ROS Noetic Assignment — Differential-Drive Kinematics on turtlesim

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GitHub - shreyaavinod/Assignment-2-ROS1-TURTLESIM-DIFFERENTIAL-DRIVE-SYSTEM

NODES TO BE IMPLEMENTED:

fk_wheels_to_twist.cpp

- Sub: ~wheel_vel_in → WheelVel
- Pub: /turtle1/cmd_vel → Twist
- Implements FK.

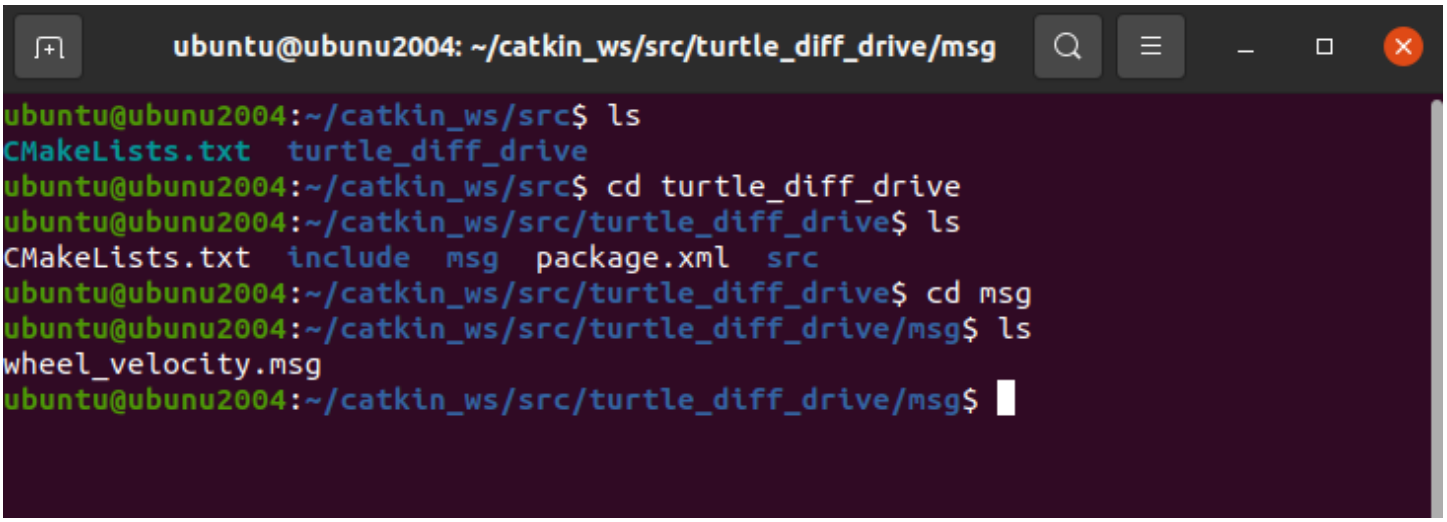
go_to_goal_controller.cpp

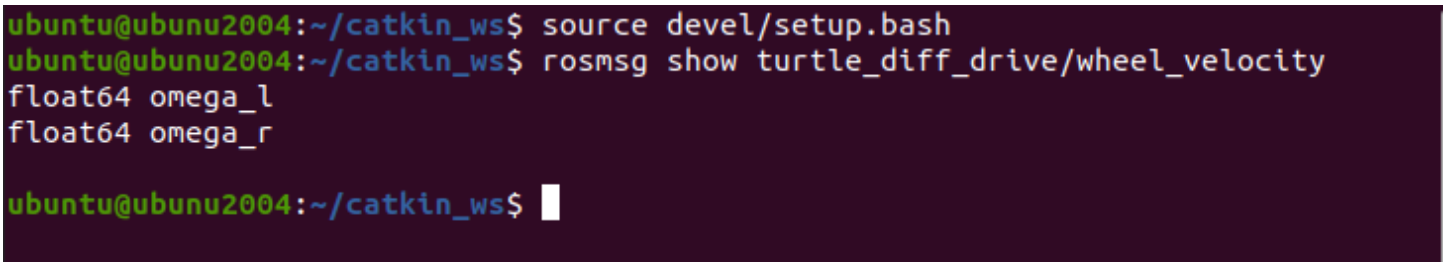
- Sub: /turtle1/pose
- Pub: /turtle1/cmd_vel → Twist
- Implements IK.
- Pub: ~wheel_vel_dbg → WheelVel (from IK)
- Implements proportional controller.

