古月居
GYH.AI

ROS助力机器人智能化变革

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华中科技大学自动化学院 硕士

自我介绍

古月居　古月春旭

- 博客/公众号/知乎：古月居
- 《ROS机器人开发实践》作者
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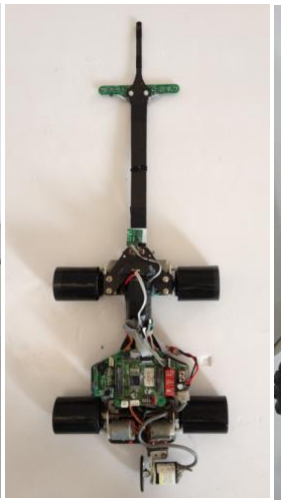

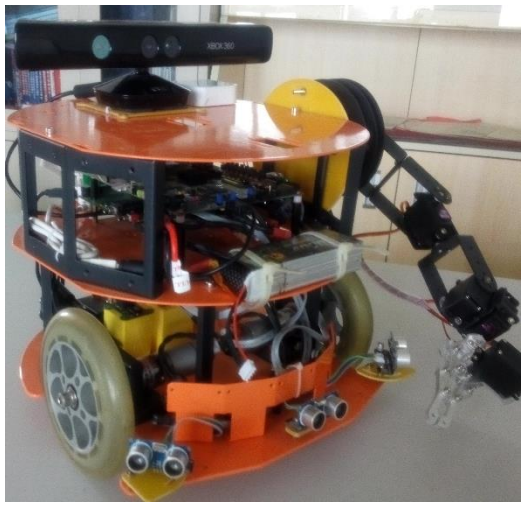

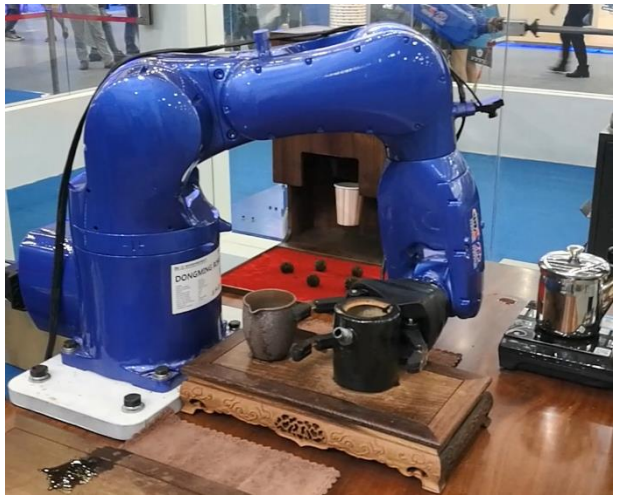

竞速智能车　　移动机器人　　**机械臂**

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1. ROS发展历程

2007
诞生于斯坦福
STAIR项目
Morgan
Quigley

2010
ROS 1.0 发布

2012
第一届ROScon

2014
ROS Indigo发布

2017
ROS 2.0 Ardent发布

2008
Willow Garage接手

Willow Garage

2011
TurtleBot发布

2013
OSRF接管

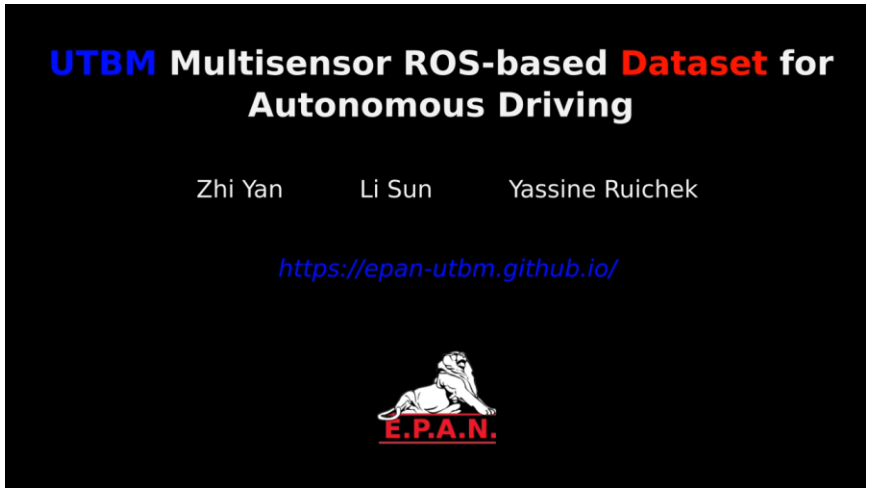
Open Source Robotics Foundation

2016
ROS Kinetic发布

2018
ROS Melodic发布

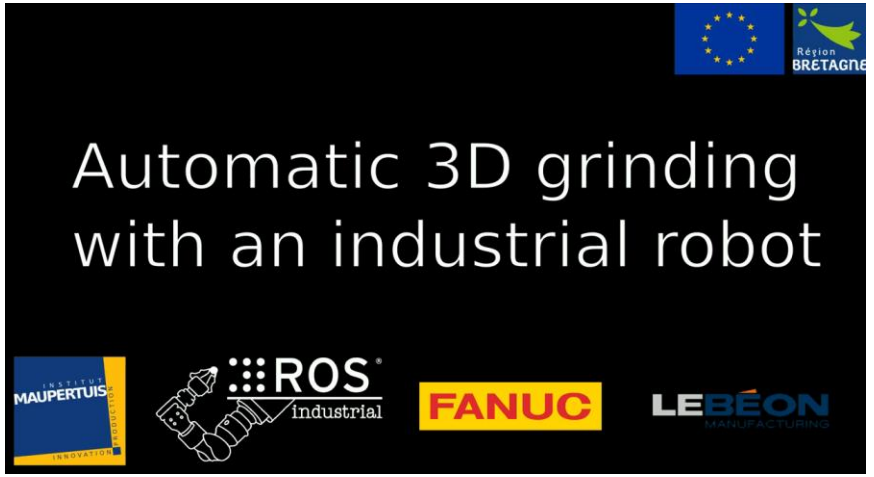
1. ROS发展历程

AutoRally platform team from Georgia Tech



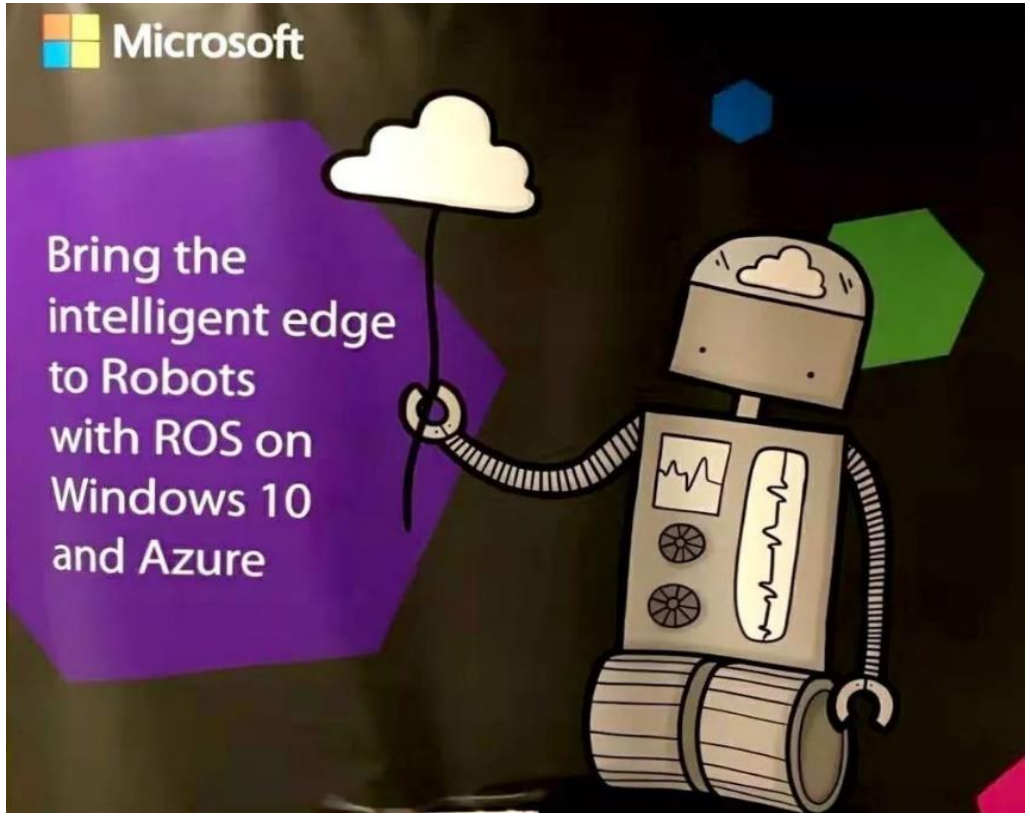
UTBM Multisensor ROS-based Dataset for Autonomous Driving

An Autonomous UAV with ROS



Automatic 3D grinding with an industrial robot

1. ROS发展历程



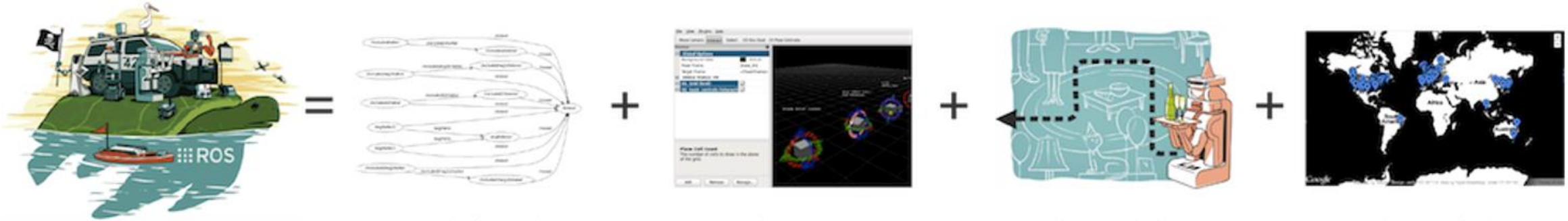
微软将ROS引入Windows 10，支持基于硬件加速的Windows机器学习、Azure Cognitive服务、Azure IoT云服务、 Visual Studio等

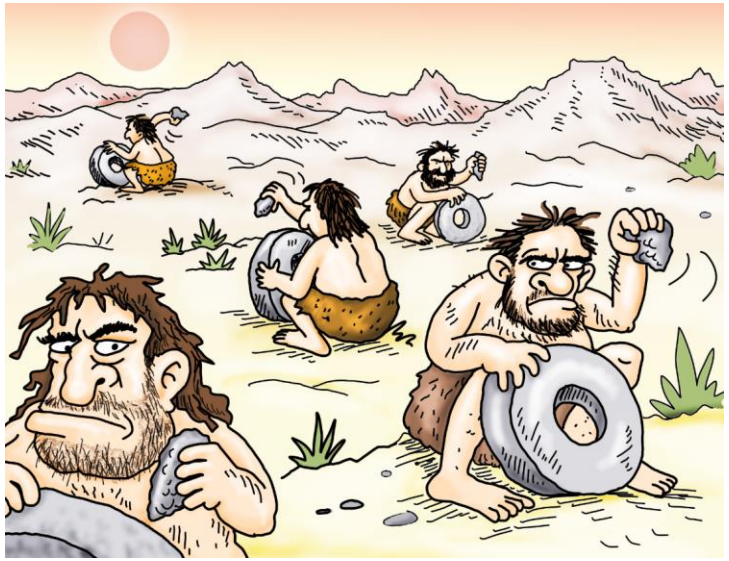
AWS RoboMaker扩展了ROS功能，可以轻松实现大规模开发、测试和部署智能机器人应用程序，可连接到云服务

