

ROS Noetic Assignment — Differential-Drive Kinematics on turtlesim

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Nodes to Implement

fk_wheels_to_twist.cpp

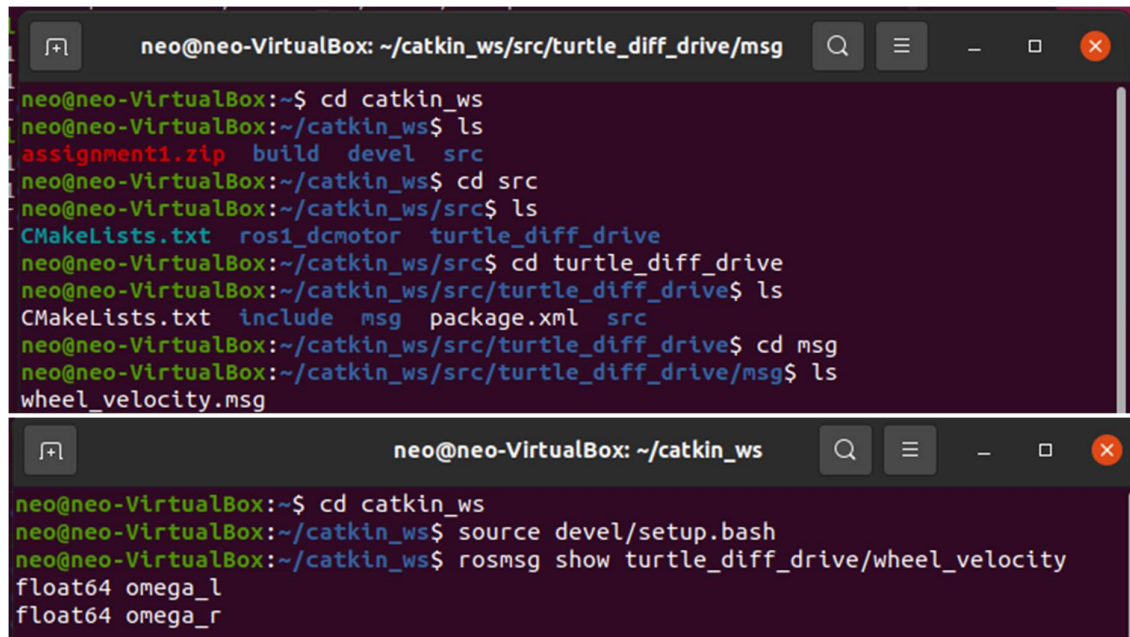
- Sub: ~wheel_vel_in → WheelVel
- Pub: /turtle1/cmd_vel → Twist
- Implements FK.

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.



```
neo@neo-VirtualBox: ~/catkin_ws/src/turtle_diff_drive/msg
neo@neo-VirtualBox:~$ cd catkin_ws
neo@neo-VirtualBox:~/catkin_ws$ ls
assignment1.zip  build  devel  src
neo@neo-VirtualBox:~/catkin_ws$ cd src
neo@neo-VirtualBox:~/catkin_ws/src$ ls
CMakeLists.txt  rosi_dcmotor  turtle_diff_drive
neo@neo-VirtualBox:~/catkin_ws/src$ cd turtle_diff_drive
neo@neo-VirtualBox:~/catkin_ws/src/turtle_diff_drive$ ls
CMakeLists.txt  include  msg  package.xml  src
neo@neo-VirtualBox:~/catkin_ws/src/turtle_diff_drive$ cd msg
neo@neo-VirtualBox:~/catkin_ws/src/turtle_diff_drive/msg$ ls
wheel_velocity.msg

neo@neo-VirtualBox:~/catkin_ws
neo@neo-VirtualBox:~$ cd catkin_ws
neo@neo-VirtualBox:~/catkin_ws$ source devel/setup.bash
neo@neo-VirtualBox:~/catkin_ws$ rosmmsg show turtle_diff_drive/wheel_velocity
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

