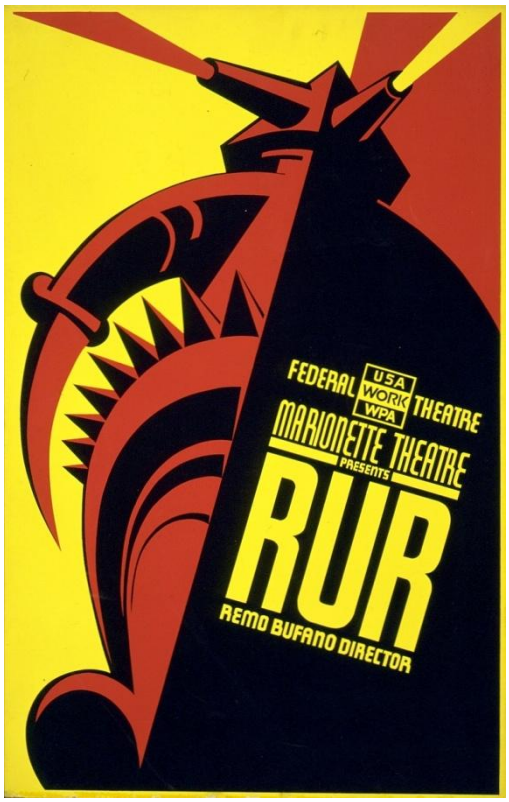
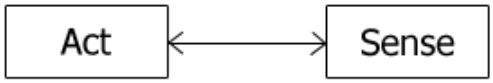
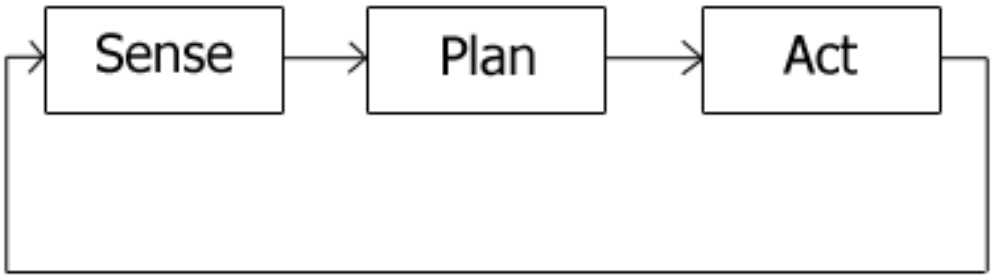
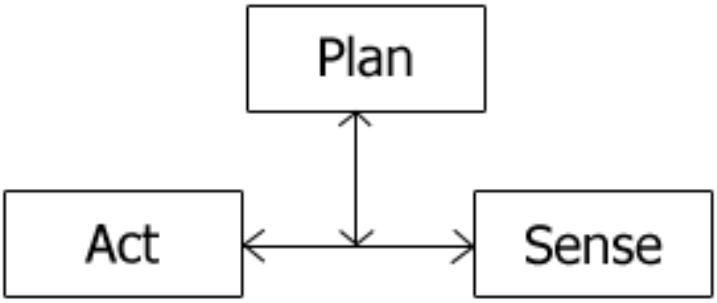
Chapter 1, Introduction to Robotics

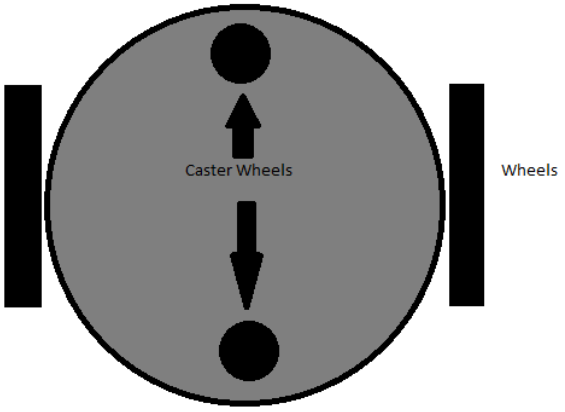


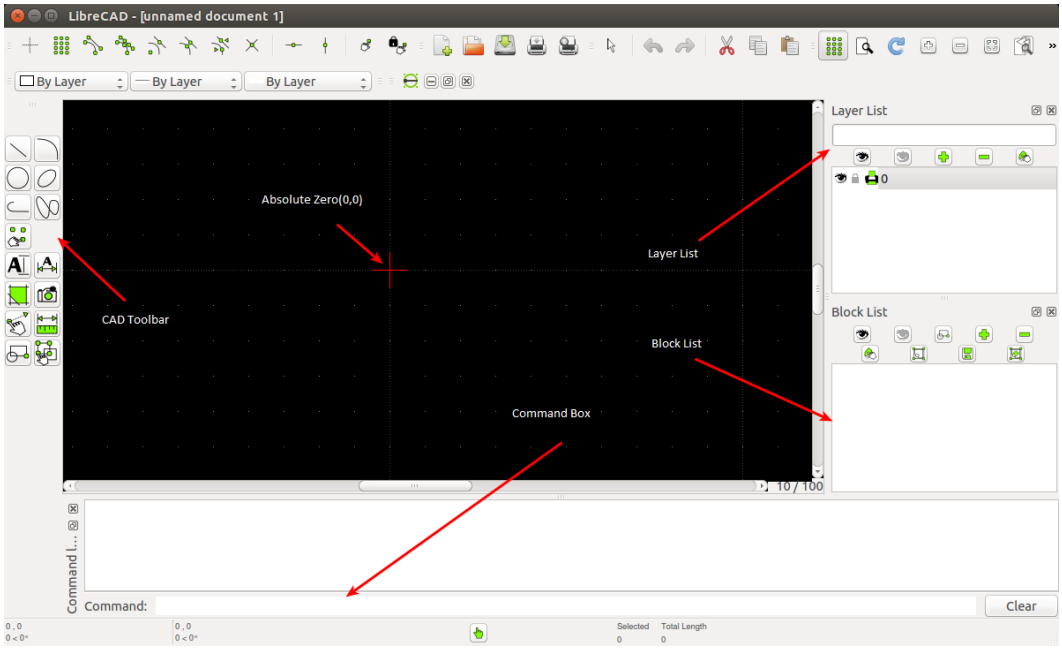

Act
Sense

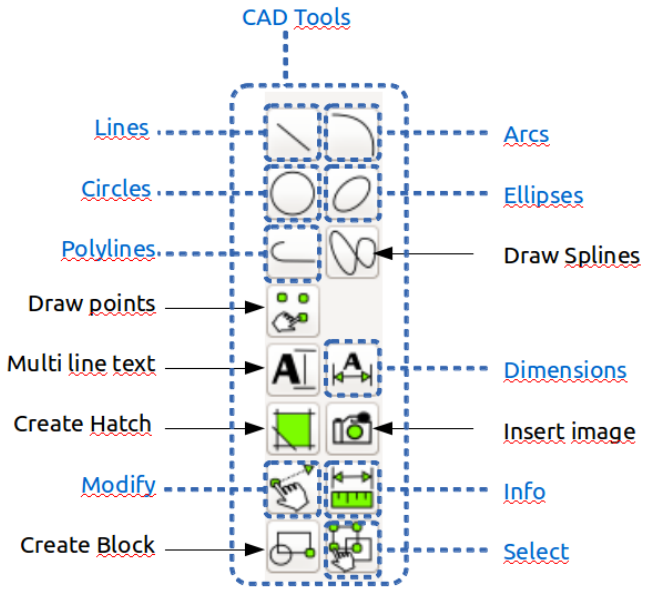

Sense
Plan
Act


Plan
Act
Sense

Chapter 2, Mechanical Design of Service Robot






CAD Tools
Lines
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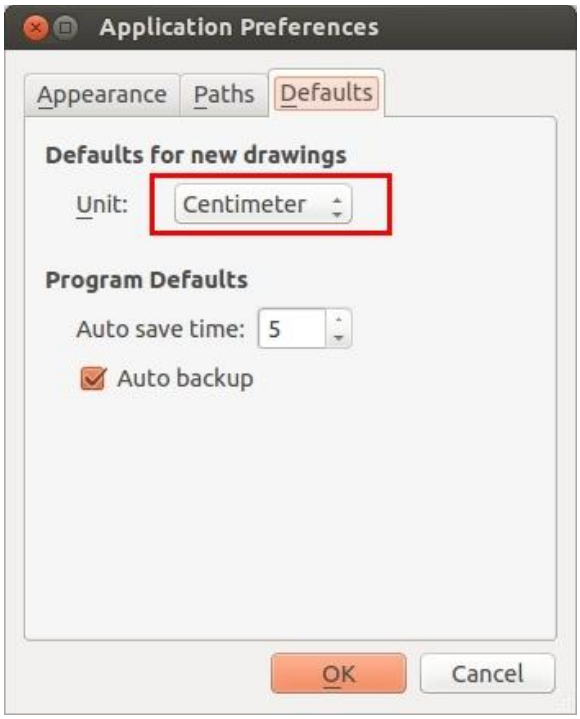
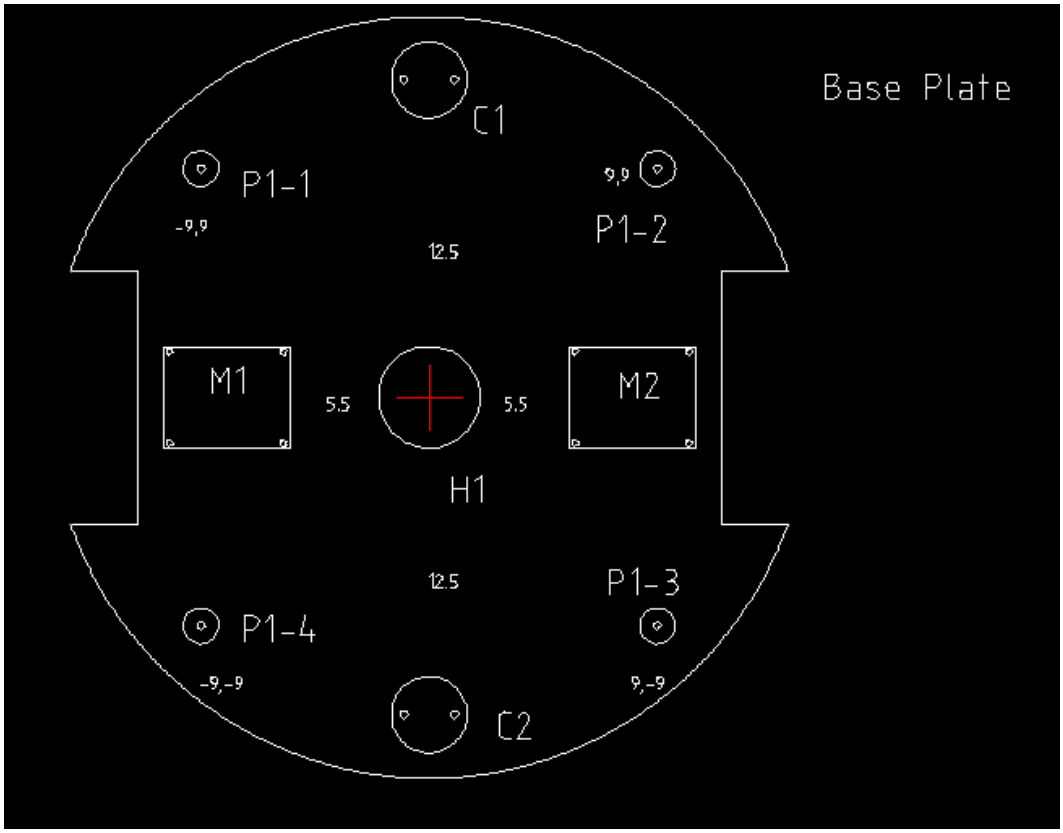
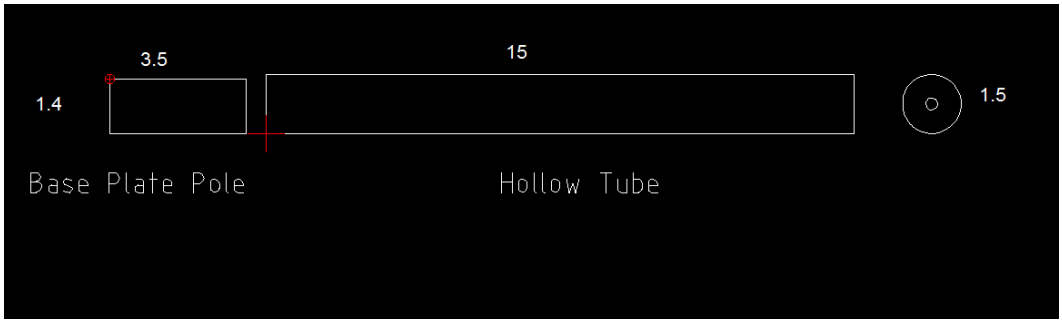
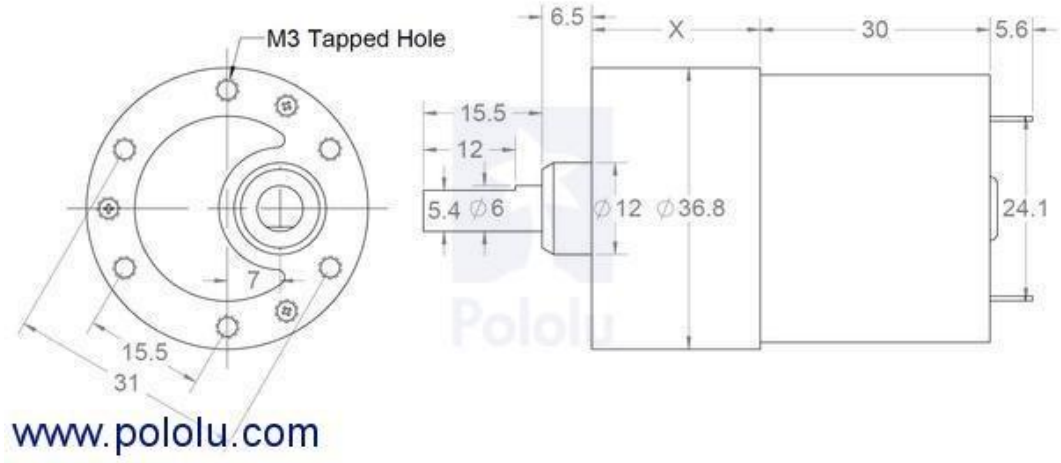
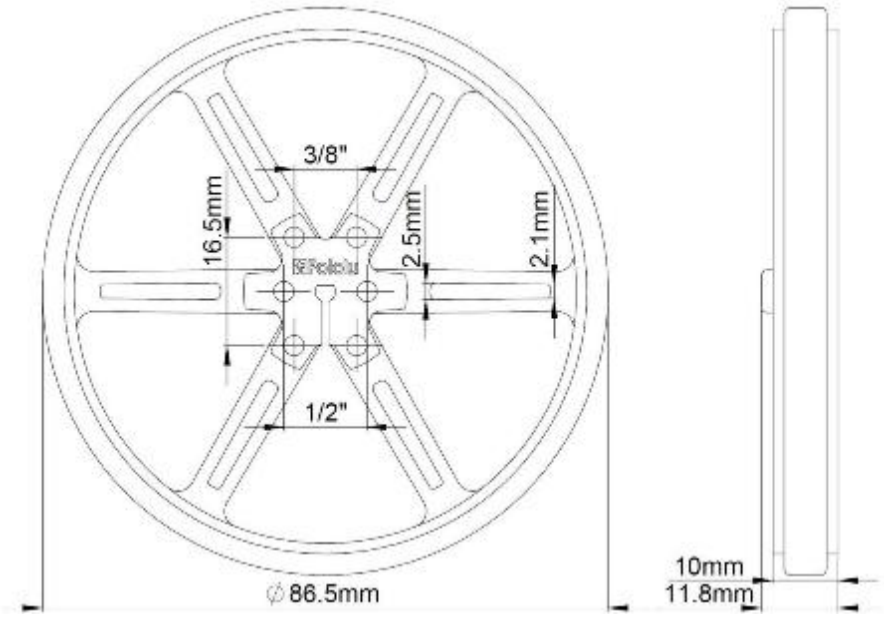
Circles
Ellipses
Polylines
Draw Splines
Draw points
Multi line text
Dimensions
Create Hatch
Insert image
Modify
Info
Create Block
Select

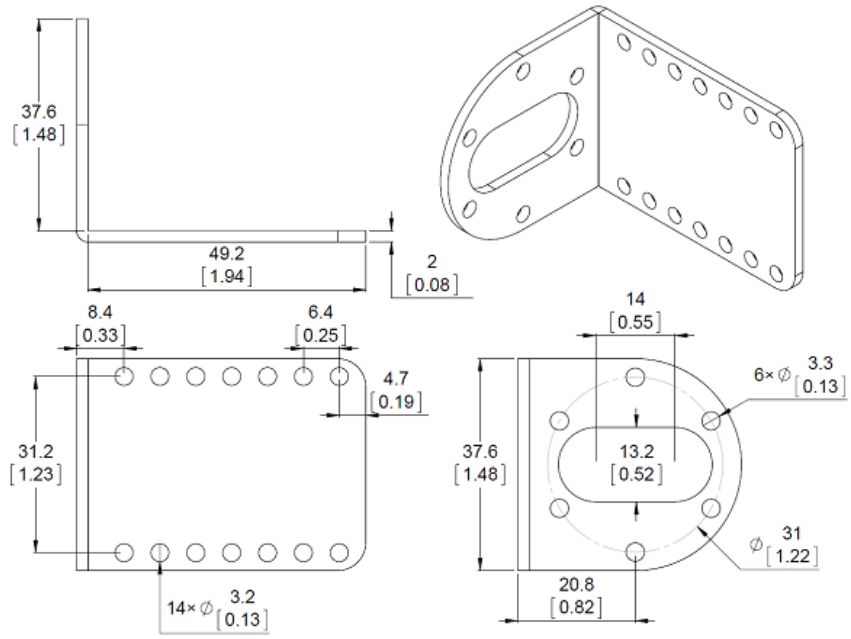

Application Preferences
Appearance
Paths
Defaults
Defaults for new drawings
Unit:
Centimeter
Program Defaults
Auto save time:
5
Auto backup
OK
Cancel


Base Plate
C1
P1-1
-9,9
9,9
P1-2
12.5
M1
5.5
5.5
M2
H1
12.5
P1-3
P1-4
-9,-9
9,-9
C2

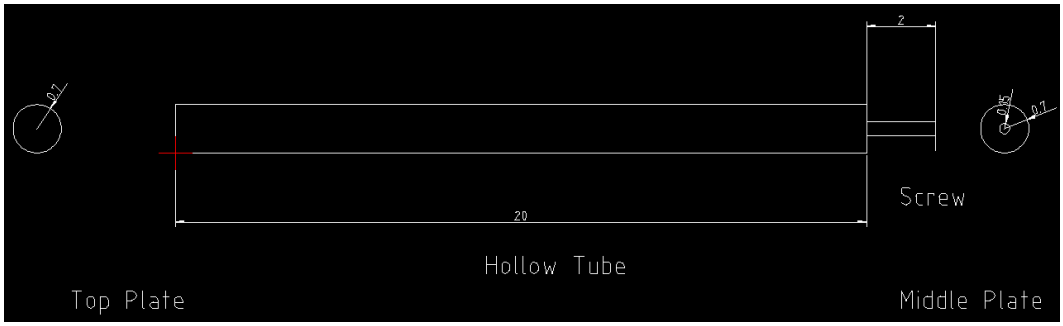

3.5
15
1.4
1.5
Base Plate Pole
Hollow Tube

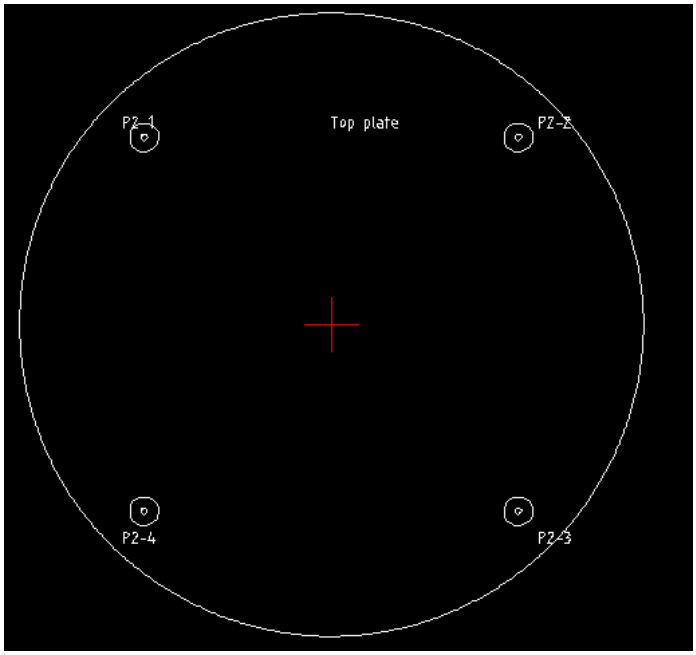

M3 Tapped Hole
6.5
X
30
5.6
15.5
12
5.4
Ø6
Ø12
Ø36.8
24.1
7
15.5
31
www.pololu.com

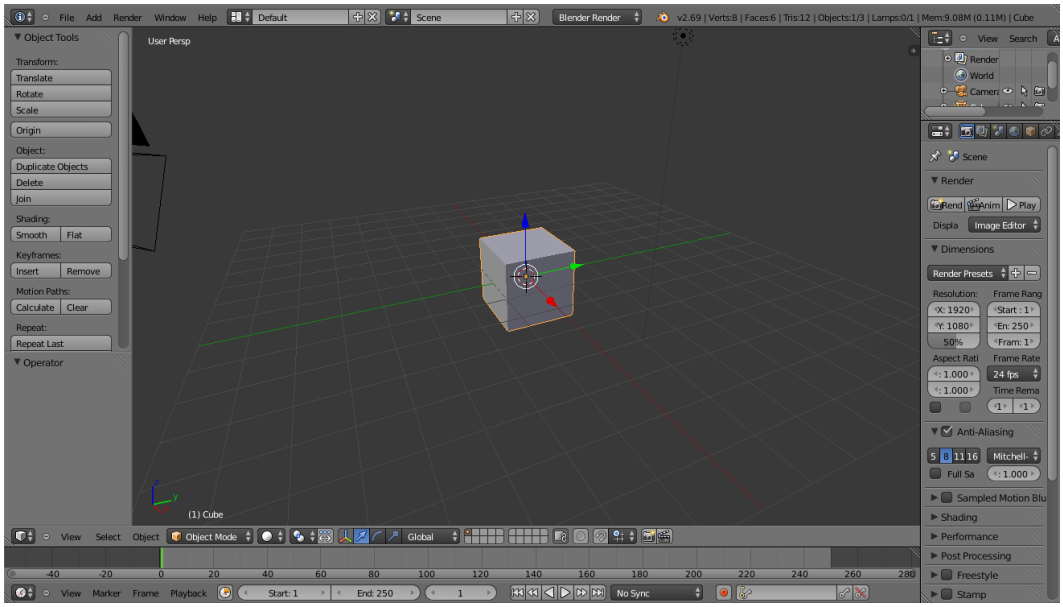

3/8"
16.5mm
2.5mm
2.1mm
1/2"
⌀86.5mm
10mm
11.8mm


37.6
[1.48]
49.2
[1.94]
2
[0.08]
8.4
[0.33]
6.4
[0.25]
4.7
[0.19]
31.2
[1.23]
14× ⌀ 3.2
[0.13]
14
[0.55]
6× ⌀ 3.3
[0.13]
37.6
[1.48]
13.2
[0.52]
⌀ 31
[1.22]
20.8
[0.82]