目录

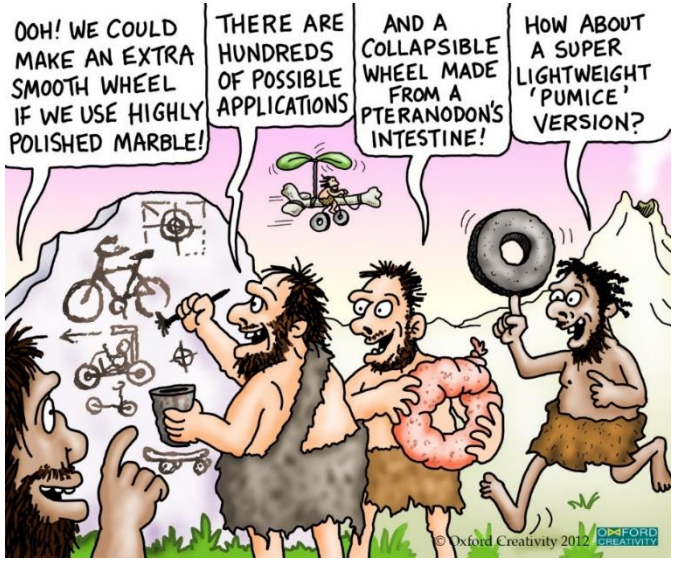
➢2. ROS核心概念

2. ROS核心概念





传统模式

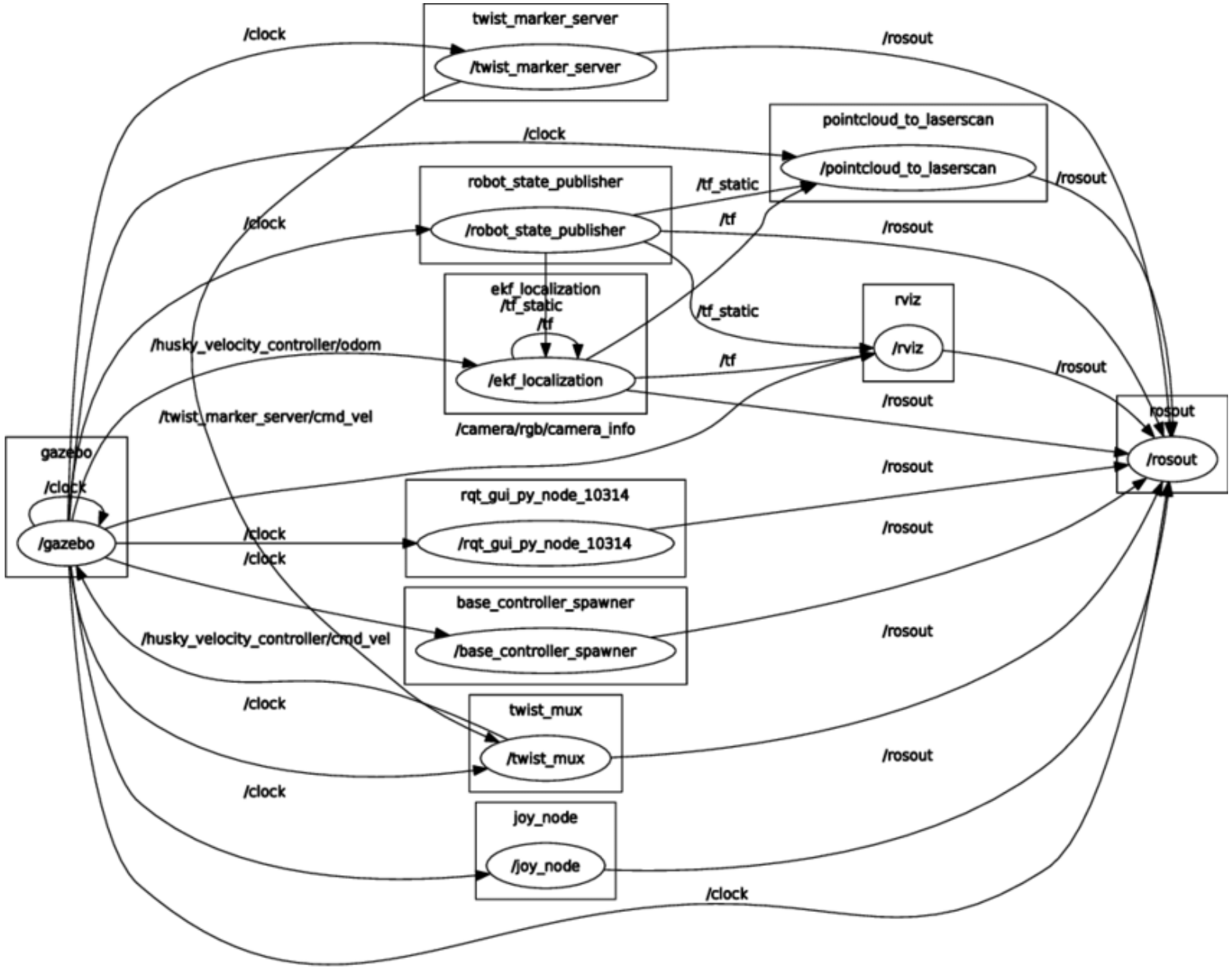


现代模式

提高机器人研发中的软件复用率

2. ROS核心概念 —— 松耦合分布式通信

计算图



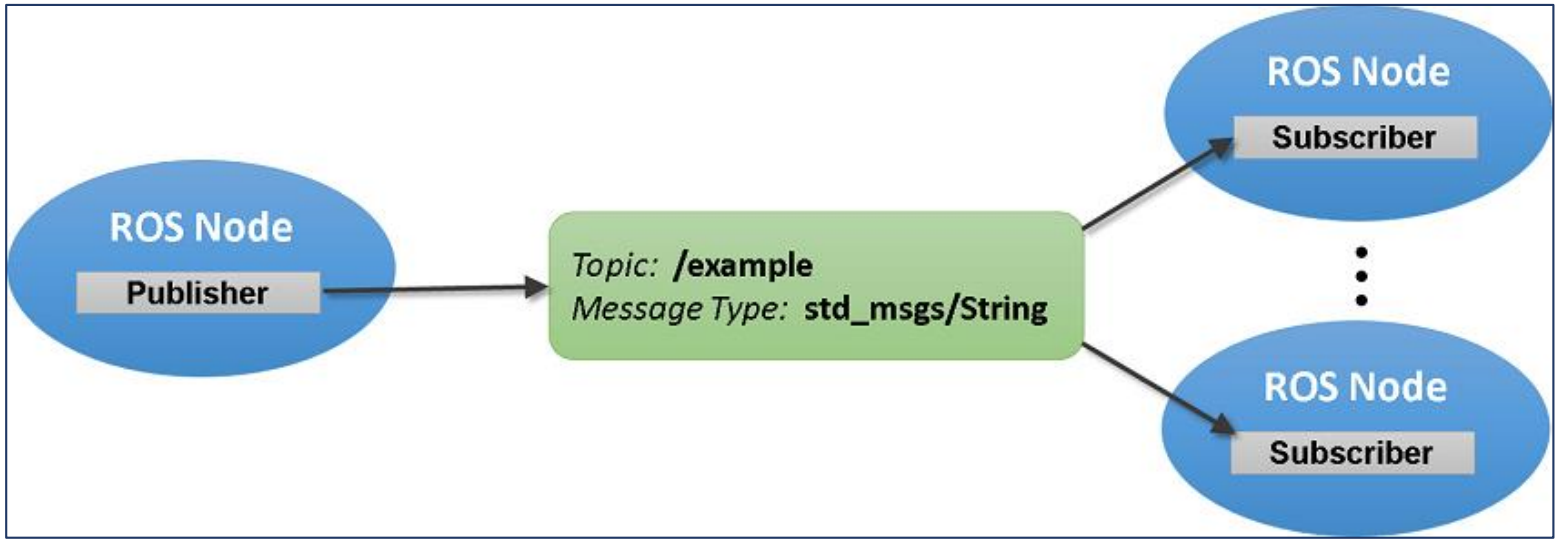
2. ROS核心概念 —— 松耦合分布式通信

（1）**节点**（Node）—— 软件模块

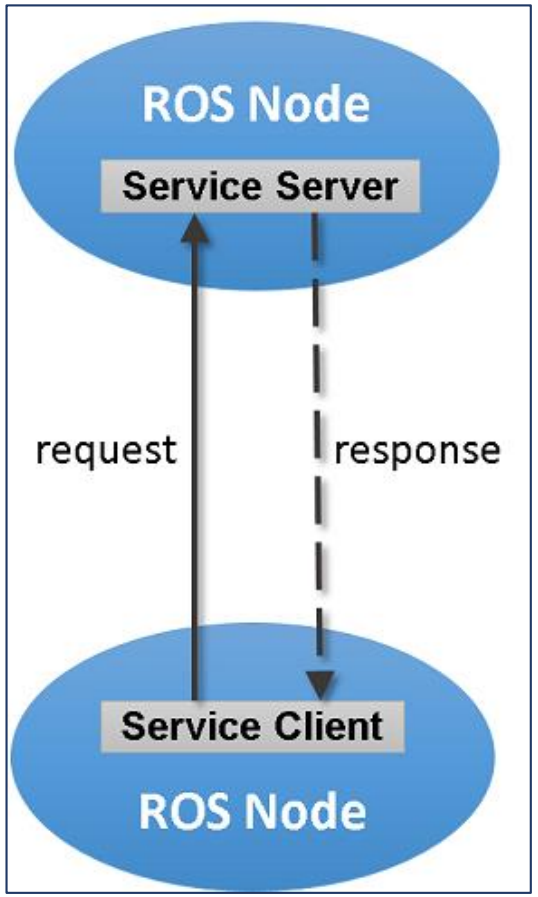
（2）节点管理器 （ROS Master）—— 控制中心，提供参数管理

（3）话题（Topic）—— 异步通信机制，传输消息（Message）

（4）服务（Service）—— 同步通信机制，传输请求/应答数据



话题模型（发布/订阅）



服务模型
（请求/应答）

2. ROS核心概念 —— 开发工具

命令行&编译器

WORKSPACES

Create Workspace

```
mkdir catkin_ws && cd catkin_ws
wstool init src
catkin_make
source devel/setup.bash
```

Add Repo to Workspace

```
roscd; cd ../src
wstool set repo_name \
--git http://github.com/org/repo_name.git \
--version=kinetic-devel
wstool up
```

Resolve Dependencies in Workspace

```
sudo rosdep init  # only once
rosdep update
rosdep install --from-paths src --ignore-src \
--rosdistro=${ROS_DISTRO} -y
```

PACKAGES

Create a Package

```
catkin_create_pkg package_name [dependencies ...]
```

Package Folders

include/package_name	C++ header files
src	Source files. Python libraries in subdirectories
scripts	Python nodes and scripts
msg, srv, action	Message, Service, and Action definitions

Release Repo Packages

```
catkin_generate_changelog
# review & commit changelogs
catkin_prepare_release
bloom-release --track kinetic --ros-distro kinetic repo_name
```

Reminders

- Testable logic
- Publish diagnostics
- Desktop dependencies in a separate package

CMakeLists.txt

Skeleton

```
cmake_minimum_required(VERSION 2.8.3)
project(package_name)
find_package(catkin REQUIRED)
catkin_package()
```

Package Dependencies

To use headers or libraries in a package, or to use a package's exported CMake macros, express a build-time dependency:

```
find_package(catkin REQUIRED COMPONENTS roscpp)
```

Tell dependent packages what headers or libraries to pull in when your package is declared as a catkin component:

```
catkin_package(
  INCLUDE_DIRS include
  LIBRARIES ${PROJECT_NAME}
  CATKIN_DEPENDS roscpp)
```

Note that any packages listed as `CATKIN_DEPENDS` dependencies must also be declared as a `<run_depend>` in `package.xml`.