1. fk_wheels_to_twist.cpp

wheel_velocity_pub.cpp

a. This node published to the **topic - wheel_vel** - it publishes the **message - wheel_velocity (omega_l,omega_r)** the left and right wheel velocities of the differential drive system resp.
b. First created a **catkin_ws** - with the package **turtle_diff_drive** which contains all the nodes which are to be implemented.
c. In the package first created **subdirectory - msg** in which the custom msg type was defined **wheel_velocity.msg with omega_l, omega_r.**
d. Compilation using catkin_make was successful and after modifying CMakeLists.txt and package.xml, sourcing the setup.bash ros custom msg type was displayed.





wheel_velocity_pub.cpp

a. This node publishes constant values for left and right wheel velocity - **omega_l = 12 rad/s and omega_r = 8 rad/s** (used unequal quantities to demonstrate circular motion- experimented using equal values for demonstrating linear motion as well).
b. This node published the **msg of type wheel_velocity to the topic - wheel_vel.**

```
turtle_diff_drive::wheel_velocity msg;
msg.omega_l=12;
msg.omega_r=8;
```

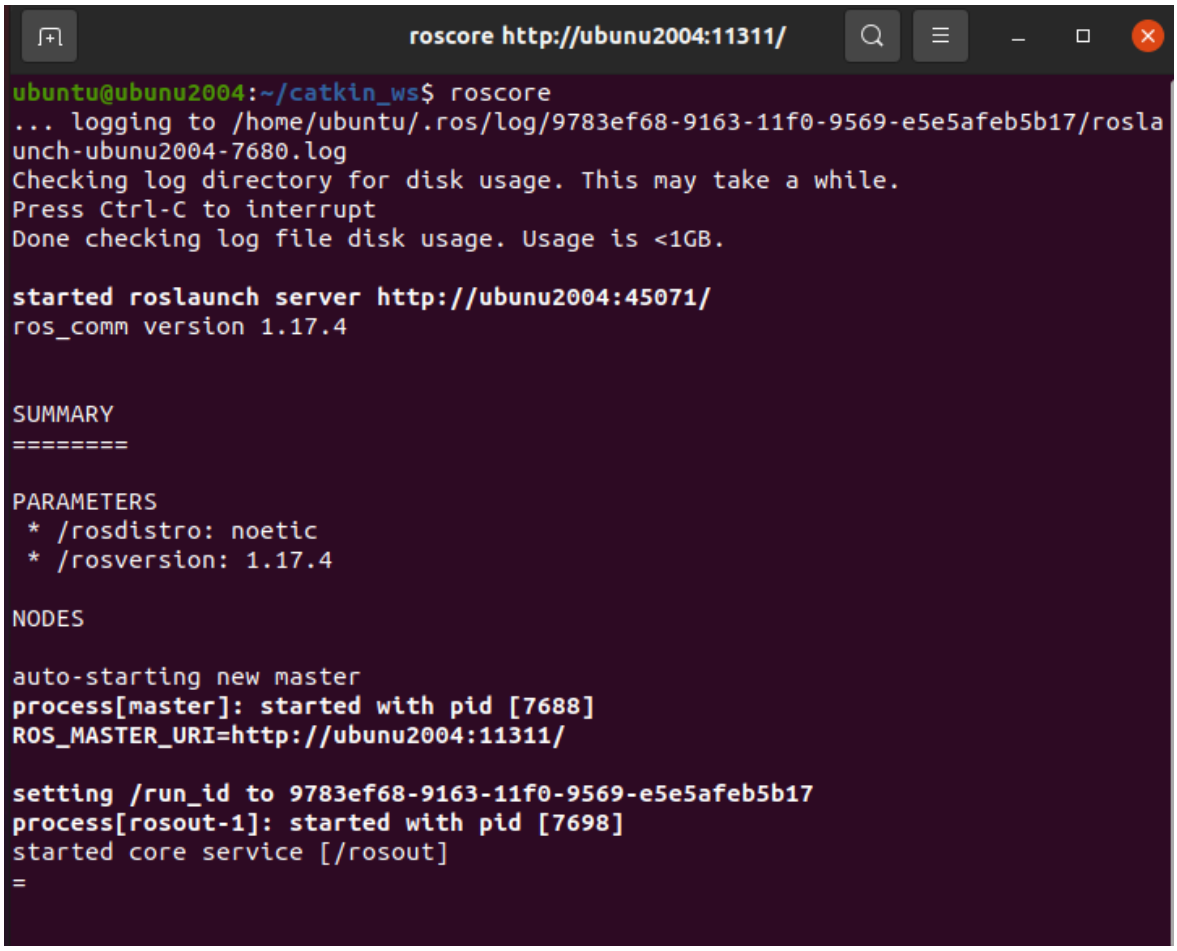
fk_wheels_to_twist.cpp

a. This node subscribes to the **topic wheel_vel** and listens to the msgs published by the **wheel_velocity_pub node.**
b. In this node - the linear and angular velocities v and w which are **the message fields of the message type std_msgs/Twist** were calculated using the formula given with constant wheel radius =0.05m and axle length =0.20 m.
c. This message of type std_msgs/Twist was then **published to the topic turtle1/cmd_vel** which the turtlesim_node listens to and responds.

