

ROS Noetic Assignment — Differential-Drive Kinematics on turtlesim

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Nodes to Implement

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

- 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.
- First created a **catkin_ws** - with the package **turtle_diff_drive** which contains all the nodes which are to be implemented.
- In the package first created **subdirectory - msg** in which the custom msg type was defined **wheel_velocity.msg** with **omega_l, omega_r**.
- Compilation using **catkin_make** was successful and after modifying CMakeLists.txt and package.xml, sourcing the setup.bash ros custom msg type was displayed.

The image shows two terminal windows side-by-side. The top window is in the directory `~/catkin_ws/src/turtle_diff_drive/msg`. It lists files: `assignment1.zip`, `build`, `devel`, `src`, and `wheel_velocity.msg`. The bottom window is in the directory `~/catkin_ws`. It shows the command `source devel/setup.bash` being run, followed by `rosmsg show turtle_diff_drive/wheel_velocity`, which displays the message definition:

```
float64 omega_l
float64 omega_r
```

wheel_velocity_pub.cpp

- 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).
- 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

- This node subscribes to the **topic wheel_vel** and listens to the msgs published by the **wheel_velocity_pub node**.
- 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.
- 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

```
Scanning dependencies of target std_msgs_generate_messages_cpp
[ 11x] Built target rosgraph_msgs_generate_messages_cpp
[ 11x] Built target std_msgs_generate_messages_cpp
Scanning dependencies of target rosgraph_msgs_generate_messages_eus
Scanning dependencies of target rosgraph_msgs_generate_messages_lisp
[ 11x] Built target rosgraph_msgs_generate_messages_eus
[ 11x] Built target rosgraph_msgs_generate_messages_lisp
Scanning dependencies of target rospp_generate_messages_lisp
Scanning dependencies of target rosgraph_msgs_generate_messages_py
[ 11x] Built target rospp_generate_messages_lisp
[ 11x] Built target rosgraph_msgs_generate_messages_py
Scanning dependencies of target geometry_msgs_generate_messages_py
Scanning dependencies of target geometry_msgs_generate_messages_nodejs
[ 11x] Built target geometry_msgs_generate_messages_py
[ 11x] Built target geometry_msgs_generate_messages_nodejs
Scanning dependencies of target geometry_msgs_generate_messages_eus
[ 11x] Built target geometry_msgs_generate_messages_eus
Scanning dependencies of target geometry_msgs_generate_messages_cpp
Scanning dependencies of target turtle_diff_drive_generate_messages_lisp
[ 11x] Built target geometry_msgs_generate_messages_cpp
[ 17x] Generating Lisp code from turtle_diff_drive/wheel_velocity.msg
Scanning dependencies of target turtle_diff_drive_generate_messages_py
[ 23x] Generating Python msg from MSG turtle_diff_drive/wheel_velocity
[ 23x] Built target turtle_diff_drive_generate_messages_lisp
Scanning dependencies of target turtle_diff_drive_generate_messages_nodejs
[ 29x] Generating Javascript code from turtle_diff_drive/wheel_velocity.msg
[ 29x] Built target turtle_diff_drive_generate_messages_nodejs
Scanning dependencies of target turtle_diff_drive_generate_messages_cpp
[ 35x] Generating C++ code from turtle_diff_drive/wheel_velocity.msg
[ 41x] Generating Python msg __init__.py for turtle_diff_drive
[ 41x] Built target turtle_diff_drive_generate_messages_cpp
Scanning dependencies of target turtle_diff_drive_generate_messages_eus
[ 47x] Generating Euslisp code from turtle_diff_drive/wheel_velocity.msg
[ 52x] Generating Euslisp manifest code for turtle_diff_drive
[ 52x] Built target turtle_diff_drive_generate_messages_py
[ 52x] Built target turtle_diff_drive_generate_messages_eus
Scanning dependencies of target go_to_goal_controller
Scanning dependencies of target wheel_velocity_pub
[ 58x] Building CXX object turtle_diff_drive/CMakeFiles/go_to_goal_controller.dir/src/go_to_goal_controller.cpp.o
[ 64x] Building CXX object turtle_diff_drive/CMakeFiles/wheel_velocity_pub.dir/src/wheel_velocity_pub.cpp.o
[ 70x] Linking CXX executable /home/neo/catkin_ws/devel/lib/roslaunch_simulator
[ 76x] Linking CXX executable /home/neo/catkin_ws/devel/lib/roslaunch_controller
[ 76x] Built target simulator
Scanning dependencies of target turtle_diff_drive_generate_messages
[ 76x] Built target turtle_diff_drive_generate_messages
Scanning dependencies of target fk_wheels_to_twist
[ 82x] Building CXX object turtle_diff_drive/CMakeFiles/fk_wheels_to_twist.dir/src/fk_wheels_to_twist.cpp.o
[ 82x] Built target controller
[ 88x] Linking CXX executable /home/neo/catkin_ws/devel/lib/turtle_diff_drive/wheel_velocity_pub
[ 88x] Built target wheel_velocity_pub
[ 94x] Linking CXX executable /home/neo/catkin_ws/devel/lib/turtle_diff_drive/go_to_goal_controller
[ 94x] Built target go_to_goal_controller
[100x] Linking CXX executable /home/neo/catkin_ws/devel/lib/turtle_diff_drive/fk_wheels_to_twist
[100x] Built target fk_wheels_to_twist
neo@neo-VirtualBox:~/catkin_ws$ source devel/setup.bash
neo@neo-VirtualBox:~/catkin_ws$
```