Messages, Services

These go after find_package(), but before catkin_package().
Example:

```
find_package(catkin REQUIRED COMPONENTS message_generation
std_msgs)
add_message_files(FILES MyMessage.msg)
add_service_files(FILES MyService.msg)
generate_messages(DEPENDENCIES std_msgs)
catkin_package(CATKIN_DEPENDS message_runtime std_msgs)ww
```

Build Libraries, Executables

Goes after the `catkin_package()` call.

```
add_library(${PROJECT_NAME} src/main)
add_executable(${PROJECT_NAME}_node src/main)
target_link_libraries(
  ${PROJECT_NAME}_node ${catkin_LIBRARIES})
```

Installation

```
install(TARGETS ${PROJECT_NAME}
  DESTINATION ${CATKIN_PACKAGE_LIB_DESTINATION})
install(TARGETS ${PROJECT_NAME}_node
  DESTINATION ${CATKIN_PACKAGE_BIN_DESTINATION})
install(PROGRAMS scripts/myscript
  DESTINATION ${CATKIN_PACKAGE_BIN_DESTINATION})
install(DIRECTORY launch
  DESTINATION ${CATKIN_PACKAGE_SHARE_DESTINATION})
```

RUNNING SYSTEM

Run ROS using plain:

```
roscore
```

Alternatively, roslaunch will run its own roscore automatically if it can't find one:

```
roslaunch my_package package_launchfile.launch
```

Suppress this behaviour with the `--wait` flag.

Nodes, Topics, Messages

```
rosnode list
rostopic list
rostopic echo cmd_vel
rostopic hz cmd_vel
rostopic info cmd_vel
rosmsg show geometry_msgs/Twist
```

Remote Connection

Master's ROS environment:

- `ROS_IP` or `ROS_HOSTNAME` set to this machine's network address.
- `ROS_MASTER_URI` set to URI containing that IP or hostname.

Your environment:

- `ROS_IP` or `ROS_HOSTNAME` set to your machine's network address.
- `ROS_MASTER_URI` set to the URI from the master.

To debug, check ping from each side to the other, run roswtf on each side.

ROS Console

Adjust using rqt_logger_level and monitor via rqt_console. To enable debug output across sessions, edit the `$HOME/.ros/config/rosconsole.config` and add a line for your package:

```
log4j.logger.ros.package_name=DEBUG
```

And then add the following to your session:

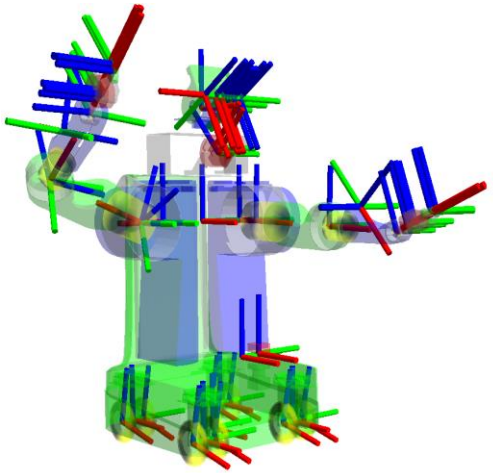
```
export ROSCONSOLE_CONFIG_FILE=$HOME/.ros/config/rosconsole.config
```

Use the roslaunch `--screen` flag to force all node output to the screen, as if each declared `<node>` had the `output="screen"` attribute.

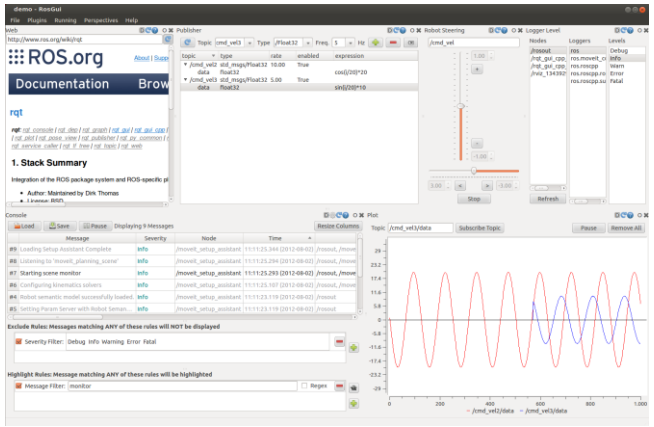
CLEARPATH ROBOTICS™

www.clearpathrobotics.com/ros-cheat-sheet

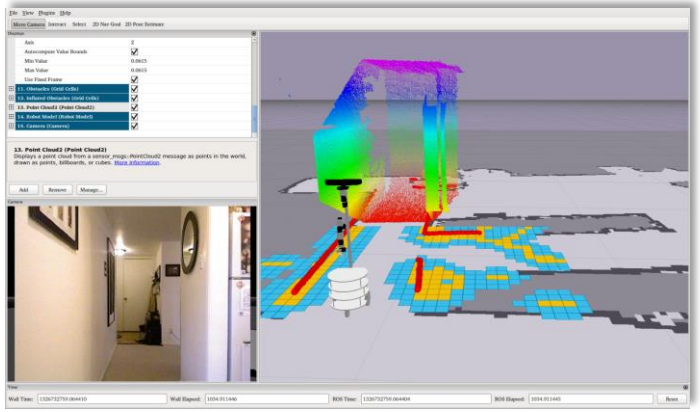
2. ROS核心概念 —— 开发工具



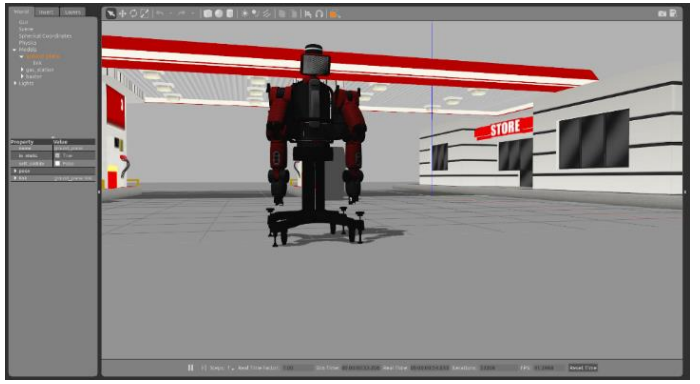
TF坐标变换



QT工具箱

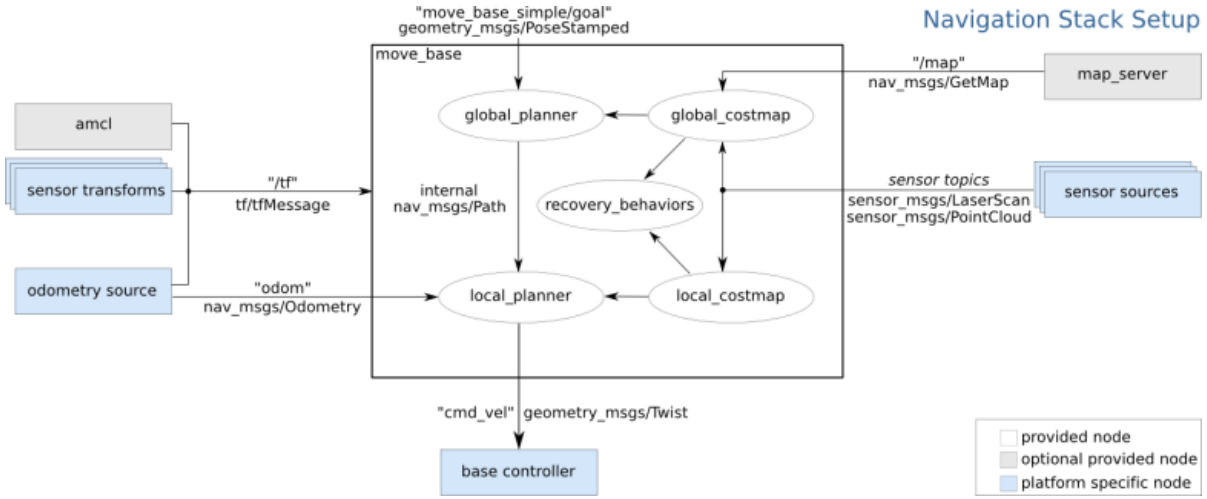


Rviz

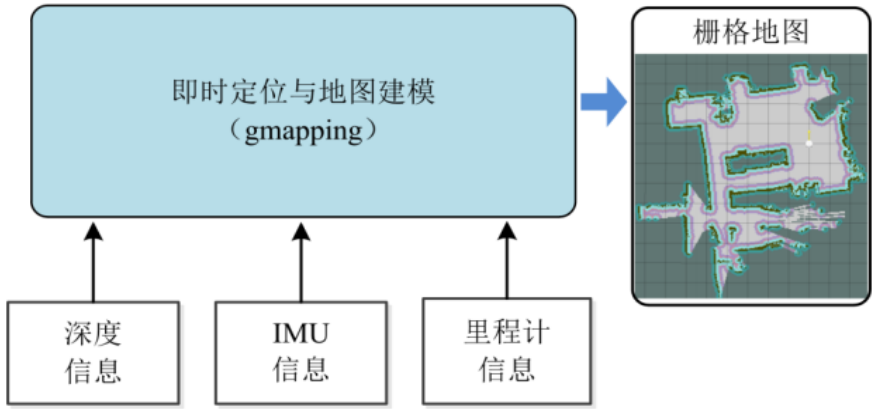


Gazebo

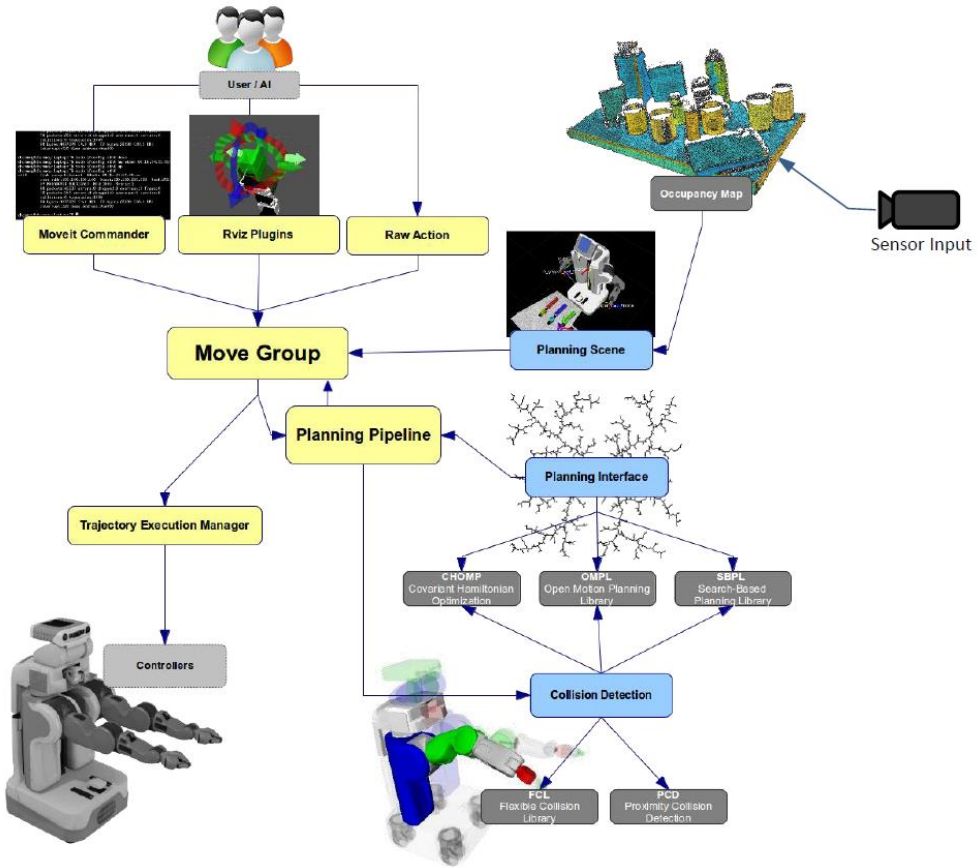
2. ROS核心概念 —— 应用功能



Navigation

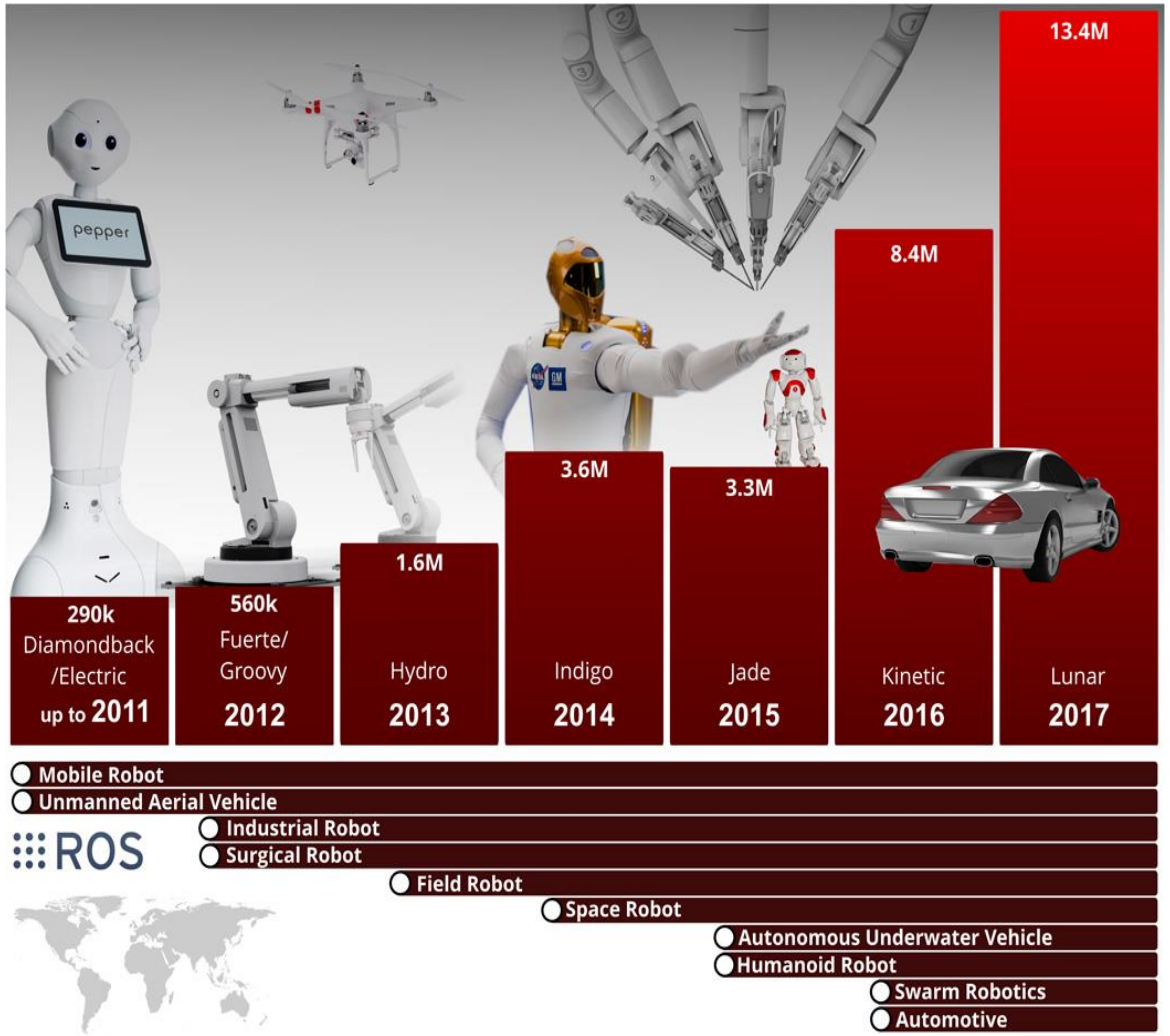


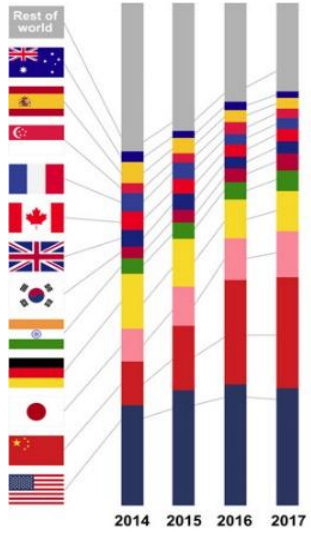
SLAM

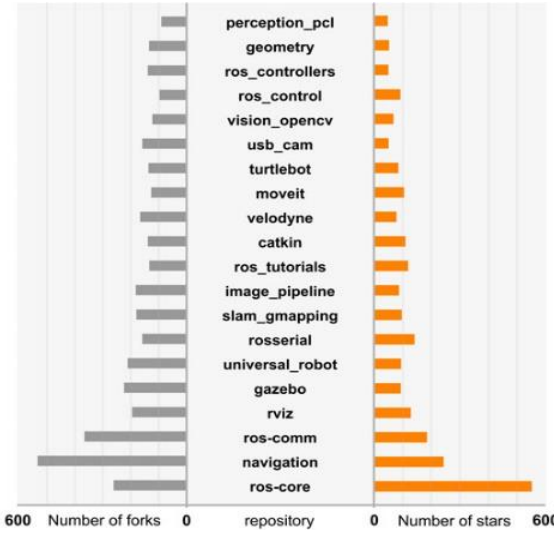


MoveIt!

