15. Autonomous driving obstacle clearance

15.1. Use

This function has a line patrol function, which can autonomously clear obstacles on the ground line and continue to patrol the line after cleaning. It also has a radar obstacle avoidance function.

Note: [R2] on the remote control handle has the [pause/start] function for this gameplay. When using it for the first time, perform color calibration first.

HSV (Hue, Saturation, Value) is a color space created by A. R. Smith in 1978 based on the intuitive characteristics of color, also known as the Hexcone Model.

The parameters of color in this model are: hue (H), saturation (S), and lightness (V).

H: 0 — 180

S: 0 — 255

V: 0 — 255

Here some reds are classified into the purple range:

	Black	Grey	White	Red		Orange	Yellow	Green	Cyan	Blue	Purple
H_min	0	0	0	0	156	11	26	35	78	100	125
H_max	180	180	180	10	180	25	34	77	99	124	155
S_min	0	0	0	43		43	43	43	43	43	43
S_max	255	43	30	255		255	255	255	255	255	255
V_min	0	46	221	46		46	46	46	46	46	46
V_max	46	220	255	255		255	255	255	255	255	255

```
#Raspberry Pi 5 master needs to enter docker first, please perform this step
#If running the script into docker fails, please refer to ROS/07, Docker tutorial
~/run_docker.sh
```

Start command (robot side)

```
roslaunch arm_autopilot arm_autopilot.launch
```

<PI5 needs to open another terminal to enter the same docker container

1. In the above steps, a docker container has been opened. You can open another terminal on the host (car) to view:

```
docker ps -a
```

```
jetson@ubuntu:~$ docker ps -a
CONTAINER ID   IMAGE                                 COMMAND       CREATED      STATUS       PORTS     NAMES
5b698ea10535   yahboomtechnology/ros-foxy:3.3.9   "/bin/bash"   3 days ago   Up 9 hours             ecstatic_lewin
jetson@ubuntu:~$
```

2. Now enter the docker container in the newly opened terminal:

```
docker exec -it 5b698ea10535 /bin/bash
```

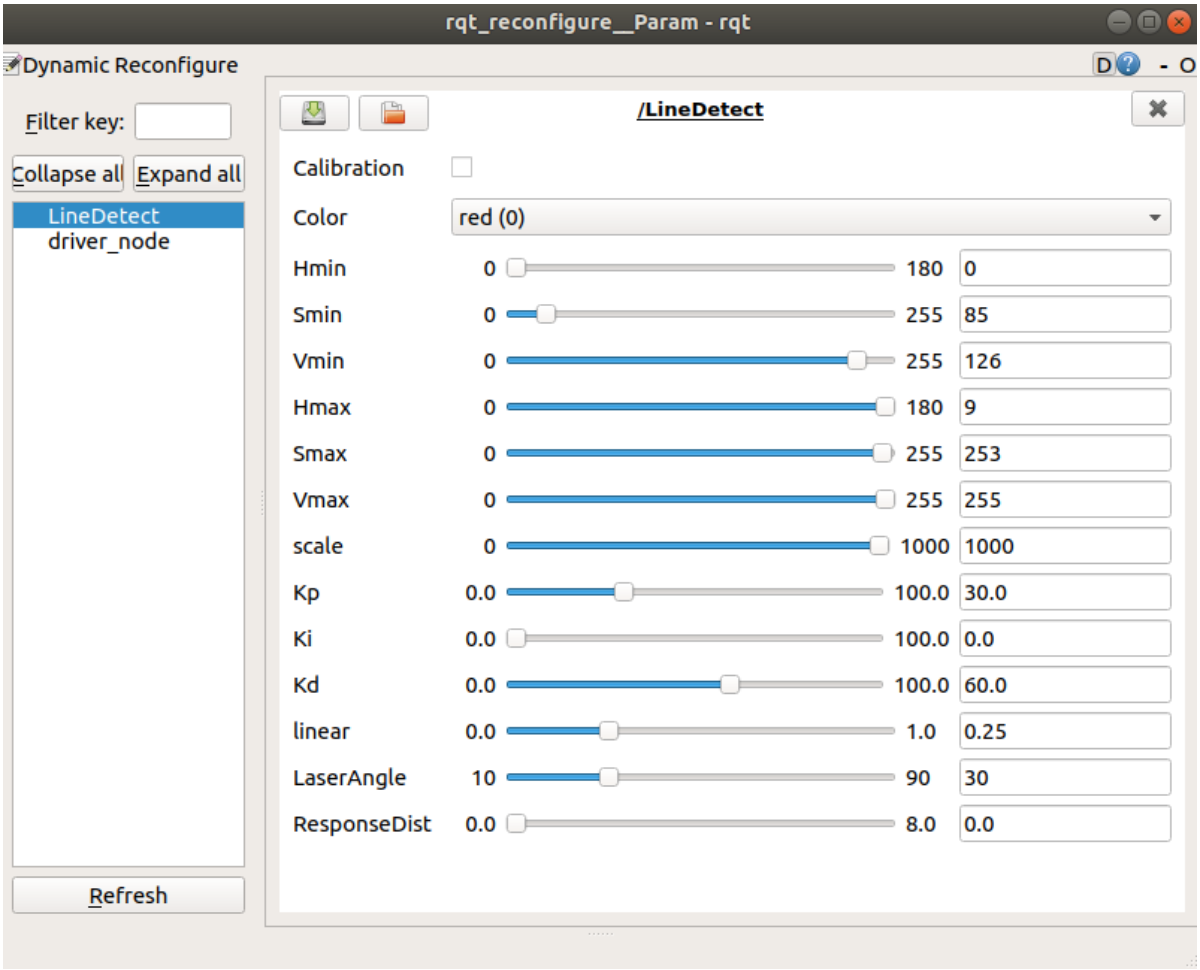
```
jetson@ubuntu:~$ docker ps -a
CONTAINER ID   IMAGE                                 COMMAND       CREATED      STATUS       PORTS     NAMES
5b698ea10535   yahboomtechnology/ros-foxy:3.3.9   "/bin/bash"   3 days ago   Up 9 hours             ecstatic_lewin
jetson@ubuntu:~$ docker exec -it 5b698ea10535 /bin/bash
-------------------------------------------------------
my_robot_type: x3 | my_lidar: a1 | my_camera: astrapro
-------------------------------------------------------
root@ubuntu:/#
```