Middle__Plate


2
Screw
20
Hollow Tube
Top Plate
Middle Plate


P2-1
Top plate
P2-2
P2-4
P2-3


File Add Render Window Help Default Scene Blender Render v2.69 | Verts:8 | Faces:6 | Tris:12 | Objects:1/3 | Lamps:0/1 | Mem:9.08M (0.11M) | Cube
Object Tools
Transform:
Translate
Rotate
Scale
Origin
Object:
Duplicate Objects
Delete
Join
Shading:
Smooth
Flat
Keyframes:
Insert
Remove
Motion Paths:
Calculate
Clear
Repeat:
Repeat Last
Operator
User Persp
(1) Cube
View Select Object Object Mode Global
View Marker Frame Playback Start: 1 End: 250 1 No Sync
View Search
Render
World
Camera
Scene
Render
Rend
Anim
Play
Displa
Image Editor
Dimensions
Render Presets
Resolution:
X: 1920
Y: 1080
50%
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Start : 1
En: 250
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Frame Rate
24 fps
Time Rema
Anti-Aliasing
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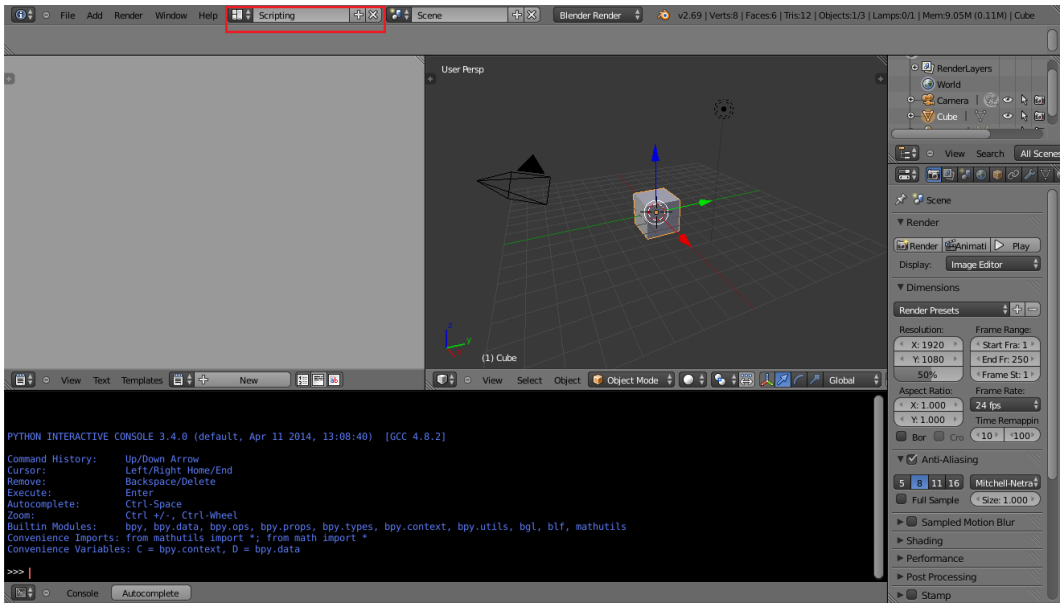
1.000
Sampled Motion Blu
Shading
Performance
Post Processing
Freestyle
Stamp


File Add Render Window Help Scripting Scene Blender Render v2.69 | Verts:8 | Faces:6 | Tris:12 | Objects:1/3 | Lamps:0/1 | Mem:9.05M (0.11M) | Cube
User Persp
(1) Cube
View Text Templates New
View Select Object Object Mode Global
PYTHON INTERACTIVE CONSOLE 3.4.0 (default, Apr 11 2014, 13:08:40) [GCC 4.8.2]
Command History: Up/Down Arrow
Cursor: Left/Right Home/End
Remove: Backspace/Delete
Execute: Enter
Autocomplete: Ctrl-Space
Zoom: Ctrl +/-, Ctrl-Wheel
Builtin Modules: bpy, bpy.data, bpy.ops, bpy.props, bpy.types, bpy.context, bpy.utils, bgl, blf, mathutils
Convenience Imports: from mathutils import *; from math import *
Convenience Variables: C = bpy.context, D = bpy.data
>>>
Console Autocomplete
RenderLayers
World
Camera
Cube
View Search All Scenes
Scene
Render
Render Animati Play
Display: Image Editor
Dimensions
Render Presets
Resolution:
X: 1920
Y: 1080
50%
Frame Range:
Start Fra: 1
End Fr: 250
Frame St: 1
Aspect Ratio:
X: 1.000
Y: 1.000
Frame Rate:
24 fps
Time Remappin
Bor
Cro
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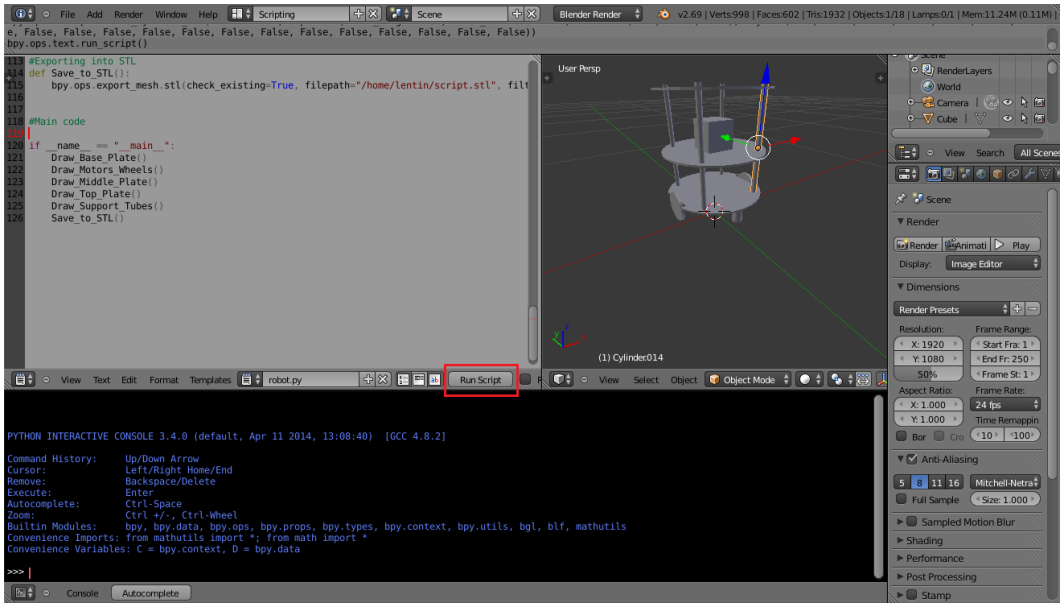
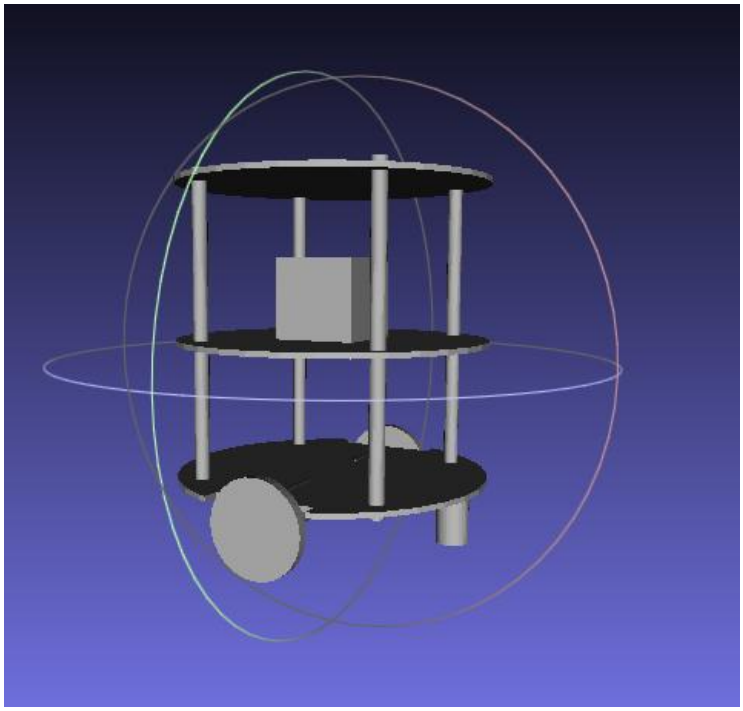
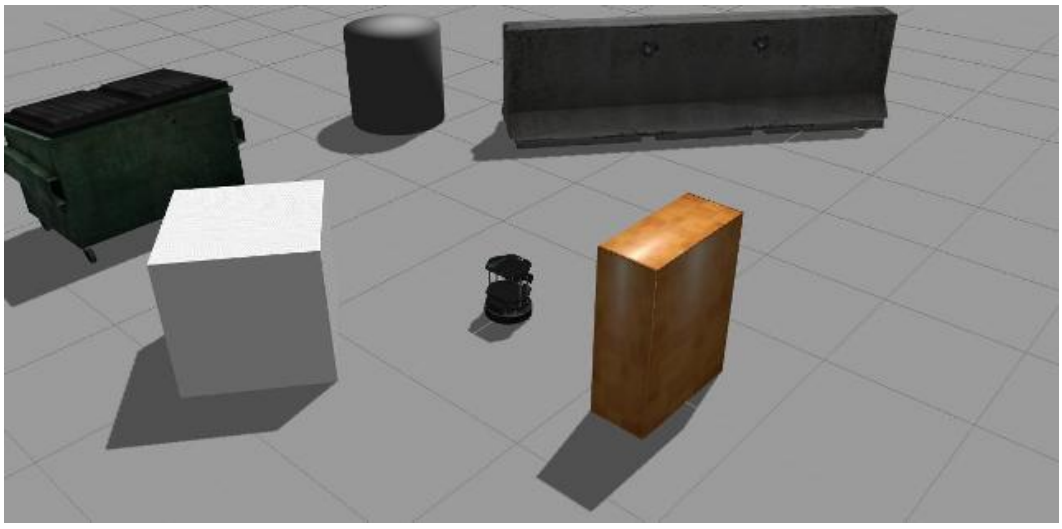
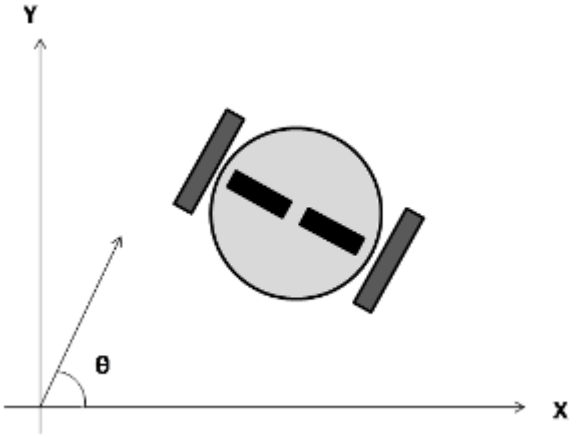
100
Anti-Aliasing
5 8 11 16
Mitchell-Netra
Full Sample
Size: 1.000
Sampled Motion Blur
Shading
Performance
Post Processing
Stamp

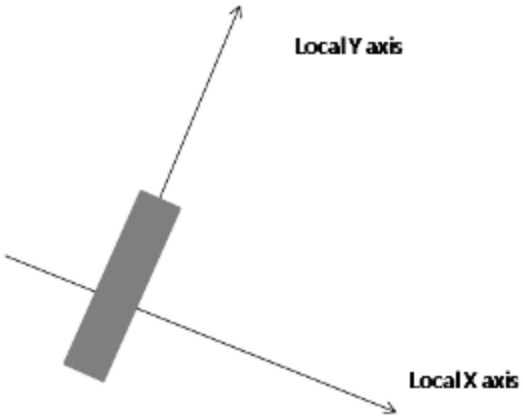

File Add Render Window Help Scripting Scene Blender Render v2.69 | Verts:998 | Faces:602 | Tris:1932 | Objects:1/18 | Lamps:0/1 | Mem:11.24M (0.11M)
bpy.ops.text.run_script()
#Exporting into STL
def Save_to_STL():
bpy.ops.export_mesh.stl(check_existing=True, filepath="/home/lentin/script.stl",
#Main code
if __name__ == "__main__":
Draw_Base_Plate()
Draw_Motors_Wheels()
Draw_Middle_Plate()
Draw_Top_Plate()
Draw_Support_Tubes()
Save_to_STL()
User Persp
(1) Cylinder.014
View Text Edit Format Templates robot.py Run Script
View Select Object Object Mode
PYTHON INTERACTIVE CONSOLE 3.4.0 (default, Apr 11 2014, 13:08:40) [GCC 4.8.2]
Command History: Up/Down Arrow
Cursor: Left/Right Home/End
Remove: Backspace/Delete
Execute: Enter
Autocomplete: Ctrl-Space
Zoom: Ctrl +/-, Ctrl-Wheel
Builtin Modules: bpy, bpy.data, bpy.ops, bpy.props, bpy.types, bpy.context, bpy.utils, bgl, blf, mathutils
Convenience Imports: from mathutils import *; from math import *
Convenience Variables: C = bpy.context, D = bpy.data
>>>
Console Autocomplete
RenderLayers
World
Camera
Cube
View Search All Scenes
Scene
Render
Render Animati Play
Display: Image Editor
Dimensions
Render Presets
Resolution: X: 1920 Y: 1080 50%
Frame Range: Start Fra: 1 End Fr: 250 Frame St: 1
Aspect Ratio: X: 1.000 Y: 1.000
Frame Rate: 24 fps
Anti-Aliasing
5 8 11 16 Mitchell-Netra
Full Sample Size: 1.000
Sampled Motion Blur
Shading
Performance
Post Processing
Stamp

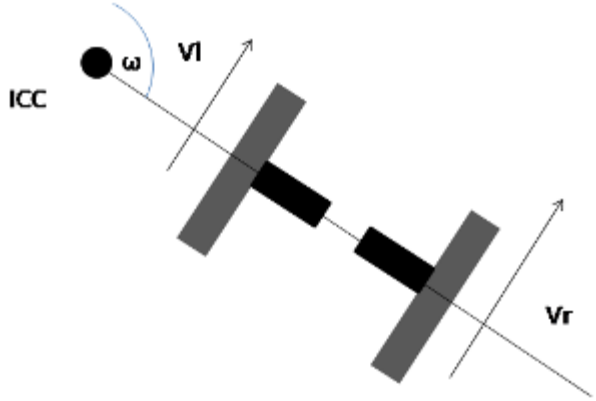


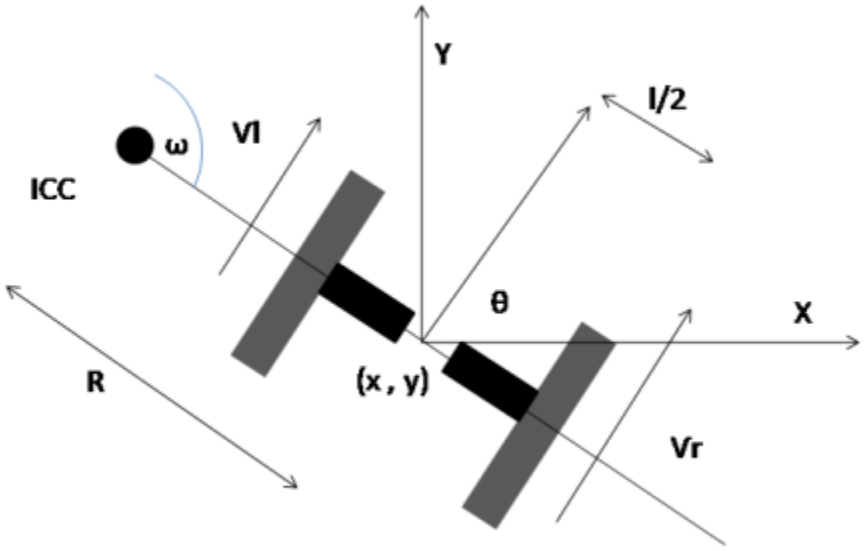
Chapter 3, Working with Robot Simulation Using ROS and Gazebo

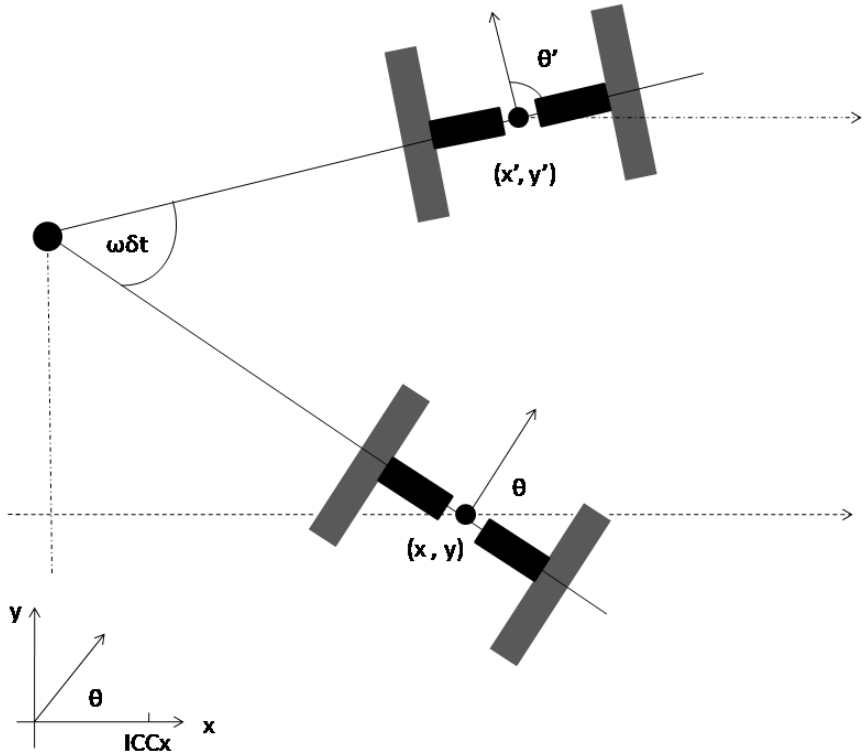


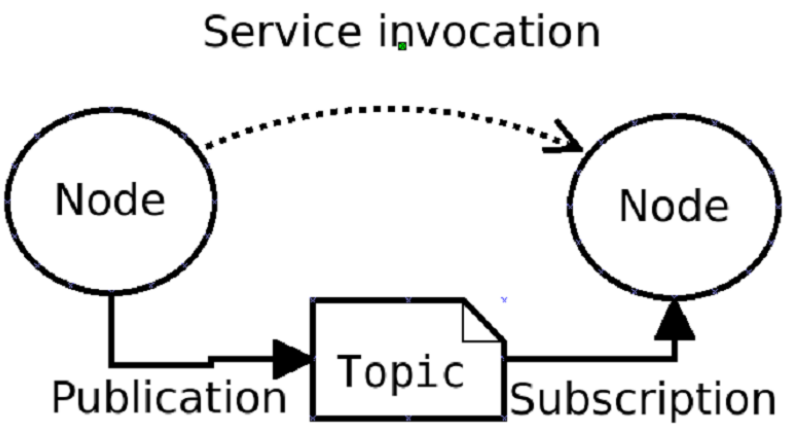


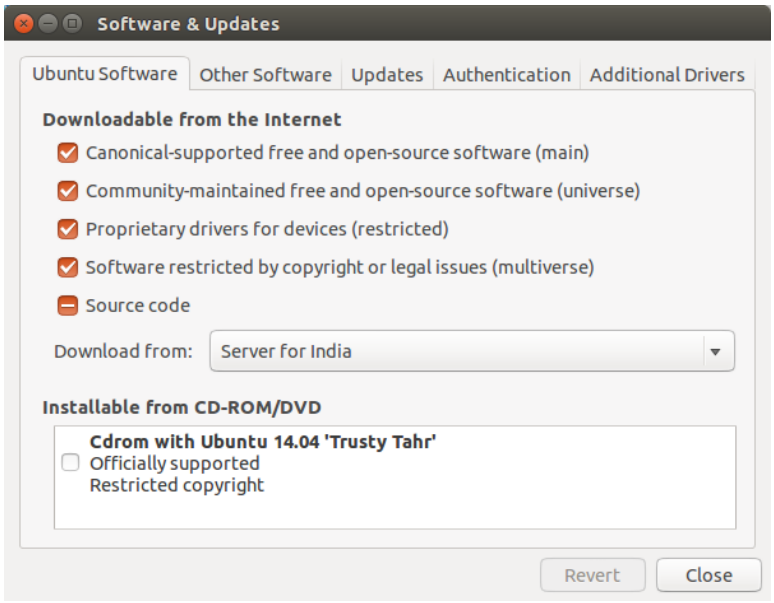

Local Y axis
Local X axis

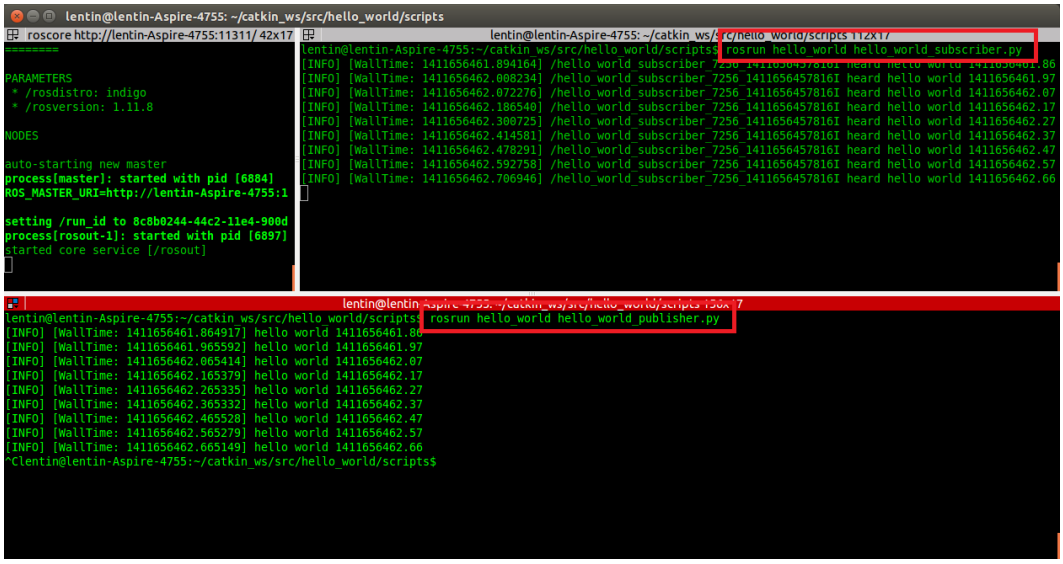

ω
Vl
ICC
Vr

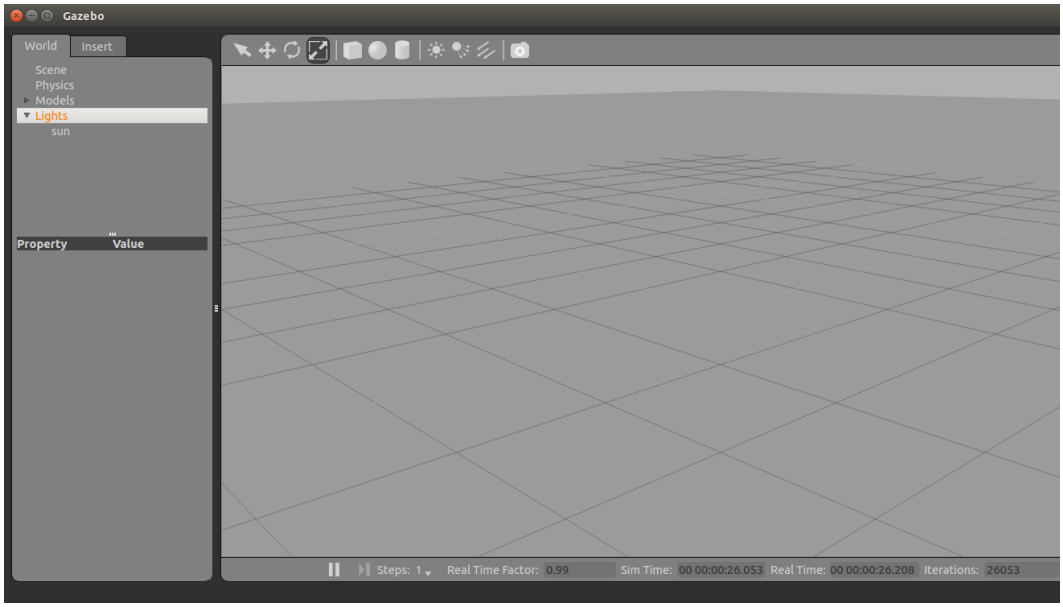

Y
l/2
ω
Vl
ICC
θ
X
R
(x , y)
Vr


θ'
(x', y')
ωδt
θ
(x , y)
y
θ
x
ICCx


Service invocation
Node
Node
Topic
Publication
Subscription


Software & Updates
Ubuntu Software
Other Software
Updates
Authentication
Additional Drivers
Downloadable from the Internet
Canonical-supported free and open-source software (main)
Community-maintained free and open-source software (universe)
Proprietary drivers for devices (restricted)
Software restricted by copyright or legal issues (multiverse)
Source code
Download from:
Server for India
Installable from CD-ROM/DVD
Cdrom with Ubuntu 14.04 'Trusty Tahr'
Officially supported
Restricted copyright
Revert
Close


lentin@lentin-Aspire-4755: ~/catkin_ws/src/hello_world/scripts
roscore http://lentin-Aspire-4755:11311/ 42x17
PARAMETERS
* /rosdistro: indigo
* /rosversion: 1.11.8
NODES
auto-starting new master
process[master]: started with pid [6884]
ROS_MASTER_URI=http://lentin-Aspire-4755:1
setting /run_id to 8c8b0244-44c2-11e4-900d
process[rosout-1]: started with pid [6897]
started core service [/rosout]
lentin@lentin-Aspire-4755:~/catkin_ws/src/hello_world/scripts$ rosrun hello_world hello_world_subscriber.py
[INFO] [WallTime: 1411656461.894164] /hello_world_subscriber_7256_14116564578161 heard hello world 1411656461.86
[INFO] [WallTime: 1411656462.008234] /hello_world_subscriber_7256_14116564578161 heard hello world 1411656461.97
[INFO] [WallTime: 1411656462.072276] /hello_world_subscriber_7256_14116564578161 heard hello world 1411656462.07
[INFO] [WallTime: 1411656462.186540] /hello_world_subscriber_7256_14116564578161 heard hello world 1411656462.17
[INFO] [WallTime: 1411656462.300725] /hello_world_subscriber_7256_14116564578161 heard hello world 1411656462.27
[INFO] [WallTime: 1411656462.414581] /hello_world_subscriber_7256_14116564578161 heard hello world 1411656462.37
[INFO] [WallTime: 1411656462.478291] /hello_world_subscriber_7256_14116564578161 heard hello world 1411656462.47
[INFO] [WallTime: 1411656462.592758] /hello_world_subscriber_7256_14116564578161 heard hello world 1411656462.57
[INFO] [WallTime: 1411656462.706946] /hello_world_subscriber_7256_14116564578161 heard hello world 1411656462.66
lentin@lentin-Aspire-4755:~/catkin_ws/src/hello_world/scripts$ rosrun hello_world hello_world_publisher.py
[INFO] [WallTime: 1411656461.864917] hello world 1411656461.86
[INFO] [WallTime: 1411656461.965592] hello world 1411656461.97
[INFO] [WallTime: 1411656462.065414] hello world 1411656462.07
[INFO] [WallTime: 1411656462.165379] hello world 1411656462.17
[INFO] [WallTime: 1411656462.265335] hello world 1411656462.27
[INFO] [WallTime: 1411656462.365332] hello world 1411656462.37
[INFO] [WallTime: 1411656462.465528] hello world 1411656462.47
[INFO] [WallTime: 1411656462.565279] hello world 1411656462.57
[INFO] [WallTime: 1411656462.665149] hello world 1411656462.66
^Clentin@lentin-Aspire-4755:~/catkin_ws/src/hello_world/scripts$