2. ROS核心概念 —— 生态系统







ROS社区内的功能包数量、关注度、相关文章均呈指数级上涨

（来源：http://robotics.sciencemag.org/content/2/11/eaar1868 ）

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3. ROS与机器人开发 —— Kungfu Arm

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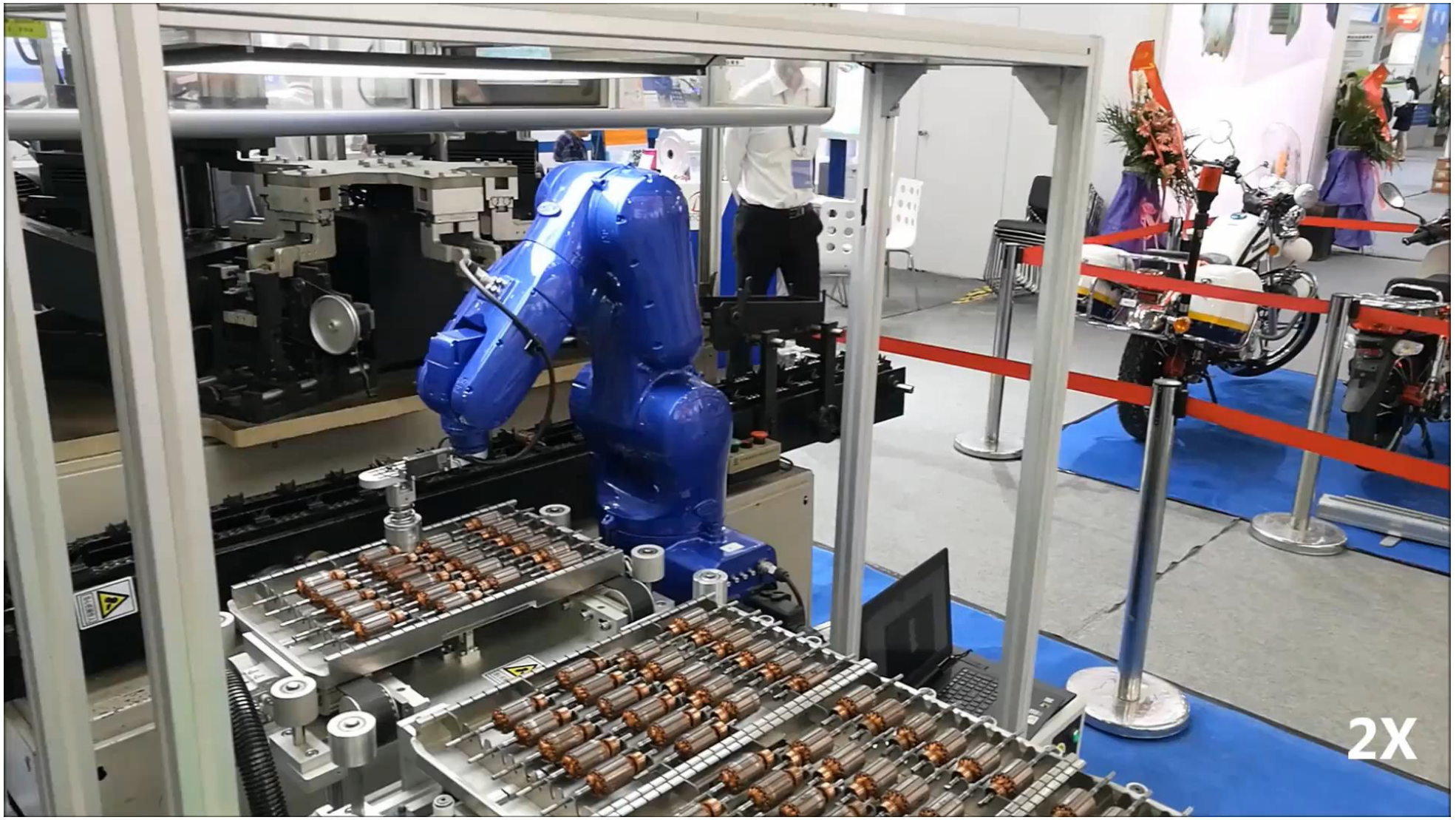
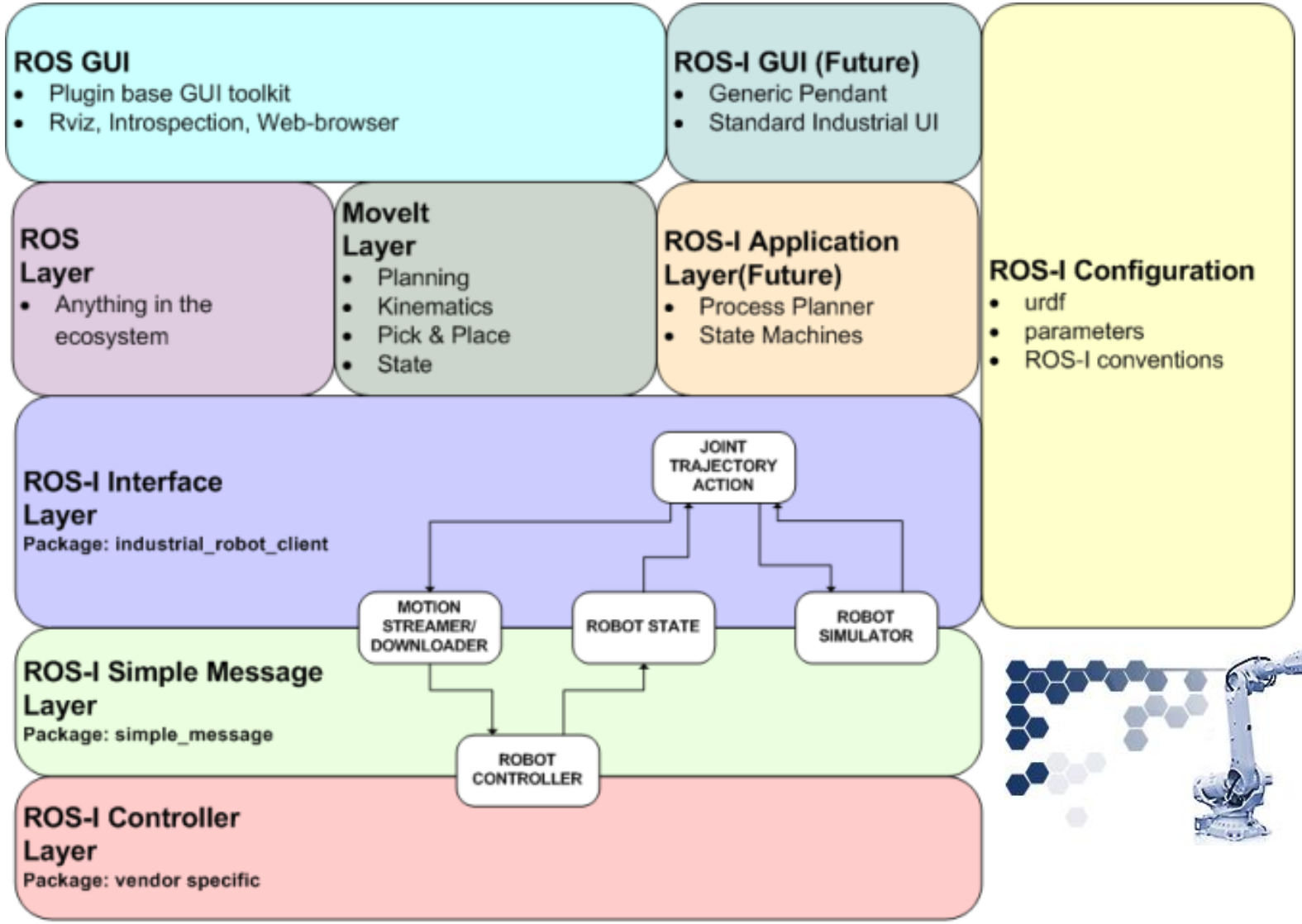


