4. Robot state estimation

4.1 Program function Description

After the program is run, combined with the imu data read from the ROS expansion board and the speed vel data, output an odom data that integrates imu and odom data, which can be applied to the positioning function.

4.2. Program Code Reference path

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

```
/userdata/yahboomcar_ws/src/yahboomcar_bringup/launch/yahboomcar_bringup_launch.py
```

ekf fusion program code reference path,

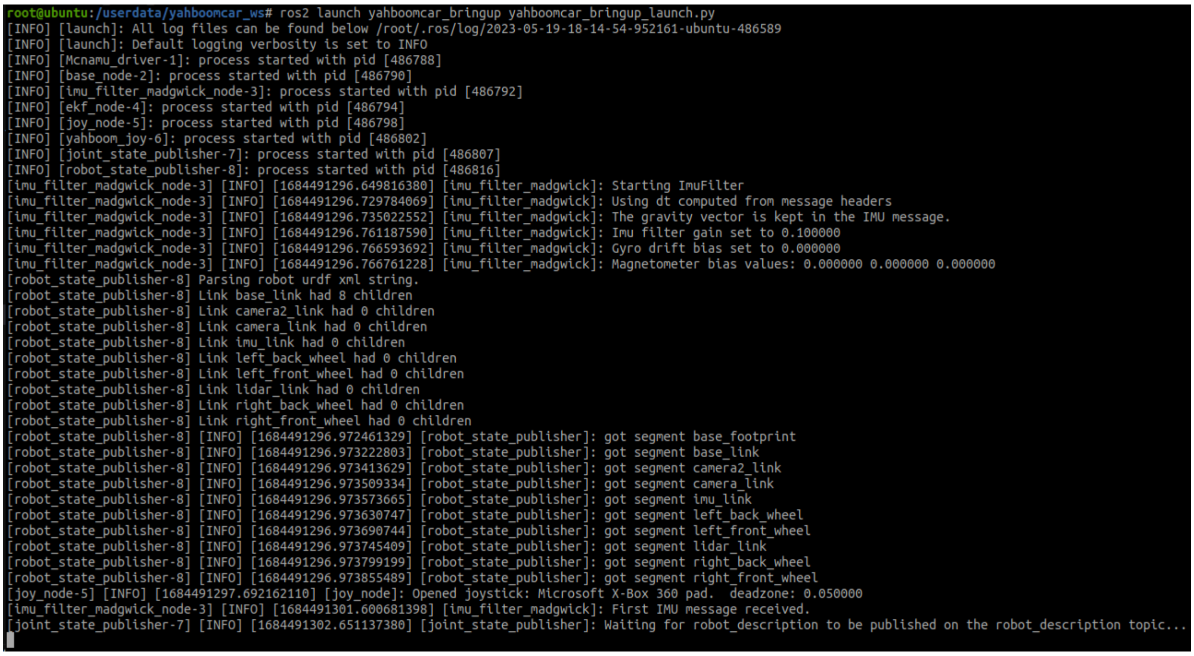
```
/userdata/yahboomcar_ws/src/robot_localization/launch/ekf.launch.py
```

4.3. Program Startup

4.3.1. Launch command

After SSH connects to the car, terminal input,

```
ros2 launch yahboomcar_bringup yahboomcar_bringup_launch.py
```

