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INFO 802

Master Advanced Mechatronics

Luc Marechal

UNIVERSITÉ SAVOIE MONT BLANC

POLYTECH ANNECY-CHAMBÉRY

ROS

Environment Setup Tutorial 1

Exercice 1 - Bash

1– What is the bashrc file ? --> it is a script file that's executed every time you open a Terminal it contains your preferences, configurations and environmental variables.

2 – Where is located your bashrc file? --> In the home folder: ~/

3 – Edit your bashrc file and add *your country name* in the following environment variable to your system:

MY_COUNTRY

```
> nano ~/.bashrc
```

4 – Source your environment

```
> source  ~/.bashrc
```

5 – Check that your variable exists with the command: ***echo***

```
> echo $MY_COUNTRY
```

Exercice 2 – Create your catkin workspace

1 – Create a catkin ROS Workspace named : *catkin_ws*

Explain each command

```
> mkdir -p ~/catkin_ws/src

> cd ~/catkin_ws/src

> catkin_init_workspace

> cd ~/catkin_ws

> catkin_make
```

--> create a new folder named catkin_ws and inside a folder named *src*

--> navigate to folder ~/catkin_ws/src

--> catkin_init_workspace

--> navigate to folder ~/catkin_ws

--> build any packages located in ~/catkin_ws/src.
always call catkin_make in the root of your catkin workspace

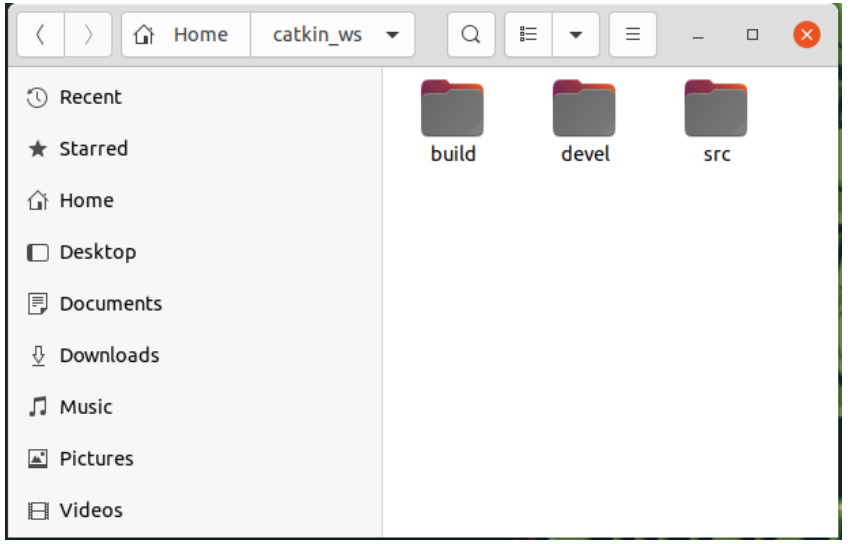
More info
http://wiki.ros.org/catkin/Tutorials/create_a_workspace

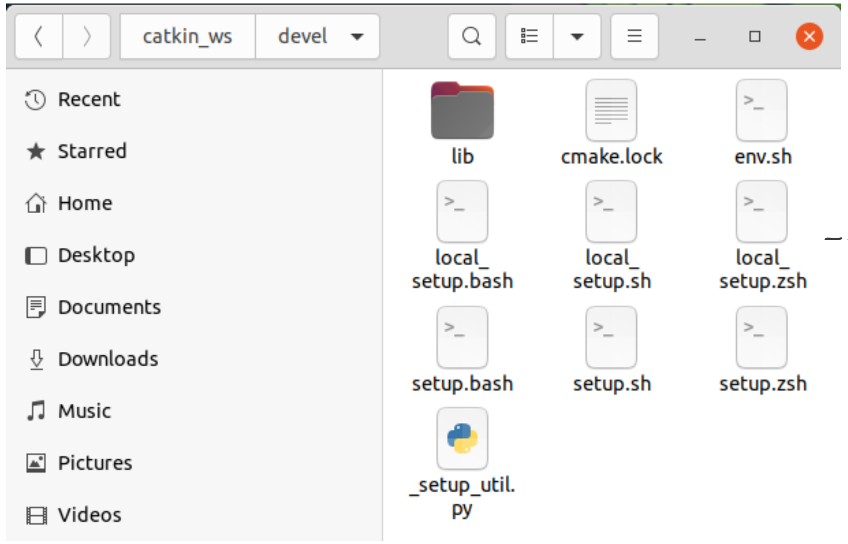
Exercice 2 – Create your catkin workspace

If you look in your current directory you should now have a 'build' and 'devel' folder.

Inside the 'devel' folder you can see that there are now several setup.*sh files.

Sourcing any of these files will overlay this workspace on top of your environment.





--> Automatically generated when you create a catkin workspace

More info
http://wiki.ros.org/catkin/Tutorials/create_a_workspace

Exercice 2 – Create your catkin workspace

2 – Before continuing, source your new setup.*sh file

Explain what it does

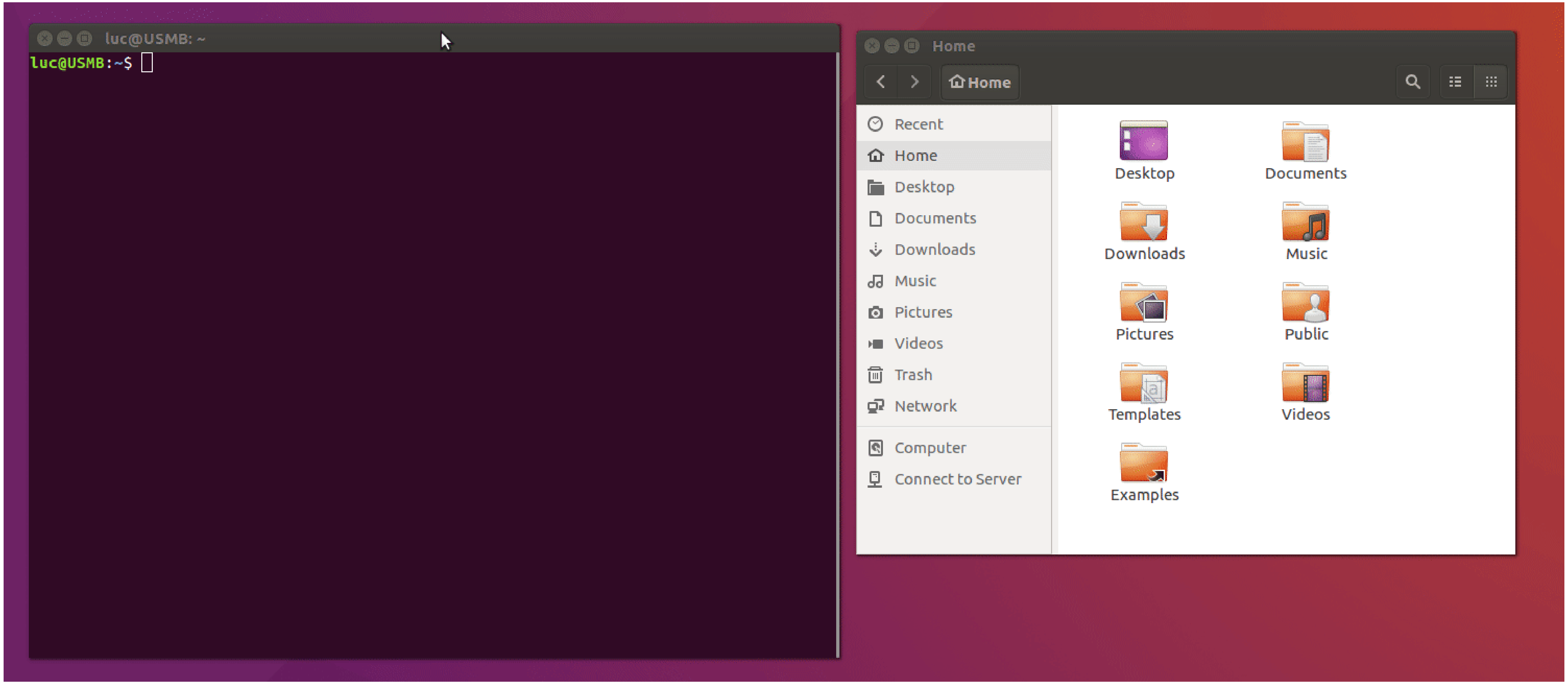
```
> source devel/setup.bash
```

--> It adds the workspace to your ROS environment

3 – Check your workspace is properly overlayed by the setup script, make sure *ROS_PACKAGE_PATH* environment variable includes the directory you're in.

```
> echo $ROS_PACKAGE_PATH
```