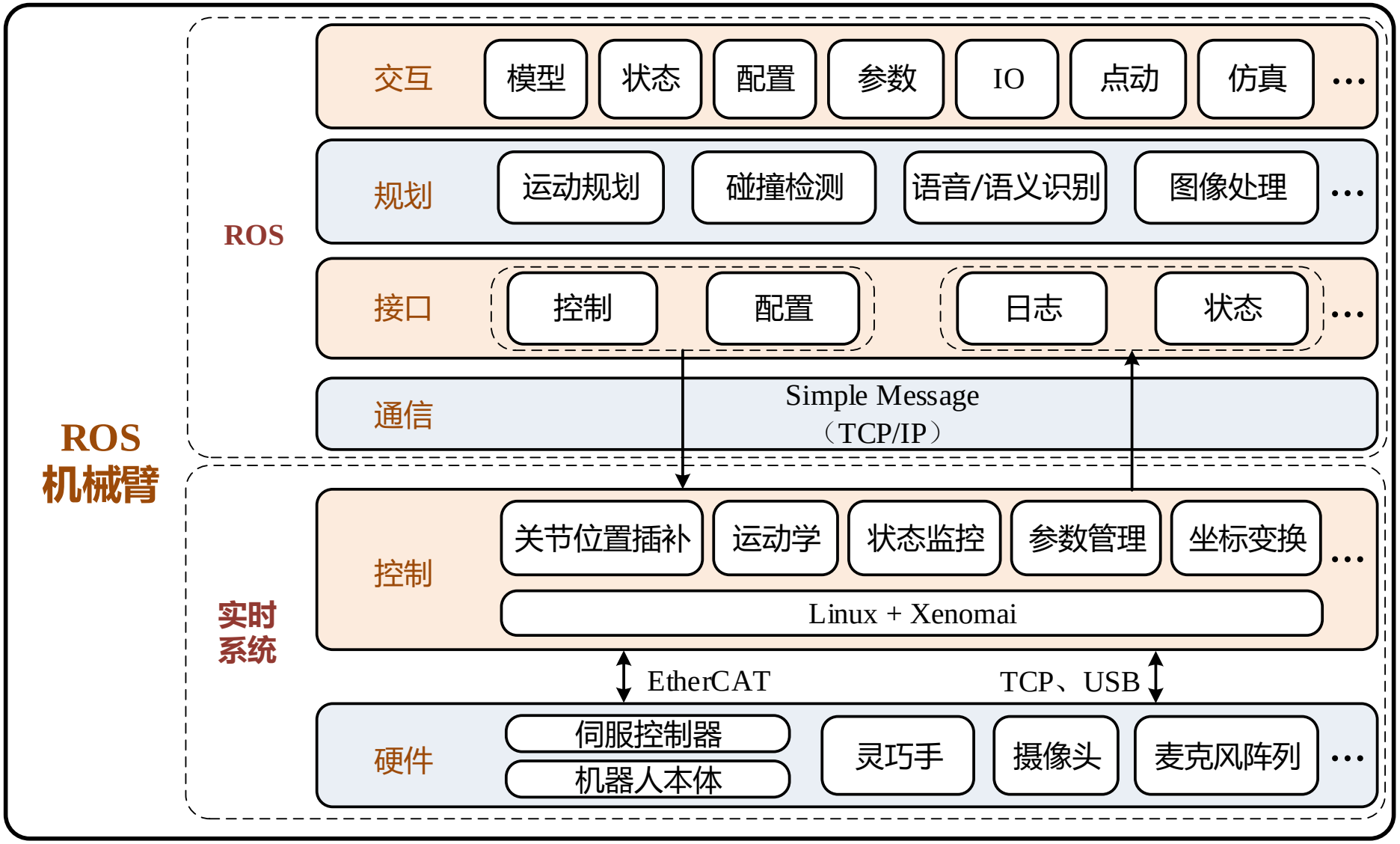
3. ROS与机器人开发 —— Kungfu Arm



ROS-Industrial High Level Architecture - Rev 0.02.vsd

图像源: http://wiki.ros.org/Industrial

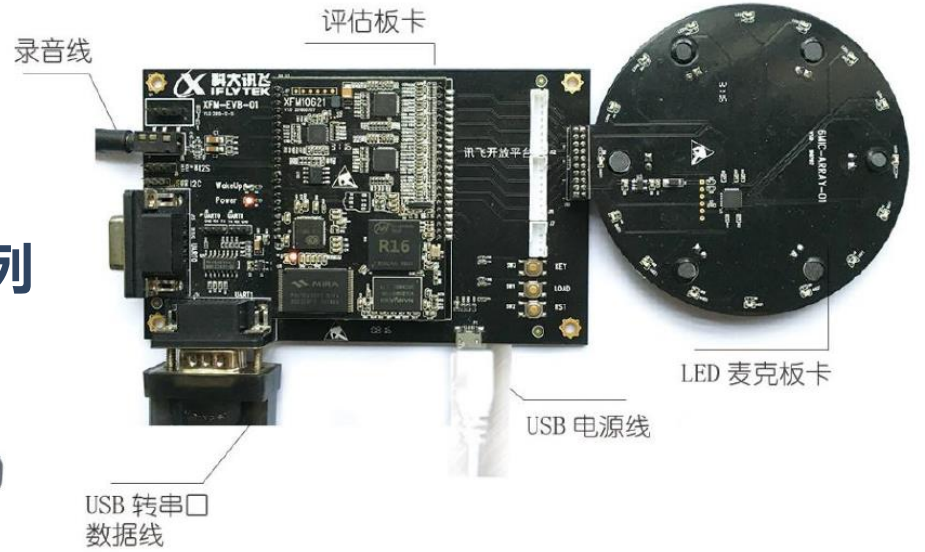
3. ROS与机器人开发 —— Kungfu Arm



3. ROS与机器人开发 —— Kungfu Arm

EtherCAT®

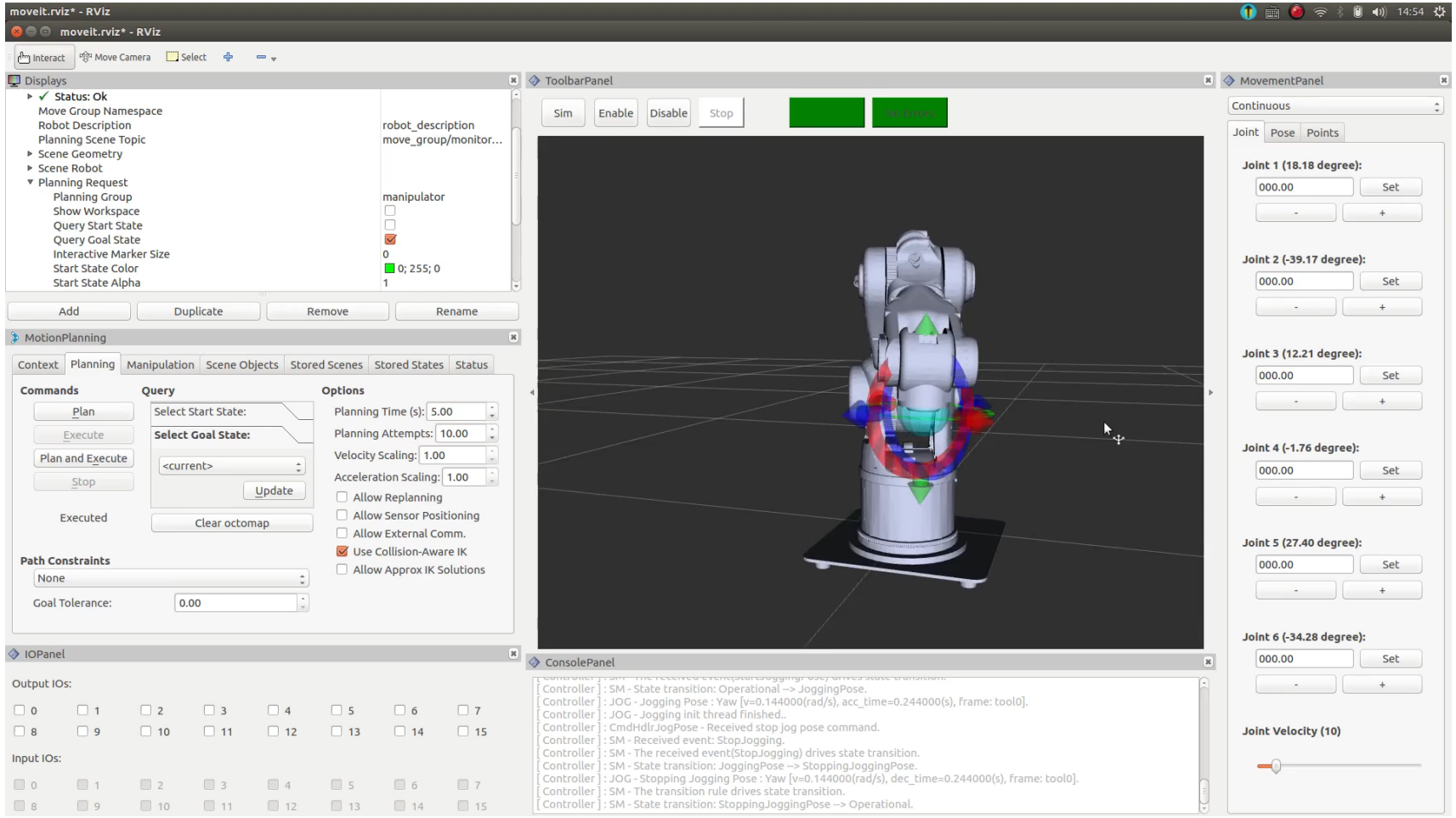
高清摄像头



麦克风阵列

灵巧手

3. ROS与机器人开发 —— Kungfu Arm



- 模型显示
- 点动控制
- 状态监控
- 工具插件
- 动态配置
- 程序监控
- 在线/离线仿真

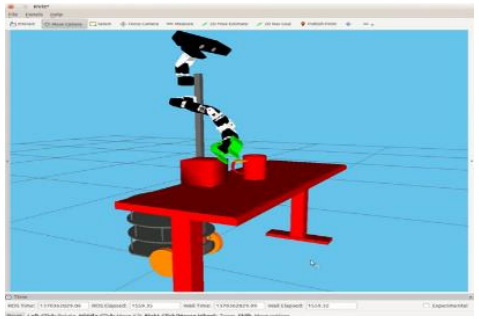
3. ROS与机器人开发 —— Kungfu Arm

运动规划

MoveIt! + OMPL

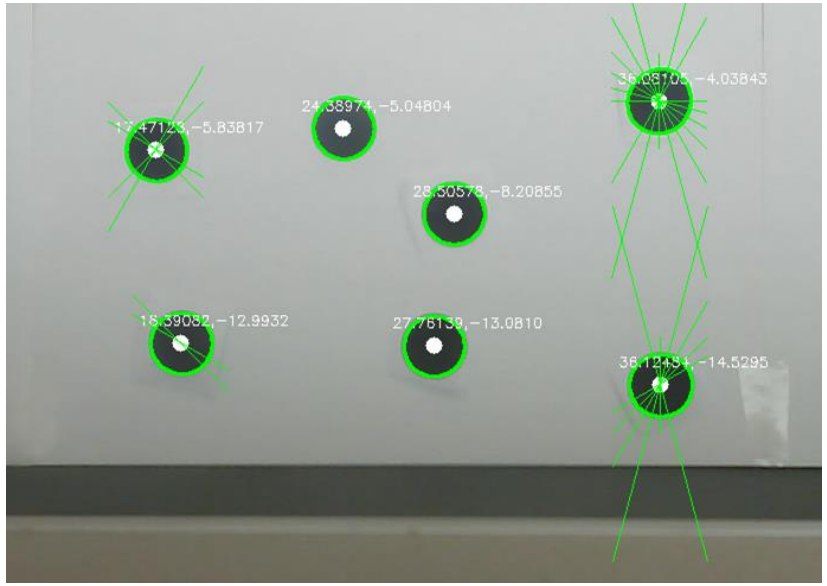
The Open Motion Planning Library

OpenRAVE



图像处理

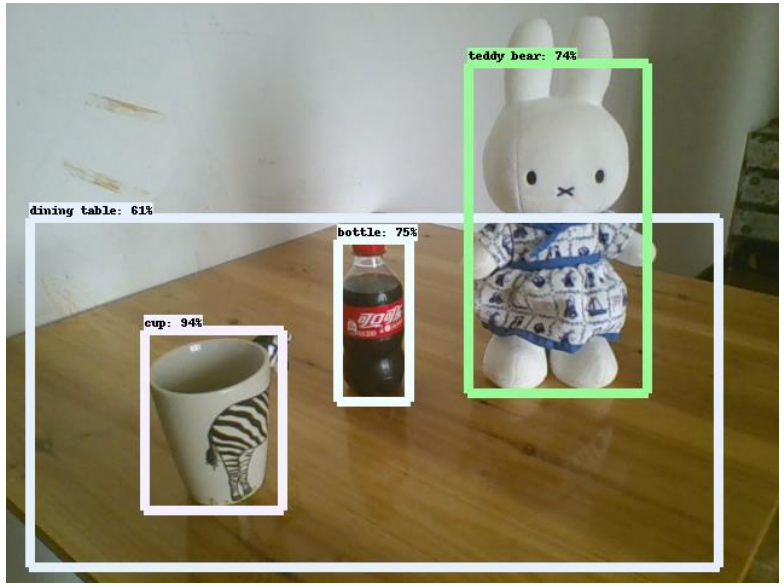
OpenCV



抓取姿态分析

语音交互

TensorFlow™ + 讯飞开放平台



机器学习与图像识别

3. ROS与机器人开发 —— Kungfu Arm

控制

Simple Message数据解析器

非实时处理

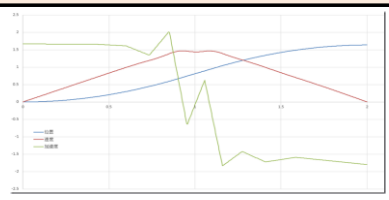
参数管理器
(Yaml file based / Mongo DB)

状态监控

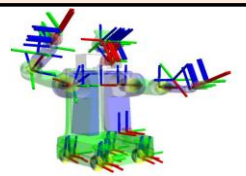
运动前瞻

实时处理

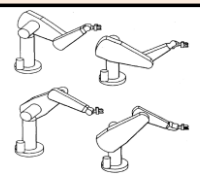
关节位置插补
(ros_controller package based)



坐标变换
(TF package based)



运动学
(trac_ik, fast_ik package based)



OS

Linux

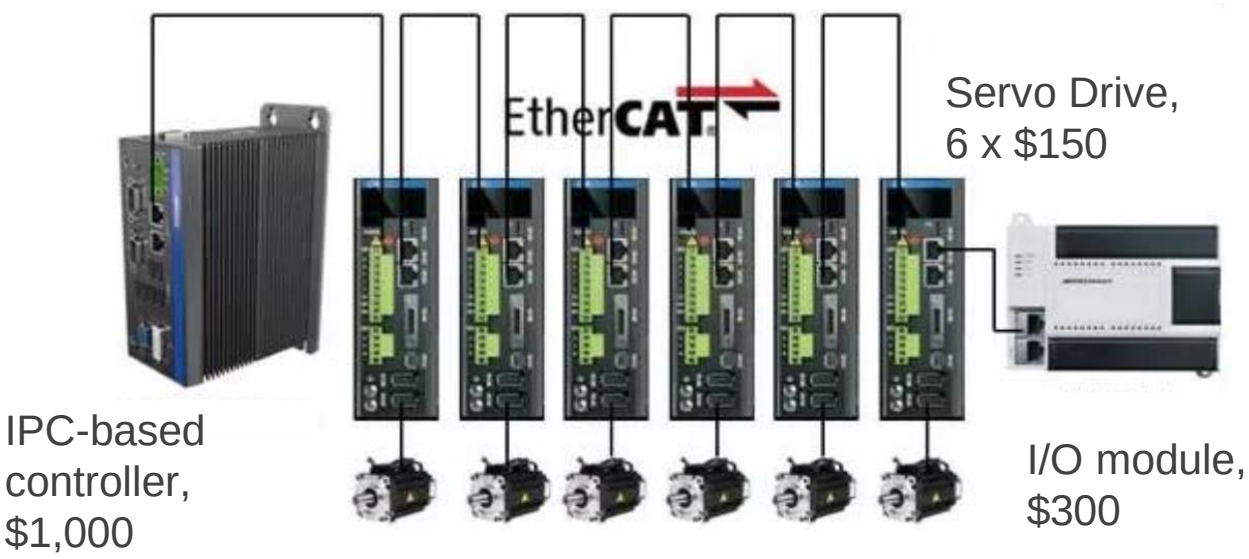
XENOMAI

IgH

3. ROS与机器人开发 —— Kungfu Arm

- ROS 1不稳定，ROS 2不完善!
- ROS不能解决机器人的所有问题!
- 硬件和成本方面还有较大优化空间!

