Universal Indoor Path Planning by 3d propagation approximate Euclidean distance transformation

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Why do I do?

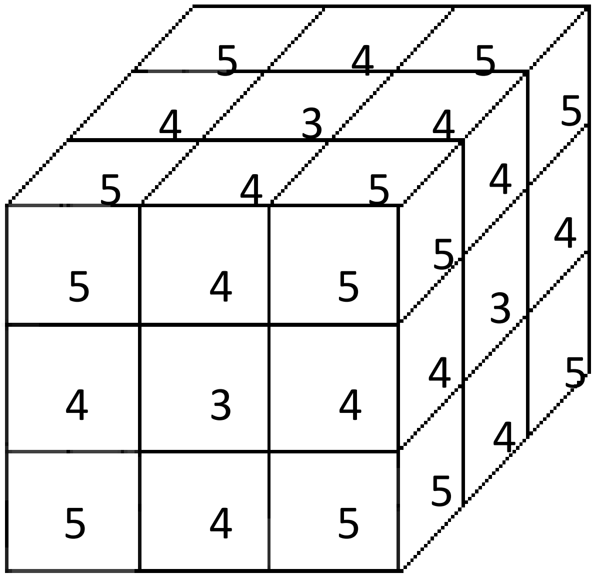
1. The universal indoor path planning is to plan a collision-free continuous path connecting different locations in an environment which is known totally. It is one of the basic issues of indoor navigation, which is useful especially in the big public buildings in a normal case or an emergency.

2. The indoor path planning requirements for different actors are different. Most of the research on indoor path planning is about people or robot who walk on the floor. The method is based on floor plans and indoor surface models. But, there are some special requirements for an autonomous drone(Unmaned Areaial Viecle) which flies in the air. And the height of the obstacles can't be neglected.

What is the problem?

How to find a shortest path from the start to the goal, and let the drone keep a minimum clearance from the obstacles, for the purpose of preventing the drone fly across some narrow channels and avoiding obstacles .

Cell decomposition

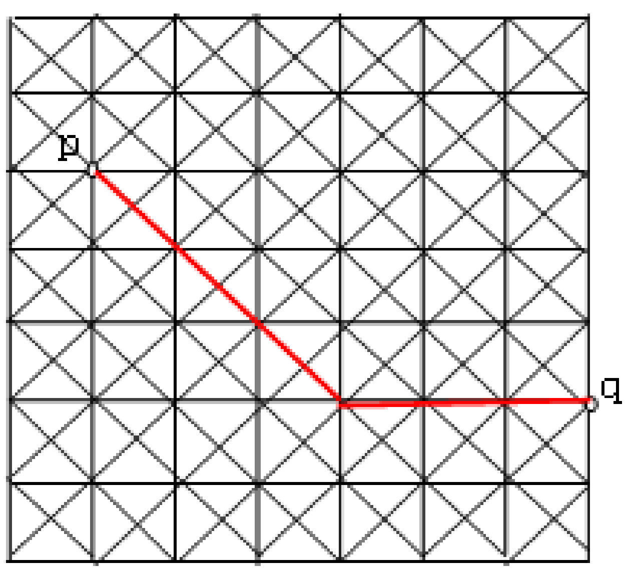


$$d(V, V_{n1}) = 3$$

$$d(V, V_{n2}) = 4$$

$$d(V, V_{n3}) = 5$$

Approximate Euclidean distance



Path length:

$$l(P) = \sum_{i=1}^{m-1} d(V_i, V_{i+1})$$

Distance transformation

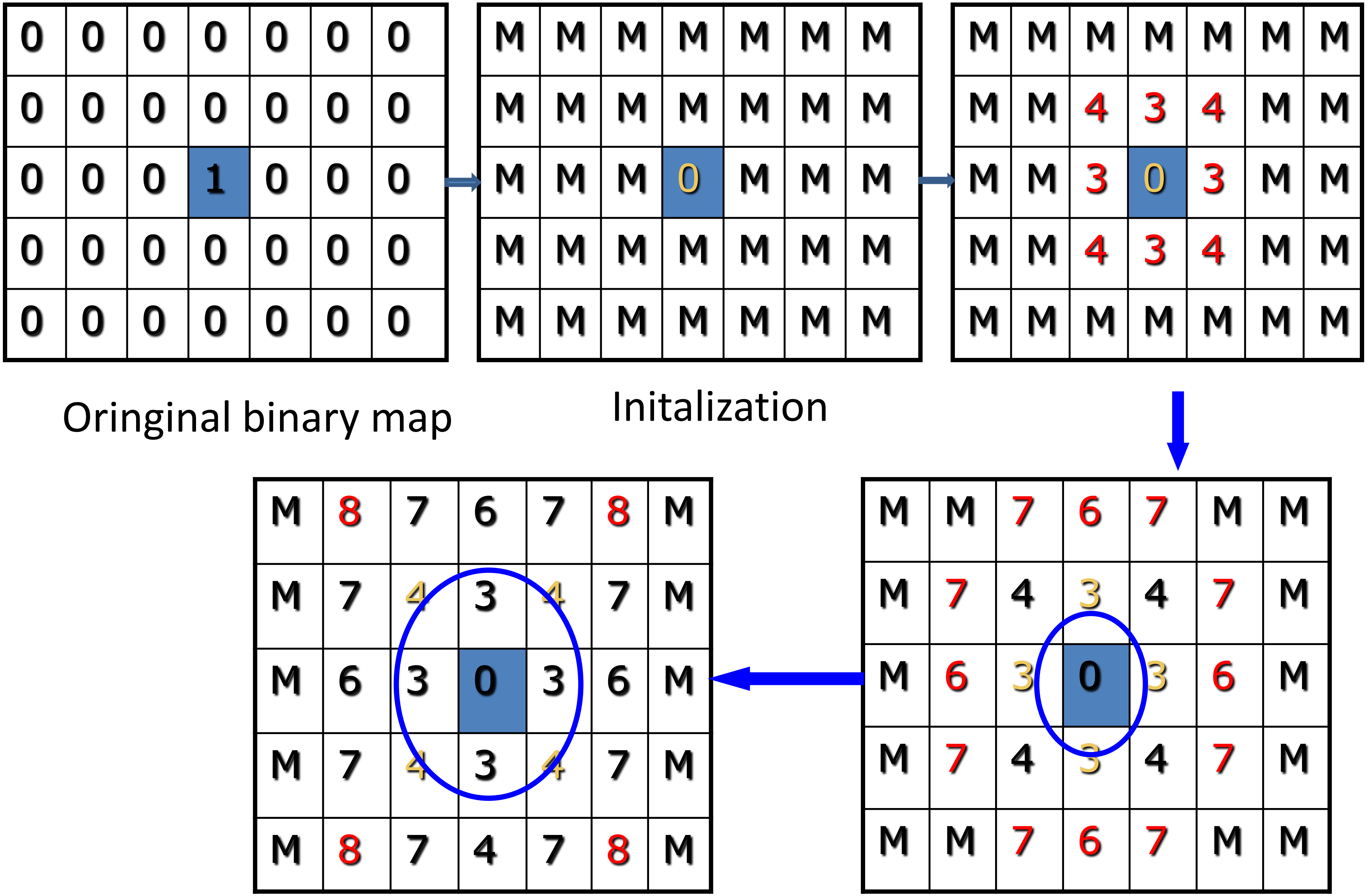
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	1	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