EXECUTION:

```
s Terminal ▾ Nov 29 08:  
 roscore http://neo-VirtualBox:11311/  
  
Press Ctrl-C to interrupt  
Done checking log file disk usage. Usage is <1GB.  
  
started roslaunch server http://neo-VirtualBox:34775/  
ros_comm version 1.17.4  
  
SUMMARY  
=====
```

PARAMETERS

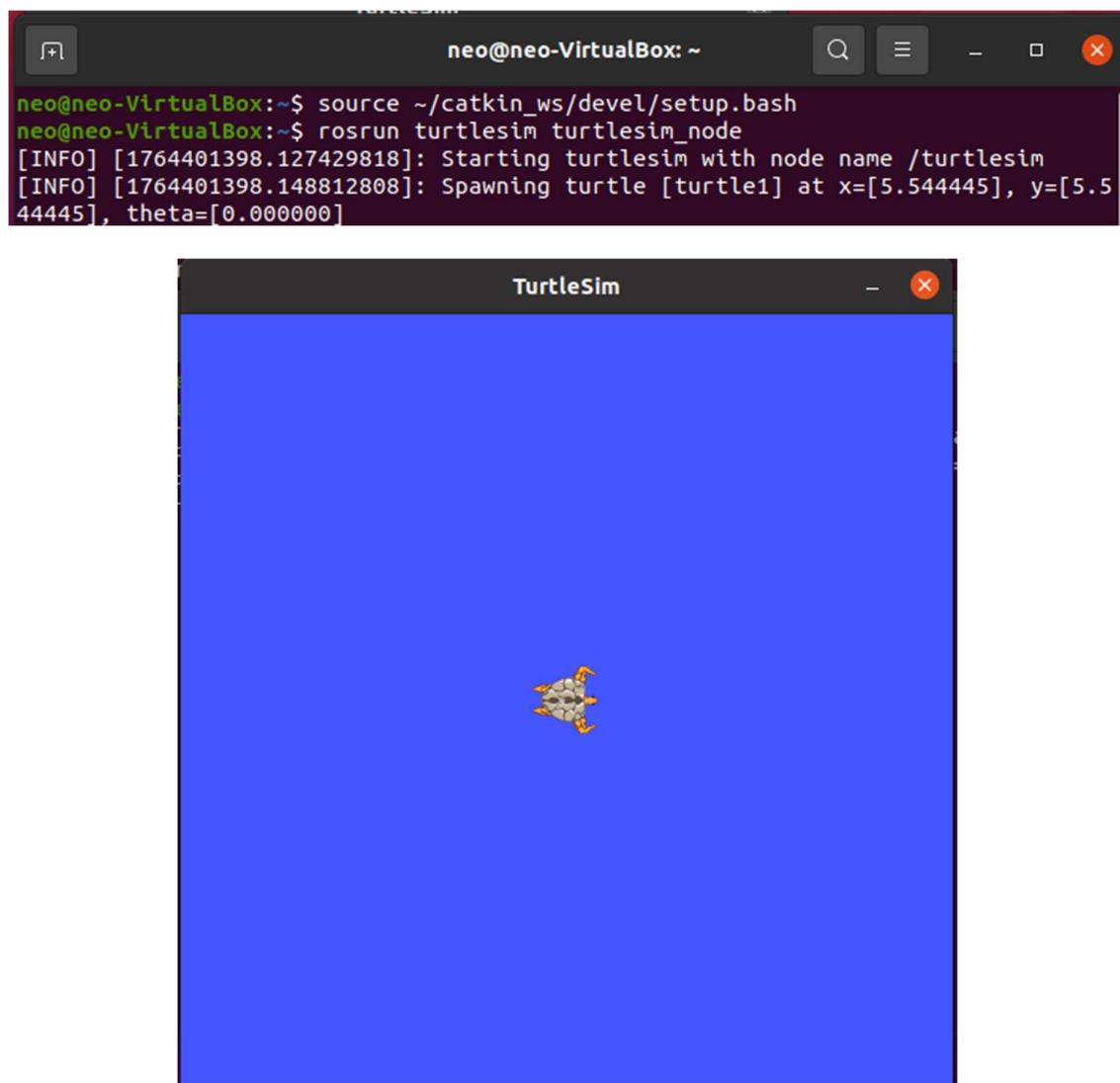
- * /rosdistro: noetic
- * /rosversion: 1.17.4

