6、Data calibration

Note: The parameters have been calibrated before the product leaves the factory, and generally do not need to be calibrated.

If you feel that there are large deviation when control car, you need to calibrate [imu], [linear velocity], [angular velocity]; before calibration, please place the robot on a flat ground and do not move the robot.

6.1、imu calibration

The error of IMU mainly comes from three parts, including noise (Bias and Noise), scale factor (Scale errors) and axis deviation (Axis misalignments).

Calculate the accelerometer calibration parameters. Because it requires keyboard input, it should be run directly in the terminal, not from the startup file. After receiving the first IMU message, the node will prompt you to keep the IMU in a specific direction, and then press Enter to record the measured value. After completing all 6 directions, the node will calculate the calibration parameters and write them into the specified YAML file. The basic algorithm is based on and similar to the least squares calibration method described in the STMicroelectronics application note. Due to the nature of the algorithm, obtaining a good calibration requires the IMU to perform fairly precise positioning along each of its axes.

6.1.1、Calibration steps

Note: When calibrating, we need ensure that the robot is still.

On the robot system (jetson nano as an example). Open the terminal, enter the start command.

```
roslaunch transbot_bringup calibrate_imu.launch
```

```
/home/jetson/transbot_ws/src/transbot_bringup/launch/calibrate_imu.launch http://192.168.2.98:11311
/home/jetson/transbot_ws/src/transbot_bringup/launch/calibrate_imu.launch http://192.168.2.98:11311 108x31
jetson@jetson-yahboom:~$ roslaunch transbot_bringup calibrate_imu.launch
... logging to /home/jetson/.ros/log/60deda9c-0f83-11ec-b21c-18cc189b2896/roslaunch-jetson-yahboom-32243.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://192.168.2.98:33441/

SUMMARY
========

PARAMETERS
 * /do_calib/output_file: /home/jetson/tran...
 * /rosdistro: melodic
 * /rosversion: 1.14.11
 * /transbot_node/imu: /transbot/imu
 * /transbot_node/vel: /transbot/get_vel

NODES
  /
    do_calib (imu_calib/do_calib)
    transbot_node (transbot_bringup/transbot_driver.py)

ROS_MASTER_URI=http://192.168.2.98:11311

process[transbot_node-1]: started with pid [32482]
process[do_calib-2]: started with pid [32483]
cmd delay=0.002s
Serial Opened! Baudrate=115200
(0.3, 0.0, 1.0)
Orient IMU with X+ axis - Front side of the robot facing up. Press [ENTER] once done.
```

Start calibrate, we need calibrate the 6 axes of imu [X+, X-, Y+, Y-, Z+, Z-] in sequence. Then, click 【Enter】key repeatedly until it appears the interface as shown below.