binary map

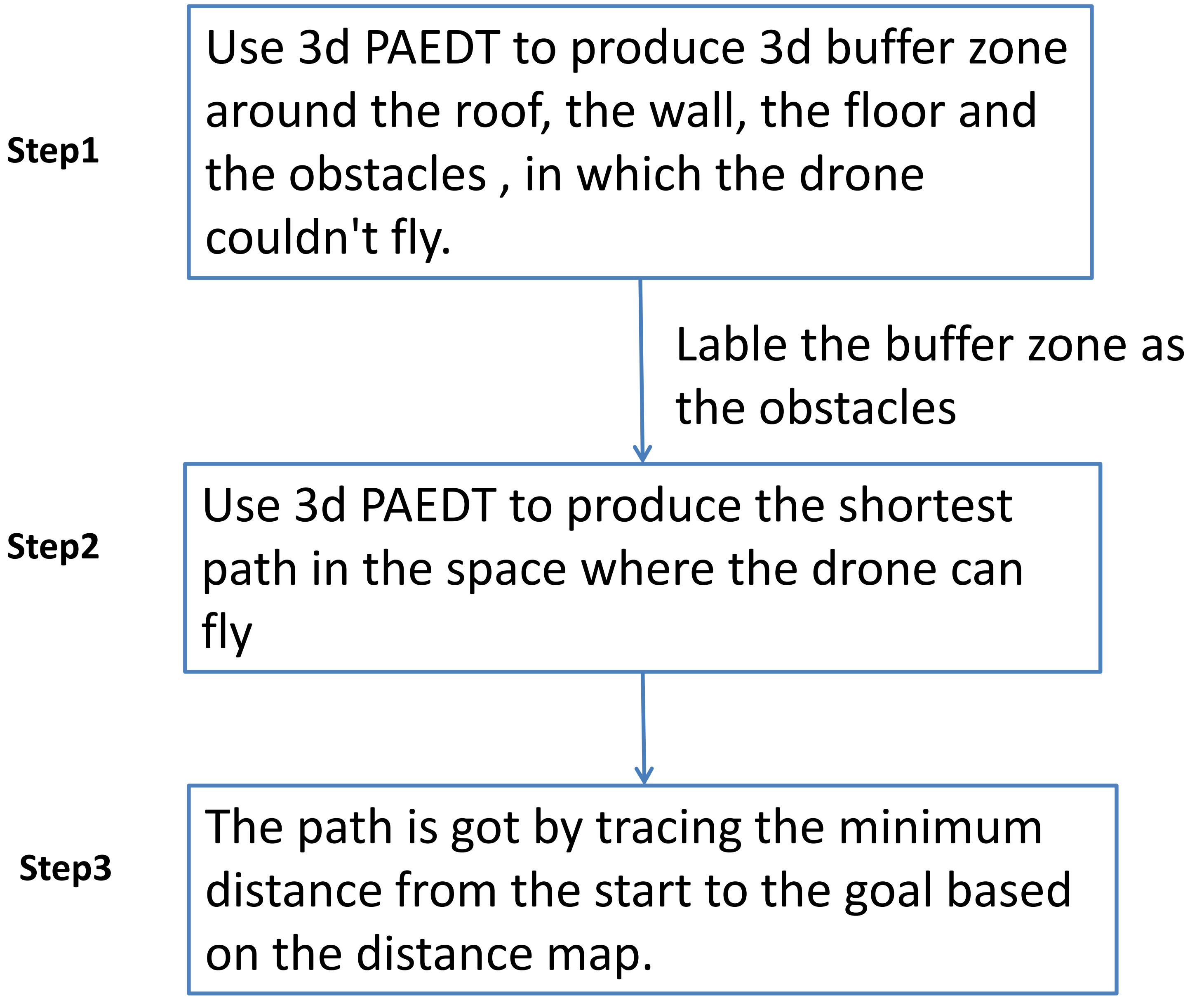
11	8	7	6	7	8	11
10	7	4	3	4	7	10
9	6	3	0	3	6	9
10	7	4	3	4	7	10
11	8	7	4	7	8	11