Exercice 2 – Create your catkin workspace: *Catkin_ws*

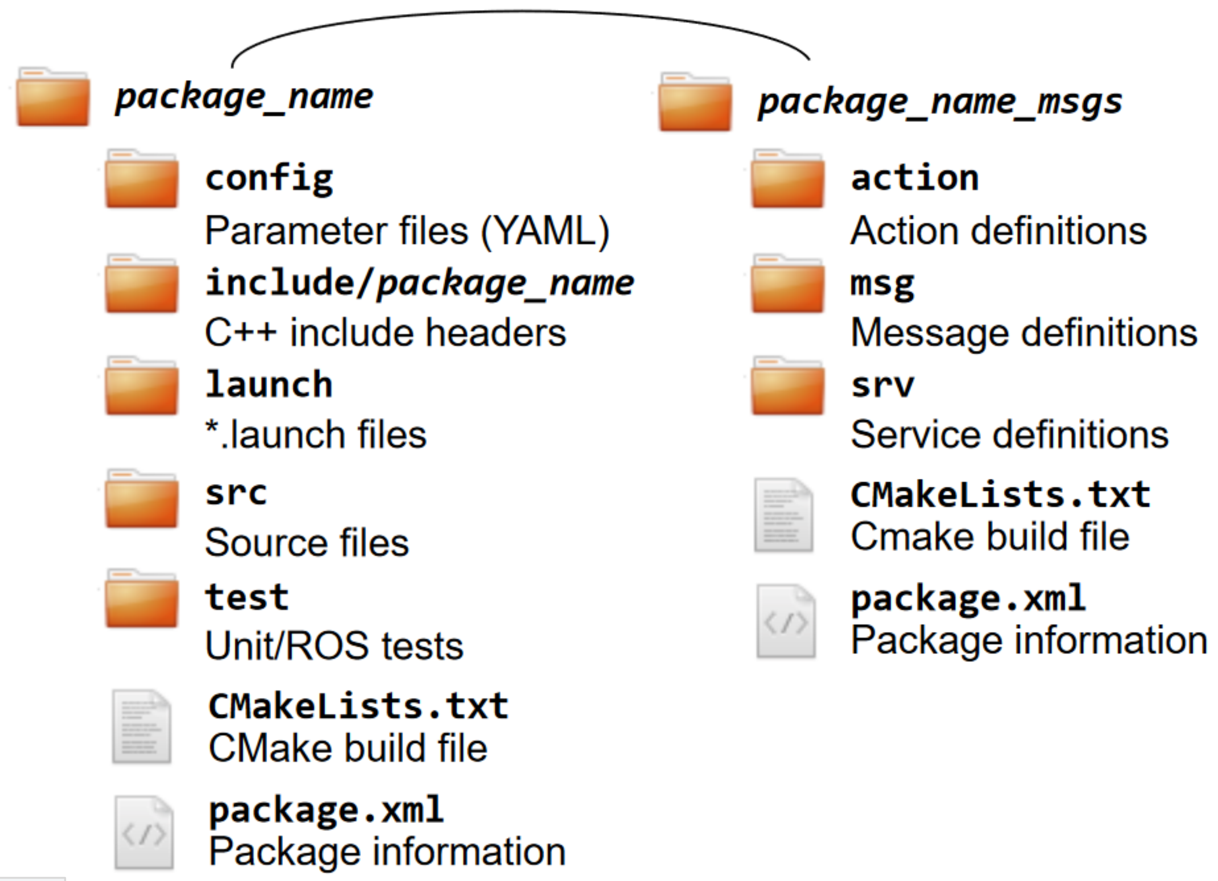


```
luc@USMB:~$ 
```

Exercice 3 – Create a ROS Package

Separate message definition packages from other packages!

