5. Robot calibration

5.1. Description of program functions

After the program is run, the dynamic parameter adjuster is used here to adjust the parameters to calibrate the linear and angular speed of the car. The intuitive embodiment of the calibration line speed makes the car go straight forward 1 meter, to see how far it actually runs and whether it is within the error range; The visual representation of calibration angular velocity allows the car to rotate 360 degrees to see if the Angle of rotation of the car is within the error range.

5.2. Program Code Reference Path

After SSH connection car, the location of the function source code is located at,

```
#标定线速度源码# Calibration line speed source code
/userdata/yahboomcar_ws/src/yahboomcar_bringup/yahboomcar_bringup/calibrate_line
ar.py
#标定角速度源码# Calibration angular velocity source code
/userdata/yahboomcar_ws/src/yahboomcar_bringup/yahboomcar_bringup/calibrate_angu
lar.py
```

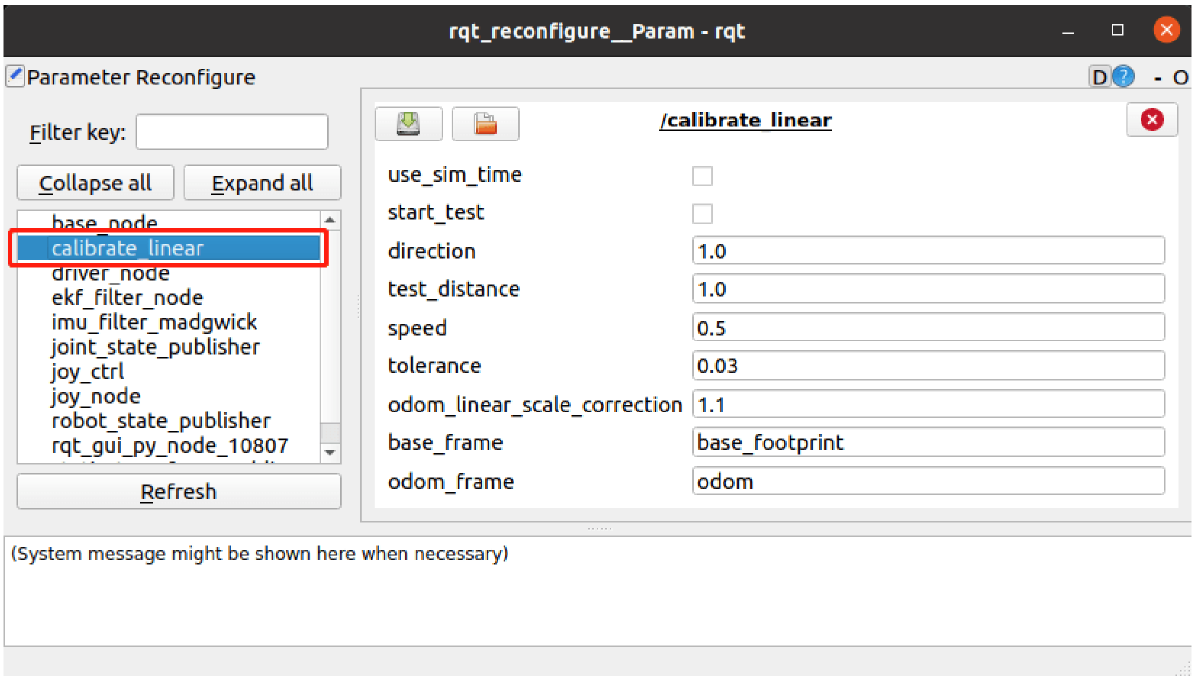
5.3. Program Startup

After SSH connects to the car, terminal input,

```
#启动底盘# Start chassis
ros2 launch yahboomcar_bringup yahboomcar_bringup_launch.py
#标定线速度# Calibrate the line speed
ros2 run yahboomcar_bringup calibrate_linear
#标定角速度# Calibrate the angular velocity
ros2 run yahboomcar_bringup calibrate_angular
```

Open the virtual machine terminal, input,

```
#动态参数调节# Dynamic parameter adjustment
ros2 run rqt_reconfigure rqt_reconfigure
```



base_node
calibrate_linear
driver_node
ekf_filter_node
imu_filter_madgwick
joint_state_publisher
joy_ctrl
joy_node
robot_state_publisher
rqt_gui_py_node_10807

use_sim_time	☐
start_test	☐
direction	1.0
test_distance	1.0
speed	0.5
tolerance	0.03
odom_linear_scale_correction	1.1
base_frame	base_footprint
odom_frame	odom

(System message might be shown here when necessary)

Take the calibration line speed as an example, click [start_test] car calibration x direction line speed, observe whether the car moved the test_distance distance, the default setting here is 1m, before calibration can customize the test distance, must be a decimal, set the click in the blank, the program will automatically write. If the car moves farther than the acceptable error range (the value of the tolerance variable), then the value of odom_linear_scale_correction is set. Here's what each parameter means,

Parameters	Meanings
rate	release frequency(can need not modify)
test_distance	The distance from which the line speed is tested
speed	The magnitude of the line speed
tolerance	The acceptable error
odom_linear_scale_correction	The ratio factor
start_test	To start the test
direction	direction (linear velocity test X (1) Y direction (0))
base_frame	listens for the parent coordinate of the TF transform
odom_frame	listens for the sub-coordinate of the TF transformation

The variable Settings for testing angular velocity are roughly the same, but test_distance becomes test_angle and speed becomes angular velocity.