Distance map

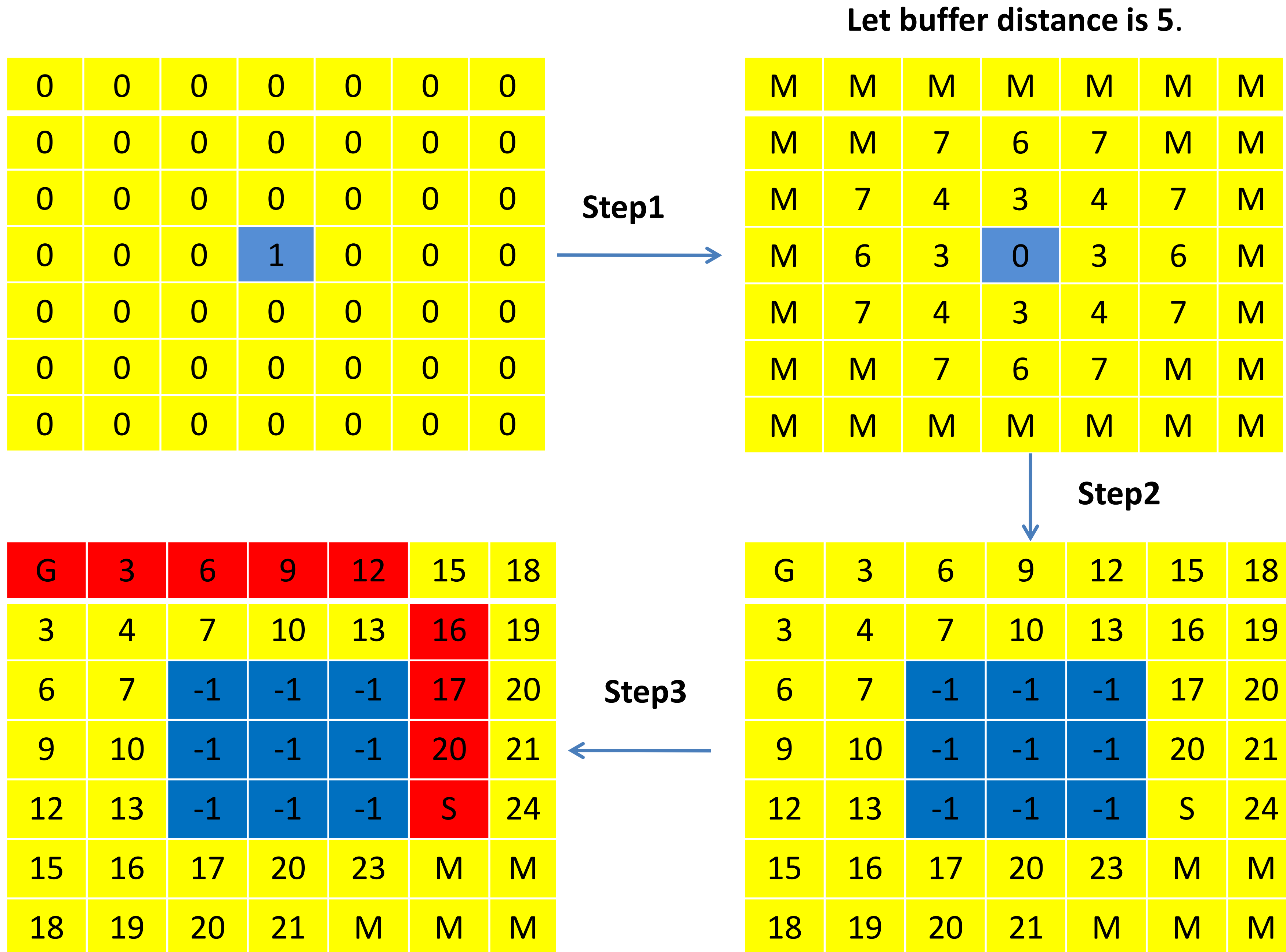
Distance transformation is to convert a digital binary image that consists of object (foreground) and non-object (background) pixels into another image in which each background pixel has a value corresponding to the minimum distance from the object by a distance function.