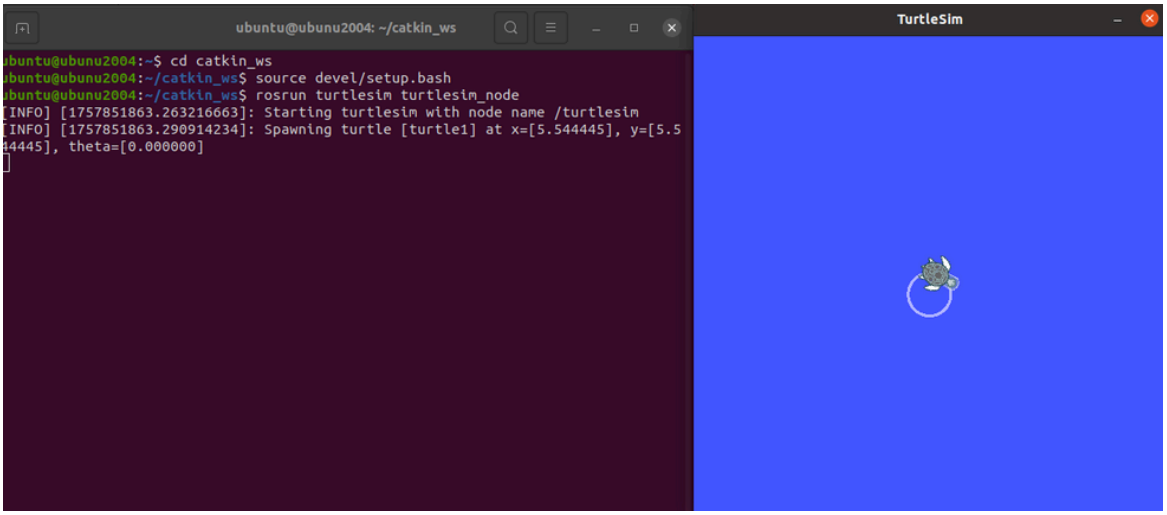
Successful build using catkin_make command

```
ubuntu@ubunu2004:~/catkin_ws$ catkin_make
Base path: /home/ubuntu/catkin_ws
Source space: /home/ubuntu/catkin_ws/src
Build space: /home/ubuntu/catkin_ws/build
Devel space: /home/ubuntu/catkin_ws/devel
Install space: /home/ubuntu/catkin_ws/install
####
#### Running command: "make cmake_check_build_system" in "/home/ubuntu/catkin_ws/build"
####
####
#### Running command: "make -j8 -l8" in "/home/ubuntu/catkin_ws/build"
####
[  0%] Built target geometry_msgs_generate_messages_py
[  0%] Built target geometry_msgs_generate_messages_nodejs
[  0%] Built target std_msgs_generate_messages_py
[  0%] Built target std_msgs_generate_messages_nodejs
[  0%] Built target std_msgs_generate_messages_eus
[  0%] Built target roscpp_generate_messages_lisp
[  0%] Built target geometry_msgs_generate_messages_eus
[  0%] Built target rosgraph_msgs_generate_messages_py
[  0%] Built target roscpp_generate_messages_eus
[  0%] Built target rosgraph_msgs_generate_messages_cpp
[  0%] Built target geometry_msgs_generate_messages_cpp
[  0%] Built target geometry_msgs_generate_messages_lisp
[  0%] Built target rosgraph_msgs_generate_messages_eus
[  0%] Built target std_msgs_generate_messages_cpp
[  0%] Built target _turtle_diff_drive_generate_messages_check_deps_wheel_velocity
[  0%] Built target rosgraph_msgs_generate_messages_lisp
[  0%] Built target roscpp_generate_messages_nodejs
[  0%] Built target roscpp_generate_messages_py
[  0%] Built target std_msgs_generate_messages_lisp
[  0%] Built target rosgraph_msgs_generate_messages_nodejs
[  0%] Built target roscpp_generate_messages_cpp
[  7%] Built target turtle_diff_drive_generate_messages_nodejs
[ 23%] Built target turtle_diff_drive_generate_messages_py
[ 38%] Built target turtle_diff_drive_generate_messages_eus
[ 46%] Built target turtle_diff_drive_generate_messages_cpp
[ 53%] Built target turtle_diff_drive_generate_messages_lisp
[ 53%] Built target turtle_diff_drive_generate_messages
[ 69%] Built target go_to_goal_controller
[ 84%] Built target fk_wheels_to_twist
[100%] Built target wheel_velocity_pub
ubuntu@ubunu2004:~/catkin_ws$
```

