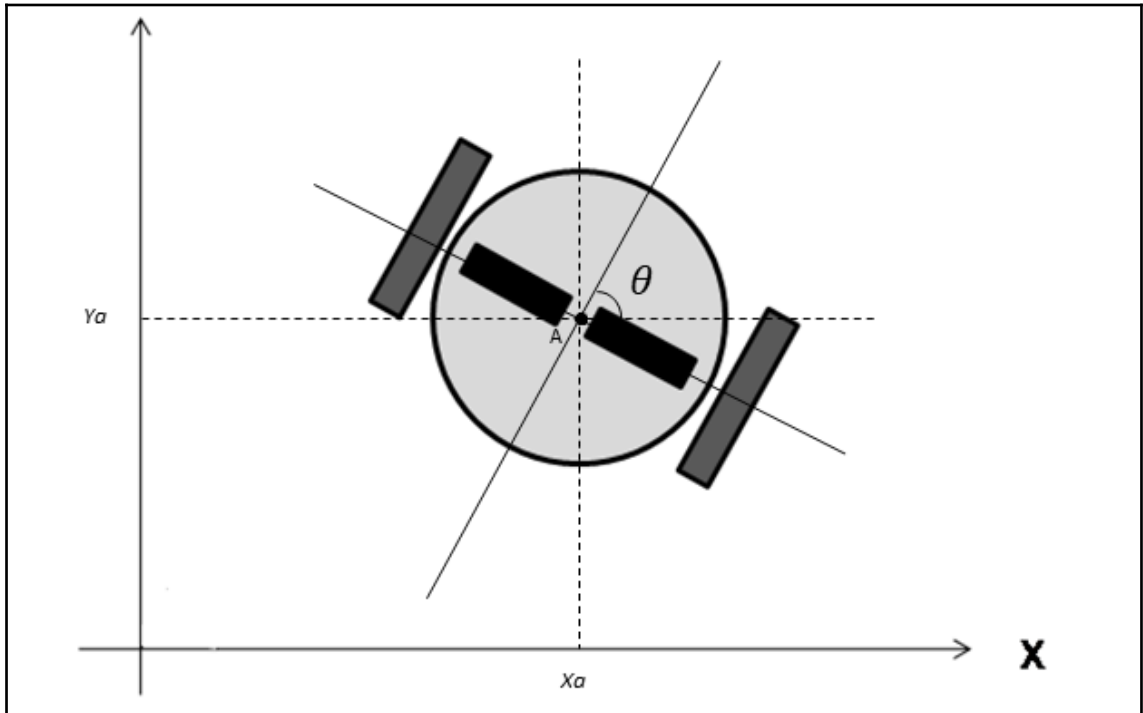
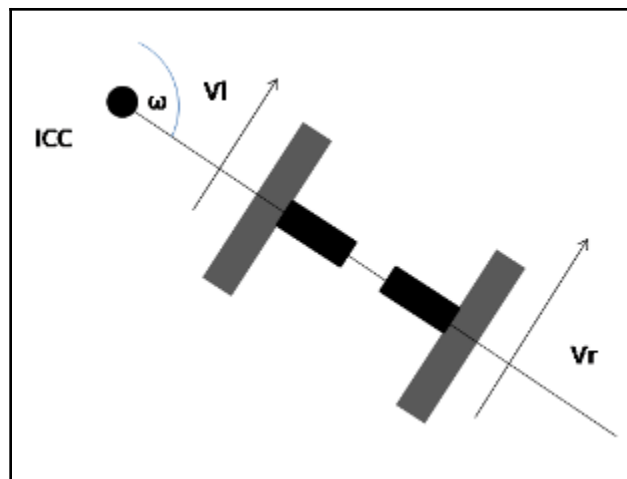
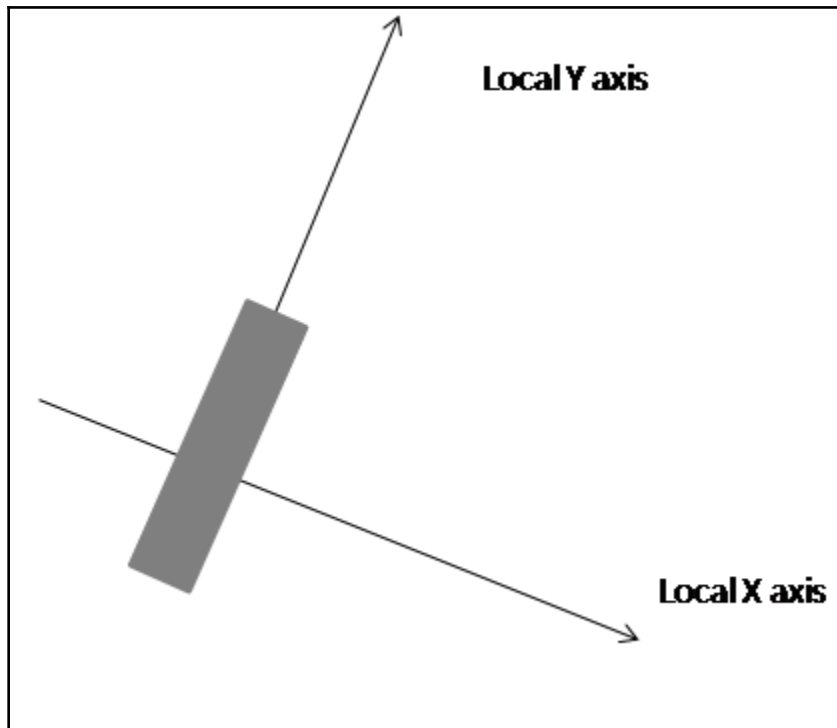


Chapter 1: Understanding the Basics of Differential Robots

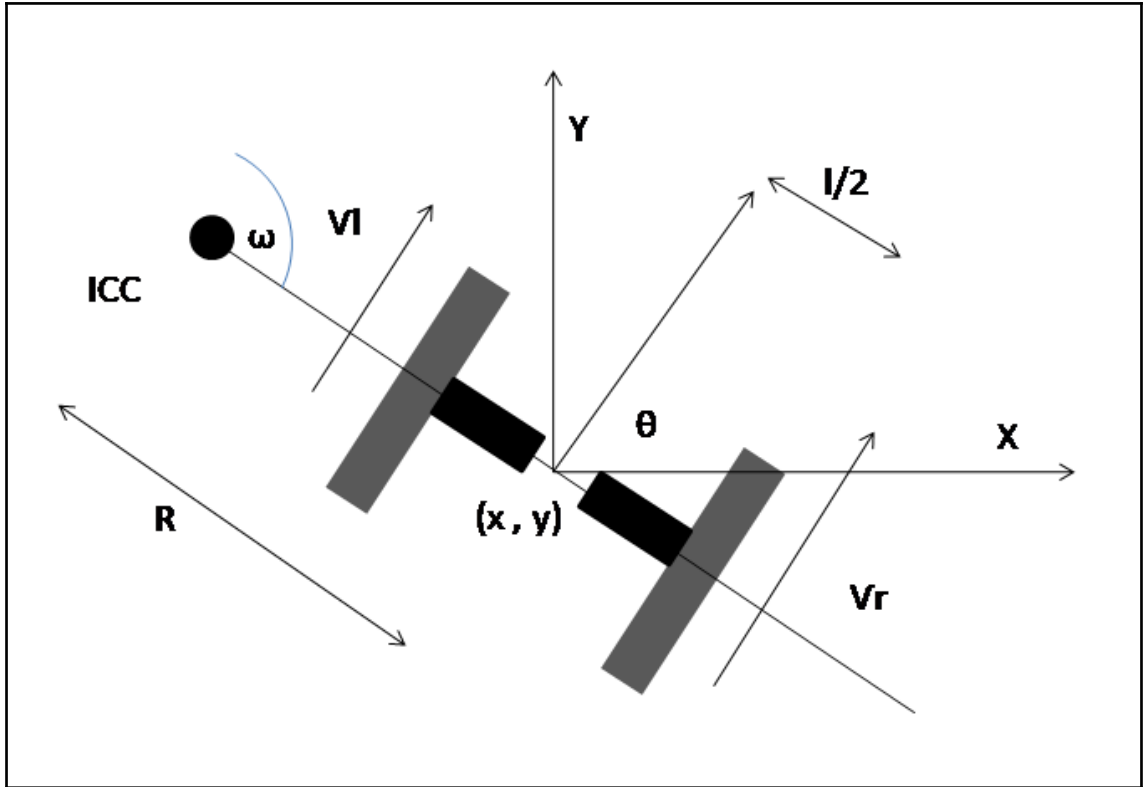






$$v = r \omega$$

(1)



$$\omega(R + l/2) = Vr \quad (2)$$

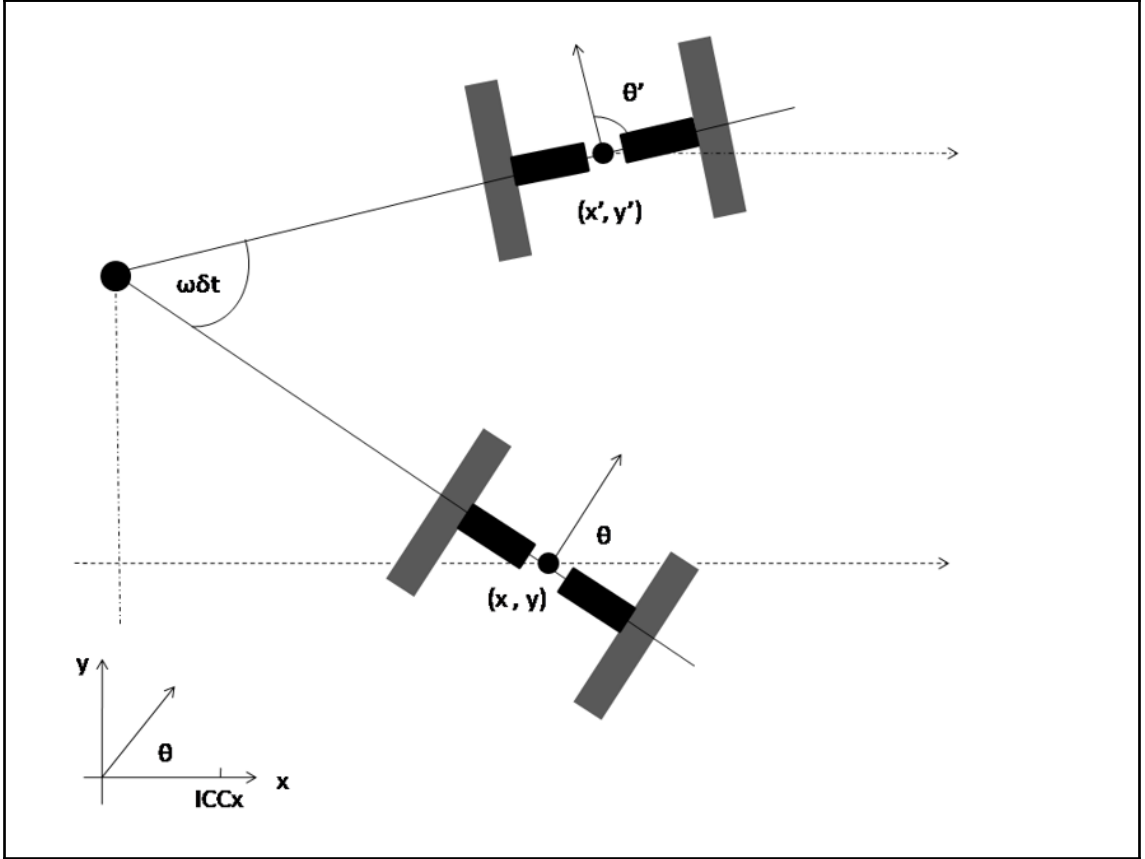
$$\omega(R - l/2) = Vl \quad (3)$$

$$R = l/2(Vl + Vr) / (Vr - Vl) \quad (4)$$

$$\omega = (Vr - Vl) / l \quad (5)$$

$$\theta' = \omega \delta t + \theta \quad (6)$$

$$ICC = [ICC_x, ICC_y] = [x - R \sin\theta, y + R \cos\theta] \quad (7)$$



$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} \cos(\omega\delta t) & -\sin(\omega\delta t) \\ \sin(\omega\delta t) & \cos(\omega\delta t) \end{pmatrix} \begin{pmatrix} x - ICC_x \\ y - ICC_y \end{pmatrix} + \begin{pmatrix} ICC_x \\ ICC_y \end{pmatrix} \quad (8)$$

$$v = n * step / \delta t \quad (9)$$

$$R = l / 2(Vl + Vr) / (Vr - Vl) = l / 2(nl + nr) / (nr - nl) \quad (10)$$

$$w\delta t = (Vr - Vl)\delta t / l = (nr - nl) * \text{step} / l \quad (11)$$

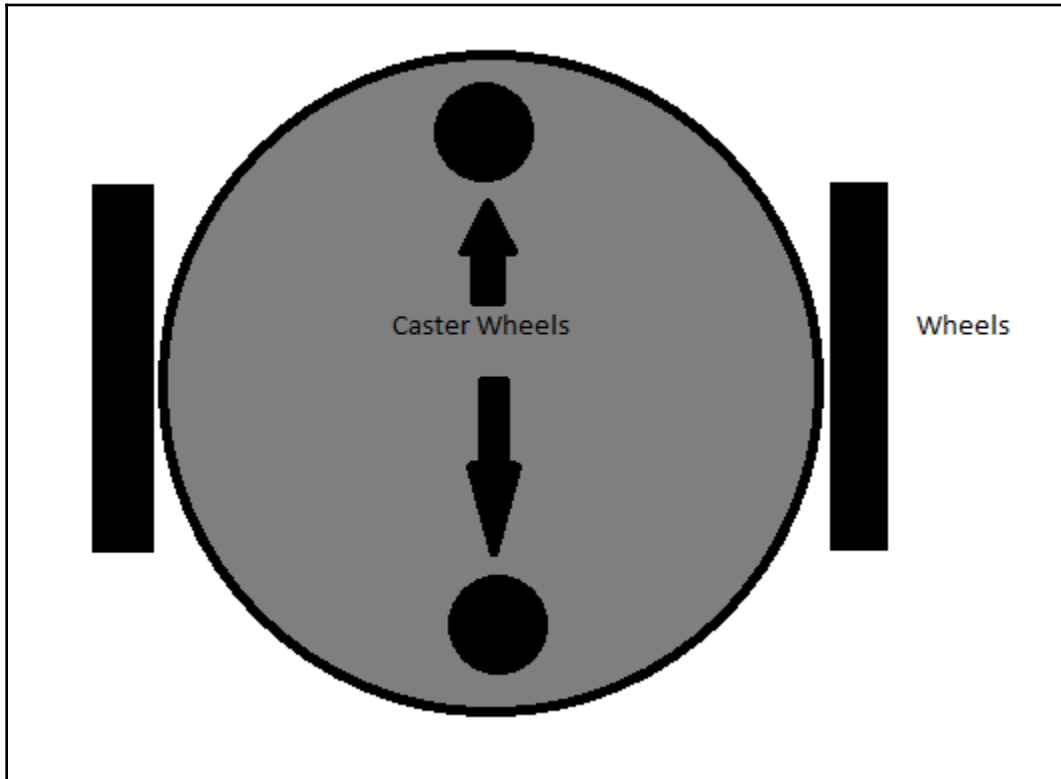
$$\begin{pmatrix} x' \\ y' \\ \theta' \end{pmatrix} = \begin{pmatrix} \cos(\omega\delta t) & -\sin(\omega\delta t) & 0 \\ \sin(\omega\delta t) & \cos(\omega\delta t) & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x - \text{ICC}_x \\ y - \text{ICC}_y \\ \theta \end{pmatrix} + \begin{pmatrix} \text{ICC}_x \\ \text{ICC}_y \\ \omega\delta t \end{pmatrix} \quad (12)$$

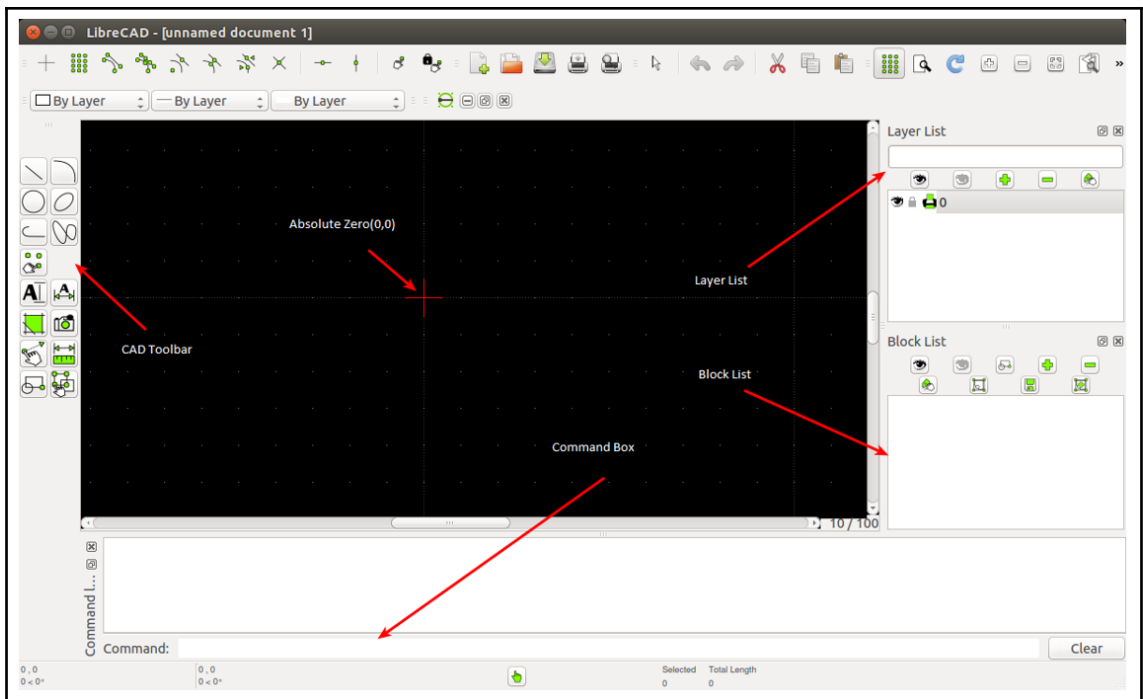
$$R = l / 2(nl + nr) / (nr - nl) \quad (13)$$

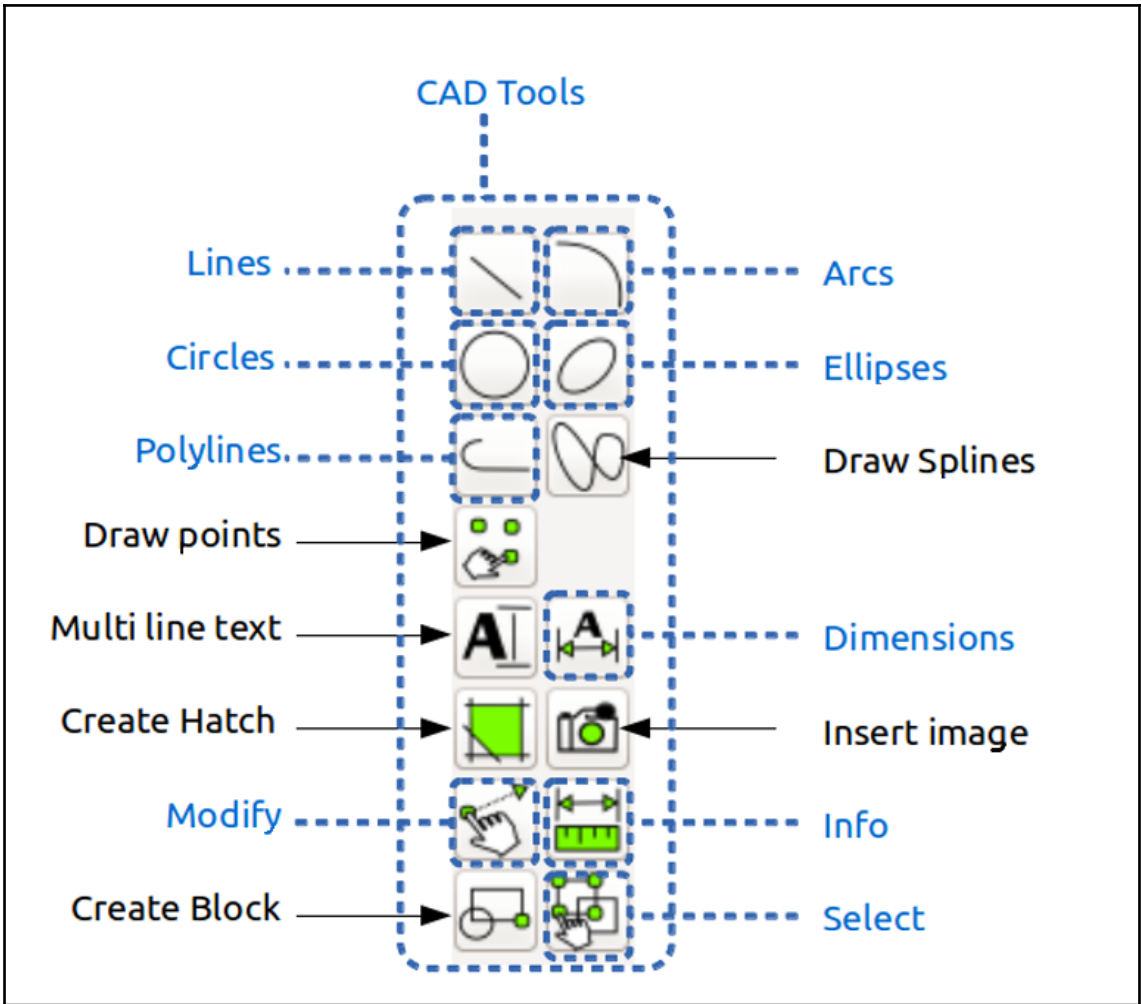
$$\omega\delta t = (nr - nl) * \text{step} / l \quad (14)$$

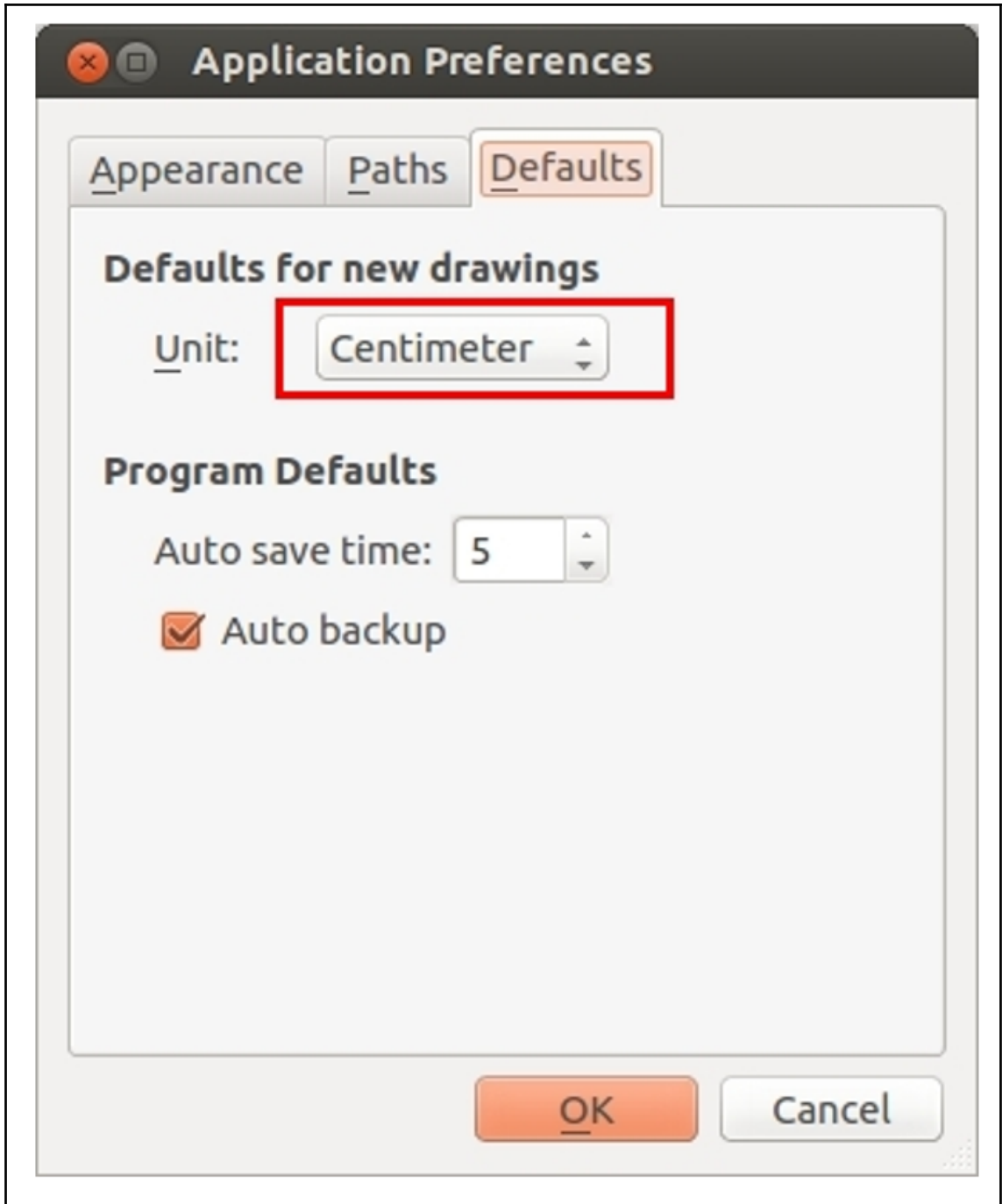
$$\text{ICC} = [x - R \sin\theta, y + R \cos\theta] \quad (15)$$

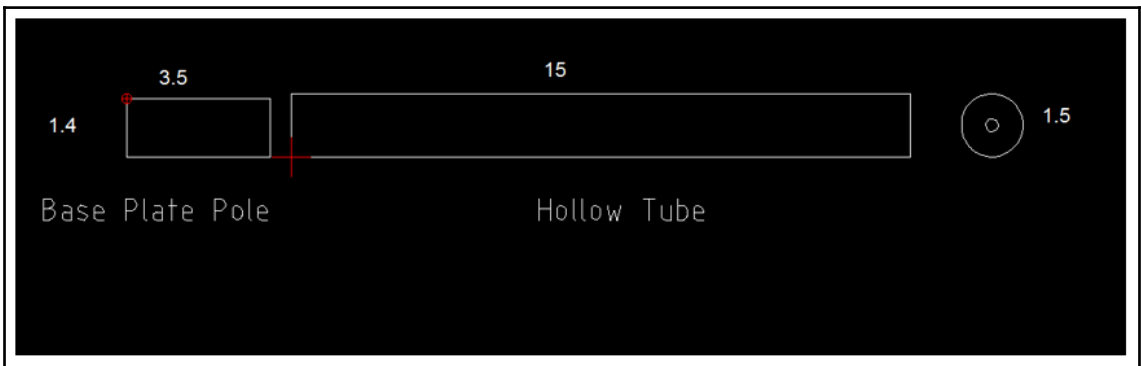
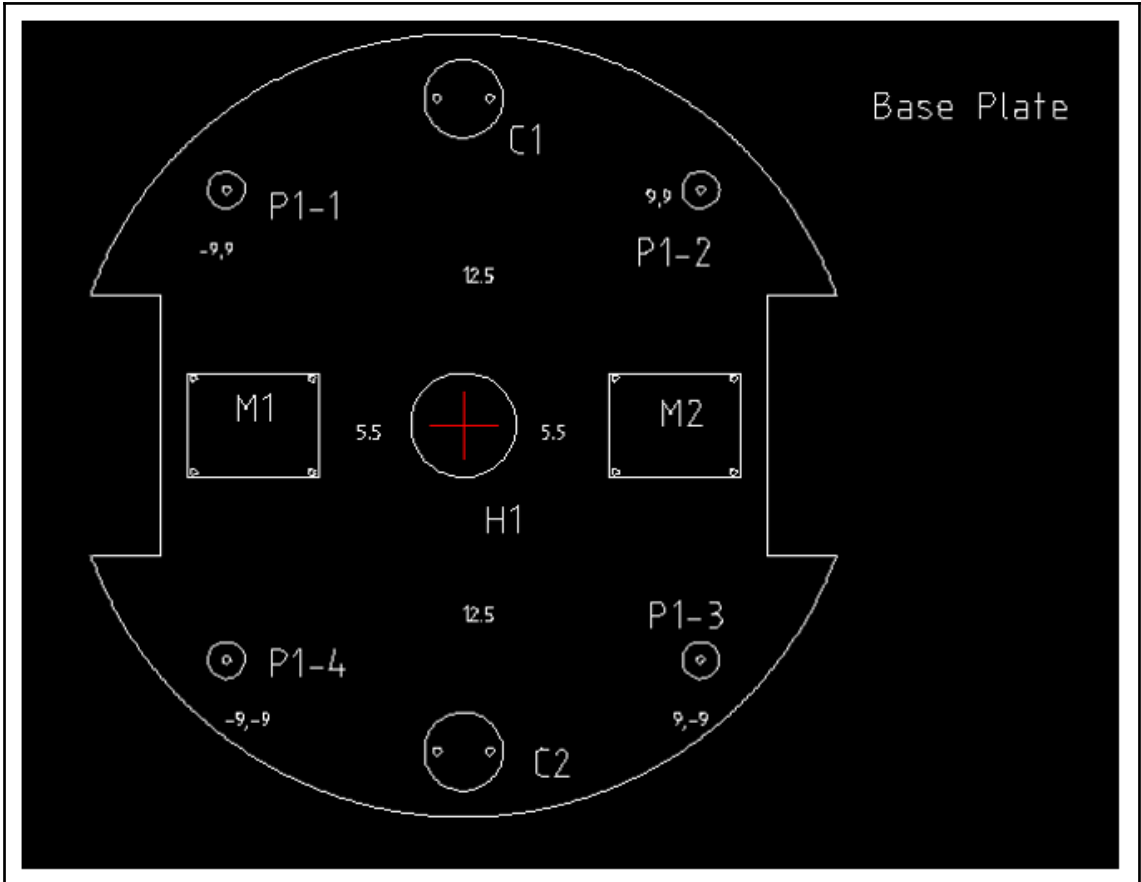
Chapter 2: Modeling the Differential Drive Robot

