Homework2 SEARCH-BASED PATH FINDING

算法实现流程

[void AstarPathFinder::AstarGetSucc(...)]

[double AstarPathFinder::getHeu(...)]

[void AstarPathFinder::AstarGraphSearch(...)]

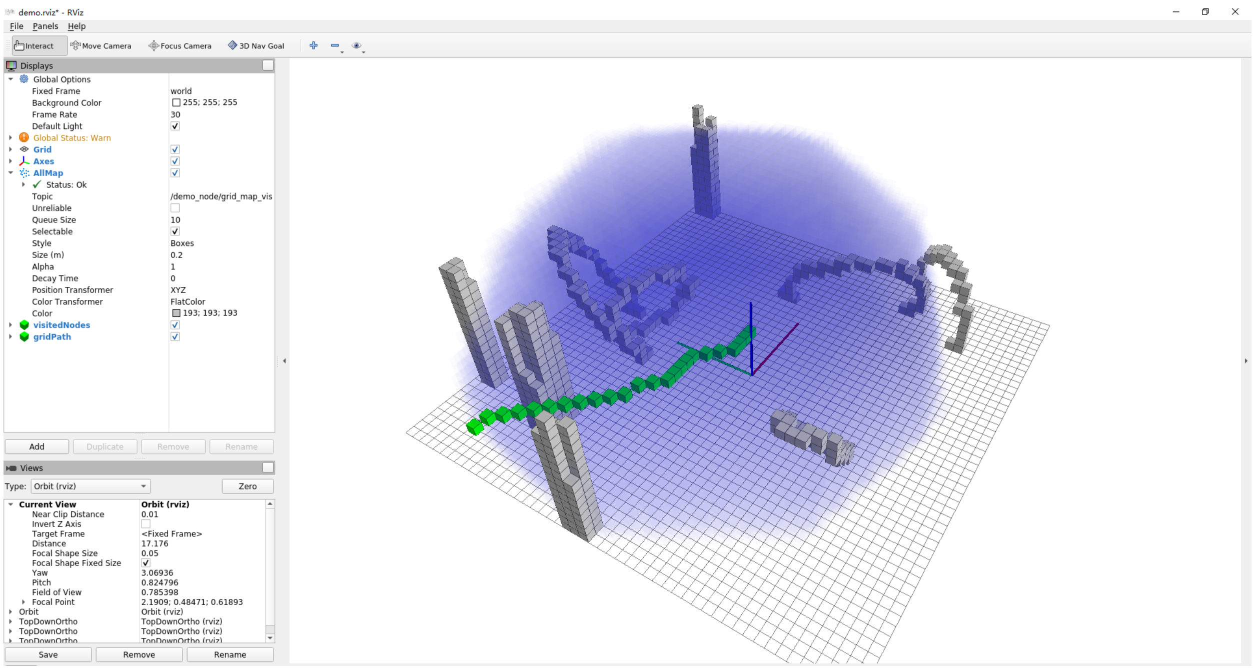
[vector AstarPathFinder::getPath(...)]

Euclidean and Diagonal heuristic function

- Euclidean heuristic function

  使用*Eigen*的`norm`函数直接求出两节点的距离

  ```
  // Euclidean
  double h = (node1->coord - node2->coord).norm();
  ```