File Edit Package Settings Help

Reload | Mark All Upgrades | Apply | Properties | Quick filter: ros-indigo-rocon | Search

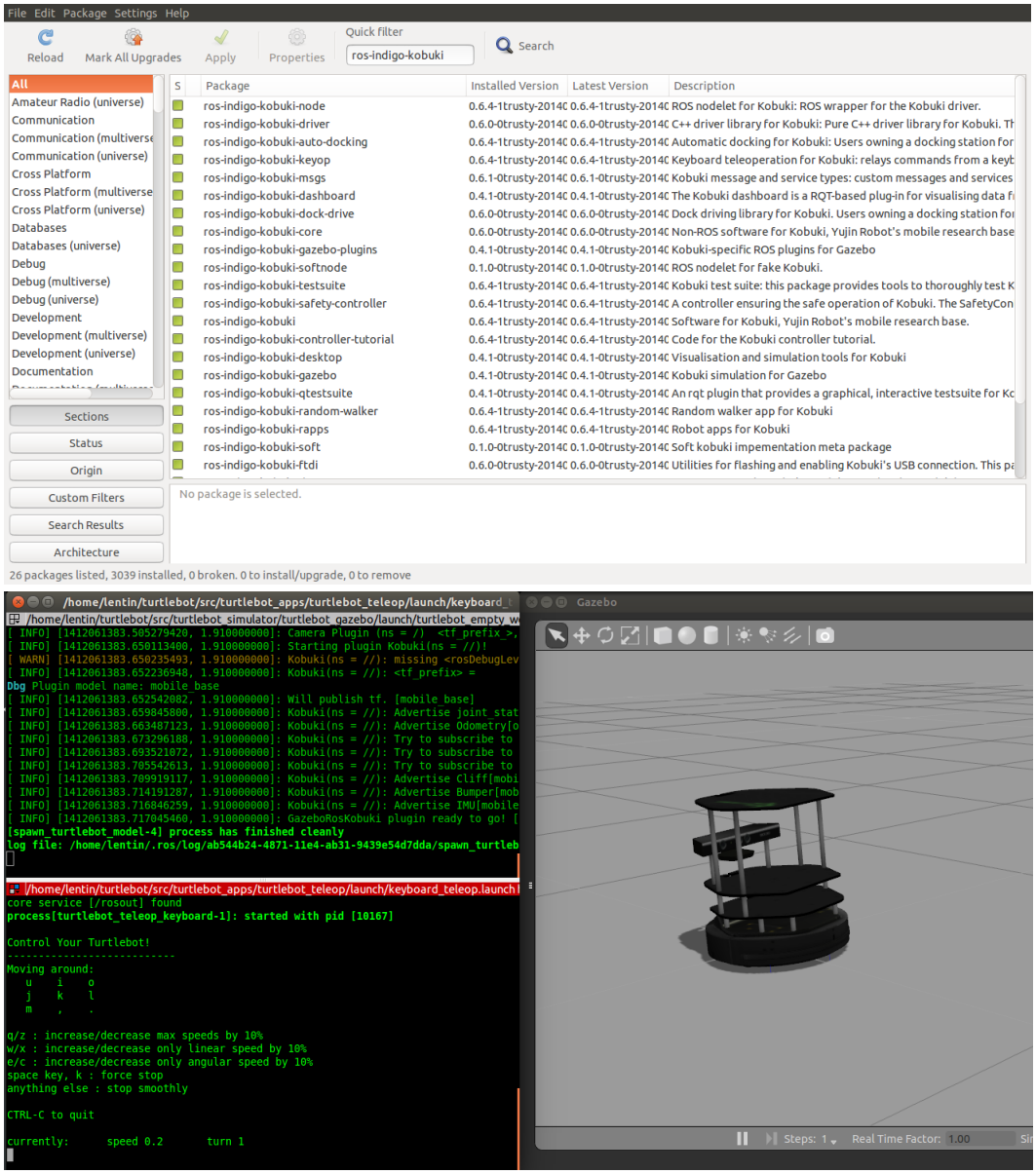
All
Amateur Radio (universe)
Communication
Communication (multiverse)
Communication (universe)
Cross Platform
Cross Platform (multiverse)
Cross Platform (universe)
Databases
Databases (universe)
Debug
Debug (multiverse)
Debug (universe)
Development
Development (multiverse)
Development (universe)
Documentation

Sections
Status
Origin
Custom Filters
Search Results
Architecture

S	Package	Installed Version	Latest Version	Description
	ros-indigo-rocon-apps	0.7.2-0trusty-2014C	0.7.2-0trusty-2014C	Core rocon apps for use with the appmanager and rocon concert.
	ros-indigo-rocon-tools	0.1.9-0trusty-2014C	0.1.9-0trusty-2014C	Utilities and tools developed for rocon, but usable beyond the bou
	ros-indigo-rocon	0.7.2-0trusty-2014C	0.7.2-0trusty-2014C	This is a meta package for robotics in concert(a.k.a rocon)
	ros-indigo-rocon-app-manager-tutorials	0.6.1-0trusty-2014C	0.6.1-0trusty-2014C	Tutorials for the rocon app manager.
	ros-indigo-rocon-bubble-icons	0.1.9-0trusty-2014C	0.1.9-0trusty-2014C	Bubble icon library for rocon.
	ros-indigo-rocon-device-msgs	0.7.7-1trusty-2014C	0.7.7-1trusty-2014C	Messages used by rocon devices
	ros-indigo-rocon-icons	0.1.9-0trusty-2014C	0.1.9-0trusty-2014C	Icons for rocon.
	ros-indigo-rocon-interaction-msgs	0.7.7-1trusty-2014C	0.7.7-1trusty-2014C	Messages used by rocon interactions.
	ros-indigo-rocon-qt-gui	0.7.0-0trusty-2014C	0.7.0-0trusty-2014C	Qt gui applications for interacting with the rocon framework.
	ros-indigo-rocon-qt-library	0.7.0-0trusty-2014C	0.7.0-0trusty-2014C	Common widgets and modules for rocon qt development.
	ros-indigo-rocon-qt-master-info	0.7.0-0trusty-2014C	0.7.0-0trusty-2014C	A rqt plugin that displays the information provided by a rocon ma
	ros-indigo-rocon-std-msgs	0.7.7-1trusty-2014C	0.7.7-1trusty-2014C	Standard messages used by other rocon specific package types.
	ros-indigo-rocon-test	0.7.5-0trusty-2014C	0.7.5-0trusty-2014C	Rocon test framework (i.e. multi-launch rostest framework).
	ros-indigo-rocon-tutorial-msgs	0.7.7-1trusty-2014C	0.7.7-1trusty-2014C	Messages used by rocon tutorials.
	ros-indigo-rocon-tutorials	0.6.1-0trusty-2014C	0.6.1-0trusty-2014C	Various tutorials to demonstrate in simulation, the rocon framew
	ros-indigo-rocon-uri	0.1.9-0trusty-2014C	0.1.9-0trusty-2014C	Module for working with rocon uri strings.
	ros-indigo-rocon-hub-client	0.7.5-0trusty-2014C	0.7.5-0trusty-2014C	Client api for discovery and connection to rocon hubs. It also has a
	ros-indigo-rocon-admin-app	0.7.0-0trusty-2014C	0.7.0-0trusty-2014C	The rocon_admin_app package
	ros-indigo-rocon-app-utilities	0.7.2-0trusty-2014C	0.7.2-0trusty-2014C	The rocon_app_utilities package
	ros-indigo-rocon-tf-reconstructor	0.6.0-0trusty-2014C	0.6.0-0trusty-2014C	The rocon_tf_reconstructor package
	ros-indigo-rocon-app-platform	0.7.2-0trusty-2014C	0.7.2-0trusty-2014C	Robot application platform for ros robots with a default impleme

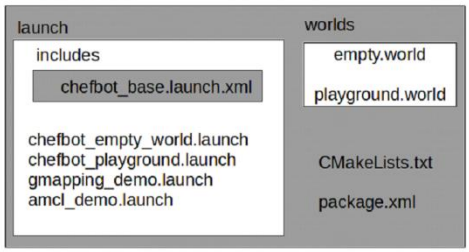
No package is selected.

56 packages listed, 3039 installed, 0 broken. 0 to install/upgrade, 0 to remove

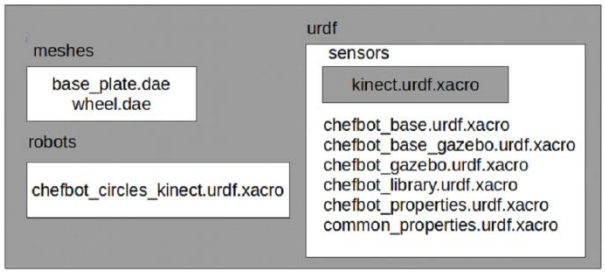

File Edit Package Settings Help
Reload
Mark All Upgrades
Apply
Properties
Quick filter
ros-indigo-kobuki
Search
All
Amateur Radio (universe)
Communication
Communication (multiverse
Communication (universe)
Cross Platform
Cross Platform (multiverse
Cross Platform (universe)
Databases
Databases (universe)
Debug
Debug (multiverse)
Debug (universe)
Development
Development (multiverse)
Development (universe)
Documentation
Sections
Status
Origin
Custom Filters
Search Results
Architecture
S
Package
Installed Version
Latest Version
Description
ros-indigo-kobuki-node 0.6.4-1trusty-2014C 0.6.4-1trusty-2014C ROS nodelet for Kobuki: ROS wrapper for the Kobuki driver.
ros-indigo-kobuki-driver 0.6.0-0trusty-2014C 0.6.0-0trusty-2014C C++ driver library for Kobuki: Pure C++ driver library for Kobuki. Th
ros-indigo-kobuki-auto-docking 0.6.4-1trusty-2014C 0.6.4-1trusty-2014C Automatic docking for Kobuki: Users owning a docking station for
ros-indigo-kobuki-keyop 0.6.4-1trusty-2014C 0.6.4-1trusty-2014C Keyboard teleoperation for Kobuki: relays commands from a keyb
ros-indigo-kobuki-msgs 0.6.1-0trusty-2014C 0.6.1-0trusty-2014C Kobuki message and service types: custom messages and services
ros-indigo-kobuki-dashboard 0.4.1-0trusty-2014C 0.4.1-0trusty-2014C The Kobuki dashboard is a RQT-based plug-in for visualising data f
ros-indigo-kobuki-dock-drive 0.6.0-0trusty-2014C 0.6.0-0trusty-2014C Dock driving library for Kobuki. Users owning a docking station for
ros-indigo-kobuki-core 0.6.0-0trusty-2014C 0.6.0-0trusty-2014C Non-ROS software for Kobuki, Yujin Robot's mobile research base
ros-indigo-kobuki-gazebo-plugins 0.4.1-0trusty-2014C 0.4.1-0trusty-2014C Kobuki-specific ROS plugins for Gazebo
ros-indigo-kobuki-softnode 0.1.0-0trusty-2014C 0.1.0-0trusty-2014C ROS nodelet for fake Kobuki.
ros-indigo-kobuki-testsuite 0.6.4-1trusty-2014C 0.6.4-1trusty-2014C Kobuki test suite: this package provides tools to thoroughly test K
ros-indigo-kobuki-safety-controller 0.6.4-1trusty-2014C 0.6.4-1trusty-2014C A controller ensuring the safe operation of Kobuki. The SafetyCon
ros-indigo-kobuki 0.6.4-1trusty-2014C 0.6.4-1trusty-2014C Software for Kobuki, Yujin Robot's mobile research base.
ros-indigo-kobuki-controller-tutorial 0.6.4-1trusty-2014C 0.6.4-1trusty-2014C Code for the Kobuki controller tutorial.
ros-indigo-kobuki-desktop 0.4.1-0trusty-2014C 0.4.1-0trusty-2014C Visualisation and simulation tools for Kobuki
ros-indigo-kobuki-gazebo 0.4.1-0trusty-2014C 0.4.1-0trusty-2014C Kobuki simulation for Gazebo
ros-indigo-kobuki-qtestsuite 0.4.1-0trusty-2014C 0.4.1-0trusty-2014C An rqt plugin that provides a graphical, interactive testsuite for Kc
ros-indigo-kobuki-random-walker 0.6.4-1trusty-2014C 0.6.4-1trusty-2014C Random walker app for Kobuki
ros-indigo-kobuki-rapps 0.6.4-1trusty-2014C 0.6.4-1trusty-2014C Robot apps for Kobuki
ros-indigo-kobuki-soft 0.1.0-0trusty-2014C 0.1.0-0trusty-2014C Soft kobuki impementation meta package
ros-indigo-kobuki-ftdi 0.6.0-0trusty-2014C 0.6.0-0trusty-2014C Utilities for flashing and enabling Kobuki's USB connection. This pa
No package is selected.
26 packages listed, 3039 installed, 0 broken. 0 to install/upgrade, 0 to remove

/home/lentin/turtlebot/src/turtlebot_apps/turtlebot_teleop/launch/keyboard_t
/home/lentin/turtlebot/src/turtlebot_simulator/turtlebot_gazebo/launch/turtlebot_empty_w
[INFO] [1412061383.505279420, 1.910000000]: Camera Plugin (ns = /) <tf_prefix_>,
[INFO] [1412061383.650113400, 1.910000000]: Starting plugin Kobuki(ns = //)!
[WARN] [1412061383.650235493, 1.910000000]: Kobuki(ns = //): missing <rosDebugLev
[INFO] [1412061383.652236948, 1.910000000]: Kobuki(ns = //): <tf_prefix> =
Dbg Plugin model name: mobile_base
[INFO] [1412061383.652542082, 1.910000000]: Will publish tf. [mobile_base]
[INFO] [1412061383.659845800, 1.910000000]: Kobuki(ns = //): Advertise joint_stat
[INFO] [1412061383.663487123, 1.910000000]: Kobuki(ns = //): Advertise Odometry[o
[INFO] [1412061383.673296188, 1.910000000]: Kobuki(ns = //): Try to subscribe to
[INFO] [1412061383.693521072, 1.910000000]: Kobuki(ns = //): Try to subscribe to
[INFO] [1412061383.705542613, 1.910000000]: Kobuki(ns = //): Try to subscribe to
[INFO] [1412061383.709919117, 1.910000000]: Kobuki(ns = //): Advertise Cliff[mobi
[INFO] [1412061383.714191287, 1.910000000]: Kobuki(ns = //): Advertise Bumper[mob
[INFO] [1412061383.716846259, 1.910000000]: Kobuki(ns = //): Advertise IMU[mobile
[INFO] [1412061383.717045460, 1.910000000]: GazeboRosKobuki plugin ready to go! [
[spawn_turtlebot_model-4] process has finished cleanly
log file: /home/lentin/.ros/log/ab544b24-4871-11e4-ab31-9439e54d7dda/spawn_turtleb
/home/lentin/turtlebot/src/turtlebot_apps/turtlebot_teleop/launch/keyboard_teleop.launch
core service [/rosout] found
process[turtlebot_teleop_keyboard-1]: started with pid [10167]
Control Your Turtlebot!
Moving around:
u i o
j k l
m , .
q/z : increase/decrease max speeds by 10%
w/x : increase/decrease only linear speed by 10%
e/c : increase/decrease only angular speed by 10%
space key, k : force stop
anything else : stop smoothly
CTRL-C to quit
currently: speed 0.2 turn 1
Gazebo
Steps: 1
Real Time Factor: 1.00

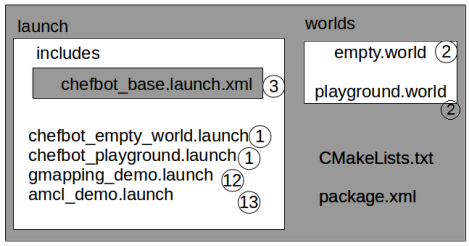
chefbot_gazebo



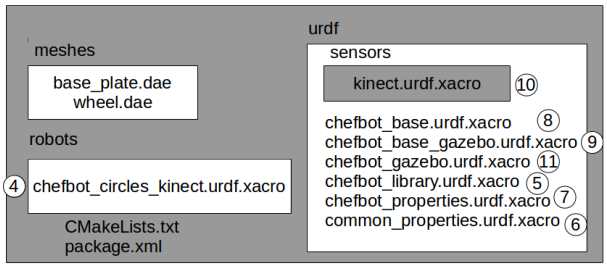
chefbot_description

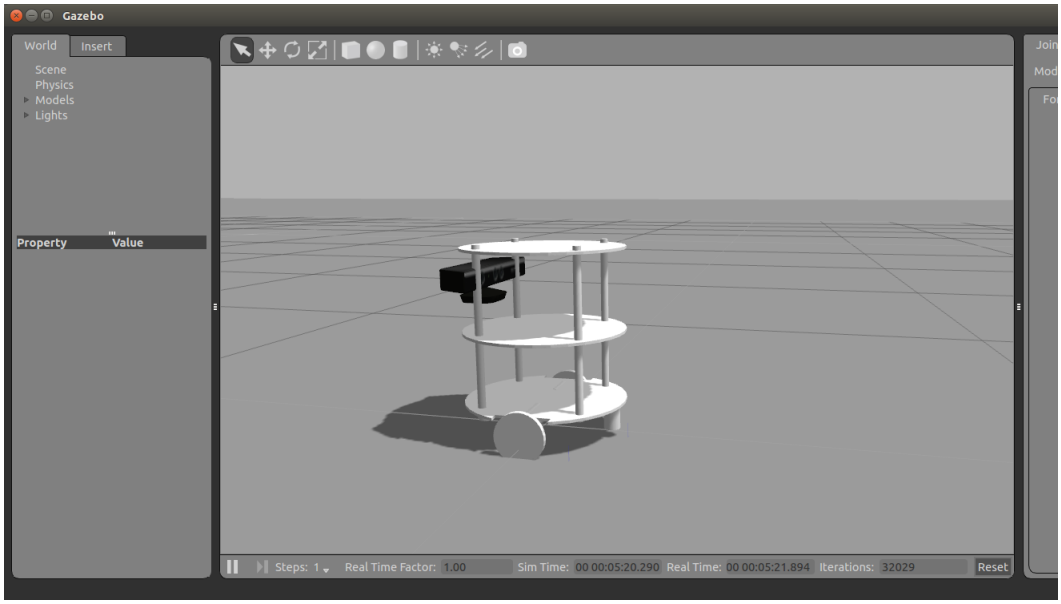


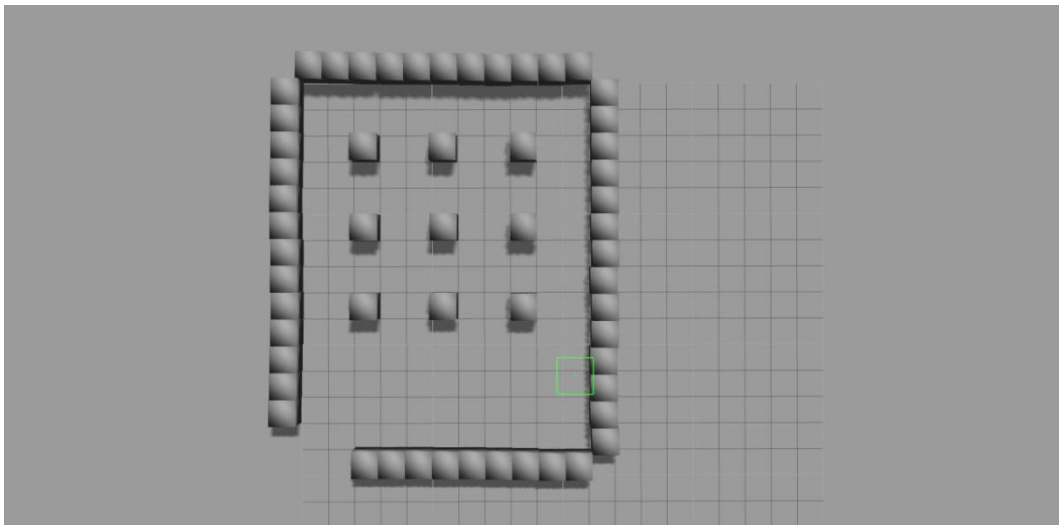
chefbot_gazebo

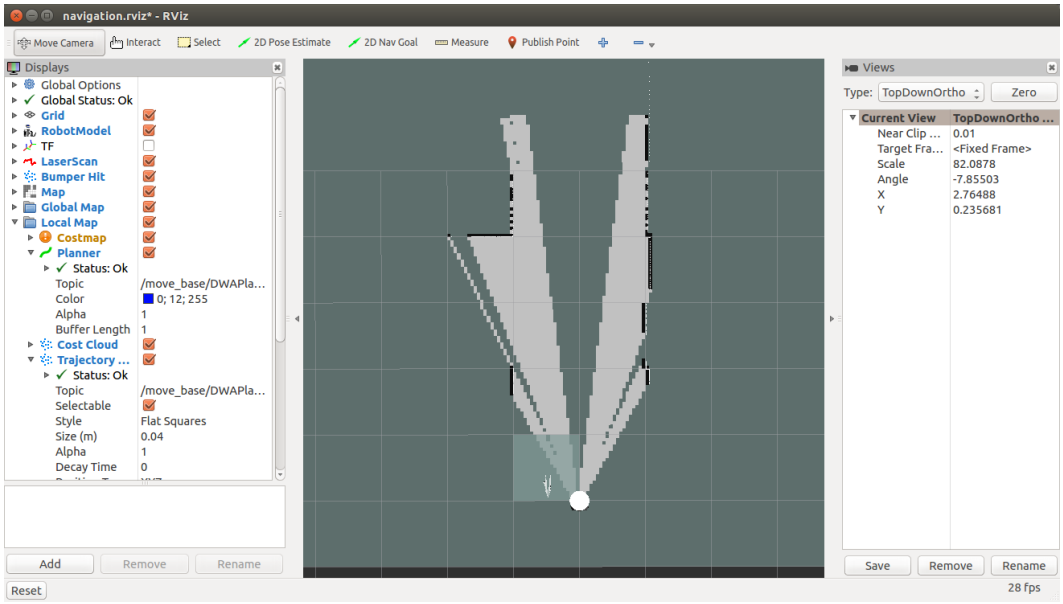


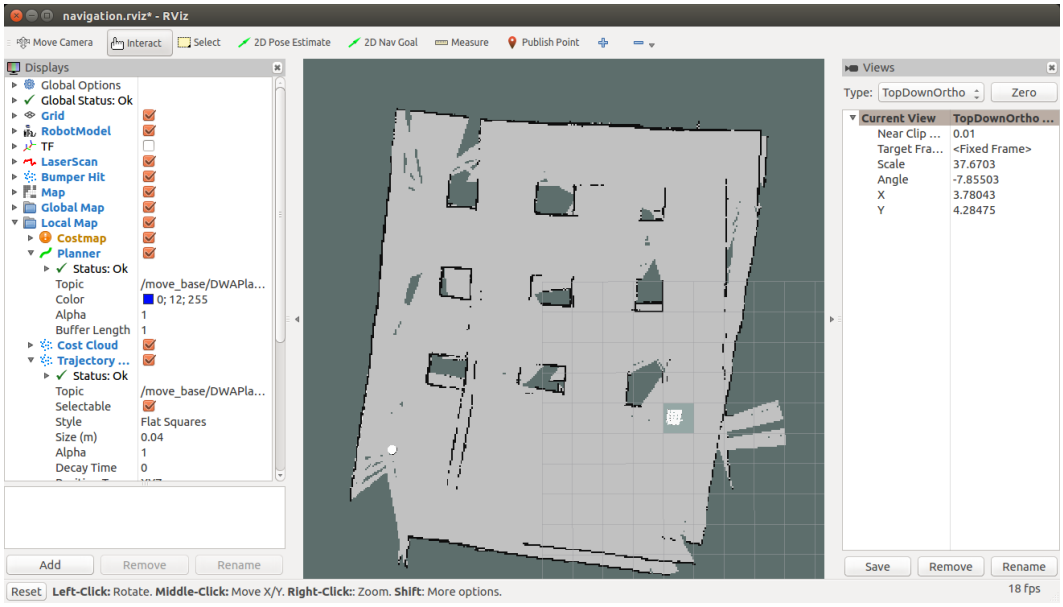
chefbot_description

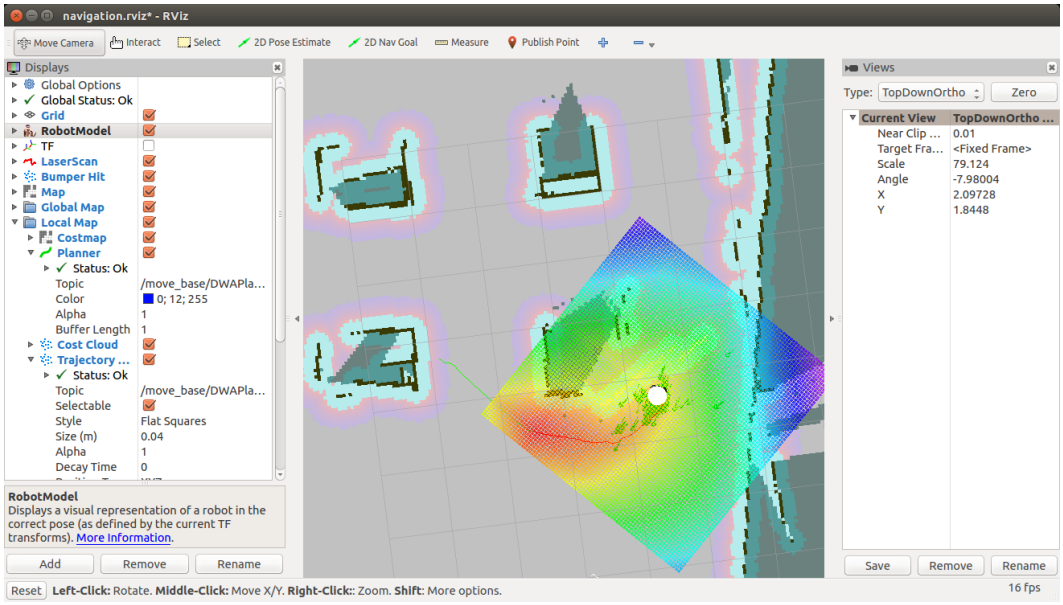



Gazebo
World
Insert
Scene
Physics
Models
Lights
Property
Value
Steps: 1
Real Time Factor: 1.00
Sim Time: 00 00:05:20.290
Real Time: 00 00:05:21.894
Iterations: 32029
Reset

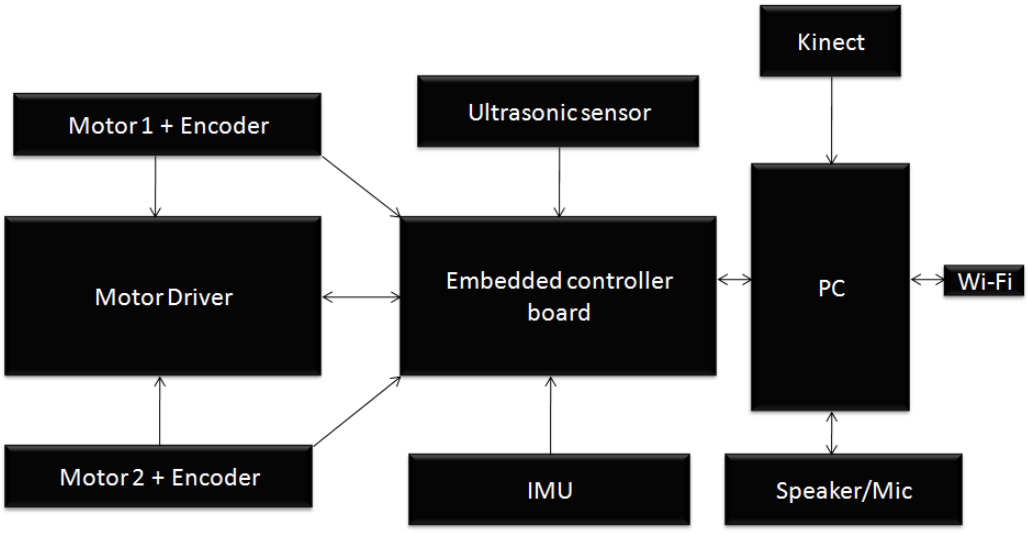


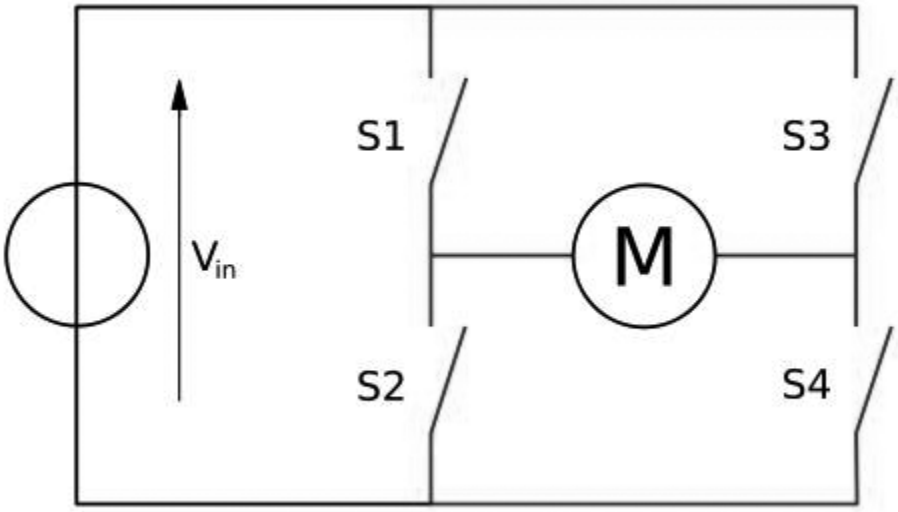

navigation.rviz* - RViz
Move Camera
Interact
Select
2D Pose Estimate
2D Nav Goal
Measure
Publish Point
Displays
Global Options
Global Status: Ok
Grid
RobotModel
TF
LaserScan
Bumper Hit
Map
Global Map
Local Map
Costmap
Planner
Status: Ok
Topic
/move_base/DWAPla...
Color
0; 12; 255
Alpha
1
Buffer Length
1
Cost Cloud
Trajectory ...
Status: Ok
Topic
/move_base/DWAPla...
Selectable
Style
Flat Squares
Size (m)
0.04
Alpha
1
Decay Time
0
Add
Remove
Rename
Reset
Views
Type:
TopDownOrtho
Zero
Current View
TopDownOrtho ...
Near Clip ...
0.01
Target Fra...
<Fixed Frame>
Scale
82.0878
Angle
-7.85503
X
2.76488
Y
0.235681
Save
Remove
Rename
28 fps

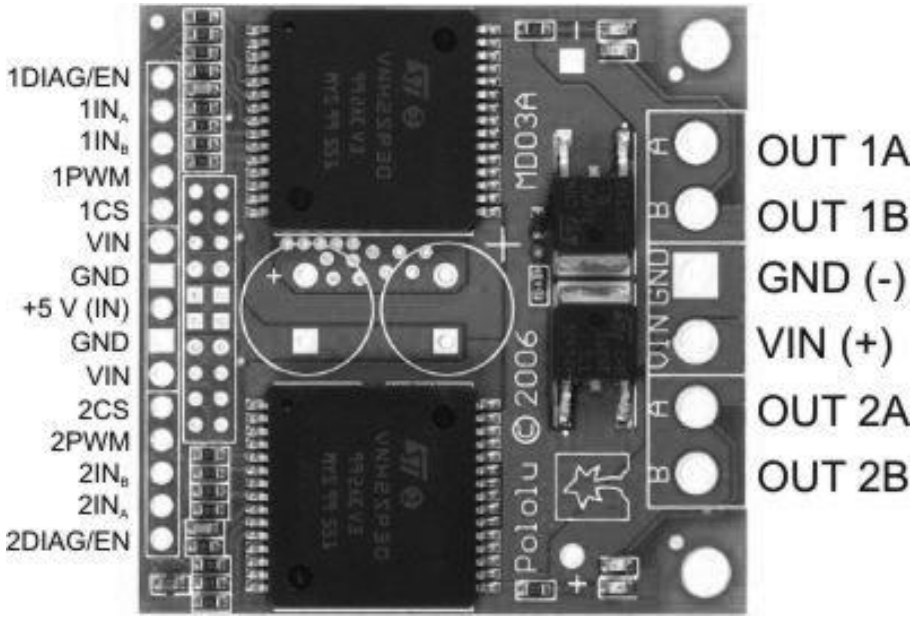

navigation.rviz* - RViz
Move Camera
Interact
Select
2D Pose Estimate
2D Nav Goal
Measure
Publish Point
Displays
Global Options
Global Status: Ok
Grid
RobotModel
TF
LaserScan
Bumper Hit
Map
Global Map
Local Map
Costmap
Planner
Status: Ok
Topic /move_base/DWAPla...
Color 0; 12; 255
Alpha 1
Buffer Length 1
Cost Cloud
Trajectory ...
Status: Ok
Topic /move_base/DWAPla...
Selectable
Style Flat Squares
Size (m) 0.04
Alpha 1
Decay Time 0
Add
Remove
Rename
Views
Type: TopDownOrtho
Zero
Current View TopDownOrtho ...
Near Clip ... 0.01
Target Fra... <Fixed Frame>
Scale 37.6703
Angle -7.85503
X 3.78043
Y 4.28475
Save
Remove
Rename
Reset
Left-Click: Rotate. Middle-Click: Move X/Y. Right-Click:: Zoom. Shift: More options.
18 fps

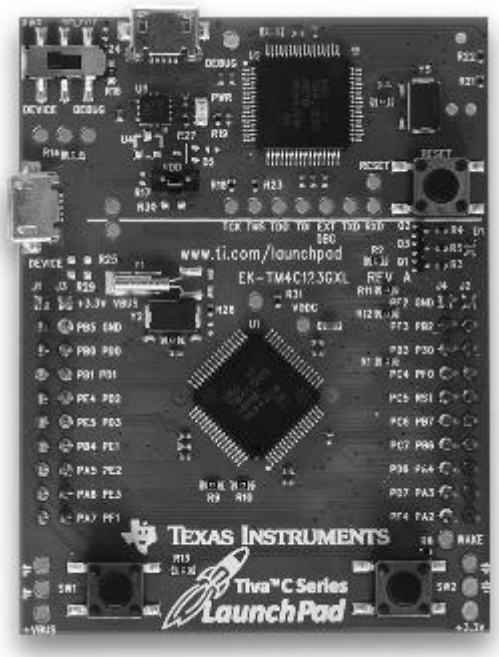

navigation.rviz* - RViz
Move Camera
Interact
Select
2D Pose Estimate
2D Nav Goal
Measure
Publish Point
Displays
Global Options
Global Status: Ok
Grid
RobotModel
TF
LaserScan
Bumper Hit
Map
Global Map
Local Map
Costmap
Planner
Status: Ok
Topic /move_base/DWAPla...
Color 0; 12; 255
Alpha 1
Buffer Length 1
Cost Cloud
Trajectory ...
Status: Ok
Topic /move_base/DWAPla...
Selectable
Style Flat Squares
Size (m) 0.04
Alpha 1
Decay Time 0
RobotModel
Displays a visual representation of a robot in the correct pose (as defined by the current TF transforms). More Information.
Add
Remove
Rename
Views
Type: TopDownOrtho
Zero
Current View TopDownOrtho ...
Near Clip ... 0.01
Target Fra... <Fixed Frame>
Scale 79.124
Angle -7.98004
X 2.09728
Y 1.8448
Save
Remove
Rename
Reset
Left-Click: Rotate. Middle-Click: Move X/Y. Right-Click:: Zoom. Shift: More options.
16 fps

Chapter 4, Designing ChefBot Hardware

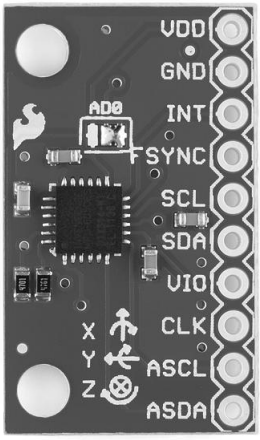


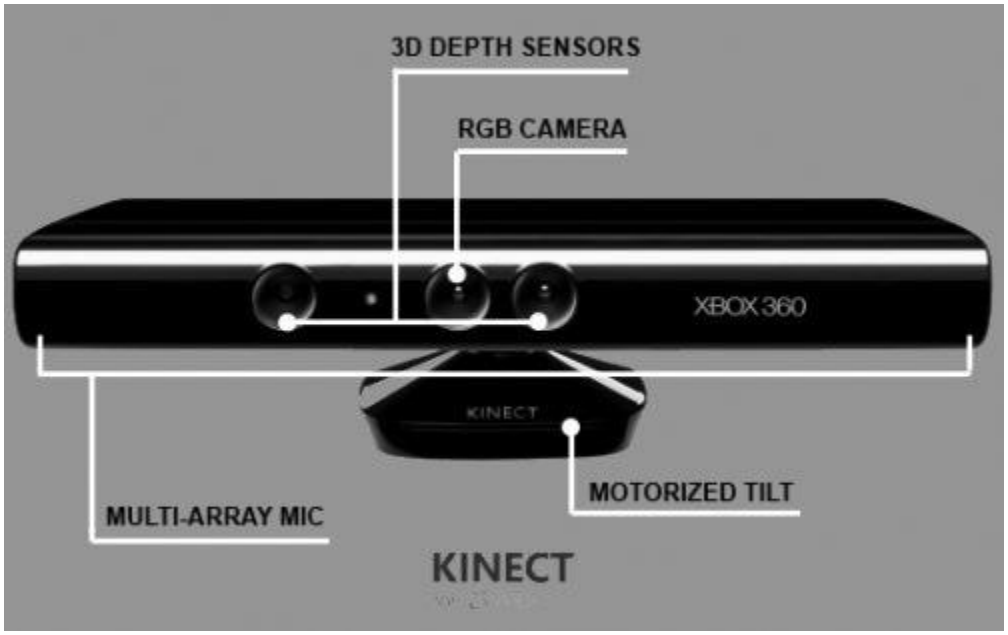

S1
S3
M
V_{in}
S2
S4


1DIAG/EN
1IN$_A$
1IN$_B$
1PWM
1CS
VIN
GND
+5 V (IN)
GND
VIN
2CS
2PWM
2IN$_B$
2IN$_A$
2DIAG/EN
MD03A
Pololu © 2006
OUT 1A
OUT 1B
GND (-)
VIN (+)
OUT 2A
OUT 2B

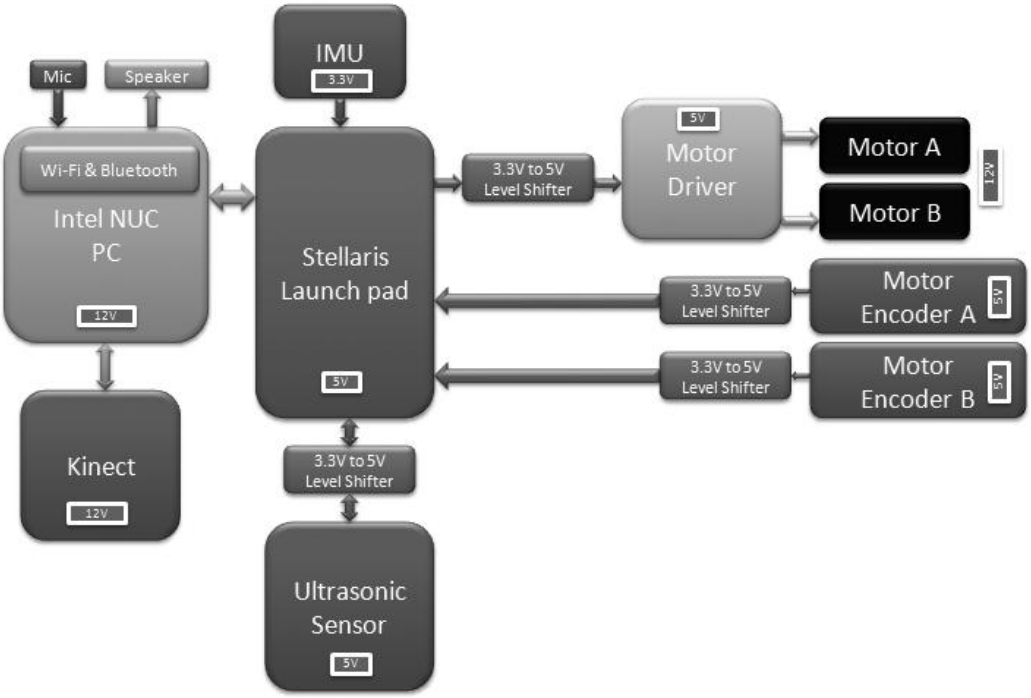

www.ti.com/launchpad
EK-TM4C123GXL
REV A
TEXAS INSTRUMENTS
Tiva™C Series
LaunchPad

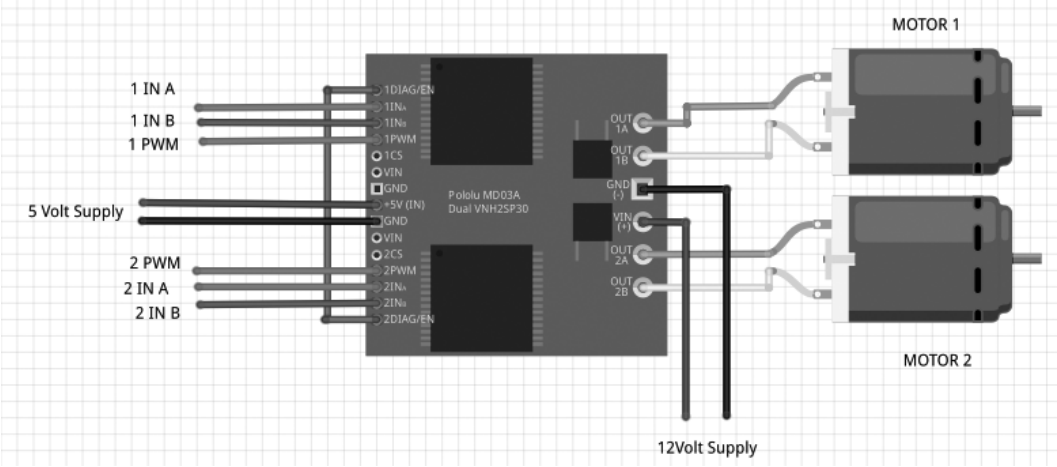

Y1
HC-SR04
Vcc
Trig
Echo
GND
T
J1
R

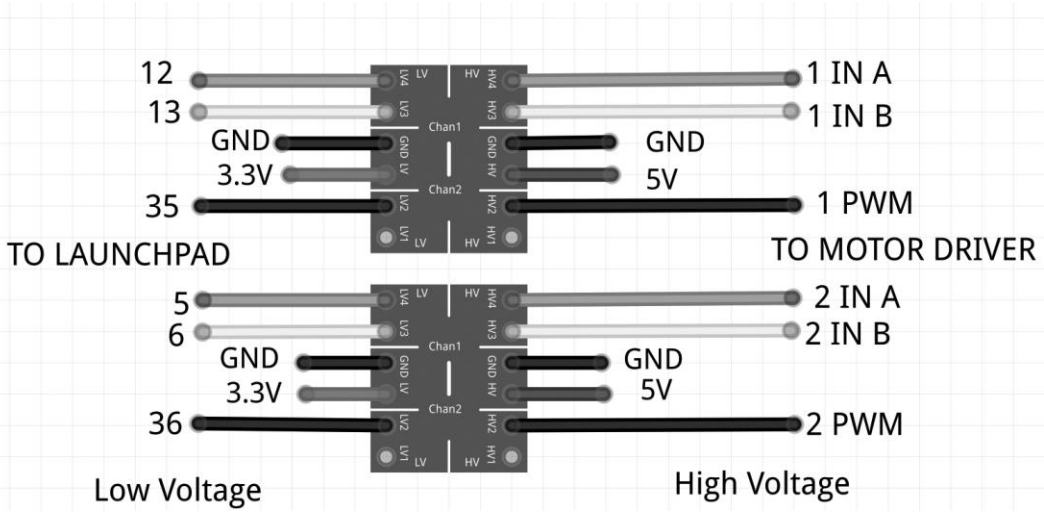

VDD
GND
AD0
INT
FSYNC
SCL
SDA
VIO
X
Y
Z
CLK
ASCL
ASDA


3D DEPTH SENSORS
RGB CAMERA
XBOX 360
KINECT
MOTORIZED TILT
MULTI-ARRAY MIC
KINECT


Store No: 113429

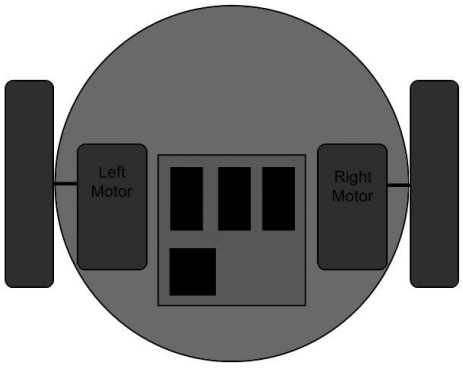

IMU
3.3V
Mic
Speaker
Wi-Fi & Bluetooth
Intel NUC
PC
12V
Kinect
12V
Stellaris
Launch pad
5V
3.3V to 5V
Level Shifter
5V
Motor
Driver
Motor A
Motor B
12V
3.3V to 5V
Level Shifter
Motor
Encoder A
5V
3.3V to 5V
Level Shifter
Motor
Encoder B
5V
3.3V to 5V
Level Shifter
Ultrasonic
Sensor
5V

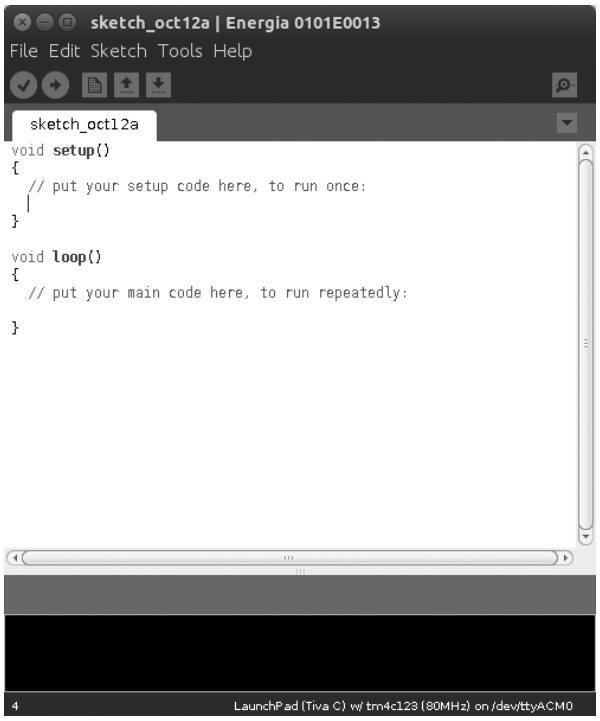

MOTOR 1
1 IN A
1 IN B
1 PWM
5 Volt Supply
2 PWM
2 IN A
2 IN B
1DIAG/EN
1INA
1INB
1PWM
1CS
VIN
GND
+5V (IN)
GND
VIN
2CS
2PWM
2INA
2INB
2DIAG/EN
Pololu MD03A
Dual VNH2SP30
OUT 1A
OUT 1B
GND (-)
VIN (+)
OUT 2A
OUT 2B
MOTOR 2
12Volt Supply