After successfully entering the container, you can open countless terminals to enter the container.

Start dynamically adjusting parameters

```
rosrun rqt_reconfigure rqt_reconfigure
```

Dynamic adjustment parameter window



Select the [LineDetect] node. Generally, you only need to adjust [Hmin], [Smin], [Vmin], and [Hmax]. These four parameters can be well identified. The slide bar is always in a dragging state and data will not be transferred to the system until it is released; you can also select a row and then slide the mouse wheel.

Parameter analysis:

Parameters	Range	Parse
[laserAngle]	[10, 90]	Lidar detection angle (left and right angles)
[ResponseDist]	[0.0, 8.0]	Obstacle detection distance
[Calibration]	[False, True]	Color calibration switch
[linear]	[0.0, 1.0]	The linear speed of the robot.

[Kp], [Ki], [Kd]: Car speed PID debugging.

[scale]: PID control scaling coefficient.

Note: If the linear speed [linear] is too fast, the robot will not be able to see obstacles while moving. The flatter the ground, the better.

- Parameter modification

When the parameters are adjusted to the optimal state, the corresponding parameters are modified into the file, and no adjustment is required when using again.

According to the optimal parameters of the [rqt_reconfigure] debugging tool, enter the [scripts] folder of the [arm_autopilot] function package and modify the parameters corresponding to the [autopilot_main.py] file, as shown below

```
class LineDetect:
    def __init__(self):
        ... ...
        self.scale = 1000.0
        self.FollowLinePID = (30.0, 0.0, 60.0)
        self.linear = 0.25 # If the speed is too fast, the robot will not be
able to see obstacles while moving.
```

[rqt_reconfigure] Modification of the initial value of the debugging tool

```
gen.add("Calibration", bool_t, 0, "color calibration", False)
command_enum = gen.enum([gen.const("red", int_t, 0, "first data"),
                         gen.const("green", int_t, 1, "two data"),
                         gen.const("blue", int_t, 2, "three datat"),
                         gen.const("yellow", int_t, 3, "four data")], "An enum
to set size")
gen.add("Color", int_t, 0, "A size parameter which is edited via an enum", 0, 0,
3, edit_method=command_enum)
gen.add("Hmin", int_t, 0, "Hmin in HSV", 0, 0, 180)
gen.add("Smin", int_t, 0, "Smin in HSV", 85, 0, 255)
gen.add("Vmin", int_t, 0, "Vmin in HSV", 126, 0, 255)
gen.add("Hmax", int_t, 0, "Hmax in HSV", 9, 0, 180)
gen.add("Smax", int_t, 0, "Smax in HSV", 253, 0, 255)
```

```
gen.add("Vmax", int_t, 0, "Vmax in HSV", 255, 0, 255)
gen.add("scale", int_t, 0, "scale", 1000, 0, 1000)
gen.add("Kp", double_t, 0, "Kp in PID", 30.0, 0, 100)
gen.add("Ki", double_t, 0, "Ki in PID", 0.0, 0, 100)
gen.add("Kd", double_t, 0, "Kd in PID", 60.0, 0, 100)
gen.add("linear", double_t, 0, "linear", 0.25, 0, 1.0)
gen.add("LaserAngle", int_t, 0, "LaserAngle", 30, 10, 90)
gen.add("ResponseDist", double_t, 0, "ResponseDist", 0.55, 0, 8)
```

Enter the [cfg] folder of the [arm_autopilot] function package and modify the initial values of the parameters corresponding to the [autopilot.cfg] file.

```
gen.add("Kp", double_t, 0, "Kp in PID", 30.0, 0, 100)
```