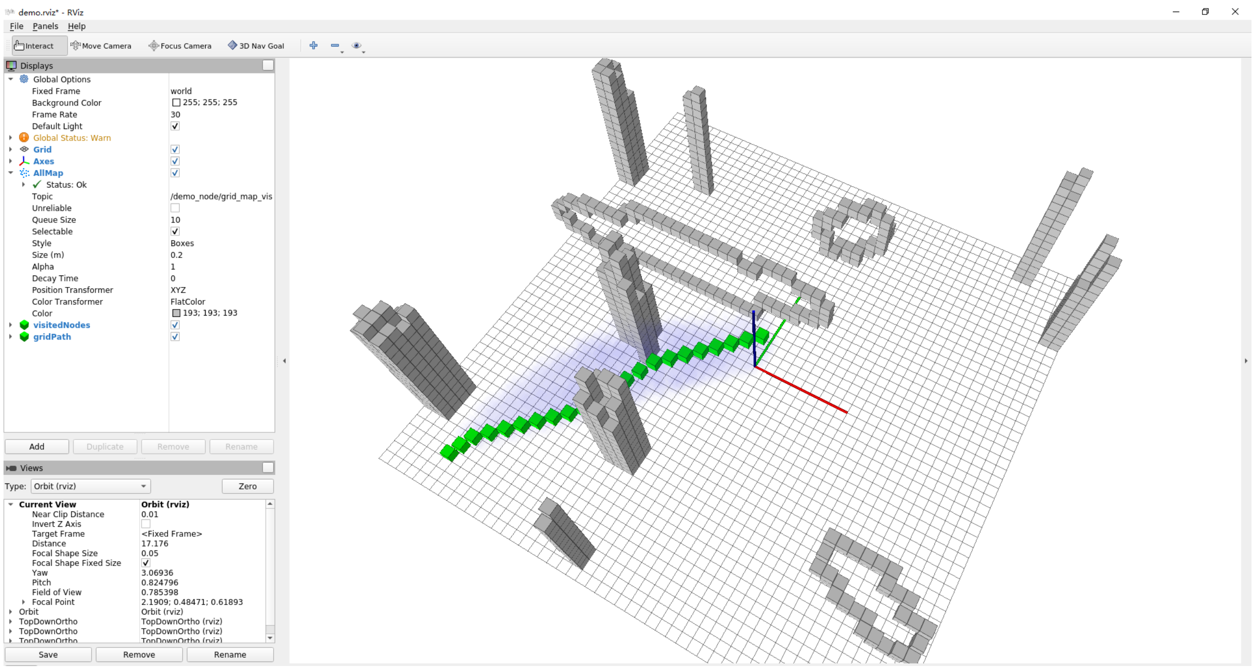
```
Global Options
  Fixed Frame              world
  Background Color         255; 255; 255
  Frame Rate               30
  Default Light            ✓
Global Status: Warn
Grid                       ✓
Axes                       ✓
AllMap                     ✓
  Status: Ok
  Topic                    /demo_node/grid_map_vis
  Unreliable
  Queue Size               10
  Selectable               ✓
  Style                    Boxes
  Size (m)                 0.2
  Alpha                    1
  Decay Time               0
  Position Transformer     XYZ
  Color Transformer        FlatColor
  Color                    193; 193; 193
visitedNodes               ✓
gridPath                   ✓

Type: Orbit (rviz)
Current View               Orbit (rviz)
  Near Clip Distance       0.01
  Invert Z Axis
  Target Frame             <Fixed Frame>
  Distance                 17.176
  Focal Shape Size         0.05
  Focal Shape Fixed Size   ✓
  Yaw                      3.06936
  Pitch                    0.824796
  Field of View            0.785398
  Focal Point              2.1909; 0.48471; 0.61893
Orbit                      Orbit (rviz)
TopDownOrtho               TopDownOrtho (rviz)
TopDownOrtho               TopDownOrtho (rviz)
TopDownOrtho               TopDownOrtho (rviz)
```

  ```
  [ WARN] [1657249475.365825800]: [A*]{sucess}  Time in A*  is 42.177300 ms, path cost if 6.052618 m
  [ WARN] [1657249475.365907600]:         Time consume in A* path finding AstarGetSucc is 18.987500 ms
  [ WARN] [1657249475.367065200]: visited_nodes size : 29590
  ```

