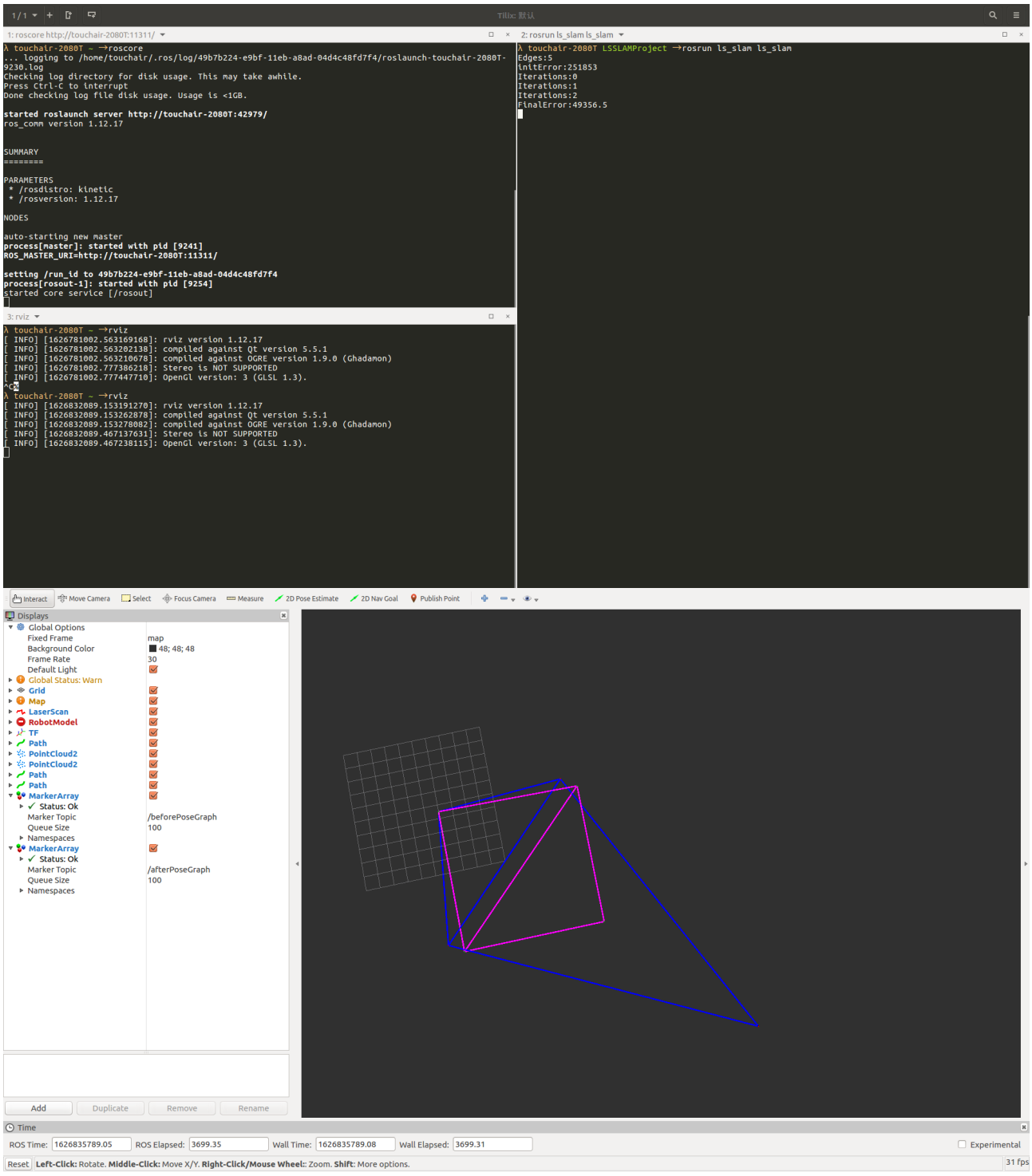
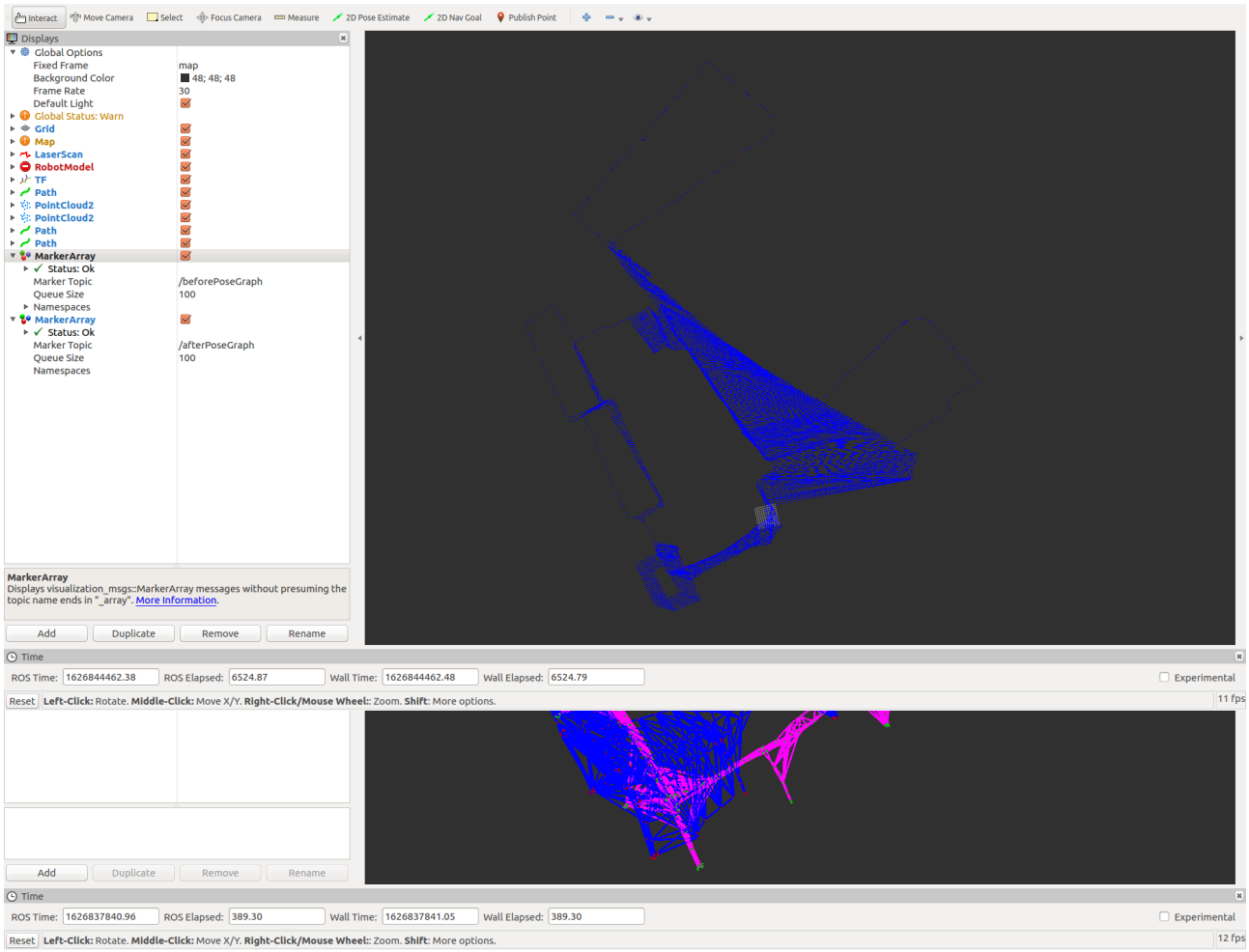
第一题：详见代码和截图


