Part I

Workspace

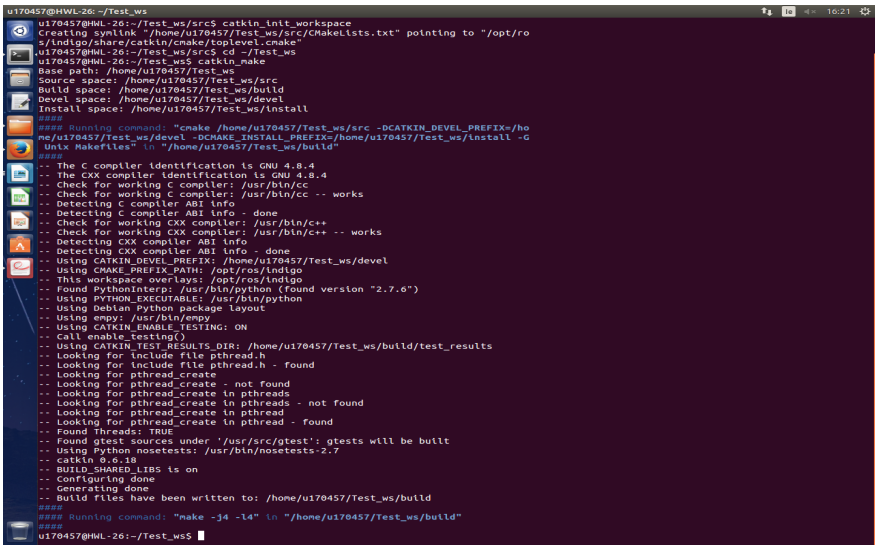
Before you start writing any ROS code, you need to set up a workspace for this code to live in. A workspace is simply a set of directories in which a related set of ROS code lives.
You can have multiple ROS workspaces, but you can only work in one of them at any one time

Getting set up

We are going to create a workspace called teleop. Within mobile robot navigation, tele-operated refers to a robot under the control of a joystick or other controlled device. To create a workspace Open a Terminal and type in the following:

```
$ source /opt/ros/indigo/setup.bash

$ mkdir -p ~/teleop_ws/src

$ cd ~/teleop_ws/src

$ catkin_init_workspace

$ cd ~/teleop_ws

$ catkin_make
```

Running catkin_make will generate a lot of output as it does its work. When it's done, you'll end up with two new directories: build and devel.



Package

ROS software is organized into packages, each of which contains some combination of code, data, and documentation. Packages sit inside workspaces, in the src directory.
Each package directory must include a CmakeLists.txt file and a package.xml file that describes the contents of the package and how catkin should interact with it.

Getting set up

To create a package is easy once we are in the src directory of our workspace.
The first argument, Teleop, is the name of the new package we want to create. The following arguments are the names of packages that the new package depends on.

```
$ source devel/setup.bash

$  cd ~/teleop_ws/src

$ catkin_create_pkg teleop rospy geometry_msgs sensor_msgs
```

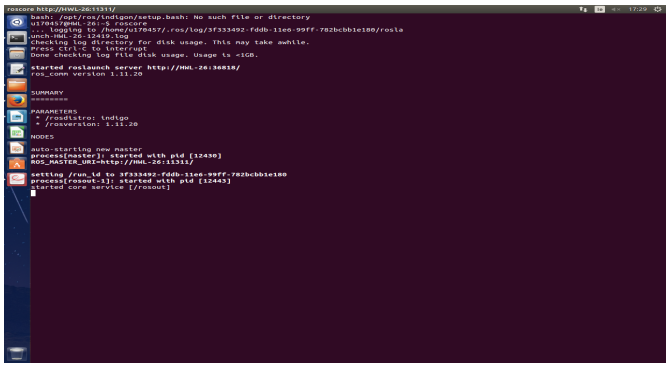
Part II

Lets Get Started

We are now going show how we can implement a number of features in ROS . All of these features will culminate with a sophisticated two dimensional navigation system that can display video of its surroundings as well as map out its environment. You are not expected to fully understand whats happening this serves as more of an introduction into what ROS can do.
We are going to be using a lot of different Terminals in this demo, so remember Ctrl-Alt-t is a shortcut to open a new Terminal.