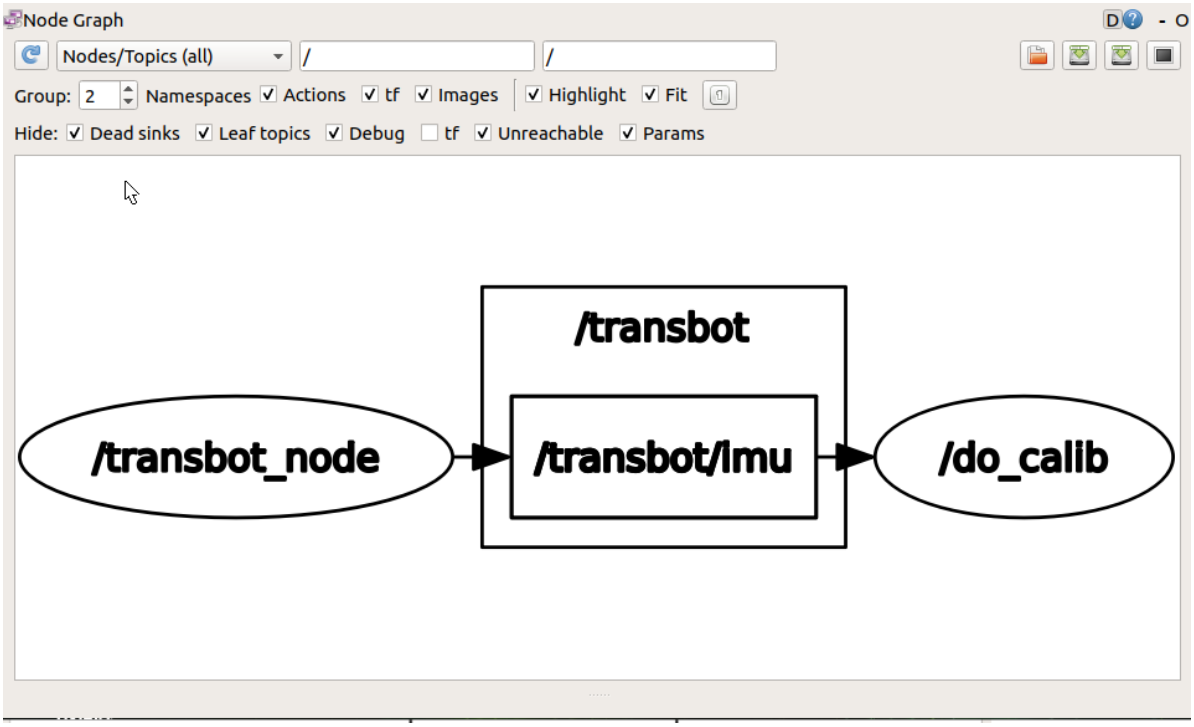
```
 Done.
Orient IMU with X- axis - Rear side of the robot facing up. Press [ENTER] once done.Calibrating! This may ta
ke a while....
 Done.
Orient IMU with Y+ axis - Right side of the robot facing up. Press [ENTER] once done.Calibrating! This may t
ake a while....
 Done.
Orient IMU with Y- axis - Left side of the robot facing up. Press [ENTER] once done.Calibrating! This may ta
ke a while....
 Done.
Orient IMU with Z+ axis - Top side of the robot facing up. Press [ENTER] once done.Calibrating! This may tak
e a while....
 Done.
Orient IMU with Z- axis - Bottom side of the robot facing up. Press [ENTER] once done.Calibrating! This may
take a while....
 Done.
Computing calibration parameters... Success!
Saving calibration file... Success!
```

After the calibration is successful, the calibration information is stored in the YAML file. After the calibration is completed, it will exit automatically, as shown below.

```
Orient IMU with Z- axis - Bottom side of the robot facing up. Press [ENTER] once
 done.
Calibrating! This may take a while....
 Done.
Computing calibration parameters... Success!
Saving calibration file... Success!
================================================================================
REQUIRED process [do_calib-3] has died!
process has finished cleanly
log file: /home/jetson/.ros/log/1713c870-1760-11ec-9c33-845cf326ed82/do_calib-3*
.log
Initiating shutdown!
================================================================================
[do_calib-3] killing on exit
[transbot_node-2] killing on exit
[INFO] [1631846504.503934]: Close the robot...
[INFO] [1631846506.141232]: Final!!!
[rosout-1] killing on exit
[master] killing on exit
shutting down processing monitor...
... shutting down processing monitor complete
done
```

View node graph

```
rqt_graph
```



6.1.2、Related nodes

transbot_node

Topic	Type	Parsing
/transbot/imu	sensor_msgs/Imu	The most primitive imu data of the car

do_calib node

/	Type	Defaults value	Parsing
Subscribed	sensor_msgs/Imu	/raw_imu	Original, uncalibrated IMU measurement
~calib_file	string	"imu_calib.yaml"	The file where the calibration parameters will be written
~measurements	int	500	Number of measurements collected for each direction
~reference_acceleration	double	9.80665	Acceleration of gravity

6.2、Linear speed calibration

Preparation：

- Measure a distance of 1 meter and make a mark.
- Place the cart to the starting point.
- Modify the parameter [linear_scale] in bringup.launch to 1.0.