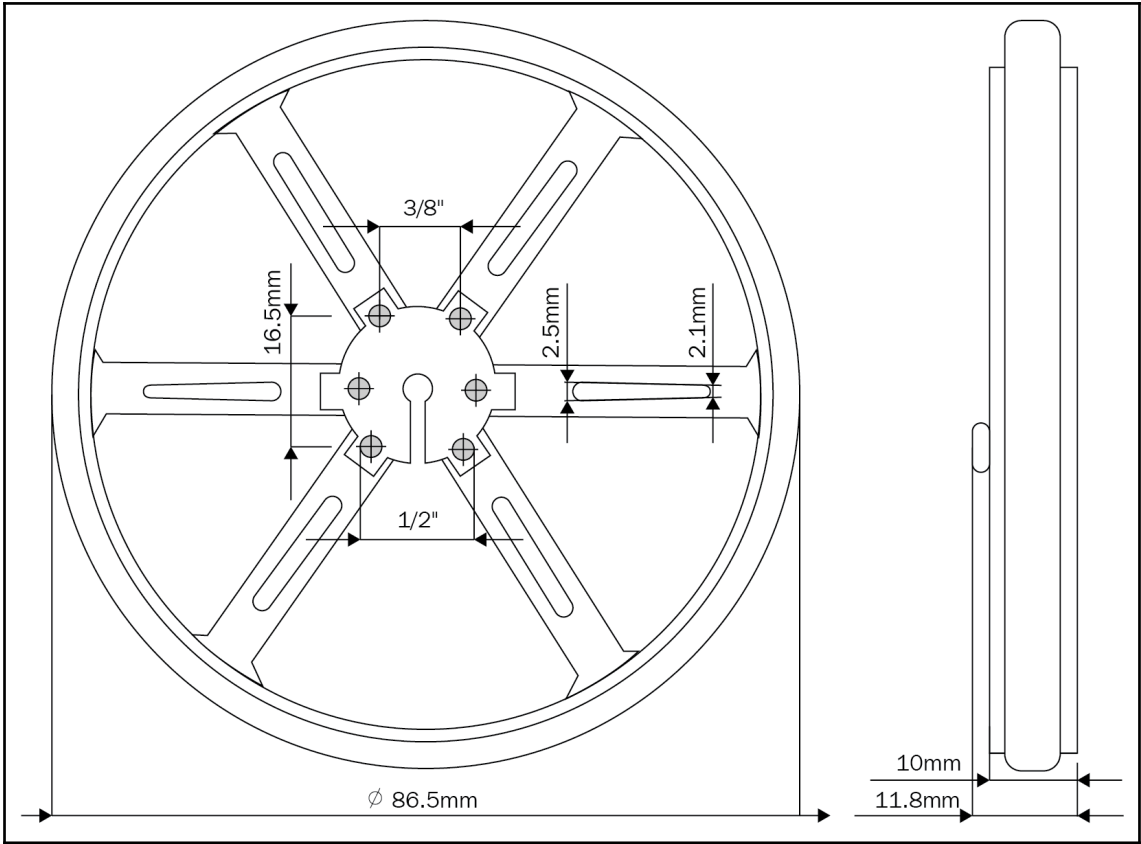


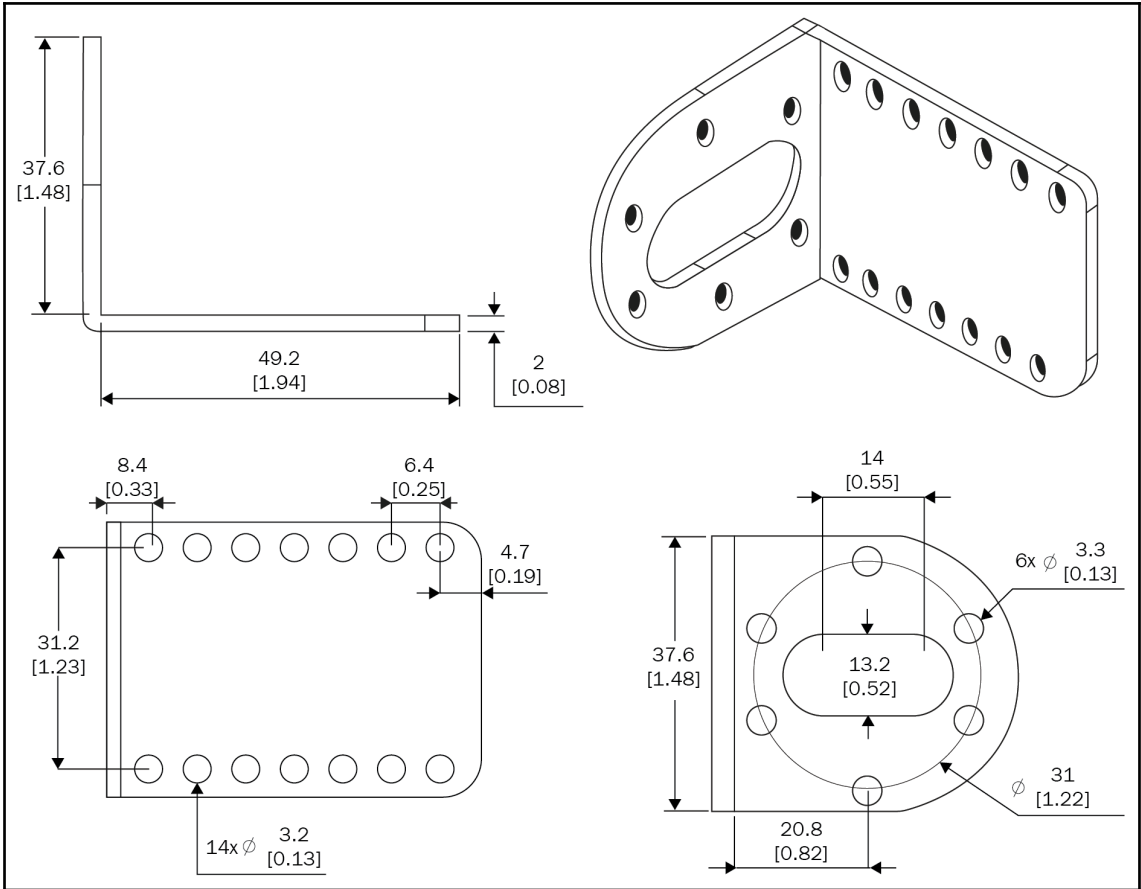


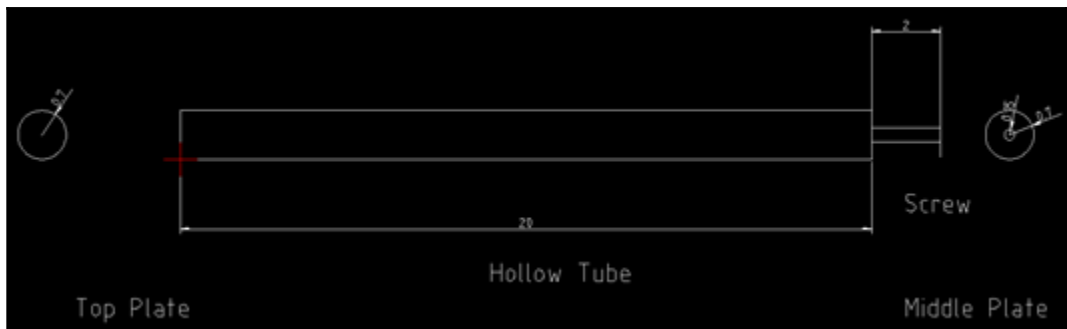
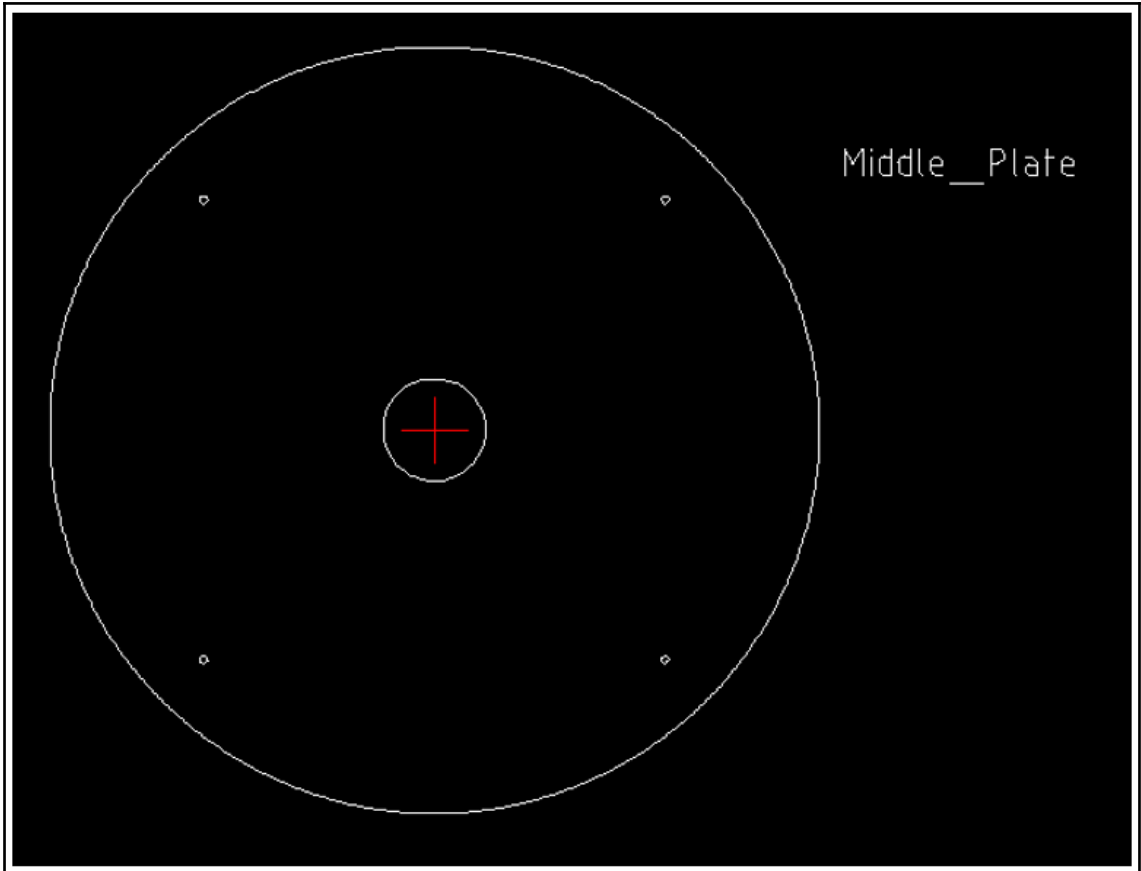


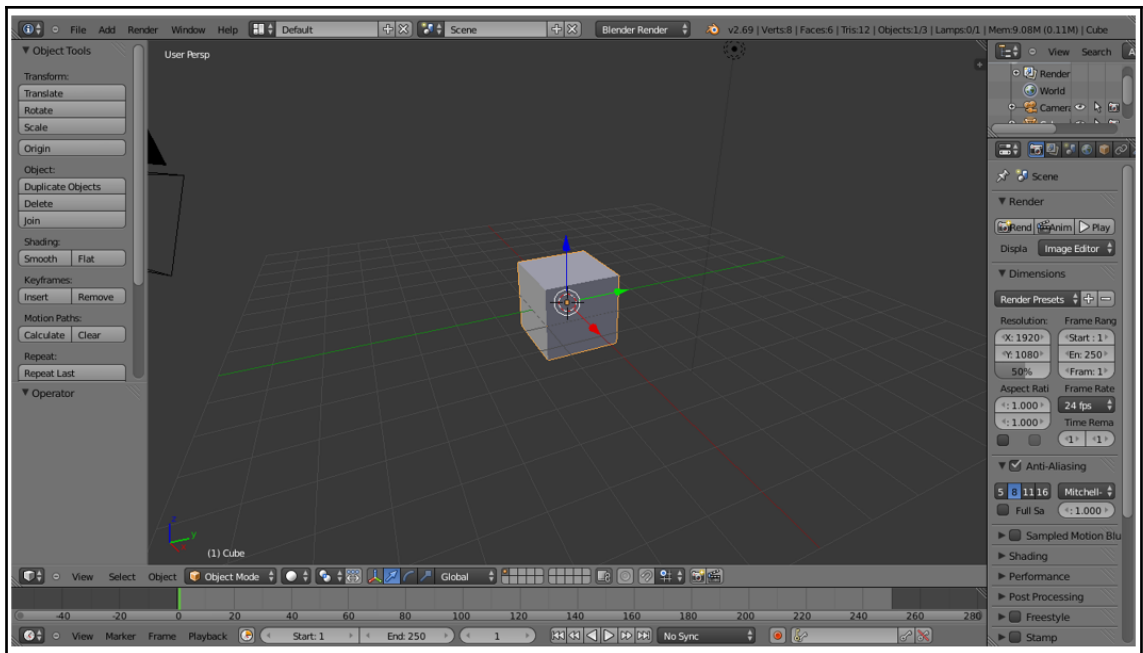
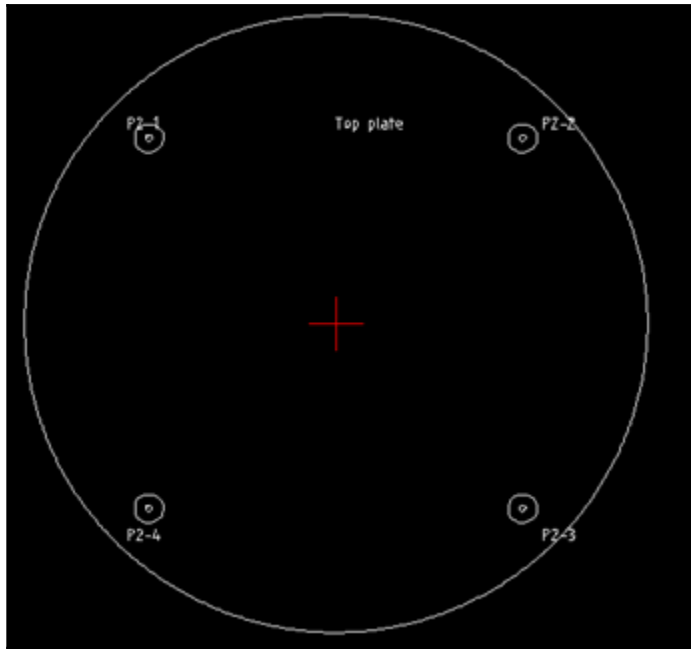


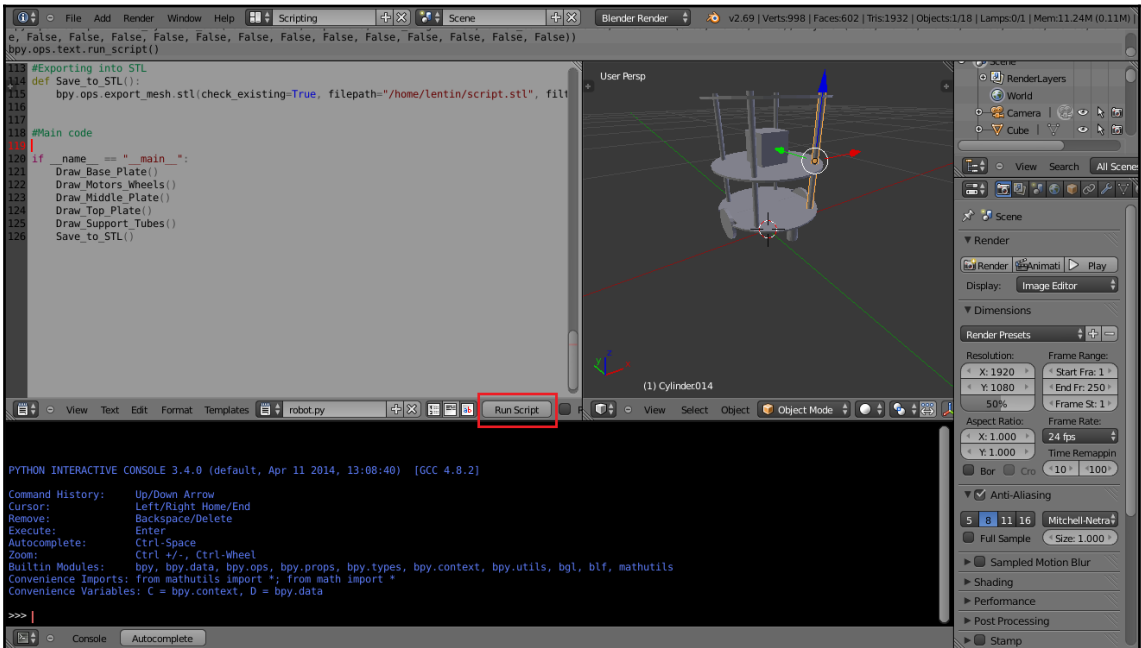
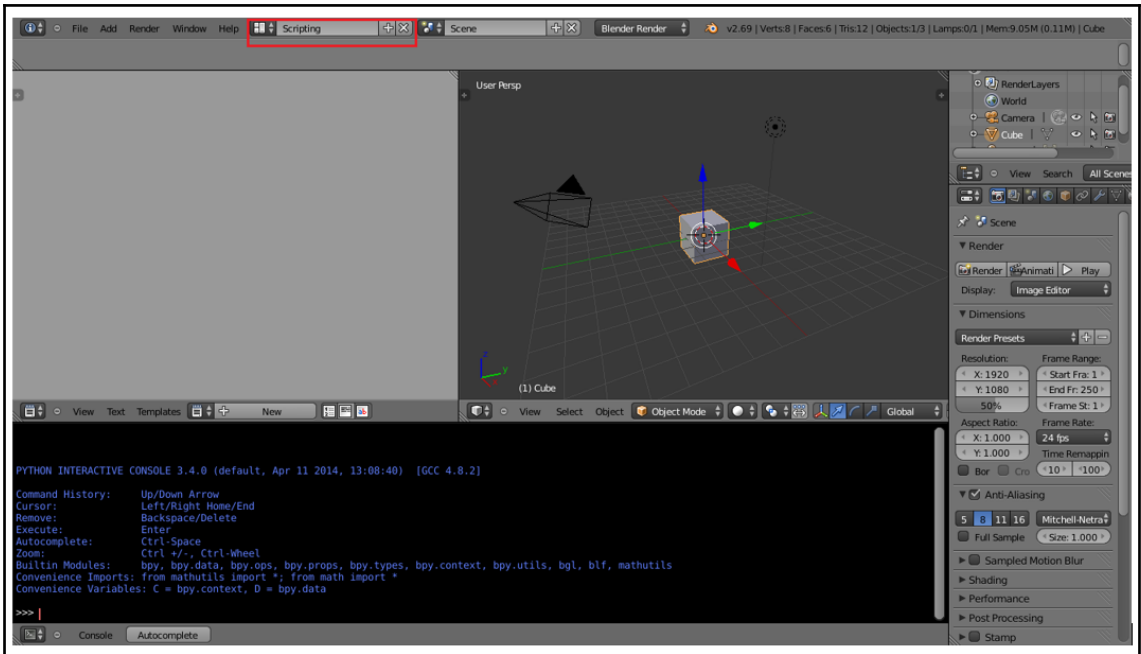


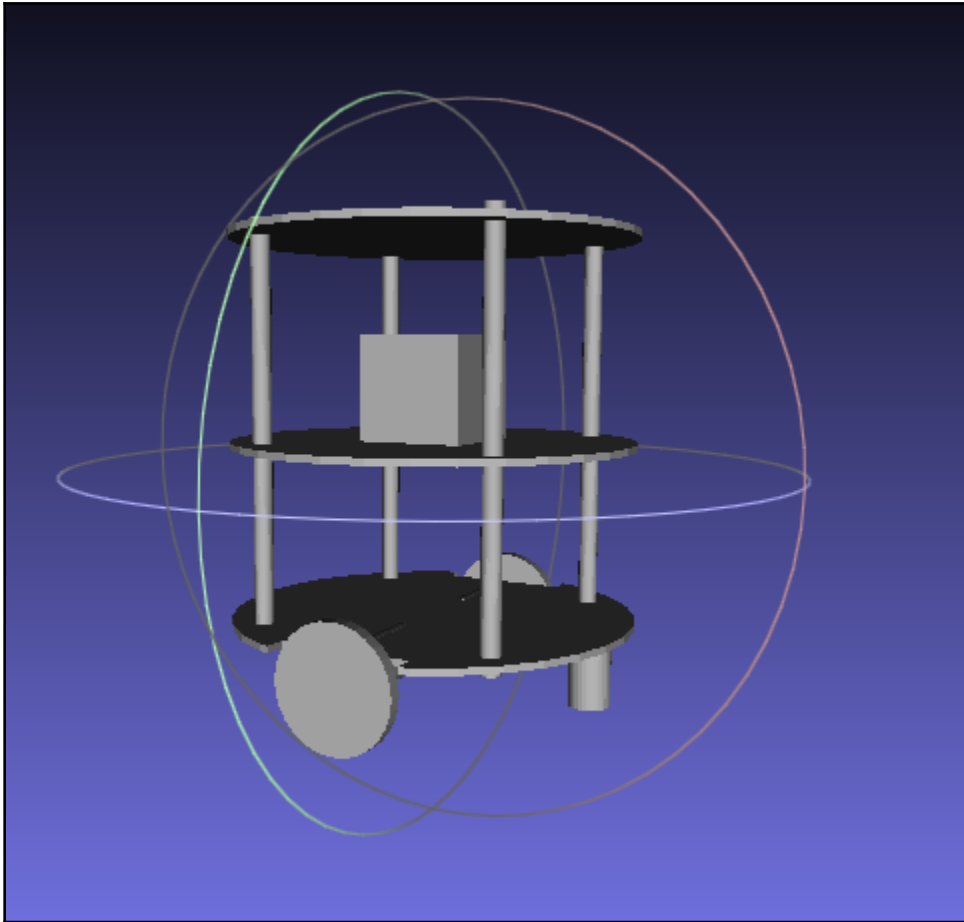












chefbot_description

meshes

base_plate.dae
wheel.dae

robots

chefbot_circles_kinect.urdf.xacro

launch

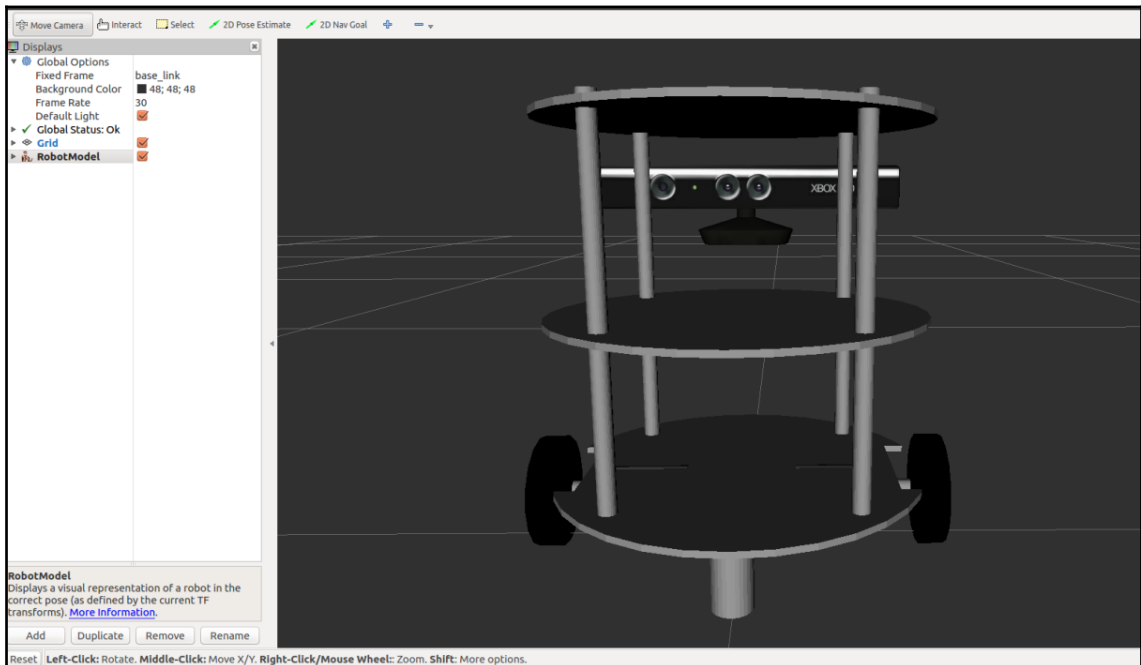
view_robot.launch

urdf

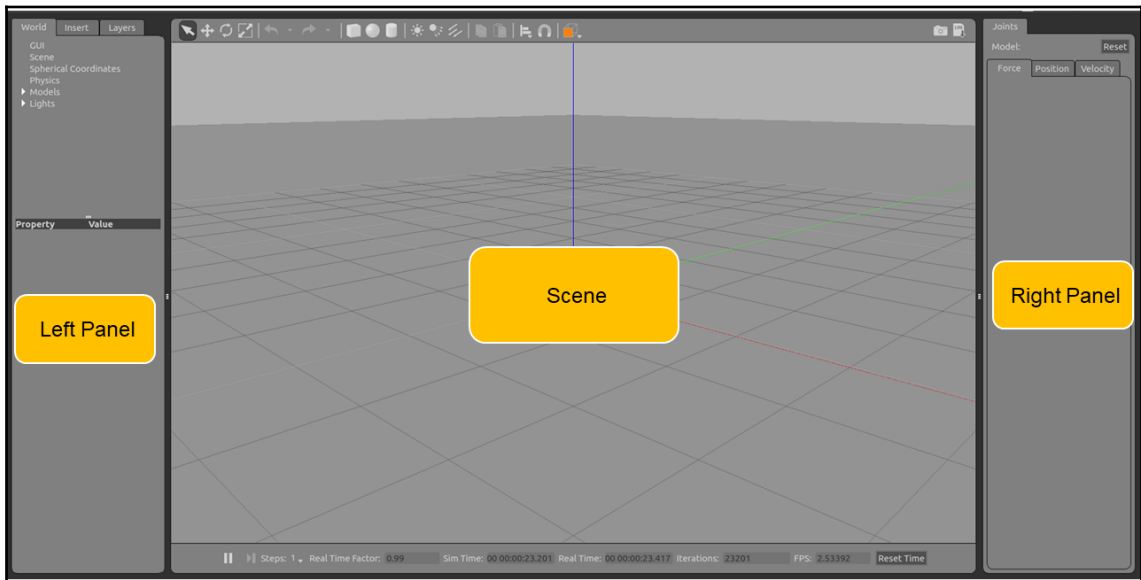
sensors

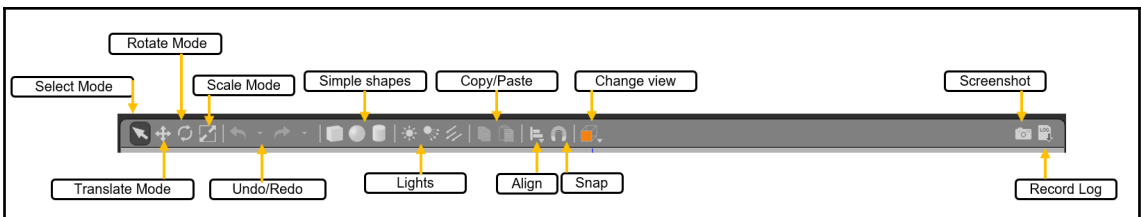
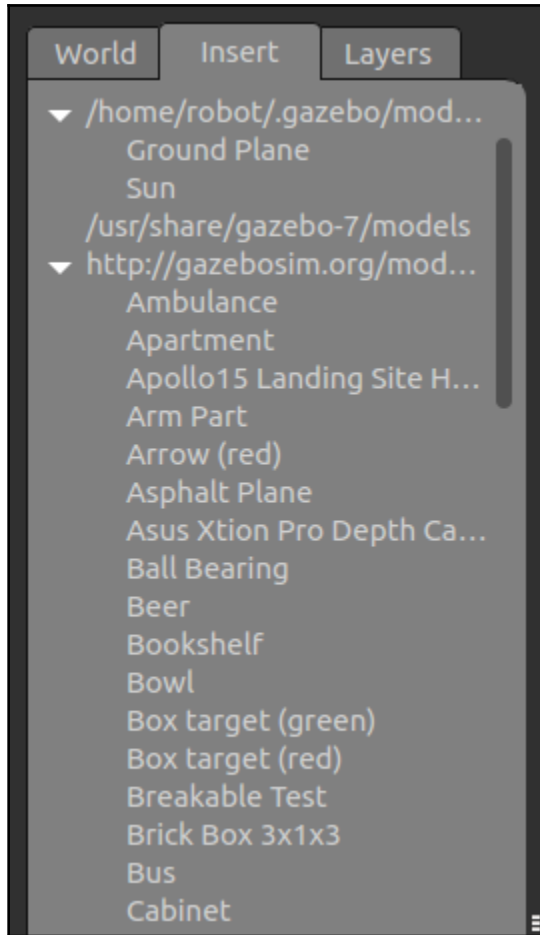
kinect.urdf.xacro

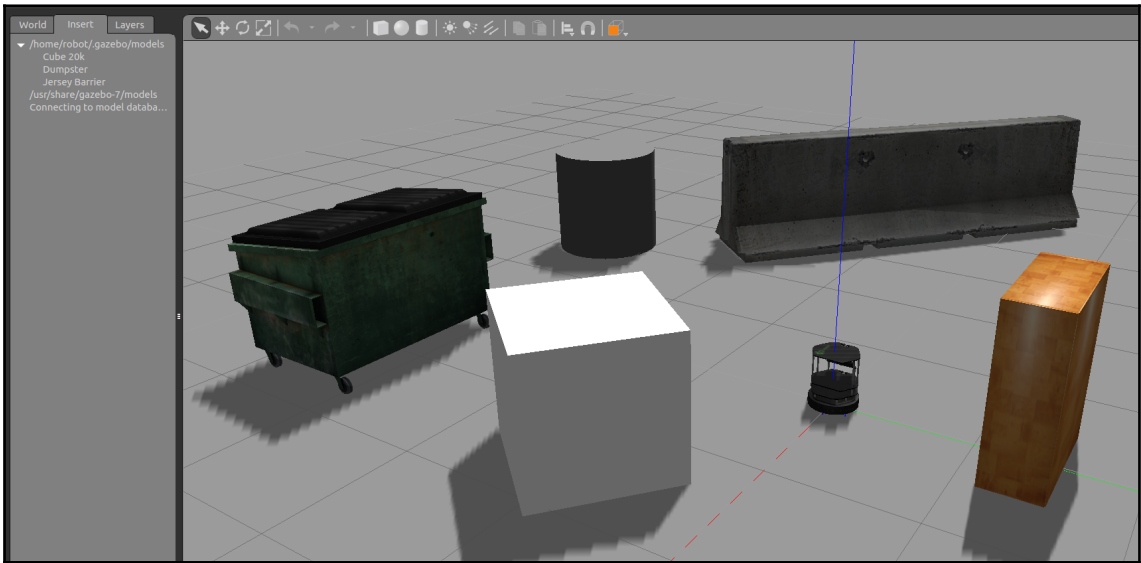
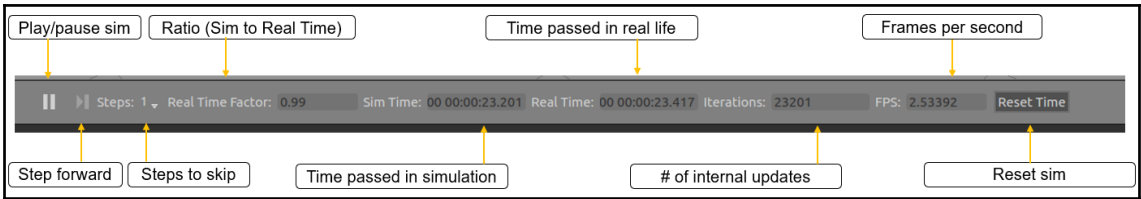
chefbot_base.urdf.xacro
chefbot_base_gazebo.urdf.xacro
chefbot_gazebo.urdf.xacro
chefbot_library.urdf.xacro
chefbot_properties.urdf.xacro
common_properties.urdf.xacro