- ROS software is organized into packages, which can contain source code, launch files, configuration files, message definitions, data, and documentation
- A package that builds up on/requires other packages (e.g. message definitions), declares these as dependencies



To create a new package, use

```
> cd ~/catkin_ws/src
> catkin_create_pkg package_name {dependencies}
```

More info
http://wiki.ros.org/Packages

Exercice 3 – Create a ROS Package

1 – Create a ROS package named : *beginner_tutorials_pkg*

```
> cd ~/catkin_ws/src

> catkin_create_pkg beginner_tutorials_pkg rospy std_msg
```

you must be in the src folder of the catkin workspace

$\underbrace{\texttt{catkin\_create\_pkg}}_{\text{Catkin function}}\ \underbrace{\texttt{beginner\_tutorials\_pkg}}_{\text{Package name}}\ \underbrace{\texttt{rospy std\_msg}}_{\text{Dependencies}}$

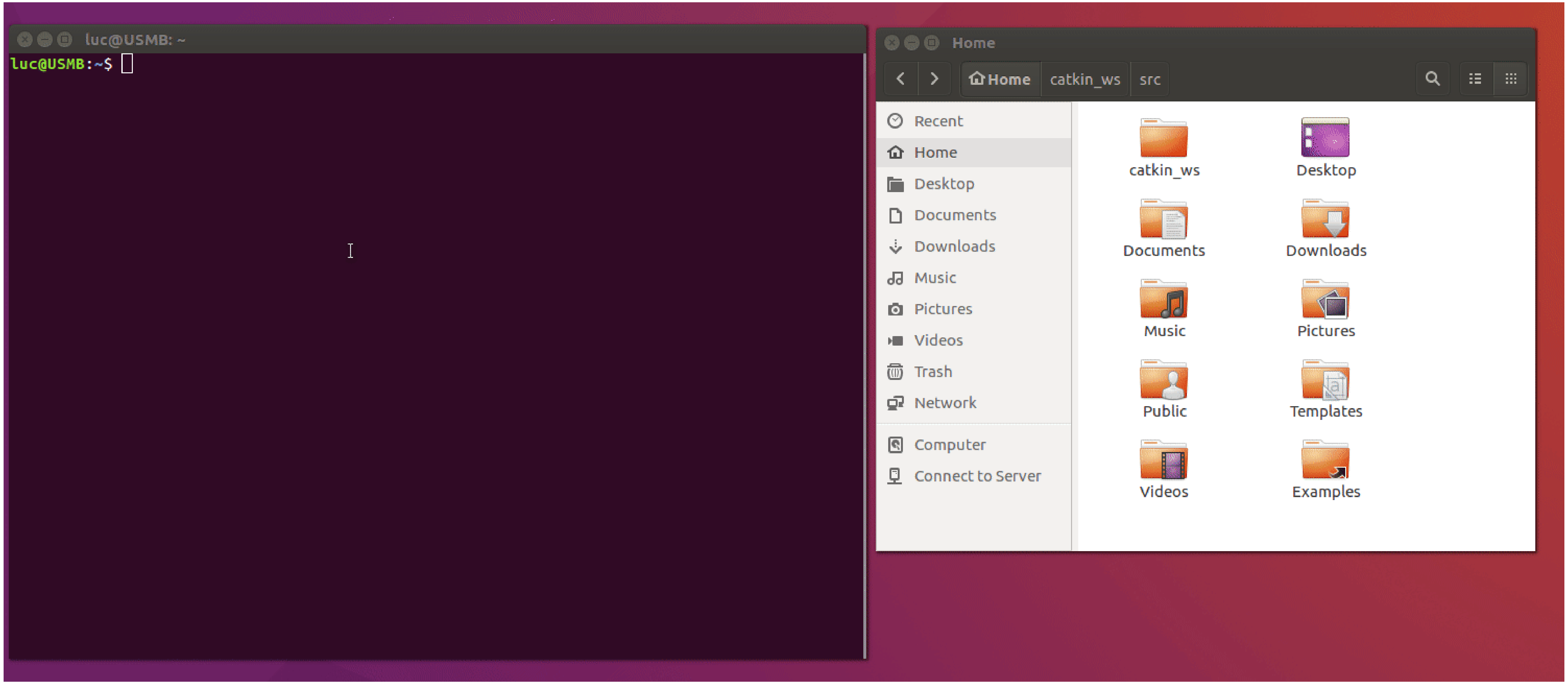
(other packages that we will use and that already exist elsewhere)

2 - Whenever you build a new package, update your environment

```
> source ~/catkin_ws/devel/setup.bash
```