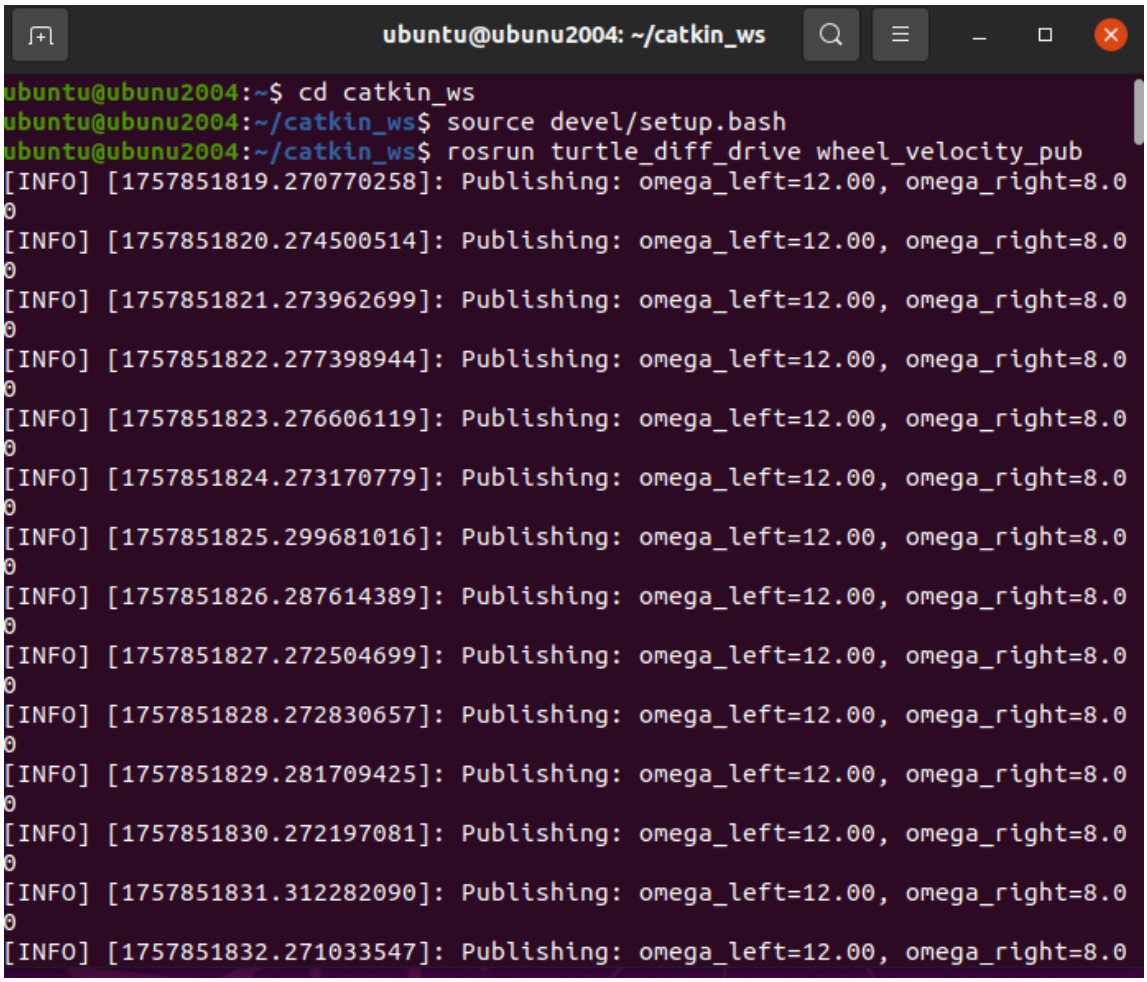
EXECUTION:



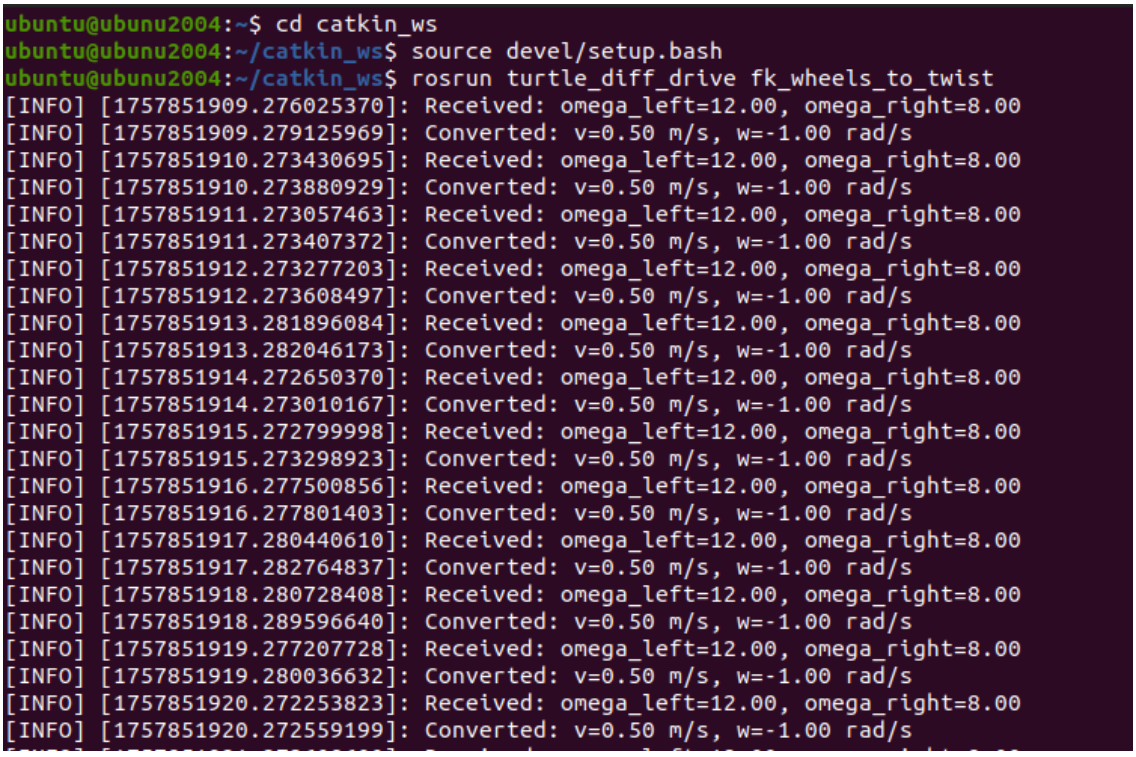
Turtlesim node :