Chapter 3: Simulating a Differential Drive Robot Using ROS







```

robot@robot-VirtualBox:~$ rostopic list
/camera/depth/camera_info
/camera/depth/image_raw
/camera/depth/points
/camera/parameter_descriptions
/camera/parameter_updates
/camera/rgb/camera_info
/camera/rgb/image_raw
/camera/rgb/image_raw/compressed
/camera/rgb/image_raw/compressed/parameter_descriptions
/camera/rgb/image_raw/compressed/parameter_updates
/camera/rgb/image_raw/compressedDepth
/camera/rgb/image_raw/compressedDepth/parameter_descriptions
/camera/rgb/image_raw/compressedDepth/parameter_updates
/camera/rgb/image_raw/theora
/camera/rgb/image_raw/theora/parameter_descriptions
/camera/rgb/image_raw/theora/parameter_updates
/clock
/cmd_vel_mux/active
/cmd_vel_mux/input/navi
/cmd_vel_mux/input/safety_controller
/cmd_vel_mux/input/switch
/cmd_vel_mux/input/teleop
/cmd_vel_mux/parameter_descriptions
/cmd_vel_mux/parameter_updates
/depthimage_to_laserscan/parameter_descriptions
/depthimage_to_laserscan/parameter_updates
/gazebo/link_states
/gazebo/model_states
/gazebo/parameter_descriptions
/gazebo/parameter_updates
/gazebo/set_link_state
/gazebo/set_model_state
/joint_states
/laserscan/nodelet_manager/bond
/mobile_base/commands/motor_power
/mobile_base/commands/reset_odometry
/mobile_base/commands/velocity
/mobile_base/events/bumper
/mobile_base/events/cliff
/mobile_base/sensors/bumper_pointcloud
/mobile_base/sensors/core
/mobile_base/sensors/imu_data
/mobile_base/nodelet_manager/bond
/odom
/rosout
/rosout_agg
/scan
/tf
/tf_static

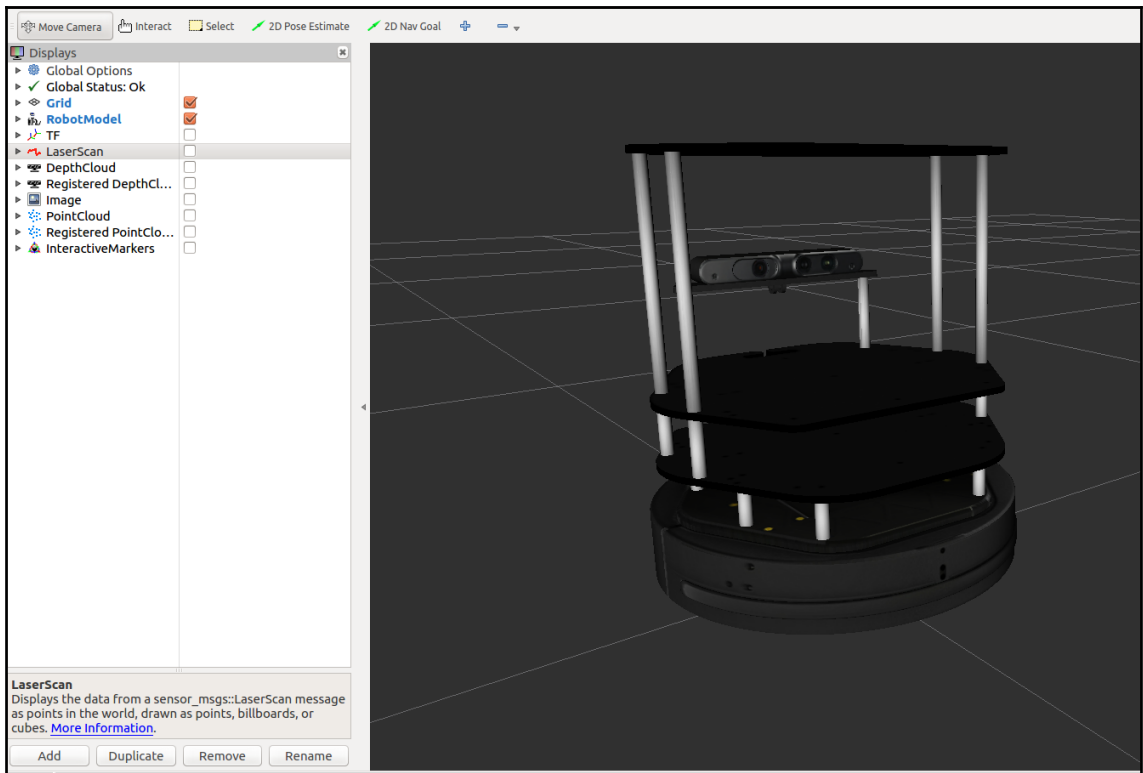
```

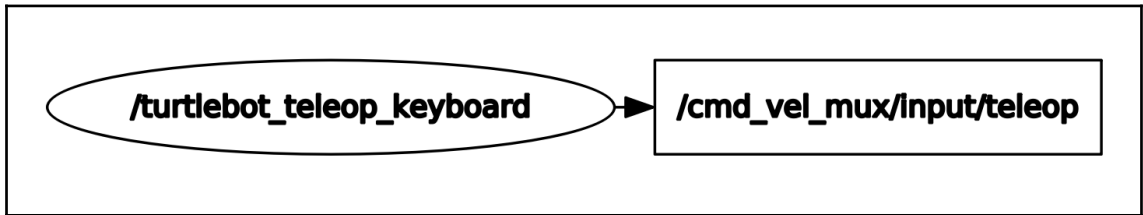
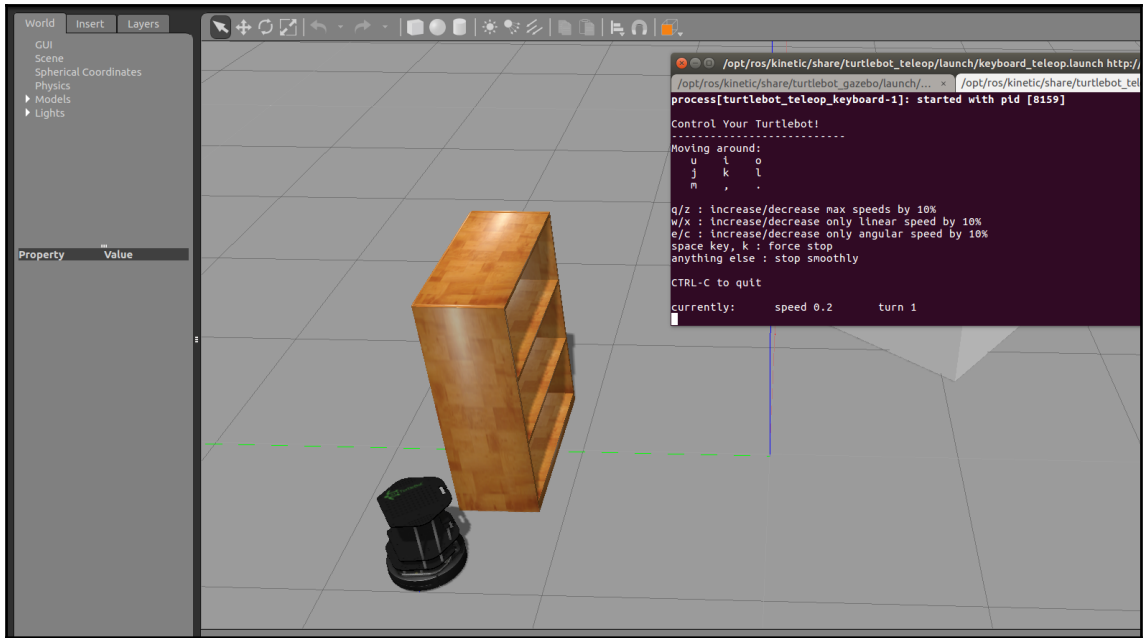
Camera

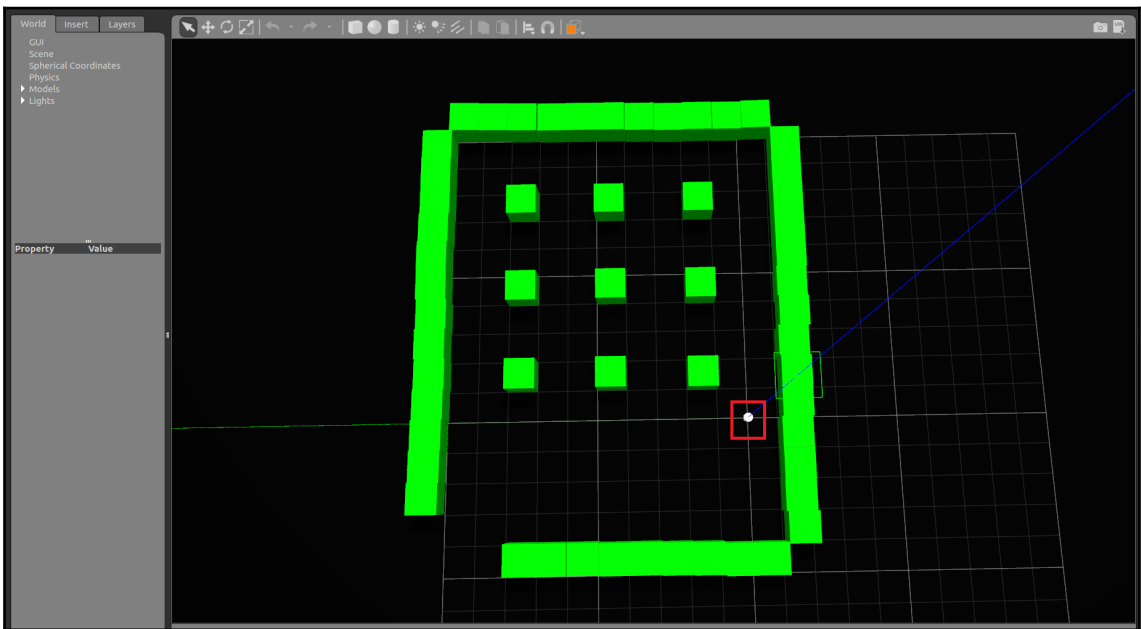
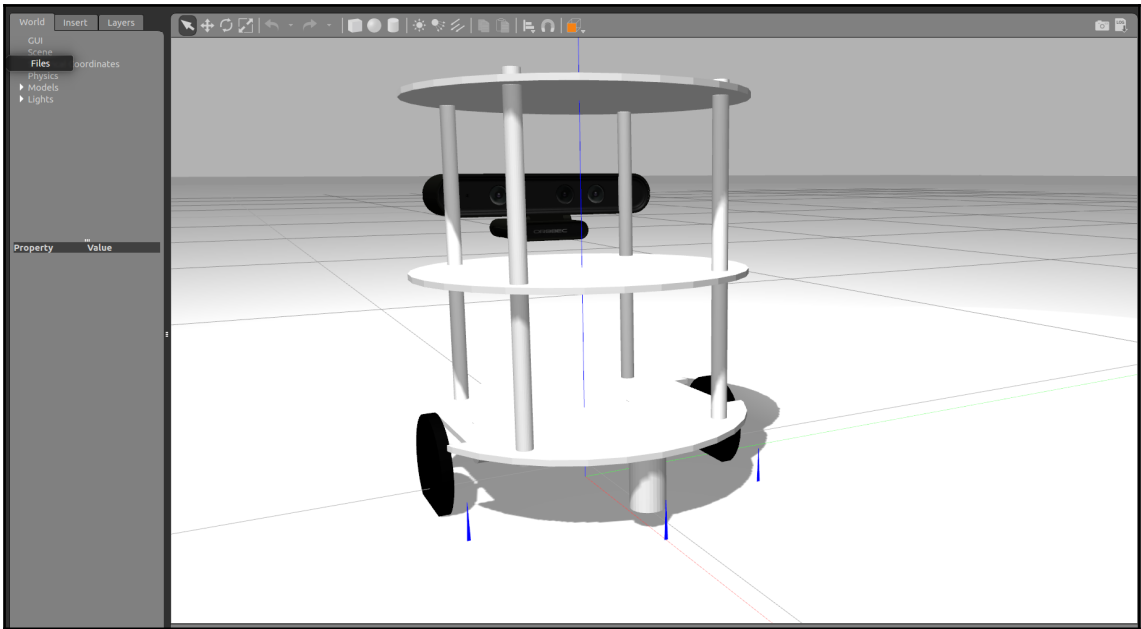
Drive

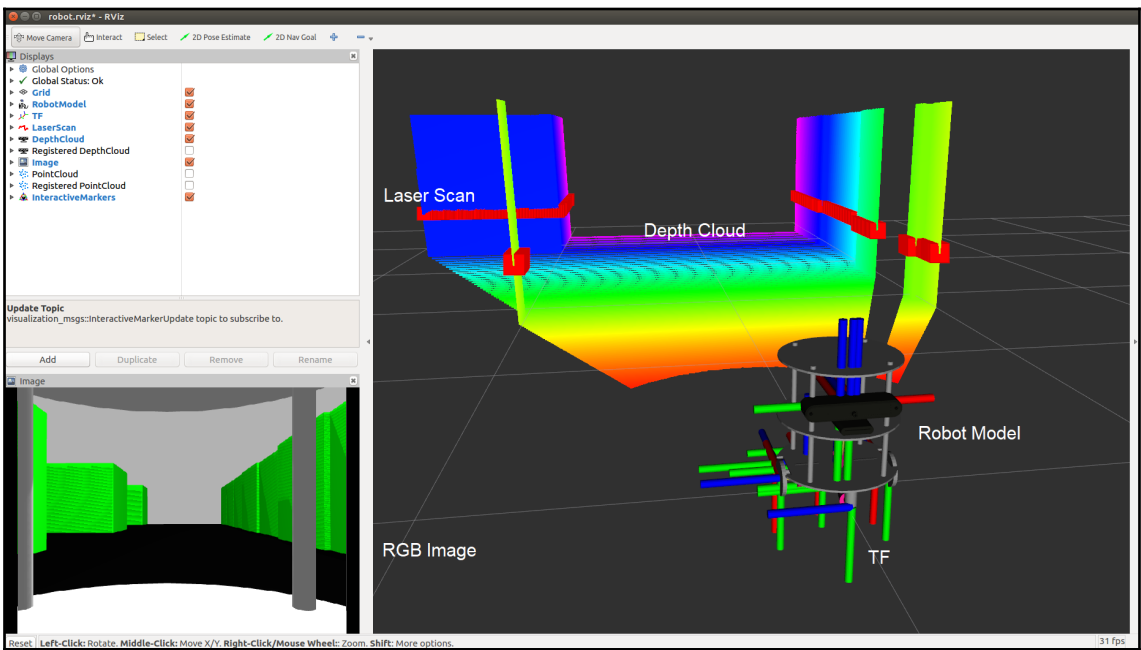
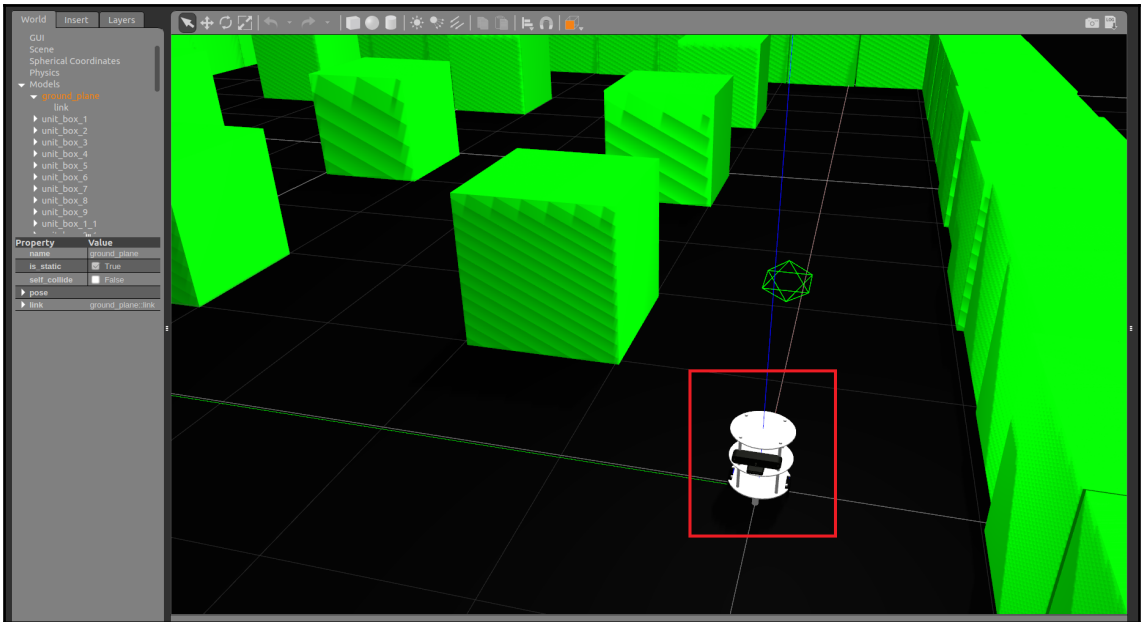
Gazebo

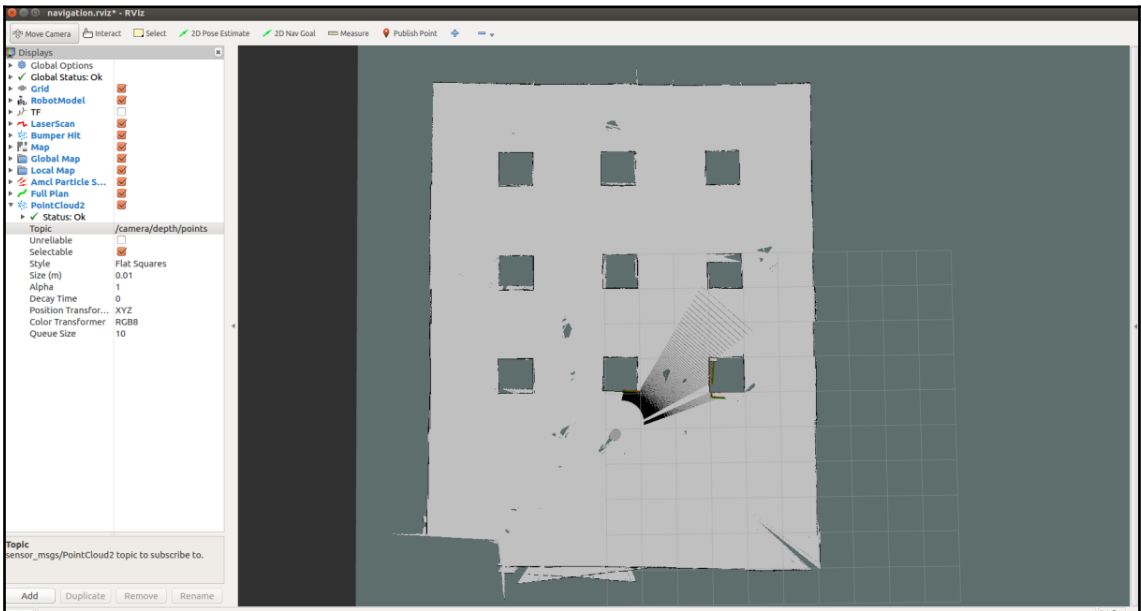
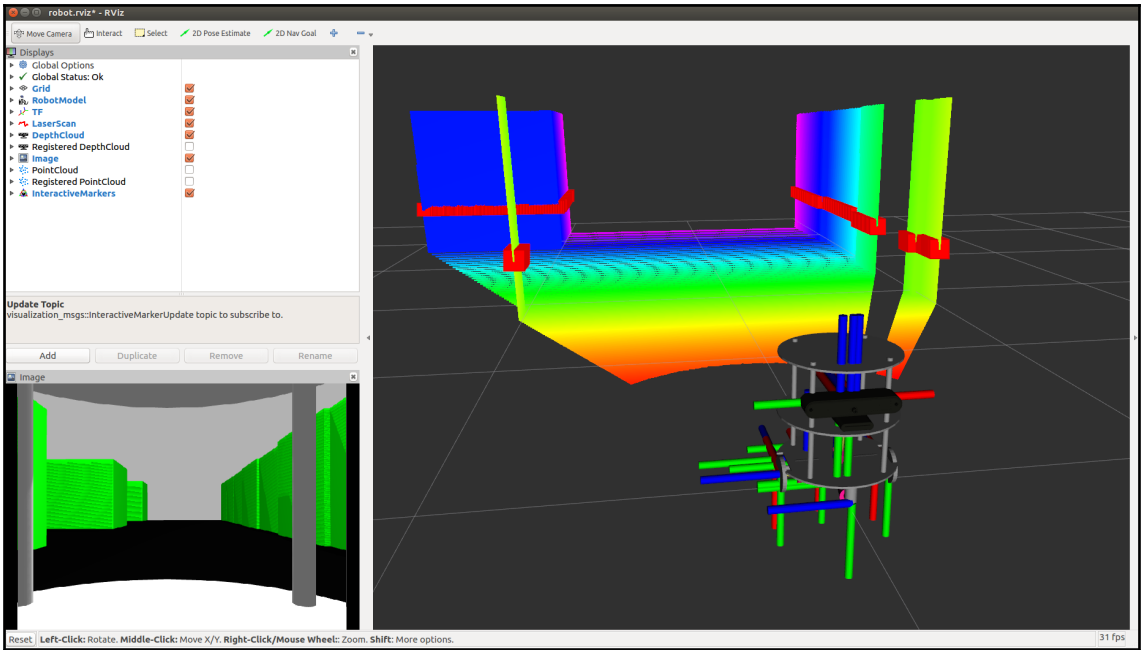
Drive and Bumper

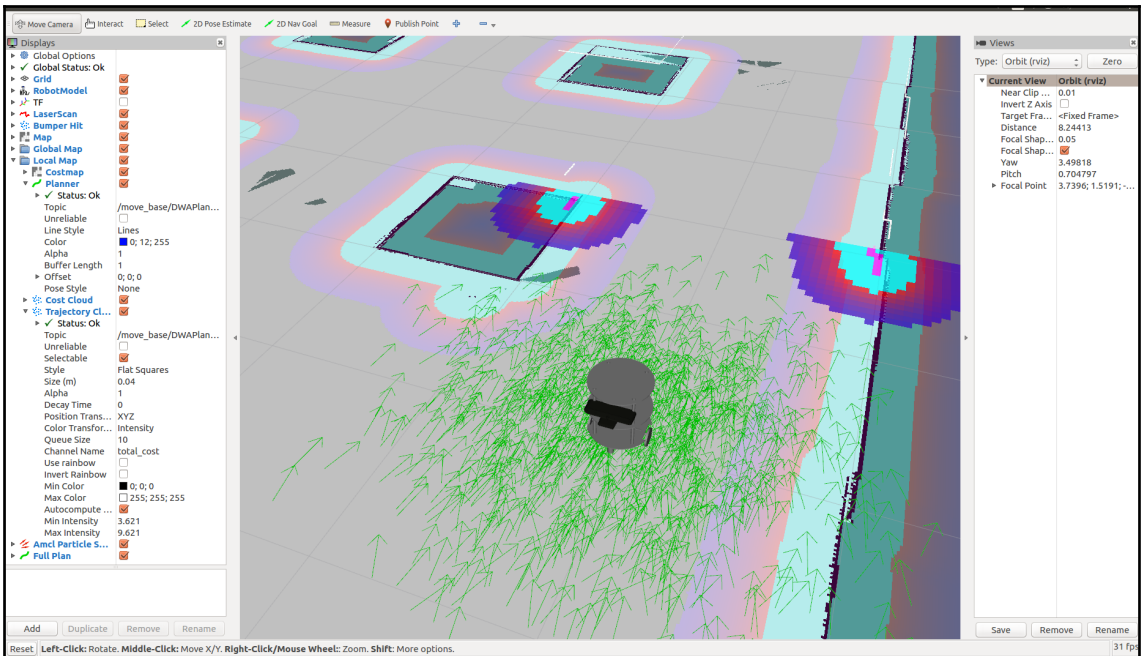
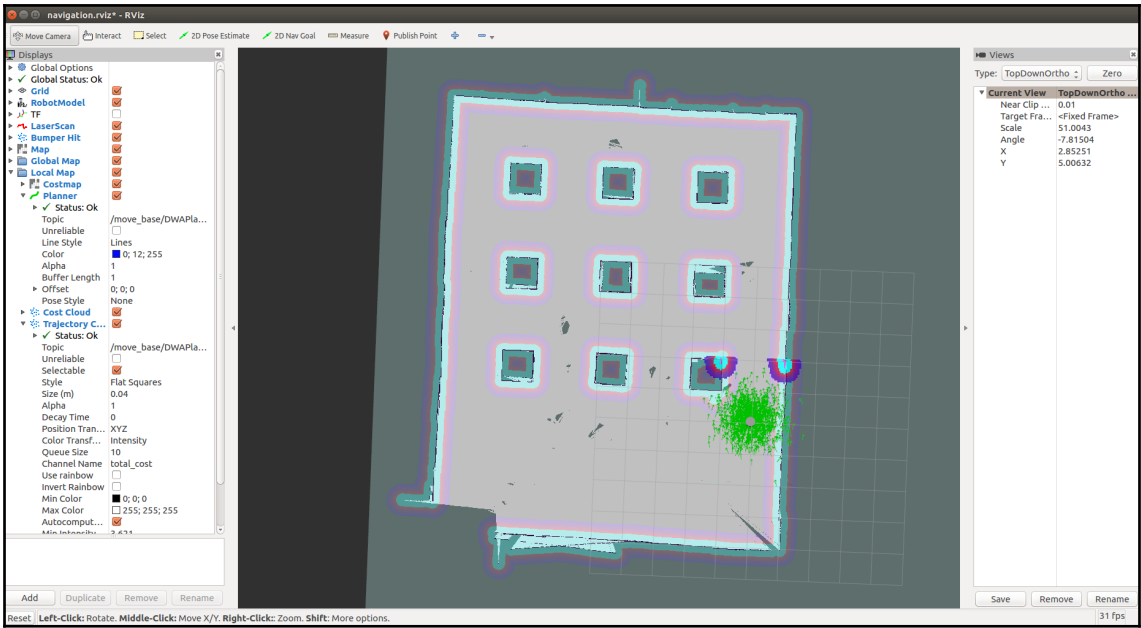