```
es Terminal Nov 29 12:54
neo@neo-VirtualBox: ~/catkin_ws

Scanning dependencies of target std_msgs_generate_messages_cpp
[ 11%] Built target rosgenmsg_generate_messages_cpp
[ 11%] Built target std_msgs_generate_messages_cpp
Scanning dependencies of target rosgenmsg_generate_messages_eus
Scanning dependencies of target rosgenmsg_generate_messages_lisp
[ 11%] Built target rosgenmsg_generate_messages_eus
[ 11%] Built target rosgenmsg_generate_messages_lisp
Scanning dependencies of target roscpp_generate_messages_lisp
Scanning dependencies of target roscpp_generate_messages_py
[ 11%] Built target roscpp_generate_messages_lisp
[ 11%] Built target roscpp_generate_messages_py
Scanning dependencies of target geometry_msgs_generate_messages_py
Scanning dependencies of target geometry_msgs_generate_messages_nodejs
[ 11%] Built target geometry_msgs_generate_messages_py
[ 11%] Built target geometry_msgs_generate_messages_nodejs
Scanning dependencies of target geometry_msgs_generate_messages_eus
[ 11%] Built target geometry_msgs_generate_messages_eus
Scanning dependencies of target turtle_diff_drive_generate_messages_lisp
[ 11%] Built target geometry_msgs_generate_messages_cpp
[ 17%] Generating Lisp code from turtle_diff_drive/wheel_velocity.msg
Scanning dependencies of target turtle_diff_drive_generate_messages_py
[ 23%] Generating Python from MSG turtle_diff_drive/wheel_velocity
[ 23%] Built target turtle_diff_drive_generate_messages_lisp
Scanning dependencies of target turtle_diff_drive_generate_messages_nodejs
[ 29%] Generating Javascript code from turtle_diff_drive/wheel_velocity.msg
[ 29%] Built target turtle_diff_drive_generate_messages_nodejs
Scanning dependencies of target turtle_diff_drive_generate_messages_cpp
[ 35%] Generating C++ code from turtle_diff_drive/wheel_velocity.msg
[ 41%] Generating Python msg _init_.py for turtle_diff_drive
[ 41%] Built target turtle_diff_drive_generate_messages_cpp
Scanning dependencies of target turtle_diff_drive_generate_messages_eus
[ 47%] Generating Euslisp code from turtle_diff_drive/wheel_velocity.msg
[ 52%] Generating Euslisp manifest code for turtle_diff_drive
[ 52%] Built target turtle_diff_drive_generate_messages_py
[ 52%] Built target turtle_diff_drive_generate_messages_eus
Scanning dependencies of target go_to_goal_controller
Scanning dependencies of target wheel_velocity_pub
[ 58%] Building CXX object turtle_diff_drive/CMakeFiles/go_to_goal_controller.dir/src/go_to_goal_controller.cpp.o
[ 64%] Building CXX object turtle_diff_drive/CMakeFiles/wheel_velocity_pub.dir/src/wheel_velocity_pub.cpp.o
[ 70%] Linking CXX executable /home/neo/catkin_ws/devel/lib/ros1_dcmotor/simulator
[ 76%] Linking CXX executable /home/neo/catkin_ws/devel/lib/ros1_dcmotor/controller
[ 76%] Built target simulator
Scanning dependencies of target turtle_diff_drive_generate_messages
[ 76%] Built target turtle_diff_drive_generate_messages
Scanning dependencies of target fk_wheels_to_twist
[ 82%] Building CXX object turtle_diff_drive/CMakeFiles/fk_wheels_to_twist.dir/src/fk_wheels_to_twist.cpp.o
[ 82%] Built target controller
[ 88%] Linking CXX executable /home/neo/catkin_ws/devel/lib/turtle_diff_drive/wheel_velocity_pub
[ 88%] Built target wheel_velocity_pub
[ 94%] Linking CXX executable /home/neo/catkin_ws/devel/lib/turtle_diff_drive/go_to_goal_controller
[ 94%] Built target go_to_goal_controller
[100%] Linking CXX executable /home/neo/catkin_ws/devel/lib/turtle_diff_drive/fk_wheels_to_twist
[100%] Built target fk_wheels_to_twist
neo@neo-VirtualBox:~/catkin_ws$ source devel/setup.bash
neo@neo-VirtualBox:~/catkin_ws$
```

EXECUTION:

```
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
* /rostdistro: noetic
* /rosversion: 1.17.4

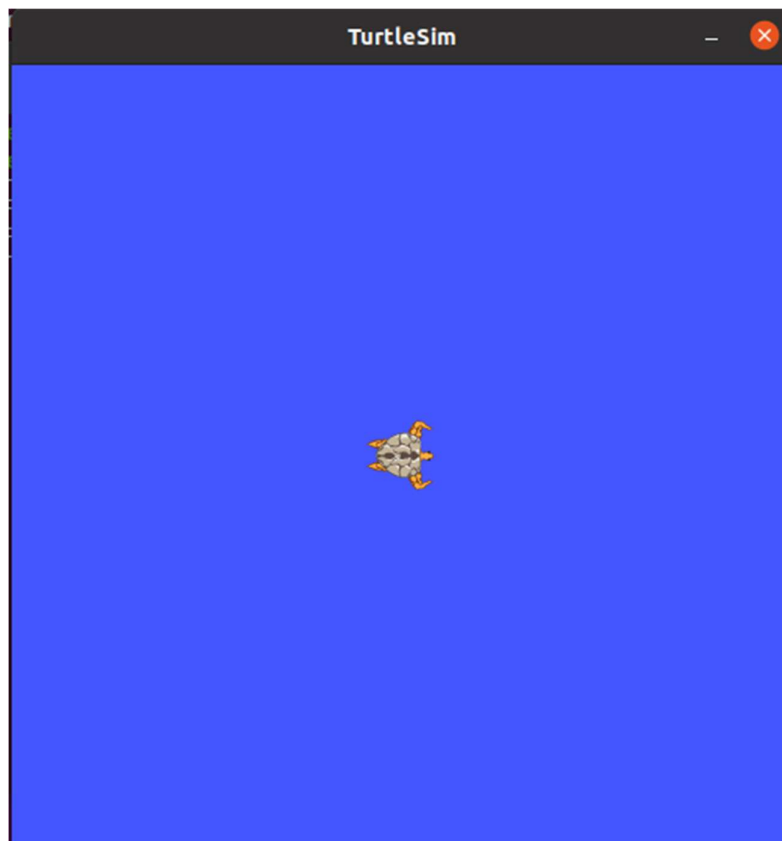
NODES

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:~$ roslaunch 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]
```



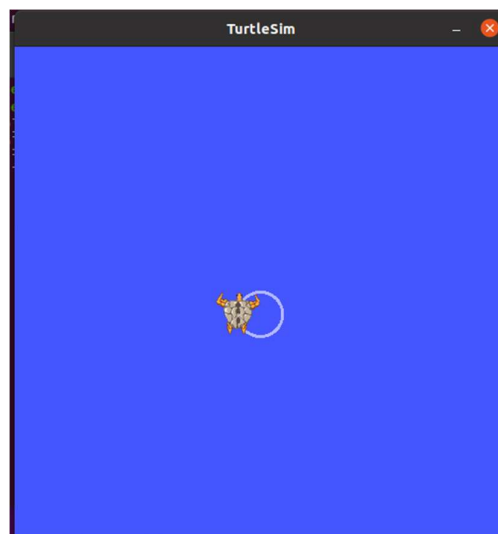
wheel_velocity_pub node:


```
neo@neo-VirtualBox: ~/catkin_ws
neo@neo-VirtualBox:~/catkin_ws$ source ~/catkin_ws/devel/setup.bash
neo@neo-VirtualBox:~/catkin_ws$ roslaunch 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
neo@neo-VirtualBox:~/catkin_ws$ source ~/catkin_ws/devel/setup.bash
neo@neo-VirtualBox:~/catkin_ws$ roslaunch 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

```

Terminal
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
* /rostdistro: noetic
* /rosversion: 1.17.4

NODES

auto-starting new master
process[roscout-1]: started with pid [3622]
ROS_MASTER_URI=http://neo-VirtualBox:11311/

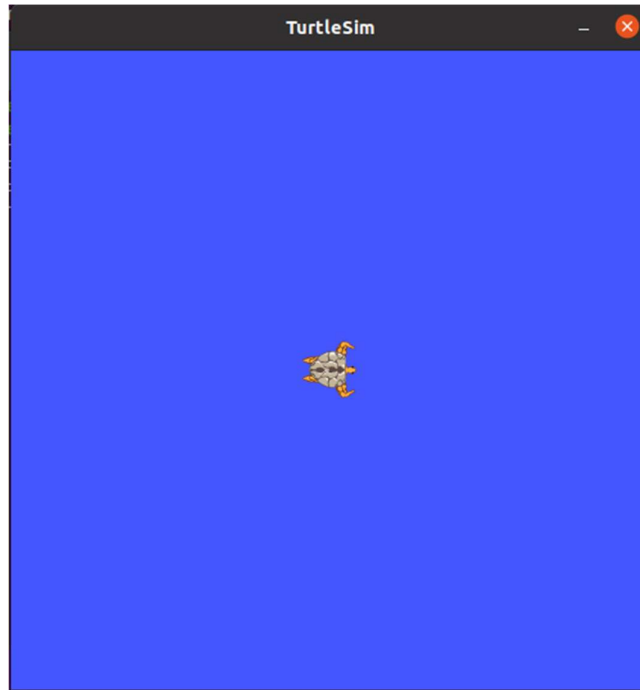
setting /run_id to d59ad87c-cccb-11f0-be6f-a1509f300256
process[roscout-1]: started with pid [3632]
started core service [/roscout]
  
```

turtlesim_node:

```

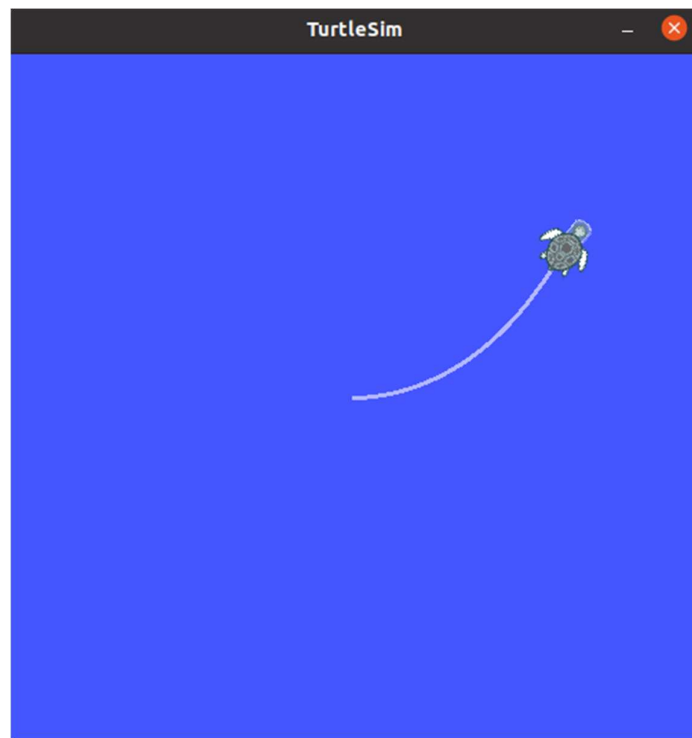
neo@neo-VirtualBox: ~
neo@neo-VirtualBox:~$ source ~/catkin_ws/devel/setup.bash
neo@neo-VirtualBox:~$ rosruncmd turtlesim turtlesim_node
[INFO] [1764401398.127429818]: Starting turtlesim with node name /turtlesim
[INFO] [1764401398.148812808]: Spawning turtle [turtle1] at x=[5.544445], y=[5.544445],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

initial orientation of turtle:



go_to_goal_controller node

```
neo@neo-VirtualBox: ~  
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:

