6.gmapping mapping algorithm

Gmapping： http://wiki.ros.org/gmapping/

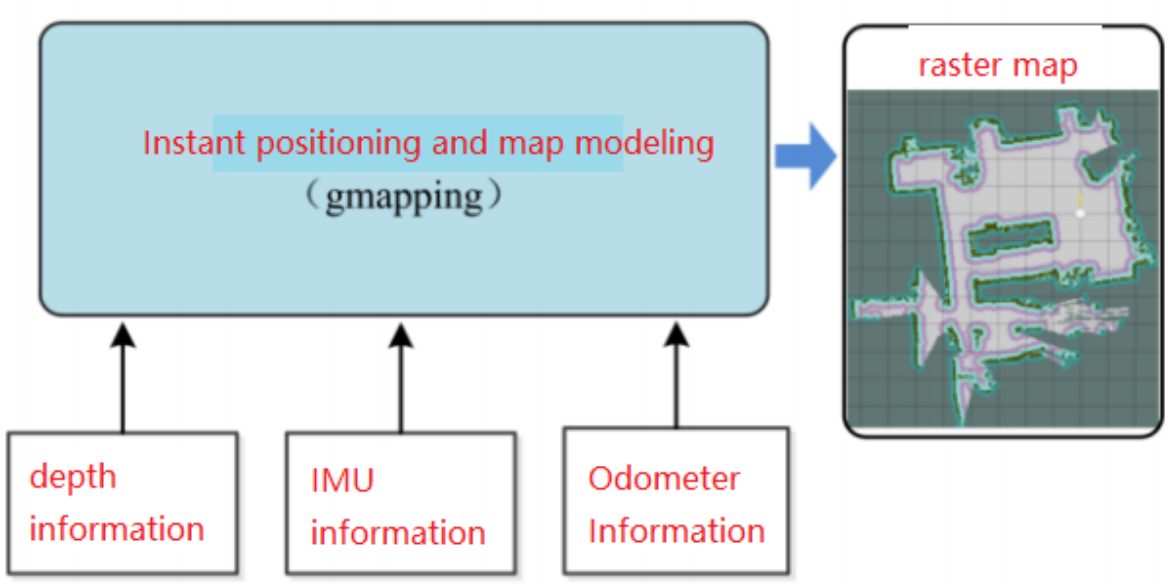
map_server： https://wiki.ros.org/map_server

6.1 Introduction

- gmapping is only applicable to points with less than 1440 2D laser points in a single frame. If the number of laser points in a single frame is greater than 1440, there will be a problem like [[mapping-4] process has died].
- Gmapping is a common open source SLAM algorithm based on the filtering SLAM framework.
- Gmapping is based on the RBpf particle filter algorithm, and the real-time positioning and mapping process are separated, and the positioning is carried out first and then the mapping is carried out.
- Gmapping makes two major improvements to the RBpf algorithm: improved proposal distribution and selective resampling.

Advantages: Gmapping can build indoor maps in real time, requiring less computation and higher accuracy in building small scene maps.

Disadvantage: As the scene grows, the number of particles required increases, because each particle carries a map, so the memory and computation required to build a large map will increase. Therefore, it is not suitable for building large scene maps. And there is no loopback detection, so the map may be dislocated when the loopback is closed. Although increasing the number of particles can make the map closed, it comes at the cost of increasing computation and memory.



6.2 Use

Note: When building a map, the slower the speed, the better the effect(note that if the rotation speed is slower), the effect will be poor if the speed is too fast.