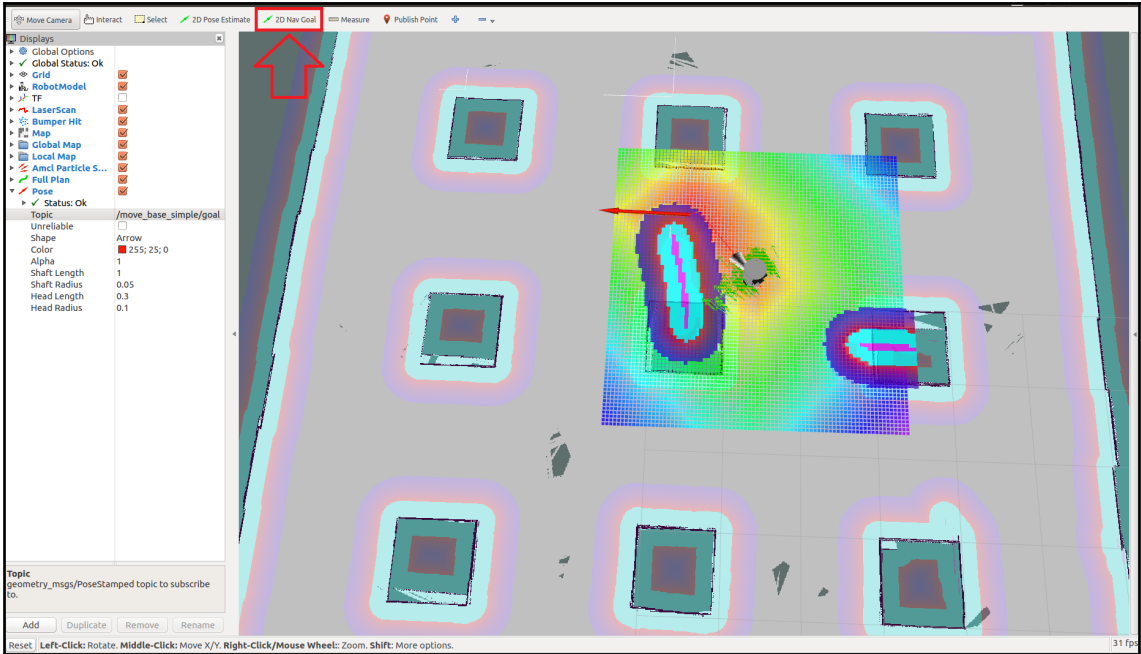




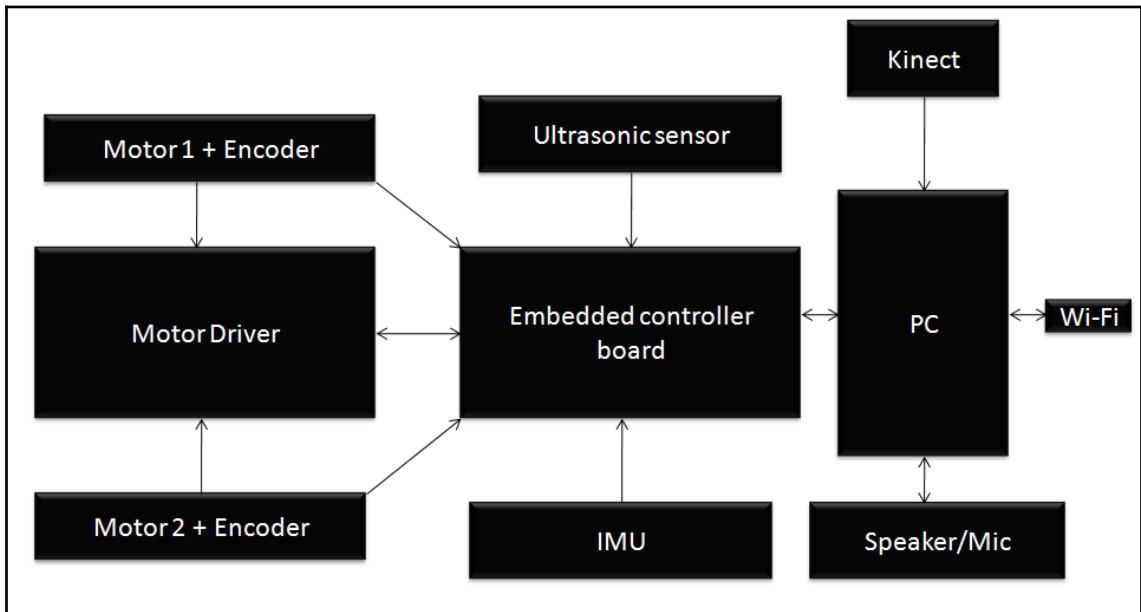


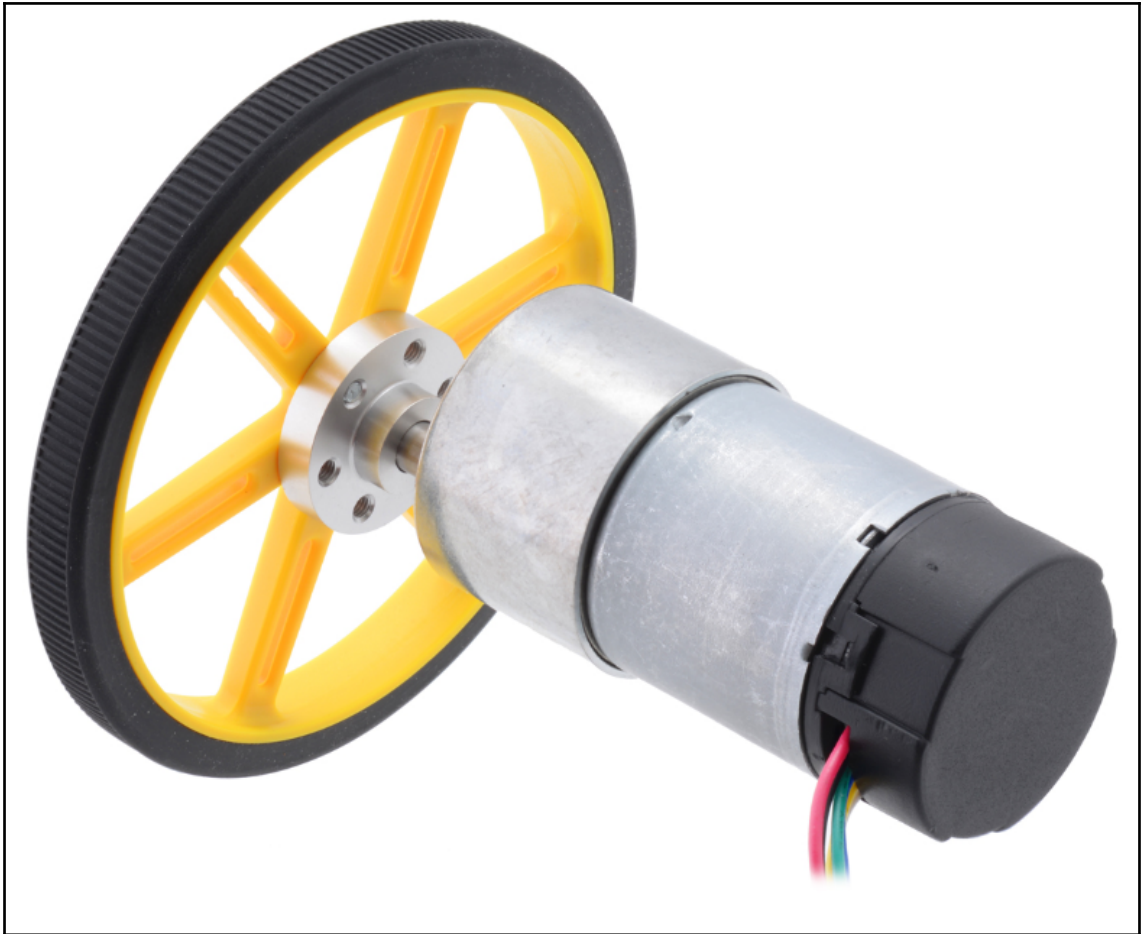


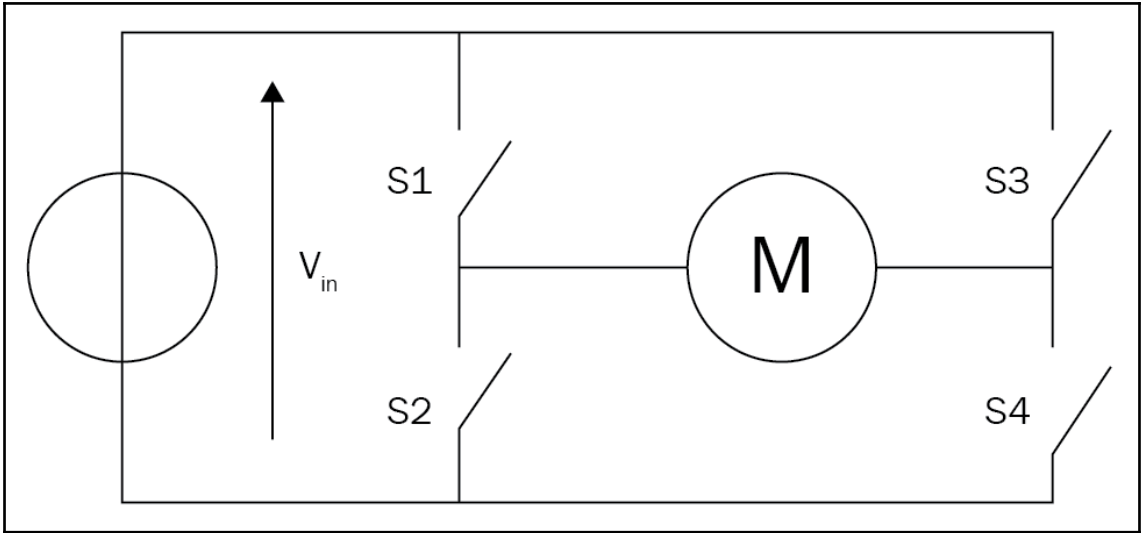


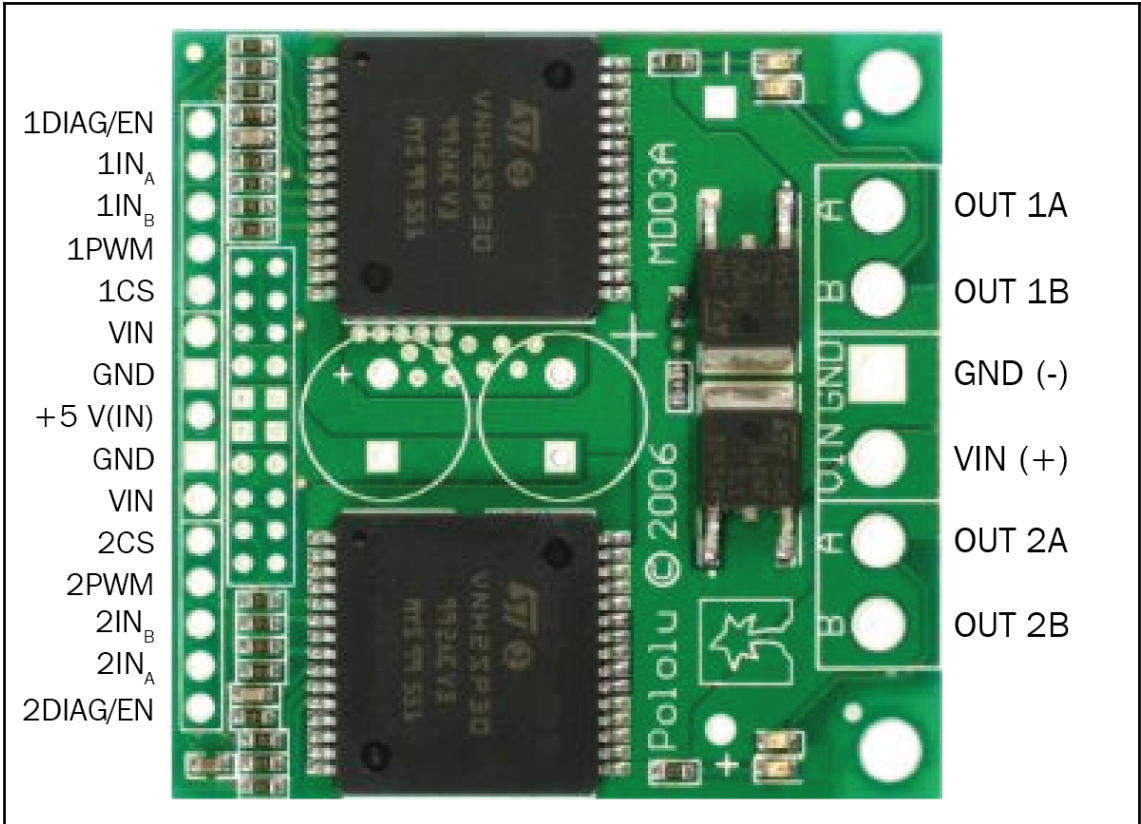


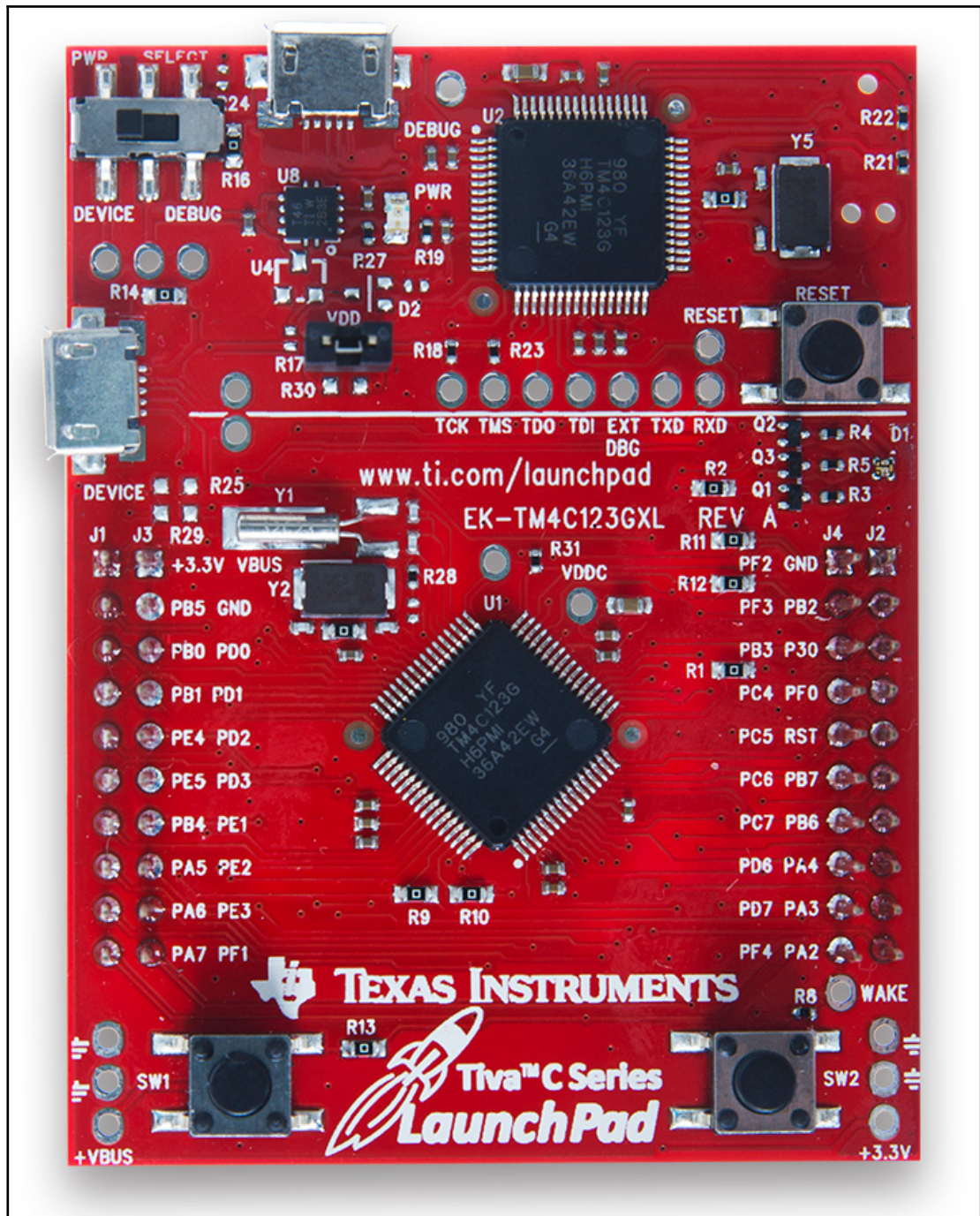
Chapter 4: Designing ChefBot Hardware and Circuits



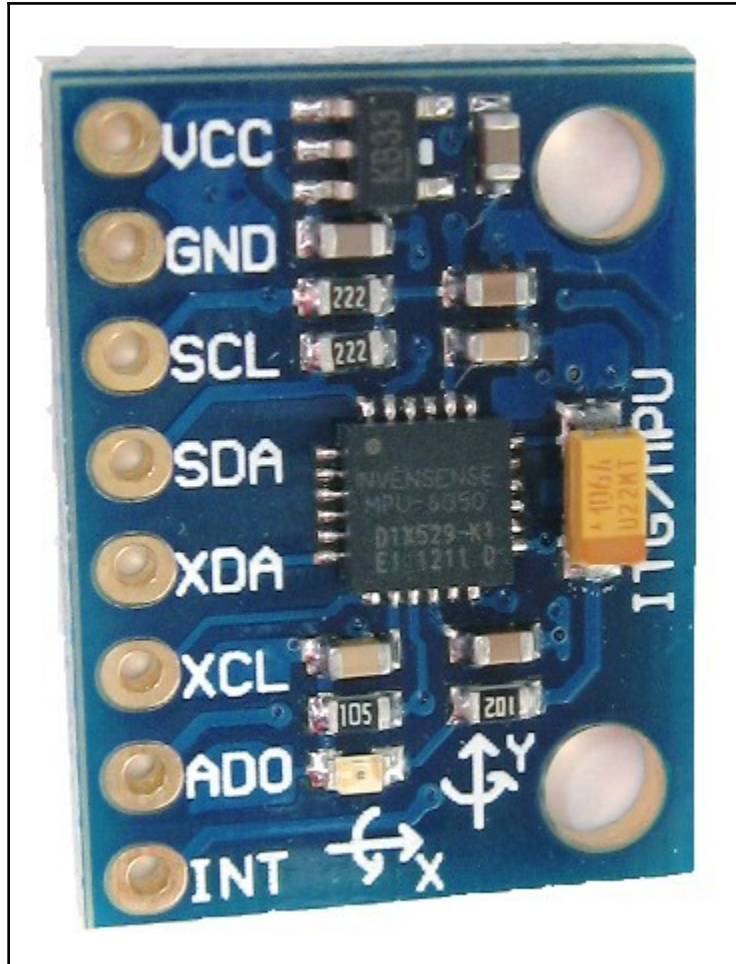






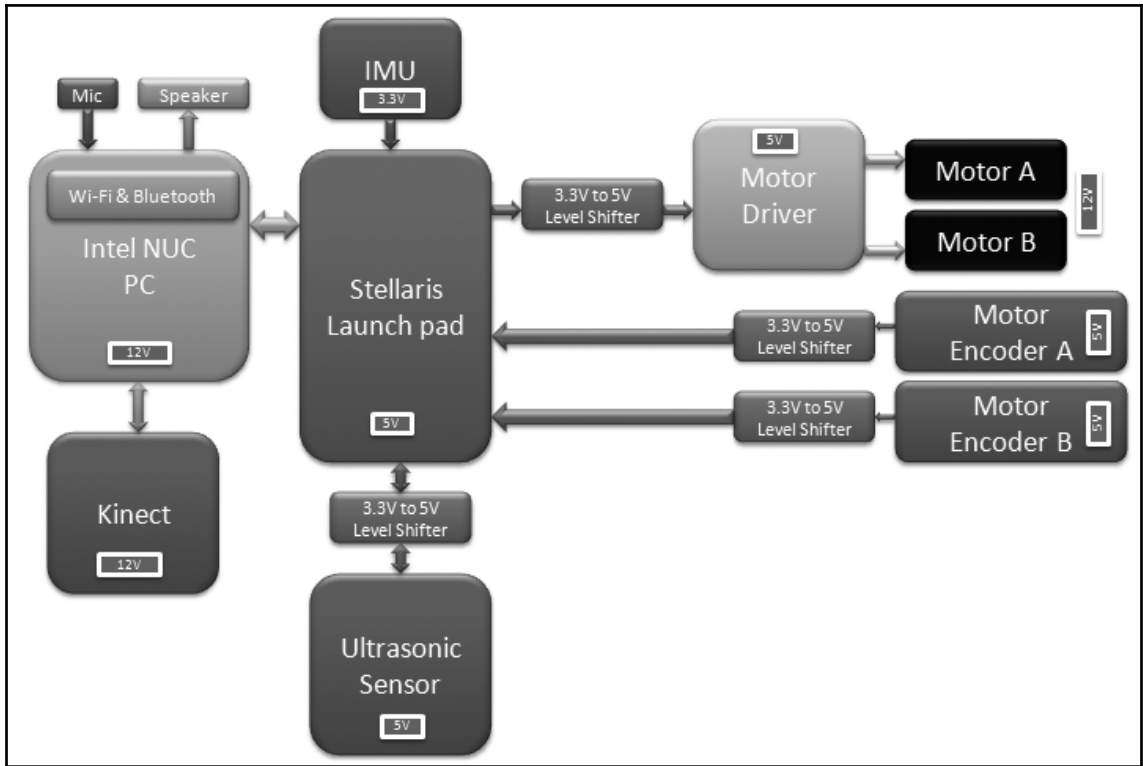




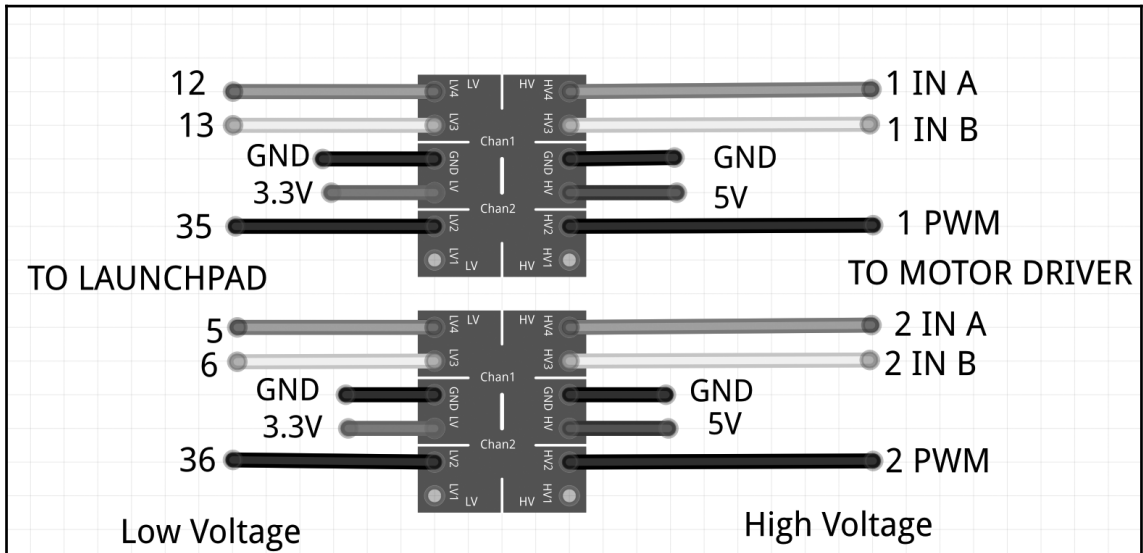
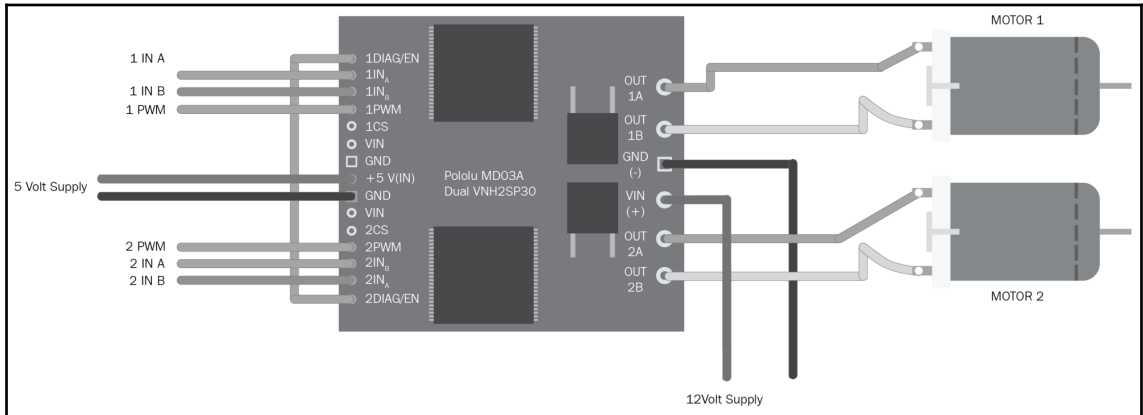


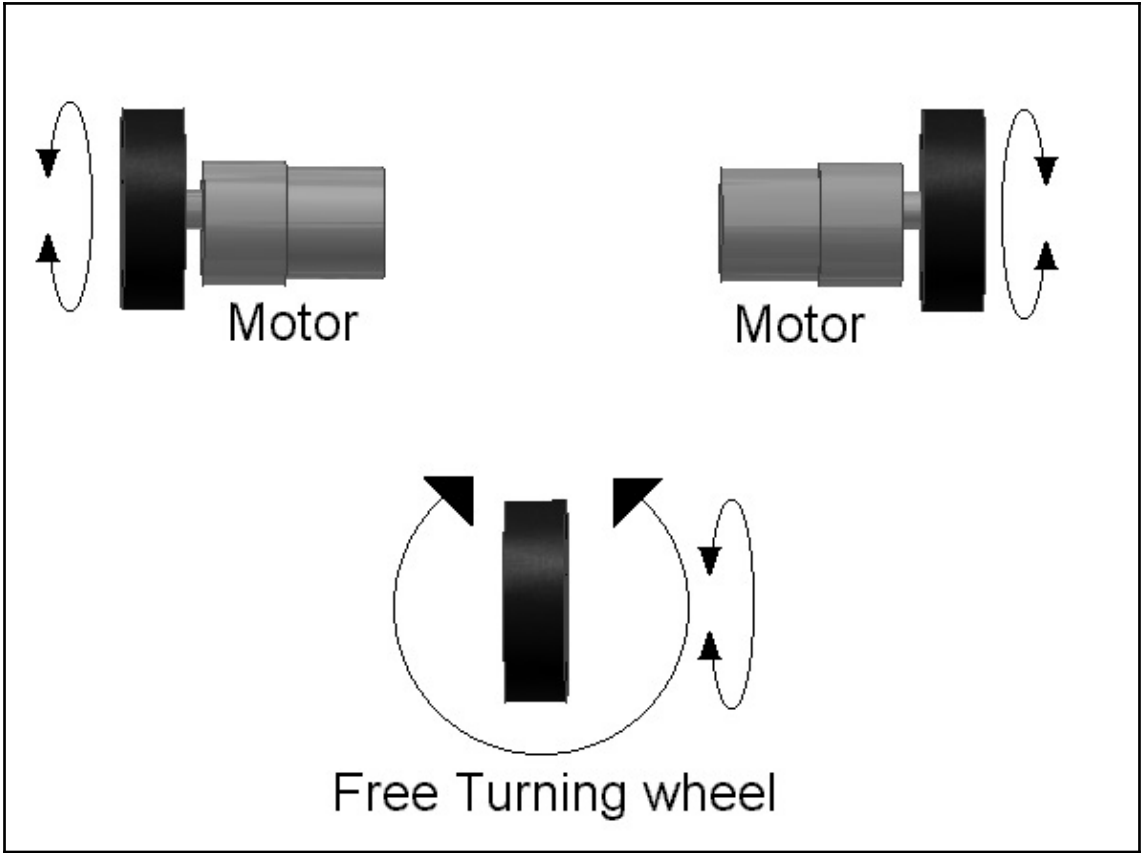


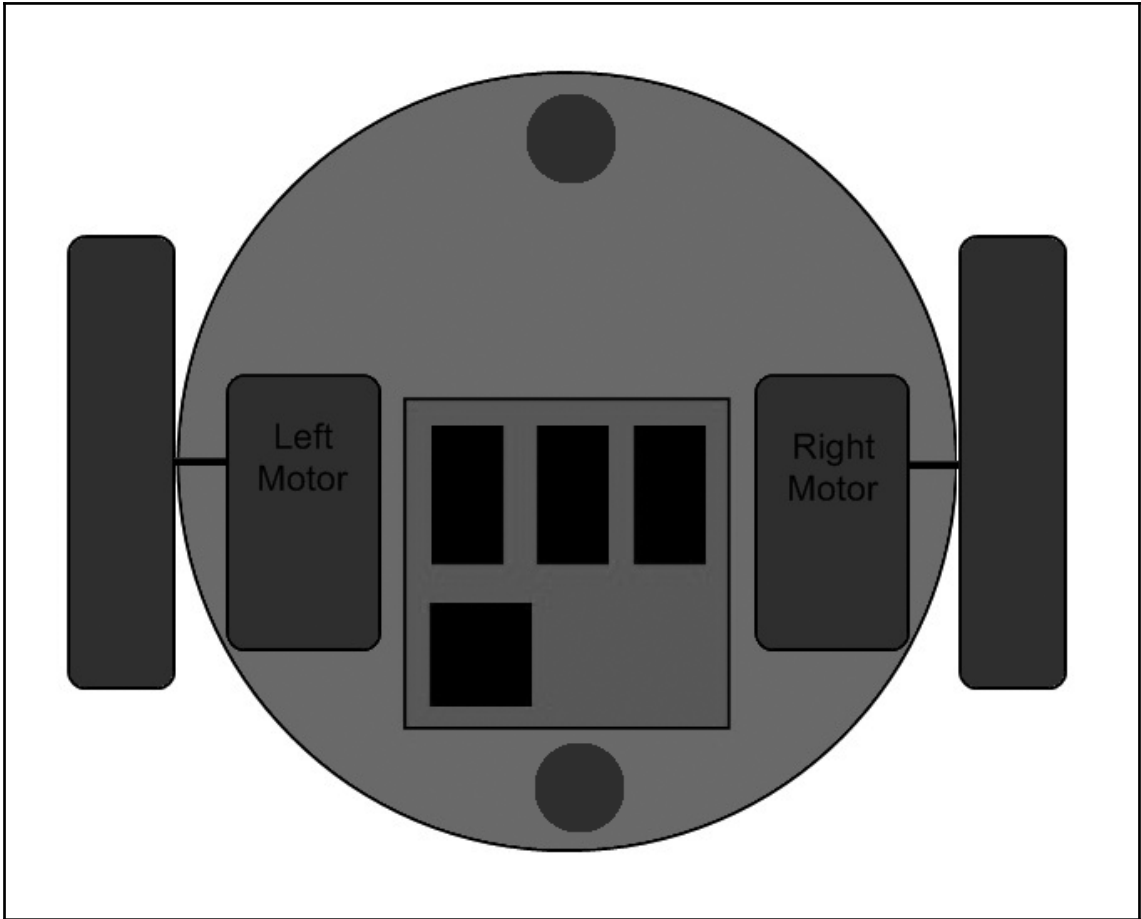




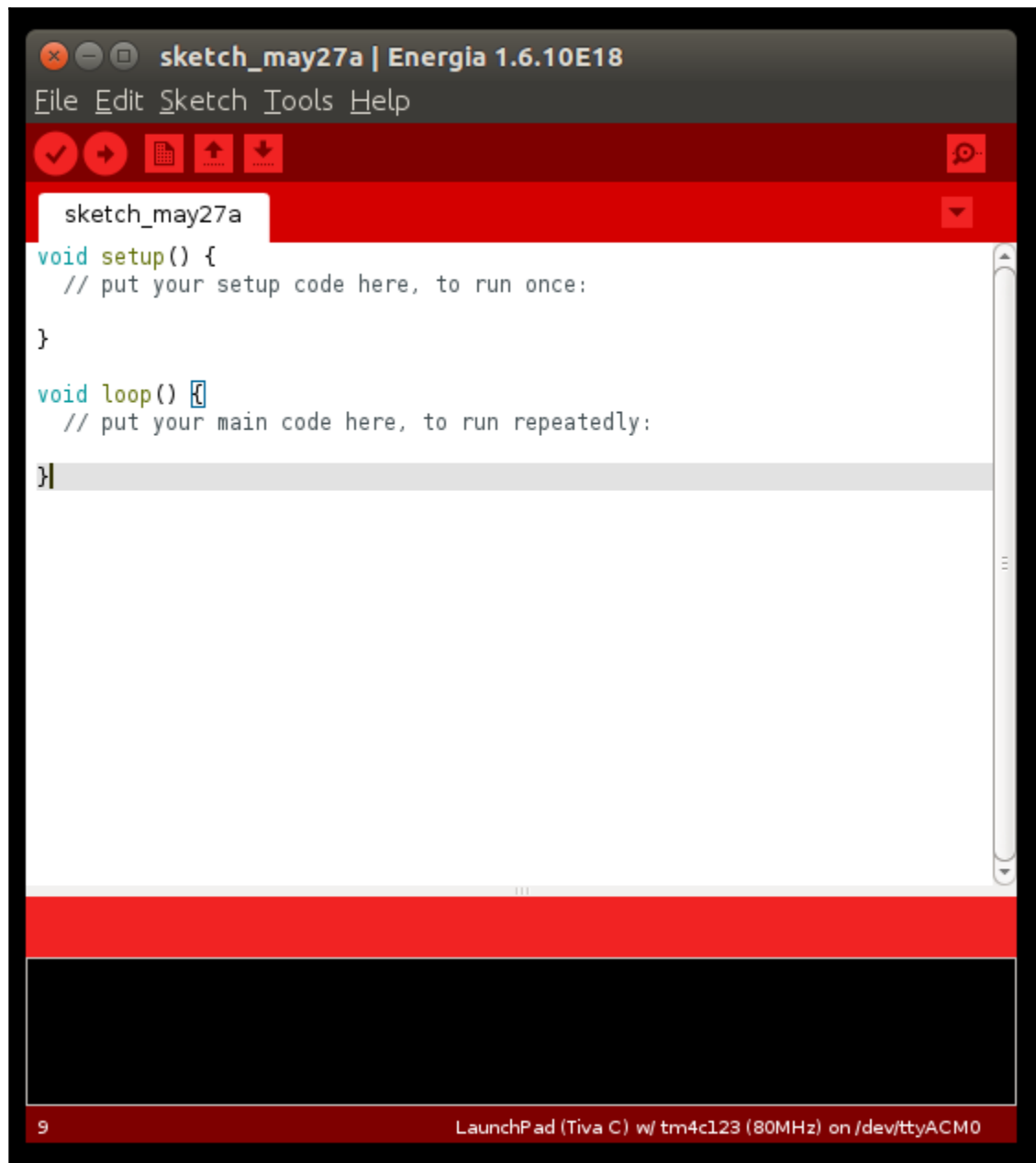
Chapter 5: Interfacing Actuators and Sensors to the Robot Controller