More info
http://wiki.ros.org/Packages

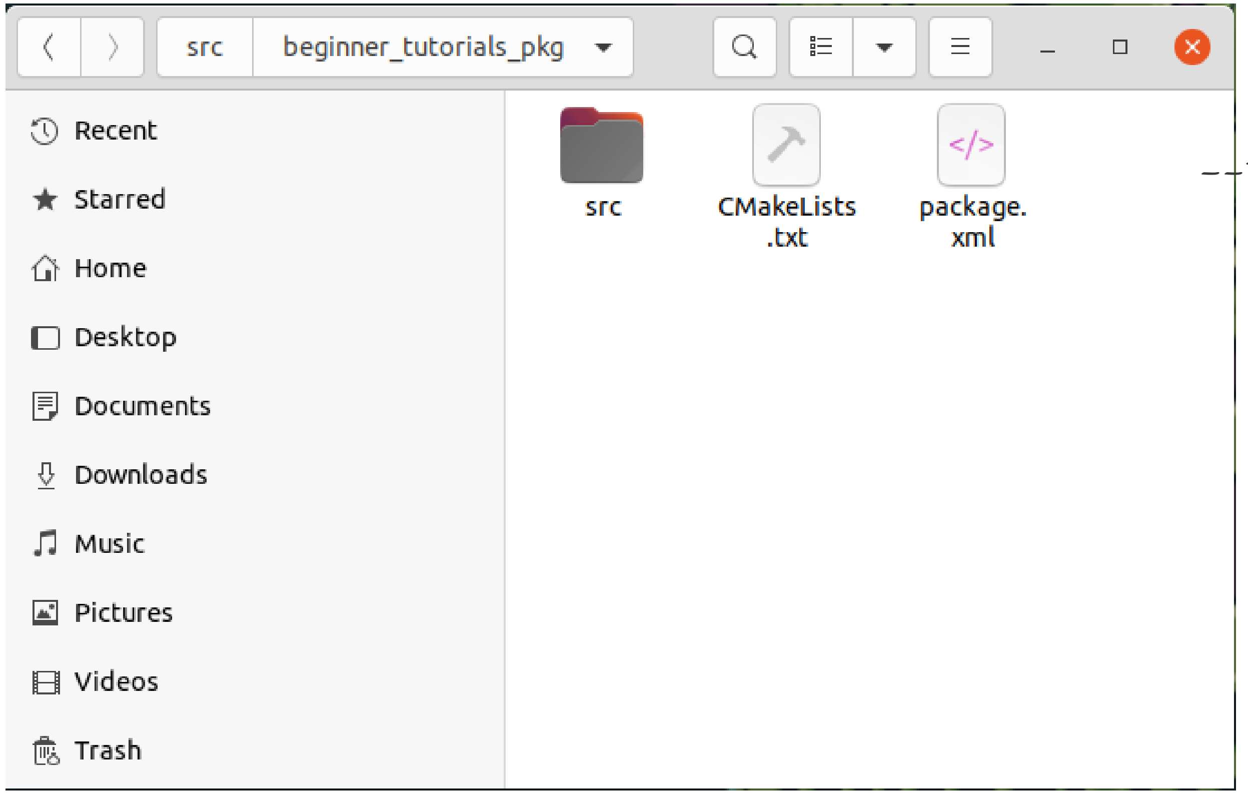
Creating a ROS package : *beginner_tutorials*



```
luc@USMB:~$ 
```

ROS Package

package.xml and CMakeLists.txt files



--> Automatically generated when you create a package

ROS Package

package.xml

- The package.xml defines properties of the package
  - <name>	Package name
  - <version>	Version numbers
  - <description>	Description of the content
  - <maintainer>	Person maintaning the package
  - <licence>	Type of licence (usualy BSD)
  - Dependencies on other catkin packages

    The dependencies are split into :
    build_depend, buildtool_depend, exec_depend, test_depend
  - and more

```
<?xml version="1.0"?>
<package format="2">
<name>beginner_tutorials_pkg</name>
<version>0.1.0</version>
<description>A ROS packages for beginnner</description>
<maintainer email="luc.marechal@univ-smb.fr">Luc</maintainer>
<license>BSD</license>

<url type="website">https://github.com/my_project/ros_…</url>
<author email="luc.marechal@univ-smb.fr">Luc Mare</author>

<buildtool_depend>catkin</buildtool_depend>

<build_depend>rospy</build_depend>
<build_depend>std_msgs</build_depend>

<run_depend>rospy</run_depend>
<run_depend>std_msgs</run_depend>
</package>
```

This file must be included with the catkin package's root folder

If dependencies are missing or incorrect, you may be able to build from source and run tests on your own machine, but your package will not work correctly when released to the ROS community.