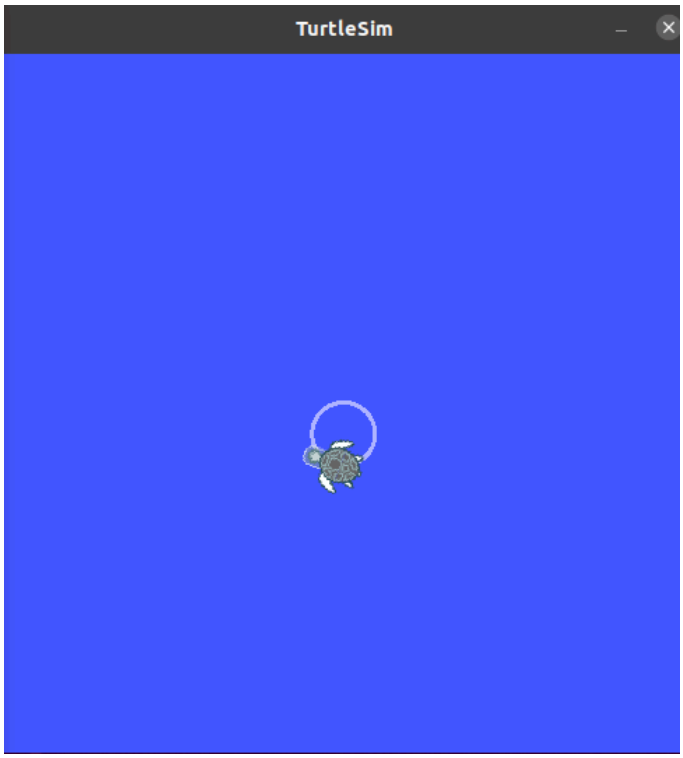
wheel_velocity_pub node:



fk_wheels_to_twist node:



Turtlesim output:



2.go_to_goal_controller.cpp

1. the go_to_goal_controller.cpp subscribed to the **topic turtle1/pose in which the position of the turtle was continuously published.**
2. The message fields of the message type turtlesim/pose were -
   a. x
   b. y
   c. theta
3. The goal position was defined by **x_g, y_g, theta_g.**
4. **In the** go_to_goal_controller node the Euclidean distance was calculated followed by calculation of the euclidean vector's orientation wrt x axis and final orientation using the formulae.
5. The controller gains given were then used to find the linear and angular velocities according to the control law.

Successful navigation to the goal point was demonstrated when x_g, y_g and theta were given values 9,8,0.9 rad resp.