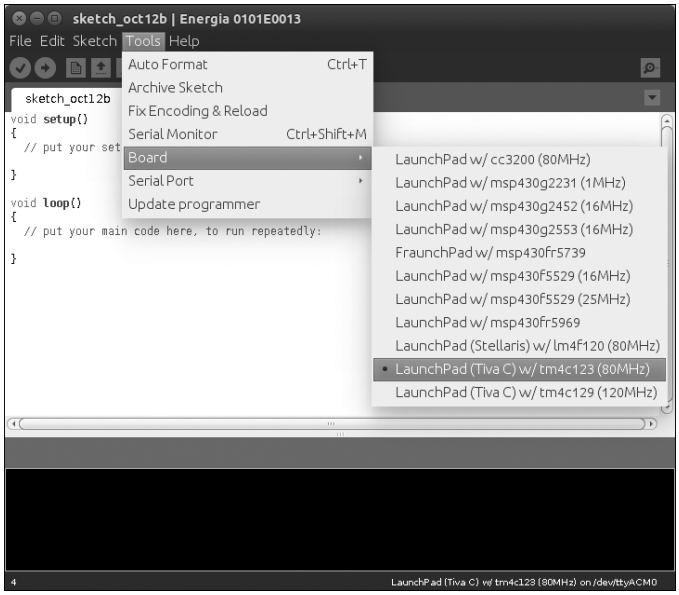

12
13
GND
3.3V
35
1 IN A
1 IN B
GND
5V
1 PWM
Chan1
Chan2
TO LAUNCHPAD
TO MOTOR DRIVER
5
6
GND
3.3V
36
2 IN A
2 IN B
GND
5V
2 PWM
Low Voltage
High Voltage

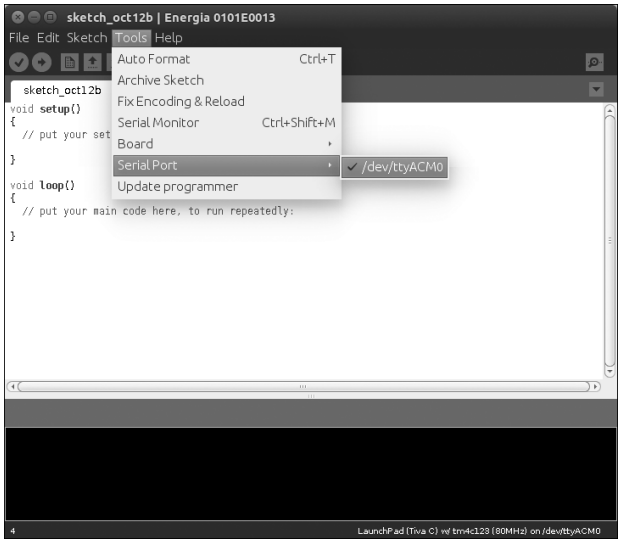

Motor
Motor

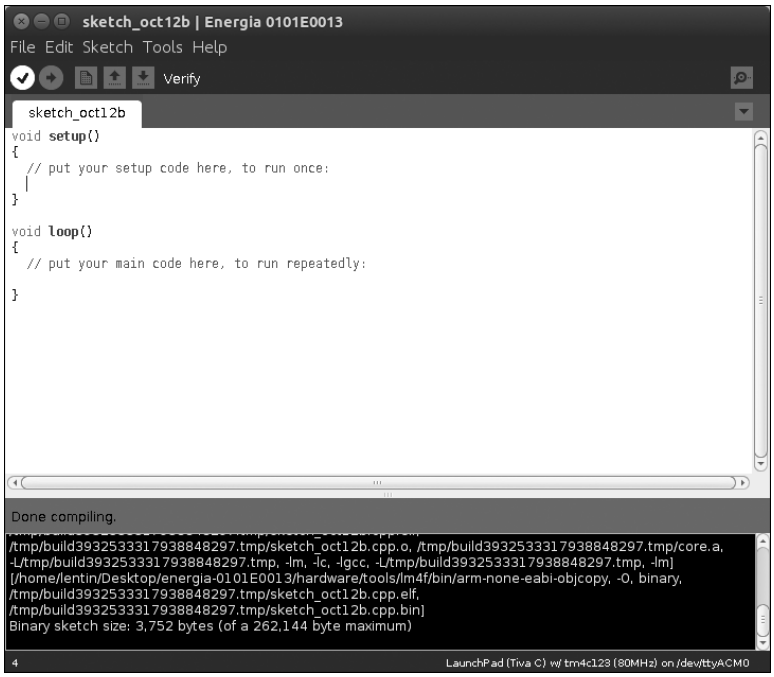

Free Turning wheel

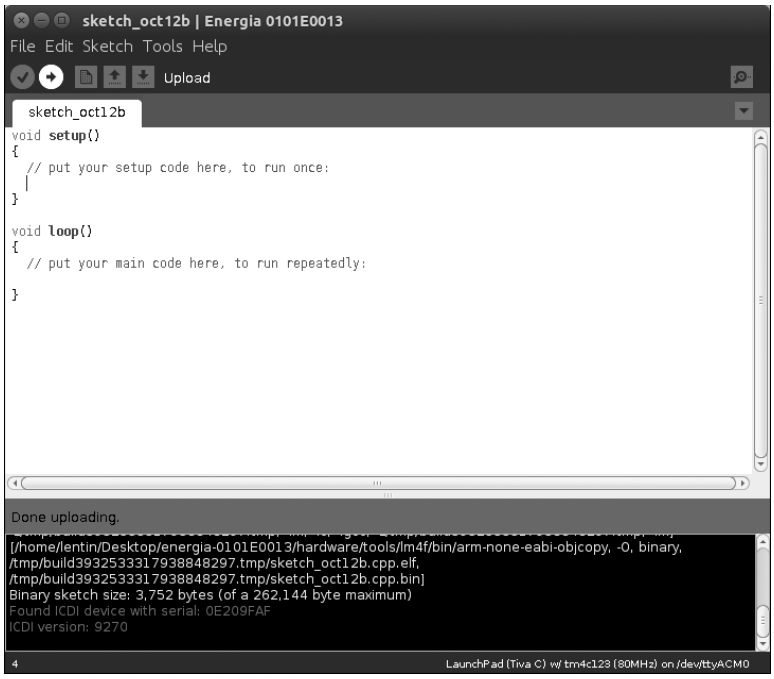

Left
Motor
Right
Motor

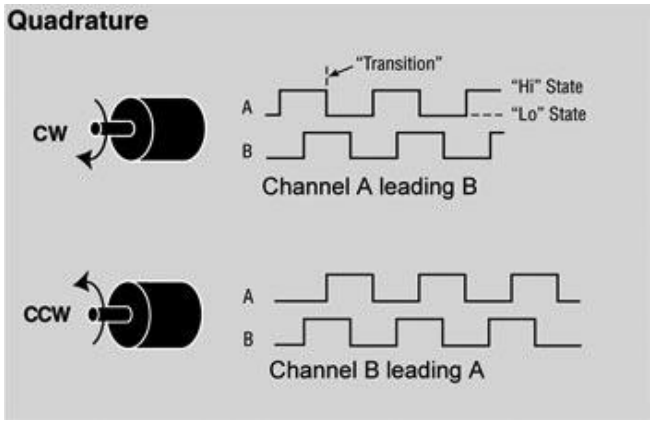

sketch_oct12a | Energia 0101E0013
File Edit Sketch Tools Help
sketch_oct12a
void setup()
{
// put your setup code here, to run once:
}
void loop()
{
// put your main code here, to run repeatedly:
}
4
LaunchPad (Tiva C) w/ tm4c123 (80MHz) on /dev/ttyACM0

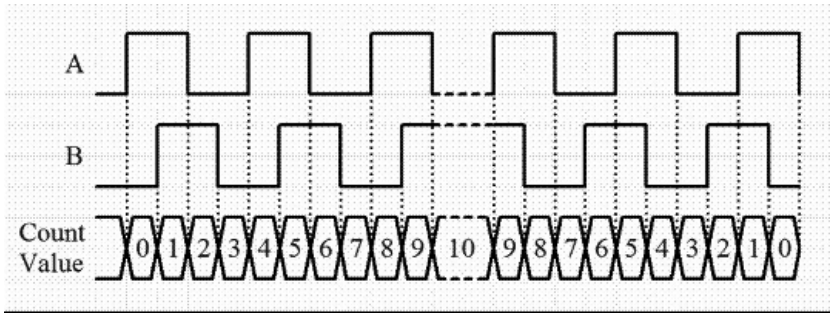

sketch_oct12b | Energia 0101E0013
File Edit Sketch Tools Help
Auto Format Ctrl+T
Archive Sketch
Fix Encoding & Reload
Serial Monitor Ctrl+Shift+M
Board
Serial Port
Update programmer
LaunchPad w/ cc3200 (80MHz)
LaunchPad w/ msp430g2231 (1MHz)
LaunchPad w/ msp430g2452 (16MHz)
LaunchPad w/ msp430g2553 (16MHz)
FraunchPad w/ msp430fr5739
LaunchPad w/ msp430f5529 (16MHz)
LaunchPad w/ msp430f5529 (25MHz)
LaunchPad w/ msp430fr5969
LaunchPad (Stellaris) w/ lm4f120 (80MHz)
LaunchPad (Tiva C) w/ tm4c123 (80MHz)
LaunchPad (Tiva C) w/ tm4c129 (120MHz)
sketch_oct12b
void setup()
{
// put your set
}
void loop()
{
// put your main code here, to run repeatedly:
}
4
LaunchPad (Tiva C) w/ tm4c123 (80MHz) on /dev/ttyACM0

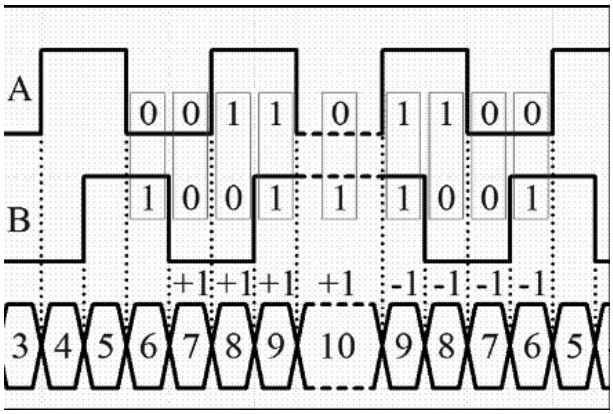

sketch_oct12b | Energia 0101E0013
File Edit Sketch Tools Help
Auto Format Ctrl+T
Archive Sketch
Fix Encoding & Reload
Serial Monitor Ctrl+Shift+M
Board
Serial Port
Update programmer
/dev/ttyACM0
sketch_oct12b
void setup()
{
// put your set
}
void loop()
{
// put your main code here, to run repeatedly:
}
4
LaunchPad (Tiva C) w/ tm4c123 (80MHz) on /dev/ttyACM0

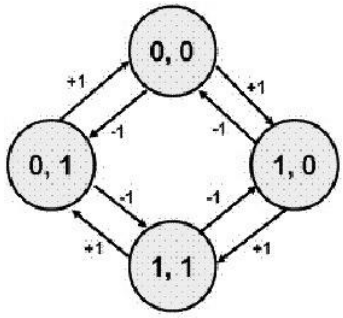

sketch_oct12b | Energia 0101E0013
File Edit Sketch Tools Help
Verify
sketch_oct12b
void setup()
{
// put your setup code here, to run once:
}
void loop()
{
// put your main code here, to run repeatedly:
}
Done compiling.
/tmp/build3932533317938848297.tmp/sketch_oct12b.cpp.o, /tmp/build3932533317938848297.tmp/core.a,
-L/tmp/build3932533317938848297.tmp, -lm, -lc, -lgcc, -L/tmp/build3932533317938848297.tmp, -lm]
[/home/lentin/Desktop/energia-0101E0013/hardware/tools/lm4f/bin/arm-none-eabi-objcopy, -O, binary,
/tmp/build3932533317938848297.tmp/sketch_oct12b.cpp.elf,
/tmp/build3932533317938848297.tmp/sketch_oct12b.cpp.bin]
Binary sketch size: 3,752 bytes (of a 262,144 byte maximum)
4
LaunchPad (Tiva C) w/ tm4c123 (80MHz) on /dev/ttyACM0

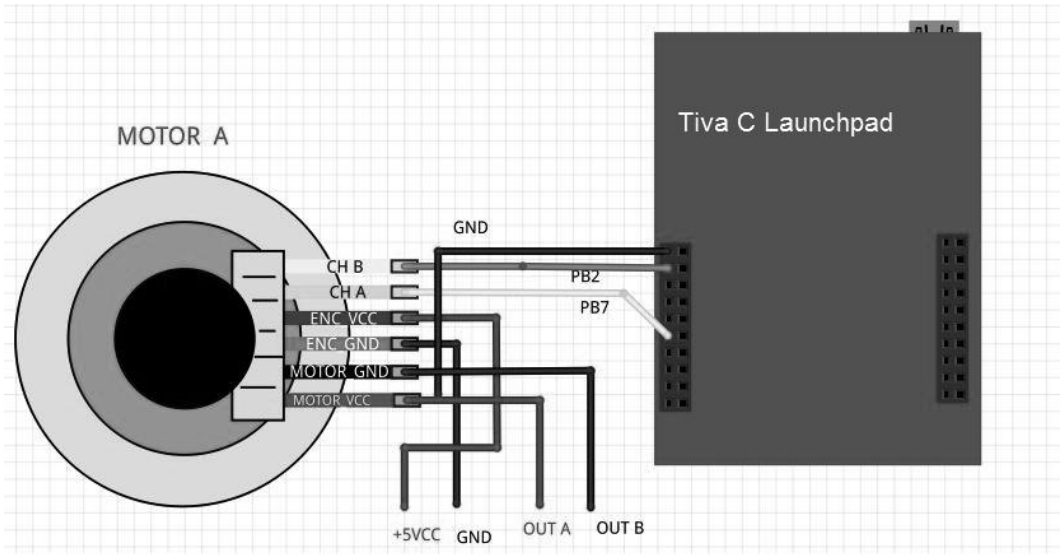

sketch_oct12b | Energia 0101E0013
File Edit Sketch Tools Help
Upload
sketch_oct12b
void setup()
{
// put your setup code here, to run once:
}
void loop()
{
// put your main code here, to run repeatedly:
}
Done uploading.
[/home/lentin/Desktop/energia-0101E0013/hardware/tools/lm4f/bin/arm-none-eabi-objcopy, -O, binary,
/tmp/build3932533317938848297.tmp/sketch_oct12b.cpp.elf,
/tmp/build3932533317938848297.tmp/sketch_oct12b.cpp.bin]
Binary sketch size: 3,752 bytes (of a 262,144 byte maximum)
Found ICDI device with serial: 0E209FAF
ICDI version: 9270
4
LaunchPad (Tiva C) w/ tm4c123 (80MHz) on /dev/ttyACM0

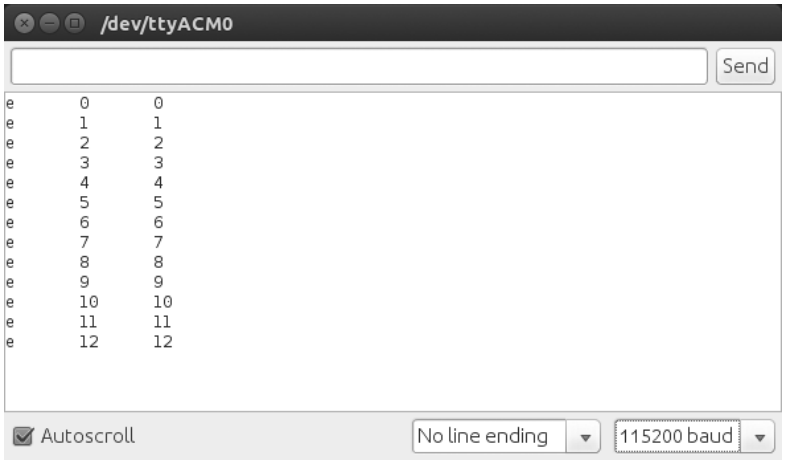

Quadrature
"Transition"
"Hi" State
"Lo" State
CW
A
B
Channel A leading B
CCW
A
B
Channel B leading A

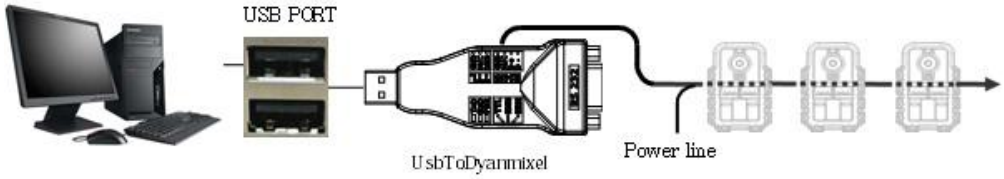

A
B
Count Value
0 1 2 3 4 5 6 7 8 9 10 9 8 7 6 5 4 3 2 1 0


A
0 0 1 1 0 1 1 0 0
B
1 0 0 1 1 1 0 0 1
+1 +1 +1 +1 -1 -1 -1 -1
3 4 5 6 7 8 9 10 9 8 7 6 5

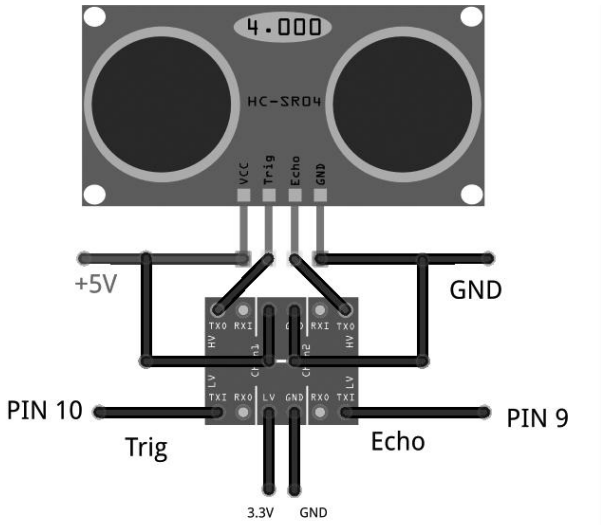

0, 0
0, 1
1, 0
1, 1
+1
-1

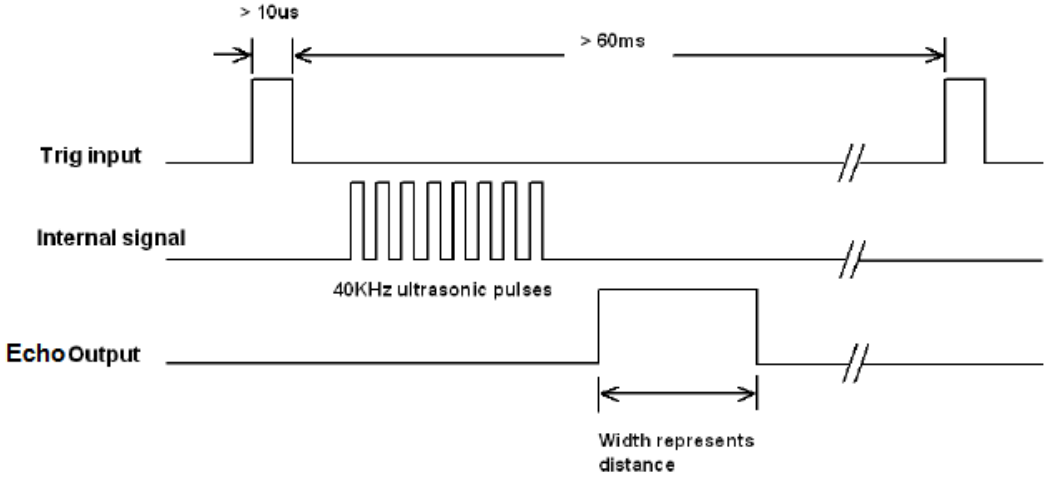

MOTOR A
Tiva C Launchpad
GND
CH B
CH A
ENC_VCC
ENC_GND
MOTOR_GND
MOTOR_VCC
PB2
PB7
+5VCC
GND
OUT A
OUT B

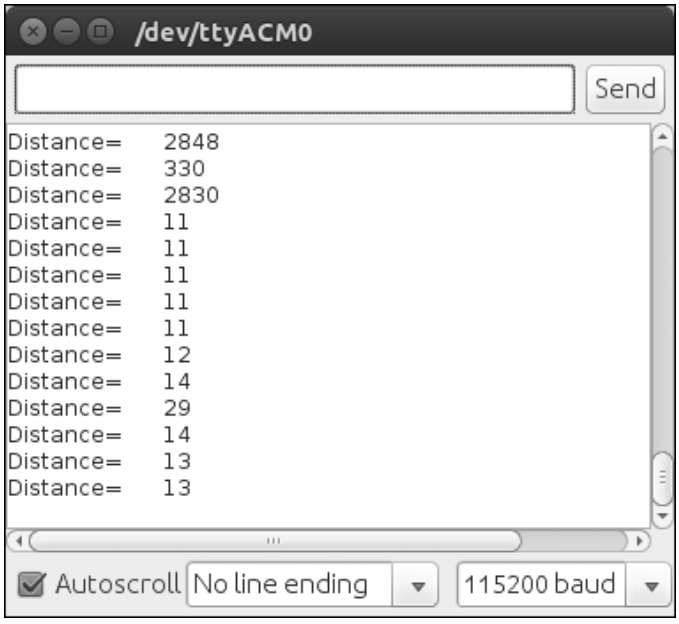

/dev/ttyACM0
Send
e 0 0
e 1 1
e 2 2
e 3 3
e 4 4
e 5 5
e 6 6
e 7 7
e 8 8
e 9 9
e 10 10
e 11 11
e 12 12
Autoscroll
No line ending
115200 baud