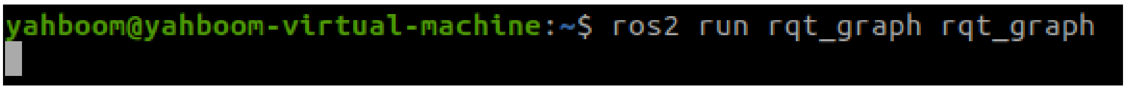


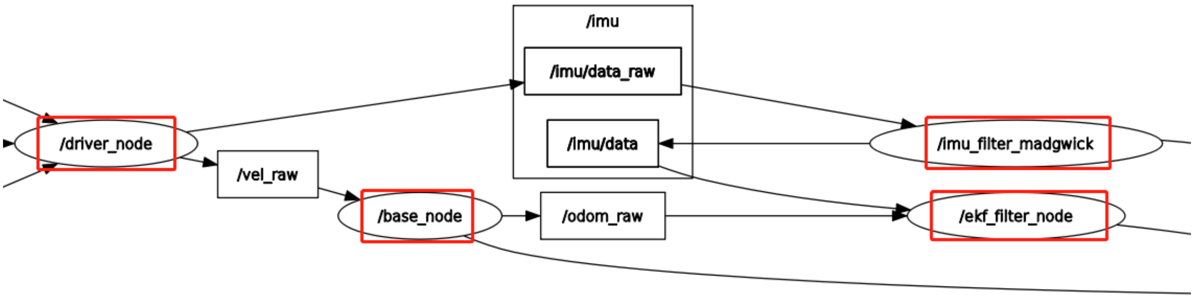
```
root@ubuntu:/userdata/yahboomcar_ws# ros2 launch yahboomcar_bringup yahboomcar_bringup_launch.py
[INFO] [launch]: All log files can be found below /root/.ros/log/2023-05-19-18-14-54-952161-ubuntu-486589
[INFO] [launch]: Default logging verbosity is set to INFO
[INFO] [Mcnamu_driver-1]: process started with pid [486788]
[INFO] [base_node-2]: process started with pid [486790]
[INFO] [imu_filter_madgwick_node-3]: process started with pid [486792]
[INFO] [ekf_node-4]: process started with pid [486794]
[INFO] [joy_node-5]: process started with pid [486798]
[INFO] [yahboom_joy-6]: process started with pid [486802]
[INFO] [joint_state_publisher-7]: process started with pid [486807]
[INFO] [robot_state_publisher-8]: process started with pid [486816]
[imu_filter_madgwick_node-3] [INFO] [1684491296.649816380] [imu_filter_madgwick]: Starting ImuFilter
[imu_filter_madgwick_node-3] [INFO] [1684491296.729784069] [imu_filter_madgwick]: Using dt computed from message headers
[imu_filter_madgwick_node-3] [INFO] [1684491296.735022552] [imu_filter_madgwick]: The gravity vector is kept in the IMU message.
[imu_filter_madgwick_node-3] [INFO] [1684491296.761187590] [imu_filter_madgwick]: Imu filter gain set to 0.100000
[imu_filter_madgwick_node-3] [INFO] [1684491296.766593692] [imu_filter_madgwick]: Gyro drift bias set to 0.000000
[imu_filter_madgwick_node-3] [INFO] [1684491296.766761228] [imu_filter_madgwick]: Magnetometer bias values: 0.000000 0.000000 0.000000
[robot_state_publisher-8] Parsing robot urdf xml string.
[robot_state_publisher-8] Link base_link had 8 children
[robot_state_publisher-8] Link camera2_link had 0 children
[robot_state_publisher-8] Link camera_link had 0 children
[robot_state_publisher-8] Link imu_link had 0 children
[robot_state_publisher-8] Link left_back_wheel had 0 children
[robot_state_publisher-8] Link left_front_wheel had 0 children
[robot_state_publisher-8] Link lidar_link had 0 children
[robot_state_publisher-8] Link right_back_wheel had 0 children
[robot_state_publisher-8] Link right_front_wheel had 0 children
[robot_state_publisher-8] [INFO] [1684491296.972461329] [robot_state_publisher]: got segment base_footprint
[robot_state_publisher-8] [INFO] [1684491296.973222803] [robot_state_publisher]: got segment base_link
[robot_state_publisher-8] [INFO] [1684491296.973413629] [robot_state_publisher]: got segment camera2_link
[robot_state_publisher-8] [INFO] [1684491296.973509334] [robot_state_publisher]: got segment camera_link
[robot_state_publisher-8] [INFO] [1684491296.973573665] [robot_state_publisher]: got segment imu_link
[robot_state_publisher-8] [INFO] [1684491296.973630747] [robot_state_publisher]: got segment left_back_wheel
[robot_state_publisher-8] [INFO] [1684491296.973690744] [robot_state_publisher]: got segment left_front_wheel
[robot_state_publisher-8] [INFO] [1684491296.973745409] [robot_state_publisher]: got segment lidar_link
[robot_state_publisher-8] [INFO] [1684491296.973799199] [robot_state_publisher]: got segment right_back_wheel
[robot_state_publisher-8] [INFO] [1684491296.973855489] [robot_state_publisher]: got segment right_front_wheel
[joy_node-5] [INFO] [1684491297.692162110] [joy_node]: Opened joystick: Microsoft X-Box 360 pad.  deadzone: 0.050000
[imu_filter_madgwick_node-3] [INFO] [1684491301.600681398] [imu_filter_madgwick]: First IMU message received.
[joint_state_publisher-7] [INFO] [1684491302.651137380] [joint_state_publisher]: Waiting for robot_description to be published on the robot_description topic...
```

4.3.2. View the node communication graph

Open the VM terminal and enter.

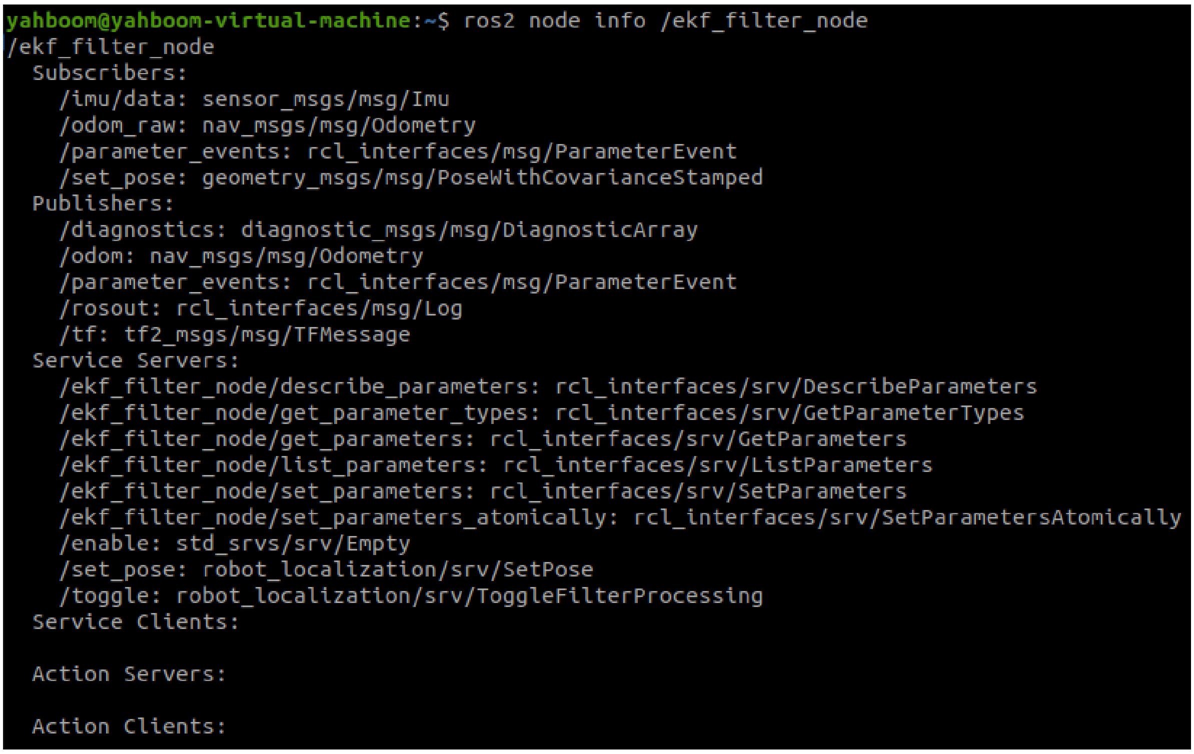
```
ros2 run rqt_graph rqt_graph
```

> [Note] As RDK-X3 board does not provide a graphical desktop environment, ros rqt related operations need to be implemented on the PC side (virtual machine side). That is, as long as the communication between the PC and the car is normal, you can directly run the relevant instructions without SSH connection to the car after opening the terminal.
>
> 
>
> ```
> yahboom@yahboom-virtual-machine:~$ ros2 run rqt_graph rqt_graph
> ```



It can be seen from the node input and output in the red box in the above figure that /ekf_filter_node receives odom_raw data and imu_data data for fusion, and finally outputs and publishes an odom data, which can be viewed through ros2 node tool.

```
ros2 node info /ekf_filter_node
```



```
yahboom@yahboom-virtual-machine:~$ ros2 node info /ekf_filter_node
/ekf_filter_node
  Subscribers:
    /imu/data: sensor_msgs/msg/Imu
    /odom_raw: nav_msgs/msg/Odometry
    /parameter_events: rcl_interfaces/msg/ParameterEvent
    /set_pose: geometry_msgs/msg/PoseWithCovarianceStamped
  Publishers:
    /diagnostics: diagnostic_msgs/msg/DiagnosticArray
    /odom: nav_msgs/msg/Odometry
    /parameter_events: rcl_interfaces/msg/ParameterEvent
    /rosout: rcl_interfaces/msg/Log
    /tf: tf2_msgs/msg/TFMessage
  Service Servers:
    /ekf_filter_node/describe_parameters: rcl_interfaces/srv/DescribeParameters
    /ekf_filter_node/get_parameter_types: rcl_interfaces/srv/GetParameterTypes
    /ekf_filter_node/get_parameters: rcl_interfaces/srv/GetParameters
    /ekf_filter_node/list_parameters: rcl_interfaces/srv/ListParameters
    /ekf_filter_node/set_parameters: rcl_interfaces/srv/SetParameters
    /ekf_filter_node/set_parameters_atomically: rcl_interfaces/srv/SetParametersAtomically
    /enable: std_srvs/srv/Empty
    /set_pose: robot_localization/srv/SetPose
    /toggle: robot_localization/srv/ToggleFilterProcessing
  Service Clients:

  Action Servers:

  Action Clients:
```

4.4 launch file parsing

Let's look at the main relevant nodes of the launch file.

- /driver_node: start the car chassis, obtain the wheel speed vel data and publish it to the /base_node node, obtain the imu data and publish it to the /imu_filter_node node.
- /base_node: receives vel data, converts it into odom_raw data through calculation, and publishes it to the /ekf_node node.
- /imu_filter_node: receives the imu data released by the chassis, filters it by its own algorithm, and sends the filtered imu/data data to the /ekf_node.
- /ekf_node: receives odom data published by /base_node and imu/data published by /imu_filter_node, uses its own algorithm to fuse and publish odom data.