1: roscore http://touchair-2080T:11311/
touchair-2080T ~ →roscore
... logging to /home/touchairl/.ros/log/49b7b224-e9bf-11eb-a8ad-04d4c48fd7f4/roslaunch-touchair-2080T-9230.log
Checking log directory for disk usage. This may take awhile.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.
started roslaunch server http://touchair-2080T:42979/
ros_comm version 1.12.17
SUMMARY
PARAMETERS
* /rosdistro: kinetic
* /rosversion: 1.12.17
NODES
auto-starting new master
process[master]: started with pid [9241]
ROS_MASTER_URI=http://touchair-2080T:11311/
setting /run_id to 49b7b224-e9bf-11eb-a8ad-04d4c48fd7f4
process[rosout-1]: started with pid [9254]
started core service [/rosout]
2: rosrun ls_slam ls_slam
touchair-2080T LSSLAMProject →rosrun ls_slam ls_slam
Edges:5
initError:251853
Iterations:0
Iterations:1
Iterations:2
FinalError:49356.5
3: rviz
touchair-2080T ~ →rviz
[INFO] [1626781002.563169168]: rviz version 1.12.17
[INFO] [1626781002.563202138]: compiled against Qt version 5.5.1
[INFO] [1626781002.563210678]: compiled against OGRE version 1.9.0 (Ghadamon)
[INFO] [1626781002.777386218]: Stereo is NOT SUPPORTED
[INFO] [1626781002.777447710]: OpenGl version: 3 (GLSL 1.3).
^C
touchair-2080T ~ →rviz
[INFO] [1626832089.153191270]: rviz version 1.12.17
[INFO] [1626832089.153262878]: compiled against Qt version 5.5.1
[INFO] [1626832089.153278082]: compiled against OGRE version 1.9.0 (Ghadamon)
[INFO] [1626832089.467137631]: Stereo is NOT SUPPORTED
[INFO] [1626832089.467238115]: OpenGl version: 3 (GLSL 1.3).
Interact
Move Camera
Select
Focus Camera
Measure
2D Pose Estimate
2D Nav Goal
Publish Point
Displays
Global Options
Fixed Frame
map
Background Color
48; 48; 48
Frame Rate
30
Default Light
Global Status: Warn
Grid
Map
LaserScan
RobotModel
TF
Path
PointCloud2
PointCloud2
Path
Path
MarkerArray
Status: Ok
Marker Topic
/beforePoseGraph
Queue Size
100
Namespaces
MarkerArray
Status: Ok
Marker Topic
/afterPoseGraph
Queue Size
100
Namespaces
Add
Duplicate
Remove
Rename
Time
ROS Time:
1626835789.05
ROS Elapsed:
3699.35
Wall Time:
1626835789.08
Wall Elapsed:
3699.31
Experimental
Reset
Left-Click: Rotate. Middle-Click: Move X/Y. Right-Click/Mouse Wheel:: Zoom. Shift: More options.
31 fps



第二题:

第一题中求解 HΔx=-b 的过程最为耗时，可以通过 g2o 等优化库进行优化，简化计算过程。

第三题：

一阶梯度法，将目标函数在 x 附近进行泰勒展开:

$$\|f(\boldsymbol{x}+\Delta\boldsymbol{x})\|_2^2 \approx \|f(\boldsymbol{x})\|_2^2 + \boldsymbol{J}(\boldsymbol{x})\Delta\boldsymbol{x} + \frac{1}{2}\Delta\boldsymbol{x}^T\boldsymbol{H}\Delta\boldsymbol{x}$$

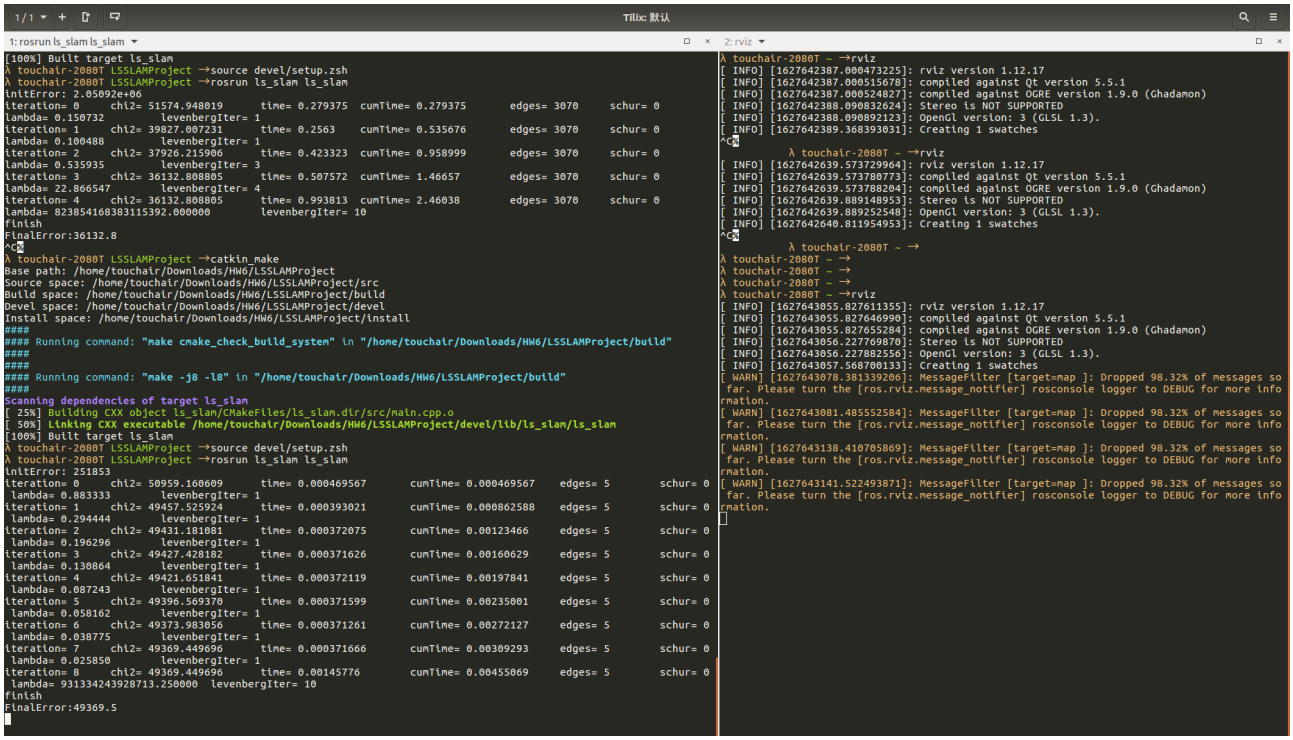
如果保留一阶梯度，则：$\Delta\boldsymbol{x}^* = -\boldsymbol{J}^T(\boldsymbol{x})$

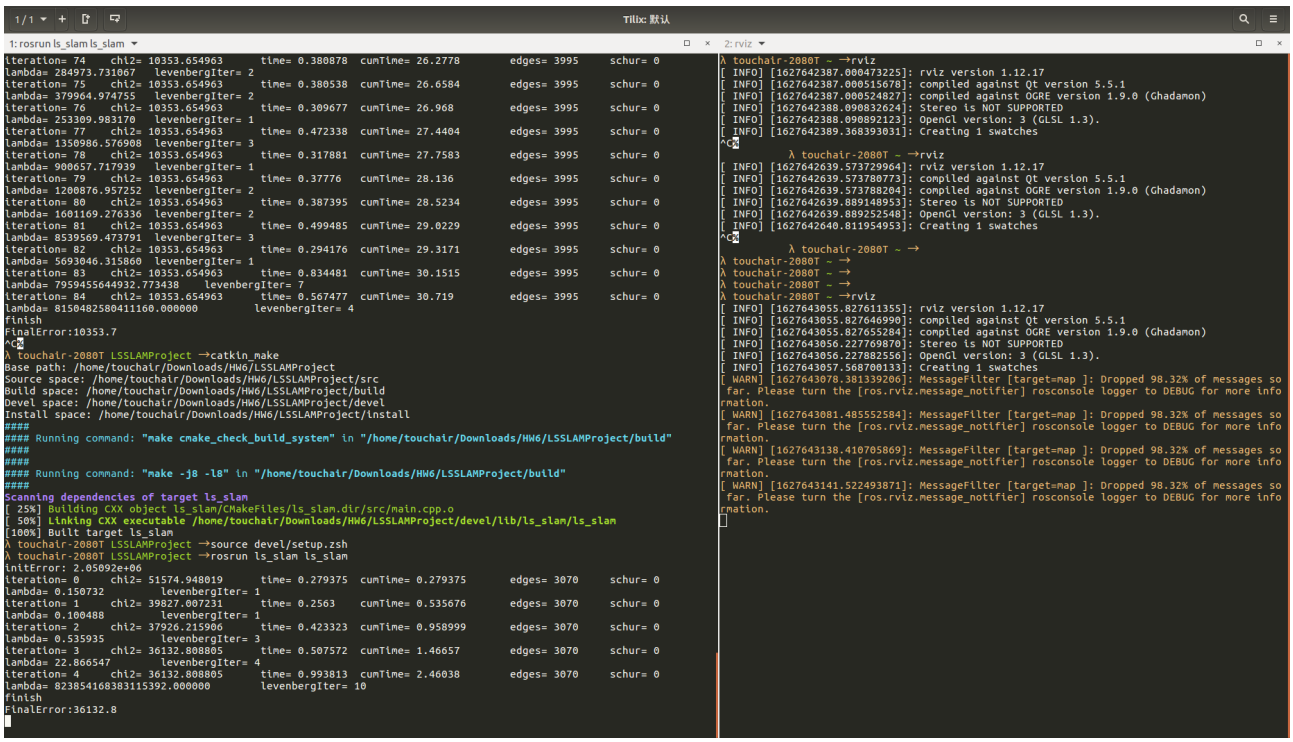
二阶梯度法，如果保留二阶梯度，则：$\boldsymbol{H}\Delta\boldsymbol{x} = -\boldsymbol{J}^T$

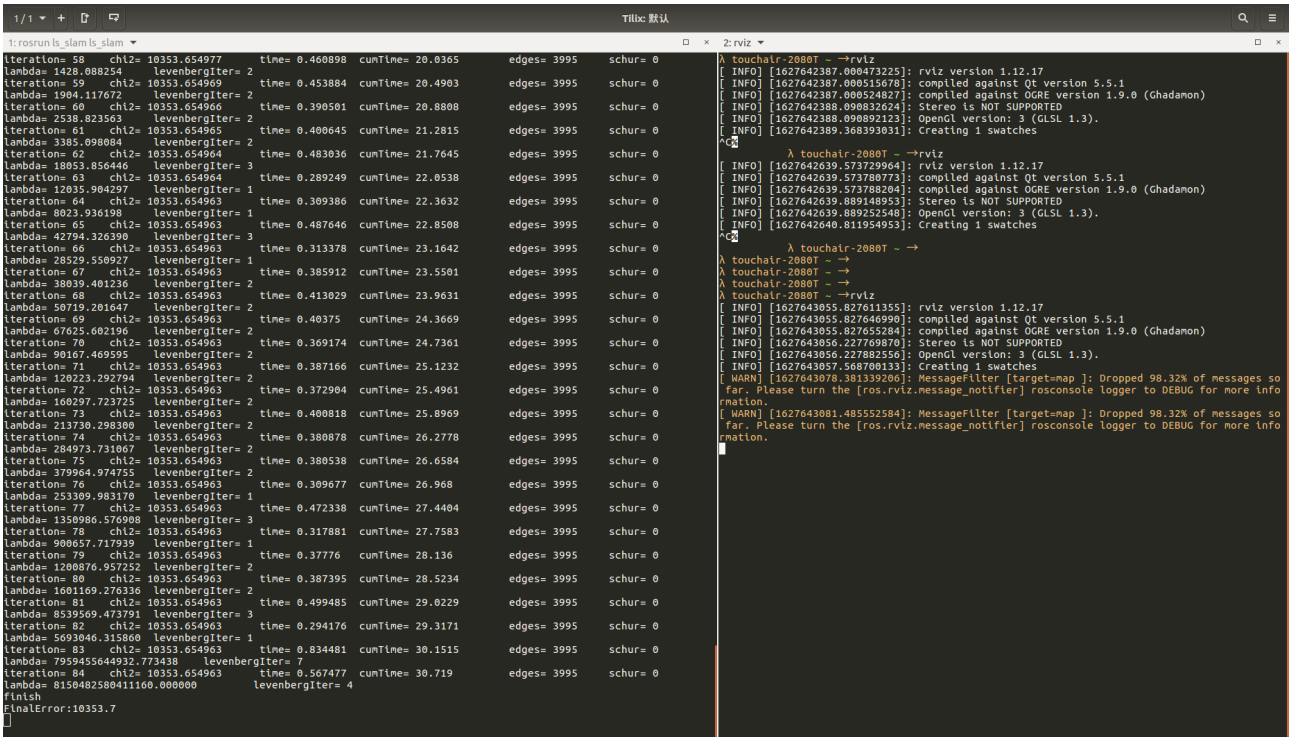
LM 方法，求解方程：$(H+\lambda I)\Delta x = g$

第四题：采用 g2o 和 ceres 进行优化，对比发现 ceres 求解时间最快，误差最小

g2o:


Tilix: 默认
1: rosrun ls_slam ls_slam
2: rviz
[100%] Built target ls_slam
λ touchair-2080T LSSLAMProject →source devel/setup.zsh
λ touchair-2080T LSSLAMProject →rosrun ls_slam ls_slam
initError: 2.05092e+06
iteration= 0 chi2= 51574.948019 time= 0.279375 cumTime= 0.279375 edges= 3070 schur= 0
lambda= 0.150732 levenbergIter= 1
iteration= 1 chi2= 39827.007231 time= 0.2563 cumTime= 0.535676 edges= 3070 schur= 0
lambda= 0.100488 levenbergIter= 1
iteration= 2 chi2= 37926.215906 time= 0.423323 cumTime= 0.958999 edges= 3070 schur= 0
lambda= 0.535935 levenbergIter= 3
iteration= 3 chi2= 36132.808805 time= 0.507572 cumTime= 1.46657 edges= 3070 schur= 0
lambda= 22.866547 levenbergIter= 4
iteration= 4 chi2= 36132.808805 time= 0.993813 cumTime= 2.46038 edges= 3070 schur= 0
lambda= 823854168383115392.000000 levenbergIter= 10
finish
FinalError:36132.8
^C
λ touchair-2080T LSSLAMProject →catkin_make
Base path: /home/touchair/Downloads/HW6/LSSLAMProject
Source space: /home/touchair/Downloads/HW6/LSSLAMProject/src
Build space: /home/touchair/Downloads/HW6/LSSLAMProject/build
Devel space: /home/touchair/Downloads/HW6/LSSLAMProject/devel
Install space: /home/touchair/Downloads/HW6/LSSLAMProject/install
####
Running command: "make cmake_check_build_system" in "/home/touchair/Downloads/HW6/LSSLAMProject/build"
####
####
Running command: "make -j8 -l8" in "/home/touchair/Downloads/HW6/LSSLAMProject/build"
####
Scanning dependencies of target ls_slam
[25%] Building CXX object ls_slam/CMakeFiles/ls_slam.dir/src/main.cpp.o
[50%] Linking CXX executable /home/touchair/Downloads/HW6/LSSLAMProject/devel/lib/ls_slam/ls_slam
[100%] Built target ls_slam
λ touchair-2080T LSSLAMProject →source devel/setup.zsh
λ touchair-2080T LSSLAMProject →rosrun ls_slam ls_slam
initError: 251853
iteration= 0 chi2= 50959.160609 time= 0.000469567 cumTime= 0.000469567 edges= 5 schur= 0
lambda= 0.883333 levenbergIter= 1
iteration= 1 chi2= 49457.525924 time= 0.000393021 cumTime= 0.000862588 edges= 5 schur= 0
lambda= 0.294444 levenbergIter= 1
iteration= 2 chi2= 49431.181081 time= 0.000372075 cumTime= 0.00123466 edges= 5 schur= 0
lambda= 0.196296 levenbergIter= 1
iteration= 3 chi2= 49427.428182 time= 0.000371626 cumTime= 0.00160629 edges= 5 schur= 0
lambda= 0.130864 levenbergIter= 1
iteration= 4 chi2= 49421.651841 time= 0.000372119 cumTime= 0.00197841 edges= 5 schur= 0
lambda= 0.087243 levenbergIter= 1
iteration= 5 chi2= 49396.569370 time= 0.000371599 cumTime= 0.00235001 edges= 5 schur= 0
lambda= 0.058162 levenbergIter= 1
iteration= 6 chi2= 49373.983056 time= 0.000371261 cumTime= 0.00272127 edges= 5 schur= 0
lambda= 0.038775 levenbergIter= 1
iteration= 7 chi2= 49369.449696 time= 0.000371666 cumTime= 0.00309293 edges= 5 schur= 0
lambda= 0.025850 levenbergIter= 1
iteration= 8 chi2= 49369.449696 time= 0.00145776 cumTime= 0.00455069 edges= 5 schur= 0
lambda= 931334243928713.250000 levenbergIter= 10
finish
FinalError:49369.5
λ touchair-2080T ~ →rviz
[INFO] [1627642387.000473225]: rviz version 1.12.17
[INFO] [1627642387.000515678]: compiled against Qt version 5.5.1
[INFO] [1627642387.000524827]: compiled against OGRE version 1.9.0 (Ghadamon)
[INFO] [1627642388.090832624]: Stereo is NOT SUPPORTED
[INFO] [1627642388.090892123]: OpenGl version: 3 (GLSL 1.3).
[INFO] [1627642389.368393031]: Creating 1 swatches
^C
λ touchair-2080T ~ →rviz
[INFO] [1627642639.573729964]: rviz version 1.12.17
[INFO] [1627642639.573780773]: compiled against Qt version 5.5.1
[INFO] [1627642639.573788204]: compiled against OGRE version 1.9.0 (Ghadamon)
[INFO] [1627642639.889148953]: Stereo is NOT SUPPORTED
[INFO] [1627642639.889252548]: OpenGl version: 3 (GLSL 1.3).
[INFO] [1627642640.811954953]: Creating 1 swatches
^C
λ touchair-2080T ~ →
λ touchair-2080T ~ →
λ touchair-2080T ~ →
λ touchair-2080T ~ →rviz
[INFO] [1627643055.827611355]: rviz version 1.12.17
[INFO] [1627643055.827646990]: compiled against Qt version 5.5.1
[INFO] [1627643055.827655284]: compiled against OGRE version 1.9.0 (Ghadamon)
[INFO] [1627643056.227769870]: Stereo is NOT SUPPORTED
[INFO] [1627643056.227882556]: OpenGl version: 3 (GLSL 1.3).
[INFO] [1627643057.568700133]: Creating 1 swatches
[WARN] [1627643078.381339206]: MessageFilter [target=map]: Dropped 98.32% of messages so far. Please turn the [ros.rviz.message_notifier] rosconsole logger to DEBUG for more information.
[WARN] [1627643081.485552584]: MessageFilter [target=map]: Dropped 98.32% of messages so far. Please turn the [ros.rviz.message_notifier] rosconsole logger to DEBUG for more information.
[WARN] [1627643138.410705869]: MessageFilter [target=map]: Dropped 98.32% of messages so far. Please turn the [ros.rviz.message_notifier] rosconsole logger to DEBUG for more information.
[WARN] [1627643141.522493871]: MessageFilter [target=map]: Dropped 98.32% of messages so far. Please turn the [ros.rviz.message_notifier] rosconsole logger to DEBUG for more information.


Tilix: 默认
1: rosrun ls_slam ls_slam
2: rviz
iteration= 74 chi2= 10353.654963 time= 0.380878 cumTime= 26.2778 edges= 3995 schur= 0
lambda= 284973.731067 levenbergIter= 2
iteration= 75 chi2= 10353.654963 time= 0.380538 cumTime= 26.6584 edges= 3995 schur= 0
lambda= 379964.974755 levenbergIter= 2
iteration= 76 chi2= 10353.654963 time= 0.309677 cumTime= 26.968 edges= 3995 schur= 0
lambda= 253309.983170 levenbergIter= 1
iteration= 77 chi2= 10353.654963 time= 0.472338 cumTime= 27.4404 edges= 3995 schur= 0
lambda= 1350986.576908 levenbergIter= 3
iteration= 78 chi2= 10353.654963 time= 0.317881 cumTime= 27.7583 edges= 3995 schur= 0
lambda= 900657.717939 levenbergIter= 1
iteration= 79 chi2= 10353.654963 time= 0.37776 cumTime= 28.136 edges= 3995 schur= 0
lambda= 1200876.957252 levenbergIter= 2
iteration= 80 chi2= 10353.654963 time= 0.387395 cumTime= 28.5234 edges= 3995 schur= 0
lambda= 1601169.276336 levenbergIter= 2
iteration= 81 chi2= 10353.654963 time= 0.499485 cumTime= 29.0229 edges= 3995 schur= 0
lambda= 8539569.473791 levenbergIter= 3
iteration= 82 chi2= 10353.654963 time= 0.294176 cumTime= 29.3171 edges= 3995 schur= 0
lambda= 5693046.315860 levenbergIter= 1
iteration= 83 chi2= 10353.654963 time= 0.834481 cumTime= 30.1515 edges= 3995 schur= 0
lambda= 7959455644932.773438 levenbergIter= 7
iteration= 84 chi2= 10353.654963 time= 0.567477 cumTime= 30.719 edges= 3995 schur= 0
lambda= 8150482580411160.000000 levenbergIter= 4
finish
FinalError:10353.7
^C
λ touchair-2080T LSSLAMProject →catkin_make
Base path: /home/touchair/Downloads/HW6/LSSLAMProject
Source space: /home/touchair/Downloads/HW6/LSSLAMProject/src
Build space: /home/touchair/Downloads/HW6/LSSLAMProject/build
Devel space: /home/touchair/Downloads/HW6/LSSLAMProject/devel
Install space: /home/touchair/Downloads/HW6/LSSLAMProject/install
####
Running command: "make cmake_check_build_system" in "/home/touchair/Downloads/HW6/LSSLAMProject/build"
####
####
Running command: "make -j8 -l8" in "/home/touchair/Downloads/HW6/LSSLAMProject/build"
####
Scanning dependencies of target ls_slam
[25%] Building CXX object ls_slam/CMakeFiles/ls_slam.dir/src/main.cpp.o
[50%] Linking CXX executable /home/touchair/Downloads/HW6/LSSLAMProject/devel/lib/ls_slam/ls_slam
[100%] Built target ls_slam
λ touchair-2080T LSSLAMProject →source devel/setup.zsh
λ touchair-2080T LSSLAMProject →rosrun ls_slam ls_slam
initError: 2.05092e+06
iteration= 0 chi2= 51574.948019 time= 0.279375 cumTime= 0.279375 edges= 3070 schur= 0
lambda= 0.150732 levenbergIter= 1
iteration= 1 chi2= 39827.007231 time= 0.2563 cumTime= 0.535676 edges= 3070 schur= 0
lambda= 0.100488 levenbergIter= 1
iteration= 2 chi2= 37926.215906 time= 0.423323 cumTime= 0.958999 edges= 3070 schur= 0
lambda= 0.535935 levenbergIter= 3
iteration= 3 chi2= 36132.808805 time= 0.507572 cumTime= 1.46657 edges= 3070 schur= 0
lambda= 22.866547 levenbergIter= 4
iteration= 4 chi2= 36132.808805 time= 0.993813 cumTime= 2.46038 edges= 3070 schur= 0
lambda= 823854168383115392.000000 levenbergIter= 10
finish
FinalError:36132.8
λ touchair-2080T ~ →rviz
[INFO] [1627642387.000473225]: rviz version 1.12.17
[INFO] [1627642387.000515678]: compiled against Qt version 5.5.1
[INFO] [1627642387.000524827]: compiled against OGRE version 1.9.0 (Ghadamon)
[INFO] [1627642388.090832624]: Stereo is NOT SUPPORTED
[INFO] [1627642388.090892123]: OpenGl version: 3 (GLSL 1.3).
[INFO] [1627642389.368393031]: Creating 1 swatches
^C
λ touchair-2080T ~ →rviz
[INFO] [1627642639.573729964]: rviz version 1.12.17
[INFO] [1627642639.573780773]: compiled against Qt version 5.5.1
[INFO] [1627642639.573788204]: compiled against OGRE version 1.9.0 (Ghadamon)
[INFO] [1627642639.889148953]: Stereo is NOT SUPPORTED
[INFO] [1627642639.889252548]: OpenGl version: 3 (GLSL 1.3).
[INFO] [1627642640.811954953]: Creating 1 swatches
^C
λ touchair-2080T ~ →
λ touchair-2080T ~ →
λ touchair-2080T ~ →
λ touchair-2080T ~ →rviz
[INFO] [1627643055.827611355]: rviz version 1.12.17
[INFO] [1627643055.827646990]: compiled against Qt version 5.5.1
[INFO] [1627643055.827655284]: compiled against OGRE version 1.9.0 (Ghadamon)
[INFO] [1627643056.227769870]: Stereo is NOT SUPPORTED
[INFO] [1627643056.227882556]: OpenGl version: 3 (GLSL 1.3).
[INFO] [1627643057.568700133]: Creating 1 swatches
[WARN] [1627643078.381339206]: MessageFilter [target=map]: Dropped 98.32% of messages so far. Please turn the [ros.rviz.message_notifier] rosconsole logger to DEBUG for more information.
[WARN] [1627643081.485552584]: MessageFilter [target=map]: Dropped 98.32% of messages so far. Please turn the [ros.rviz.message_notifier] rosconsole logger to DEBUG for more information.
[WARN] [1627643138.410705869]: MessageFilter [target=map]: Dropped 98.32% of messages so far. Please turn the [ros.rviz.message_notifier] rosconsole logger to DEBUG for more information.
[WARN] [1627643141.522493871]: MessageFilter [target=map]: Dropped 98.32% of messages so far. Please turn the [ros.rviz.message_notifier] rosconsole logger to DEBUG for more information.


Tilix: 默认
1: rosrun ls_slam ls_slam
2: rviz
iteration= 58 chi2= 10353.654977 time= 0.460898 cumTime= 20.0365 edges= 3995 schur= 0
lambda= 1428.088254 levenbergIter= 2
iteration= 59 chi2= 10353.654969 time= 0.453884 cumTime= 20.4903 edges= 3995 schur= 0
lambda= 1904.117672 levenbergIter= 2
iteration= 60 chi2= 10353.654966 time= 0.390501 cumTime= 20.8808 edges= 3995 schur= 0
lambda= 2538.823563 levenbergIter= 2
iteration= 61 chi2= 10353.654965 time= 0.400645 cumTime= 21.2815 edges= 3995 schur= 0
lambda= 3385.098084 levenbergIter= 2
iteration= 62 chi2= 10353.654964 time= 0.483036 cumTime= 21.7645 edges= 3995 schur= 0
lambda= 18053.856446 levenbergIter= 3
iteration= 63 chi2= 10353.654964 time= 0.289249 cumTime= 22.0538 edges= 3995 schur= 0
lambda= 12035.904297 levenbergIter= 1
iteration= 64 chi2= 10353.654963 time= 0.309386 cumTime= 22.3632 edges= 3995 schur= 0
lambda= 8023.936198 levenbergIter= 1
iteration= 65 chi2= 10353.654963 time= 0.487646 cumTime= 22.8508 edges= 3995 schur= 0
lambda= 42794.326390 levenbergIter= 3
iteration= 66 chi2= 10353.654963 time= 0.313378 cumTime= 23.1642 edges= 3995 schur= 0
lambda= 28529.550927 levenbergIter= 1
iteration= 67 chi2= 10353.654963 time= 0.385912 cumTime= 23.5501 edges= 3995 schur= 0
lambda= 38039.401236 levenbergIter= 2
iteration= 68 chi2= 10353.654963 time= 0.413029 cumTime= 23.9631 edges= 3995 schur= 0
lambda= 50719.201647 levenbergIter= 2
iteration= 69 chi2= 10353.654963 time= 0.40375 cumTime= 24.3669 edges= 3995 schur= 0
lambda= 67625.602196 levenbergIter= 2
iteration= 70 chi2= 10353.654963 time= 0.369174 cumTime= 24.7361 edges= 3995 schur= 0
lambda= 90167.469595 levenbergIter= 2
iteration= 71 chi2= 10353.654963 time= 0.387166 cumTime= 25.1232 edges= 3995 schur= 0
lambda= 120223.292794 levenbergIter= 2
iteration= 72 chi2= 10353.654963 time= 0.372904 cumTime= 25.4961 edges= 3995 schur= 0
lambda= 160297.723725 levenbergIter= 2
iteration= 73 chi2= 10353.654963 time= 0.400818 cumTime= 25.8969 edges= 3995 schur= 0
lambda= 213730.298300 levenbergIter= 2
iteration= 74 chi2= 10353.654963 time= 0.380878 cumTime= 26.2778 edges= 3995 schur= 0
lambda= 284973.731067 levenbergIter= 2
iteration= 75 chi2= 10353.654963 time= 0.380538 cumTime= 26.6584 edges= 3995 schur= 0
lambda= 379964.974755 levenbergIter= 2
iteration= 76 chi2= 10353.654963 time= 0.309677 cumTime= 26.968 edges= 3995 schur= 0
lambda= 253309.983170 levenbergIter= 1
iteration= 77 chi2= 10353.654963 time= 0.472338 cumTime= 27.4404 edges= 3995 schur= 0
lambda= 1350986.576908 levenbergIter= 3
iteration= 78 chi2= 10353.654963 time= 0.317881 cumTime= 27.7583 edges= 3995 schur= 0
lambda= 900657.717939 levenbergIter= 1
iteration= 79 chi2= 10353.654963 time= 0.37776 cumTime= 28.136 edges= 3995 schur= 0
lambda= 1200876.957252 levenbergIter= 2
iteration= 80 chi2= 10353.654963 time= 0.387395 cumTime= 28.5234 edges= 3995 schur= 0
lambda= 1601169.276336 levenbergIter= 2
iteration= 81 chi2= 10353.654963 time= 0.499485 cumTime= 29.0229 edges= 3995 schur= 0
lambda= 8539569.473791 levenbergIter= 3
iteration= 82 chi2= 10353.654963 time= 0.294176 cumTime= 29.3171 edges= 3995 schur= 0
lambda= 5693046.315860 levenbergIter= 1
iteration= 83 chi2= 10353.654963 time= 0.834481 cumTime= 30.1515 edges= 3995 schur= 0
lambda= 7959455644932.773438 levenbergIter= 7
iteration= 84 chi2= 10353.654963 time= 0.567477 cumTime= 30.719 edges= 3995 schur= 0
lambda= 81504825804111160.000000 levenbergIter= 4
finish
finalError:10353.7
λ touchair-2080T ~ →rviz
[INFO] [1627642387.000473225]: rviz version 1.12.17
[INFO] [1627642387.000515678]: compiled against Qt version 5.5.1
[INFO] [1627642387.000524827]: compiled against OGRE version 1.9.0 (Ghadamon)
[INFO] [1627642388.090832624]: Stereo is NOT SUPPORTED
[INFO] [1627642388.090892123]: OpenGl version: 3 (GLSL 1.3).
[INFO] [1627642389.368393031]: Creating 1 swatches
^C
λ touchair-2080T ~ →rviz
[INFO] [1627642639.573729964]: rviz version 1.12.17
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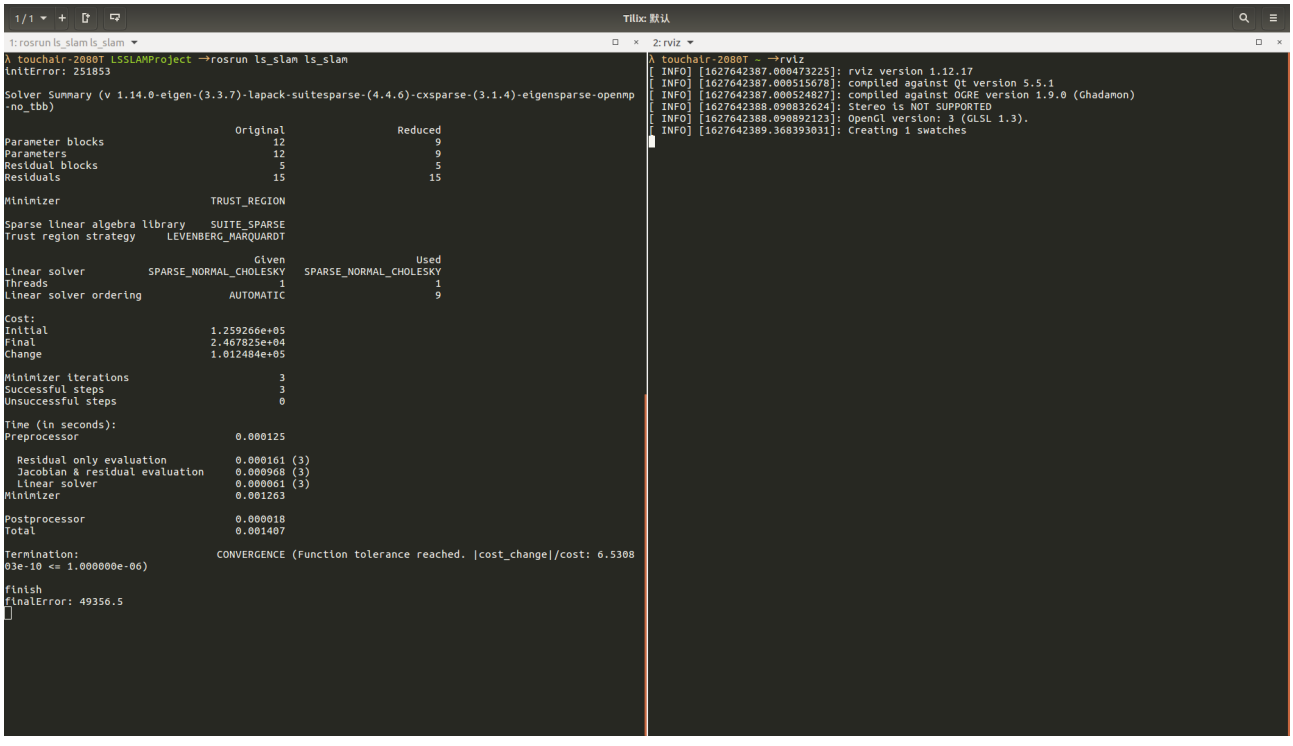
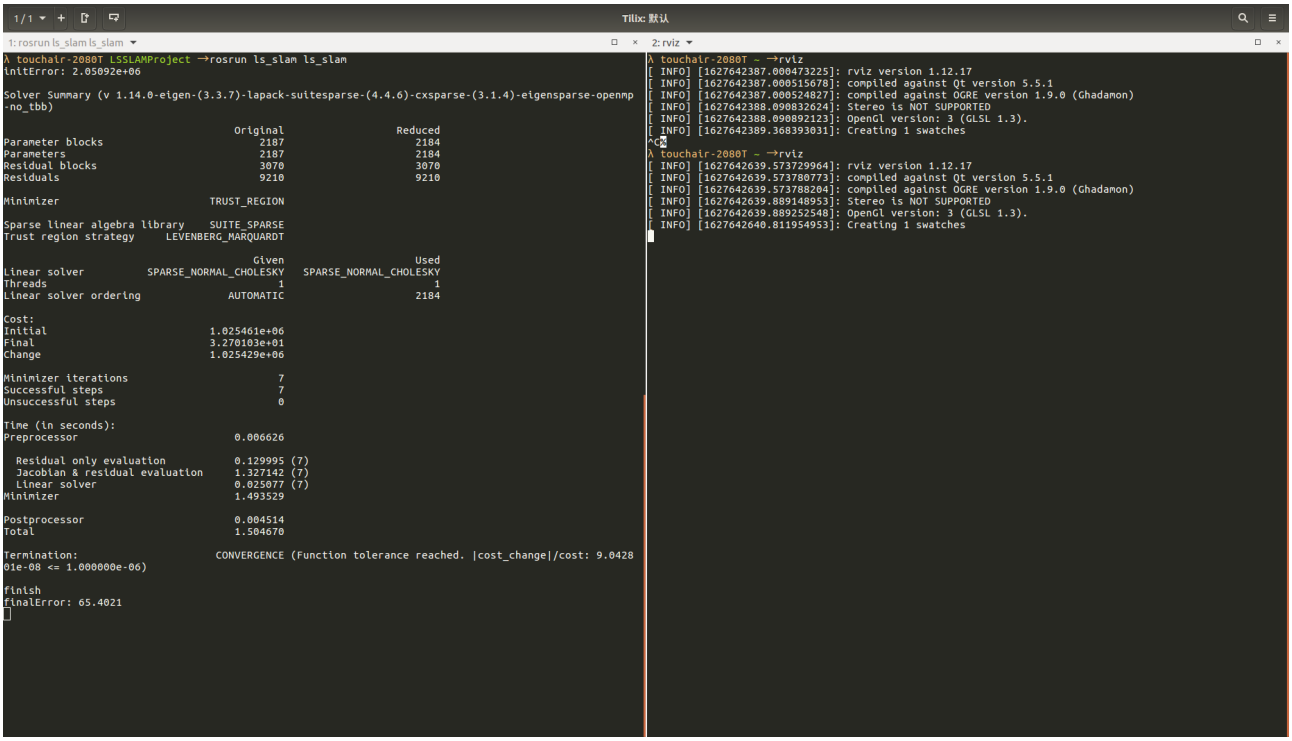
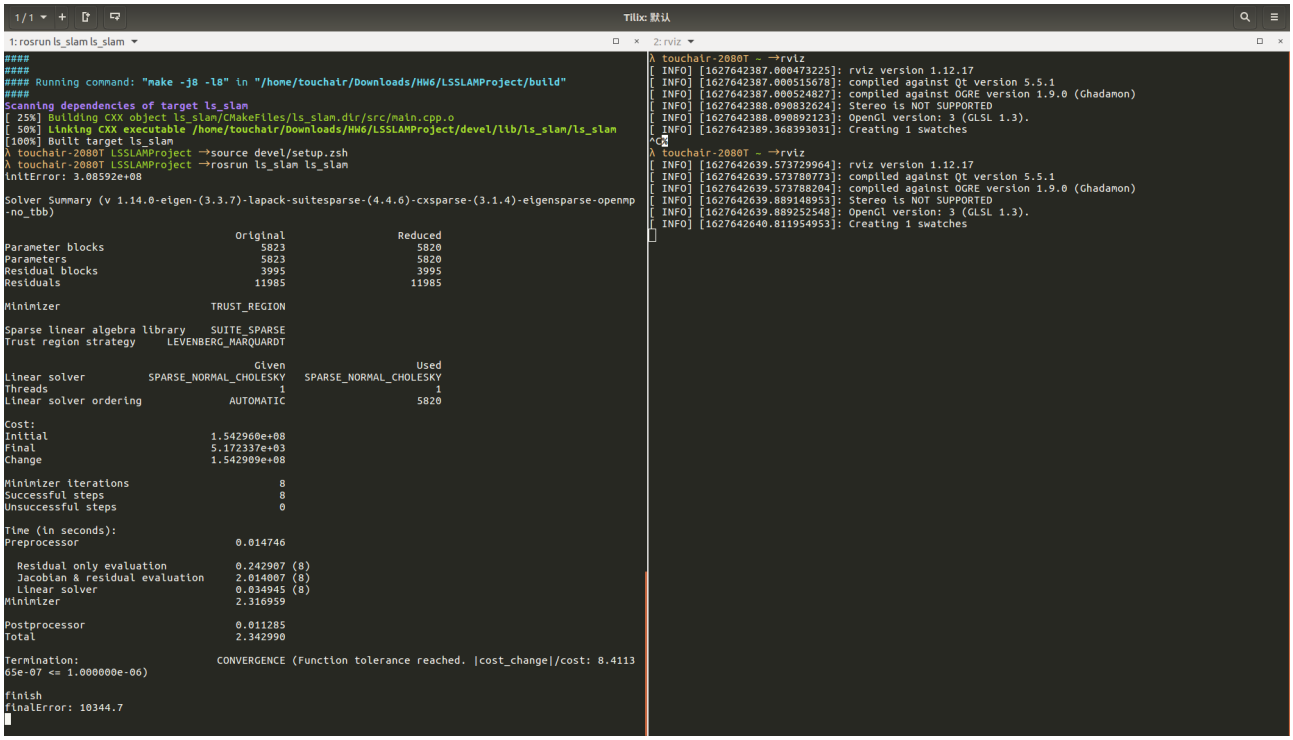
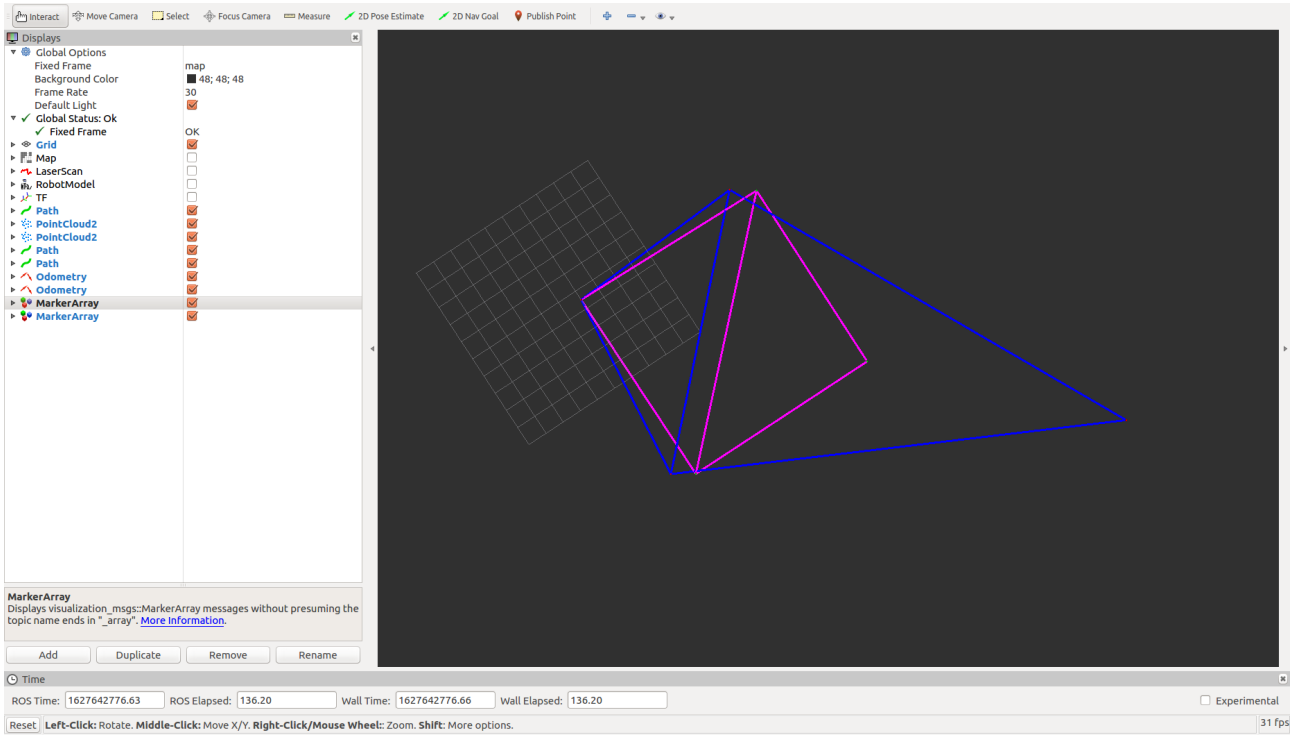
[INFO] [1627642639.889252548]: OpenGl version: 3 (GLSL 1.3).
[INFO] [1627642640.811954953]: Creating 1 swatches
^C
λ touchair-2080T ~ →
λ touchair-2080T ~ →
λ touchair-2080T ~ →
λ touchair-2080T ~ →rviz
[INFO] [1627643055.827611355]: rviz version 1.12.17
[INFO] [1627643055.827646990]: compiled against Qt version 5.5.1
[INFO] [1627643055.827655284]: compiled against OGRE version 1.9.0 (Ghadamon)
[INFO] [1627643056.227769870]: Stereo is NOT SUPPORTED
[INFO] [1627643056.227882556]: OpenGl version: 3 (GLSL 1.3).
[INFO] [1627643057.568700133]: Creating 1 swatches
[WARN] [1627643078.381339206]: MessageFilter [target=map]: Dropped 98.32% of messages so far. Please turn the [ros.rviz.message_notifier] rosconsole logger to DEBUG for more information.
[WARN] [1627643081.485552584]: MessageFilter [target=map]: Dropped 98.32% of messages so far. Please turn the [ros.rviz.message_notifier] rosconsole logger to DEBUG for more information.

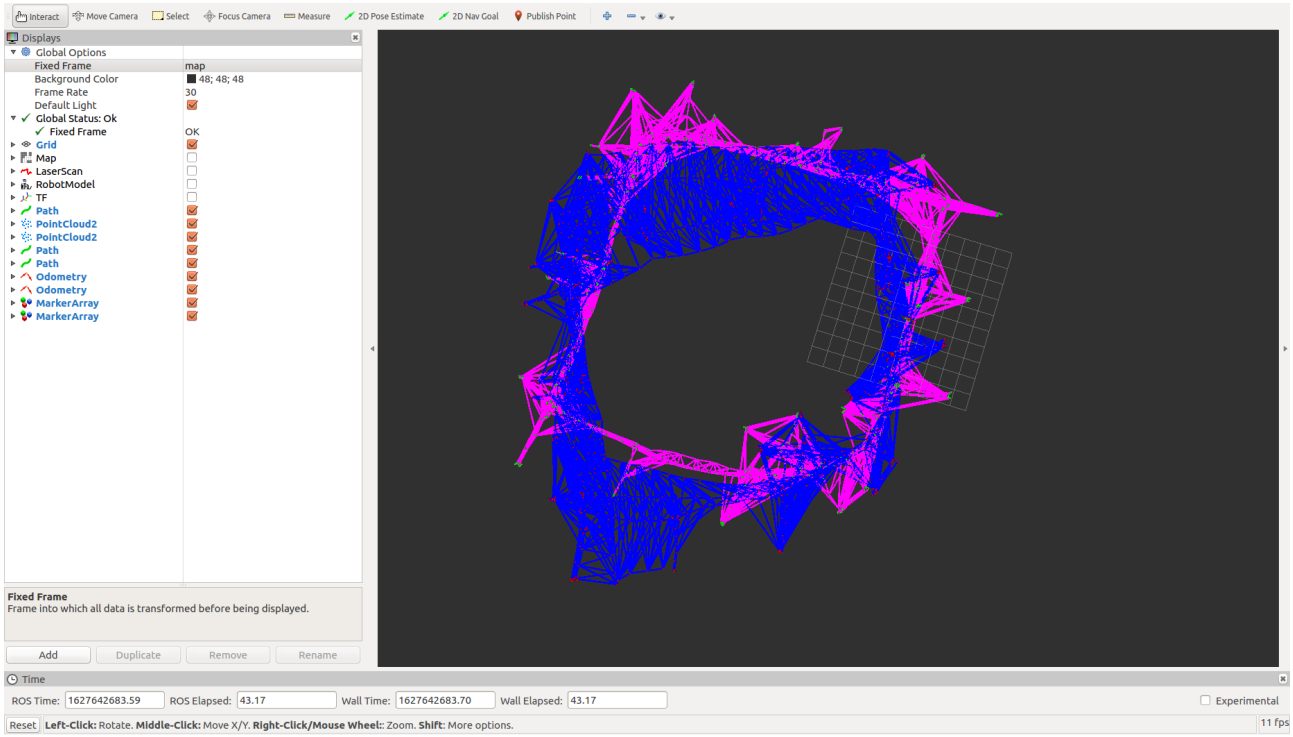
ceres:

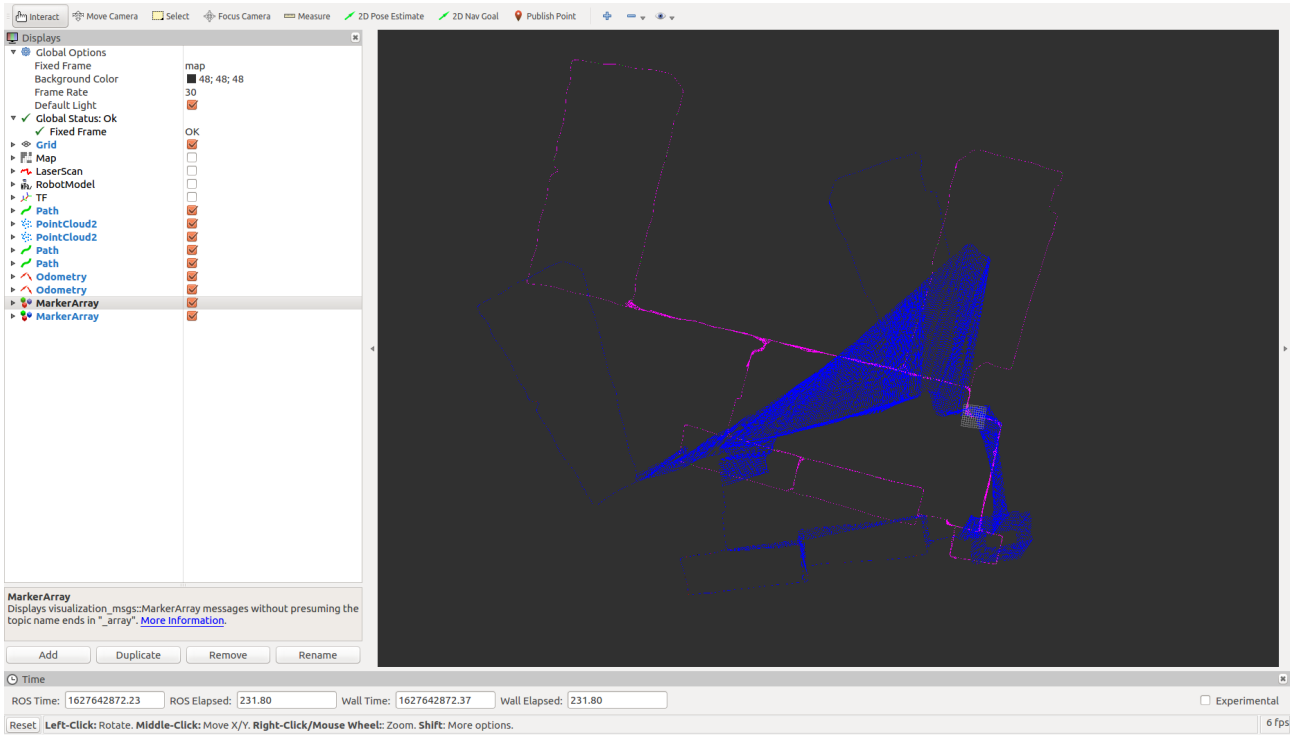

Tilix: 默认
1: rosrun ls_slam ls_slam
2: rviz
λ touchair-2080T LSSLAMProject →rosrun ls_slam ls_slam
initError: 251853
Solver Summary (v 1.14.0-eigen-(3.3.7)-lapack-suitesparse-(4.4.6)-cxsparse-(3.1.4)-eigensparse-openmp-no_tbb)
Original Reduced
Parameter blocks 12 9
Parameters 12 9
Residual blocks 5 5
Residuals 15 15
Minimizer TRUST_REGION
Sparse linear algebra library SUITE_SPARSE
Trust region strategy LEVENBERG_MARQUARDT
Given Used
Linear solver SPARSE_NORMAL_CHOLESKY SPARSE_NORMAL_CHOLESKY
Threads 1 1
Linear solver ordering AUTOMATIC 9
Cost:
Initial 1.259266e+05
Final 2.467825e+04
Change 1.012484e+05
Minimizer iterations 3
Successful steps 3
Unsuccessful steps 0
Time (in seconds):
Preprocessor 0.000125
Residual only evaluation 0.000161 (3)
Jacobian & residual evaluation 0.000968 (3)
Linear solver 0.000061 (3)
Minimizer 0.001263
Postprocessor 0.000018
Total 0.001407
Termination: CONVERGENCE (Function tolerance reached. |cost_change|/cost: 6.530803e-10 <= 1.000000e-06)
finish
finalError: 49356.5
λ touchair-2080T ~ →rviz
[INFO] [1627642387.000473225]: rviz version 1.12.17
[INFO] [1627642387.000515678]: compiled against Qt version 5.5.1
[INFO] [1627642387.000524827]: compiled against OGRE version 1.9.0 (Ghadamon)
[INFO] [1627642388.090832624]: Stereo is NOT SUPPORTED
[INFO] [1627642388.090892123]: OpenGl version: 3 (GLSL 1.3).
[INFO] [1627642389.368393031]: Creating 1 swatches