ROS Package

CMakeLists.txt

The `CMakeLists.txt` is the input to the CMakebuild system

1. Required CMake Version (`cmake_minimum_required`)
2. Package Name (`project()`)
3. Find other CMake/Catkin packages needed for build (`find_package()`)
4. Message/Service/Action Generators (`add_message_files()`, `add_service_files()`, `add_action_files()`)
5. Invoke message/service/action generation (`generate_messages()`)
6. Specify package build info export (`catkin_package()`)
7. Libraries/Executables to build (`add_library()`/`add_executable()`/`target_link_libraries()`)
8. Tests to build (`catkin_add_gtest()`)
9. Install rules (`install()`)

CMakeLists.txt

```
cmake_minimum_required(VERSION 2.8.3)
project(ros_package_template)

## Use C++11
add_definitions(--std=c++11)

## Find catkin macros and libraries
find_package(catkin REQUIRED
  COMPONENTS
    roscpp
    sensor_msgs
)

…
```

More info
http://wiki.ros.org/catkin/CMakeLists.txt

ROS Package

CMakeLists.txt Example

```
cmake_minimum_required(VERSION 2.8.3)
project(husky_highlevel_controller)
add_definitions(--std=c++11)

find_package(catkin REQUIRED
  COMPONENTS roscpp sensor_msgs
)

catkin_package(
  INCLUDE_DIRS include
  # LIBRARIES
  CATKIN_DEPENDS roscpp sensor_msgs
  # DEPENDS
)

include_directories(include ${catkin_INCLUDE_DIRS})

add_executable(${PROJECT_NAME} src/${PROJECT_NAME}_node.cpp
src/HuskyHighlevelController.cpp)

target_link_libraries(${PROJECT_NAME} ${catkin_LIBRARIES})
```

Use the same name as in the `package.xml`

We use C++11 by default

List the packages that your package requires to build (have to be listed in `package.xml`)

Specify build export information
- `INCLUDE_DIRS`: Directories with header files
- `LIBRARIES`: Libraries created in this project
- `CATKIN_DEPENDS`: Packages dependent projects also need
- `DEPENDS`: System dependencies dependent projects also need (have to be listed in `package.xml`)