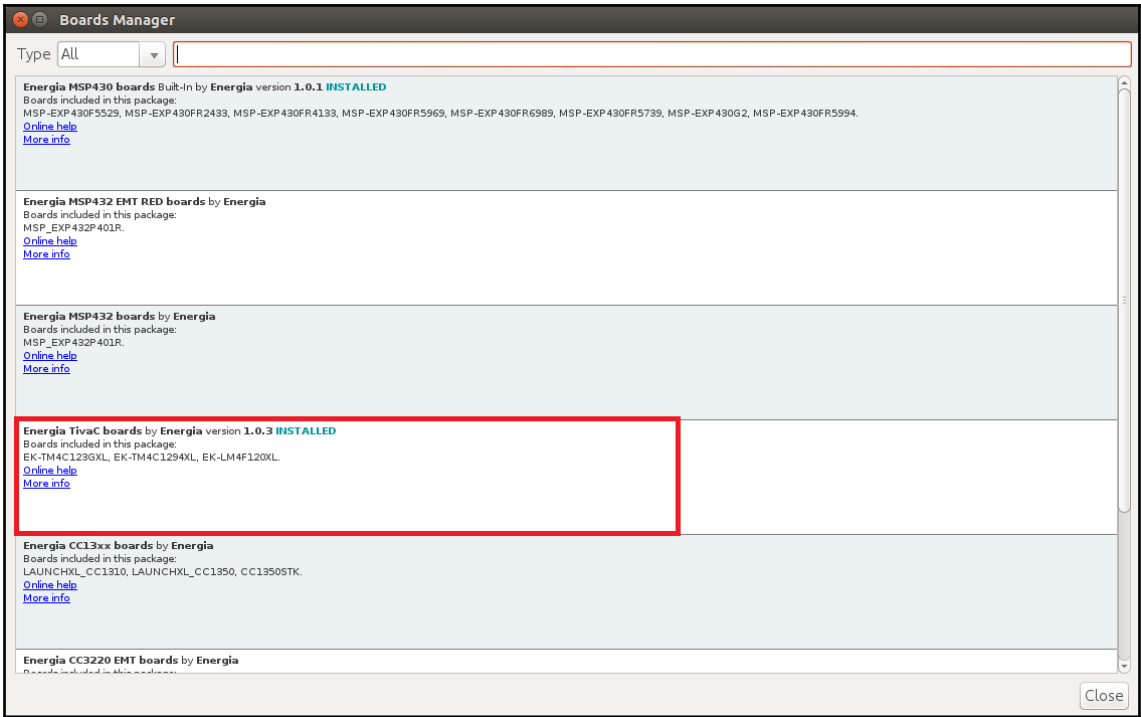


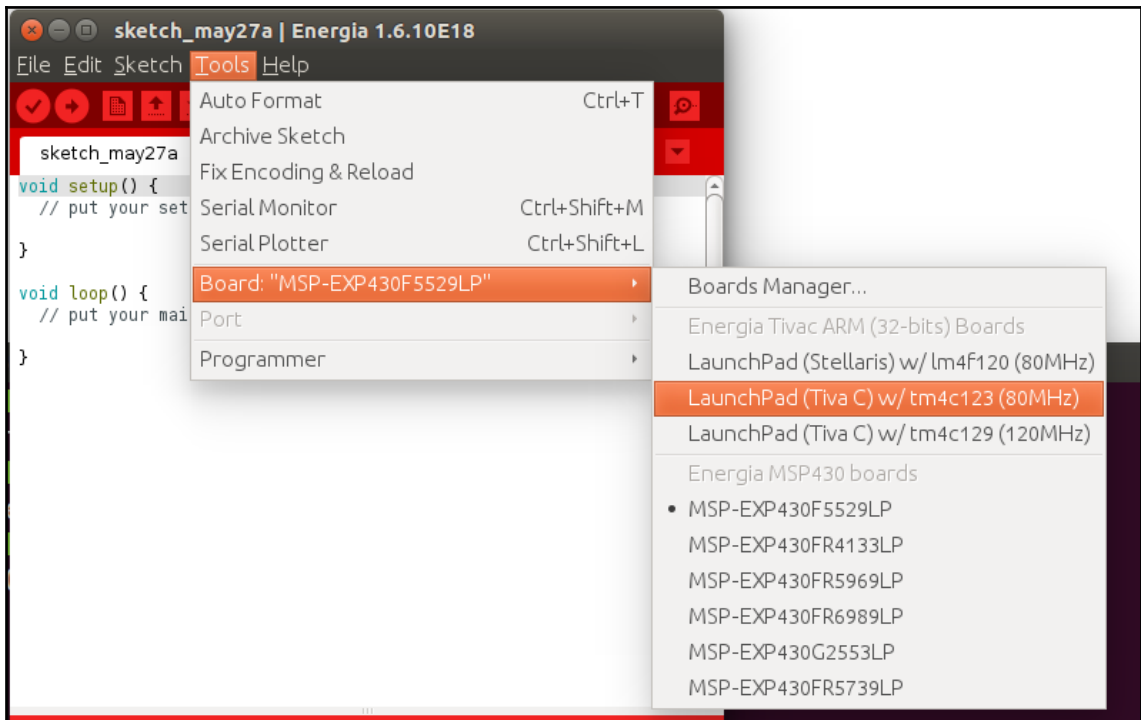


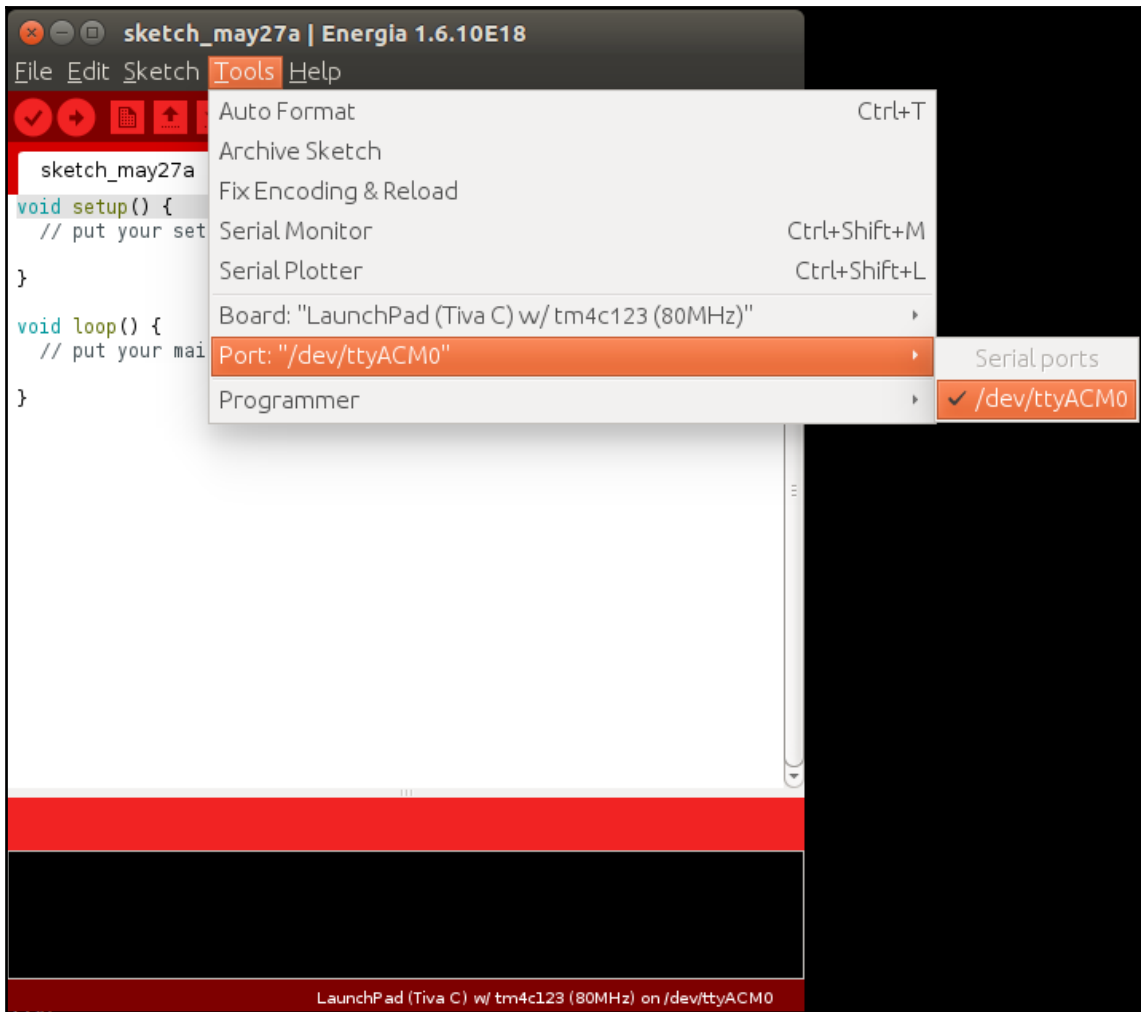


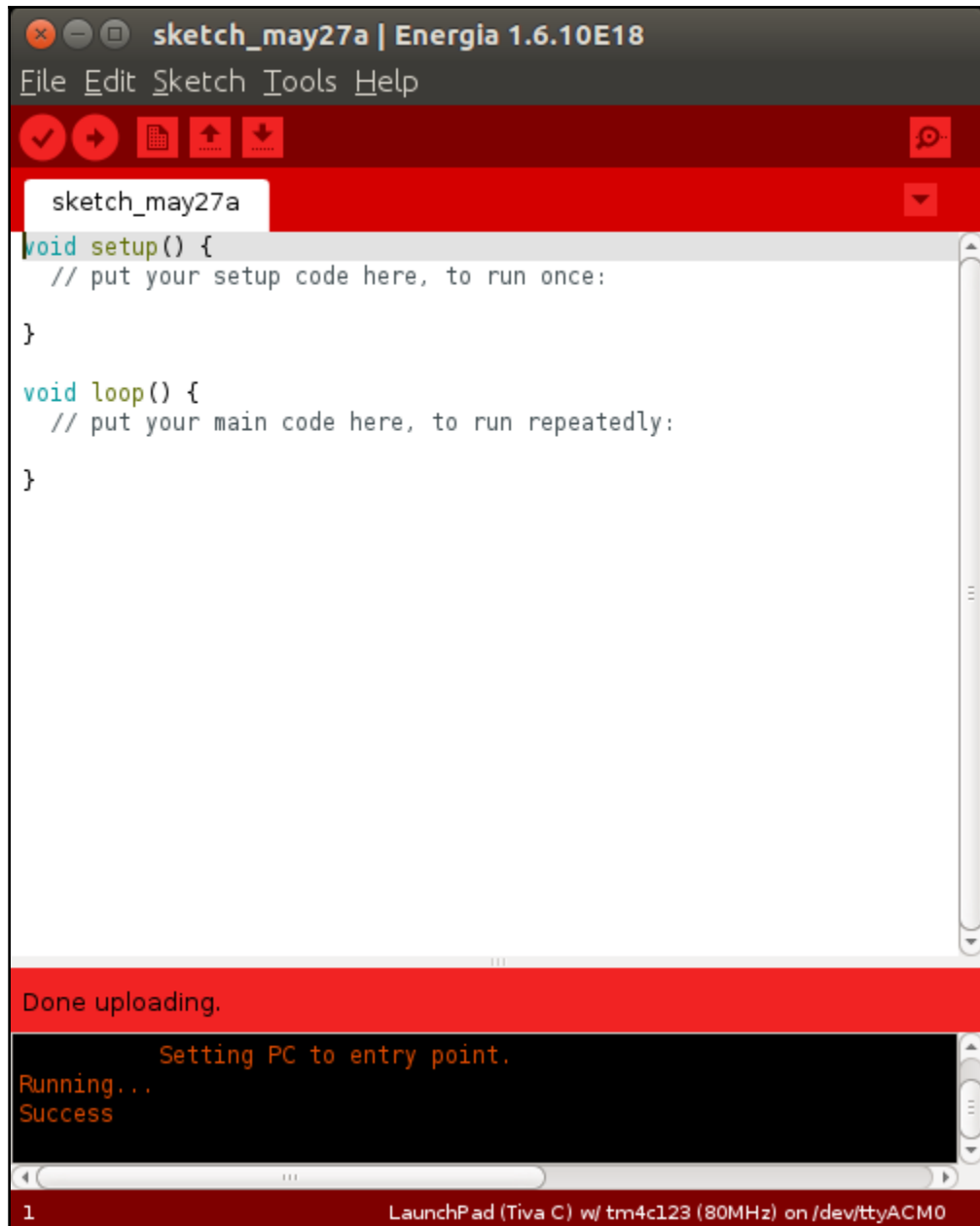
```
[ 569.441209] usb 1-5: New USB device found, idVendor=1cbe, idProduct=00fd
[ 569.441215] usb 1-5: New USB device strings: Mfr=1, Product=2, SerialNumber=3
[ 569.441218] usb 1-5: Product: In-Circuit Debug Interface
[ 569.441222] usb 1-5: Manufacturer: Texas Instruments
[ 569.441225] usb 1-5: SerialNumber: 0E2258F8
[ 569.461748] cdc_acm 1-5:1.0: ttyACM0: USB ACM device
[ 569.461943] usbcore: registered new interface driver cdc_acm
[ 569.461944] cdc_acm: USB Abstract Control Model driver for USB modems and ISDN adapters
```

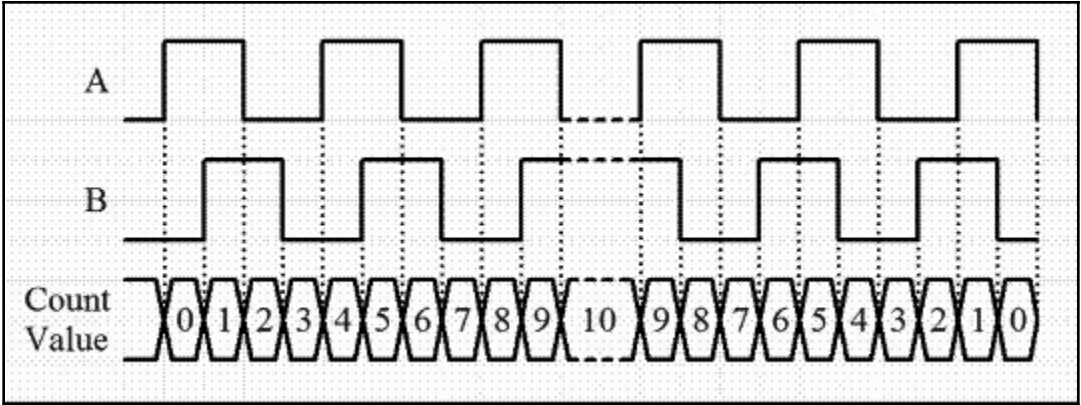
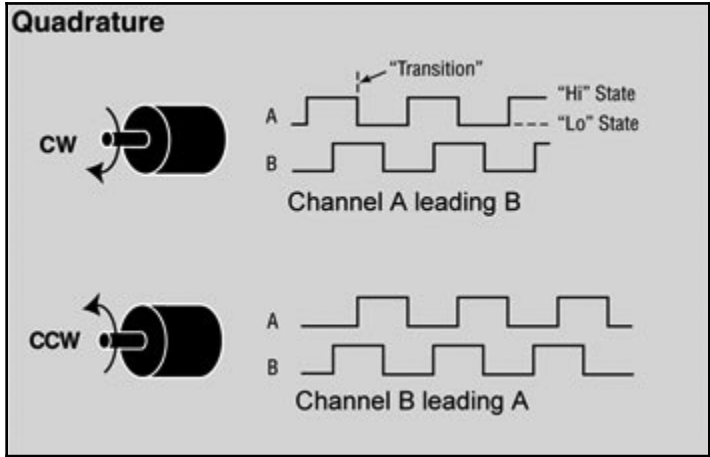


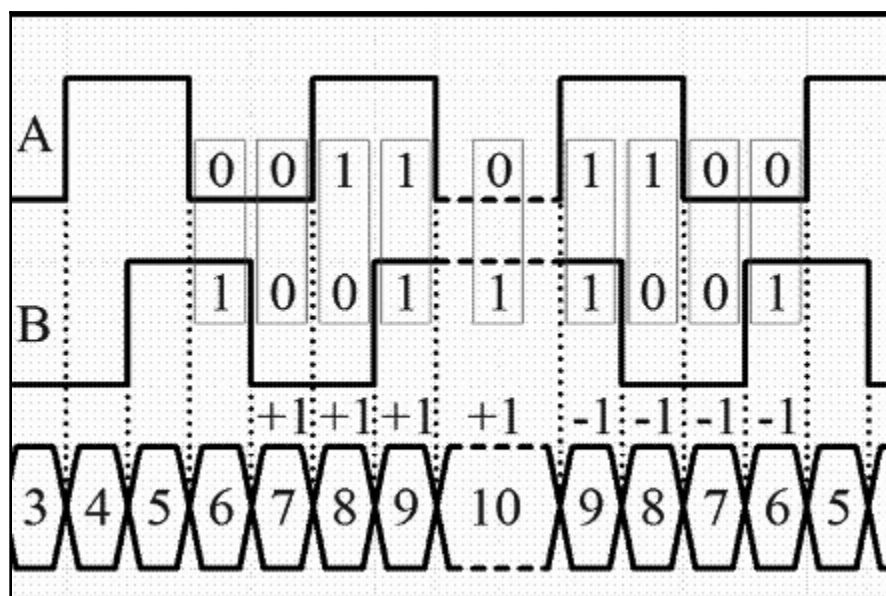


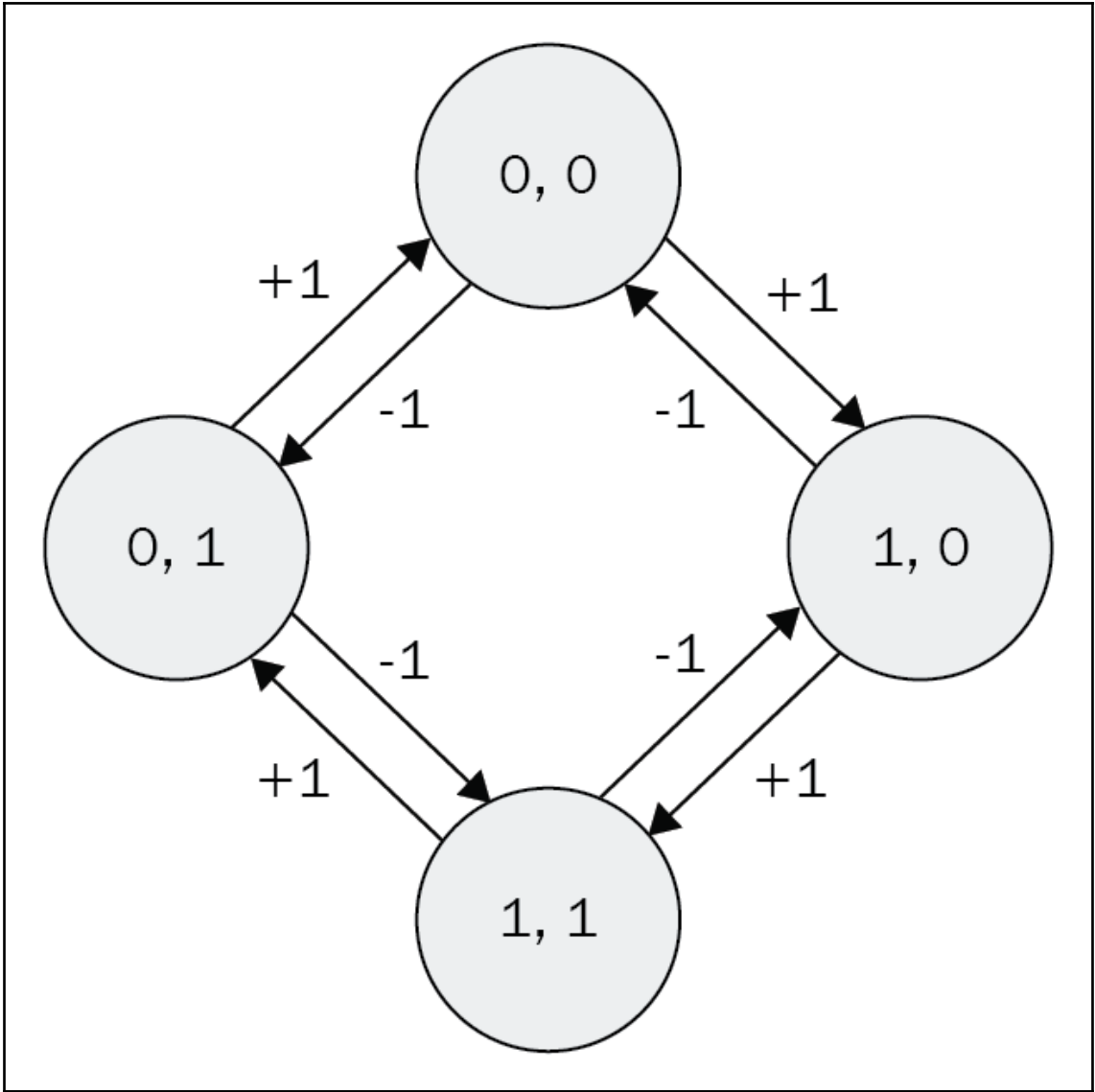


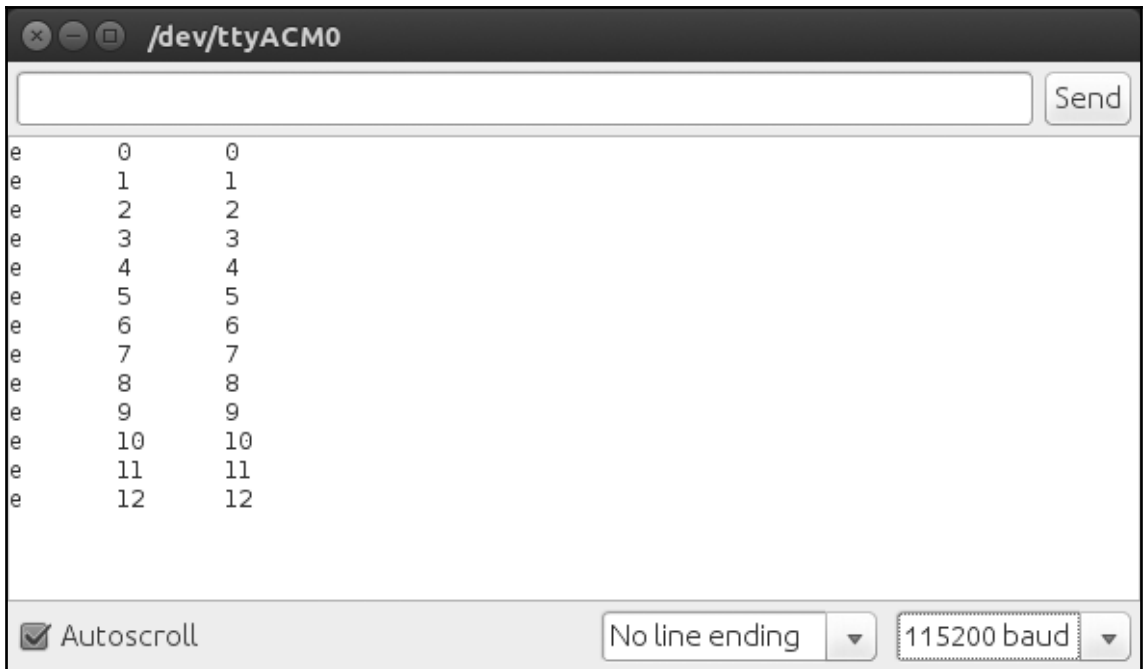
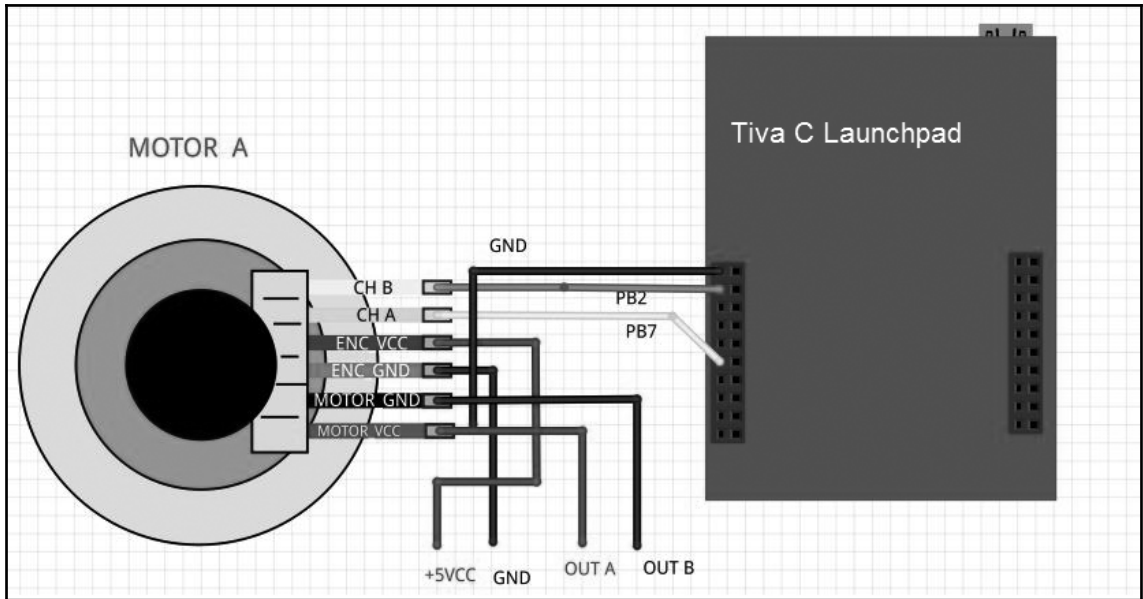


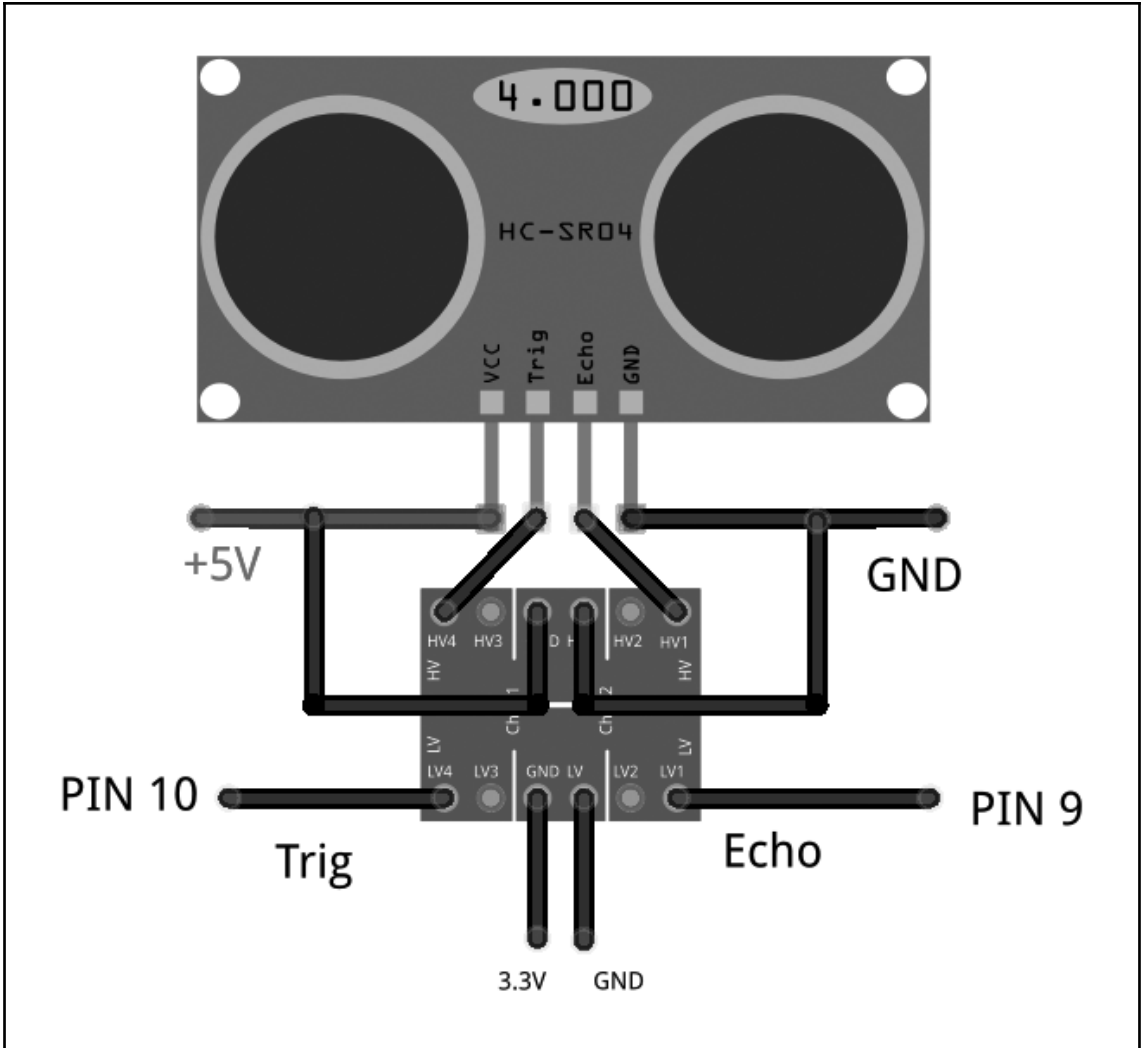
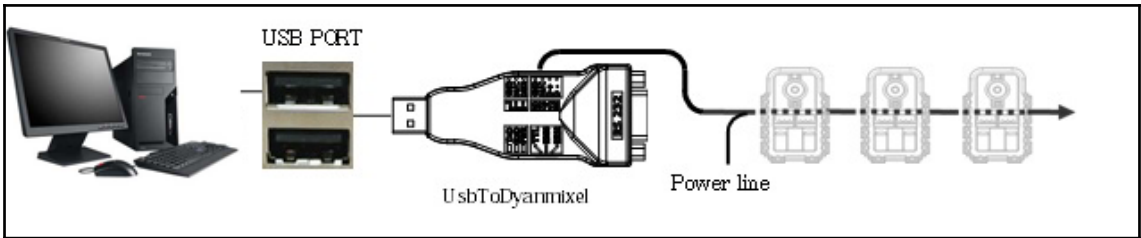


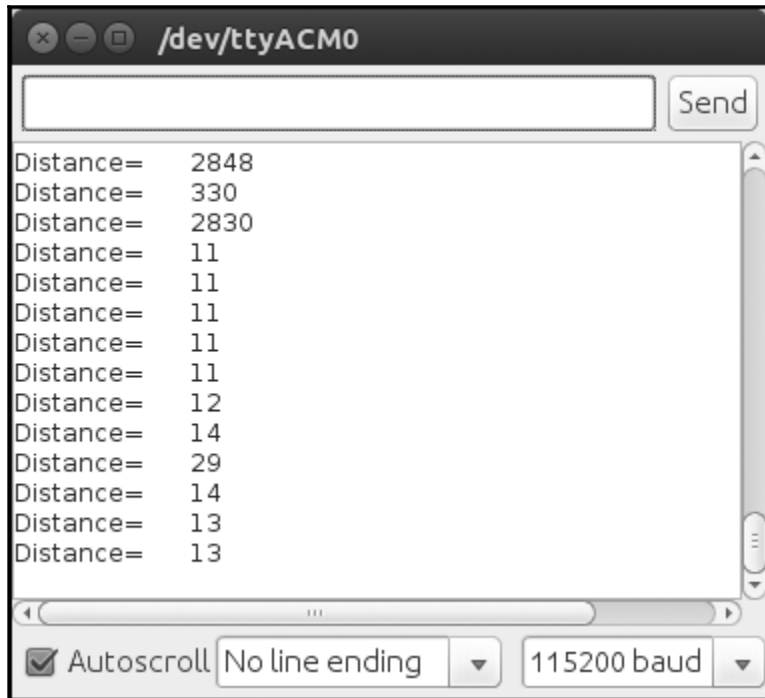
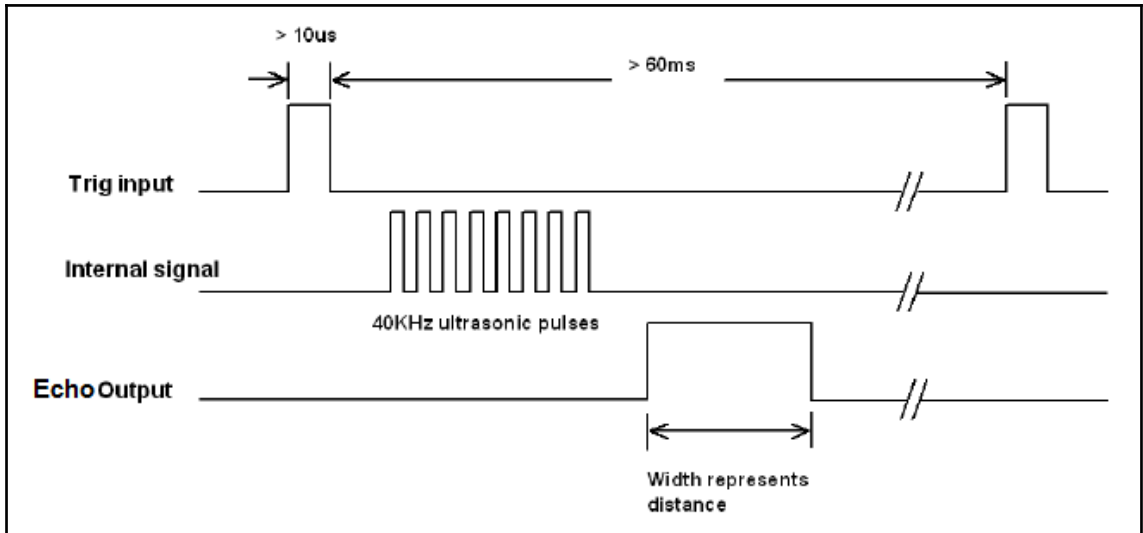




