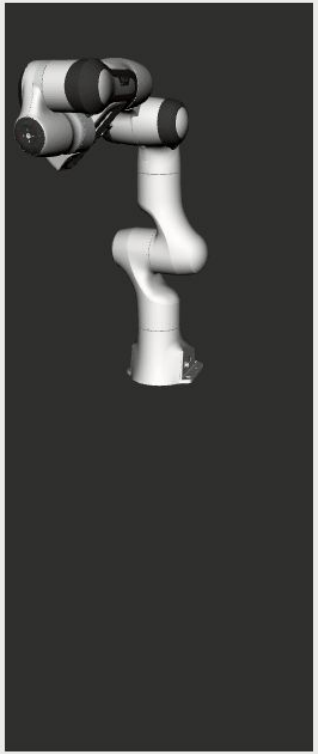
Configuration Files

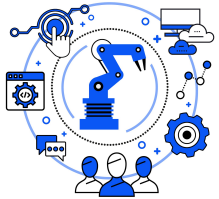
## Define Virtual Joints

Create a virtual joint between a robot link and an external frame of reference (considered fixed with respect to the robot).

| | Virtual Joint Name | Child Link | Parent Frame | Type |
|---|---|---|---|---|
| 1 | virtual_joint | panda_link0 | world | fixed |

Edit Selected | Delete Selected | Add Virtual Joint





MoveIt

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# MoveIt Setup Assistant 2.0

Special thanks to Mohmmad El Khzragy, Open Robotics, and GSoC

# Auto-configure Depth Sensors

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MoveIt! Setup Assistant

- Start
- Self-Collisions
- Virtual Joints
- Planning Groups
- Robot Poses
- End Effectors
- Passive Joints
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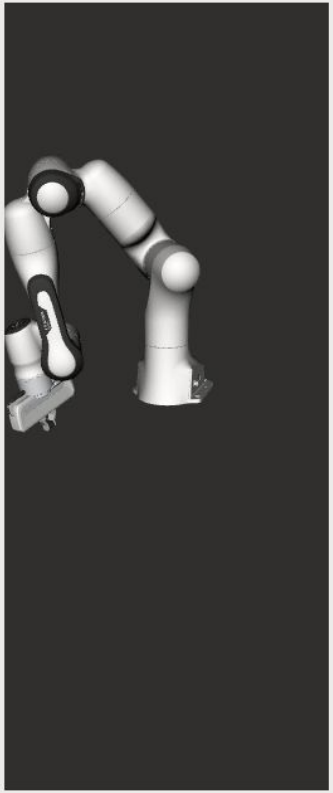
- Configuration Files

## Setup 3D Perception Sensors

Configure your 3D sensors to work with Moveit! Please see Perception Documentation for more details.

Optionally choose a type of 3D sensor plugin to configure:

None



# Setup Gazebo Simulation Integration

PICKNIK

# Setup ROS Control

PICKNIK

MoveIt! Setup Assistant

- Start
- Self-Collisions
- Virtual Joints
- Planning Groups
- Robot Poses
- End Effectors
- Passive Joints
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- ROS Control
- Author Information
- Configuration Files

## Setup ROS Controllers

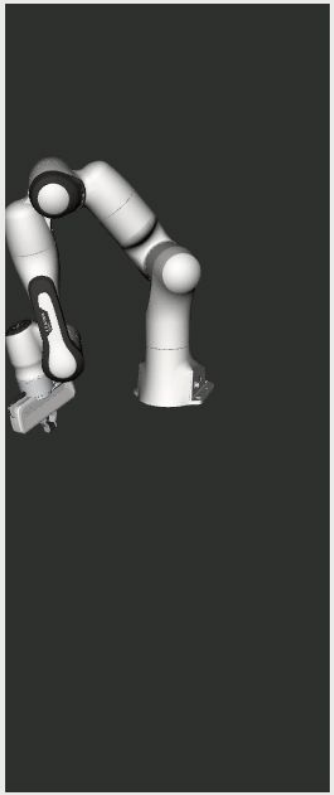
Configure MoveIt! to work with ROS Control to control the robot's physical hardware