Specify locations of header files

Declare a C++ executable

Specify libraries to link the executable against

ROS System File

Commands

Get information on packages

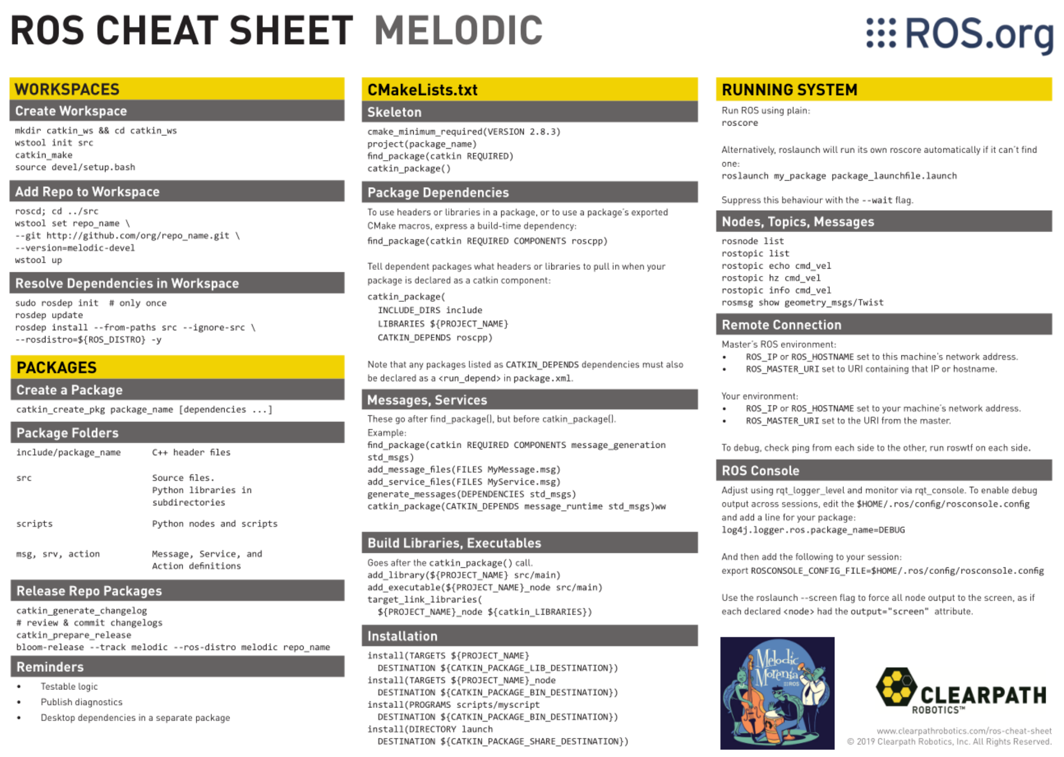
```
> rospack find [package_name]
```

Change directory (cd) directly to a package or a stack

```
> roscd [location_name[/subdir]]
```

ls directly in a package by name rather than by absolute path

```
> rosls [location_name[/subdir]]
```



ROS CHEAT SHEET MELODIC

ROS.org

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=melodic-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 melodic --ros-distro melodic 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™

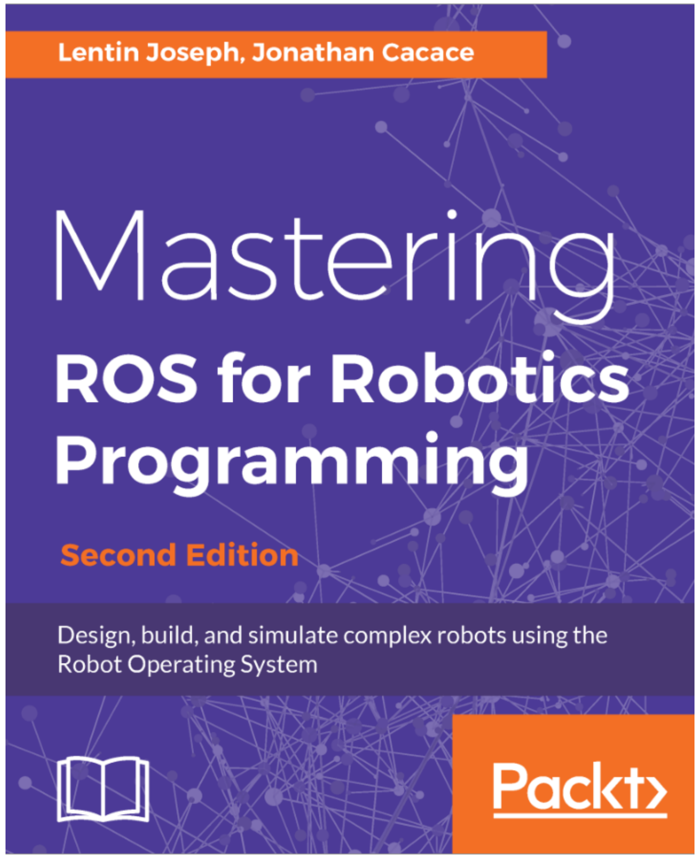
More info

http://wiki.ros.org/ROS/Tutorials/NavigatingTheFilesystem

Further References

- ROS Wiki
  - http://wiki.ros.org/
- Installation
  - http://wiki.ros.org/ROS/Installation
- Tutorials
  - http://wiki.ros.org/ROS/Tutorials
- Available packages
  - http://www.ros.org/browse/
- ROS Cheat Sheet
  - https://www.clearpathrobotics.com/ros-robot-operating-system-cheat-sheet/
  - https://kapeli.com/cheat_sheets/ROS.docset/
- ROS Best Practices
  - https://github.com/leggedrobotics/ros_best_practices/wiki
- ROS Package Template
  - https://github.com/leggedrobotics/ros_best_practices/tree/master/ros_package_template