USB PORT
UsbToDyanmixel
Power line

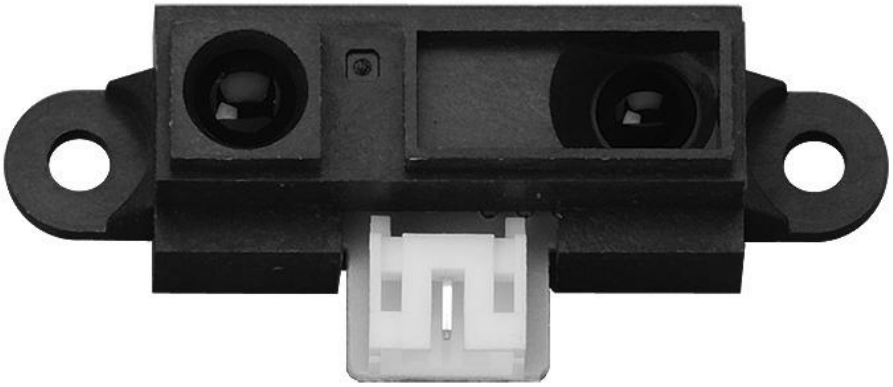
Chapter 6, Working with Robotic Sensors

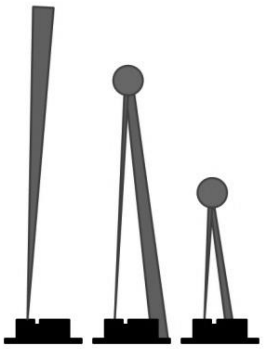


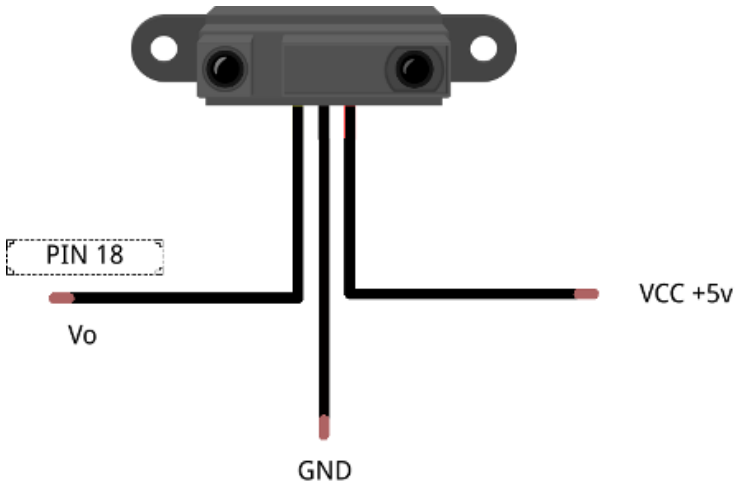


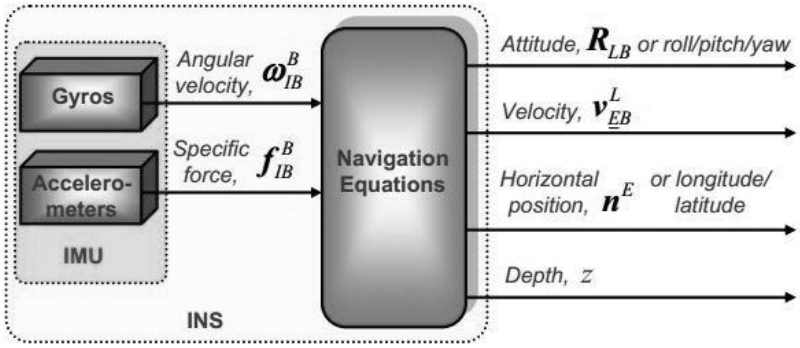


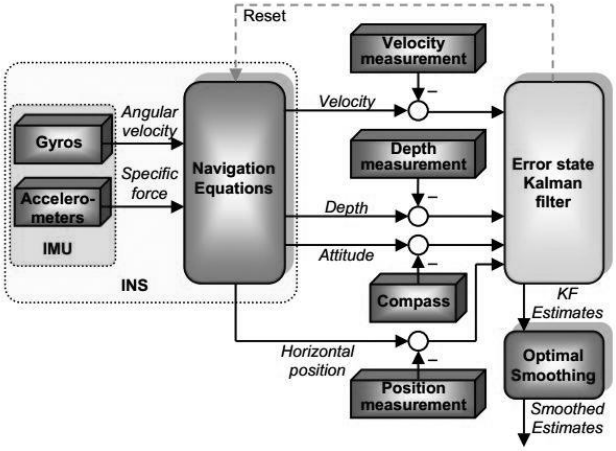
```
lentin@lentin-Aspire-4755: ~

Distance=       12

Distance=       2903

Distance=       5

Distance=       9

Distance=       7

Distance=       6
```





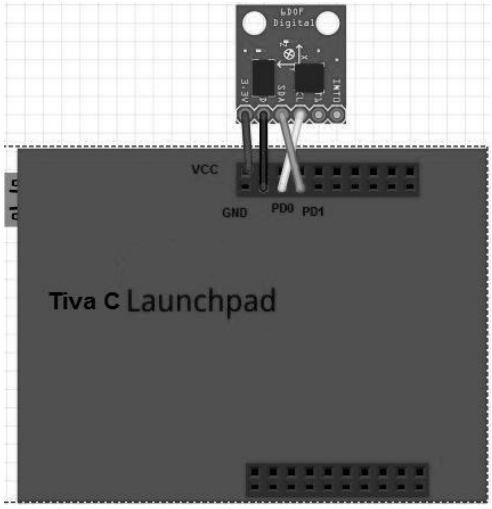

PIN 18
Vo
VCC +5v
GND

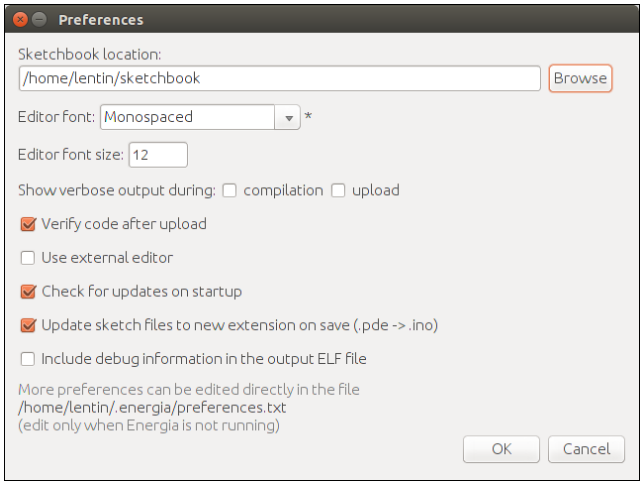

Gyros
Accelero-meters
IMU
Angular velocity, ω_{IB}^{B}
Specific force, f_{IB}^{B}
Navigation Equations
INS
Attitude, R_{LB} or roll/pitch/yaw
Velocity, v_{EB}^{L}
Horizontal position, n^{E} or longitude/ latitude
Depth, z

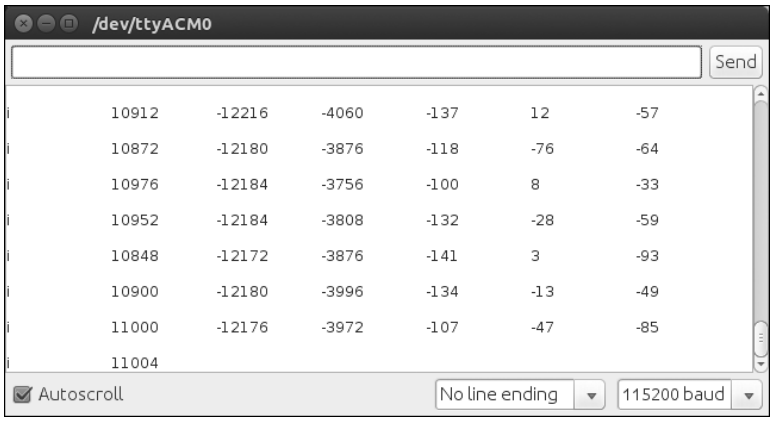

Reset
Velocity measurement
Depth measurement
Compass
Position measurement
Gyros
Accelero-meters
IMU
INS
Angular velocity
Specific force
Navigation Equations
Velocity
Depth
Attitude
Horizontal position
Error state Kalman filter
KF Estimates
Optimal Smoothing
Smoothed Estimates

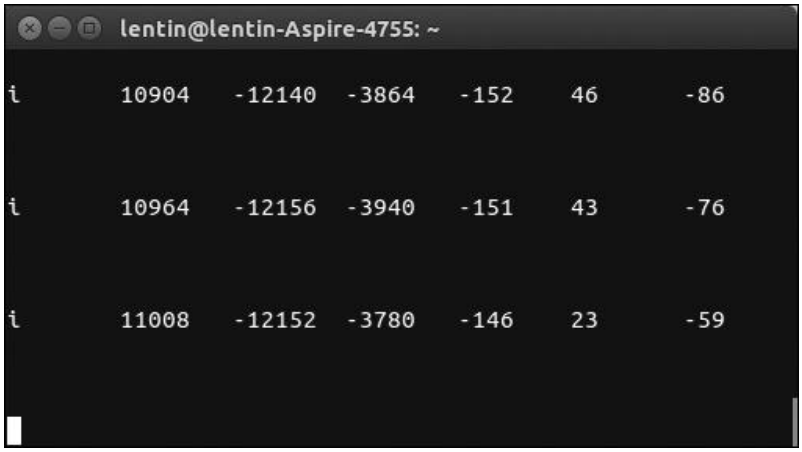

3-Axis Compass
MPU-6000/ MPU-6050
Gyro
Accel
DMP
FIFO
Application Processor
I²C or SPI


VDD
GND
AD0
INT
FSYNC
SCL
SDA
VIO
X
Y
Z
CLK
ASCL
ASDA


VCC
GND
PD0
PD1
Tiva C Launchpad


Preferences
Sketchbook location:
/home/lentin/sketchbook
Browse
Editor font:
Monospaced
Editor font size:
12
Show verbose output during:
compilation
upload
Verify code after upload
Use external editor
Check for updates on startup
Update sketch files to new extension on save (.pde -> .ino)
Include debug information in the output ELF file
More preferences can be edited directly in the file
/home/lentin/.energia/preferences.txt
(edit only when Energia is not running)
OK
Cancel



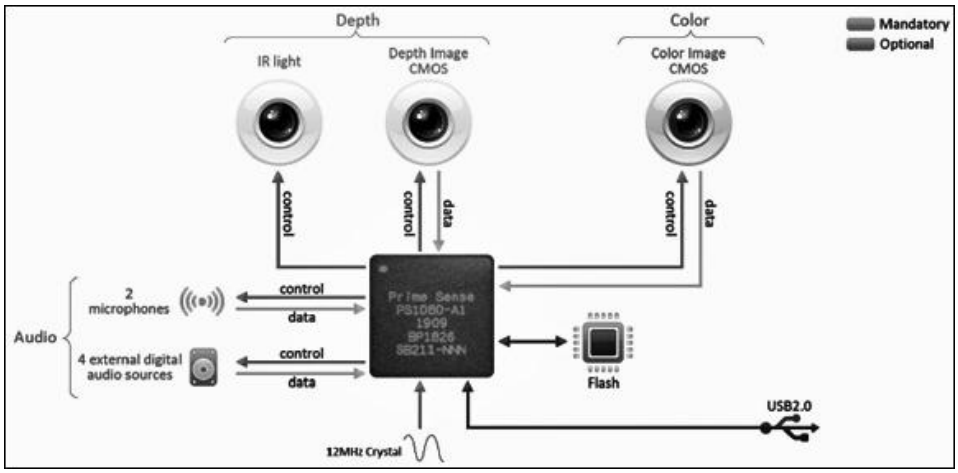


Chapter 7, Programming Vision Sensors Using Python and ROS


Logitech

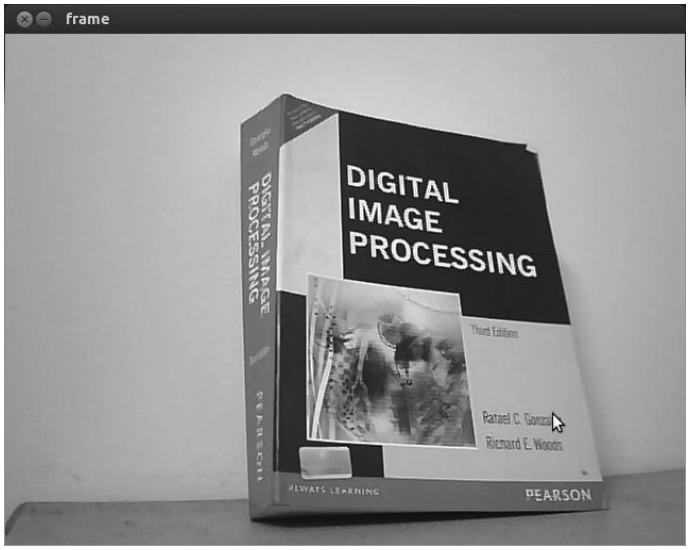

3D DEPTH SENSORS
RGB CAMERA
XBOX 360
KINECT
MULTI-ARRAY MIC
MOTORIZED TILT

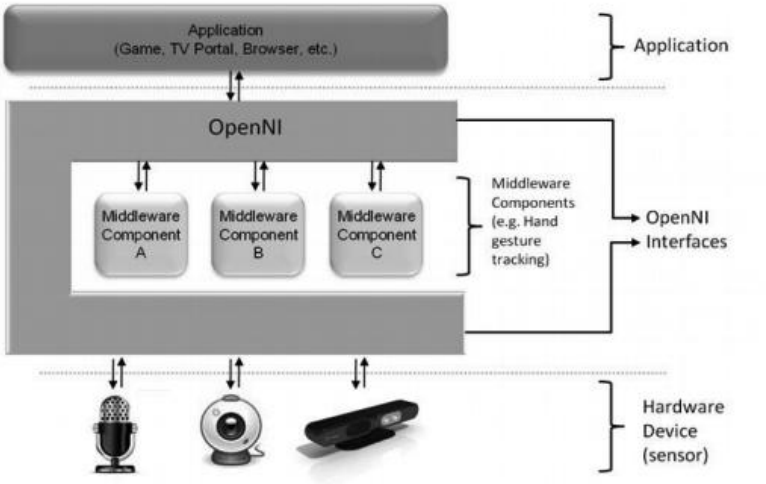

ASUS


Depth
Color
Mandatory
Optional
IR light
Depth Image CMOS
Color Image CMOS
control
control
data
control
data
Audio
2 microphones
4 external digital audio sources
control
data
control
data
Prime Sense
PS1080-A1
1909
9P1826
SB211-NNN
Flash
USB2.0
12MHz Crystal

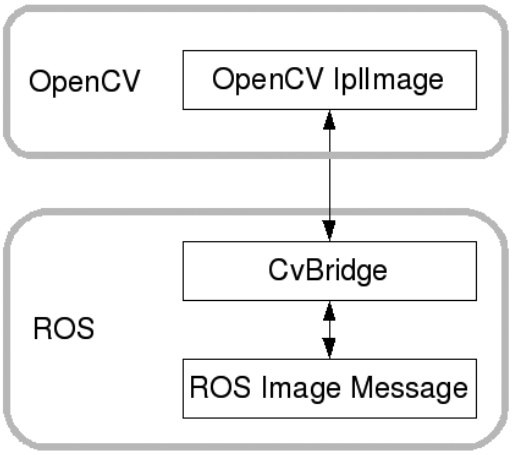

OpenCV

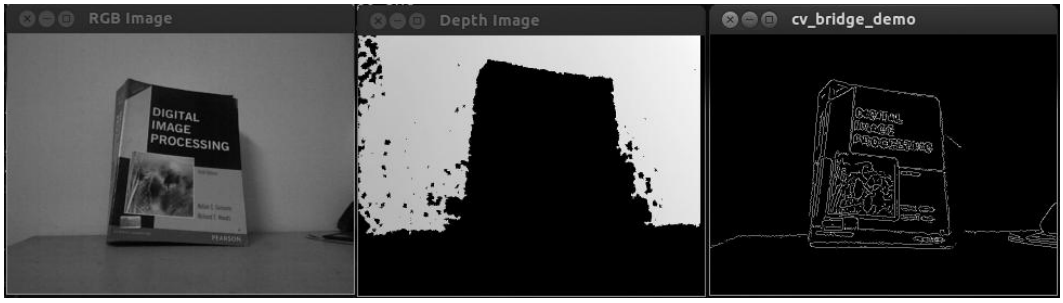

image
ASIMO
HONDA

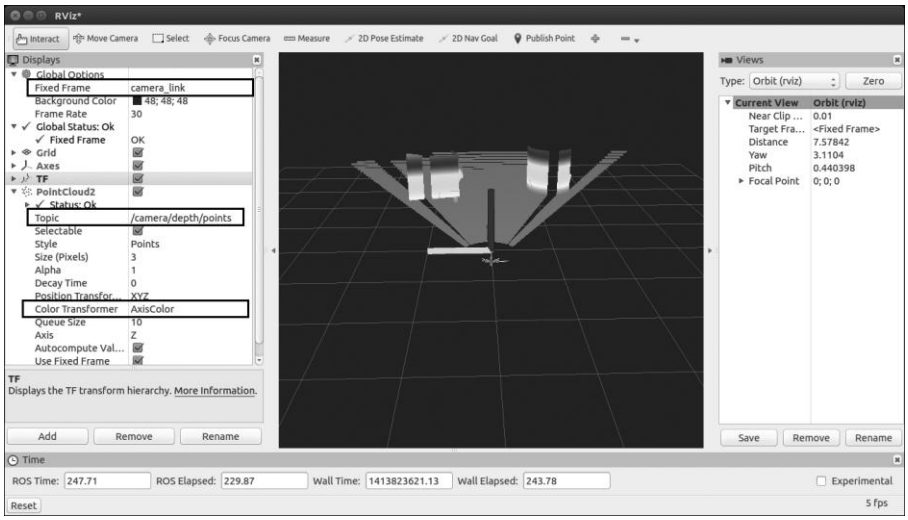

frame
DIGITAL IMAGE PROCESSING
Third Edition
Rafael C. Gonzalez
Richard E. Woods
ALWAYS LEARNING
PEARSON

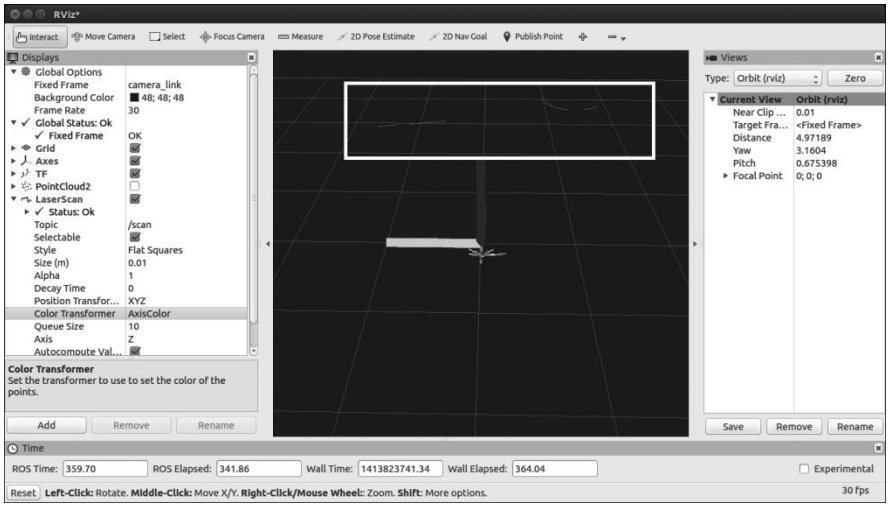

Application
(Game, TV Portal, Browser, etc.)
Application
OpenNI
Middleware Component A
Middleware Component B
Middleware Component C
Middleware Components (e.g. Hand gesture tracking)
OpenNI Interfaces
Hardware Device (sensor)

pcl

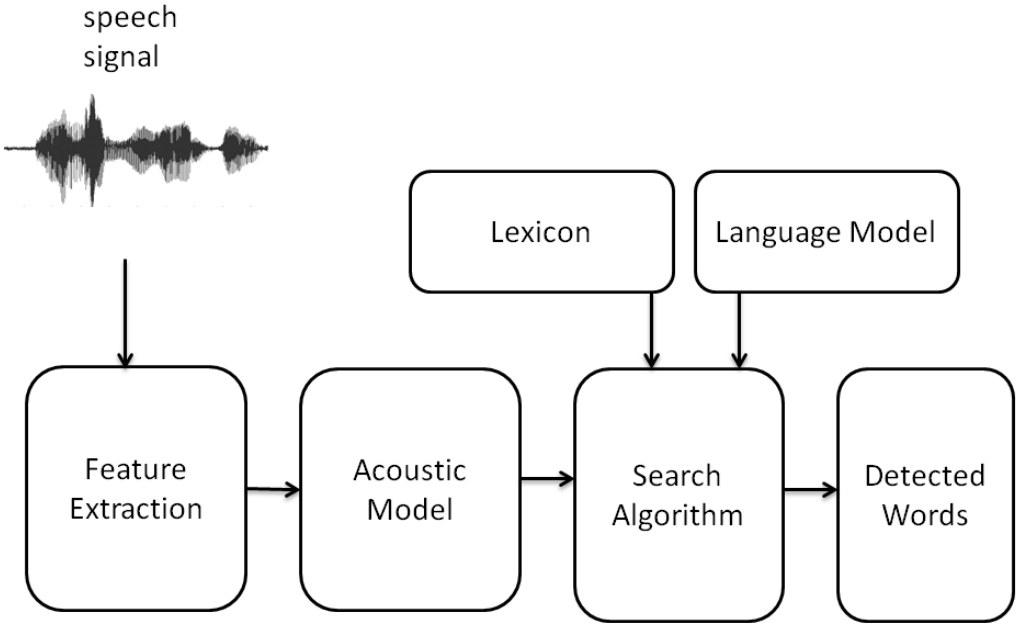

OpenCV
OpenCV IplImage
CvBridge
ROS
ROS Image Message

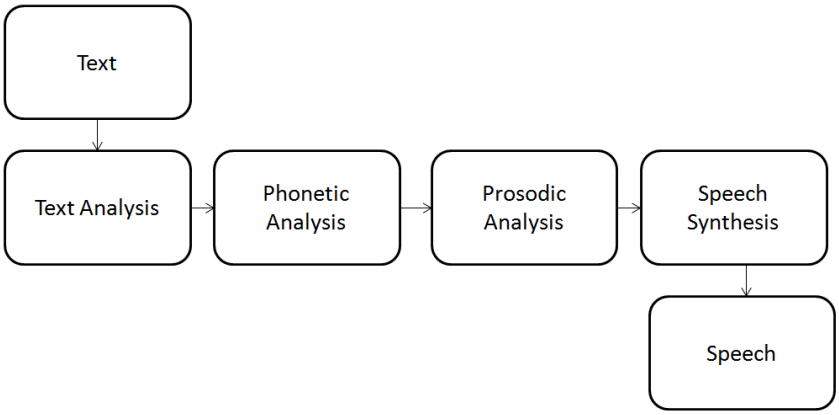

RGB Image
Depth Image
cv_bridge_demo


RViz*
Interact
Move Camera
Select
Focus Camera
Measure
2D Pose Estimate
2D Nav Goal
Publish Point
Displays
Global Options
Fixed Frame
camera_link
Background Color
48; 48; 48
Frame Rate
30
Global Status: Ok
Fixed Frame
OK
Grid
Axes
TF
PointCloud2
Status: Ok
Topic
/camera/depth/points
Selectable
Style
Points
Size (Pixels)
3
Alpha
1
Decay Time
0
Position Transfor...
XYZ
Color Transformer
AxisColor
Queue Size
10
Axis
Z
Autocompute Val...
Use Fixed Frame
TF
Displays the TF transform hierarchy. More Information.
Add
Remove
Rename
Views
Type: Orbit (rviz)
Zero
Current View
Orbit (rviz)
Near Clip ...
0.01
Target Fra...
<Fixed Frame>
Distance
7.57842
Yaw
3.1104
Pitch
0.440398
Focal Point
0; 0; 0
Save
Remove
Rename
Time
ROS Time:
247.71
ROS Elapsed:
229.87
Wall Time:
1413823621.13
Wall Elapsed:
243.78
Experimental
Reset
5 fps



Chapter 8, Working with Speech Recognition and Synthesis using Python and ROS



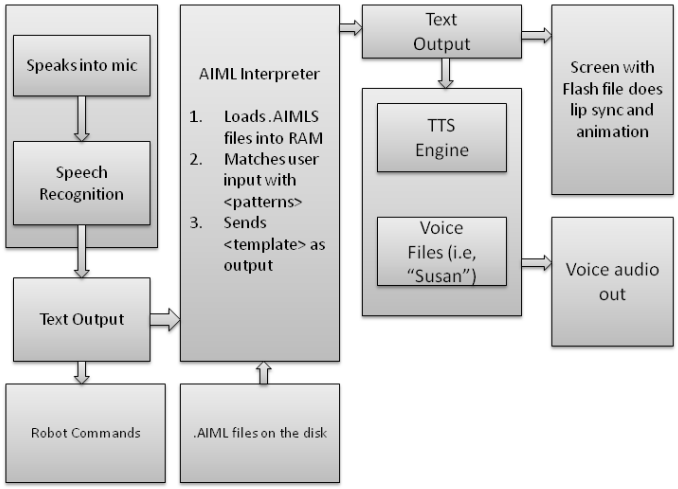



```
INFO: ngram_search.c(1214): </s> not found in last frame, using <sil>.1326 inste
ad
INFO: ngram_search.c(1266): lattice start node <s>.0 end node <sil>.1296
INFO: ngram_search.c(1294): Eliminated 0 nodes before end node
INFO: ngram_search.c(1399): Lattice has 425 nodes, 1725 links
INFO: ps_lattice.c(1365): Normalizer P(O) = alpha(<sil>:1296:1326) = -7472594
INFO: ps_lattice.c(1403): Joint P(O,S) = -7490696 P(S|O) = -18102
INFO: ngram_search.c(888): bestpath 0.01 CPU 0.001 xRT
INFO: ngram_search.c(891): bestpath 0.01 wall 0.001 xRT



Detected text:> ("to news and i'm", '000000000', -143373)




INFO: ngram_search_fwdtree.c(430): TOTAL fwdtree 3.02 CPU 0.228 xRT
INFO: ngram_search_fwdtree.c(433): TOTAL fwdtree 3.10 wall 0.234 xRT
INFO: ngram_search_fwdflat.c(174): TOTAL fwdflat 0.11 CPU 0.009 xRT
INFO: ngram_search_fwdflat.c(177): TOTAL fwdflat 0.11 wall 0.009 xRT
INFO: ngram_search.c(317): TOTAL bestpath 0.01 CPU 0.001 xRT
INFO: ngram_search.c(320): TOTAL bestpath 0.01 wall 0.001 xRT
lentin@lentin-Aspire-4755:~/Desktop/Chapter-8/codes$
```

```
INFO: ngram_model_arpa.c(77): No \data\ mark in LM file
INFO: ngram_model_dmp.c(142): Will use memory-mapped I/O for LM file
INFO: ngram_model_dmp.c(196): ngrams 1=5001, 2=436879, 3=418286
INFO: ngram_model_dmp.c(242):     5001 = LM.unigrams(+trailer) read
INFO: ngram_model_dmp.c(288):   436879 = LM.bigrams(+trailer) read
INFO: ngram_model_dmp.c(314):   418286 = LM.trigrams read
INFO: ngram_model_dmp.c(339):    37293 = LM.prob2 entries read
INFO: ngram_model_dmp.c(359):    14370 = LM.bo_wt2 entries read
INFO: ngram_model_dmp.c(379):    36094 = LM.prob3 entries read
INFO: ngram_model_dmp.c(407):      854 = LM.tseg_base entries read
INFO: ngram_model_dmp.c(463):     5001 = ascii word strings read
INFO: ngram_search_fwdtree.c(99): 788 unique initial diphones
INFO: ngram_search_fwdtree.c(147): 0 root, 0 non-root channels, 60 single-phone
words
INFO: ngram_search_fwdtree.c(186): Creating search tree
INFO: ngram_search_fwdtree.c(191): before: 0 root, 0 non-root channels, 60 singl
e-phone words
INFO: ngram_search_fwdtree.c(326): after: max nonroot chan increased to 13428
INFO: ngram_search_fwdtree.c(338): after: 457 root, 13300 non-root channels, 26
single-phone words

(original_code_gst.py:3611): GStreamer-CRITICAL **: gst_clock_get_time: assertio
n 'GST_IS_CLOCK (clock)' failed
Press any key to start recognition:>
```

```
lentin@lentin-desktop:~/ros_ws/pocketsphinx/demo$ rostopic echo /recognizer/output
data: move left
---
data: move right
---
data: full speed
---
data: left
---
data: left
---
data: ''
---
```