- Custom heuristic function

  原本是想实现 3D Diagonal distance，但是好像不太对，但也能跑出来结果，而且比Euclidean heuristic function要快很多

```
// Diagonal
double dx = abs(node1->index.x() - node2->index.x());
double dy = abs(node1->index.y() - node2->index.y());
double dz = abs(node1->index.z() - node2->index.z());
double dxdz = abs(dx - dz);
double dydz = abs(dy - dz);
double h = (dx + dy + dz) + (sqrt(2.0) - 2.0) * min(dxdz, dydz) + (sqrt(3.0) - 3.0) *
min(min(dx, dy), dz);
```



Displays	
Global Options	
Fixed Frame	world
Background Color	☐ 255; 255; 255
Frame Rate	30
Default Light	✓
Global Status: Warn	
Grid	✓
Axes	✓
AllMap	✓
Status: Ok	
Topic	/demo_node/grid_map_vis
Unreliable	☐
Queue Size	10
Selectable	✓
Style	Boxes
Size (m)	0.2
Alpha	1
Decay Time	0
Position Transformer	XYZ
Color Transformer	FlatColor
Color	▨ 193; 193; 193
visitedNodes	✓
gridPath	✓

Views

Type: Orbit (rviz)

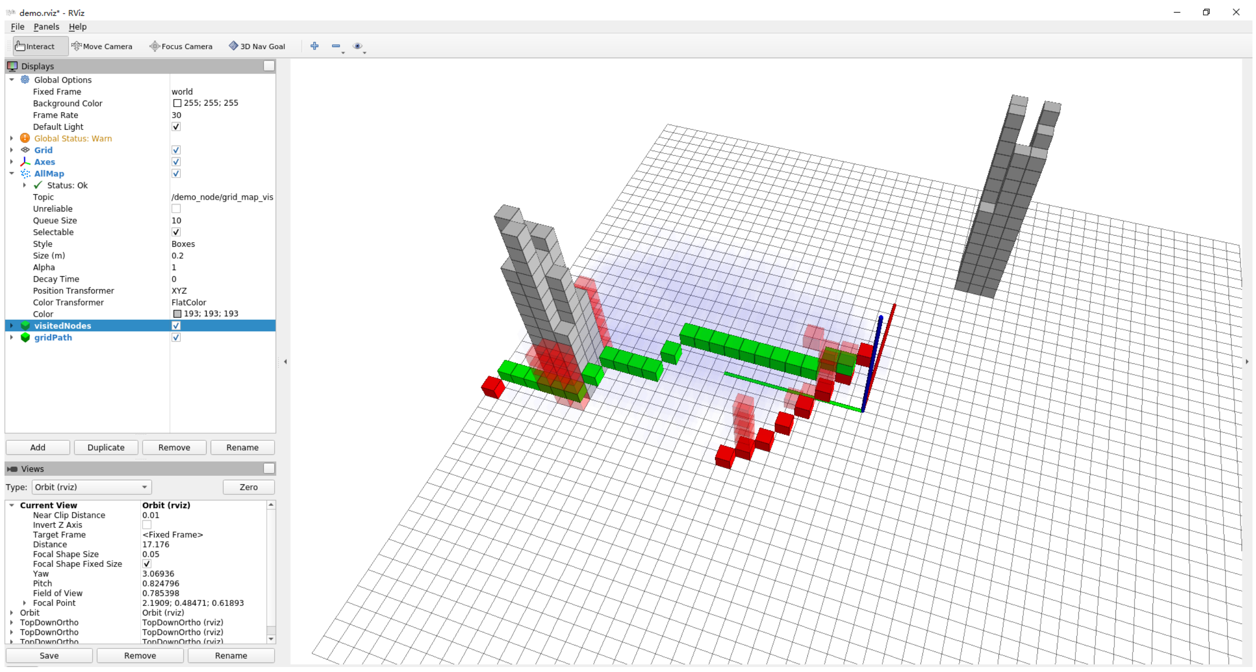
Current View	Orbit (rviz)
Near Clip Distance	0.01
Invert Z Axis	☐
Target Frame	<Fixed Frame>
Distance	17.176
Focal Shape Size	0.05
Focal Shape Fixed Size	✓
Yaw	3.06936
Pitch	0.824796
Field of View	0.785398
Focal Point	2.1909; 0.48471; 0.61893
Orbit	Orbit (rviz)
TopDownOrtho	TopDownOrtho (rviz)
TopDownOrtho	TopDownOrtho (rviz)
TopDownOrtho	TopDownOrtho (rviz)

```
[ WARN] [1657249645.914920500]: [A*]{sucess}  Time in A*  is 1.961100 ms, path cost
if 6.374691 m
[ WARN] [1657249645.915042600]:          Time consume in A* path finding AstarGetSucc
is 0.872800 ms
[ WARN] [1657249645.915639700]: visited_nodes size : 846
```