1 / 1
Tilix: 默认
1: rosrun ls_slam ls_slam
2: rviz
λ touchair-2080T LSSLAMProject →rosrun ls_slam ls_slam
initError: 2.05092e+06
Solver Summary (v 1.14.0-eigen-(3.3.7)-lapack-suitesparse-(4.4.6)-cxsparse-(3.1.4)-eigensparse-openmp-no_tbb)
Original Reduced
Parameter blocks 2187 2184
Parameters 2187 2184
Residual blocks 3070 3070
Residuals 9210 9210
Minimizer TRUST_REGION
Sparse linear algebra library SUITE_SPARSE
Trust region strategy LEVENBERG_MARQUARDT
Given Used
Linear solver SPARSE_NORMAL_CHOLESKY SPARSE_NORMAL_CHOLESKY
Threads 1 1
Linear solver ordering AUTOMATIC 2184
Cost:
Initial 1.025461e+06
Final 3.270103e+01
Change 1.025429e+06
Minimizer iterations 7
Successful steps 7
Unsuccessful steps 0
Time (in seconds):
Preprocessor 0.006626
Residual only evaluation 0.129995 (7)
Jacobian & residual evaluation 1.327142 (7)
Linear solver 0.025077 (7)
Minimizer 1.493529
Postprocessor 0.004514
Total 1.504670
Termination: CONVERGENCE (Function tolerance reached. |cost_change|/cost: 9.04281e-08 <= 1.000000e-06)
finish
finalError: 65.4021
λ touchair-2080T ~ →rviz
[INFO] [1627642387.000473225]: rviz version 1.12.17
[INFO] [1627642387.000515678]: compiled against Qt version 5.5.1
[INFO] [1627642387.000524827]: compiled against OGRE version 1.9.0 (Ghadamon)
[INFO] [1627642388.090832624]: Stereo is NOT SUPPORTED
[INFO] [1627642388.090892123]: OpenGl version: 3 (GLSL 1.3).
[INFO] [1627642389.368393031]: Creating 1 swatches
^C
λ touchair-2080T ~ →rviz
[INFO] [1627642639.573729964]: rviz version 1.12.17
[INFO] [1627642639.573780773]: compiled against Qt version 5.5.1
[INFO] [1627642639.573788204]: compiled against OGRE version 1.9.0 (Ghadamon)
[INFO] [1627642639.889148953]: Stereo is NOT SUPPORTED
[INFO] [1627642639.889252548]: OpenGl version: 3 (GLSL 1.3).
[INFO] [1627642640.811954953]: Creating 1 swatches


1 / 1
Tilix: 默认
1: rosrun ls_slam ls_slam
2: rviz
####
####
Running command: "make -j8 -l8" in "/home/touchair/Downloads/HW6/LSSLAMProject/build"
####
Scanning dependencies of target ls_slam
[25%] Building CXX object ls_slam/CMakeFiles/ls_slam.dir/src/main.cpp.o
[50%] Linking CXX executable /home/touchair/Downloads/HW6/LSSLAMProject/devel/lib/ls_slam/ls_slam
[100%] Built target ls_slam
λ touchair-2080T LSSLAMProject →source devel/setup.zsh
λ touchair-2080T LSSLAMProject →rosrun ls_slam ls_slam
initError: 3.08592e+08
Solver Summary (v 1.14.0-eigen-(3.3.7)-lapack-suitesparse-(4.4.6)-cxsparse-(3.1.4)-eigensparse-openmp-no_tbb)
Original Reduced
Parameter blocks 5823 5820
Parameters 5823 5820
Residual blocks 3995 3995
Residuals 11985 11985
Minimizer TRUST_REGION
Sparse linear algebra library SUITE_SPARSE
Trust region strategy LEVENBERG_MARQUARDT
Given Used
Linear solver SPARSE_NORMAL_CHOLESKY SPARSE_NORMAL_CHOLESKY
Threads 1 1
Linear solver ordering AUTOMATIC 5820
Cost:
Initial 1.542960e+08
Final 5.172337e+03
Change 1.542909e+08
Minimizer iterations 8
Successful steps 8
Unsuccessful steps 0
Time (in seconds):
Preprocessor 0.014746
Residual only evaluation 0.242907 (8)
Jacobian & residual evaluation 2.014007 (8)
Linear solver 0.034945 (8)
Minimizer 2.316959
Postprocessor 0.011285
Total 2.342990
Termination: CONVERGENCE (Function tolerance reached. |cost_change|/cost: 8.411365e-07 <= 1.000000e-06)
finish
finalError: 10344.7
λ touchair-2080T ~ →rviz
[INFO] [1627642387.000473225]: rviz version 1.12.17
[INFO] [1627642387.000515678]: compiled against Qt version 5.5.1
[INFO] [1627642387.000524827]: compiled against OGRE version 1.9.0 (Ghadamon)
[INFO] [1627642388.090832624]: Stereo is NOT SUPPORTED
[INFO] [1627642388.090892123]: OpenGl version: 3 (GLSL 1.3).
[INFO] [1627642389.368393031]: Creating 1 swatches
^C
λ touchair-2080T ~ →rviz
[INFO] [1627642639.573729964]: rviz version 1.12.17
[INFO] [1627642639.573780773]: compiled against Qt version 5.5.1
[INFO] [1627642639.573788204]: compiled against OGRE version 1.9.0 (Ghadamon)
[INFO] [1627642639.889148953]: Stereo is NOT SUPPORTED
[INFO] [1627642639.889252548]: OpenGl version: 3 (GLSL 1.3).
[INFO] [1627642640.811954953]: Creating 1 swatches


Interact
Move Camera
Select
Focus Camera
Measure
2D Pose Estimate
2D Nav Goal
Publish Point
Displays
Global Options
Fixed Frame map
Background Color 48; 48; 48
Frame Rate 30
Default Light
Global Status: Ok
Fixed Frame OK
Grid
Map
LaserScan
RobotModel
TF
Path
PointCloud2
PointCloud2
Path
Path
Odometry
Odometry
MarkerArray
MarkerArray
MarkerArray
Displays visualization_msgs::MarkerArray messages without presuming the topic name ends in "_array". More Information.
Add
Duplicate
Remove
Rename
Time
ROS Time: 1627642776.63
ROS Elapsed: 136.20
Wall Time: 1627642776.66
Wall Elapsed: 136.20
Experimental
Reset
Left-Click: Rotate. Middle-Click: Move X/Y. Right-Click/Mouse Wheel:: Zoom. Shift: More options.
31 fps


Interact
Move Camera
Select
Focus Camera
Measure
2D Pose Estimate
2D Nav Goal
Publish Point
Displays
Global Options
Fixed Frame map
Background Color 48; 48; 48
Frame Rate 30
Default Light
Global Status: Ok
Fixed Frame OK
Grid
Map
LaserScan
RobotModel
TF
Path
PointCloud2
PointCloud2
Path
Path
Odometry
Odometry
MarkerArray
MarkerArray
Fixed Frame
Frame into which all data is transformed before being displayed.
Add
Duplicate
Remove
Rename
Time
ROS Time: 1627642683.59
ROS Elapsed: 43.17
Wall Time: 1627642683.70
Wall Elapsed: 43.17
Experimental
Reset
Left-Click: Rotate. Middle-Click: Move X/Y. Right-Click/Mouse Wheel:: Zoom. Shift: More options.
11 fps


Interact
Move Camera
Select
Focus Camera
Measure
2D Pose Estimate
2D Nav Goal
Publish Point
Displays
Global Options
Fixed Frame
map
Background Color
48; 48; 48
Frame Rate
30
Default Light
Global Status: Ok
Fixed Frame
OK
Grid
Map
LaserScan
RobotModel
TF
Path
PointCloud2
PointCloud2
Path
Path
Odometry
Odometry
MarkerArray
MarkerArray
MarkerArray
Displays visualization_msgs::MarkerArray messages without presuming the topic name ends in "_array". More Information.
Add
Duplicate
Remove
Rename
Time
ROS Time: 1627642872.23
ROS Elapsed: 231.80
Wall Time: 1627642872.37
Wall Elapsed: 231.80
Experimental
Reset
Left-Click: Rotate. Middle-Click: Move X/Y. Right-Click/Mouse Wheel:: Zoom. Shift: More options.
6 fps