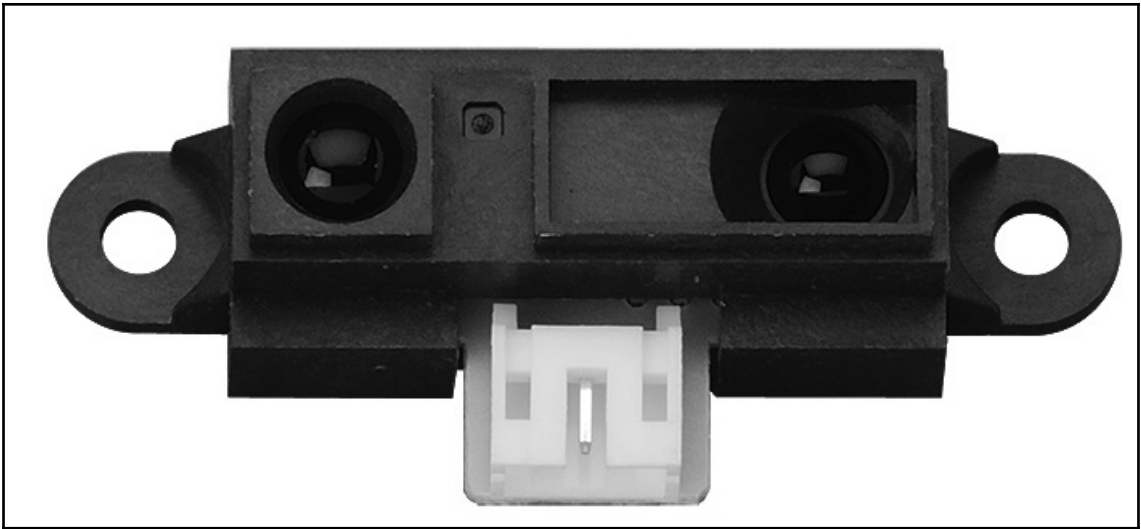


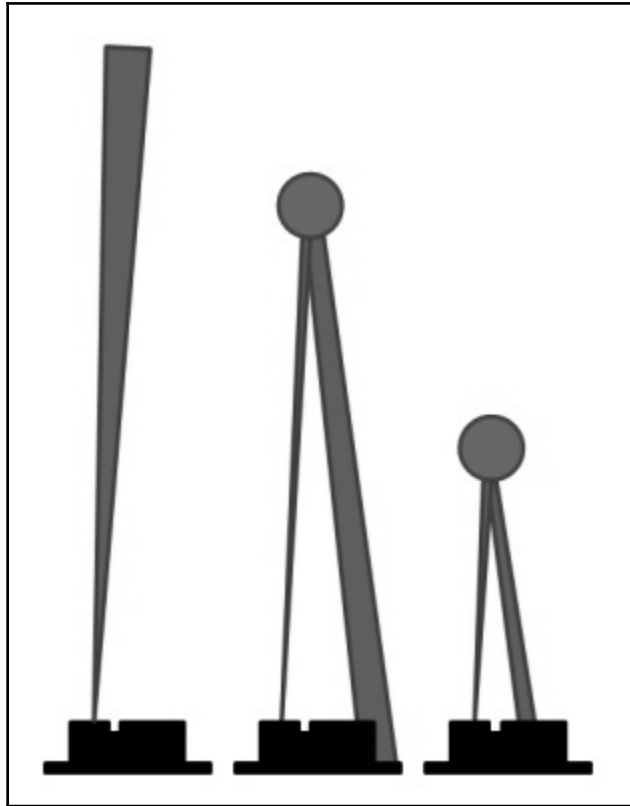


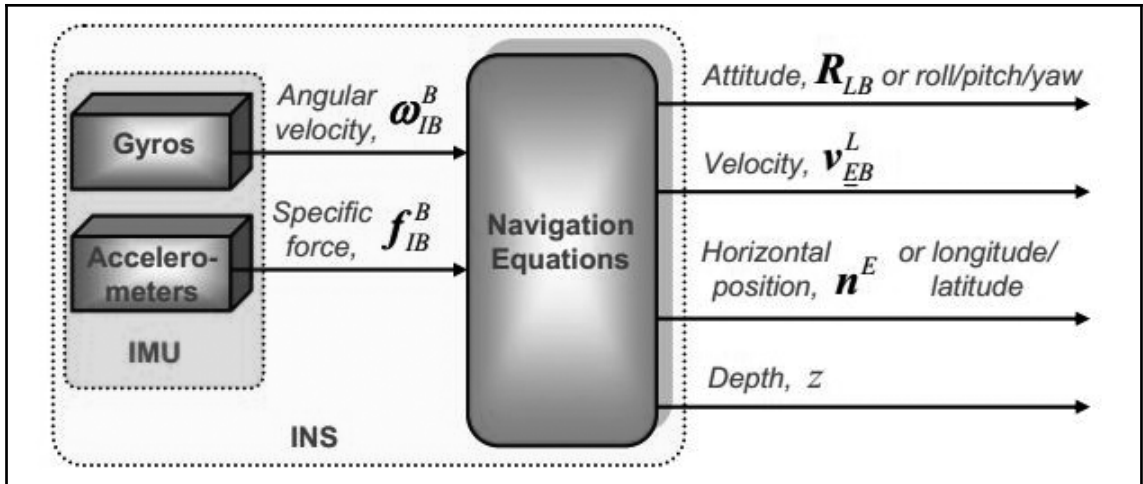
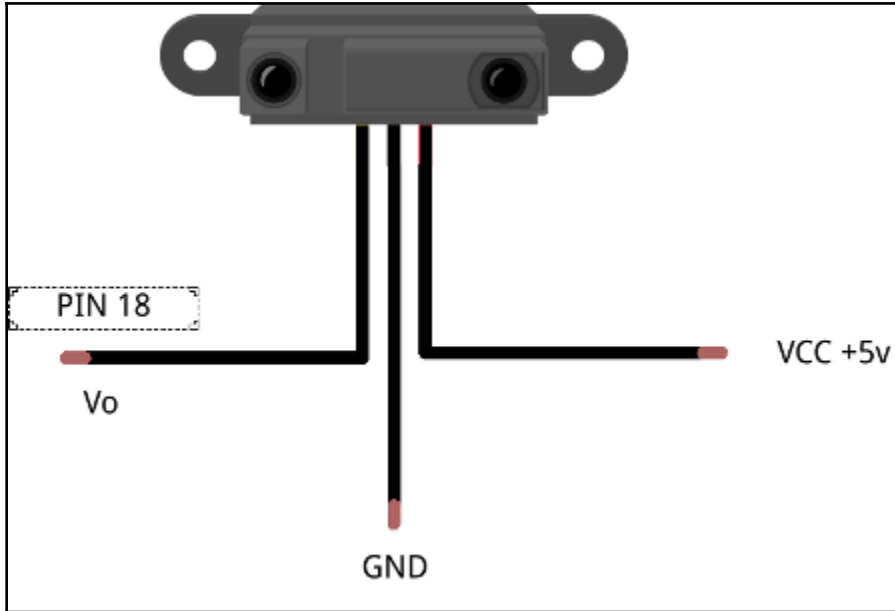


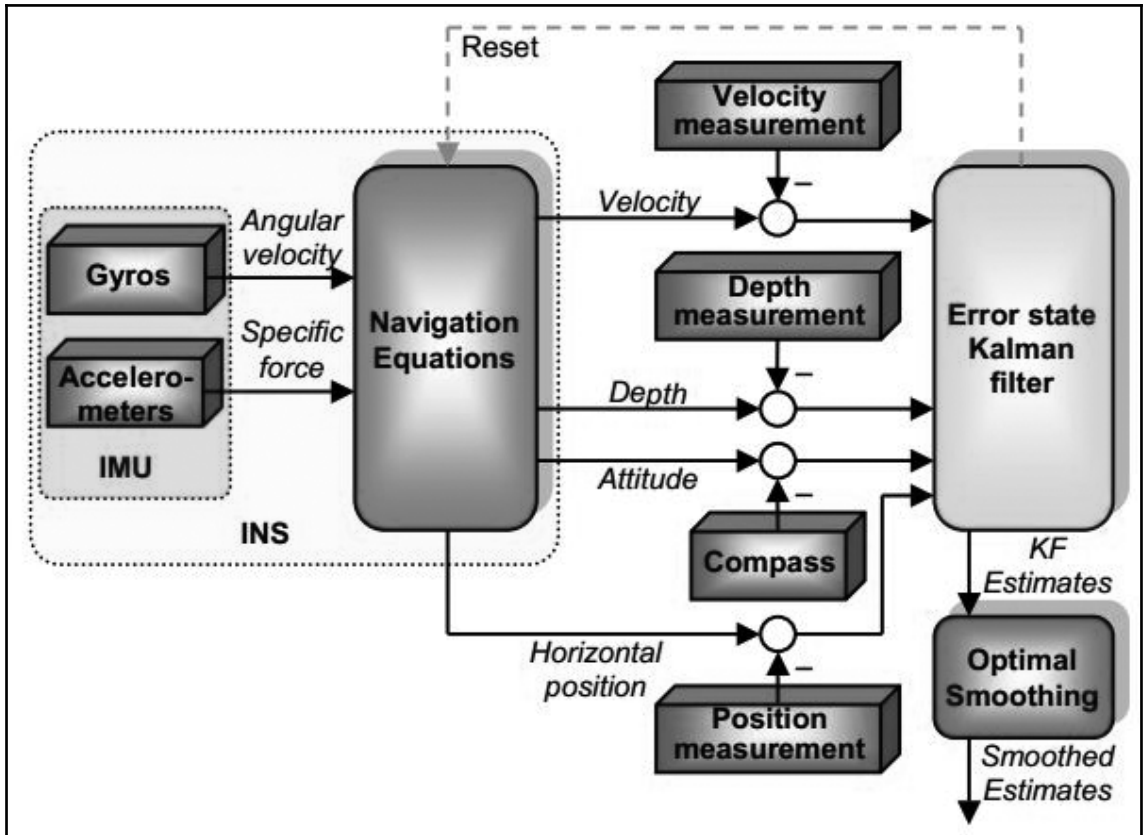


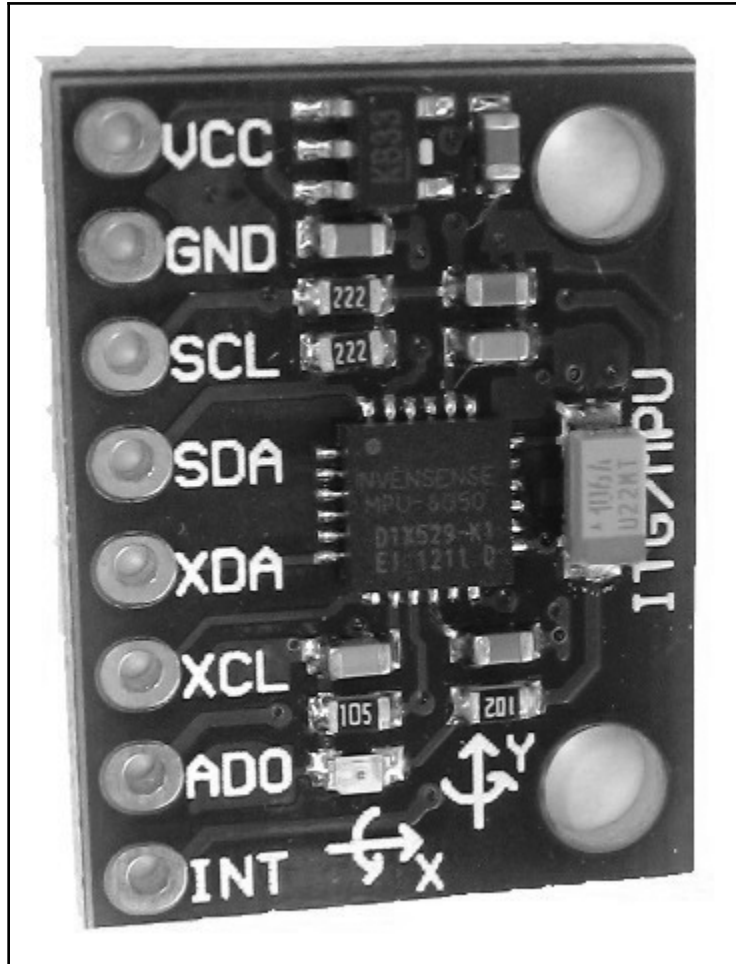
```
lentin@lentin-Aspire-4755: ~  
Distance=      12  
Distance=     2903  
Distance=       5  
Distance=       9  
Distance=       7  
Distance=       6
```

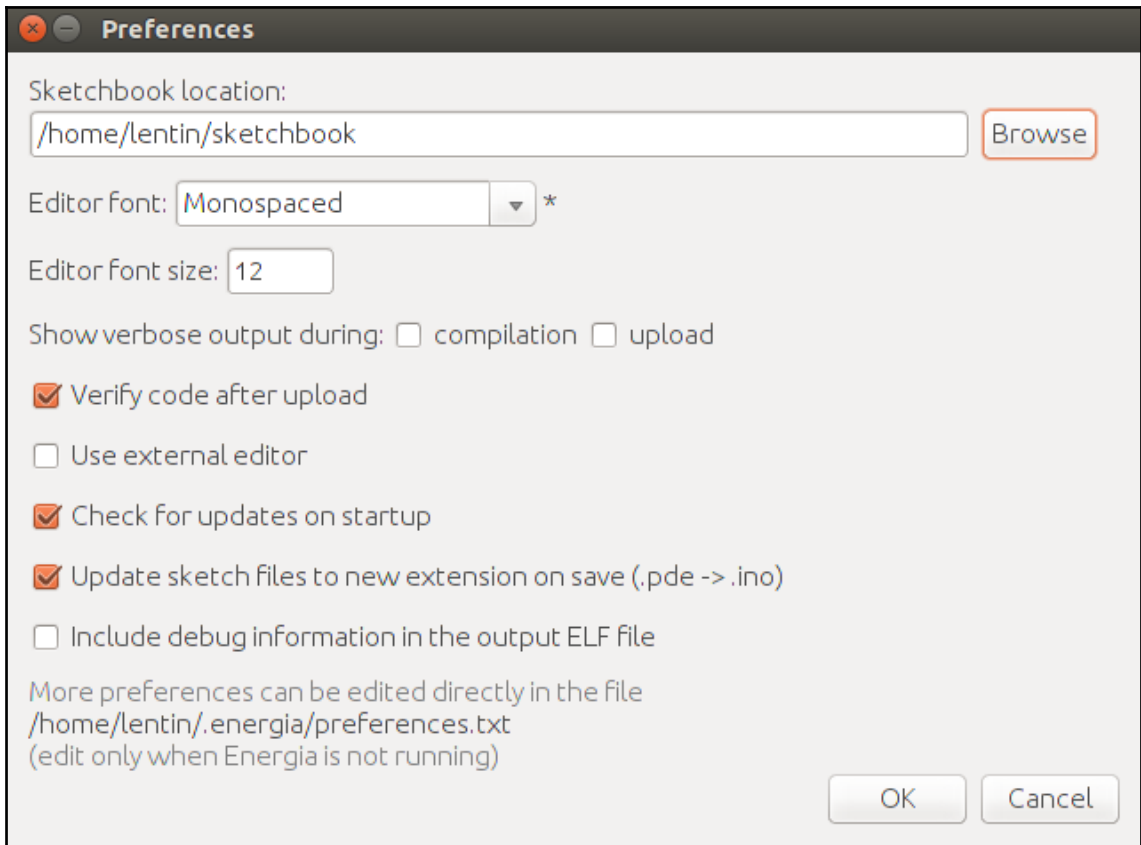


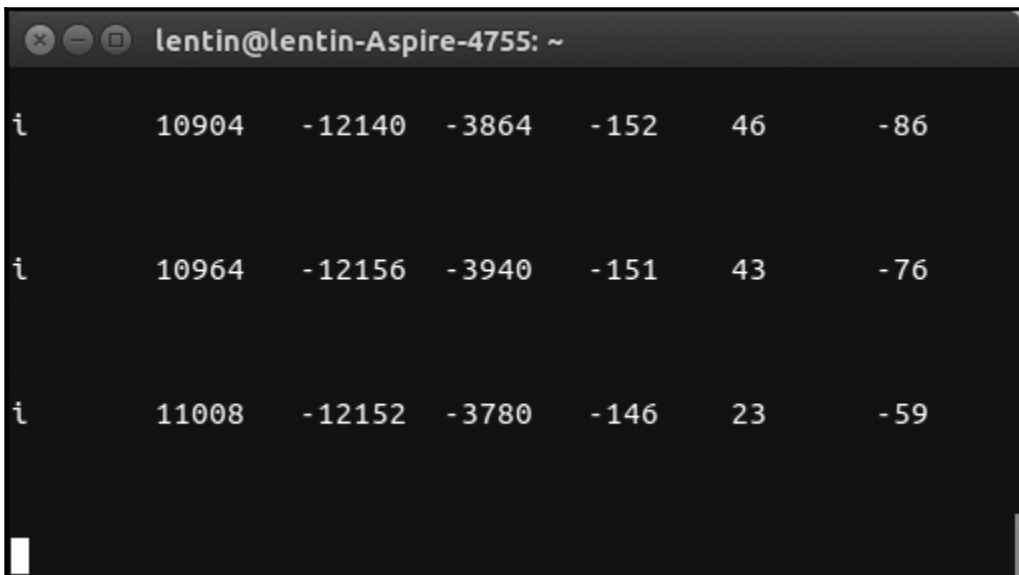
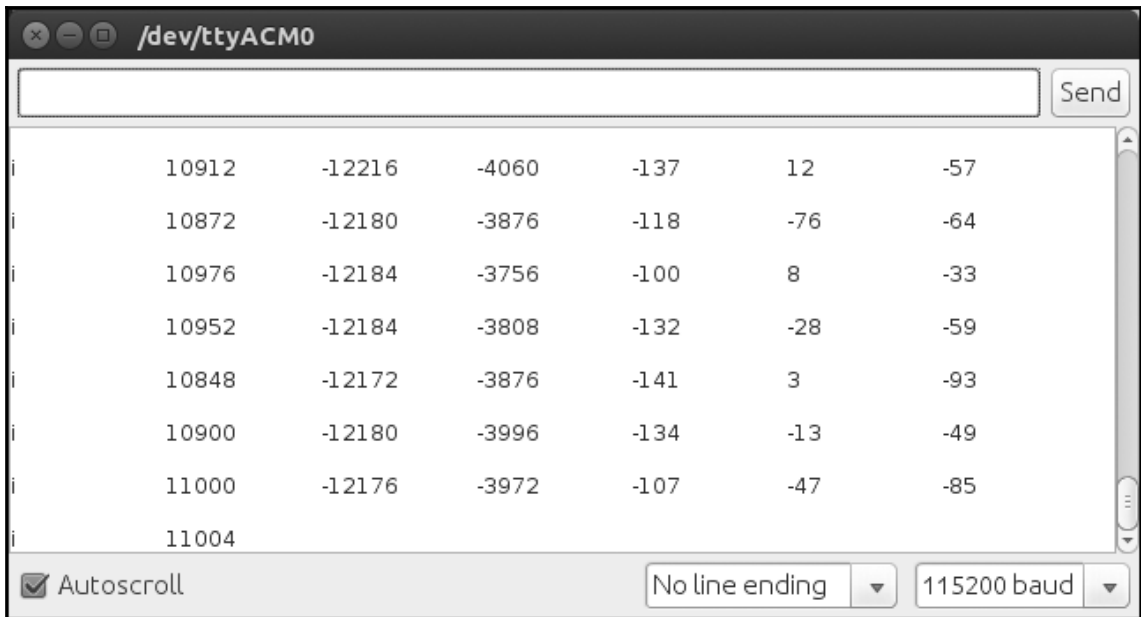




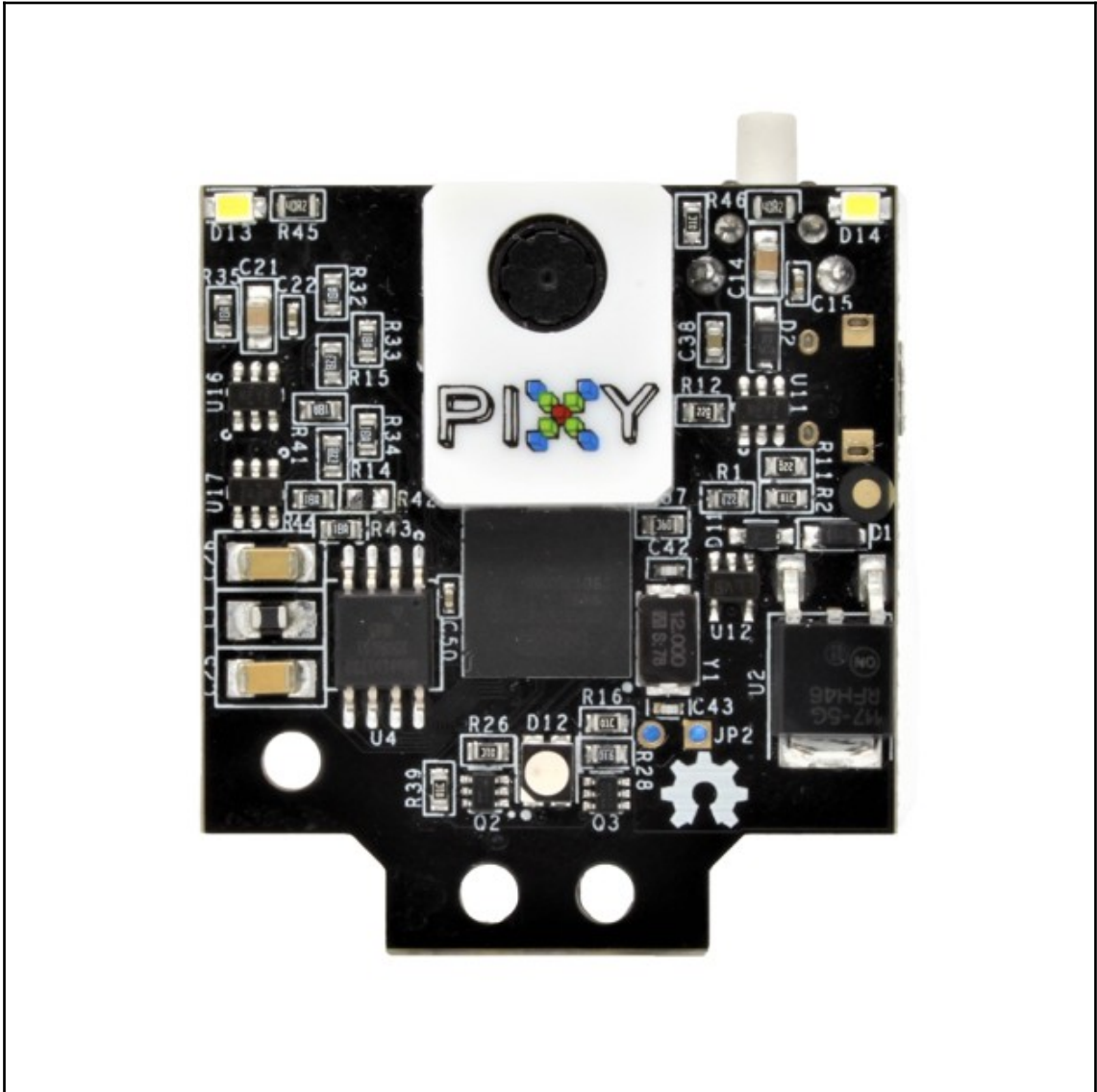




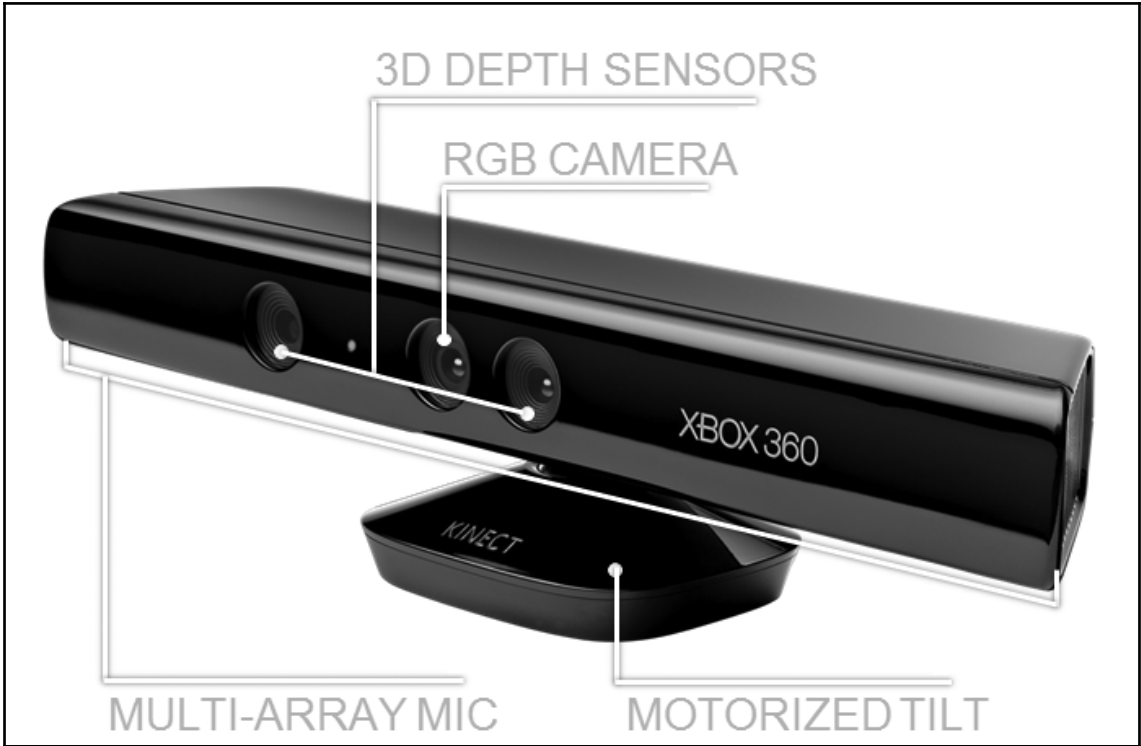


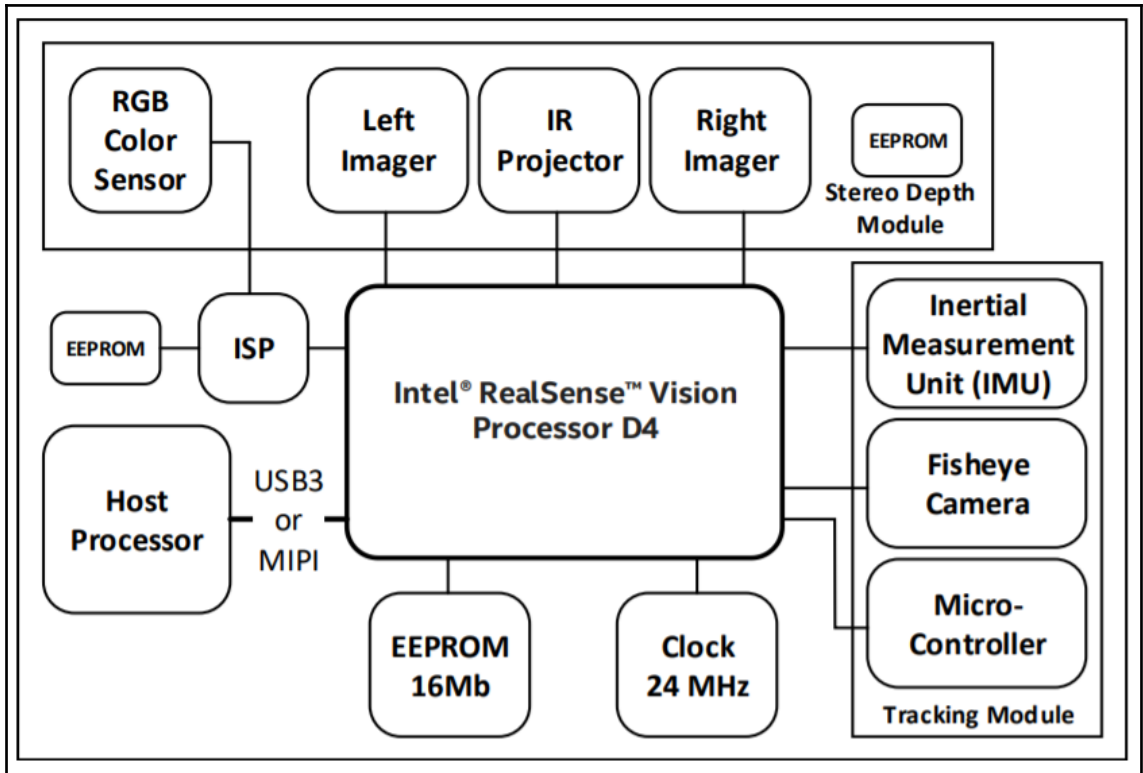


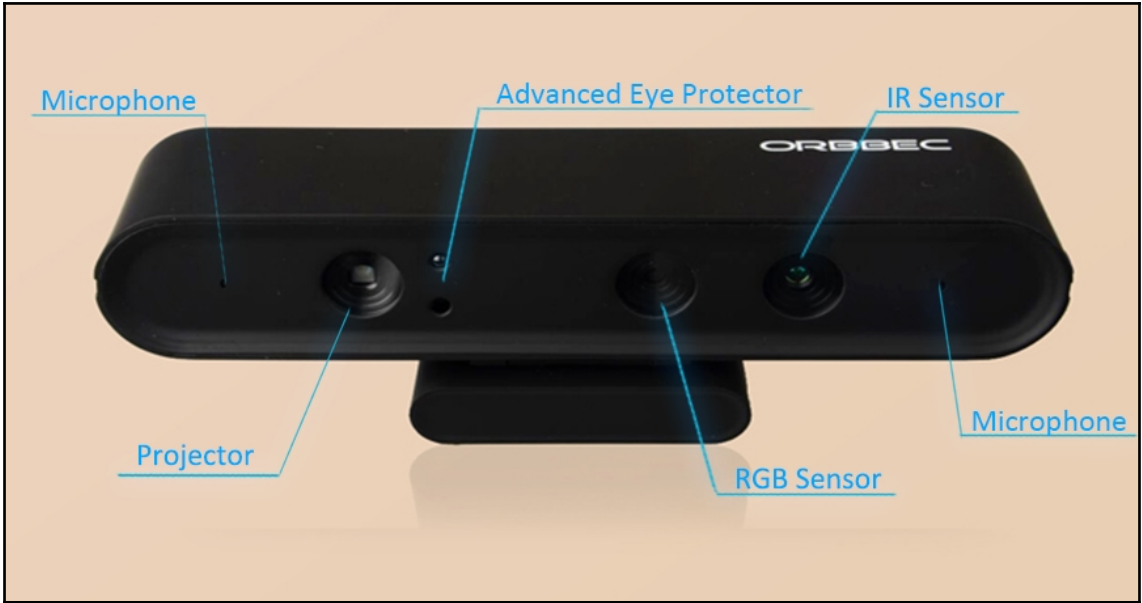
Chapter 6: Interfacing Vision Sensors with ROS