NODES

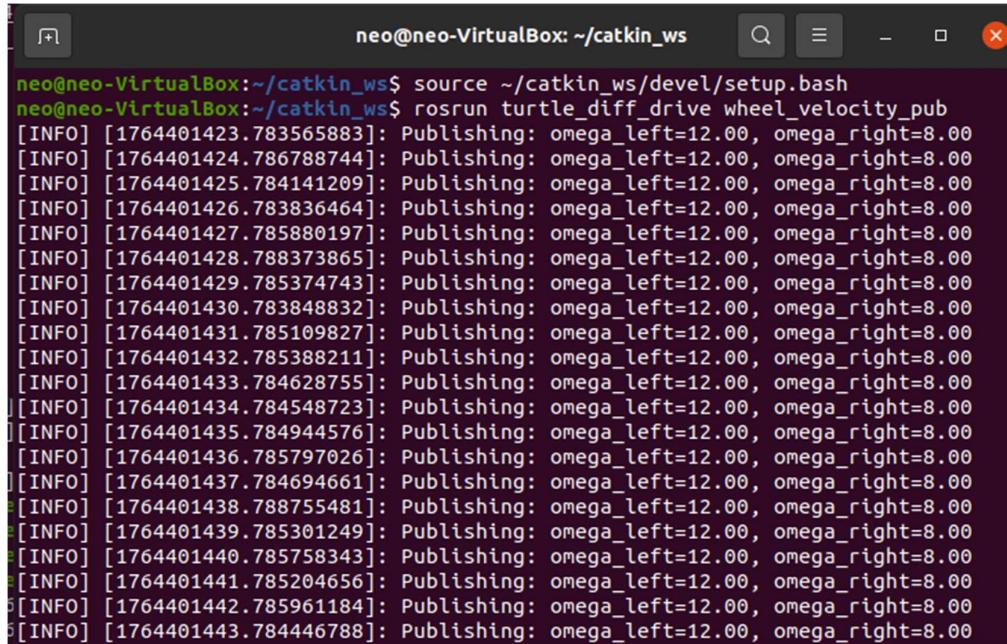
auto-starting new master
process[master]: started with pid [3622]
ROS_MASTER_URI=http://neo-VirtualBox:11311/

setting /run_id to d59ad87c-cccb-11f0-be6f-a1509f300256
process[rosout-1]: started with pid [3632]
started core service [/rosout]

Turtlesim node :



wheel_velocity_pub node:

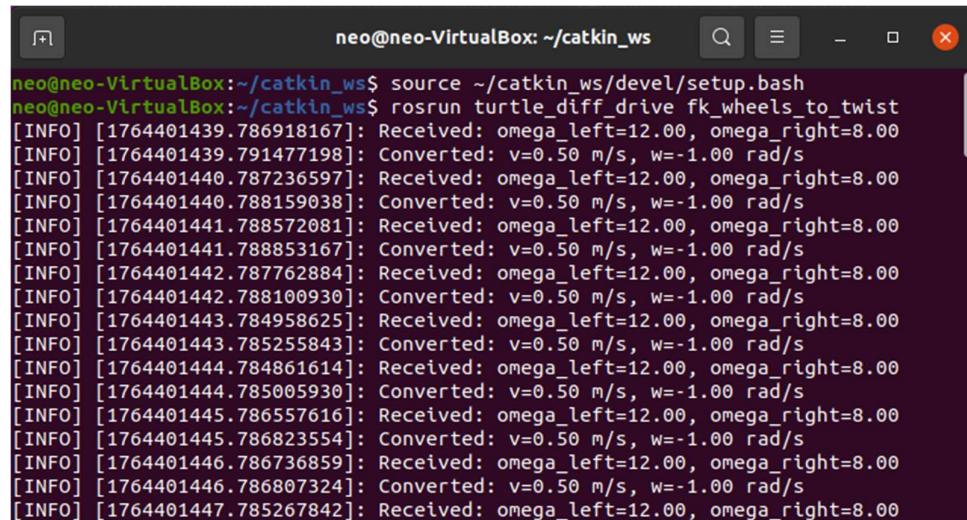


```

neo@neo-VirtualBox:~/catkin_ws$ source ~/catkin_ws/devel/setup.bash
neo@neo-VirtualBox:~/catkin_ws$ rosrun turtle_diff_drive wheel_velocity_pub
[INFO] [1764401423.783565883]: Publishing: omega_left=12.00, omega_right=8.00
[INFO] [1764401424.786788744]: Publishing: omega_left=12.00, omega_right=8.00
[INFO] [1764401425.784141209]: Publishing: omega_left=12.00, omega_right=8.00
[INFO] [1764401426.783836464]: Publishing: omega_left=12.00, omega_right=8.00
[INFO] [1764401427.785880197]: Publishing: omega_left=12.00, omega_right=8.00
[INFO] [1764401428.788373865]: Publishing: omega_left=12.00, omega_right=8.00
[INFO] [1764401429.785374743]: Publishing: omega_left=12.00, omega_right=8.00
[INFO] [1764401430.783848832]: Publishing: omega_left=12.00, omega_right=8.00
[INFO] [1764401431.785109827]: Publishing: omega_left=12.00, omega_right=8.00
[INFO] [1764401432.785388211]: Publishing: omega_left=12.00, omega_right=8.00
[INFO] [1764401433.784628755]: Publishing: omega_left=12.00, omega_right=8.00
[INFO] [1764401434.784548723]: Publishing: omega_left=12.00, omega_right=8.00
[INFO] [1764401435.784944576]: Publishing: omega_left=12.00, omega_right=8.00
[INFO] [1764401436.785797026]: Publishing: omega_left=12.00, omega_right=8.00
[INFO] [1764401437.784694661]: Publishing: omega_left=12.00, omega_right=8.00
[INFO] [1764401438.788755481]: Publishing: omega_left=12.00, omega_right=8.00
[INFO] [1764401439.785301249]: Publishing: omega_left=12.00, omega_right=8.00
[INFO] [1764401440.785758343]: Publishing: omega_left=12.00, omega_right=8.00
[INFO] [1764401441.785204656]: Publishing: omega_left=12.00, omega_right=8.00
[INFO] [1764401442.785961184]: Publishing: omega_left=12.00, omega_right=8.00
[INFO] [1764401443.784446788]: Publishing: omega_left=12.00, omega_right=8.00

```

fk_wheels_to_twist node:

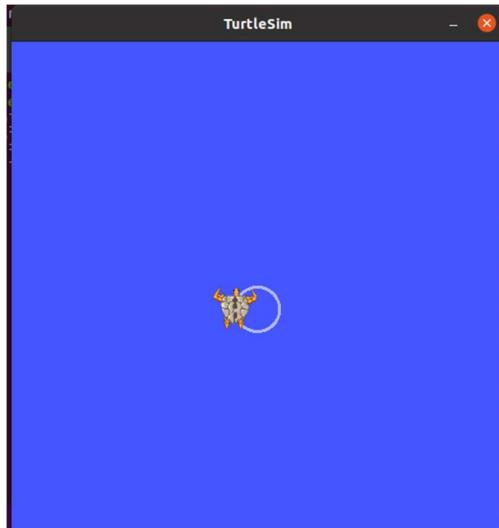


```

neo@neo-VirtualBox:~/catkin_ws$ source ~/catkin_ws/devel/setup.bash
neo@neo-VirtualBox:~/catkin_ws$ rosrun turtle_diff_drive fk_wheels_to_twist
[INFO] [1764401439.786918167]: Received: omega_left=12.00, omega_right=8.00
[INFO] [1764401439.791477198]: Converted: v=0.50 m/s, w=-1.00 rad/s
[INFO] [1764401440.787236597]: Received: omega_left=12.00, omega_right=8.00
[INFO] [1764401440.788159038]: Converted: v=0.50 m/s, w=-1.00 rad/s
[INFO] [1764401441.788572081]: Received: omega_left=12.00, omega_right=8.00
[INFO] [1764401441.788853167]: Converted: v=0.50 m/s, w=-1.00 rad/s
[INFO] [1764401442.787762884]: Received: omega_left=12.00, omega_right=8.00
[INFO] [1764401442.788100930]: Converted: v=0.50 m/s, w=-1.00 rad/s
[INFO] [1764401443.784958625]: Received: omega_left=12.00, omega_right=8.00
[INFO] [1764401443.785255843]: Converted: v=0.50 m/s, w=-1.00 rad/s
[INFO] [1764401444.784861614]: Received: omega_left=12.00, omega_right=8.00
[INFO] [1764401444.785005930]: Converted: v=0.50 m/s, w=-1.00 rad/s
[INFO] [1764401445.786557616]: Received: omega_left=12.00, omega_right=8.00
[INFO] [1764401445.786823554]: Converted: v=0.50 m/s, w=-1.00 rad/s
[INFO] [1764401446.786736859]: Received: omega_left=12.00, omega_right=8.00
[INFO] [1764401446.786807324]: Converted: v=0.50 m/s, w=-1.00 rad/s
[INFO] [1764401447.785267842]: Received: omega_left=12.00, omega_right=8.00

```

Turtlesim output:



2. go_to_goal_controller.cpp

- the go_to_goal_controller.cpp subscribed to the **topic turtle1/pose** in which the position of the turtle was continuously published.
- The message fields of the message type turtlesim/pose were -
 - x
 - y
 - theta
- The goal position was defined by **x_g, y_g, theta_g**.
- 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.
- 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

```

s Terminal ▾ Nov 29 08:53
roscore http://neo-VirtualBox:11311/
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://neo-VirtualBox:34775/
ros_comm version 1.17.4

SUMMARY
=====

PARAMETERS
  * /rosdistro: noetic
  * /rosversion: 1.17.4

NODES

auto-starting new master
process[master]: started with pid [3622]
ROS_MASTER_URI=http://neo-VirtualBox:11311/

setting /run_id to d59ad87c-cccb-11f0-be6f-a1509f300256
process[rosout-1]: started with pid [3632]
started core service [/rosout]

```

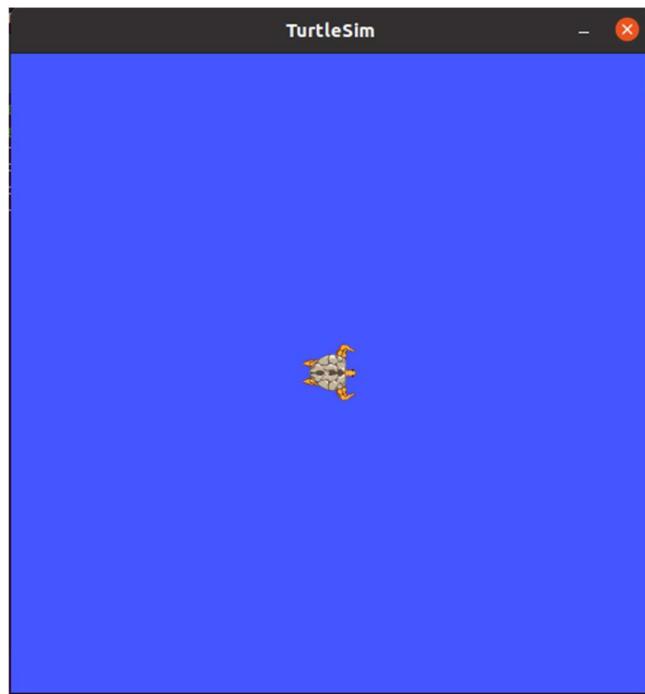
turtlesim_node:

```

neo@neo-VirtualBox:~$ source ~/catkin_ws/devel/setup.bash
neo@neo-VirtualBox:~$ rosrun turtlesim turtlesim_node
[INFO] [1764401398.127429818]: Starting turtlesim with node name /turtlesim
[INFO] [1764401398.148812808]: Spawning turtle [turtle1] at x=[5.544445], y=[5.544445], theta=[0.000000]

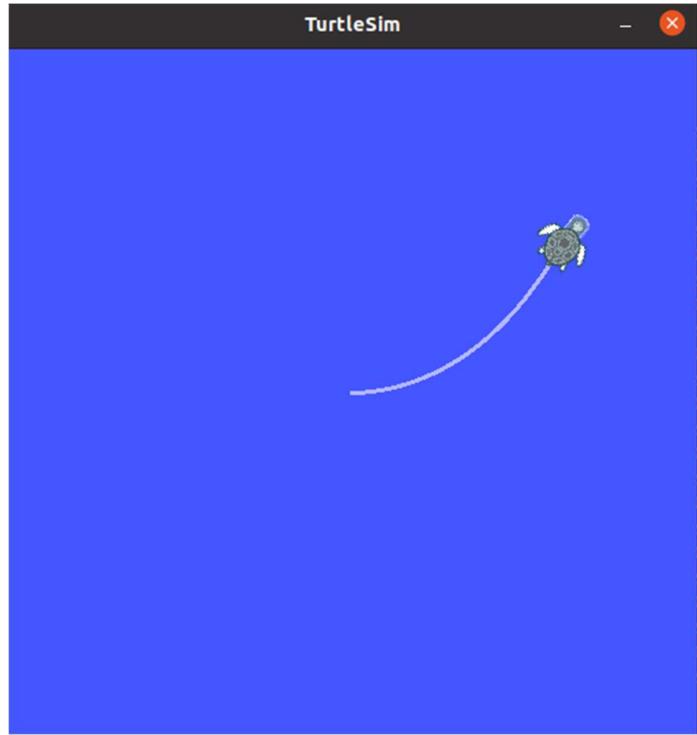
```