According to different models, you only need to set the purchased model in [.bashrc], X1(ordinary four-wheel drive) X3(Mike wheel) X3plus(Mike wheel mechanical arm) R2(Ackerman differential) and so on. Section takes X3 as an example

Open the [.bashrc] file

```
sudo vim .bashrc
```

Find the [ROBOT_TYPE] parameter and modify the corresponding model

```
export  ROBOT_TYPE=X3    # ROBOT_TYPE: X1 X3 X3plus R2 X7
```

6.2.1 Start

Start command(robot side), for the convenience of operation, this section takes [mono + laser + yahboomcar] as an example.

```
#You need to enter docker first, perform this step more
#If running the script to enter docker fails, please refer to 07.Docker-orin/05,
Enter the robot's docker container
~/run_docker.sh
roslaunch  yahboomcar_nav  laser_bringup.launch           # laser + yahboomcar
roslaunch  yahboomcar_nav  laser_usb_bringup.launch       # mono + laser +
yahboomcar
roslaunch  yahboomcar_nav  laser_astrapro_bringup.launch   # Astra + laser +
yahboomcar
```

Mapping command(robot side)

<Open another terminal and 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:/#
```

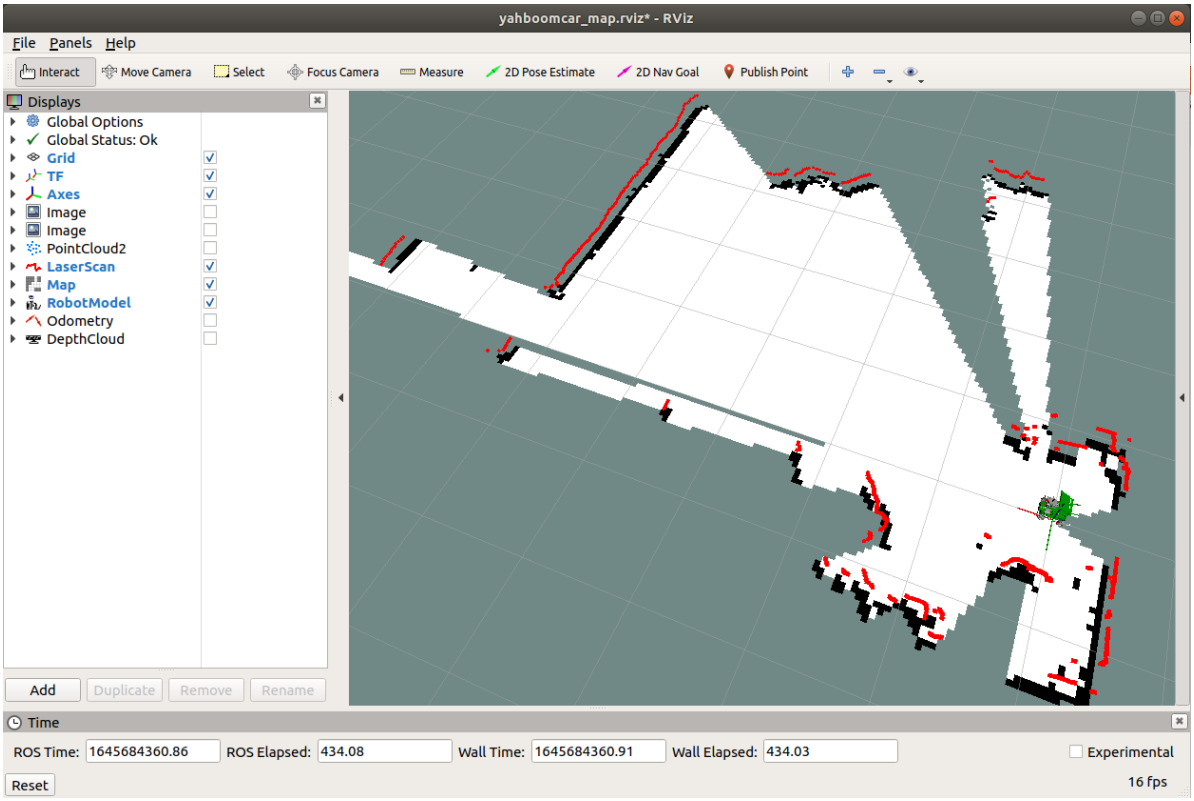
After successfully entering the container, you can open countless terminals to enter the container.