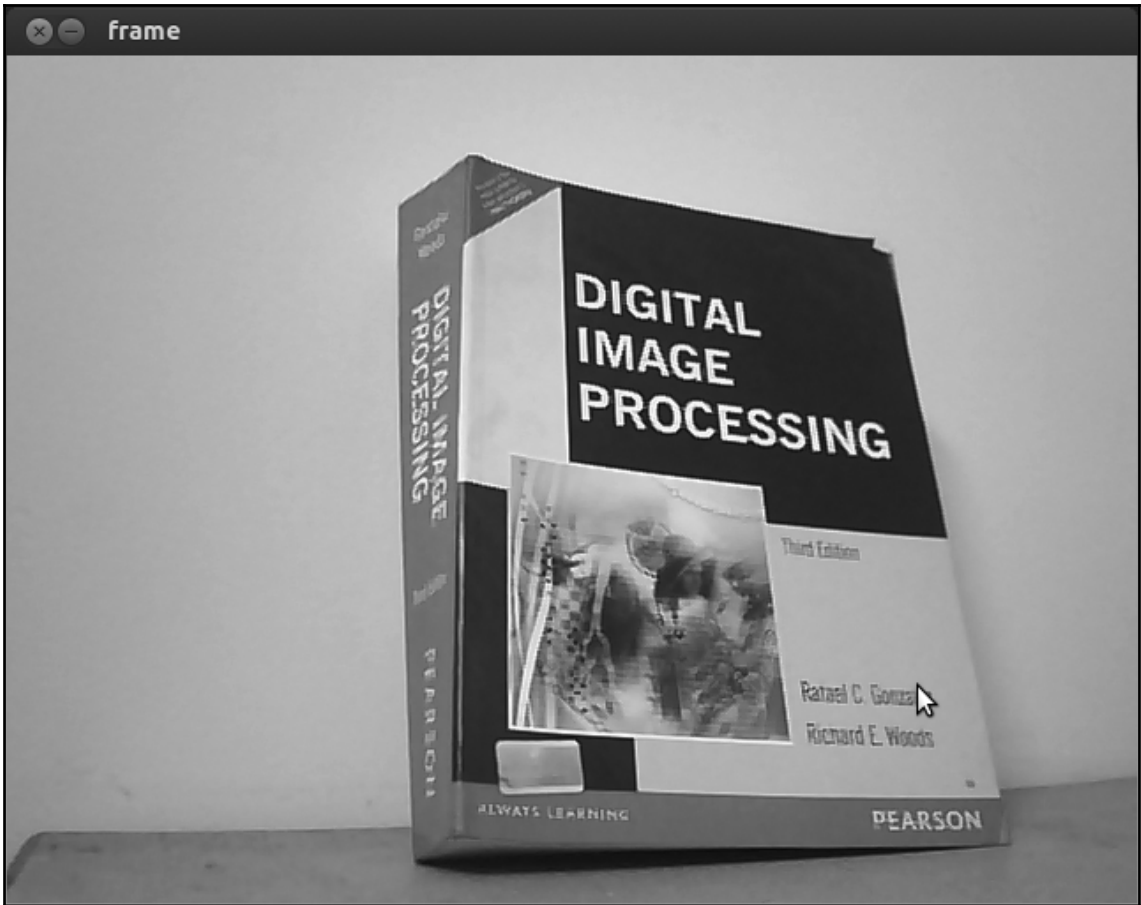


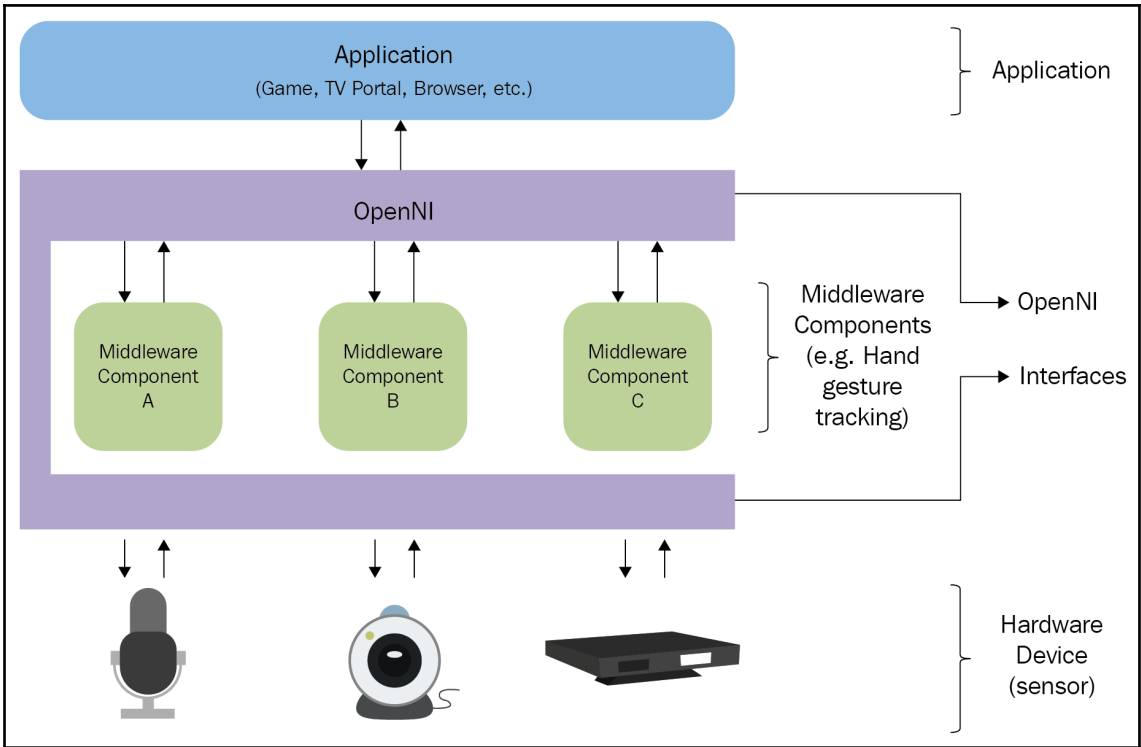


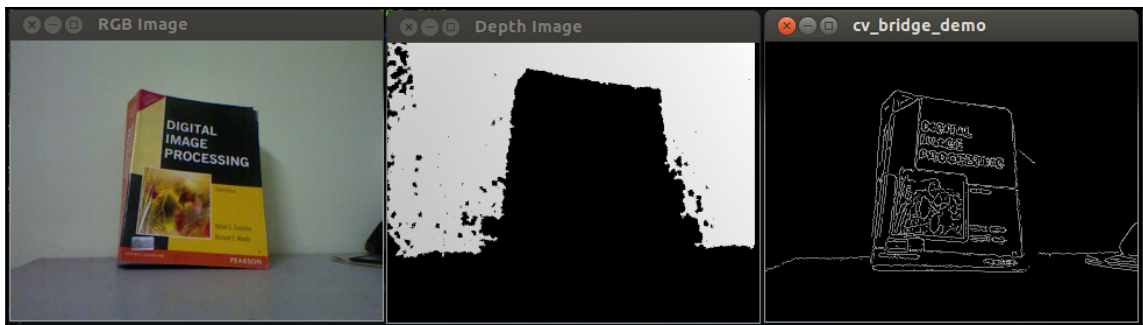
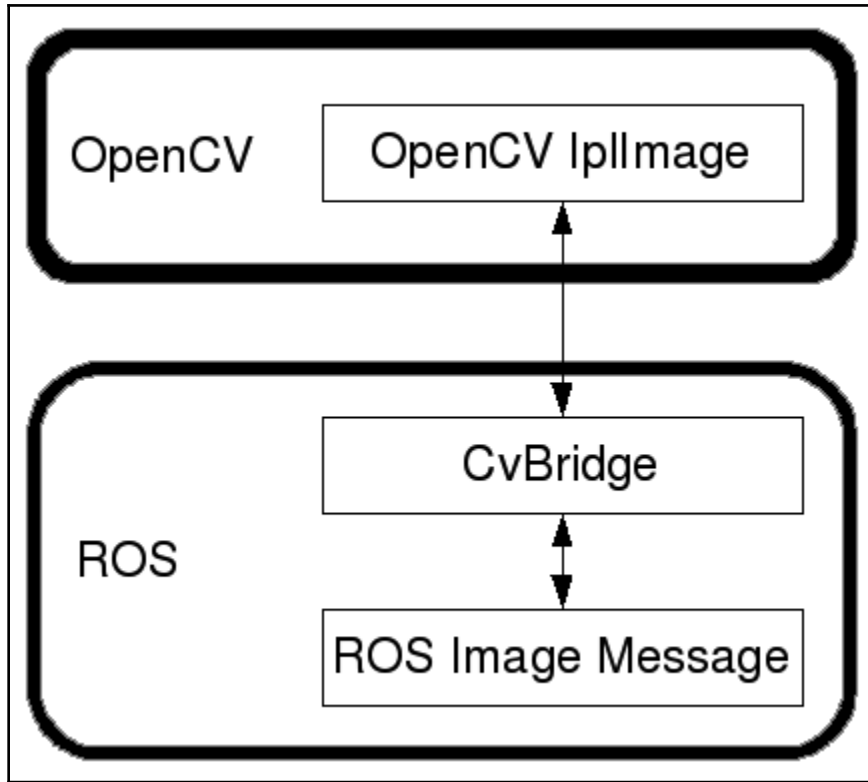


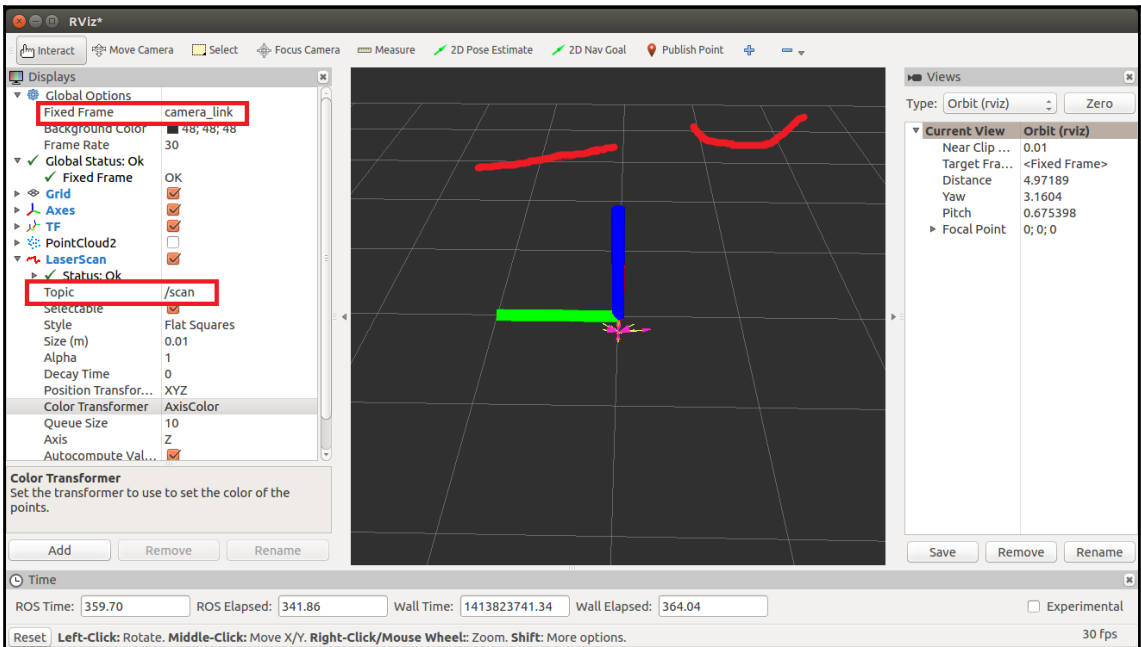
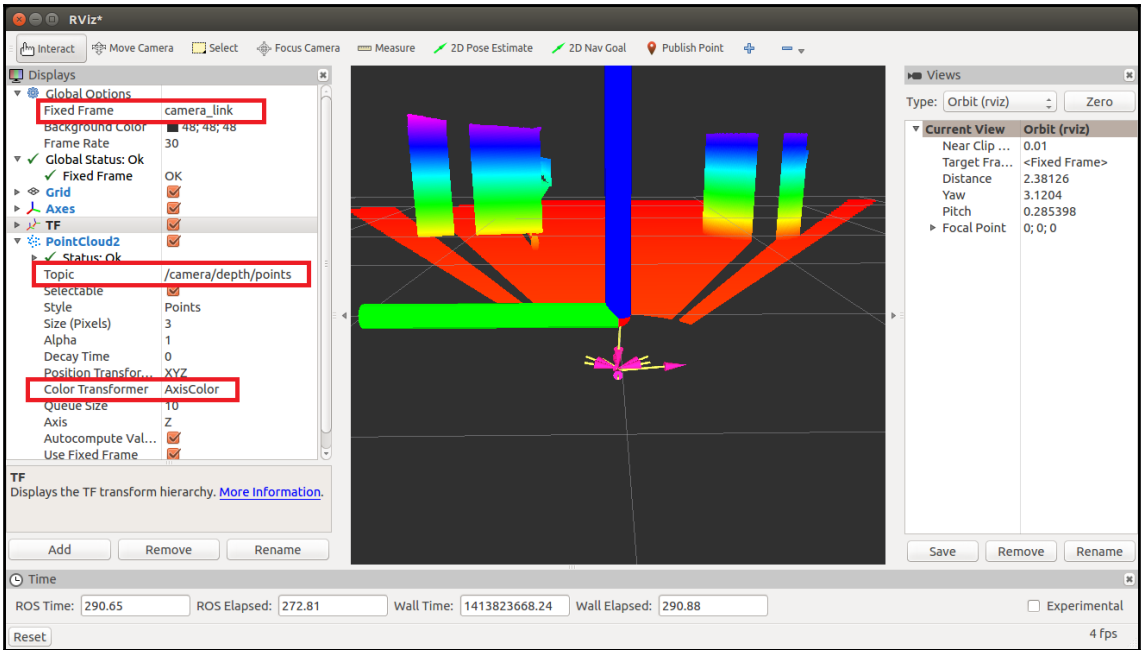




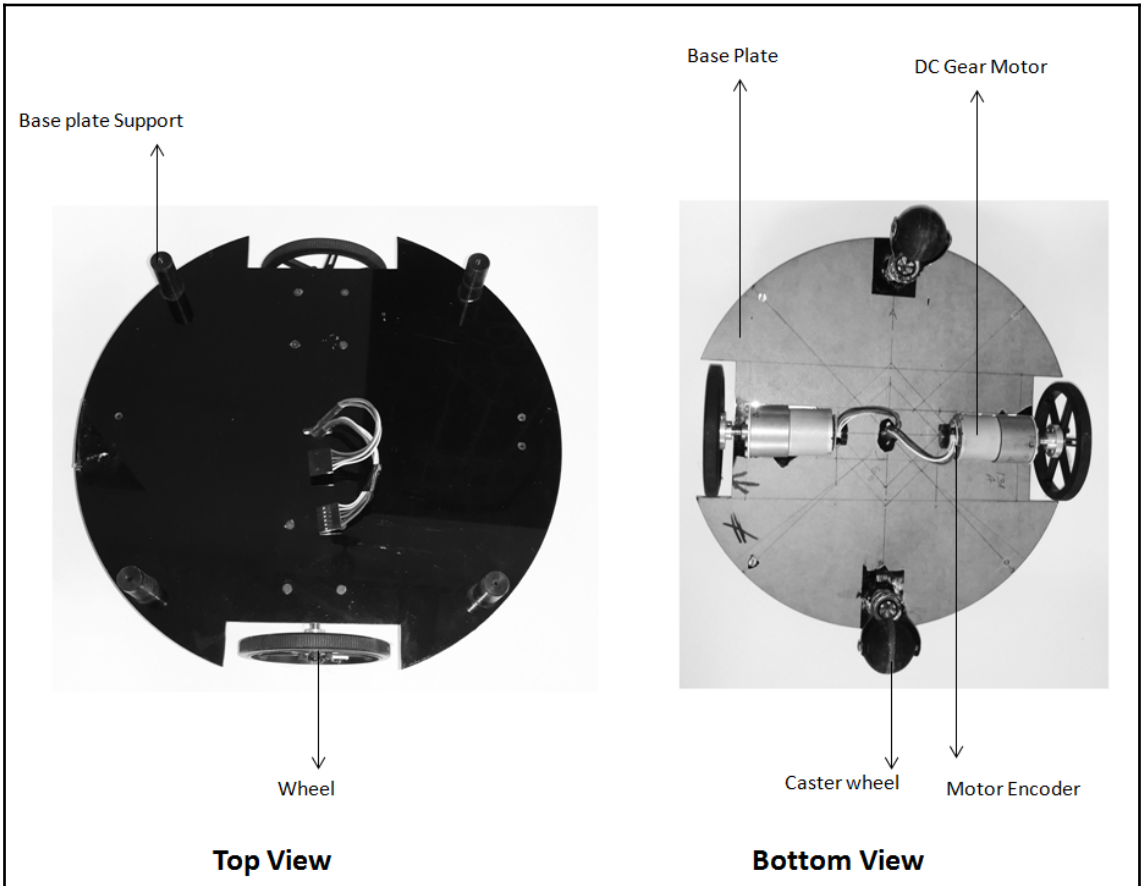






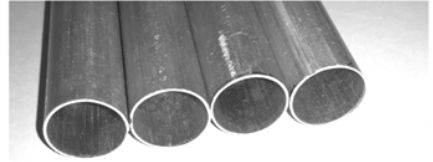


Chapter 7: Building ChefBot Hardware and the Integration of Software

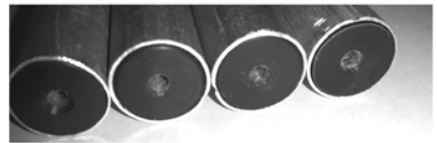




Middle plate



Base plate Female connector



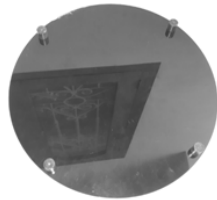
Middle plate Female connector



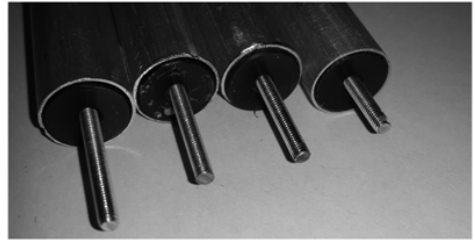
Assembled up to Middle plate



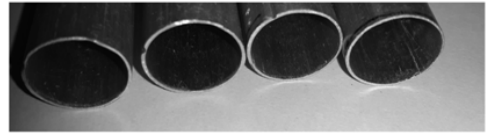
Semi-assembled body



Top plate



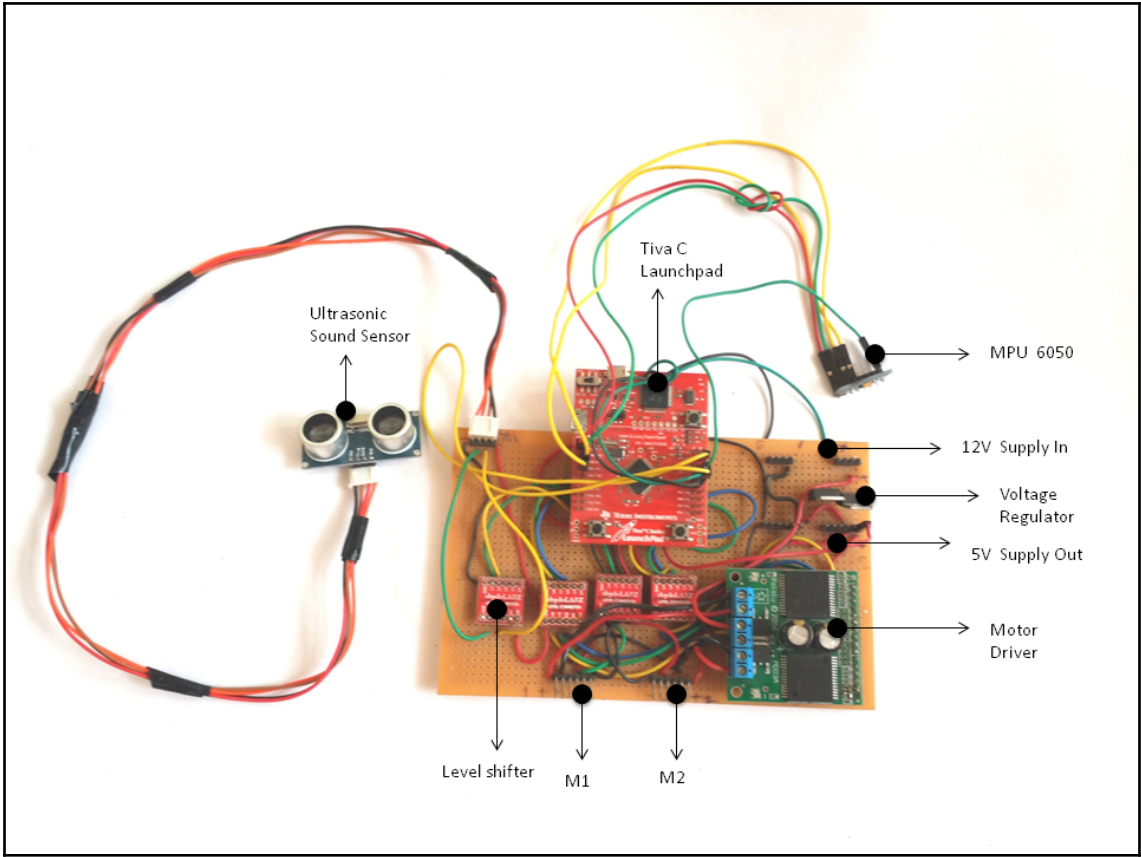
Middle plate male connector

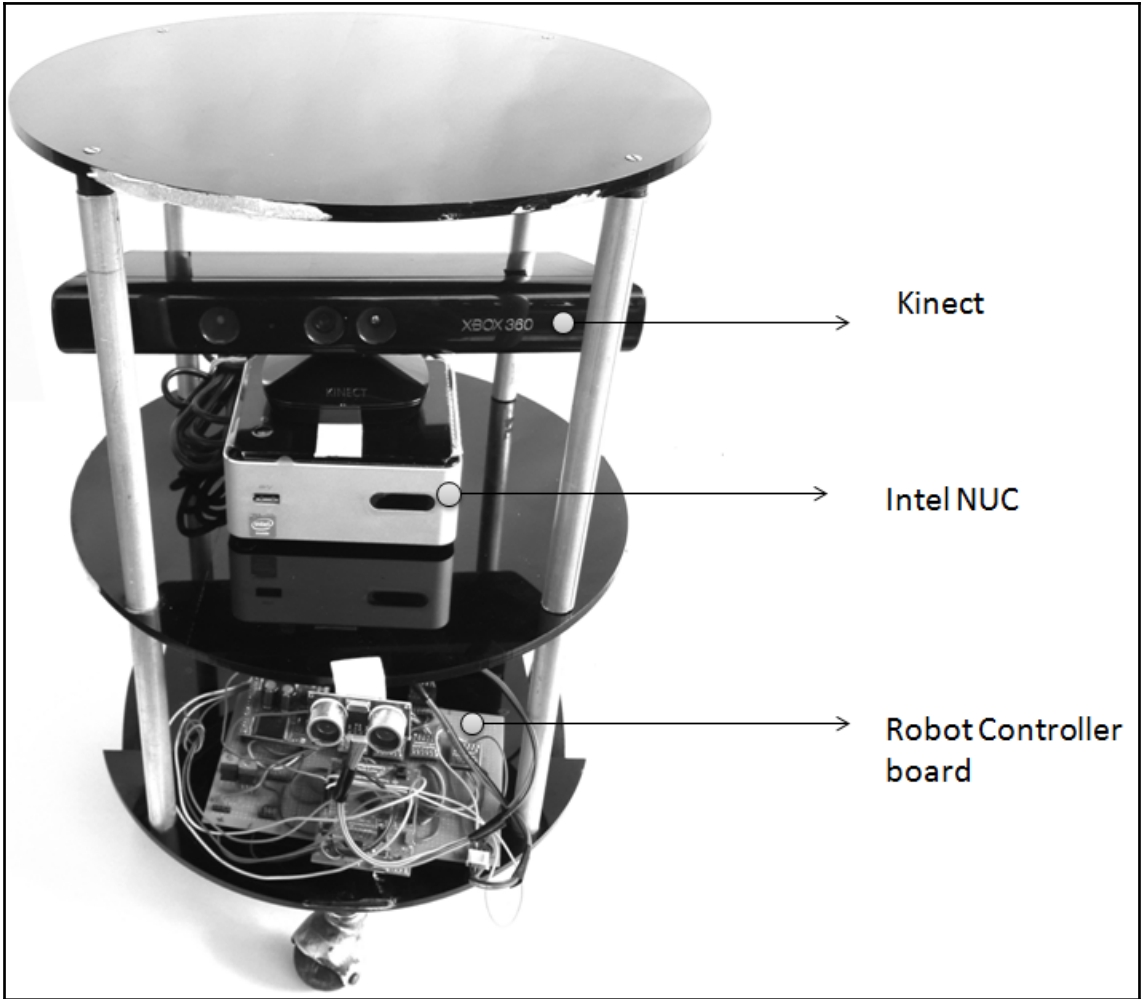


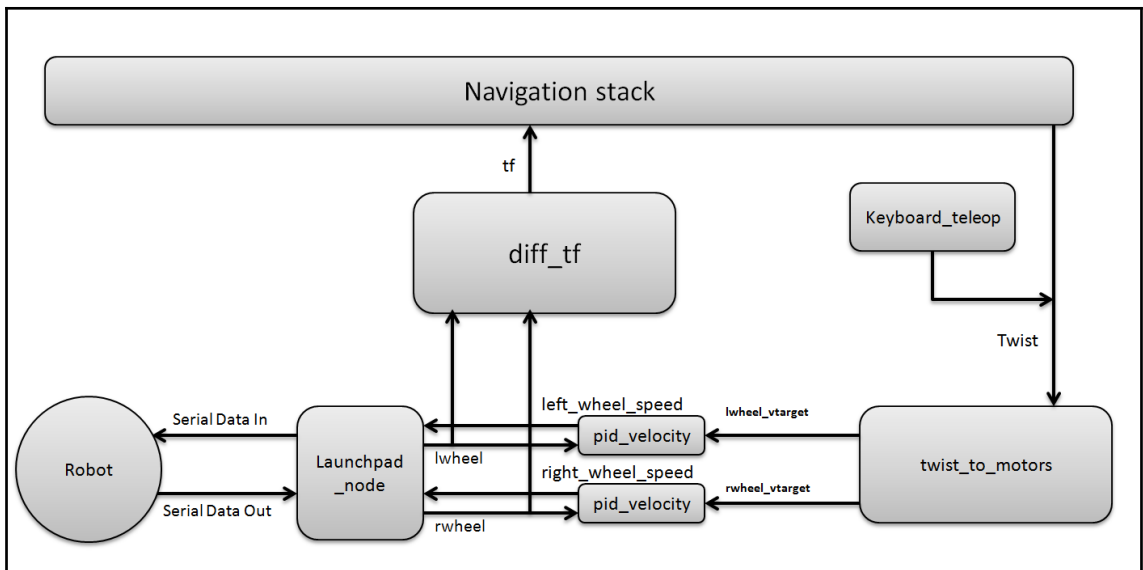
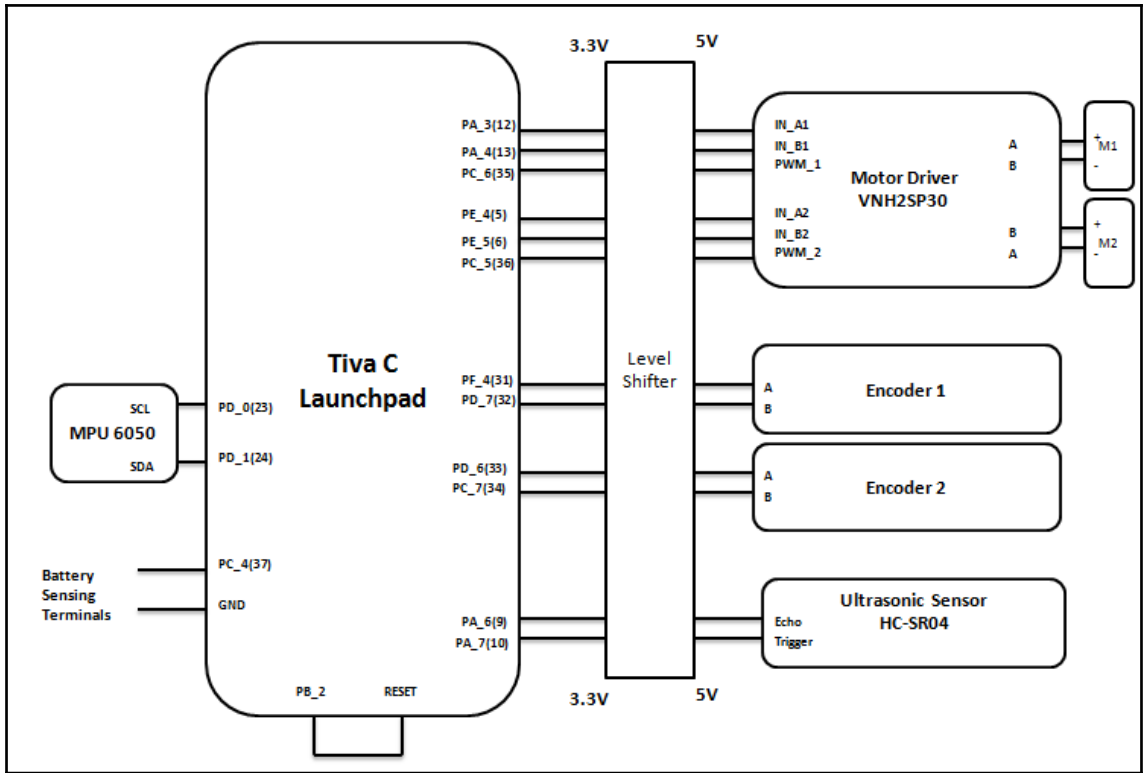
Top plate Female connector