initial orientation of turtle:



go_to_goal_controller node

```
+ neo@neo-VirtualBox: ~$ source ~/catkin_ws/devel/setup.bash
neo@neo-VirtualBox: ~$ rosrun turtle_diff_drive go_to_goal_controller
[INFO] [1764401470.321649698]: Pose received: x=5.19, y=4.69, theta=2.36
[INFO] [1764401470.331110223]: Converted: v=7.57 m/s, w=-6.77 rad/s
[INFO] [1764401470.334189010]: Pose received: x=5.11, y=4.79, theta=2.25
[INFO] [1764401470.336237442]: Converted: v=7.57 m/s, w=-6.45 rad/s
[INFO] [1764401470.349102812]: Pose received: x=5.04, y=4.89, theta=2.15
[INFO] [1764401470.350728454]: Converted: v=7.55 m/s, w=-6.16 rad/s
[INFO] [1764401470.367011825]: Pose received: x=4.99, y=5.00, theta=2.05
[INFO] [1764401470.368111024]: Converted: v=7.52 m/s, w=-5.89 rad/s
[INFO] [1764401470.381130728]: Pose received: x=4.94, y=5.11, theta=1.96
[INFO] [1764401470.382091102]: Converted: v=7.48 m/s, w=-5.63 rad/s
[INFO] [1764401470.398297136]: Pose received: x=4.91, y=5.22, theta=1.87
[INFO] [1764401470.398402818]: Converted: v=7.42 m/s, w=-5.38 rad/s
[INFO] [1764401470.413574463]: Pose received: x=4.88, y=5.34, theta=1.78
[INFO] [1764401470.413863385]: Converted: v=7.35 m/s, w=-5.15 rad/s
[INFO] [1764401470.429106637]: Pose received: x=4.87, y=5.45, theta=1.70
[INFO] [1764401470.429535045]: Converted: v=7.28 m/s, w=-4.93 rad/s
[INFO] [1764401470.446691060]: Pose received: x=4.86, y=5.57, theta=1.62
[INFO] [1764401470.446964562]: Converted: v=7.20 m/s, w=-4.72 rad/s
[INFO] [1764401470.462922035]: Pose received: x=4.87, y=5.69, theta=1.54
[INFO] [1764401470.465633221]: Converted: v=7.11 m/s, w=-4.52 rad/s
[INFO] [1764401470.475925965]: Pose received: x=4.88, y=5.80, theta=1.47
[INFO] [1764401470.476244924]: Converted: v=7.01 m/s, w=-4.33 rad/s
```



Go to controller after wheel twist:

