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Experiment-2

Path planning of a Car-Like Mobile Robot

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8.1. Investigation of the Roadmap Method

	Start	Goal	Path found	Path optimal
Map 1	X:71px, Y:47px	X:492px, Y:447px	YES, L=587.35px	YES
	X:34px, Y:161px	X:441px, Y:317px	YES, L=443.27px	YES
	X:316px, Y:25px	X:492px, Y:452px	YES, L=483.78px	YES
Map 2	X:22px, Y:58px	X:413px, Y:470px	YES, L=587.16px	YES
	X:481px, Y:190px	X:36px, Y:3px	YES, L=488.59px	YES
	X:140px, Y:2px	X:69px, Y:458px	YES, L=469.06 px	YES
Map 3	X:18px, Y:114px	X:304px, Y:481px	YES, L=517.69px	YES
	X:358px, Y:52px	X:342px, Y:468px	YES, L=536.29px	YES
	X:24px, Y:180px	X:300px, Y:469px	YES, L=454.78px	YES
Map 4	X:18px, Y:74px	X:441px, Y:449px	YES, L=581.85px	YES
	X:408px, Y:13px	X:140px, Y:483px	YES, L=650.12px	YES
	X:44px, Y:258px	X:477px, Y:483px	YES, L=527.04px	YES
Map 5	X:20px, Y:9px	X:478px, Y:190px	YES, L= 497.90px	YES
	X:42px, Y:471px	X:268px, Y:10px	YES, L=527.30px	YES
	X:92px, Y:483px	X:347px, Y:151px	YES, L=422.71px	YES

1. Does the algorithm always find a path? If not, write down the map number and the start and goal point and a proposal what are the reasons for the failure.

Ans) Yes, the algorithm always finds a path.

2. Does the algorithm always find the shortest path? If not, write down the map number and the start and goal point and a possible explanation.

Ans) No, Although, most of the maps have shortest path length in Roadmap algorithm, that is not always the case. Sometime Roadmap algorithm fail to give the shortest distance.

For instance, the given map below has start point at X:131px, Y:203px and end point at X:258px, Y:183px has shortest path length 350.98px in Distance Transform algorithm (Fig.1) and the path length yielded in Roadmap method (Fig.2) is 520.26px.

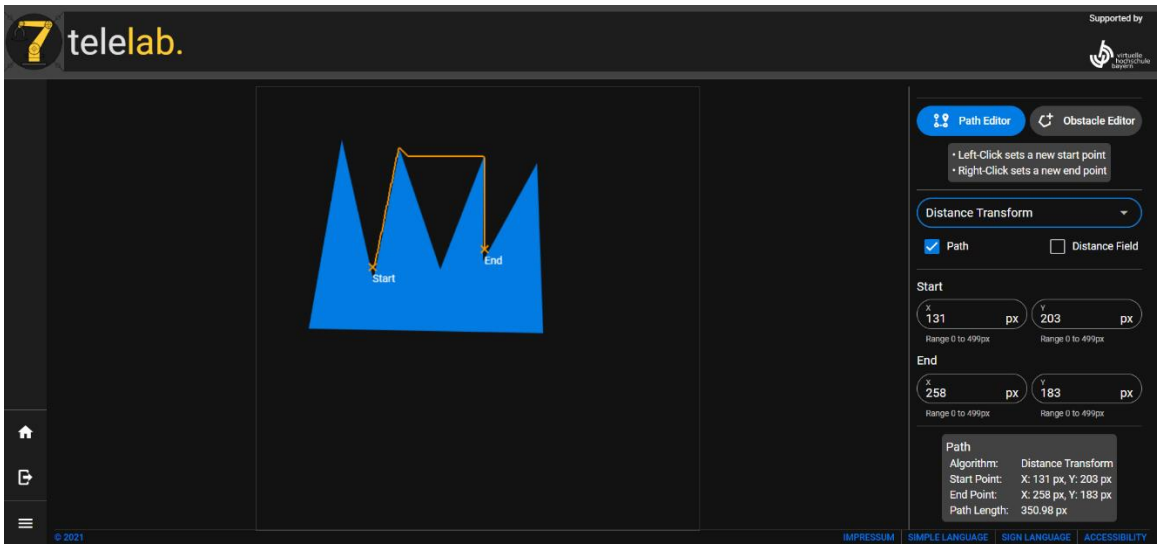


Fig. 1

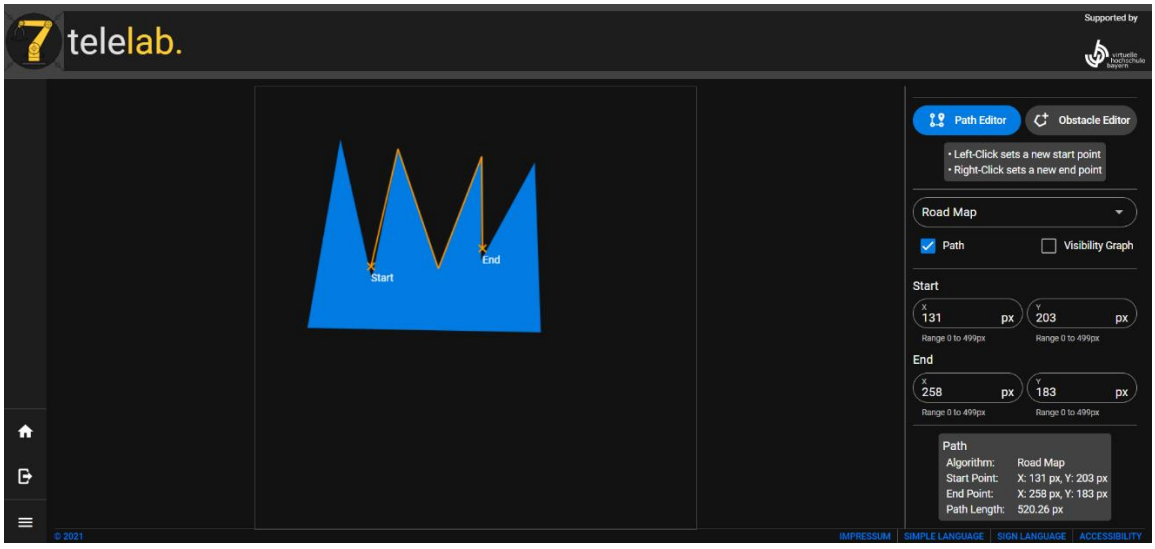


Fig.2

This is because the Roadmap algorithm utilizes initial, goal and obstacles vertices as nodes. So here the path follows the contour of the obstacle.

3. Seems the method suitable for all kind of environment maps?

Ans) Yes, the Roadmap method seems to be suitable for all types of environment maps, if the robot is given power to take real time discissions then it seems to work in unstructured environment as well.