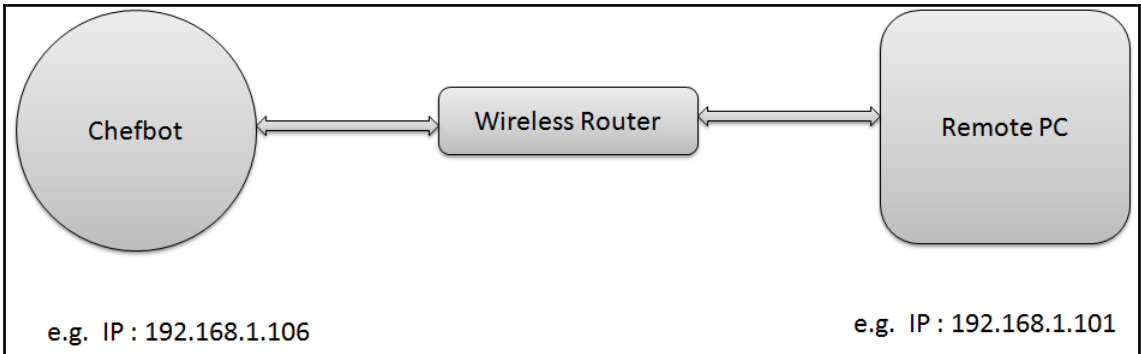


Fully assembled body









```

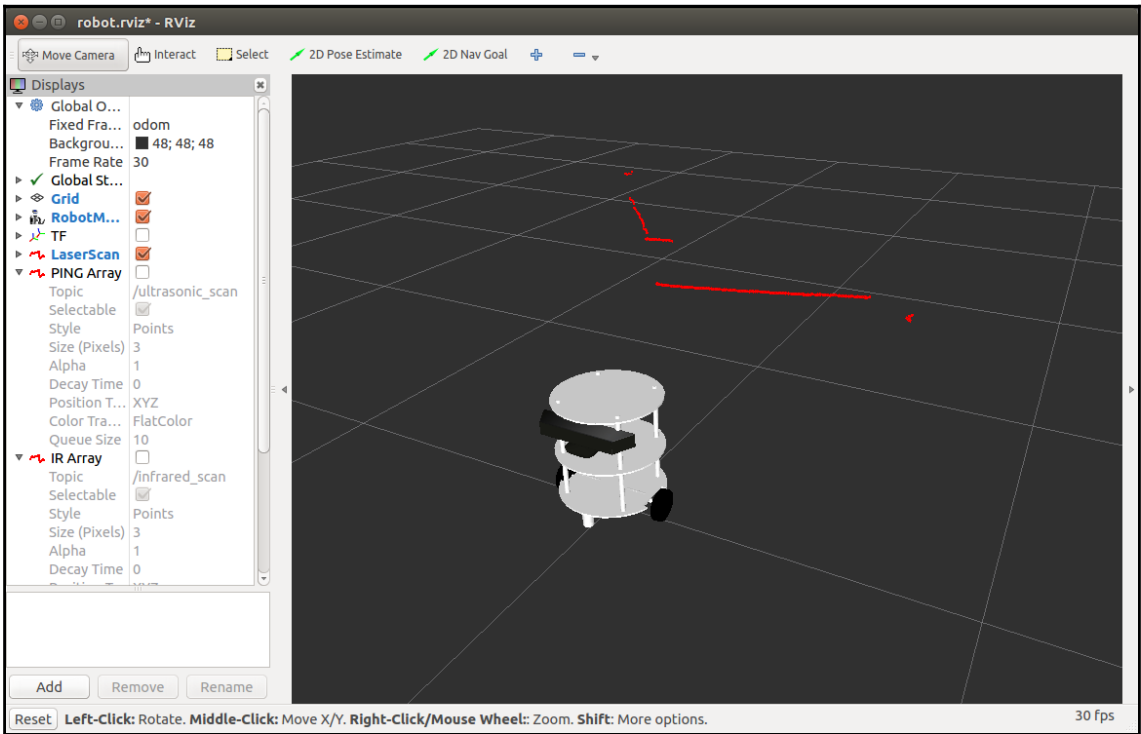
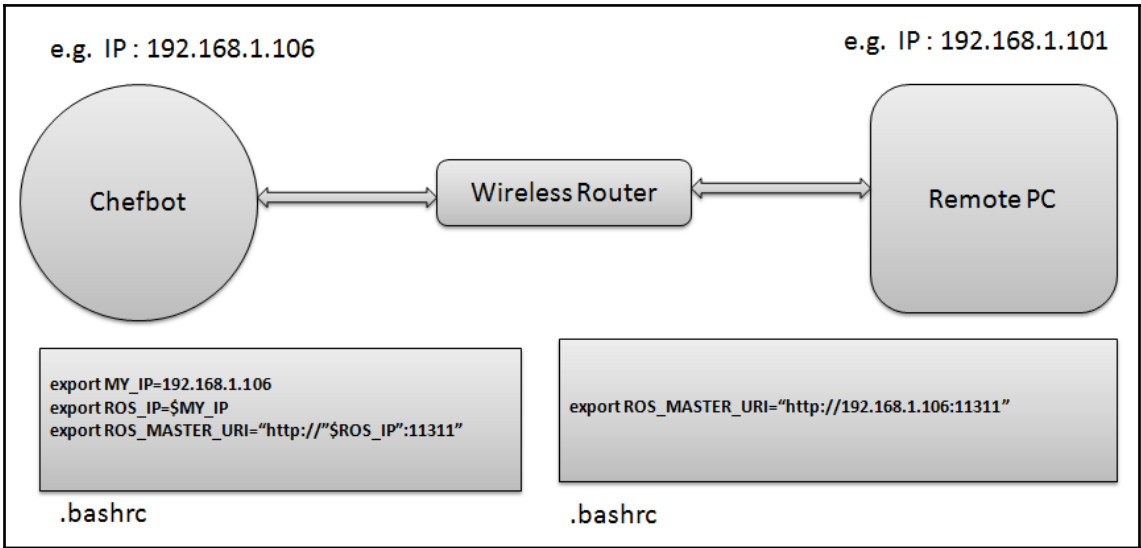
b      0.00
t      66458239      0.05
e      0      0
u      10
s      0.00      0.00
i      -0.68      -0.47      -0.40      0.40
b      0.00
t      66511681      0.05
e      0      0
u      10
s      0.00      0.00
i      -0.68      -0.47      -0.40      0.40
b      0.00
t      66566051      0.05
e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

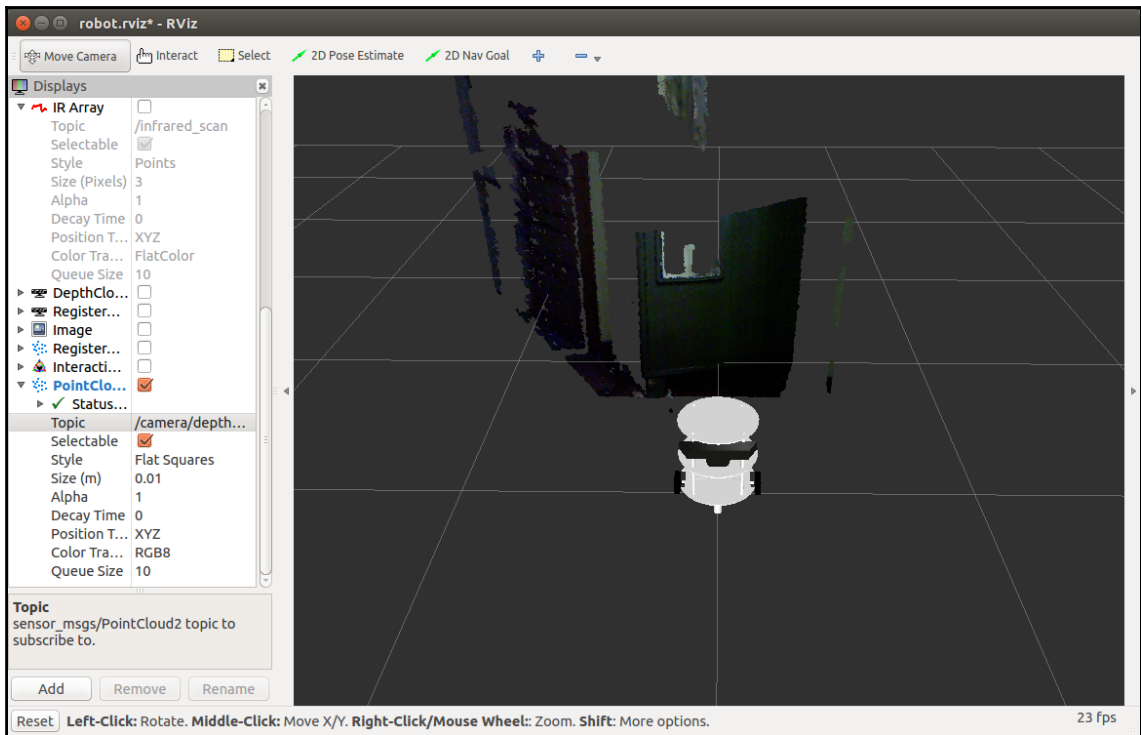
```

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

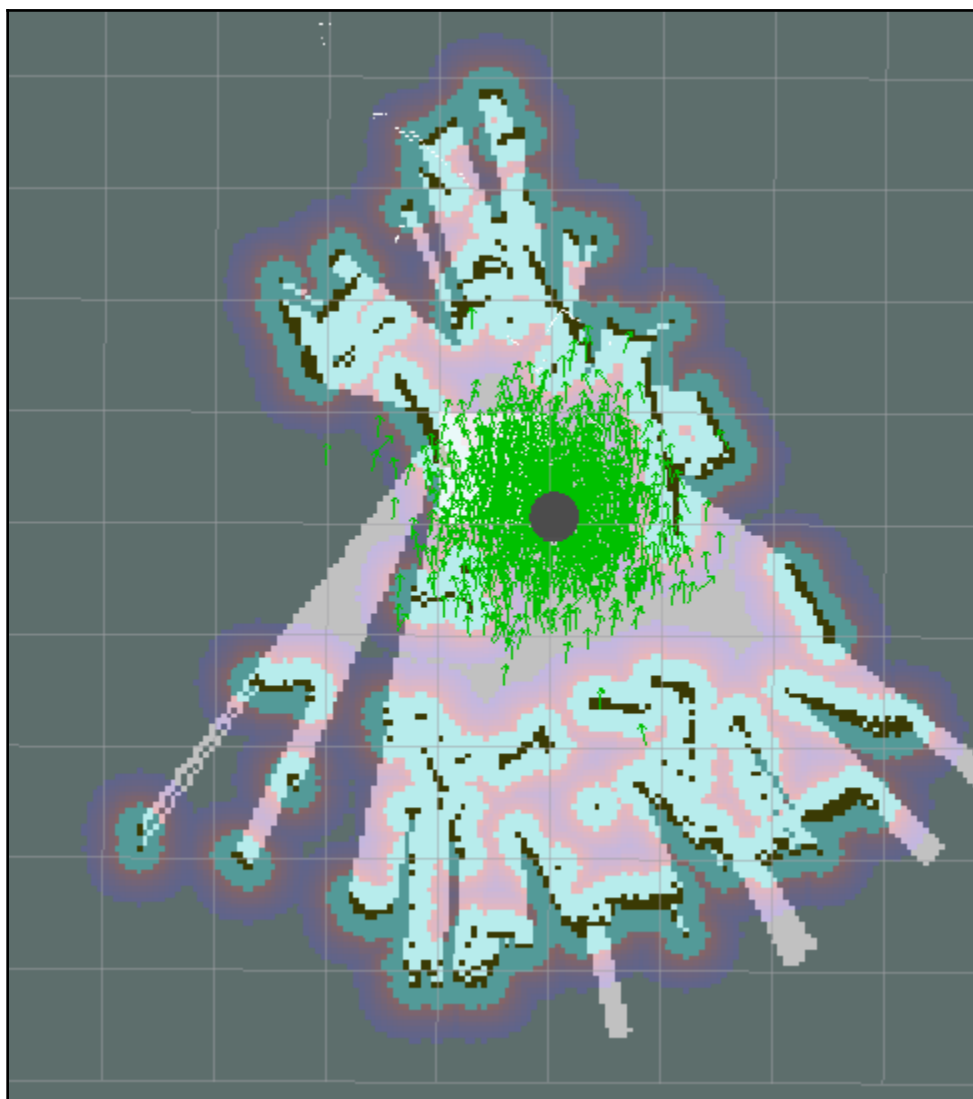
```
robot@robot-desktop:~$ rostopic list
/battery_level
/imu/data
/left_wheel_speed
/lwheel
/qw
/qx
/qy
/qz
/right_wheel_speed
/rosout
/rosout_agg
/rwheel
/serial
/ultrasonic distance
```

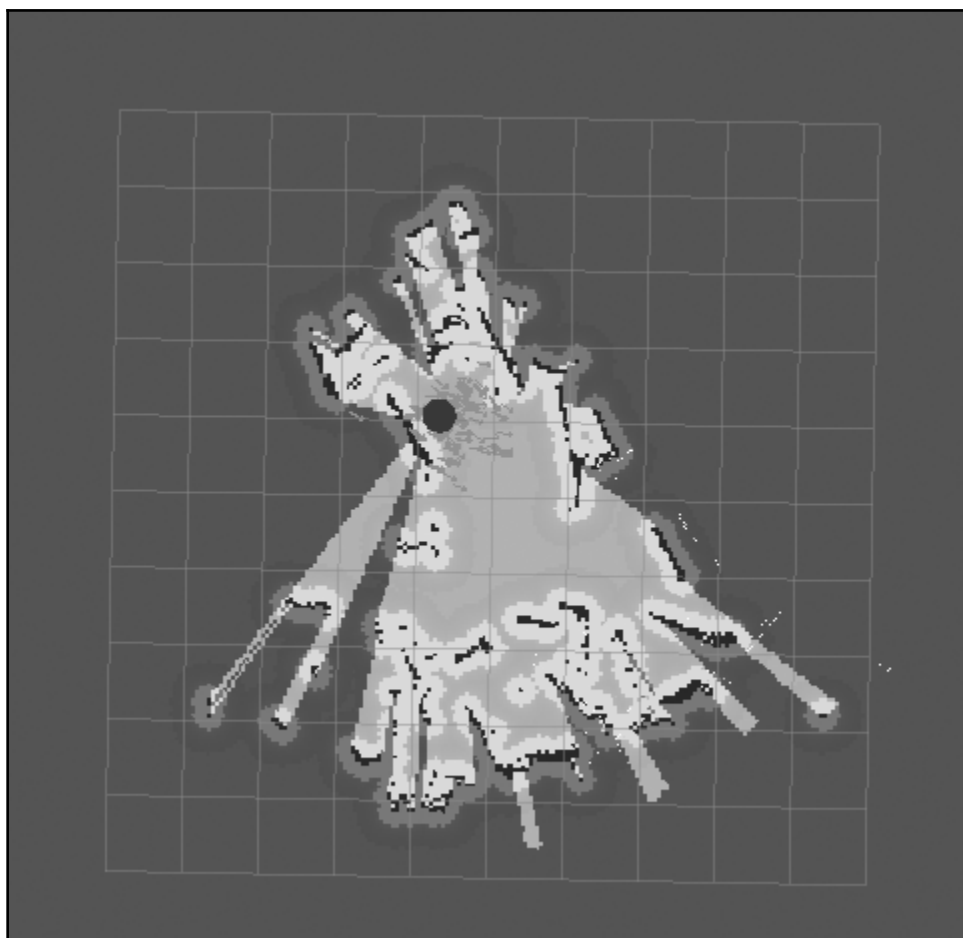
```
---
data: 16266, in: e    1    -1
---
data: 16267, in: u    10
---
data: 16268, in: s    0.00  0.00
---
```

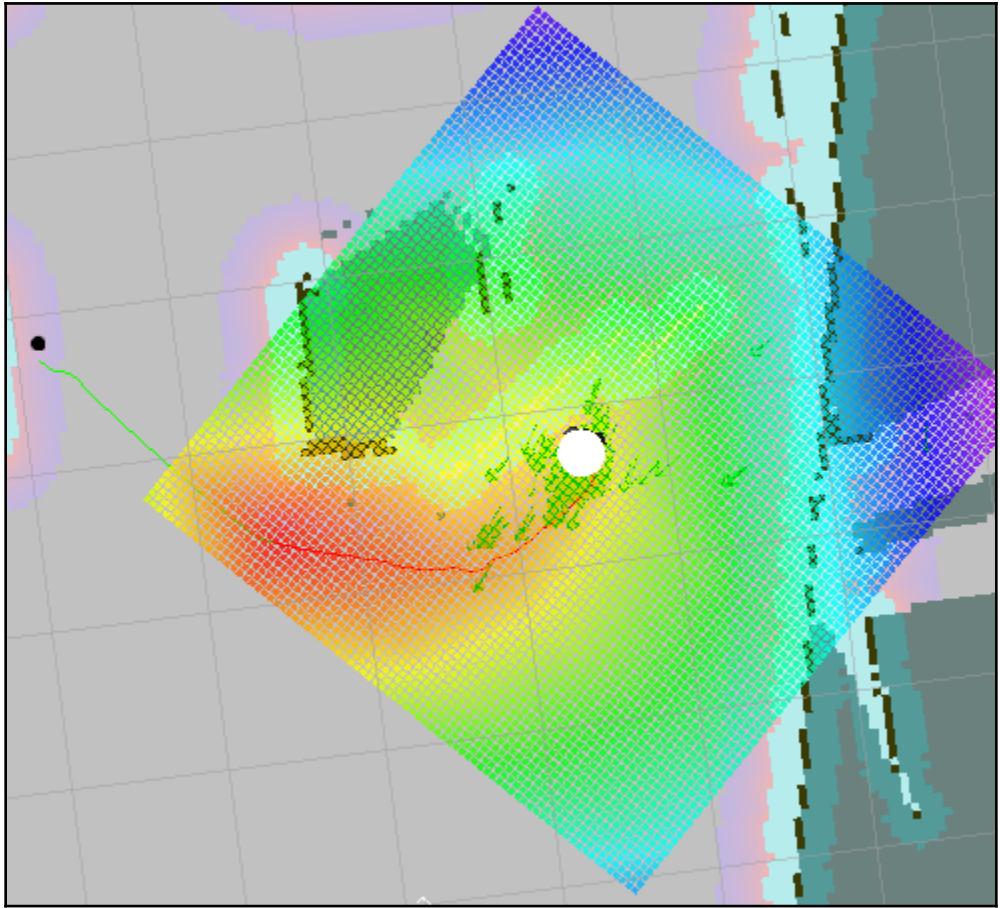




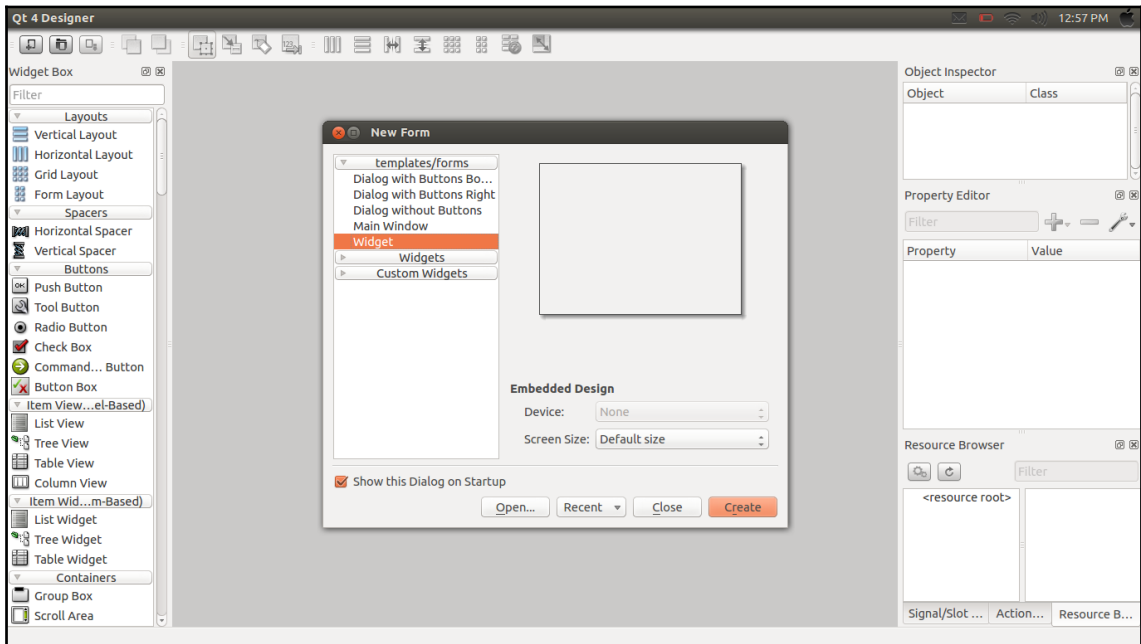
```
[ INFO] [1422618733.585407153]: Created local_planner dwa_local_planner/DWAPlaner
ROS
[ INFO] [1422618733.604762090]: Sim period is set to 0.20
[ INFO] [1422618735.208493249]: odom received!
```

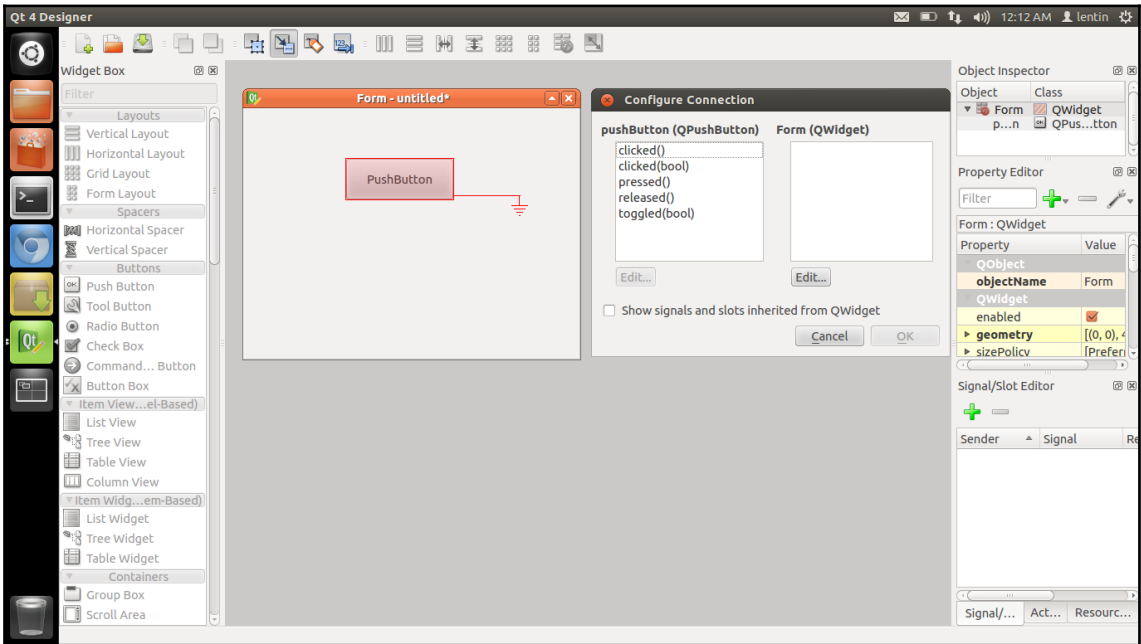
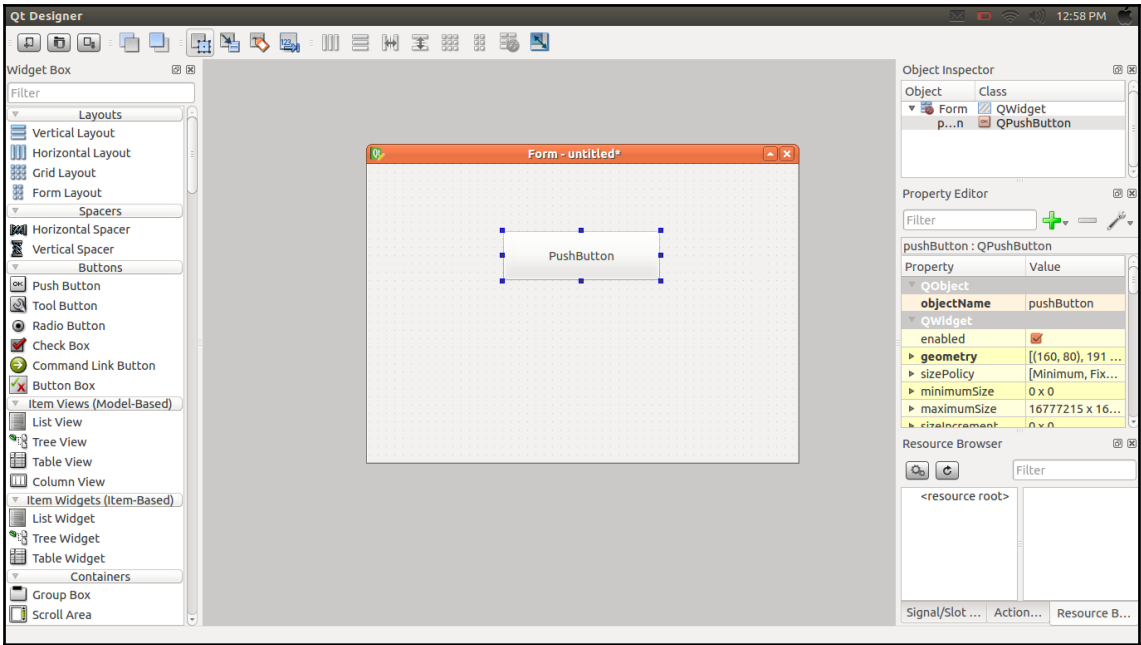


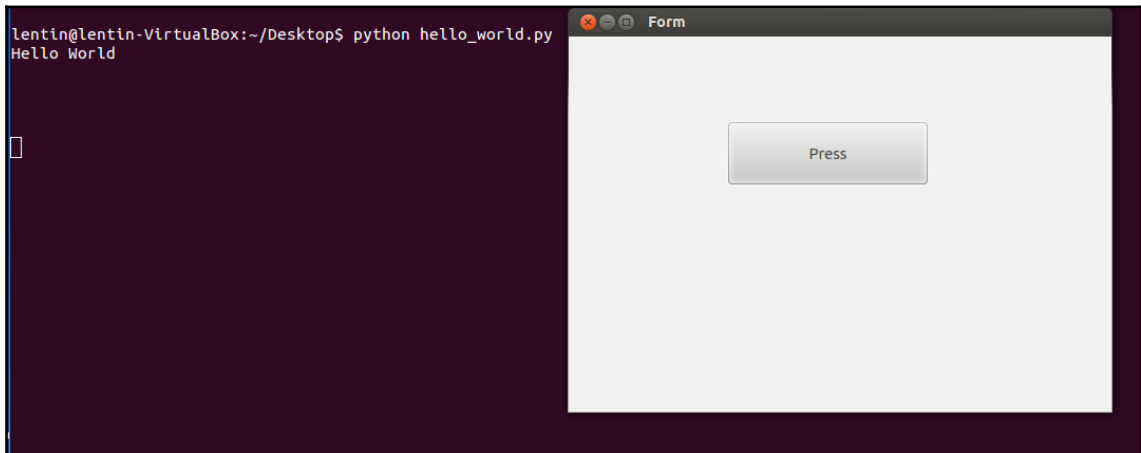
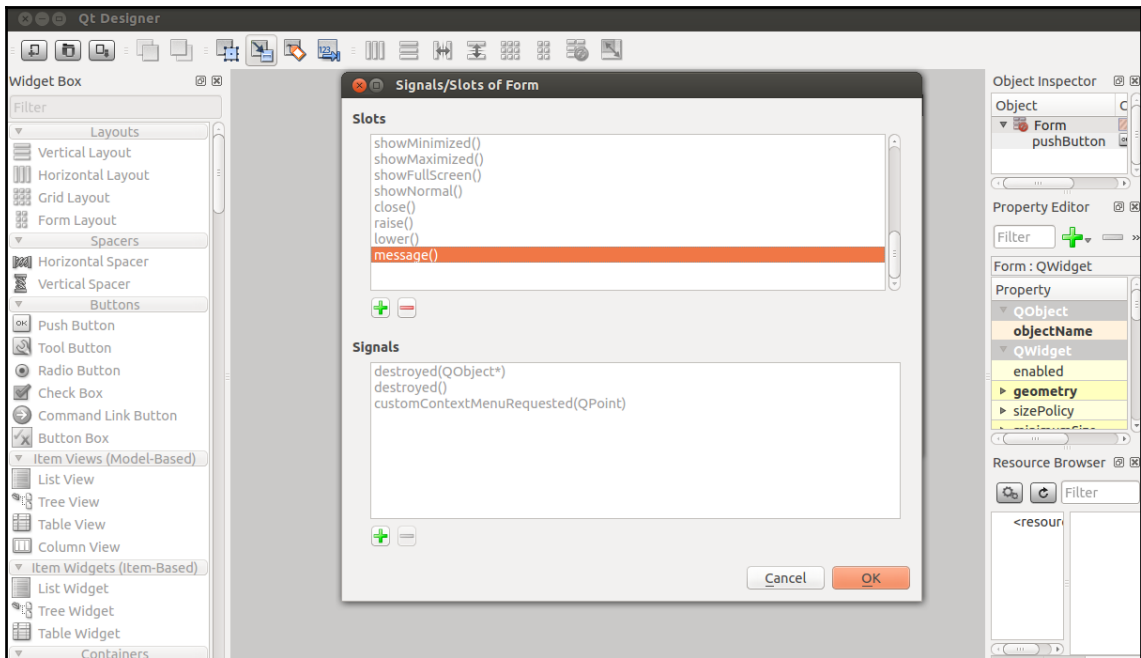


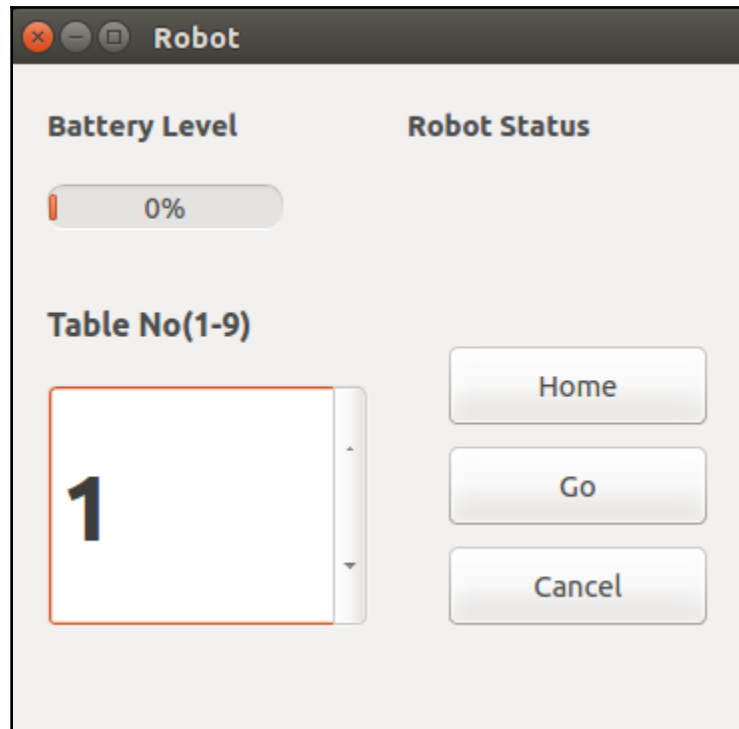


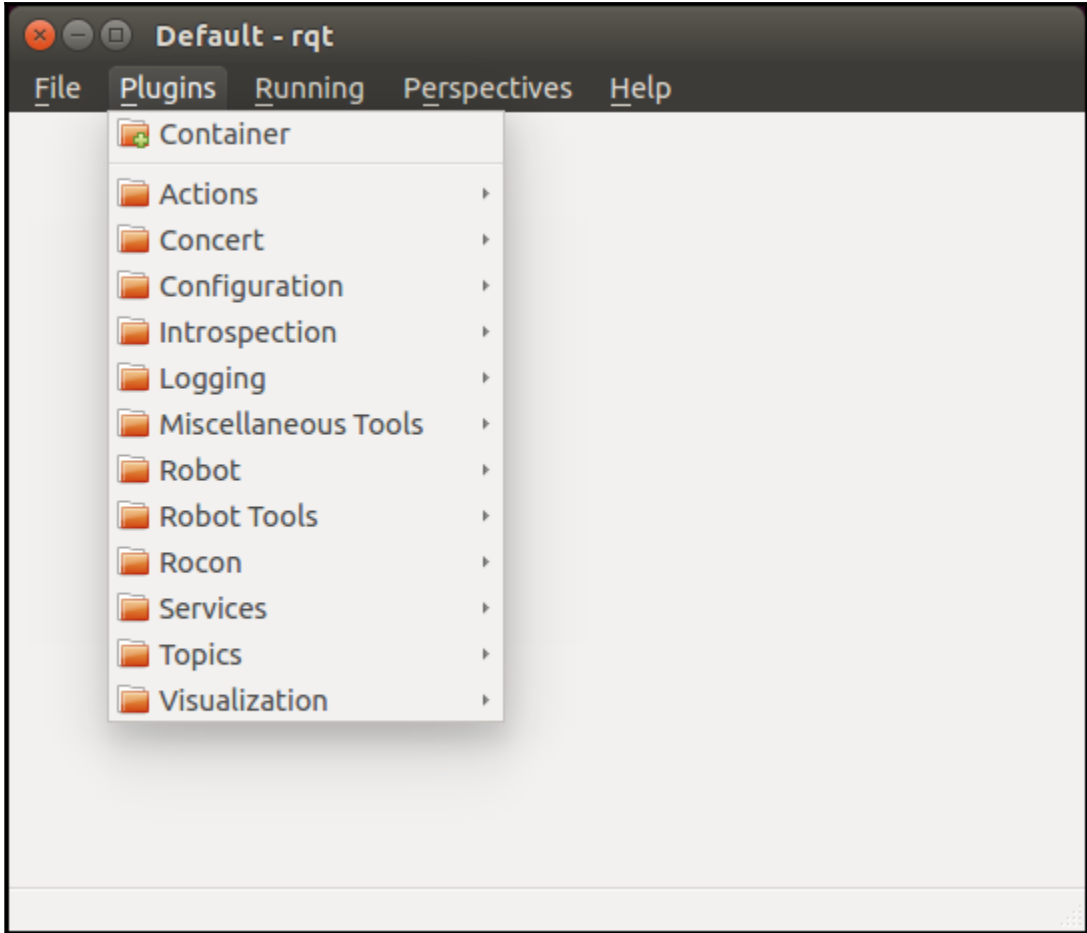
Chapter 8: Designing a GUI for a Robot Using Qt and Python











File Plugins Running Perspectives Help

Console Topic Monitor

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	Type	Bandwidth	Hz	Value
<input checked="" type="checkbox"/> /chatter	std_msgs/String	281.00B/s	10.04	
<input checked="" type="checkbox"/> data	string			'hello world 1424446308.4'
<input type="checkbox"/> /rosout	rosgraph_msgs/Log			not monitored
<input type="checkbox"/> /rosout_agg	rosgraph_msgs/Log			not monitored

Chapter 9: Getting Started with Robot Operating System