3. ROS与机器人开发 —— 新一代片上驱控系统



传统机器人控制柜

- 通用伺服器、工控机/机器人控制器、工业以太网、PLC
- 灵活，但接口过于冗余，体积偏大，产品方案同质化
- 线缆连接复杂，安装部署耗时

驱控一体控制器

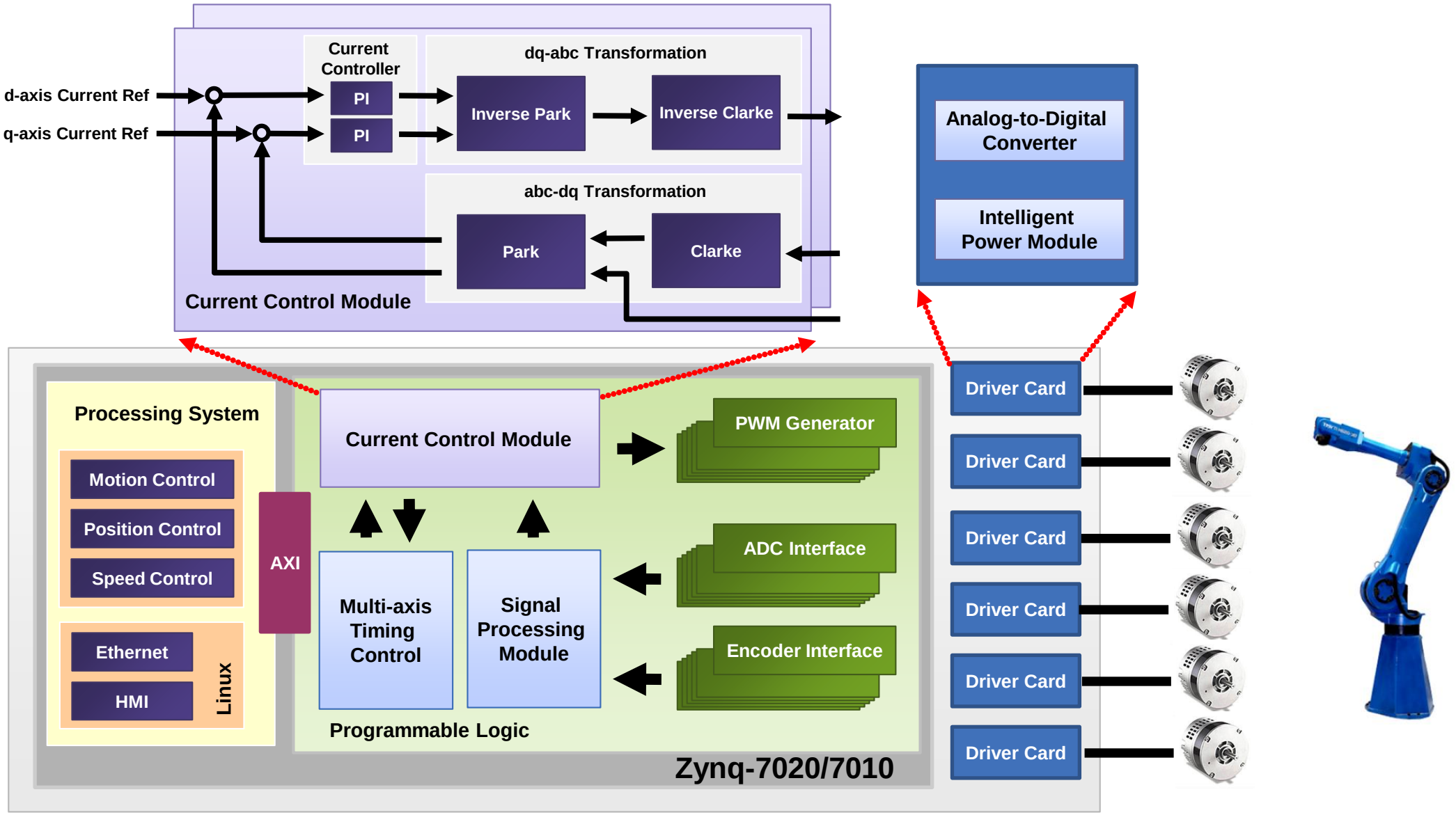
- 全新的架构带来更好的成本控制
- 更小的体积、兼顾兼容性和可用性
- 灵活、可伸缩的系统功能
- 简单的安装和部署