4. What kind of problems do you expect when transferring this algorithm to the real world? How can you solve this problem?

Ans) 1) In real life the contour of the obstacles in configuration space cannot be sharp edged polygons because the shape and orientation of the robot is to be considered.

Growing of the obstacles could be done to prevent this from happening. A polygon encapsulating the grown obstacle could me used to find the visibility graph.

2) In real life obstacles are not polygon shaped and is more rounded in shape. Most of the cases they lack vertices.

In such cases a polygon encapsulating the contour of the real obstacle could be considered as the virtual obstacle and the virtual obstacle could be used to find the visibility graph.

8.2. Investigation of the Potential field Method

	Start	Goal	Path found	Path optimal
Map 1	X:48px, Y:379px	X:347px, Y:23px	YES, L=500.70px	NO
	X:286px, Y:462px	X:171px, Y:32px	YES, L=478.61px	NO
	X:110px, Y:463px	X:443px, Y:97px	NO	NO
Map 2	X:56px, Y:21px	X:379px, Y:436px	YES, L=583.03	NO
	X:45px, Y:322px	X:415px, Y:338px	NO	NO
	X:31px, Y:78px	X:478px, Y:135px	YES, L=507.85px	NO
Map 3	X:96px, Y:179px	X:459px, Y:462px	NO	NO
	X:209px, Y:34px	X:86px, Y:475px	YES, L=502.14px	NO
	X:61px, Y:178px	X:480px, Y:254px	YES, L=456.25px	NO
Map 4	X:28px, Y:85px	X:454px, Y:475px	YES, L=632.65px	NO
	X:458px, Y:227px	X:43px, Y:31px	YES, L=472.15px	NO
	X:330px, Y:23px	X:477px, Y:483px	YES, L=585.38px	NO
Map 5	X:107px, Y:162px	X:266px, Y:162px	YES, L=159.00px	YES
	X:458px, Y:62px	X:30px, Y:321px	YES, L=532.53px	NO
	X:73px, Y:470px	X:410px, Y:32px	NO	NO

1. How effects the varying of the attracting potential gain the path planning?

Ans) Whenever the attraction potential gain increases, the chance for the collision increases and when the attracting potential decreases, the chance for the collision decreases. The length of the path decreases for higher attracting field.

2. How effects the varying of the repulsing potential gain the path planning?

Ans) Whenever the repulsing potential gain increases, the chance for the collision decreases and when the repulsing potential decreases, the chance for the collision increases. The length of the path increases for higher attracting field.

3. How effects the varying of the minimal distance value the path planning?

Ans) The minimal distance value always increases when the distance with respect to the obstacles increases. Small distance can occur collision.

4. Could you find a general optimum for the parameters? Or do you have to adjust for the different maps

Ans) I was not able to find a general optimum for parameters, I have to change parameters many times to get better results.

5. Does the algorithm always find **a** path? If not, write down the map number and the start and goal point and a proposal what are the reasons for the failure.

Ans) This algorithm doesn't always find finest path and in some positions, I was unable to join start and end point. When big object comes in front of robot then it is unable to go further.

Map No	**Start**	**Goal**
Map 1	X:110px, Y:463px	X:443px, Y:97px
Map 2	X:45px, Y:322px	X:415px, Y:338px
Map 3	X:96px, Y:179px	X:459px, Y:462px
Map 5	X:73px, Y:470px	X:410px, Y:32px

The cause of this issue is the formation of local minima; when a large object is directly Infront of a robot, the robot becomes trapped inside a local minima and is unable to go forward.

6. Does the algorithm always find **the shortest** path? If not, write down the map number and the start and goal point and a possible explanation

Ans) No, the algorithm mostly does not find a shortest path from starting point to ending point except this point in the map 5 start point X:107px, Y:162px and endpoint X:266px, Y:162px.
The path found is not the shortest path because of following reasons:

Because this method discretizes the configuration space into a tiny grid, the path line cannot be at any angle (like in Road Map visibility graph method). It is constrained to multiples of 45 degrees.

Also, because this method is based on attraction and repulsion forces, when the shortest path consists of a semi-free path, the path often becomes slightly longer as edges and corners of obstacles are avoided and a repulsive field is produced around them. As a result, the path gets curved.

7. Seems the method suitable for all kind of environment maps?

Ans) This method is not suitable for all kind of environment because it always finds minimal local distance with respect to obstacles as mentioned in the map 5 and does not choose minimal path according to environment.

8. What kind of problems do you expect when transferring this algorithm to the real world? How can you solve these problems?

Ans) The cost is not considered in this method and whenever we give a input parameters it takes time encode the input parameters in the algorithm and to get output. So, a delay is occurred. It is vulnerable to local minima. It must be occupied with different sensors like IR sensors to deal with environment with more obstacles.

8.3. Investigation of the Distance Transform Method

	Start	Goal	Path found	Path optimal
Map 1	X:31px, Y:214px	X:437px, Y:459px	YES, L=507.48px	NO
	X:127px, Y:42px	X:437px, Y:459px	YES, L=548.92px	NO
	X:24px, Y:391px	X:443px, Y:97px	YES, L=561.67px	NO
Map 2	X:285px, Y:447px	X:300px, Y:14px	YES, L=537.79px	NO
	X:119px, Y:18px	X:376px, Y:397px	YES, L=485.45px	NO
	X:76px, Y:59px	X:89px, Y:135px	YES, L=112.54px	YES
Map 3	X:184px, Y:81px	X:94px, Y:414px	YES, L=403.76px	NO
	X:454px, Y:354px	X:90px, Y:475px	YES, L=427.37px	NO
	X:44px, Y:305px	X:479px, Y:465px	YES, L=621.66px	NO
Map 4	X:65px, Y:406px	X:484px, Y:156px	YES, L=623.55px	NO
	X:234px, Y:22px	X:174px, Y:481px	YES, L=575.81px	NO
	X:19px, Y:115px	X:349px, Y:458px	YES, L=581.78px	NO
Map 5	X:118px, Y:38px	X:361px, Y:454px	YES, L=516.65px	NO
	X:456px, Y:31px	X:40px, Y:445px	YES, L=619.12px	NO
	X:13px, Y:240px	X:490px, Y:490px	YES, L=580.55px	NO

1) Does the algorithm always find a path? If not, write down the map number and the start and goal point and a proposal what are the reasons for the failure.

Ans) Yes, the algorithm always successfully finds a path.

2) Does the algorithm always find the shortest path? If not, write down the map number and the start and goal point and a possible explanation.

Ans) Except one point in Map 2 with start and end points X:76px, Y:59px and X:89px, Y:135px, Distance transform method doesn't find any shortest path. That is because the configuration space is discretized into a fine grid using Distance transform method. It constrains the angle of the line of path to angles of multiples of 45 degrees.

3) Seems the method suitable for all kind of environment maps?