- 使用欧式距离作为启发函数会增加很多不必要的探索点，使用自定义的 heuristic function 可以极大减少探索范围。

JPS and A*

- JPS is slower than A*

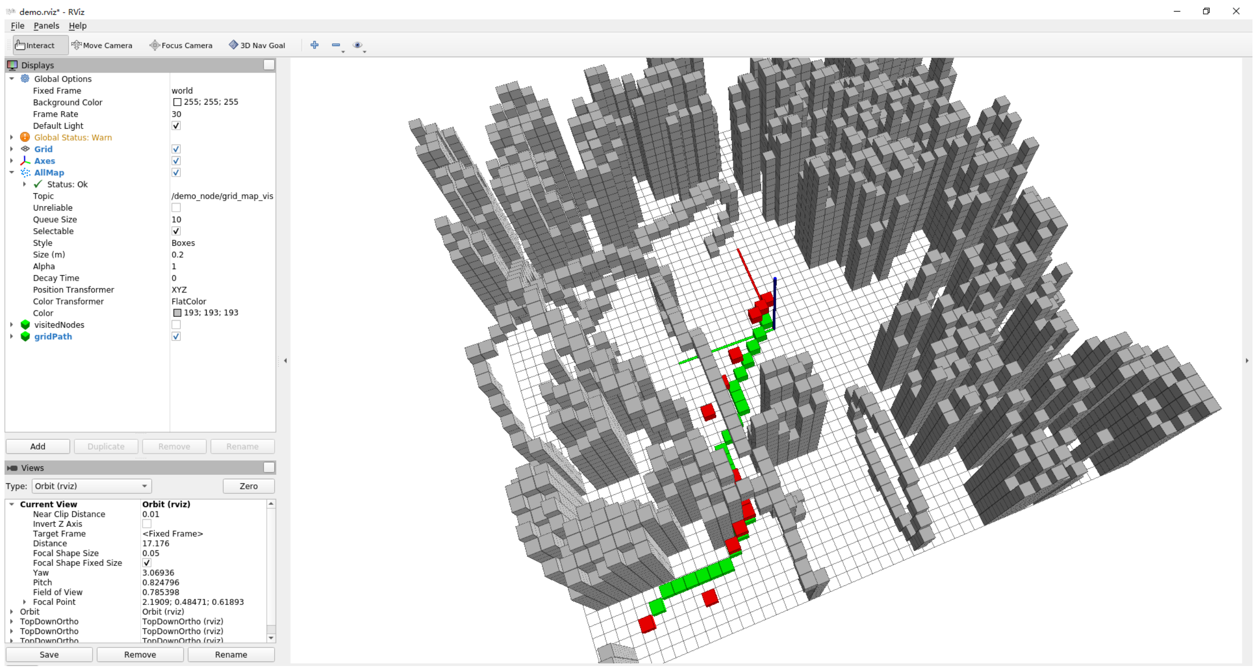


```
Displays
Global Options
  Fixed Frame              world
  Background Color         255; 255; 255
  Frame Rate               30
  Default Light            ✓
Global Status: Warn
Grid                       ✓
Axes                       ✓
AllMap                     ✓
  Status: Ok
  Topic                    /demo_node/grid_map_vis
  Unreliable
  Queue Size               10
  Selectable               ✓
  Style                    Boxes
  Size (m)                 0.2
  Alpha                    1
  Decay Time               0
  Position Transformer     XYZ
  Color Transformer        FlatColor
  Color                    193; 193; 193
visitedNodes               ✓
gridPath                   ✓

Views
Type: Orbit (rviz)         Zero
Current View               Orbit (rviz)
  Near Clip Distance       0.01
  Invert Z Axis
  Target Frame             <Fixed Frame>
  Distance                 17.176
  Focal Shape Size         0.05
  Focal Shape Fixed Size   ✓
  Yaw                      3.06936
  Pitch                    0.824796
  Field of View            0.785398
  Focal Point              2.1909; 0.48471; 0.61893
Orbit                      Orbit (rviz)
TopDownOrtho               TopDownOrtho (rviz)
TopDownOrtho               TopDownOrtho (rviz)
TopDownOrtho               TopDownOrtho (rviz)
```

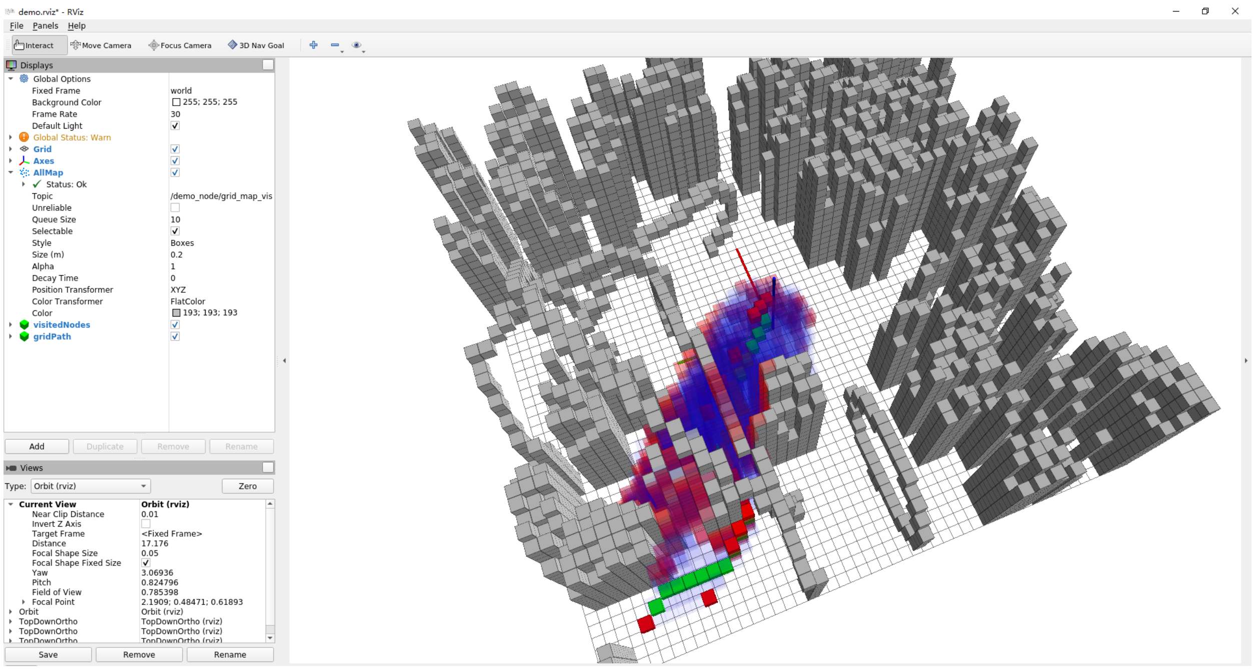
```
[ WARN] [1657246204.078784900]: [A*]{sucess}  Time in A*  is 1.221800 ms, path cost
if 5.697736 m
[ WARN] [1657246204.078858700]:         Time consume in A* path finding AstarGetSucc
is 0.471000 ms
[ WARN] [1657246204.079422800]: visited_nodes size : 834
[ WARN] [1657246204.081826000]: [JPS]{sucess} Time in JPS is 1.688000 ms, path cost
if 5.697736 m
[ WARN] [1657246204.081900400]:         Time consume in JPS path finding JPSGetSucc
is 1.643300 ms
[ WARN] [1657246204.082415500]: visited_nodes size : 60
```