Roscore and Simulation

First thing we are going to do is launch Roscore.You'll remember that roscore is the network that all the nodes communicate on and it is how we will send and receive data from out robot
Since we don't all have a mobile robot such as Turtlebot to ourselves we are going to simulate one in Gazebo



Open New Terminal T1

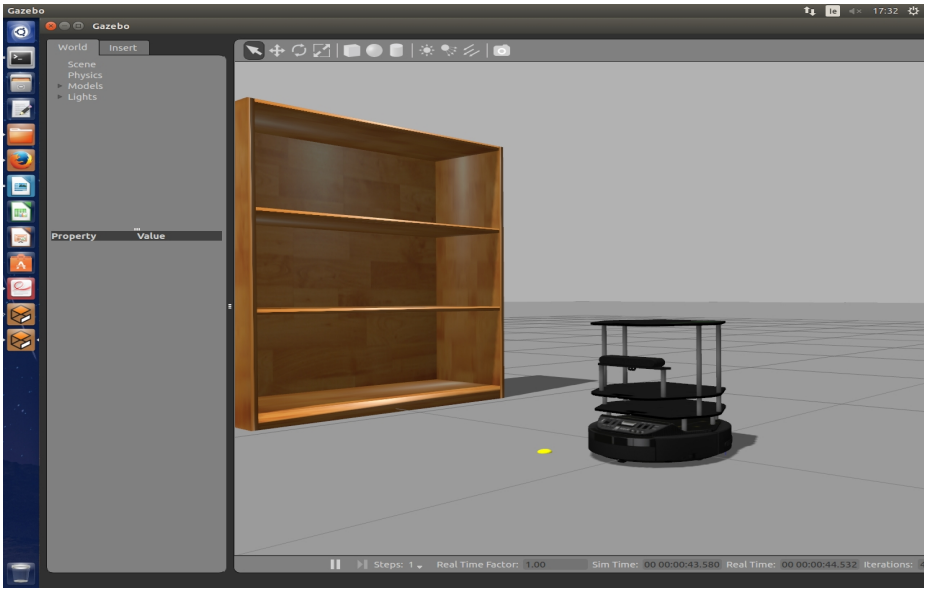
$ roscore

//" Minimize Terminal"

Open New Terminal T2

$ roslaunch turtlebot_gazebo turtlebot_world.launch

//" Minimize Terminal "



This will open up a pre-set simulation of a turtlebot environment that we can pass all of our messages to over Roscore
Take some time to familiarize your self with the camera controls


Program and Nodes

To get the robot we need to create and program two nodes.

1. A program that will publish our keyboard key strokes and broadcast them over Roscore
2. A program that will subscribe to the first programs message and apply the correct motion to it

In simple terms one Program to say *“I pressed the arrow up key ”* and one program to say *“the up arrow key means go forward”*

Save the following program as key_publisher.py in the file we created teleop_ws/

```
#!/usr/bin/env python
import sys, select, tty, termios
import rospy
from std_msgs.msg import String

if __name__ == '__main__':
        key_pub = rospy.Publisher('keys', String, queue_size=1)
        rospy.init_node("keyboard_driver")
        rate = rospy.Rate(100)

        old_attr = termios.tcgetattr(sys.stdin)
        tty.setcbreak(sys.stdin.fileno())

        print   "Publishing keystrokes. Press Ctrl-C to exit..."


        while   not     rospy.is_shutdown():
                if select.select([sys.stdin], [], [], 0)[0] == [sys.stdin]:
                        key_pub.publish(sys.stdin.read(1))
                rate.sleep()
        termios.tcsetattr(sys.stdin, termios.TCSADRAIN, old_attr)
```

This program uses the termios library to capture raw keystrokes, as soon as they are pressed. However it dose not support exteneded keys such as arrows keys ,these will result in std_msgs/String messages that are either weird symbols or multiple messages.