Ans) Yes, the Distance Transform method seems to be suitable for all types of environment maps, if the robot is given power to take real time discissions then it seems to work in unstructured environment as well.

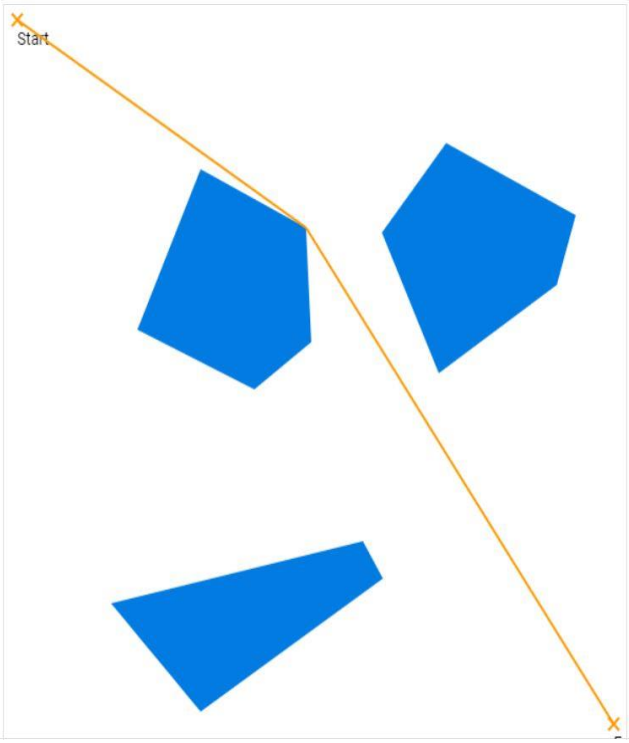
4. What kind of problems do you expect when transferring this algorithm to the real world? How can you solve these problems?

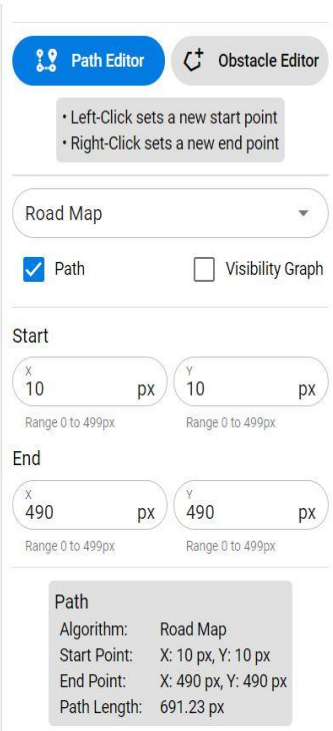
Ans) Since distance transformation method uses spatial decomposition, the resolution of the grid is limited by cell size. This could be solved by reducing the cell size.

8.4. Comparison of the Path Planning Methods

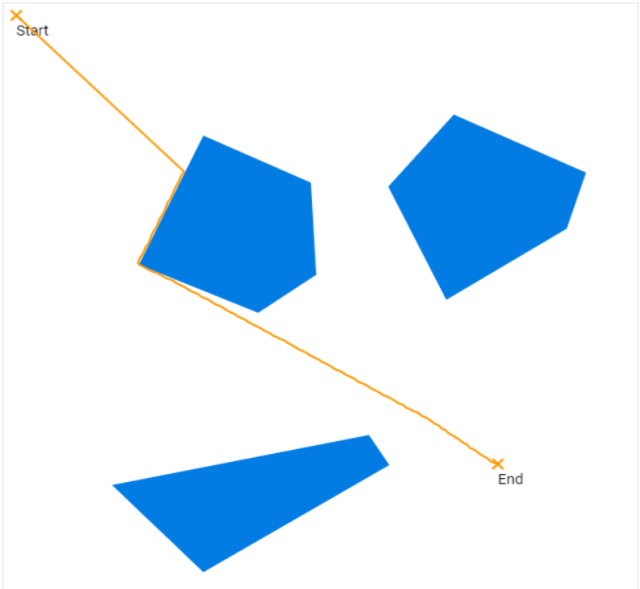
1) Describe the differences in the paths by means of the screenshot and explain the result.