Relevant books

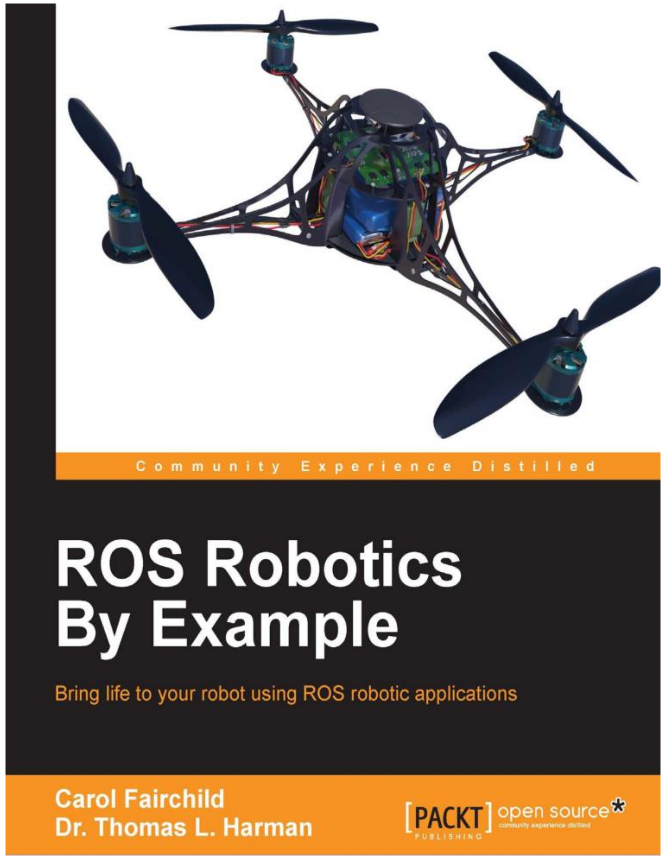

Lentin Joseph, Jonathan Cacace

Mastering ROS for Robotics Programming

Second Edition

Design, build, and simulate complex robots using the Robot Operating System

Packt>

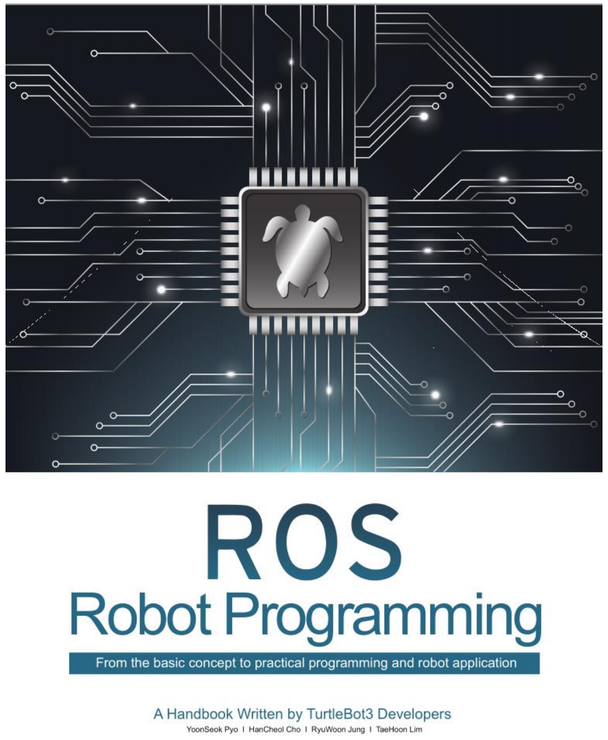

Community Experience Distilled

ROS Robotics By Example

Bring life to your robot using ROS robotic applications

Carol Fairchild
Dr. Thomas L. Harman

[PACKT] PUBLISHING open source*


ROS Robot Programming

From the basic concept to practical programming and robot application

A Handbook Written by TurtleBot3 Developers
YoonSeok Pyo I HanCheol Cho I RyuWoon Jung I TaeHoon Lim

Contact Information

Université Savoie Mont Blanc

Polytech' Annecy Chambery
Chemin de Bellevue
74940 Annecy
France

https://www.polytech.univ-savoie.fr

Lecturer

Luc Marechal (luc.marechal@univ-smb.fr)
SYMME Lab (Systems and Materials for Mechatronics)