Start the robot drive (robot side)

```
roslaunch transbot_bringup bringup.launch
```

Linear speed calibration (robot side or virtual machine side)

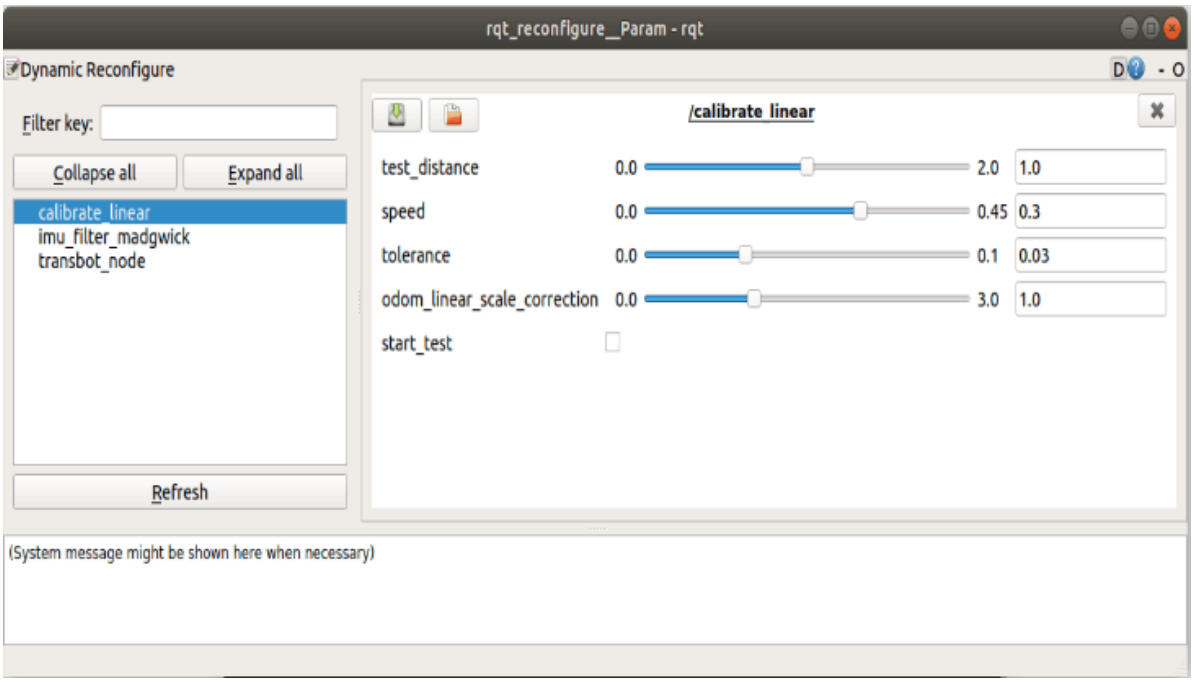
```
roslaunch transbot_bringup calibrate_linear.launch
```

As shown below.

```
process[calibrate_linear-1]: started with pid [3895]
[INFO] [1630983687.677758]: Bring up rqt_reconfigure to control the test.
```

Enable dynamic parameter adjustment (robot side or virtual machine side)

```
rosrun rqt_reconfigure rqt_reconfigure
```



Click the square on the right side of [start_test] to start moving [test_distance]. At this time, observe whether the car really moves [test_distance]. If it is not the adjustment parameter [odom_linear_scale_correction], put the car back to the starting point to continue the test.

- test_distance：Test distance.
- speed：Test line speed. If the speed is too great, the inertia will be great.
- tolerance：The error in reaching the target. If the error is too small, it will jitter at the target position, otherwise, the error of reaching the target point will be large.
- odom_linear_scale_correction：Odometer zoom ratio.
- start_test：Start test.

After the test, remember the value of [odom_linear_scale_correction] and modify it to the value of the parameter [linear_scale] in bringup.launch.