Integrated robot controller, $800

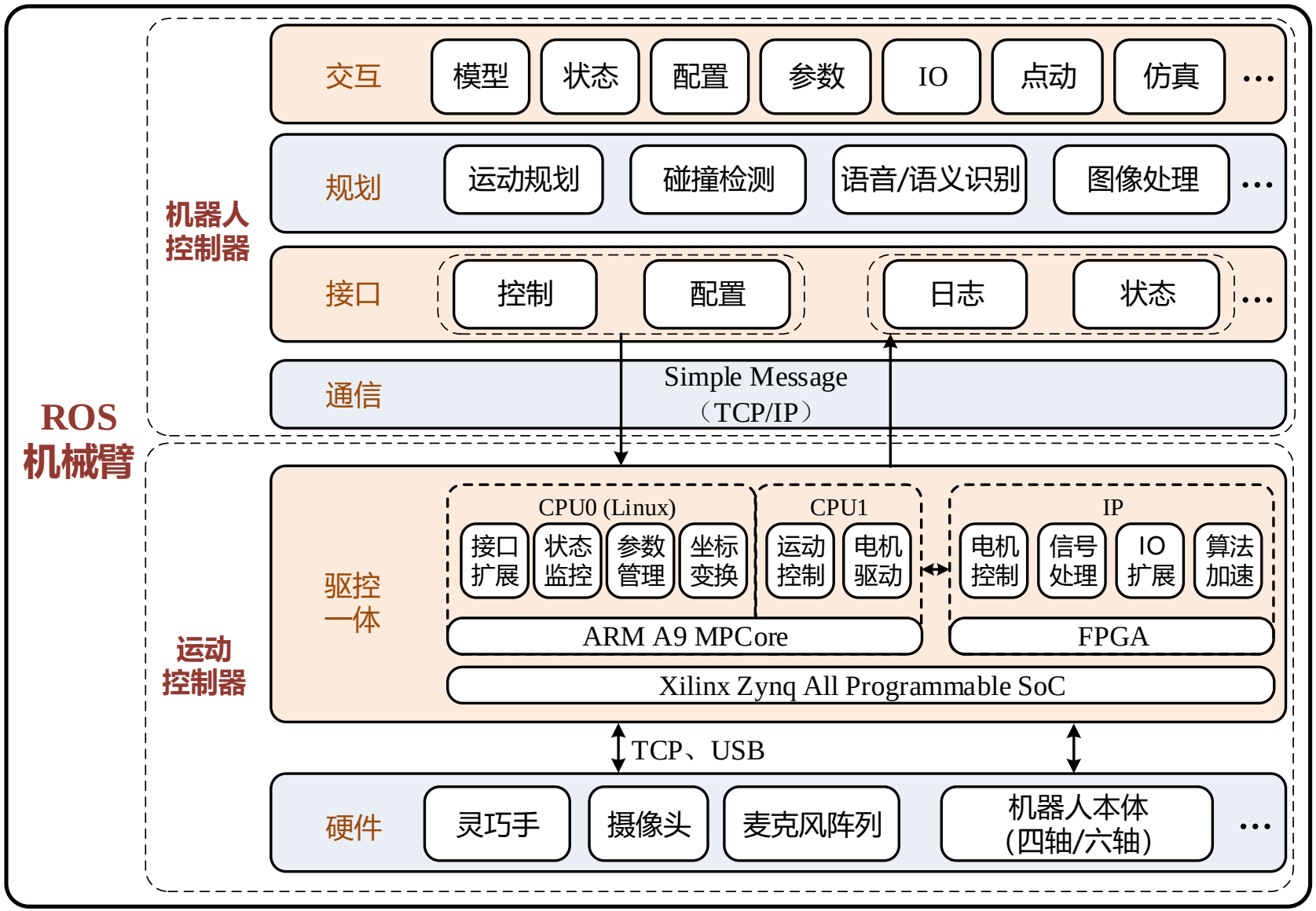
1/6的体积

1/5的价格

3. ROS与机器人开发 —— 新一代片上驱控系统

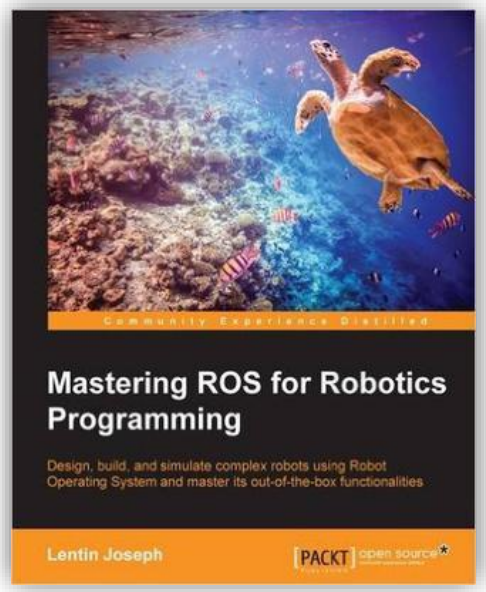


3. ROS与机器人开发 —— 新一代片上驱控系统



3. ROS与机器人开发 —— 新一代片上驱控系统

参考书目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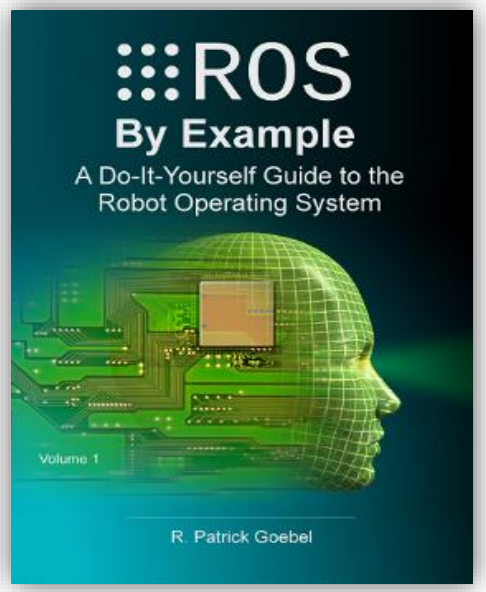
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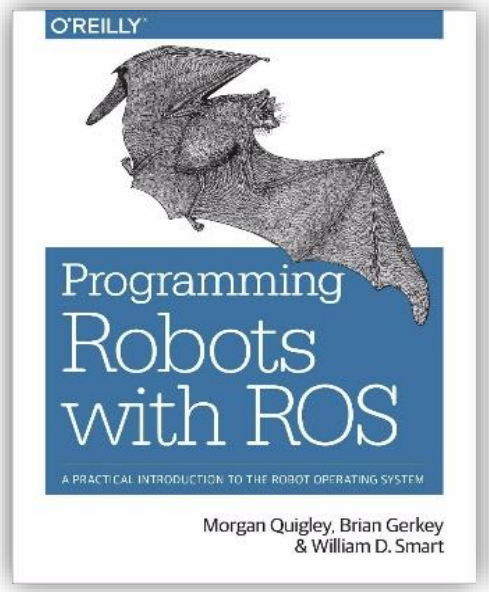
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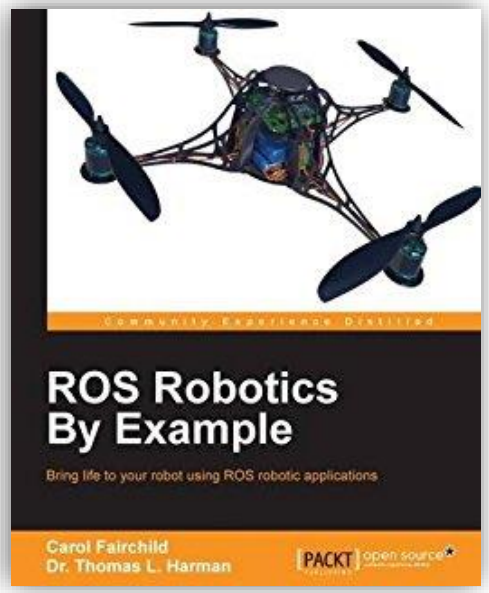
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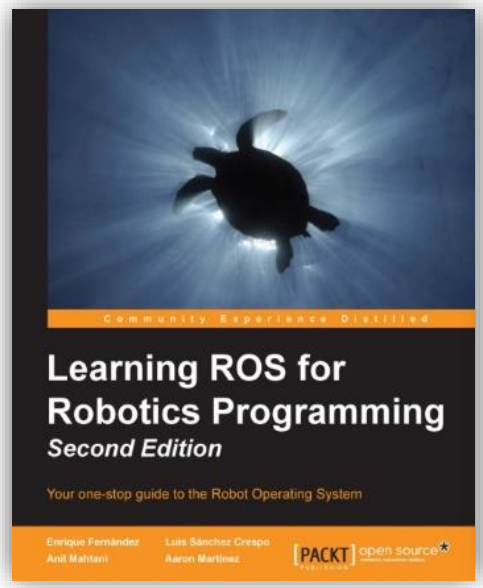
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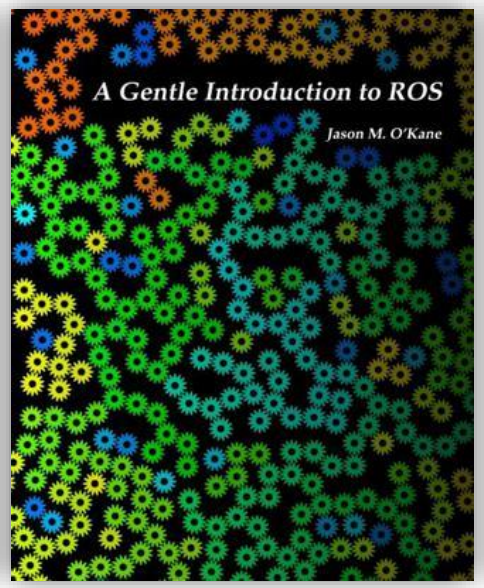
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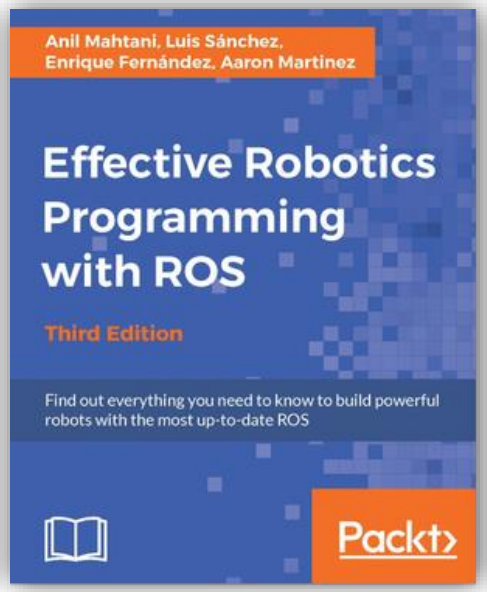
Anil Mahtani, Luis Sánchez, Enrique Fernández, Aaron Martinez
Effective Robotics Programming with ROS
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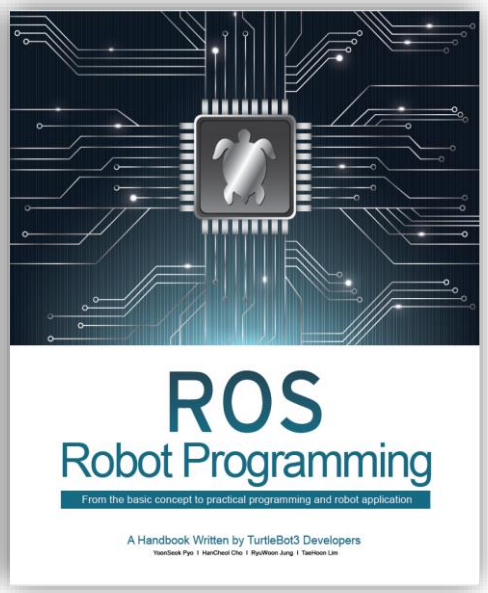
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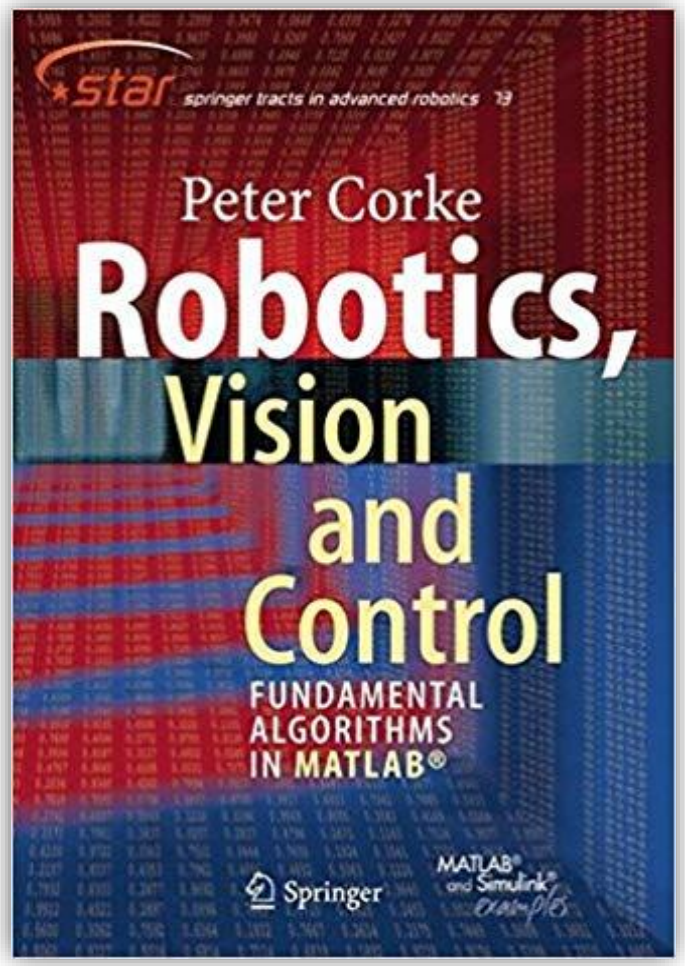

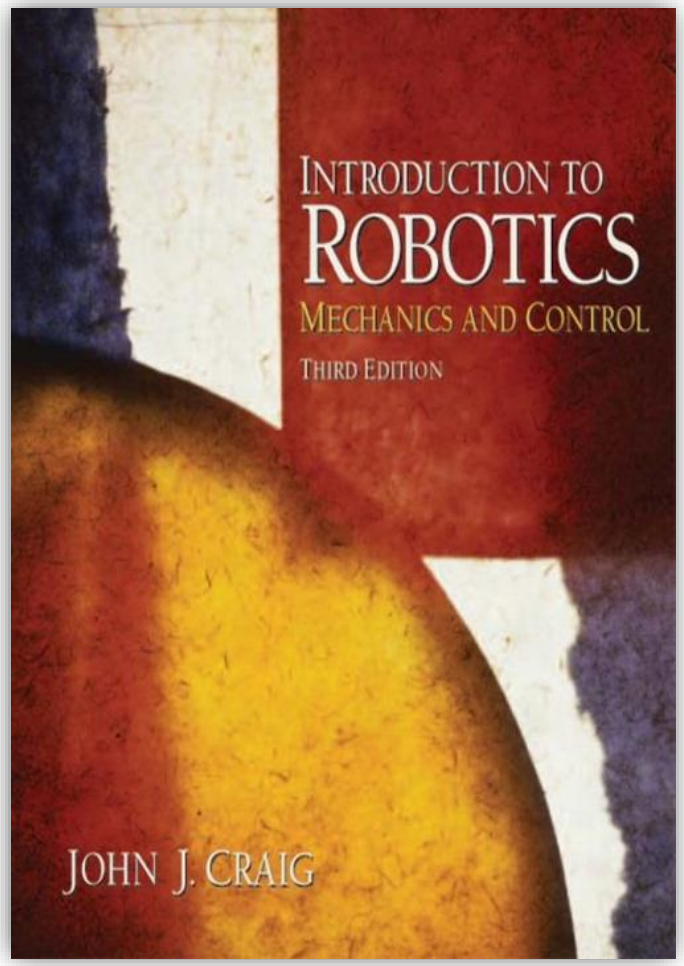

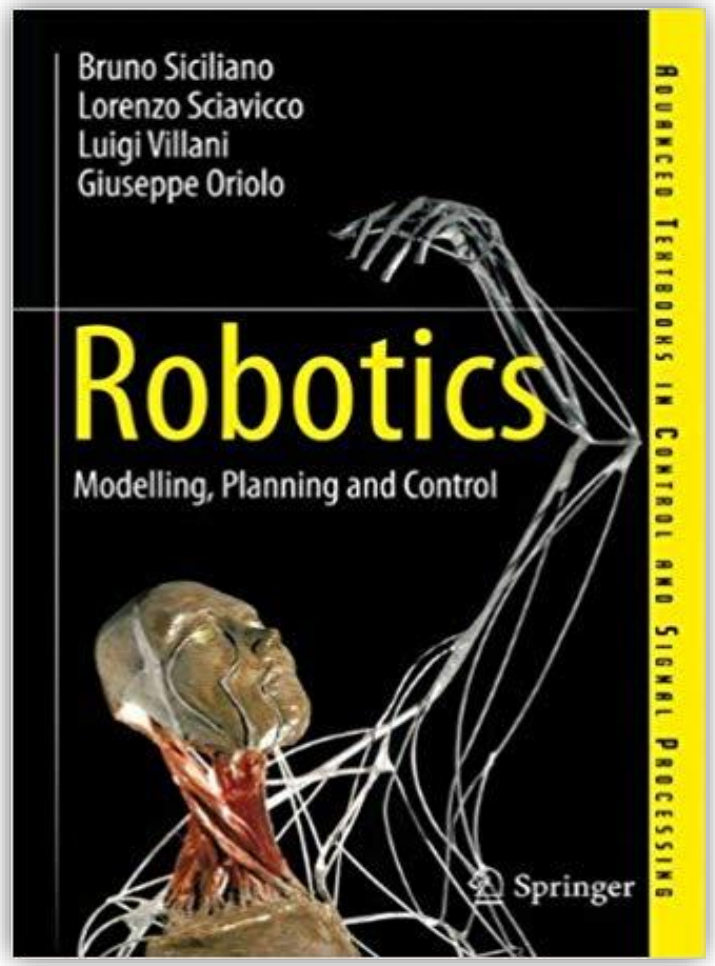

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