Save the following as keys_to_twist_with_ramps.py in the file we created teleop_ws/

```
#!/usr/bin/env python
import rospy
import math
from std_msgs.msg import String
from geometry_msgs.msg import Twist

key_mapping = { 'w':[ 0,1], 'x':[ 0, -1],'a':[ 1, 0], 'd': [-1, 0], 's': [ 0, 0] }
g_twist_pub = None
g_target_twist = None
g_last_twist = None
g_last_send_time = None
g_vel_scales = [0.1, 0.1] # default to very slow
g_vel_ramps = [1, 1]  # units: meters per second^2

def ramped_vel(v_prev, v_target, t_prev, t_now, ramp_rate):
                # compute maximum velocity step
                step = ramp_rate*(t_now - t_prev).to_sec()
                sign = 1.0 if (v_target > v_prev) else -1.0
                error = math.fabs(v_target - v_prev)
                if error < step: # we can get there within this timestep-we're done.
                        return  v_target
                else:
                        return  v_prev + sign*step # take a step toward the target

def ramped_twist(prev, target, t_prev, t_now, ramps):
                tw = Twist()
                tw.angular.z = ramped_vel(prev.angular.z, target.angular.z, t_prev, t_now, ramps[0])
                tw.linear.x = ramped_vel(prev.linear.x, target.linear.x, t_prev,t_now, ramps[1])
                return tw

def send_twist():
        global g_last_twist_send_time, g_target_twist, g_last_twist, g_vel_scales, g_vel_ramps, g_twist_pub
        t_now = rospy.Time.now()
        g_last_twist = ramped_twist(g_last_twist,g_target_twist, g_last_twist_send_time, t_now, g_vel_ramps)
        g_last_twist_send_time = t_now
        g_twist_pub.publish(g_last_twist)

def keys_cb(msg):
        global g_target_twist, g_last_twist, g_vel_scales
        if len(msg.data) == 0 or not key_mapping.has_key(msg.data[0]):
                return  # unknown key
        vels = key_mapping[msg.data[0]]
        g_target_twist.angular.z = vels[0]*g_vel_scales[0]
        g_target_twist.linear.x = vels[1]*g_vel_scales[1]

def fetch_param(name, default):
        if rospy.has_param(name):
                return rospy.get_param(name)
        else:
                print "parameter [%s] not defined. Defaulting to %.3f"  % (name, default)
                return default
if __name__ == '__main__':
                rospy.init_node('keys_to_twist')
                g_last_twist_send_time = rospy.Time.now()
                g_twist_pub = rospy.Publisher('cmd_vel', Twist, queue_size=1)
                rospy.Subscriber('keys', String, keys_cb)
                g_target_twist = Twist() # initializes to zero
                g_last_twist = Twist()
                g_vel_scales[0] = fetch_param('~angular_scale', 0.5)
                g_vel_scales[1] = fetch_param('~linear_scale', 0.5)
                g_vel_ramps[0] = fetch_param('~angular_accel', 1.0)
                g_vel_ramps[1] = fetch_param('~linear_accel', 1.0)
                rate = rospy.Rate(20)
                while not rospy.is_shutdown():
                                send_twist()
                                rate.sleep()
```


Lets get moving

Open New Terminal T3

$ cd teleopbot_ws

$ ./key_publisher.py

//"Right Click on the top of this terminal and click Always on top "

//"This terminal is important and we will be coming back to this "

Open New Terminal T4

$ cd teleopbot_ws

$ ./keys_to_twist_with_ramps.py cmd_vel:=cmd_vel_mux/input/teleop

//" Minimize"

Open Terminal 3 again

//" Using w,x the robot will move forward and back"

//" Using a,d the robot will rotate"

//" Using s the robot will stop"