6.3、Angular velocity calibration

Preparation：

- Place the car in a position where it is easy to rotate separately.
- Modify the parameter [angular_scale] in bringup.launch to 1.0.

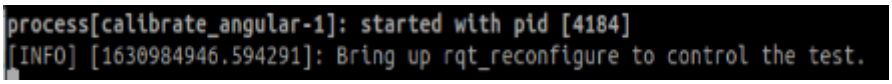
Start the robot drive (robot side)

```
roslaunch transbot_bringup bringup.launch
```

Angular velocity calibration (robot side or virtual machine side)

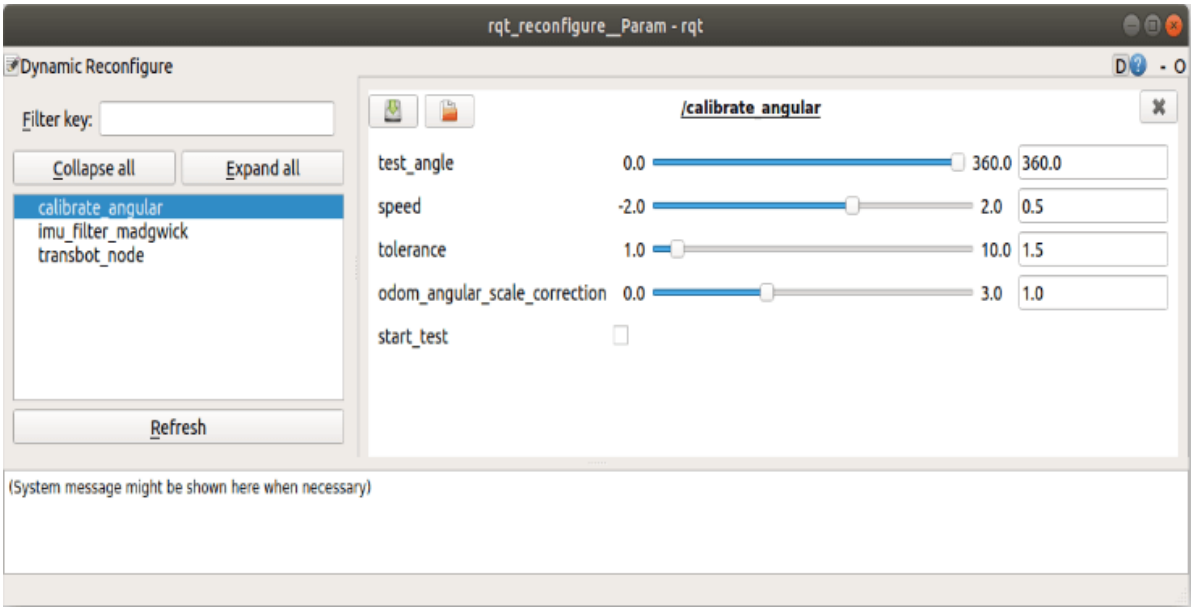
```
roslaunch transbot_bringup calibrate_angular.launch
```

As shown below.



Enable dynamic parameter adjustment (robot side or virtual machine side)

```
rosrun rqt_reconfigure rqt_reconfigure
```



Click the square on the right side of [start_test] to start moving the [test_angle] distance. At this time, observe whether the car really moves [test_angle]. If it is not the adjustment parameter [odom_angule_scale_correction], return the car to the starting point to continue the test.

- test_angle: Test distance. It is not easy to be too big, the default is 360°.
- speed：Test the angular velocity. If the speed is too great, the inertia will be great.
- tolerance：The error in reaching the target. If the error is too small, it will jitter at the target position, otherwise, the error of reaching the target point will be large.
- odom_angule_scale_correction：Odometer zoom ratio.
- start_test：start test.

After the test, remember the value of [odom_angule_scale_correction] and modify it to the value of the parameter [angular_scale] in bringup.launch.