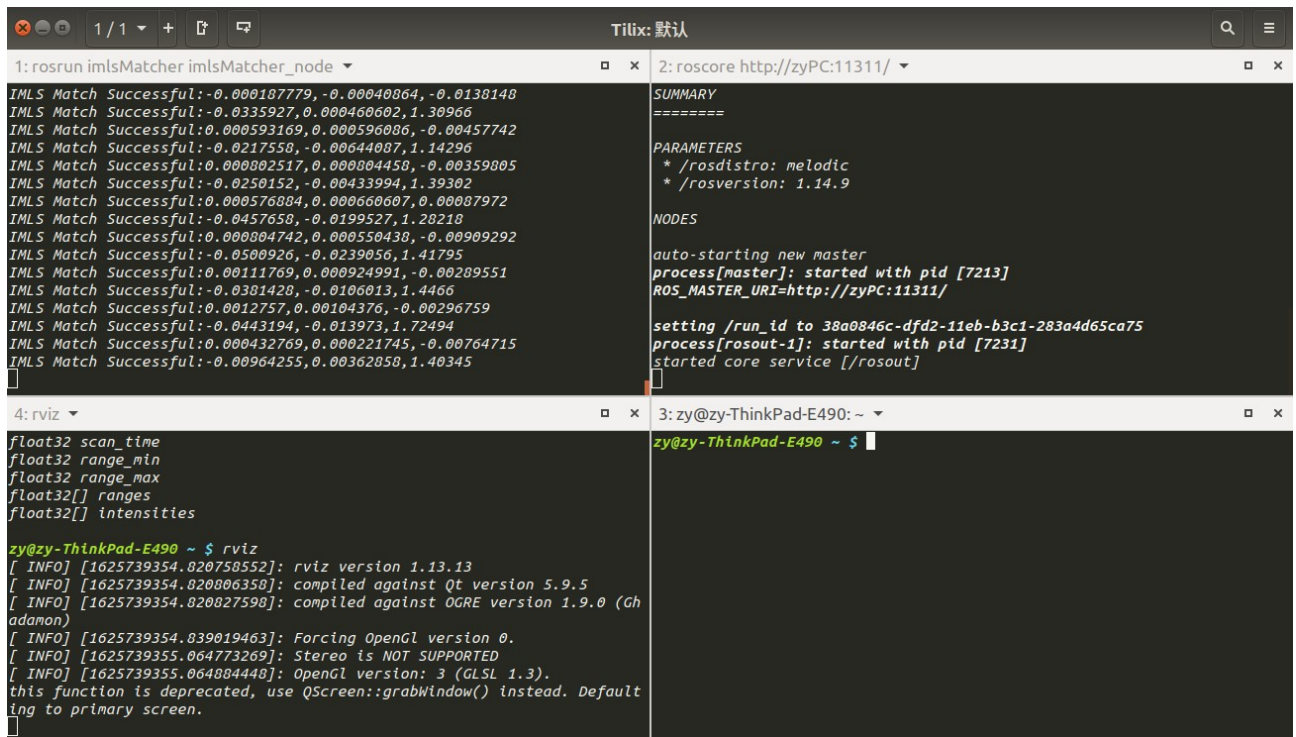


第一题：详见代码 imls_icp.cpp 和截图

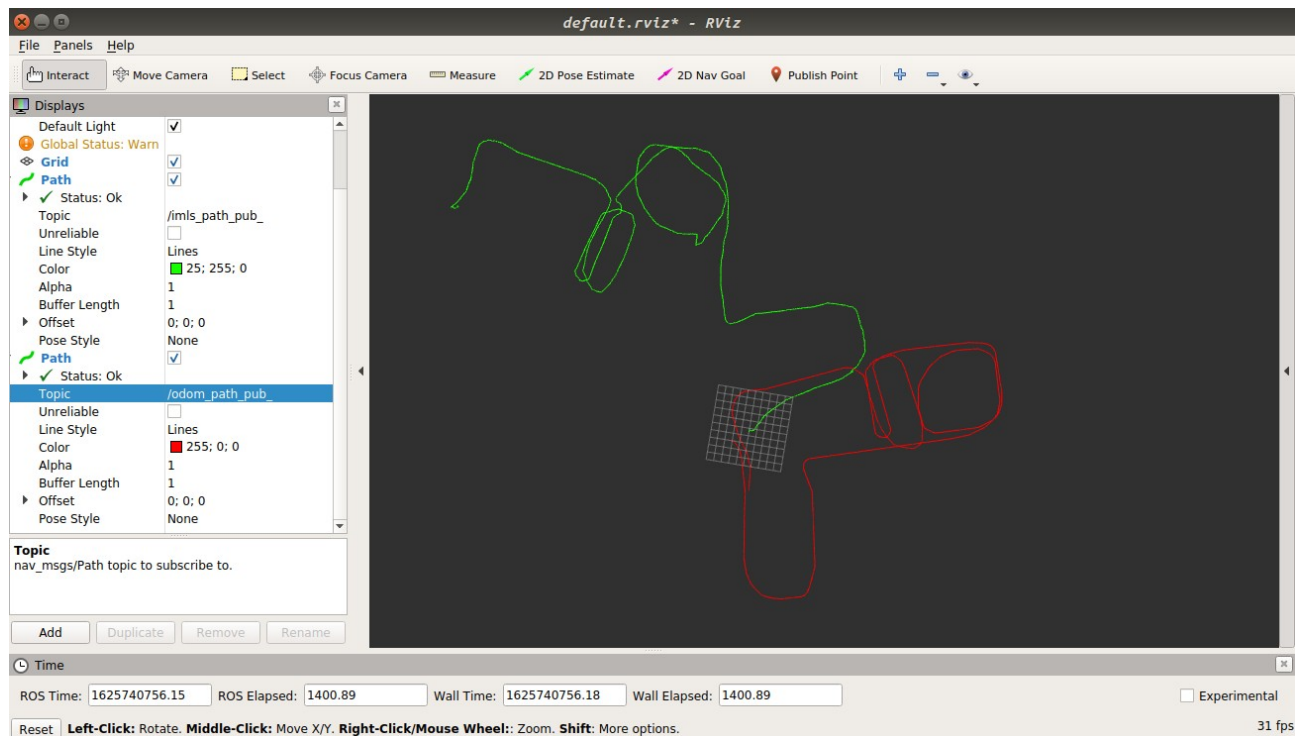


The screenshot shows a terminal window with four panes. The top-left pane shows the output of 'rosrun imlsMatcher imlsMatcher_node', displaying a series of 'IMLS Match Successful' messages with numerical data. The top-right pane shows the output of 'roscore http://zyPC:11311/', displaying the ROS master's startup summary, parameters (melodic, 1.14.9), and nodes (auto-starting new master). The bottom-left pane shows the output of 'rviz', displaying the rviz version (1.13.13) and various system messages. The bottom-right pane shows the prompt 'zy@zy-ThinkPad-E490 ~ \$'.

```
1: rosrn imlsMatcher imlsMatcher_node
IMLS Match Successful:-0.000107779,-0.00040064,-0.0130148
IMLS Match Successful:-0.0335927,0.000460602,1.30966
IMLS Match Successful:0.000593169,0.000596006,-0.00457742
IMLS Match Successful:-0.0217550,-0.00644007,1.14296
IMLS Match Successful:0.000002517,0.000004450,-0.00359005
IMLS Match Successful:-0.0250152,-0.00433994,1.39302
IMLS Match Successful:0.000576004,0.000660607,0.00087972
IMLS Match Successful:-0.0457658,-0.0199527,1.20218
IMLS Match Successful:0.000004742,0.000550438,-0.00909292
IMLS Match Successful:-0.0500926,-0.0239056,1.41795
IMLS Match Successful:0.00111769,0.000924991,-0.00209551
IMLS Match Successful:0.0301428,-0.0106013,1.4466
IMLS Match Successful:0.0012757,0.00104376,-0.00296759
IMLS Match Successful:-0.0443194,-0.013973,1.72494
IMLS Match Successful:0.000432769,0.000221745,-0.00764715
IMLS Match Successful:-0.00964255,0.00362058,1.40345

2: roscore http://zyPC:11311/
SUMMARY
=====
PARAMETERS
* /rostdistro: melodic
* /rosversion: 1.14.9
NODES
auto-starting new master
process[master]: started with pid [7213]
ROS_MASTER_URI=http://zyPC:11311/
setting /run_id to 38a0046c-dfd2-11eb-b3c1-283a4d65ca75
process[rosout-1]: started with pid [7231]
started core service [/rosout]

4: rviz
float32 scan_time
float32 range_min
float32 range_max
float32[] ranges
float32[] intensities
zy@zy-ThinkPad-E490 ~ $ rviz
[ INFO] [1625739354.020758552]: rviz version 1.13.13
[ INFO] [1625739354.020806358]: compiled against Qt version 5.9.5
[ INFO] [1625739354.020827598]: compiled against OGRE version 1.9.0 (Gh
adamon)
[ INFO] [1625739354.839019463]: Forcing OpenGL version 0.
[ INFO] [1625739355.064773269]: Stereo is NOT SUPPORTED
[ INFO] [1625739355.064804448]: OpenGL version: 3 (GLSL 1.3).
this function is deprecated, use QScreen::grabWindow() instead. Default
ing to primary screen.
```



第二题：详见代码 main.cpp 和截图

```
Tilix: 默认
1: roscore http://zyPC:11311/
2: roslaunch imlsMatcher imlsMatcher_node
3: rviz

setting /run_id to 669685a6-e17b-11eb-9564-283a4d65ca75
process[rosout-1]: started with pid [23175]
started core service [/rosout]
^C[rosout-1] killing on exit
[master] killing on exit
shutting down processing monitor...
... shutting down processing monitor complete
done
zy@zy-ThinkPad-E490 ~ $ roscore
... logging to /home/zy/.ros/log/391c9e02-e18b-11eb-872f-283a4d65ca75/r
oslaunch-zy-ThinkPad-E490-465.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://zyPC:37907/
ros_comm version 1.14.9

SUMMARY
=====
PARAMETERS
* /rostdistro: melodic
* /rosversion: 1.14.9

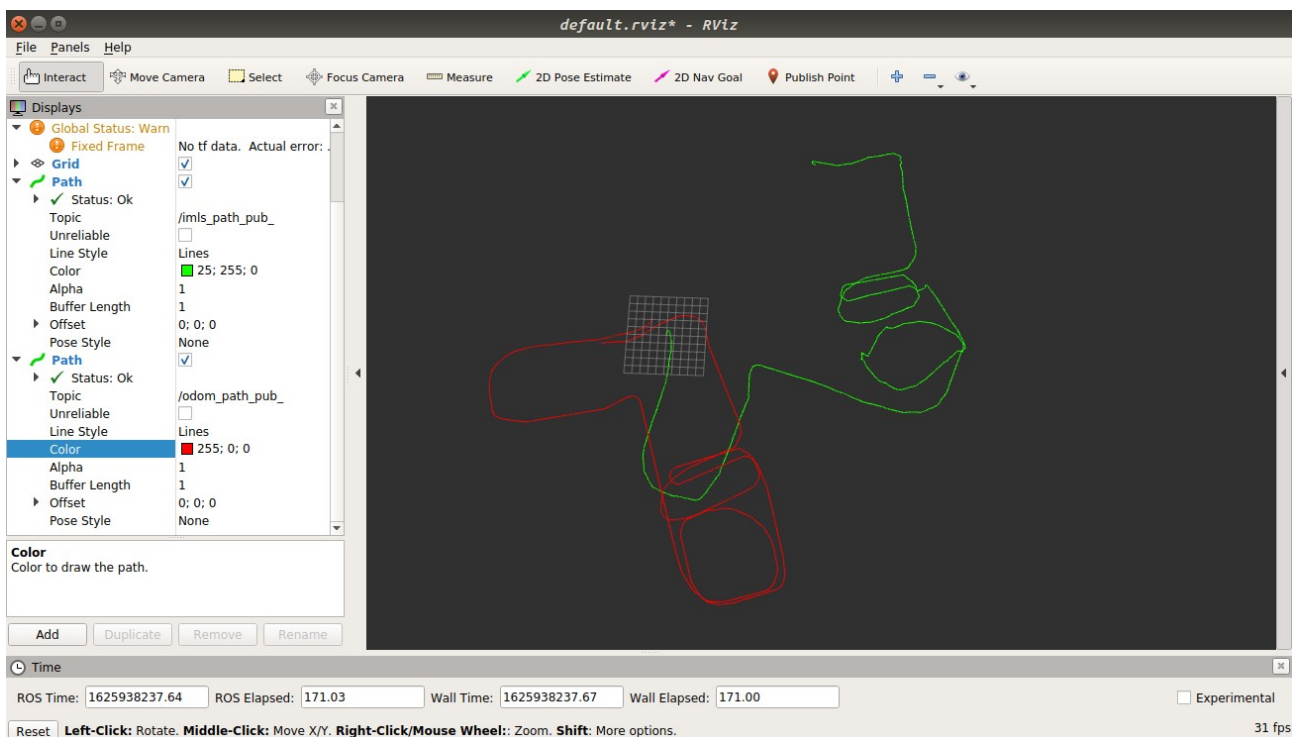
NODES

auto-starting new master
process[roscpp]: started with pid [475]
ROS_MASTER_URI=http://zyPC:11311/

setting /run_id to 391c9e02-e18b-11eb-872f-283a4d65ca75
process[rosout-1]: started with pid [487]
started core service [/rosout]

PI ICP Failed!!!!!!
k=143; I expect C to be a symmetric matrix.
:err: gpc_solve_valid failed
:err: icp_loop: Cannot compute next estimate.
:err: icp: ICP failed for some reason.
PI ICP Failed!!!!!!
k=269; I expect C to be a symmetric matrix.
:err: gpc_solve_valid failed
:err: icp_loop: Cannot compute next estimate.
:err: icp: ICP failed for some reason.
PI ICP Failed!!!!!!
k=239; I expect C to be a symmetric matrix.
:err: gpc_solve_valid failed
:err: icp_loop: Cannot compute next estimate.
:err: icp: ICP failed for some reason.
PI ICP Failed!!!!!!

[ INFO] [1625927393.507766622]: rviz version 1.13.13
[ INFO] [1625927393.507876749]: compiled against Qt version 5.9.5
[ INFO] [1625927393.507922956]: compiled against OGRE version 1.9.0 (Ch
adamon)
[ INFO] [1625927393.523782603]: Forcing OpenGL version 0.
[ INFO] [1625927393.820140420]: Stereo is NOT SUPPORTED
[ INFO] [1625927393.820221134]: OpenGL version: 3 (GLSL 1.3).
^C
zy@zy-ThinkPad-E490 ~ $ rviz
[ INFO] [1625938066.314866249]: rviz version 1.13.13
[ INFO] [1625938066.314918498]: compiled against Qt version 5.9.5
[ INFO] [1625938066.314930362]: compiled against OGRE version 1.9.0 (Ch
adamon)
[ INFO] [1625938066.317990993]: Forcing OpenGL version 0.
[ INFO] [1625938066.446337282]: Stereo is NOT SUPPORTED
[ INFO] [1625938066.446398529]: OpenGL version: 3 (GLSL 1.3).
```



第三题：

区别：误差定义不同：ICP 点到点的距离，PL-ICP 点到线的距离，NICP 除了考虑欧氏距离，还考虑了法向量之间的夹角和曲率，IMLS-ICP 点到隐藏线的距离

相同点：处理思路相同，激光数据预处理，构建搜索树，寻找点到点，点到线，点到面的距离，构建误差函数，迭代计算误差和求解相邻帧的位姿变换，直到收敛或者迭代达到最大次数。

第四题：

对数据预处理，数据聚类，根据曲率提取当前帧边缘点和直线点，分别与上一帧边缘点和直线点进行匹配，减小计算量。