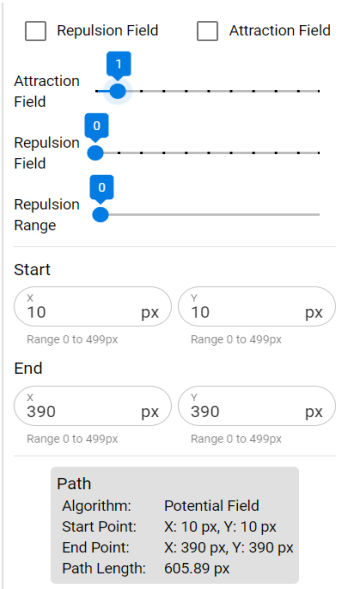
Map1: Roadmap – L=691.23PX



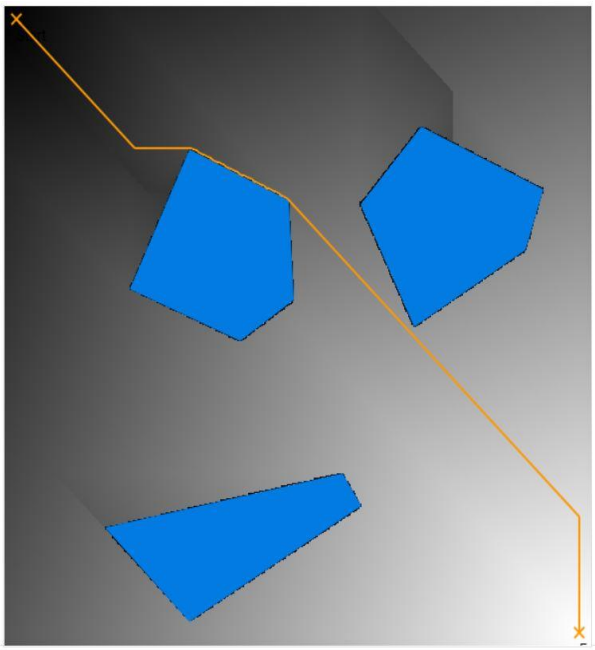


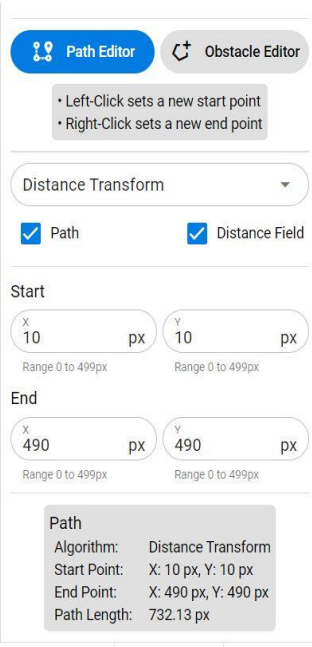
Map1: Potential Field – L=605.89PX



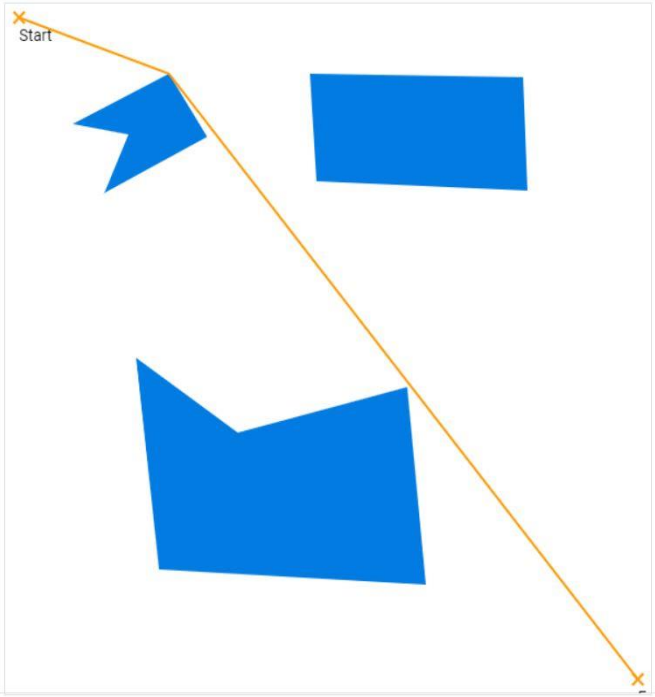


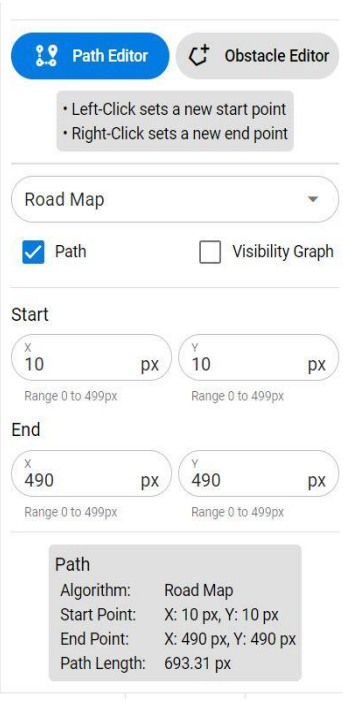
Map1: Distance Transform – L=732.13PX



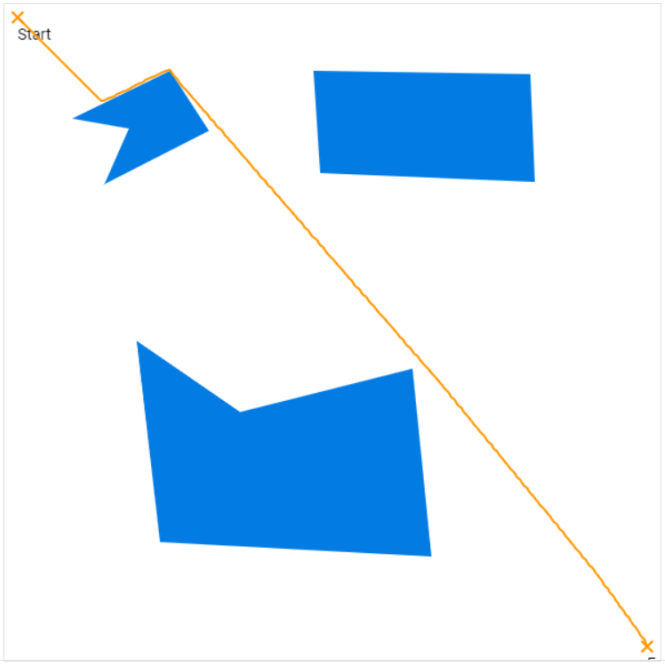


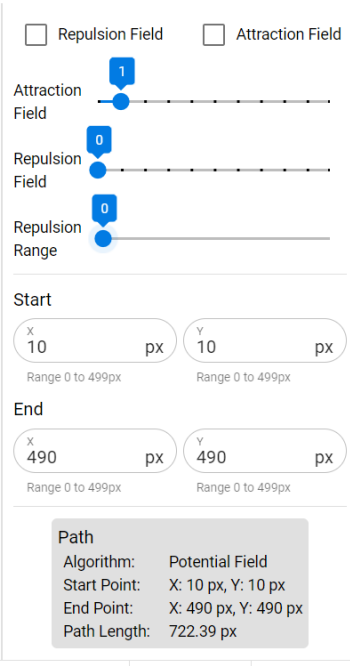
Map2: Roadmap – L=693.31PX



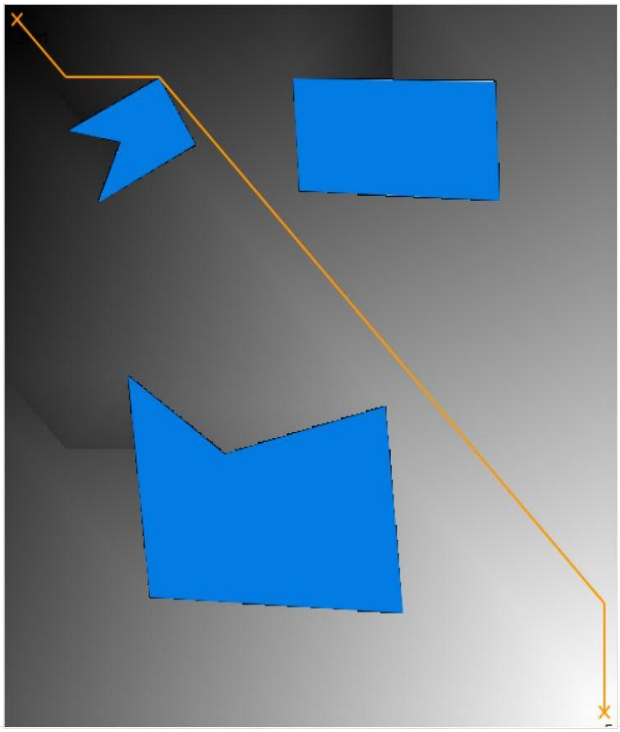


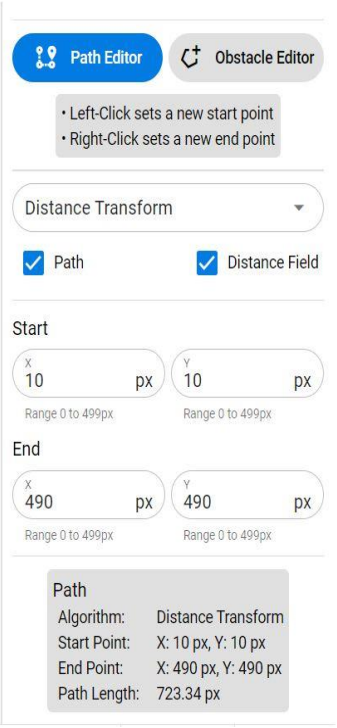