```
roslaunch yahboomcar_nav yahboomcar_map.launch use_rviz:=false map_type:=gmapping
```

- [use_rviz] parameter: whether to enable rviz visualization.
- [map_type] parameter: set the mapping algorithm [gmapping].

Open the visual interface(virtual machine side)

```
roslaunch yahboomcar_nav view_map.launch
```



The gap at the back of the robot is due to the occlusion of the installation position of the display screen, so a certain range of Lidar data is shielded. The shielding range can be adjusted or not shielded according to the actual situation. For details, see [01. Lidar Basic Course].

6.2.2 Control the robot

- The keyboard controls the movement of the robot

```
roslaunch yahboomcar_ctrl yahboom_keyboard.launch        # custom
```

- The handle controls the movement of the robot

Make the robot walk all over the area to be built, and the map is as closed as possible.

There may be some scattered points during the mapping process. If the mapping environment is well closed and regular, the movement is slow, and the scattering phenomenon is much smaller.

6.2.3 Map save

```
rosrun map_server map_saver -f ~/yahboomcar_ws/src/yahboomcar_nav/maps/my_map
  # The first way
bash ~/yahboomcar_ws/src/yahboomcar_nav/maps/map.sh
# second way
```

The map will be saved to ~/yahboomcar_ws/src/yahboomcar_nav/maps/ folder, a pgm image, a yaml file.

map.yaml

```
image :  map.pgm
resolution :  0.05
origin : [-15.4,-12.2,0.0]
negate :  0
occupied_thresh :  0.65
free_thresh:  0.196
```

Parameter parsing:

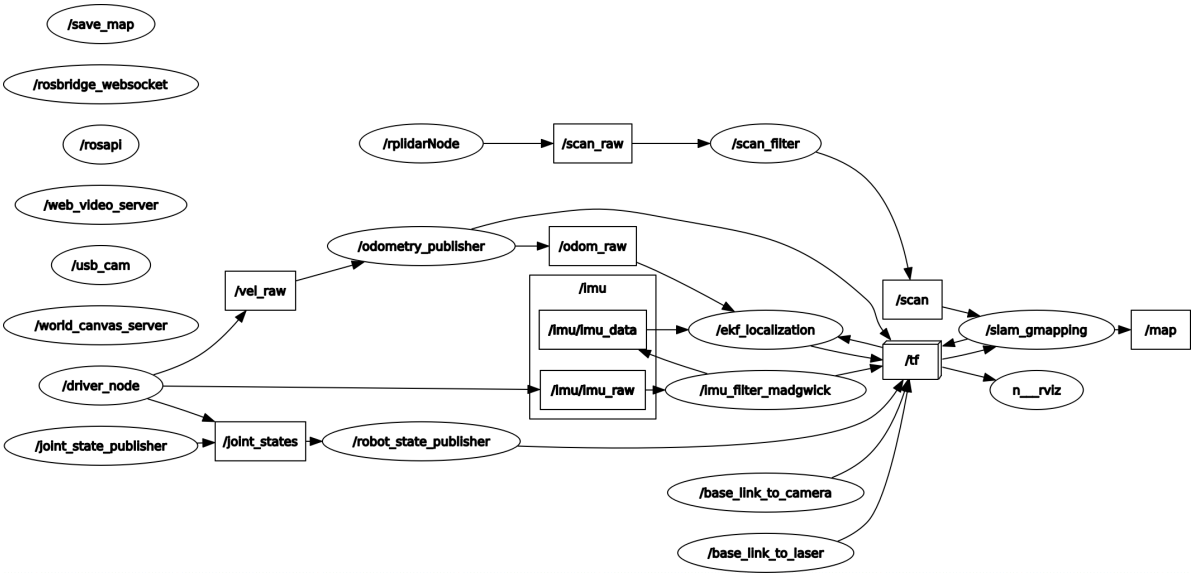
- image: The path of the map file, which can be an absolute path or a relative path
- resolution: the resolution of the map, m/pixel
- origin: The 2D pose(x, y, yaw) of the lower left corner of the map, where yaw is rotated counterclockwise(yaw=0 means no rotation). Many parts of the system currently ignore the yaw value.
- negate: whether to reverse the meaning of white/black, free/occupy(the interpretation of the threshold is not affected)
- occupied_thresh: Pixels with an occupancy probability greater than this threshold will be considered fully occupied.
- free_thresh: Pixels with an occupancy probability less than this threshold will be considered completely free.

6.2 Topics and Services

Subscribe to topics	**type**	**describe**
tf	tf/tfMessage	Used to convert between lidar coordinate system, base coordinate system, and odometer coordinate system
scan	sensor_msgs/LaserScan	Lidar scan data
Post a topic	**type**	**describe**
map_metadata	nav_msgs/MapMetaData	Publish map Meta data
map	nav_msgs/OccupancyGrid	Publish map raster data
~entropy	std_msgs/Float64	Publish an estimate of the robot pose distribution entropy
Serve	**type**	**describe**
dynamic_map	nav_msgs/GetMap	Get map data

Node view