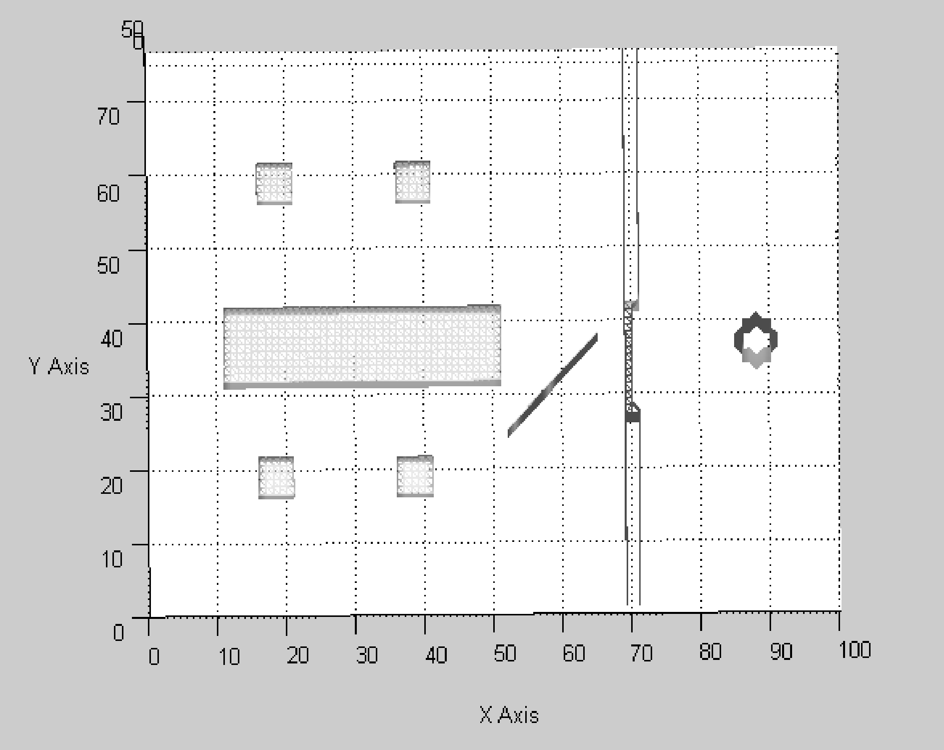
propagating approximate Euclidean distance transformation(**PAEDT)algorithm**