Map2: Potential Field – L=722.39PX



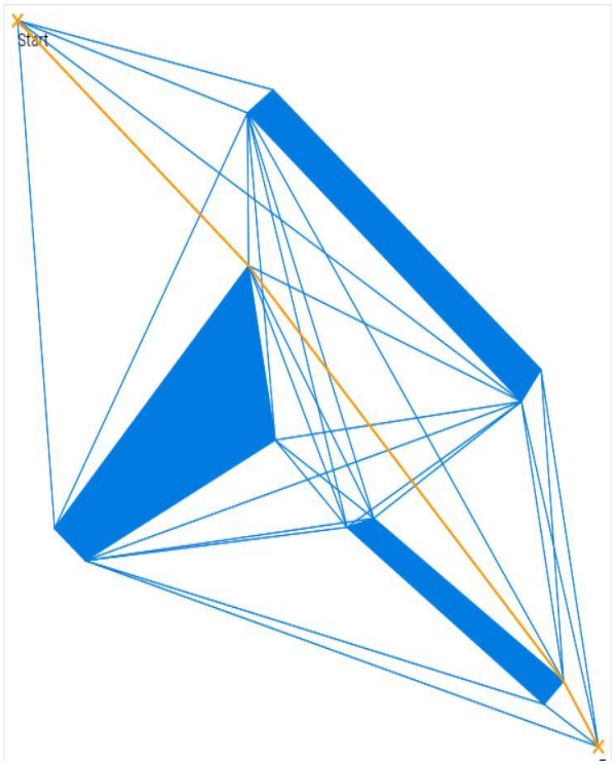


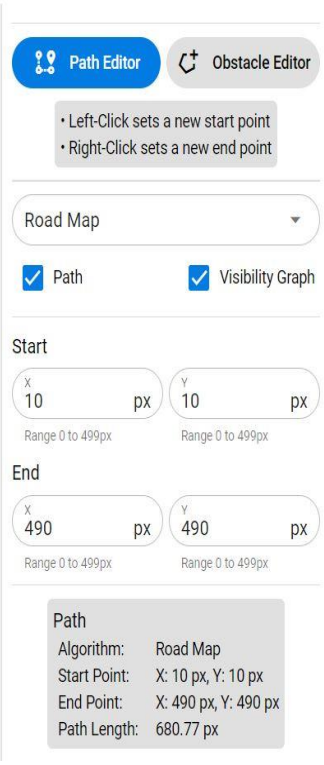
Map2: Distance Transform – L=723.34PX



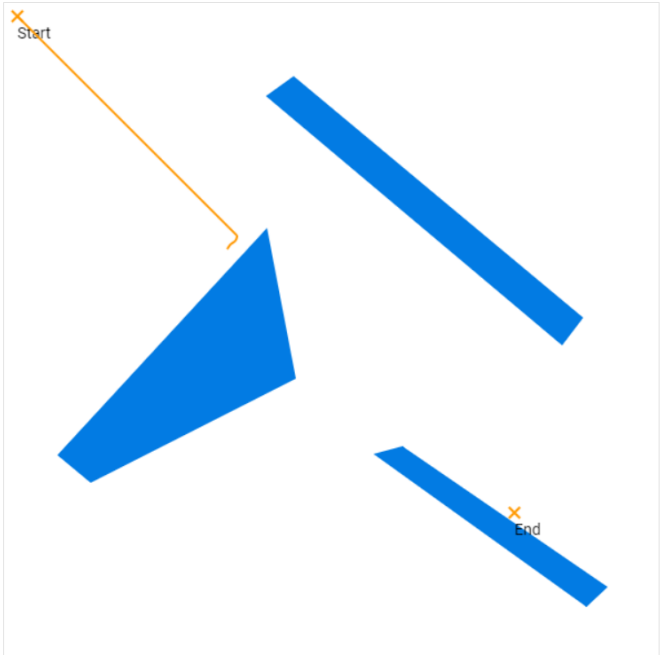


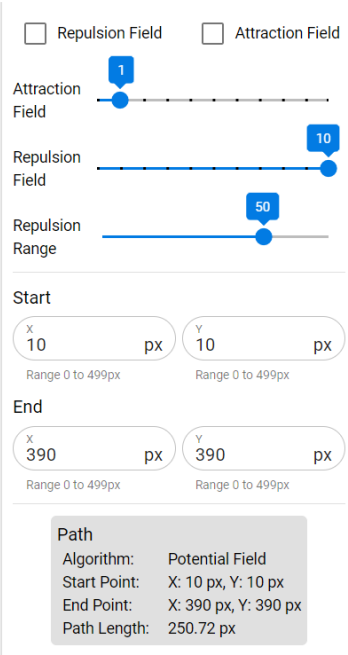
Map3: Roadmap – L=680.77PX



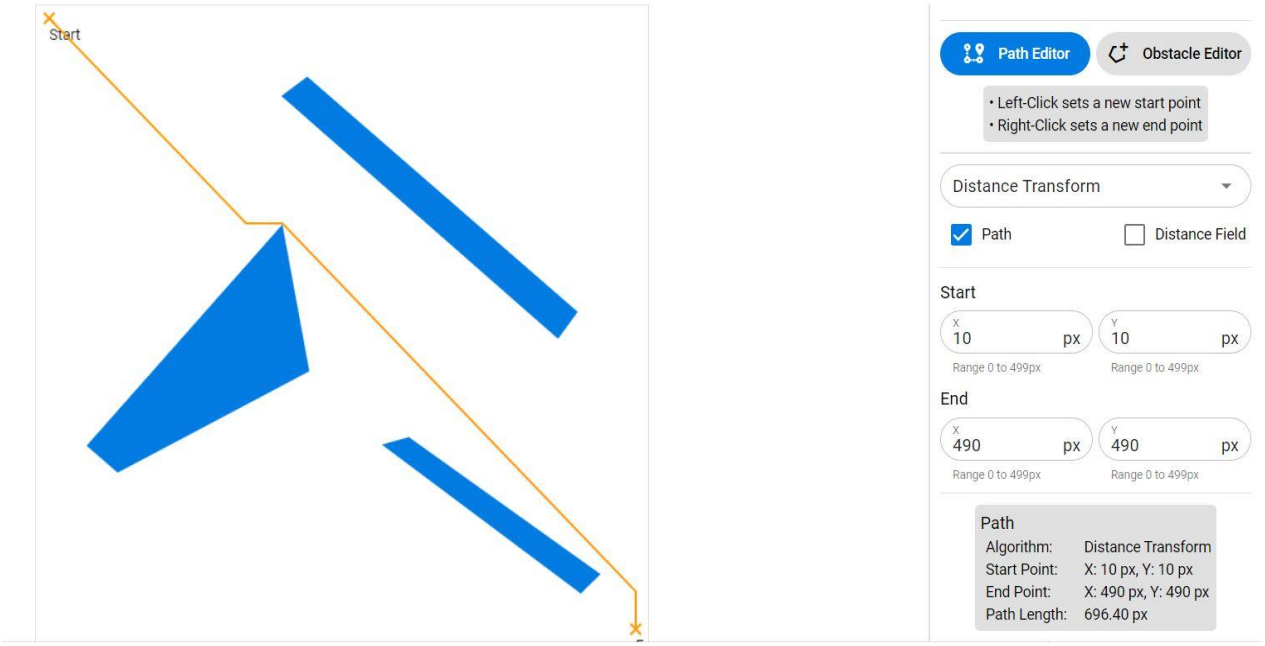


Map3: Potential Field – L=250.72PX

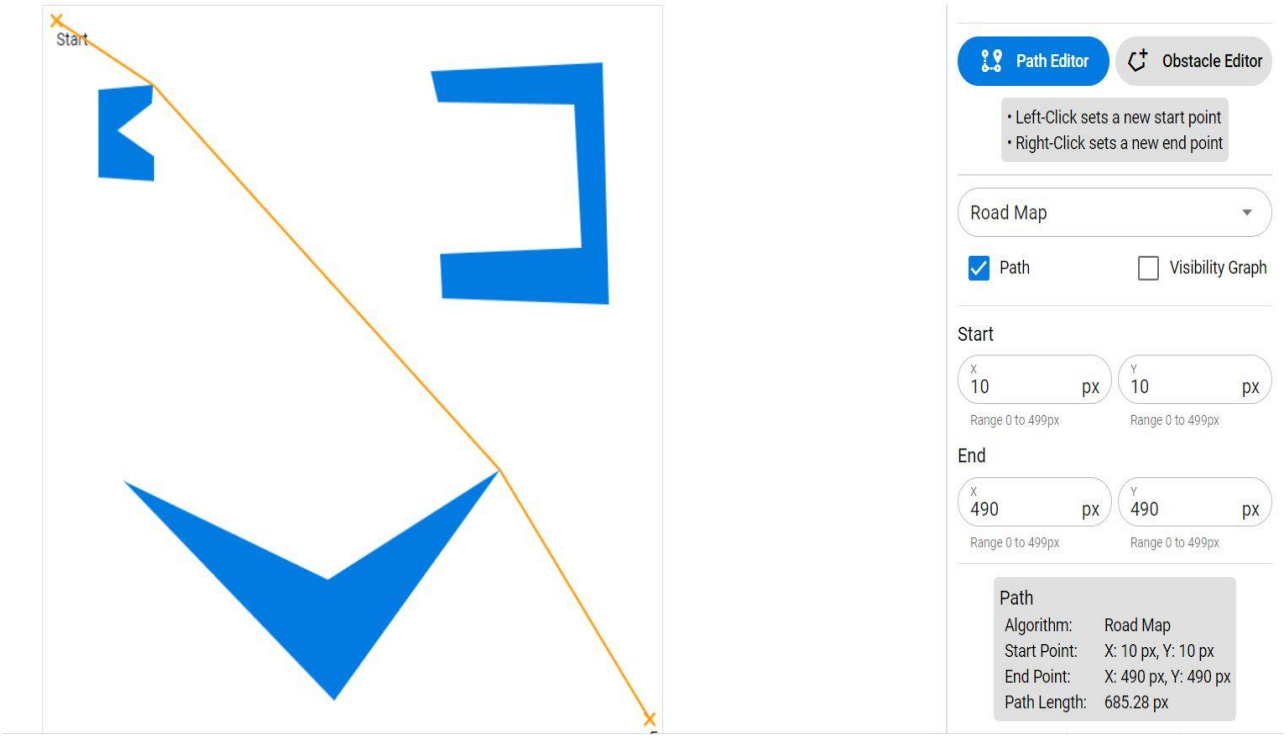




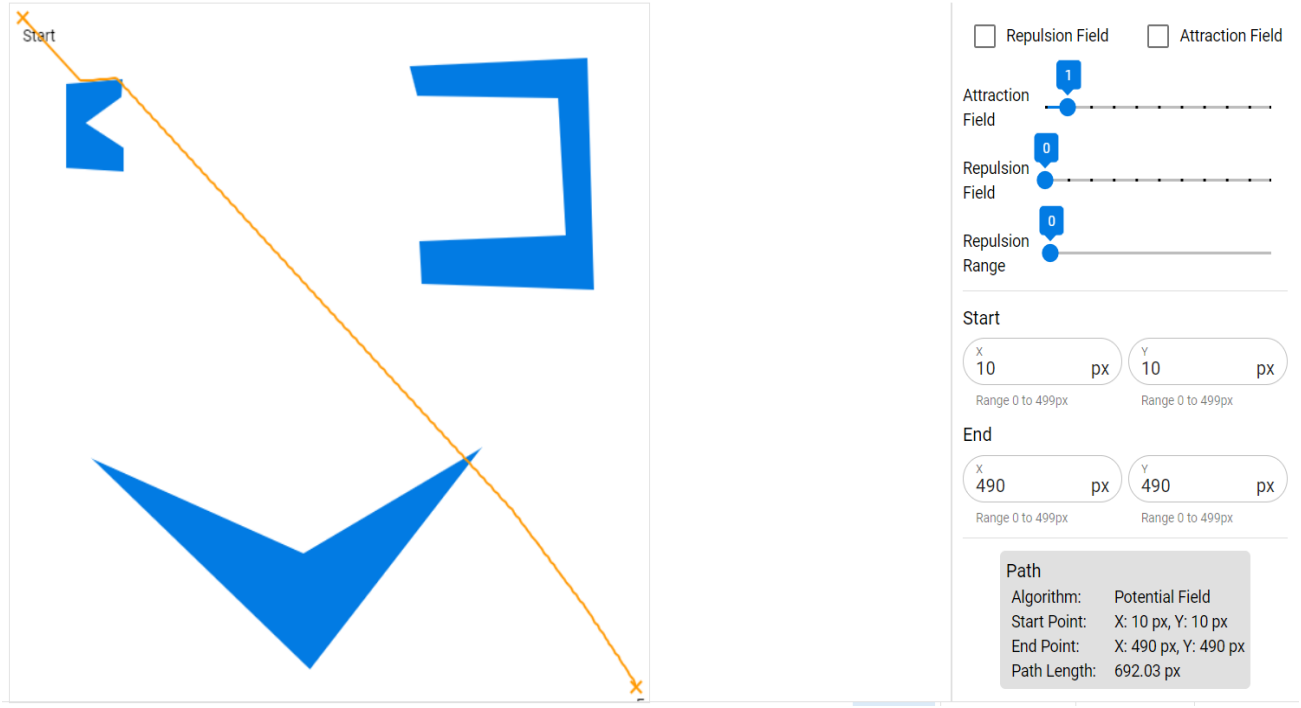
Map3: Distance Transform L=696.40PX



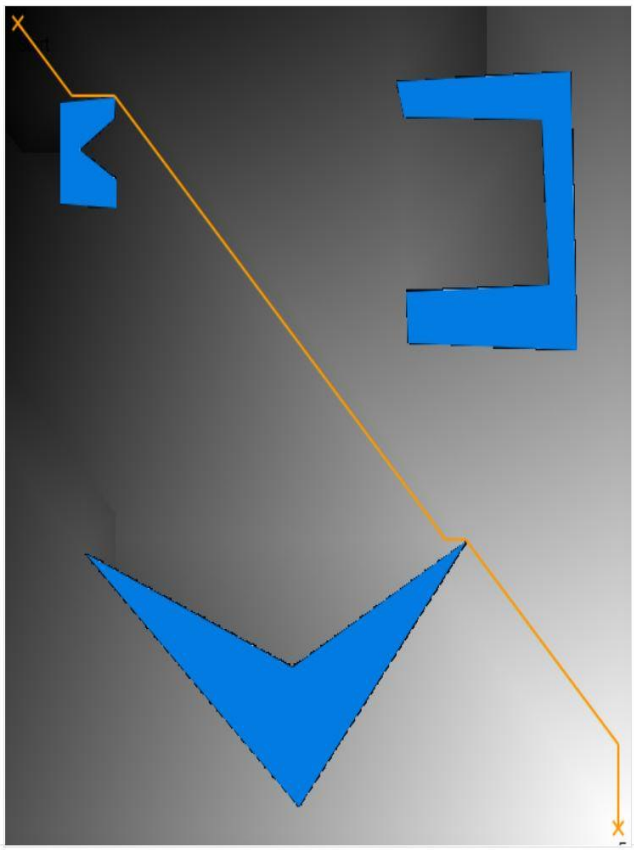