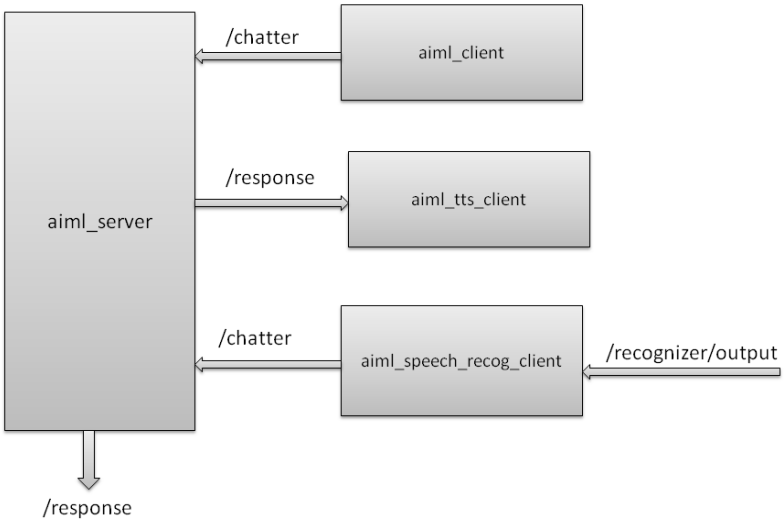
Chapter 9, Applying Artificial Intelligence to ChefBot Using Python

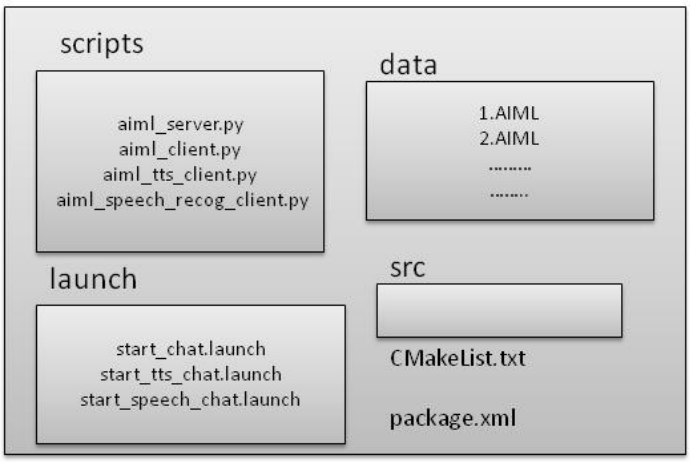



```
lentin@lentin-Aspire-4755:~/Desktop/Chapter-9_code$ ./chatbot.py sample.aiml
Loading sample.aiml... done (0.02 seconds)
Enter input >HOW ARE YOU
I AM FINE
Enter input >
```

```
PARSE ERROR: Unexpected </category> tag (line 104, column 0)
PARSE ERROR: Unexpected </category> tag (line 144, column 0)
Loading update_mccormick.aiml... done (0.01 seconds)
PARSE ERROR: Unexpected text inside <random> element (line 4311, column 262)
PARSE ERROR: Unexpected text inside <random> element (line 4848, column 172)
PARSE ERROR: Unexpected text inside <random> element (line 8844, column 351)
Loading default.aiml... done (0.72 seconds)
Enter input >How are you
I am fine, thank you.
Enter input >
```

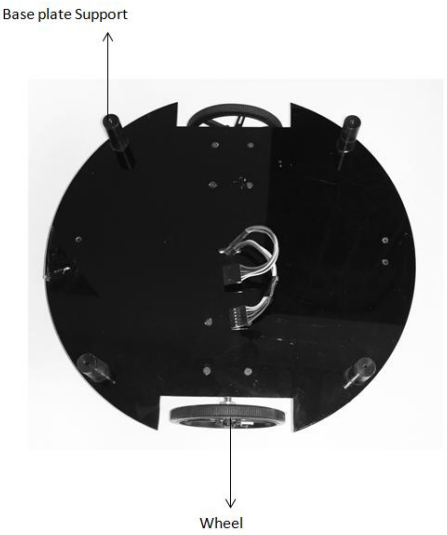
```
Loading personality.aiml... done (0.01 seconds)
Loading bot.aiml... done (0.27 seconds)
Loading biography.aiml... done (0.05 seconds)
PARSE ERROR: Unexpected </category> tag (line 104, column 0)
PARSE ERROR: Unexpected </category> tag (line 144, column 0)
Loading update_mccormick.aiml... done (0.01 seconds)
PARSE ERROR: Unexpected text inside <random> element (line 4311, column 262)
PARSE ERROR: Unexpected text inside <random> element (line 4848, column 172)
PARSE ERROR: Unexpected text inside <random> element (line 8844, column 351)
Loading default.aiml... done (0.73 seconds)
Saving brain to standard.brn... done (0.41 seconds)
Enter input >How are you
My logic and cognitive functions are normal.
Enter input >
```



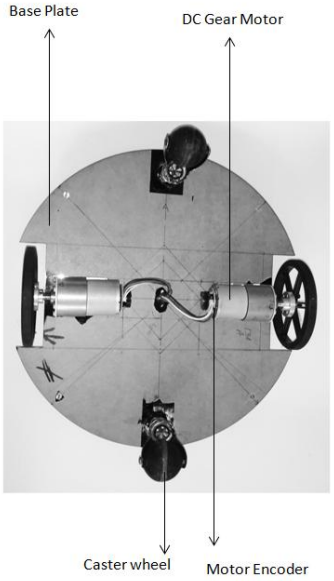


ros_aiml package

Chapter 10, Integration of ChefBot Hardware and Interfacing it into ROS Using Python



Top View

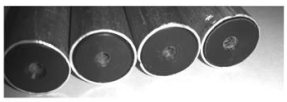


Bottom View

Middle plate

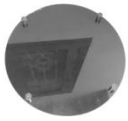
Base plate Female connector

Assembled up to Middle plate



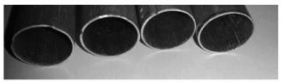
Middle plate Female connector

Semi-assembled body



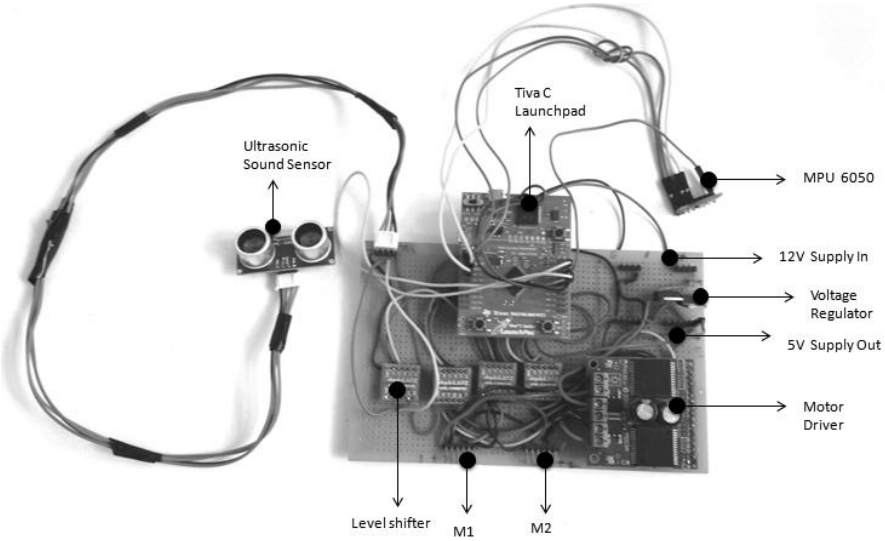
Top plate

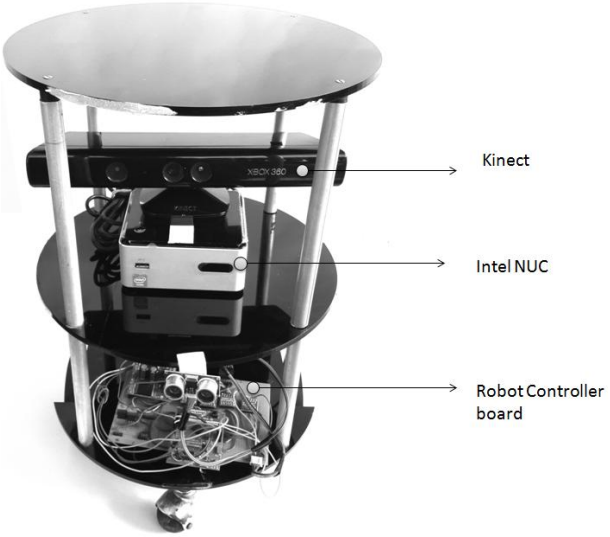
Middle plate male connector

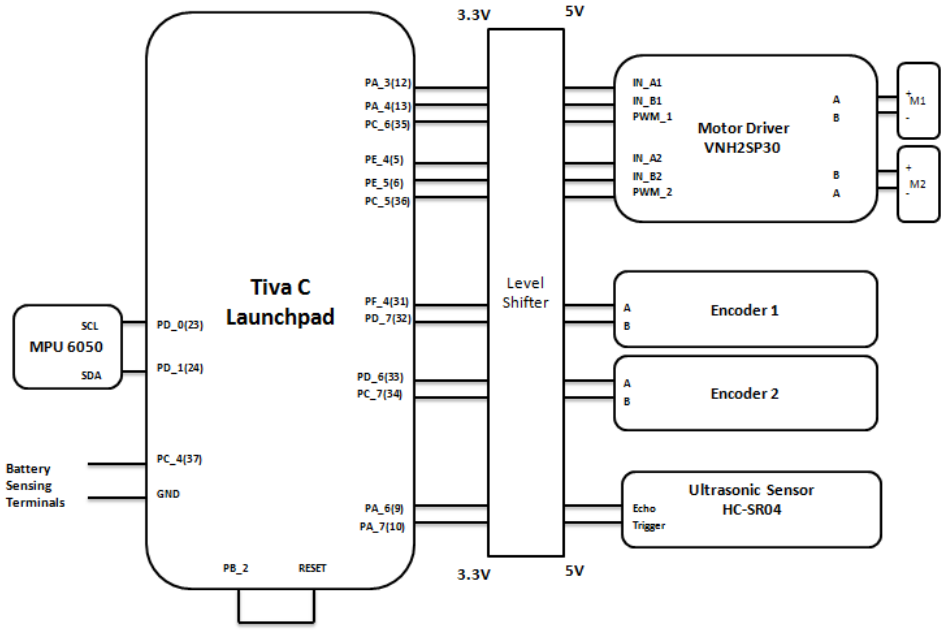


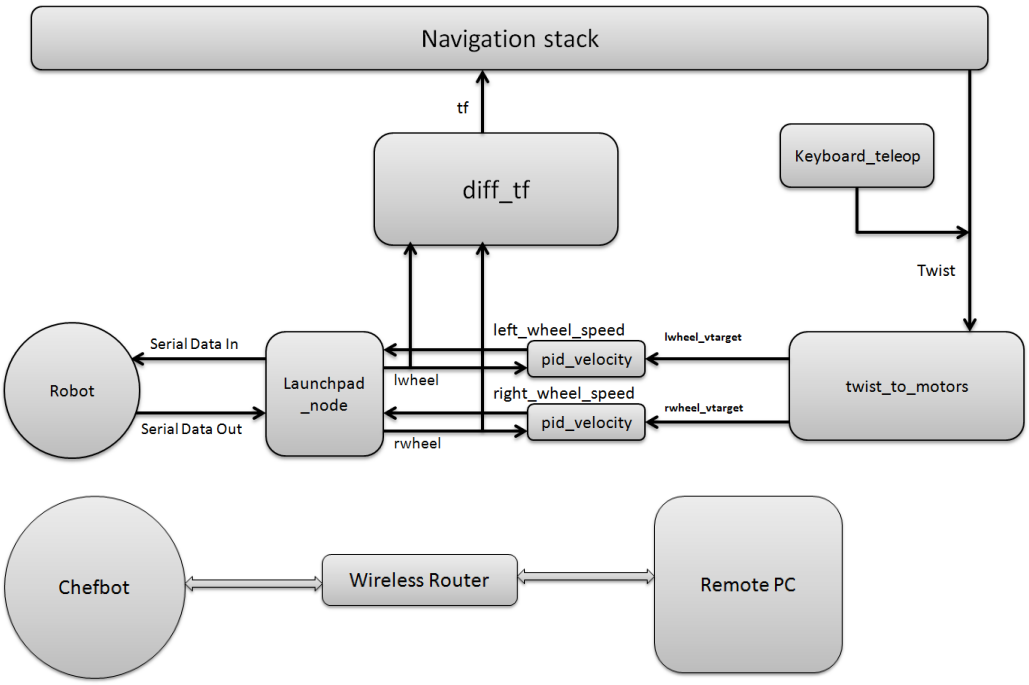
Top plate Female connector

Fully assembled body









e.g. IP : 192.168.1.106

e.g. IP : 192.168.1.101

```
b       0.00
t       66458239        0.05
e       0       0
u       10
s       0.00    0.00
i       -0.68   -0.47   -0.40   0.40
b       0.00
t       66511681        0.05
e       0       0
u       10
s       0.00    0.00
i       -0.68   -0.47   -0.40   0.40
b       0.00
t       66566051        0.05
e       0       0
u       10
s       0.00    0.00
i       -0.68   -0.47   -0.40   0.40
b       0.00
t       66620423        0.05
e       0       0
u       10
s       0.00    0.00
```

```
robot@robot-desktop:~$ rosrun chefbot_bringup launchpad_node.py
Initializing Launchpad Class
[INFO] [WallTime: 1424097603.219564] Starting with serial port: /dev/ttyACM0, bau
d rate: 115200
[INFO] [WallTime: 1424097603.220825] Started serial communication
```

```
robot@robot-desktop:~$ rostopic list
/battery_level
/imu/data
/left_wheel_speed
/lwheel
/qw
/qx
/qy
/qz
/right_wheel_speed
/rosout
/rosout_agg
/rwheel
/serial
/ultrasonic distance
```

```
---
data: 16266, in:  e     1       -1
---
data: 16267, in:  u     10
---
data: 16268, in:  s     0.00    0.00
---
```

e.g. IP : 192.168.1.106

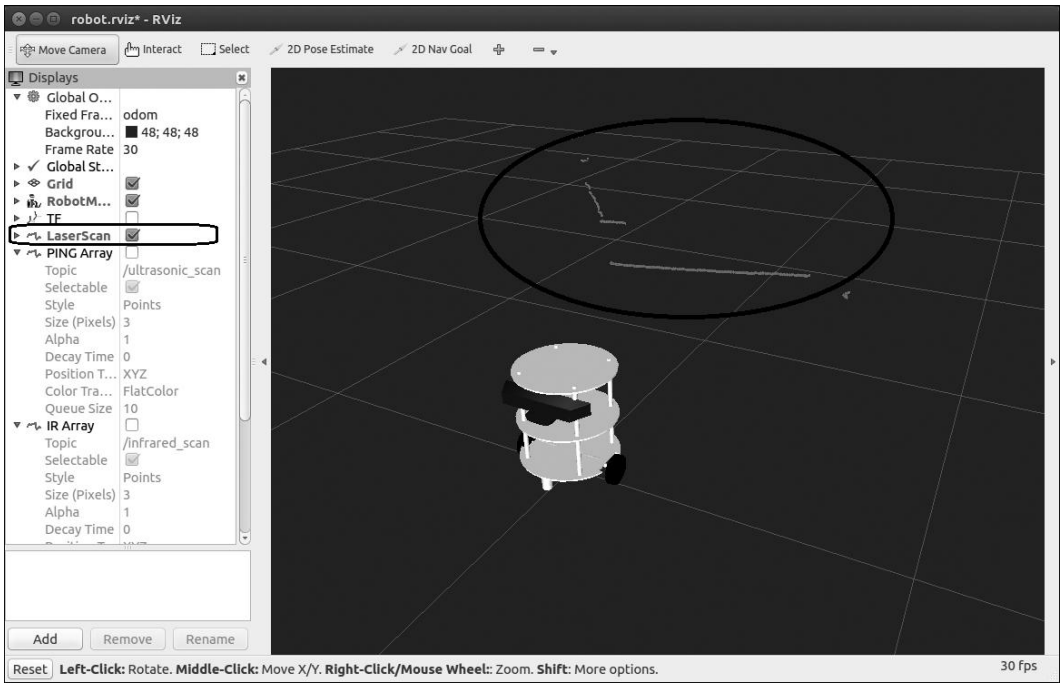
e.g. IP : 192.168.1.101

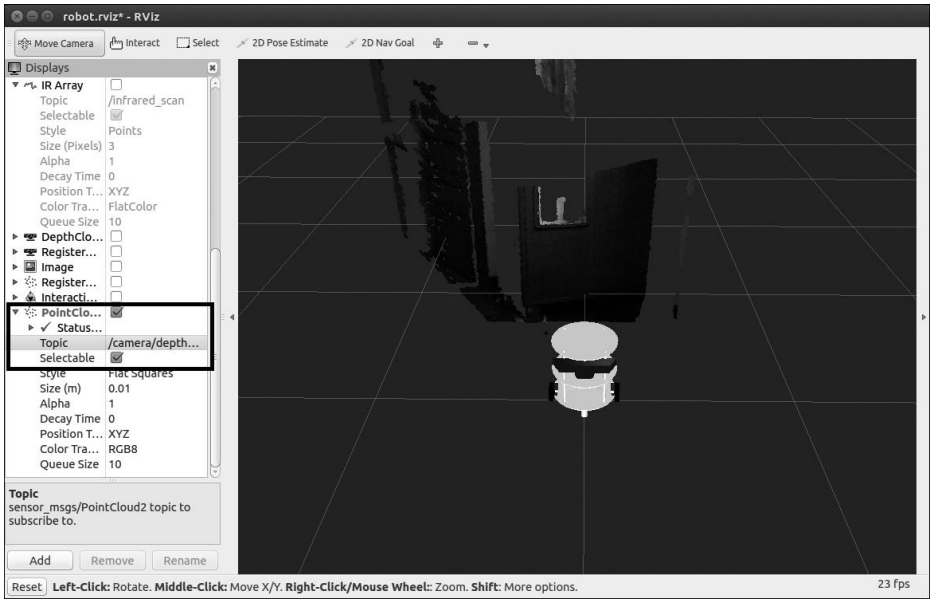

```
export MY_IP=192.168.1.106
export ROS_IP=$MY_IP
export ROS_MASTER_URI="http://"$ROS_IP":11311"
```

.bashrc

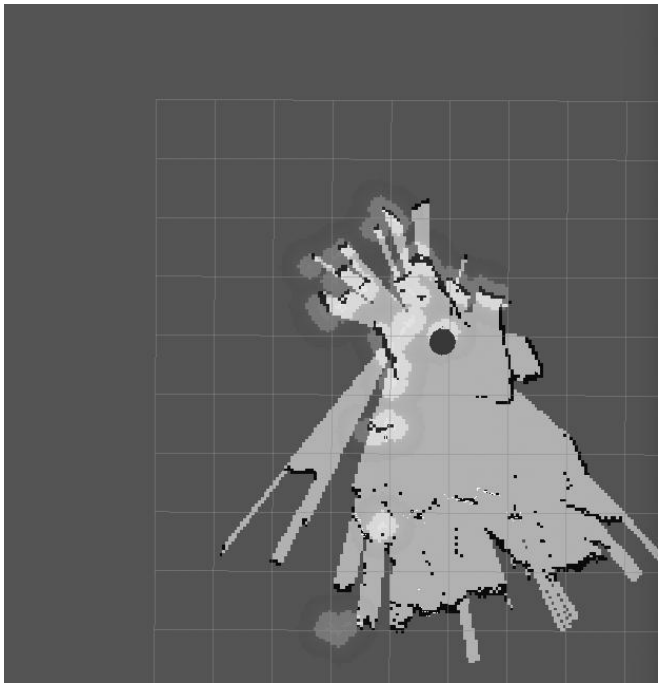
```
export ROS_MASTER_URI="http://192.168.1.106:11311"
```

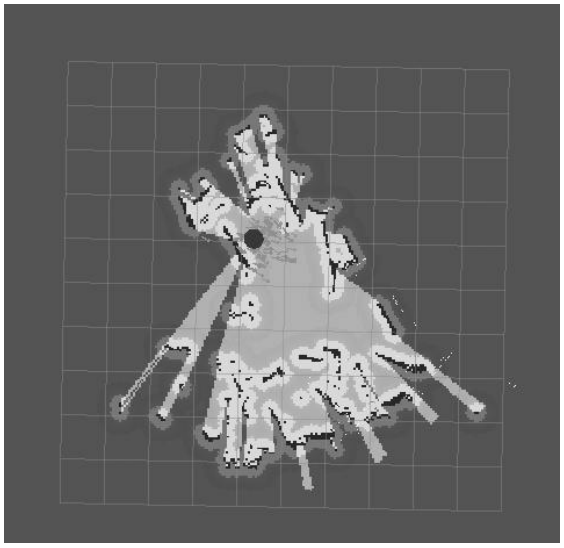
.bashrc

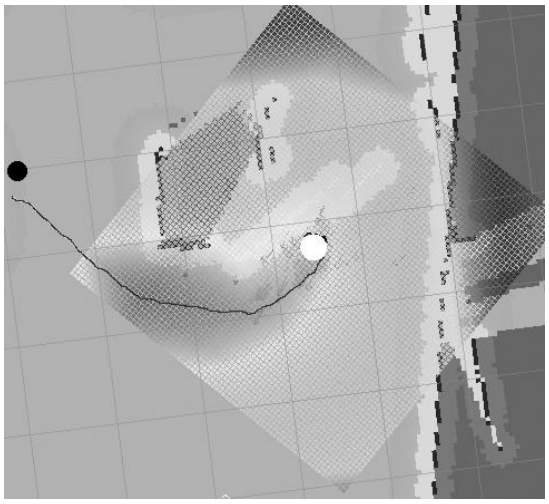




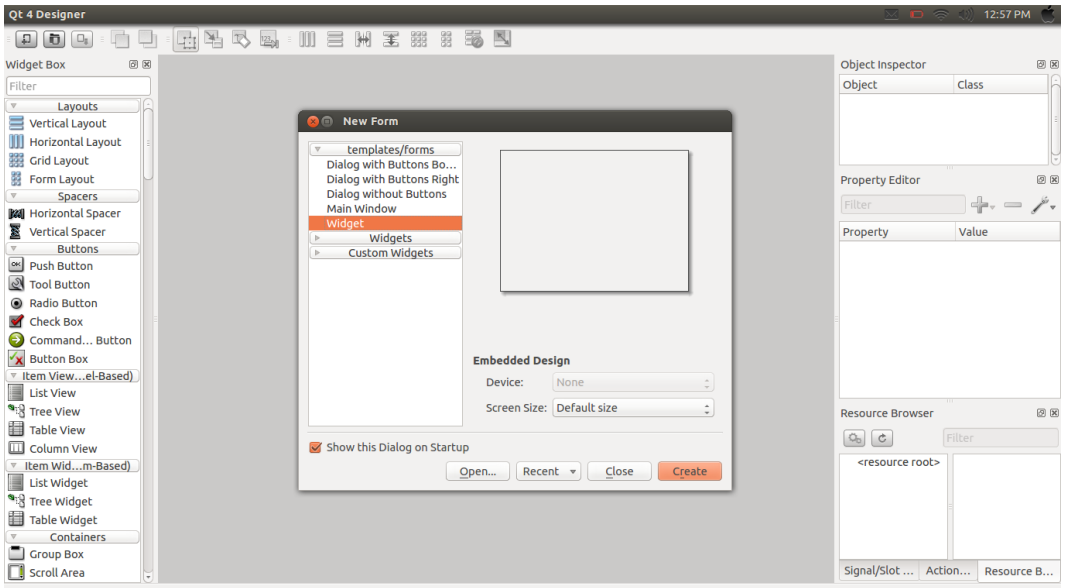

```
[ INFO] [1422618733.585407153]: Created local_planner dwa_local_planner/DWAPlanner
ROS
[ INFO] [1422618733.604762090]: Sim period is set to 0.20
[ INFO] [1422618735.208493249]: odom received!
```