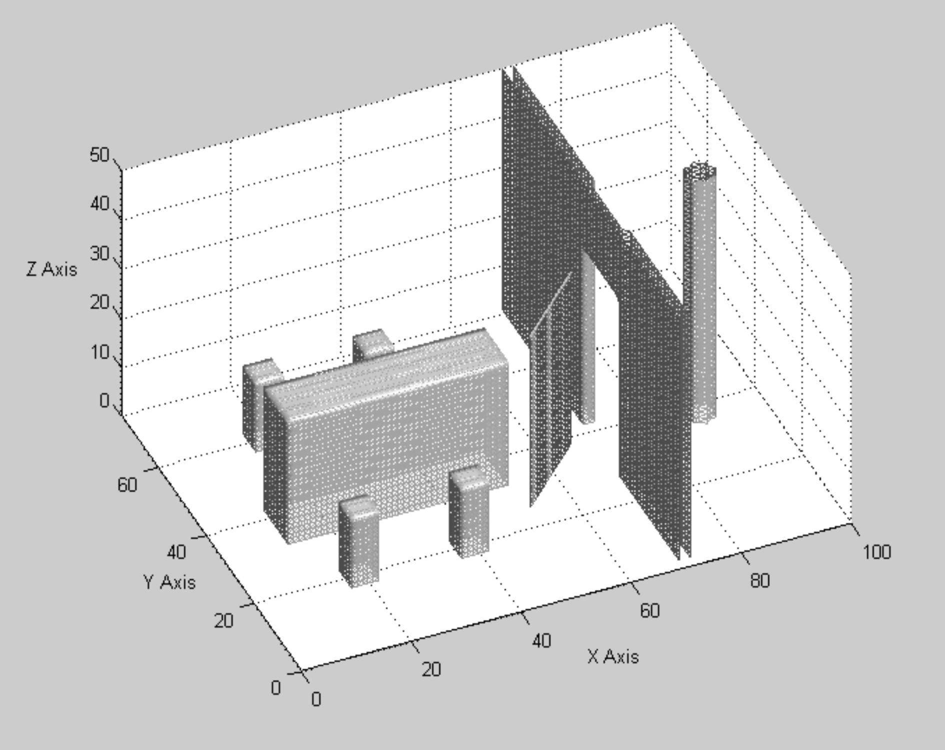
Working process



The method shown in 2d

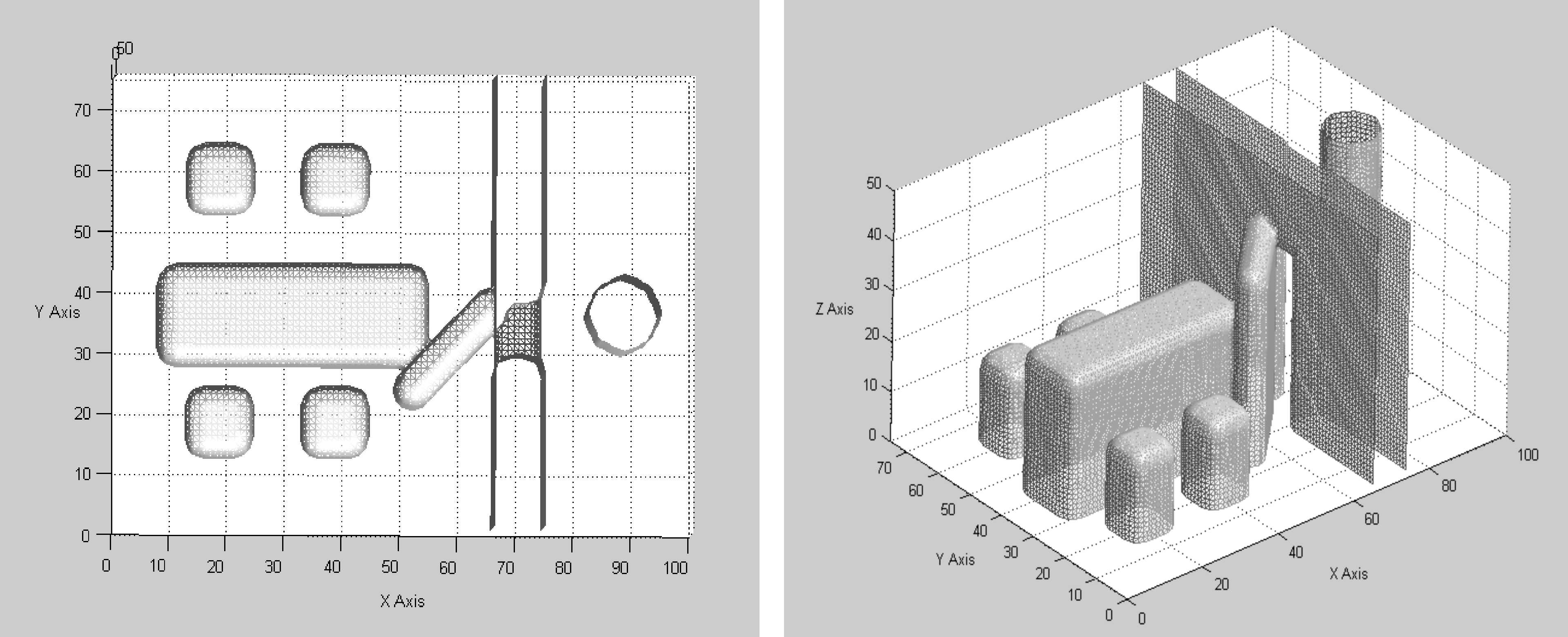


a) top view



b) side view

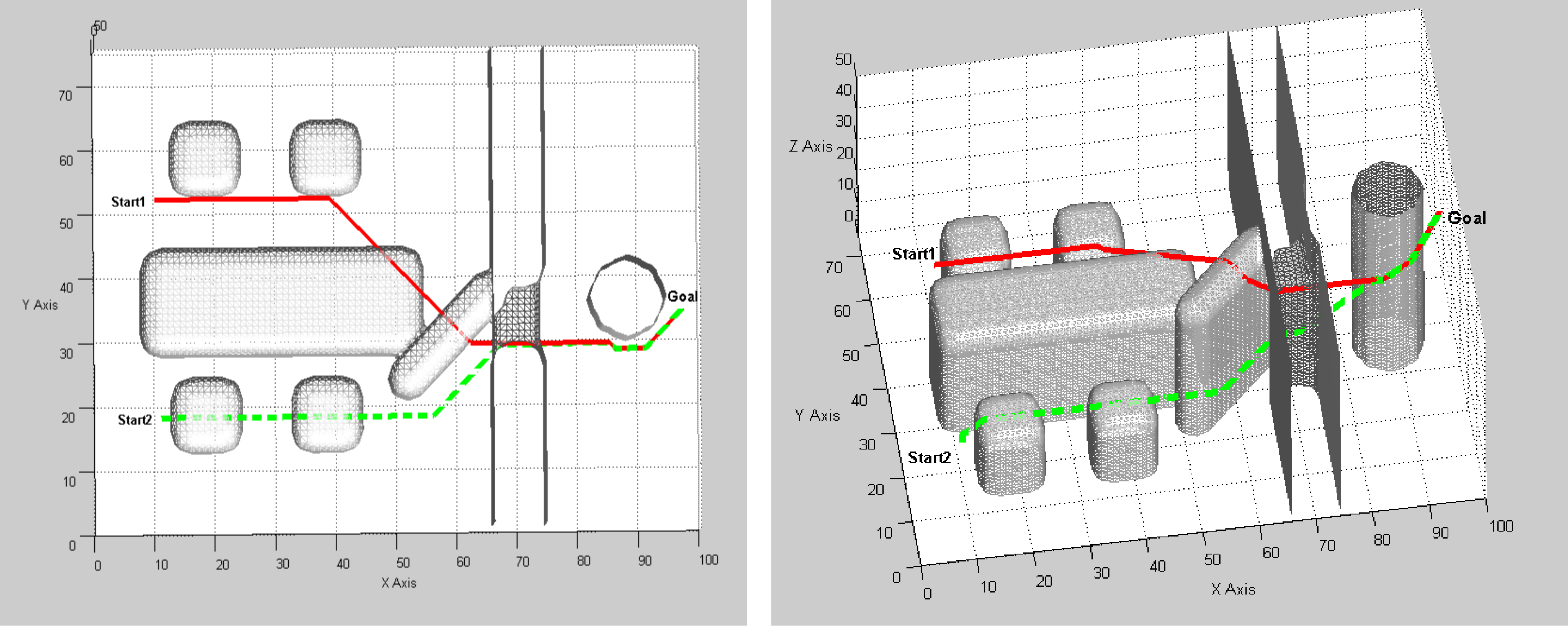