```
rqt_graph
```



6.3 configuration parameters

parameter	type	Defaults	describe
~throttle_scans	int	1	After receiving the laser data of this number of frames, only one frame of data is processed. By default, it is processed every time a frame of data is received.
~base_frame	string	"base_link"	Robot base coordinate system
~map_frame	string	"map"	map coordinate system
~odom_frame	string	"odom"	Odometer Coordinate System
~map_update_interval	float	5.0	The map update frequency, the lower the value, the greater the computational load
~maxUrange	float	80.0	The maximum range that the laser can detect
~sigma	float	0.05	Standard Deviation of Endpoint Match
~kernelSize	int	1	Find in the corresponding kernel
~lstep	float	0.05	Optimization step size during translation
~astep	float	0.05	Optimization step size during rotation
~iterations	int	5	The number of iterations to scan for matches
~lsigma	float	0.075	Laser Standard Deviation for Likelihood Calculations
~ ogain	float	3.0	Used to smooth the resampling effect when calculating the likelihood
~ lskip	int	0	Number of beams skipped per scan
~ minimumScore	float	0	Scan the lowest value for matching results. Avoid jumping pose estimation in large open spaces when using laser scanners with limited range(e.g. 5m)
~srr	float	0.1	translation function(rho/rho), odometer error while translation
~srt	float	0.2	Rotation function(rho/theta), odometry error in translation

parameter	type	Defaults	describe
~str	float	0.1	Translation function(theta/rho), odometry error while rotating
~stt	float	0.2	Rotation function(theta/theta), odometer error while rotating
~linearUpdate	float	1.0	After the robot translates this distance, the laser scan data is processed once
~angularUpdate	float	0.5	The laser scan data is processed every time the robot rotates this distance
~temporalUpdate	float	-1.0	If the latest scan is being processed slower than the update, then a scan is processed. A negative value turns off time-based updates
~resampleThreshold	float	0.5	Resampling threshold based on Neff
~particles	int	30	number of particles in the filter
~xmin	float	-100.0	map x to initial minimum size
~ymin	float	-100.0	Map y to initial minimum size
~xmax	float	100.0	map x to initial maximum size
~ymax	float	100.0	The initial maximum size of the map y direction
~delta	float	0.05	map resolution
~llsamplerange	float	0.01	Shifted sampling distance for likelihood calculation
~llsamplestep	float	0.01	Shifted sampling step size for likelihood calculation
~lasamplerange	float	0.005	Rotation sampling distance for likelihood calculation
~lasamplestep	float	0.005	Rotation sampling step size for likelihood calculation
~transform_publish_period	float	0.05	The time interval at which the TF transform is published
~occ_threh	float	0.25	Threshold for raster map occupancy
~maxRange(float)	float	-	maximum range of the sensor

6.4 TF transformation

Required TF Transform	**describe**
laser-->base_link	The transformation between the lidar coordinate system and the base coordinate system, generally published by robot_state_publisher or static_transform_publisher
base_link-->odom	The transformation between the map coordinate system and the robot's odometer coordinate system to estimate the robot's pose in the map
Published TF Transform	**describe**
map-->odom	The transformation between the map coordinate system and the robot's odometer coordinate system to estimate the robot's pose in the map

View tf tree

```
rosrun rqt_tf_tree rqt_tf_tree
```