Map4: Roadmap – L=685.28PX

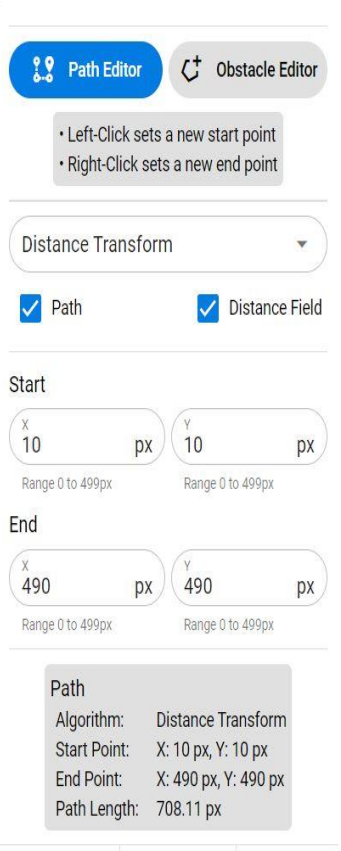


Map4: Potential Field – L=692.03PX

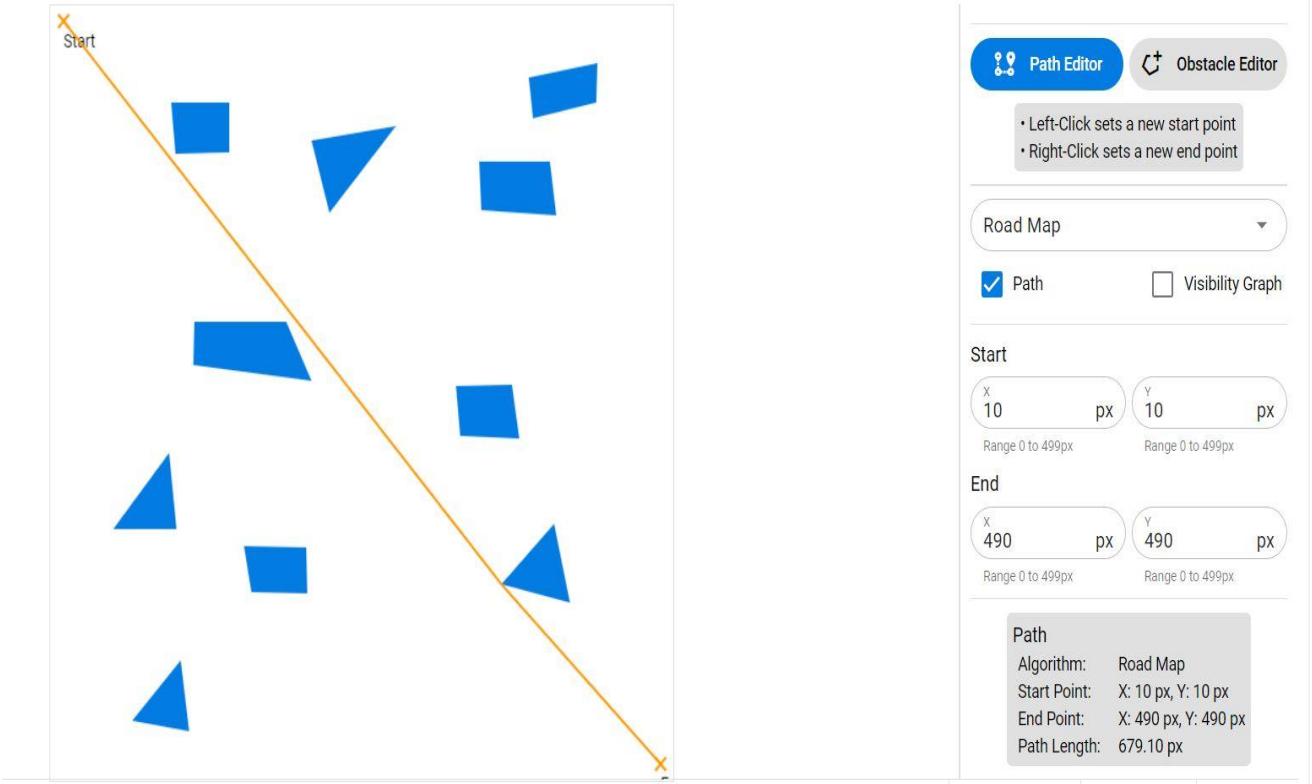


Map4: Distance Transform – L=708.11PX

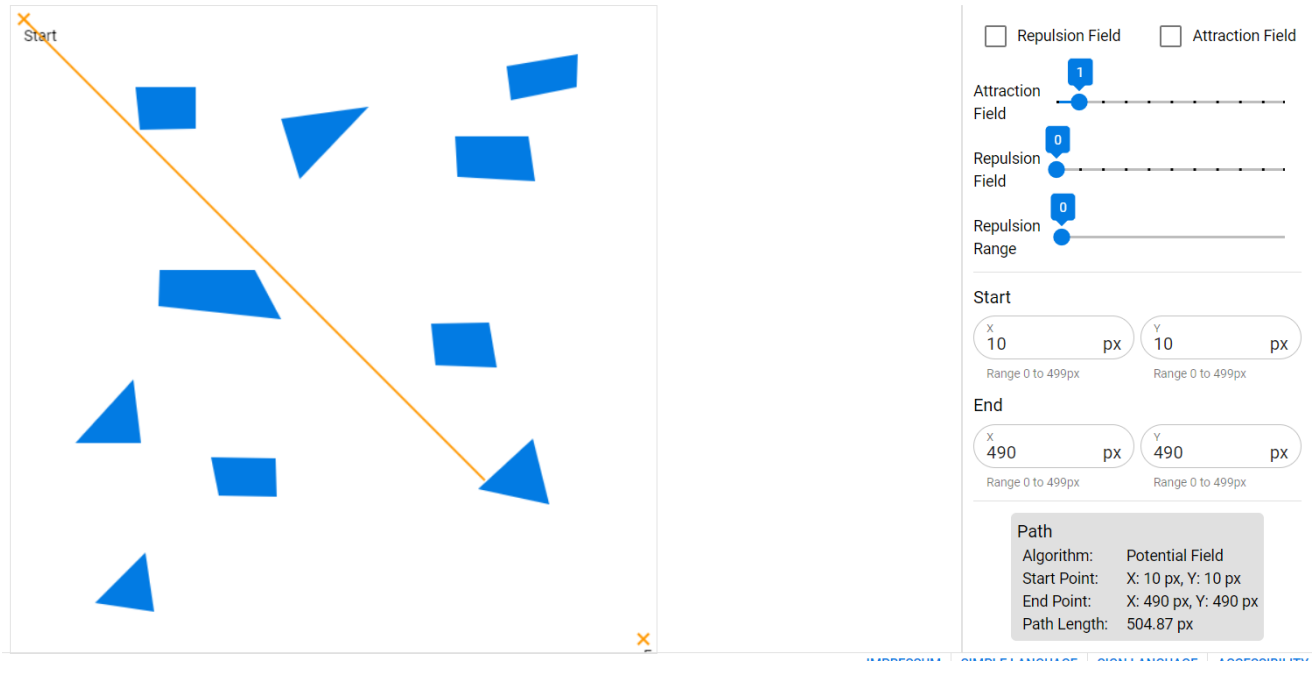




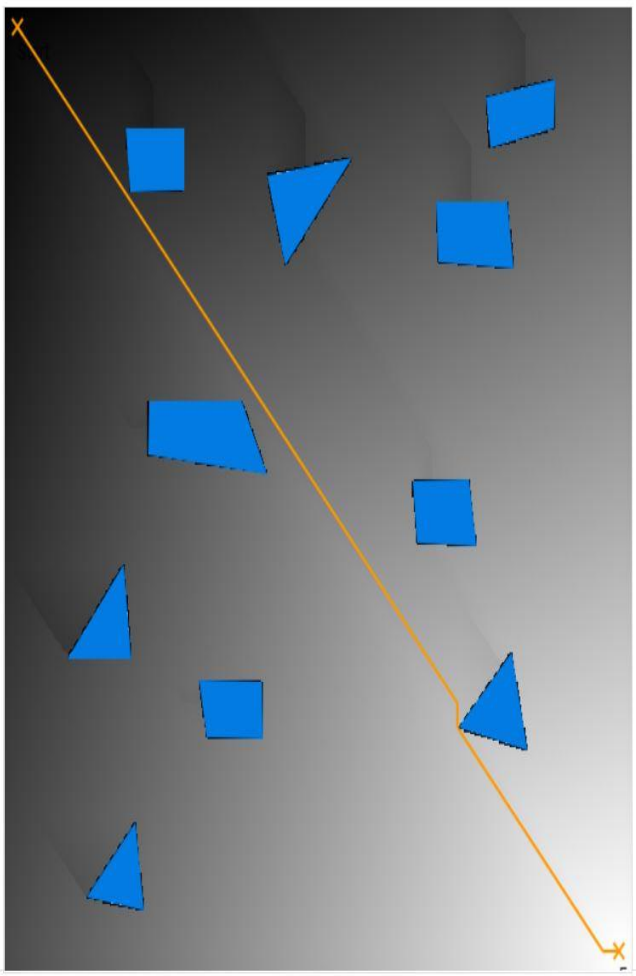
Map5: Roadmap – L=679.10PX

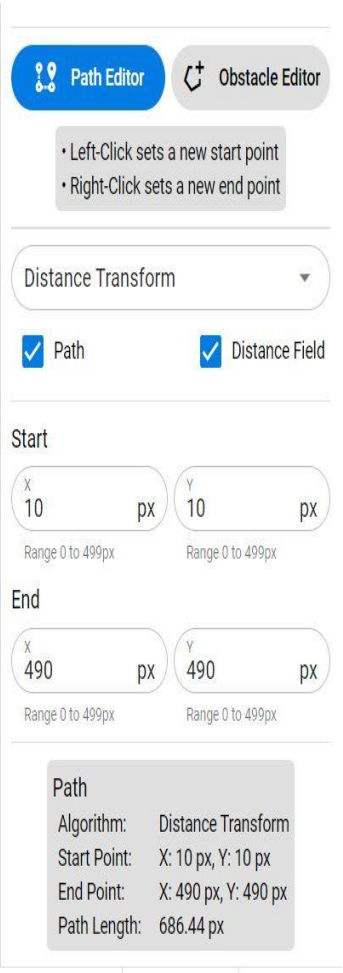


Map5: Potential Field – L-504.87PX



Map5: Distance Transform – L=686.44PX





2. Write down which algorithm seems most suitable for the certain environment (remember that the maps represent different kind of environments).

Ans)

Roadmap Method: found to be the most effective algorithm for path finding. It almost always has the least path length when compared with other two path finding algorithms. It never tends to fail in connecting start and end points. This method is mostly suitable for every environment.

Potential Field Method: this seems to be the worst algorithm in finding the machine path. Most of the time this algorithm has longest path length and many times fail to connect from start to end point. This method is mostly applicable when the environment has less objects.

Distance Transform Method: This algorithm found to be the second-best algorithm in finding path length. It always connects between start and end points and few times show least path length than Roadmap algorithm. This method always tends to choose the safest path and this method could deal small, big and curved obstacles. It gives better path when environment has less objects.