The indoor experiment data (100*75*50=375,000)visualized by matlab



a) top view.

b) side view.

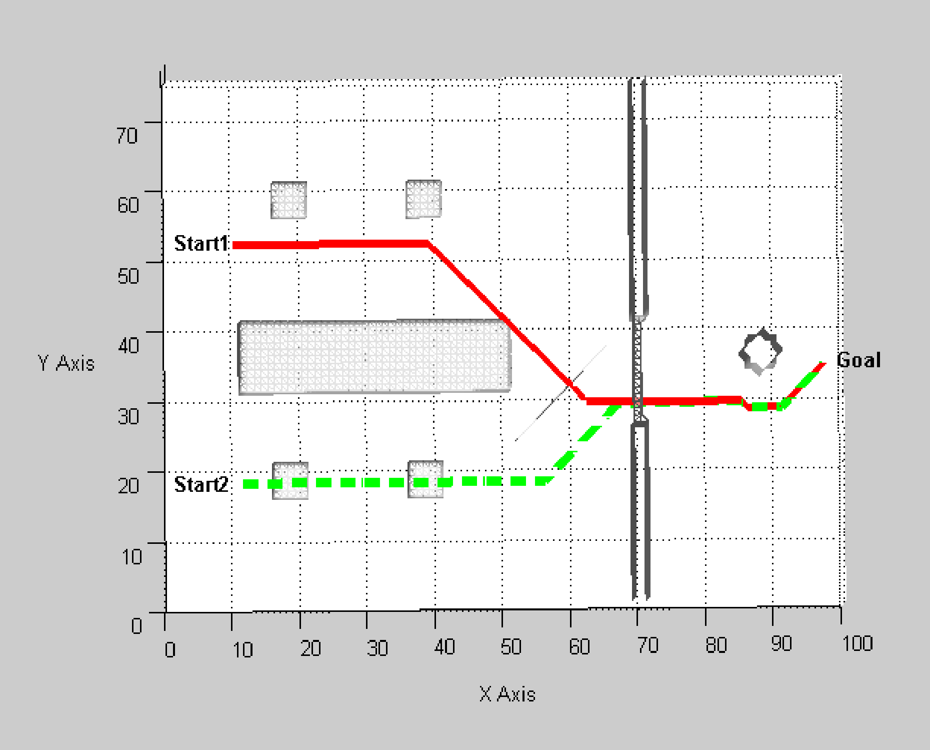
The 3d buffer result of the obstacles. The buffer distance is five times the voxel side length.