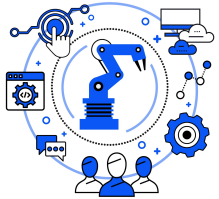
Auto Add FollowJointsTrajectory Controllers For Each Planning Group

| Controller | Controller Type |
|---|---|

Expand All Collapse All

Delete Controller | Add Controller | Edit Selected





# MoveIt

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Hello World

# Generated Quick Start Demo

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moveit.rviz* - RViz

File Panels Help

Displays

| | |
|---|---|
| Robot Alpha | 0.5 |
| Attached Body Color | 150; 50; 150 |
| Links | |
| Planning Request | |
| Planning Group | panda_arm_hand |
| Show Workspace | |
| Query Start State | |
| Query Goal State | |
| Interactive Marker Size | 0 |
| Start State Color | 50; 230; 50 |
| Start State Alpha | 1 |
| Goal State Color | 246; 160; 49 |
| Goal State Alpha | 1 |
| Colliding Link Color | 255; 0; 0 |
| Joint Violation Color | 255; 0; 255 |

Add Duplicate Remove Rename

MotionPlanning

Context Planning Manipulation Scene Objects Stored Scenes Stored States Status

Commands: Plan, Execute, Plan and Execute, Stop

Query: Select Start State:, Select Goal State:, <random valid>, Update, Clear octomap

Options: Planning Time (s): 5.00, Planning Attempts: 10.00, Velocity Scaling: 1.00, Acceleration Scaling: 1.00, Allow Replanning, Allow Sensor Positioning, Allow External Comm., Use Collision-Aware IK, Allow Approx IK Solutions

Path Constraints: None, Goal Tolerance: 0.00

MotionPlanning - Trajectory Slider

Waypoint: 0 — 0 Pause

Reset **Left-Click:** Rotate. **Middle-Click:** Move X/Y. **Right-Click:**: Move Z. **Shift**: More options. 31 fps

# New MoveIt Tutorials

PICKNIK

MoveIt

Search tutorials

- Getting Started
- MoveIt Quickstart in RViz
  - Getting Started
  - Step 1: Launch the Demo and Configure the Plugin
  - Step 2: Play with the Visualized Robots
  - Step 3: Interact with the Panda
  - Step 4: Use Motion Planning with the Panda
  - Next Steps
- 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
- Visualizing Collisions
- Time Parameterization
- Planning with Approximated Constraint Manifolds
- Pick and Place

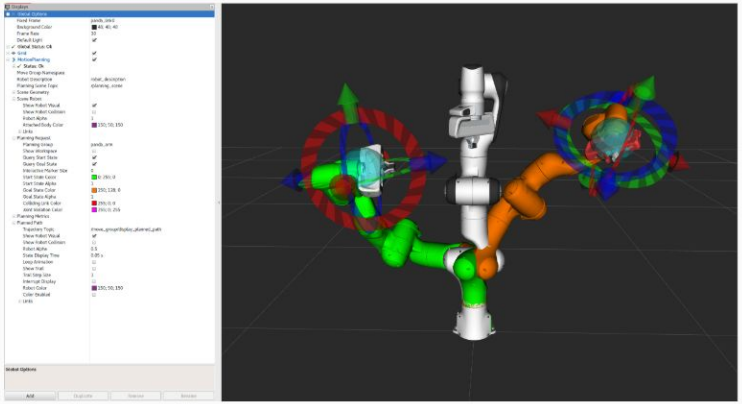
MoveIt » Tutorials » MoveIt Quickstart in RViz

Edit on GitHub

**Tutorials Version: Master**

This the latest version, which is actively developed. For beginners, we recommmend the stable ROS Melodic tutorials.

## MoveIt Quickstart in RViz



This tutorial will quickly get you motion planning using MoveIt via RViz and the MoveIt plugin. Rviz is the primary visualizer in ROS and an incredibly useful tool for debugging robotics. The MoveIt Rviz plugin allows you to setup virtual environments (scenes), create start and goal states for the robot interactively, test various motion planners, and visualize the output. Let's go!

# Conclusion

PICKNIK

- Robot software is hard
- Make your software easier to use
- Apply the entry barrier design principles
- By building a community around your software, the software gets better
- The MoveIt Setup Assistant is a good example