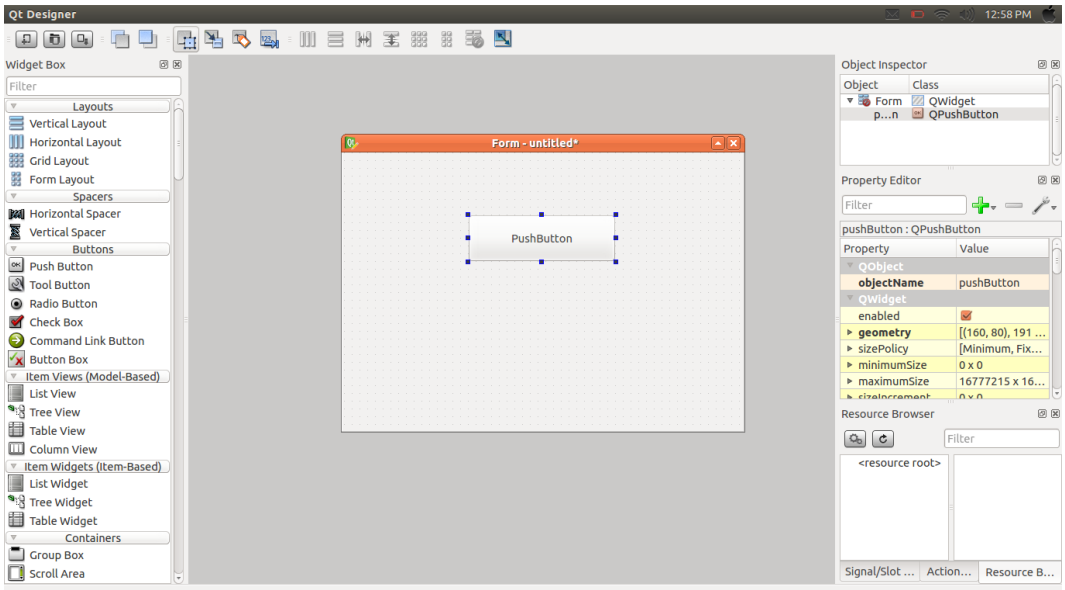


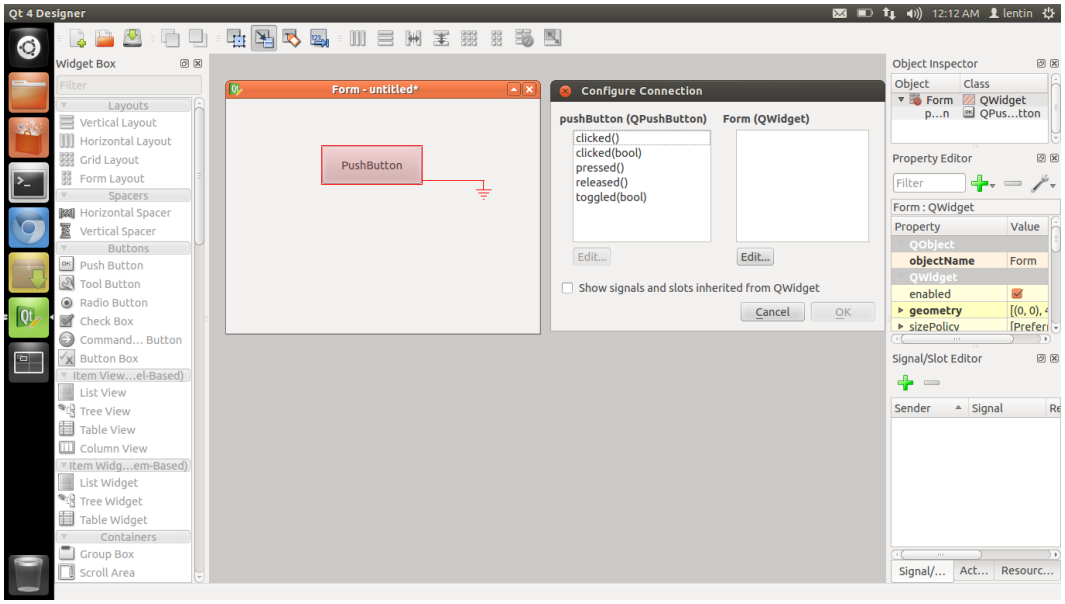


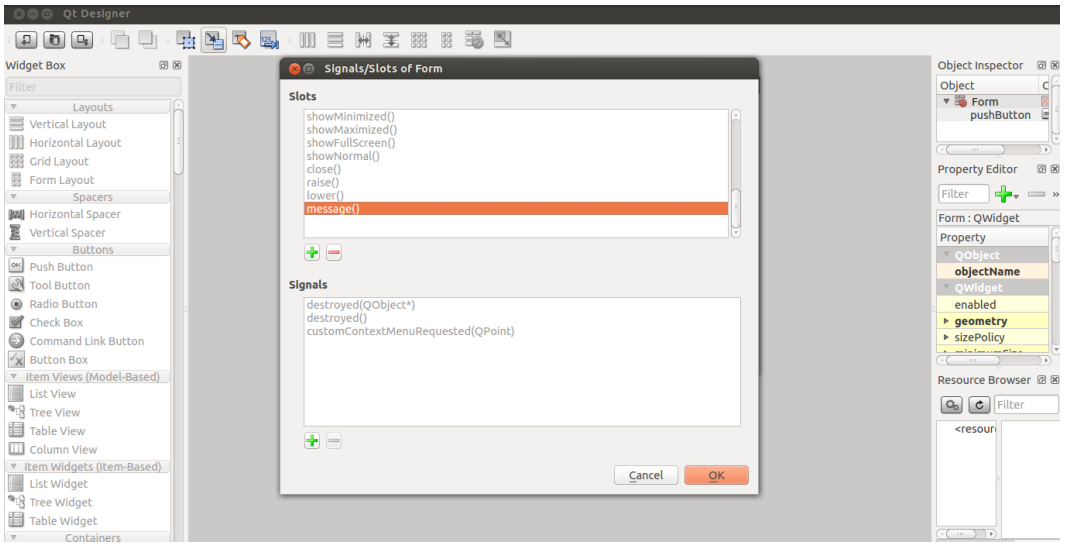


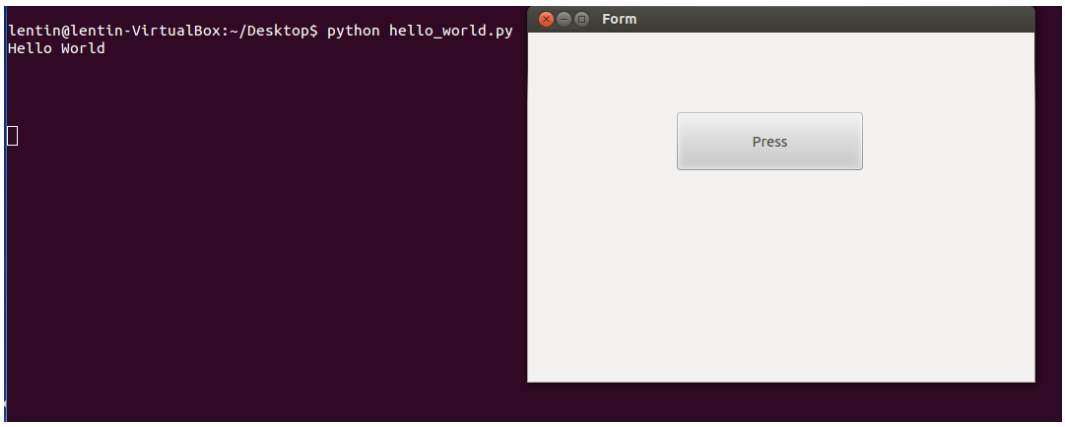
Chapter 11, Designing a GUI for a Robot using Qt and Python

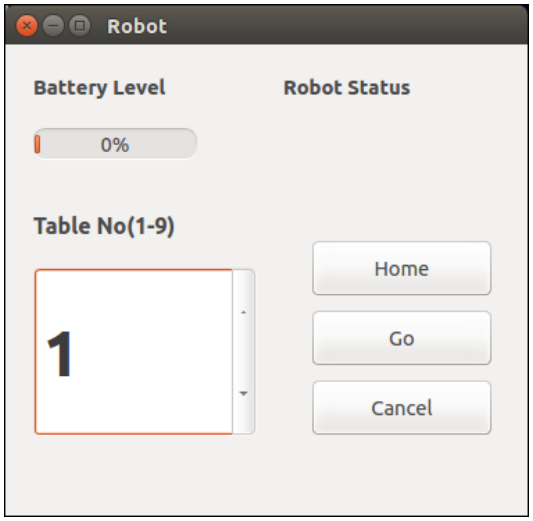


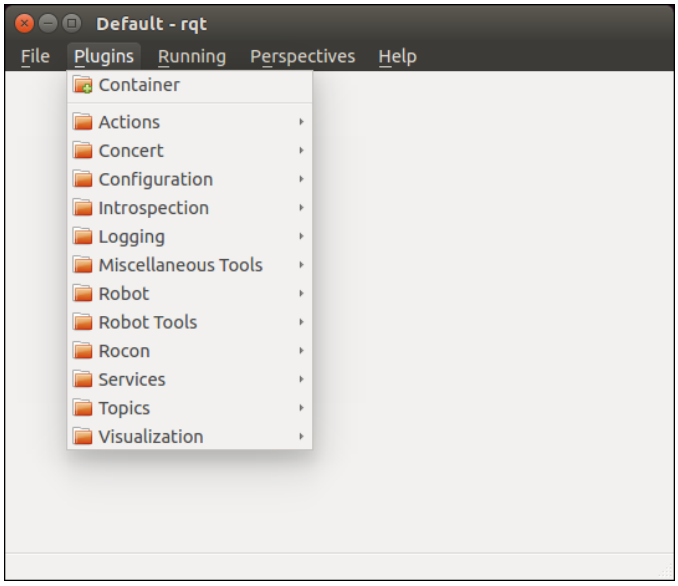


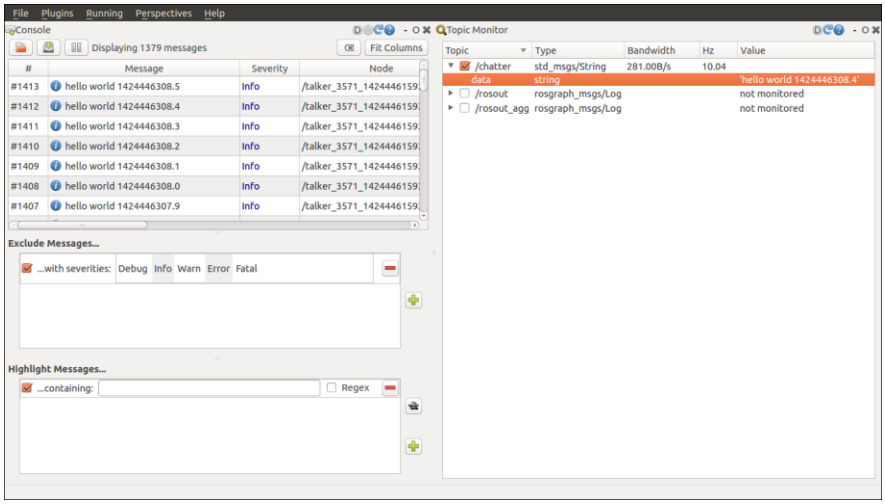

Qt 4 Designer
12:12 AM lentin
Widget Box
Layouts
Vertical Layout
Horizontal Layout
Grid Layout
Form Layout
Spacers
Horizontal Spacer
Vertical Spacer
Buttons
Push Button
Tool Button
Radio Button
Check Box
Command... Button
Button Box
Item View...el-Based)
List View
Tree View
Table View
Column View
Item Widg...em-Based)
List Widget
Tree Widget
Table Widget
Containers
Group Box
Scroll Area
Form - untitled*
PushButton
Configure Connection
pushButton (QPushButton)
Form (QWidget)
clicked()
clicked(bool)
pressed()
released()
toggled(bool)
Edit...
Edit...
Show signals and slots inherited from QWidget
Cancel
OK
Object Inspector
Object
Class
Form
QWidget
Property Editor
Filter
Form : QWidget
Property
Value
QObject
objectName
Form
QWidget
enabled
geometry
sizePolicy
Signal/Slot Editor
Sender
Signal
Signal/...
Act...
Resourc...


Qt Designer
Widget Box
Layouts
Vertical Layout
Horizontal Layout
Grid Layout
Form Layout
Spacers
Horizontal Spacer
Vertical Spacer
Buttons
Push Button
Tool Button
Radio Button
Check Box
Command Link Button
Button Box
Item Views (Model-Based)
List View
Tree View
Table View
Column View
Item Widgets (Item-Based)
List Widget
Tree Widget
Table Widget
Containers
Signals/Slots of Form
Slots
showMinimized()
showMaximized()
showFullScreen()
showNormal()
close()
raise()
lower()
message()
Signals
destroyed(QObject*)
destroyed()
customContextMenuRequested(QPoint)
Cancel
OK
Object Inspector
Object
Form
pushButton
Property Editor
Filter
Form : QWidget
Property
QObject
objectName
QWidget
enabled
geometry
sizePolicy
Resource Browser
Filter

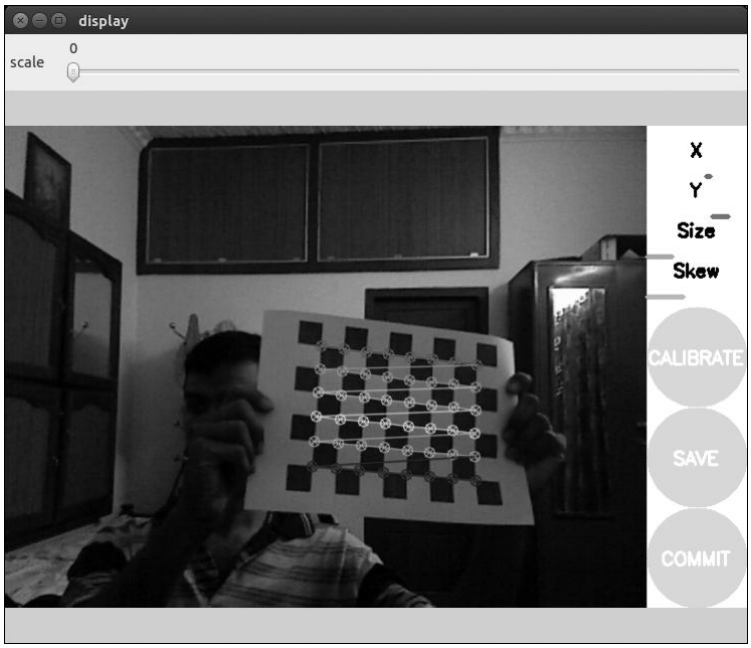

lentin@lentin-VirtualBox:~/Desktop$ python hello_world.py
Hello World
Form
Press

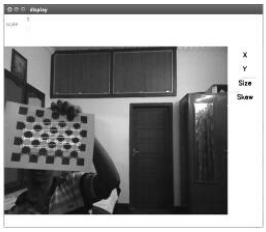

Robot
Battery Level
Robot Status
0%
Table No(1-9)
1
Home
Go
Cancel

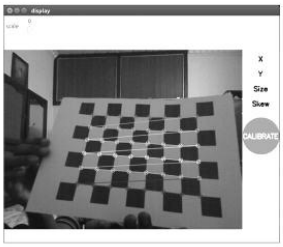

Default - rqt
File
Plugins
Running
Perspectives
Help
Container
Actions
Concert
Configuration
Introspection
Logging
Miscellaneous Tools
Robot
Robot Tools
Rocon
Services
Topics
Visualization

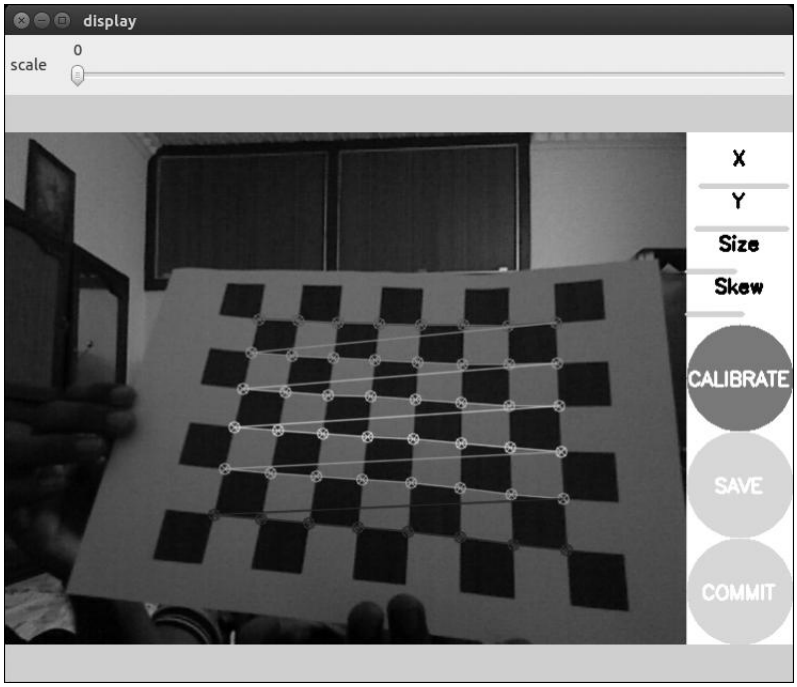

File
Plugins
Running
Perspectives
Help
Console
Displaying 1379 messages
Fit Columns
Message Severity Node
#1413 hello world 1424446308.5 Info /talker_3571_1424446159
#1412 hello world 1424446308.4 Info /talker_3571_1424446159
#1411 hello world 1424446308.3 Info /talker_3571_1424446159
#1410 hello world 1424446308.2 Info /talker_3571_1424446159
#1409 hello world 1424446308.1 Info /talker_3571_1424446159
#1408 hello world 1424446308.0 Info /talker_3571_1424446159
#1407 hello world 1424446307.9 Info /talker_3571_1424446159
Exclude Messages...
...with severities: Debug Info Warn Error Fatal
Highlight Messages...
...containing: Regex
Topic Monitor
Topic Type Bandwidth Hz Value
/chatter std_msgs/String 281.00B/s 10.04
data string 'hello world 1424446308.4'
/rosout rosgraph_msgs/Log not monitored
/rosout_agg rosgraph_msgs/Log not monitored

Chapter 12, The Calibration and Testing of ChefBot

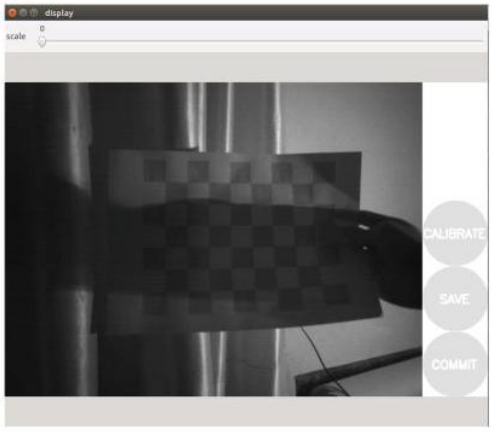






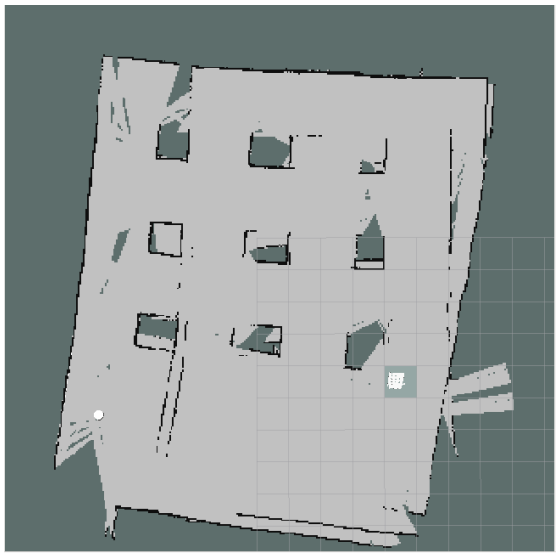


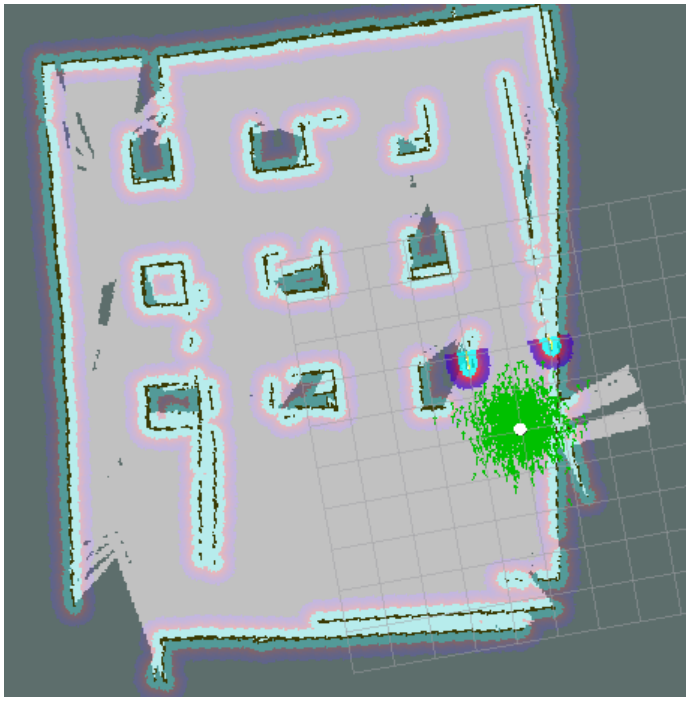
IR with speckle pattern



IR with projector covered


X,Y
X',Y'
0,0





```
Frame chefbot_caster_front_link exists with parent base_link.
Frame chefbot_caster_back_link exists with parent base_link.
Frame cliff_sensor_front_link exists with parent base_link.
Frame cliff_sensor_left_link exists with parent base_link.
Frame cliff_sensor_right_link exists with parent base_link.
Frame gyro_link exists with parent base_link.

At time 1024.033
- Translation: [0.058, 0.033, 0.010]
- Rotation: in Quaternion [0.000, 0.000, -0.005, 1.000]
            in RPY [0.000, 0.000, -0.009]
At time 1024.438
- Translation: [0.058, 0.033, 0.010]
- Rotation: in Quaternion [0.000, 0.000, -0.005, 1.000]
            in RPY [0.000, 0.000, -0.009]
At time 1024.830
- Translation: [0.058, 0.033, 0.010]
- Rotation: in Quaternion [0.000, 0.000, -0.005, 1.000]
            in RPY [0.000, 0.000, -0.009]
At time 1025.228
- Translation: [0.058, 0.033, 0.010]
- Rotation: in Quaternion [0.000, 0.000, -0.005, 1.000]
            in RPY [0.000, 0.000, -0.009]
```