5.4. Core Source Code Parsing

This program mainly uses TF to monitor the transformation between coordinates to achieve, by monitoring the coordinate transformation between base_footprint and odom to let the robot know "how far I go now/how many degrees I turn now".

Take calibrate_linear.py as an example. The core code is as follows:

```
#监听TF变换# Monitor TF transformation
def get_position(self):
    try:
        now = rclpy.time.Time()
        trans = 
self.tf_buffer.lookup_transform(self.odom_frame,self.base_frame,now)
        return trans
    except (LookupException, ConnectivityException, ExtrapolationException):
        self.get_logger().info('transform not ready')
        raise
        return

#获取当前的xy坐标，根据之前的xy坐标，计算距离
# Get the current xy coordinates and calculate the distance based on the previous
xy coordinates
self.position.x = self.get_position().transform.translation.x
self.position.y = self.get_position().transform.translation.y
print("self.position.x: ",self.position.x)
print("self.position.y: ",self.position.y)
distance = sqrt(pow((self.position.x - self.x_start), 2) +
                pow((self.position.y - self.y_start), 2))
distance *= self.odom_linear_scale_correction
```

calibrate_angular.py core code is as follows:

```
#这里同样是监听了TF变换，获取到了当前位姿信息，只不过这里还做了转换，把四元数转了欧拉角的转换，
然后再返回
# Here is also listening to the TF transformation to obtain the current pose
information, but here is also a conversion, the quaternion to the Euler Angle
conversion, and then return
def get_odom_angle(self):
    try:
        now = rclpy.time.Time()
        rot = 
self.tf_buffer.lookup_transform(self.odom_frame,self.base_frame,now)
        print("orig_rot: ",rot.transform.rotation)
        cacl_rot = PyKDL.Rotation.Quaternion(rot.transform.rotation.x,
rot.transform.rotation.y, rot.transform.rotation.z, rot.transform.rotation.w)
        #print("cacl_rot: ",cacl_rot)
        angle_rot = cacl_rot.GetRPY()[2]
        #print("angle_rot: ",angle_rot)
        return angle_rot

    except (LookupException, ConnectivityException, ExtrapolationException):
        self.get_logger().info('transform not ready')
        raise
        return

#计算旋转角度# Calculate the rotation Angle
self.odom_angle = self.get_odom_angle()
self.delta_angle = self.odom_angular_scale_correction *
self.normalize_angle(self.odom_angle - self.first_angle)
```

The published TF transform is published in the base_node node, the code path is,

```
/userdata/yahboomcar_ws/src/yahboomcar_base_node/src/base_node.cpp
```

This node will receive /vel_raw data, release odom data through mathematical calculation, and release TF transformation. The core code is as follows:

```
#计算xy坐标以及xyzw四元数的值，xy两点坐标表示位置，xyzw四元数表示姿态
# Calculate the xy coordinates and the value of the xyzw quaternion, where the xy
two-point coordinates represent the position and the xyzw quaternion represents
the attitude
double delta_heading = angular_velocity_z_ * vel_dt_; //radians
double delta_x = (linear_velocity_x_ * cos(heading_)-
linear_velocity_y_*sin(heading_)) * vel_dt_; //m
double delta_y = (linear_velocity_x_ *
sin(heading_)+linear_velocity_y_*cos(heading_)) * vel_dt_; //m
x_pos_ += delta_x;
y_pos_ += delta_y;
heading_ += delta_heading;
tf2::Quaternion myQuaternion;
geometry_msgs::msg::Quaternion odom_quat ;
myQuaternion.setRPY(0.00,0.00,heading_ );

#发布TF变换# Release TF transform
geometry_msgs::msg::TransformStamped t;
rclcpp::Time now = this->get_clock()->now();
t.header.stamp = now;
t.header.frame_id = "odom";
t.child_frame_id = "base_footprint";
t.transform.translation.x = x_pos_;
t.transform.translation.y = y_pos_;
t.transform.translation.z = 0.0;
t.transform.rotation.x = myQuaternion.x();
t.transform.rotation.y = myQuaternion.y();
t.transform.rotation.z = myQuaternion.z();
t.transform.rotation.w = myQuaternion.w();
tf_broadcaster_->sendTransform(t);
```