Take the above article as an example to analyze

Parameters	Analysis	Corresponding parameters
name	The name of the parameter	"Kp"
type	parameter data type	double_t
level	a bitmask passed to the callback	0
description	A description parameter	"Kp in PID"
default	Initial value for node startup	30.0
min	parameter minimum value	0
max	parameter maximum value	100

Note: After modification, you must recompile and update the environment to be effective.

```
cd ~/yahboomcar_ws
catkin_make
source devel/setup.bash
```

15.1.1. The first step

color calibration

- Click the box on the right side of [Calibration] to enter the calibration mode; you can also select the image window and click the [C] key on the keyboard.
- Select the color [red, green, blue, yellow] in [Color], and put the corresponding color (the color of the color block, the color of the patrol line) into the lower half of the camera's field of view.
- Adjust the [Hmin, Smin, Vmin, Hmax, Smax, Vmax] parameters in the dynamic control parameter window.
- After the parameter adjustment is completed, the system automatically writes it into the [HSV.yaml] file and saves it, and the system will read it next time it is started.

in addition:

In calibration mode, you can also use the mouse for color calibration. First press the [F] key to switch colors, then select the color block, and then fine-tune [Hmin, Smin, Vmin, Hmax, Smax, Vmax] in the dynamic control parameter window. parameter.

15.1.2, second step

Notice:

1) Here it is best to adjust the runway in the middle of the camera screen and the direction of the blocks to be parallel to the runway, so that it is easier to clamp the blocks

2). At corners, the clamping claws may not be very effective at clamping blocks (maybe because the angle of rotation is a bit large, or the vehicle is traveling too fast and cannot see the obstacles), so at this time you need to reduce the speed a bit ,try again.

Method 1: Continuously click the [R1] button on the handle within 0.5 seconds to start line tracking.

Method 2: Autopilot (select the image window)

- Make sure the box to the right of [Calibration] is not selected, as shown in the picture above.
- Click [Spacebar] to perform line patrol operation.
- Click the [f] key to switch the color of the patrol line.
- Click the [i] key to enter recognition mode.
- Click the [c] key to switch to calibration mode.
- Click the [q] key to exit the program.

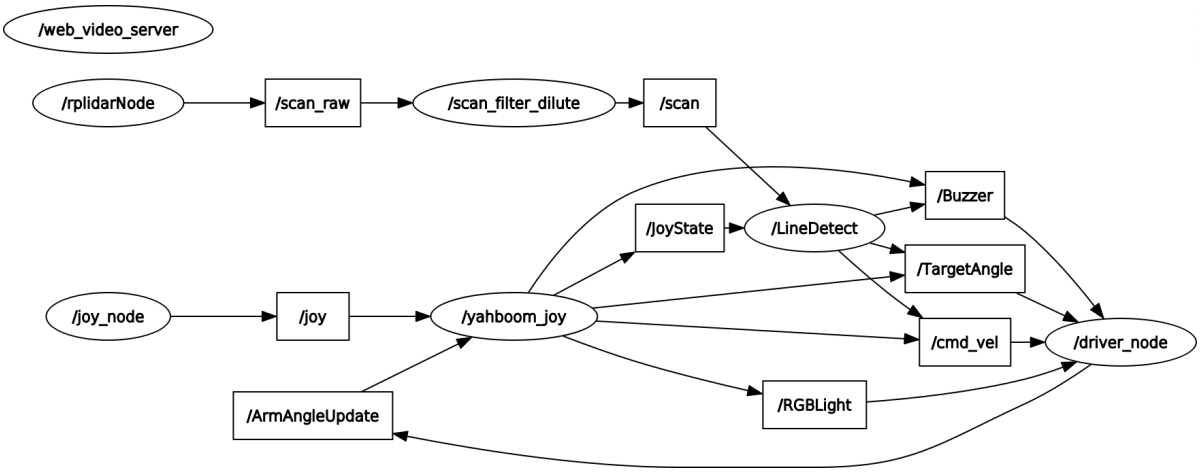
15.2, launch file

```
<launch>
     <arg name="img_flip" default="false"/>
     <include file="$(find ydlidar_ros_driver)/launch/TG.launch"/>
     <include file="$(find yahboomcar_ctrl)/launch/yahboom_joy.launch"/>
     <include file="$(find yahboomcar_bringup)/launch/yahboomcar.launch"/>
     <!-- web_video_server -->
     <node pkg="web_video_server" type="web_video_server" name="web_video_server"
output="screen"/>
     <node name="LineDetect" pkg="arm_autopilot" type="autopilot_main.py"
output="screen" required="true">
          <param name="img_flip" type="bool" value="$(arg img_flip)"/>
     </node>
</launch>
```

Generally, do not set the [img_flip] parameter. For image flip parameters, use the default [false].

15.3. Node graph

```
rqt_graph
```



15.4, flow chart