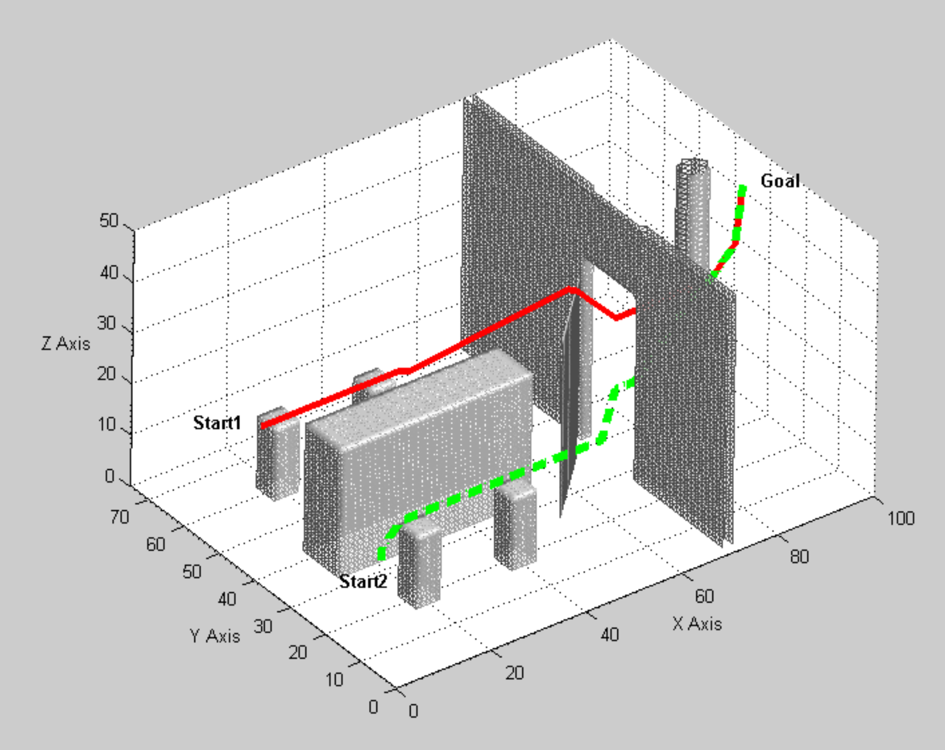
a) the top view of the two paths and 3d buffer of the obstacles.

b) the side view of the two paths and 3d buffer of the obstacles.

The path finding results. The positions of start1 and start2 are (10,52,20) and (10,18,10) respectively. The position of goal is (98,35,45). The red solid line represents the shortest path between start1 and goal. The green dash line represents the shortest path between start2 and goal.



c) the top view of the two paths and the obstacles.



d) the side view of the two paths and the obstacles.

The path finding results. The positions of start1 and start2 are (10,52,20) and (10,18,10) respectively. The position of goal is (98,35,45). The red solid line represents the optimal path between start1 and goal. The green dash line represents the optimal path between start2 and goal.

Next work

How to find a shortest path , and at the same time let the drone fly at a certain height as far as possible?

Method:

Cost map which is related to the distance from the surface?