EXECUTION

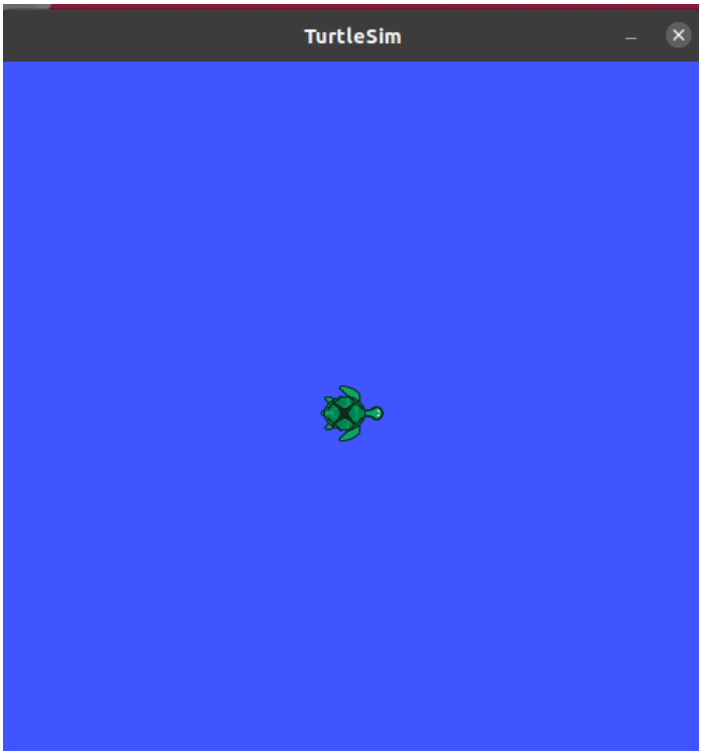
roscore

```
ubuntu@ubunu2004:~/catkin_ws$ roscore
... logging to /home/ubuntu/.ros/log/36f64af8-9166-11f0-9569-e5e5afeb5b17/roslaunch-ubunu2004-8191.log
Checking log directory for disk usage. This may take a while.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://ubunu2004:43765/
ros_comm version 1.17.4


SUMMARY
========

PARAMETERS
 * /rosdistro: noetic
 * /rosversion: 1.17.4

NODES

auto-starting new master
process[master]: started with pid [8199]
ROS_MASTER_URI=http://ubunu2004:11311/

setting /run_id to 36f64af8-9166-11f0-9569-e5e5afeb5b17
process[rosout-1]: started with pid [8209]
started core service [/rosout]
```

turtlesim_node:

```
ubuntu@ubunu2004:~$ cd catkin_ws
ubuntu@ubunu2004:~/catkin_ws$ source devel/setup.bash
ubuntu@ubunu2004:~/catkin_ws$ rosrun turtlesim turtlesim_node
[INFO] [1757852891.354347925]: Starting turtlesim with node name /turtlesim
[INFO] [1757852891.381683889]: Spawning turtle [turtle1] at x=[5.544445], y=[5.544445], theta=[0.000000]
```

initial orientation of turtle:



go_to_goal_controller node

```
ubuntu@ubunu2004:~$ cd catkin_ws
ubuntu@ubunu2004:~/catkin_ws$ source devel/setup.bash
ubuntu@ubunu2004:~/catkin_ws$ rosrun turtle_diff_drive go_to_goal_controller
[INFO] [1757853027.412247101]: Pose received: x=5.54, y=5.54, theta=0.00
[INFO] [1757853027.415934230]: Converted: v=6.36 m/s, w=2.19 rad/s
[INFO] [1757853027.428092283]: Pose received: x=5.54, y=5.54, theta=0.00
[INFO] [1757853027.428534237]: Converted: v=6.36 m/s, w=2.19 rad/s
[INFO] [1757853027.459249044]: Pose received: x=5.54, y=5.54, theta=0.00
[INFO] [1757853027.459611407]: Converted: v=6.36 m/s, w=2.19 rad/s
[INFO] [1757853027.474305103]: Pose received: x=5.54, y=5.54, theta=0.00
[INFO] [1757853027.474539150]: Converted: v=6.36 m/s, w=2.19 rad/s
[INFO] [1757853027.490863142]: Pose received: x=5.54, y=5.54, theta=0.00
[INFO] [1757853027.491410814]: Converted: v=6.36 m/s, w=2.19 rad/s
[INFO] [1757853027.507243202]: Pose received: x=5.54, y=5.54, theta=0.00
[INFO] [1757853027.508218611]: Converted: v=6.36 m/s, w=2.19 rad/s
[INFO] [1757853027.536195351]: Pose received: x=5.65, y=5.55, theta=0.04
[INFO] [1757853027.547908715]: Converted: v=6.23 m/s, w=2.12 rad/s
[INFO] [1757853027.553112039]: Pose received: x=5.75, y=5.56, theta=0.07
[INFO] [1757853027.553181428]: Converted: v=6.10 m/s, w=2.04 rad/s
[INFO] [1757853027.559079060]: Pose received: x=5.84, y=5.57, theta=0.10
[INFO] [1757853027.571499355]: Converted: v=5.98 m/s, w=1.98 rad/s
[INFO] [1757853027.573424012]: Pose received: x=5.94, y=5.58, theta=0.13
[INFO] [1757853027.578700853]: Converted: v=5.85 m/s, w=1.91 rad/s
[INFO] [1757853027.589404088]: Pose received: x=6.03, y=5.59, theta=0.16
[INFO] [1757853027.590088601]: Converted: v=5.73 m/s, w=1.85 rad/s
[INFO] [1757853027.610933158]: Pose received: x=6.12, y=5.61, theta=0.19
[INFO] [1757853027.614766798]: Converted: v=5.61 m/s, w=1.79 rad/s
[INFO] [1757853027.624612670]: Pose received: x=6.21, y=5.63, theta=0.22
[INFO] [1757853027.624931134]: Converted: v=5.49 m/s, w=1.73 rad/s
[INFO] [1757853027.634555025]: Pose received: x=6.29, y=5.65, theta=0.25
[INFO] [1757853027.634659210]: Converted: v=5.37 m/s, w=1.67 rad/s
[INFO] [1757853027.652666011]: Pose received: x=6.38, y=5.68, theta=0.28
[INFO] [1757853027.653131990]: Converted: v=5.26 m/s, w=1.62 rad/s
[INFO] [1757853027.669299643]: Pose received: x=6.46, y=5.70, theta=0.30
[INFO] [1757853027.669827217]: Converted: v=5.14 m/s, w=1.56 rad/s
[INFO] [1757853027.686550176]: Pose received: x=6.54, y=5.73, theta=0.33
[INFO] [1757853027.686908995]: Converted: v=5.03 m/s, w=1.51 rad/s
[INFO] [1757853027.704458366]: Pose received: x=6.61, y=5.76, theta=0.35
[INFO] [1757853027.705159345]: Converted: v=4.92 m/s, w=1.46 rad/s
[INFO] [1757853027.714324246]: Pose received: x=6.68, y=5.78, theta=0.38
[INFO] [1757853027.721500128]: Converted: v=4.81 m/s, w=1.41 rad/s
[INFO] [1757853027.733010446]: Pose received: x=6.75, y=5.81, theta=0.40
[INFO] [1757853027.733420390]: Converted: v=4.70 m/s, w=1.37 rad/s
[INFO] [1757853027.749101476]: Pose received: x=6.82, y=5.85, theta=0.42
[INFO] [1757853027.756834671]: Converted: v=4.59 m/s, w=1.32 rad/s
[INFO] [1757853027.766580224]: Pose received: x=6.89, y=5.88, theta=0.44
[INFO] [1757853027.768036129]: Converted: v=4.49 m/s, w=1.28 rad/s
```