在较为空旷的情况下，JPS会花很多时间在探索下一个跳点上，如上例`95%`的时间在探索跳点上

- JPS is faster than A*



```
Displays
Global Options
  Fixed Frame              world
  Background Color         255; 255; 255
  Frame Rate               30
  Default Light            ✓
Global Status: Warn
Grid                       ✓
Axes                       ✓
AllMap                     ✓
  Status: Ok
  Topic                    /demo_node/grid_map_vis
  Unreliable
  Queue Size               10
  Selectable               ✓
  Style                    Boxes
  Size (m)                 0.2
  Alpha                    1
  Decay Time               0
  Position Transformer     XYZ
  Color Transformer        FlatColor
  Color                    193; 193; 193
visitedNodes
gridPath                   ✓

Views
Type: Orbit (rviz)         Zero
Current View               Orbit (rviz)
  Near Clip Distance       0.01
  Invert Z Axis
  Target Frame             <Fixed Frame>
  Distance                 17.176
  Focal Shape Size         0.05
  Focal Shape Fixed Size   ✓
  Yaw                      3.06936
  Pitch                    0.824796
  Field of View            0.785398
  Focal Point              2.1909; 0.48471; 0.61893
Orbit                      Orbit (rviz)
TopDownOrtho               TopDownOrtho (rviz)
TopDownOrtho               TopDownOrtho (rviz)
TopDownOrtho               TopDownOrtho (rviz)
```



Global Options	
Fixed Frame	world
Background Color	☐ 255; 255; 255
Frame Rate	30
Default Light	✓
Global Status: Warn	
Grid	✓
Axes	✓
AllMap	✓
Status: Ok	
Topic	/demo_node/grid_map_vis
Unreliable	☐
Queue Size	10
Selectable	✓
Style	Boxes
Size (m)	0.2
Alpha	1
Decay Time	0
Position Transformer	XYZ
Color Transformer	FlatColor
Color	▨ 193; 193; 193
visitedNodes	✓
gridPath	✓

Type: Orbit (rviz)

Current View	**Orbit (rviz)**
Near Clip Distance	0.01
Invert Z Axis	☐
Target Frame	<Fixed Frame>
Distance	17.176
Focal Shape Size	0.05
Focal Shape Fixed Size	✓
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TopDownOrtho	TopDownOrtho (rviz)
TopDownOrtho	TopDownOrtho (rviz)

```
[ WARN] [1657247014.815823900]: [A*]{sucess}  Time in A*  is 3.252700 ms, path cost if 6.886933 m
[ WARN] [1657247014.815888300]:          Time consume in A* path finding AstarGetSucc is 1.334300 ms
[ WARN] [1657247014.816652300]: visited_nodes size : 1973
[ WARN] [1657247014.818374500]: [JPS]{sucess} Time in JPS is 1.035300 ms, path cost if 6.886933 m
[ WARN] [1657247014.818431000]:          Time consume in JPS path finding JPSGetSucc is 0.664600 ms
[ WARN] [1657247014.818910000]: visited_nodes size : 647
```

在障碍物较多的情况下，JPS可以很快确定下一个跳点，最终比自定义启发函数的A*要快很多