

31388 Advanced Autonomous Robots

Planning and Navigation

(rev 1.0)

Objective

The objective of this exercise is to give an introduction to planning and navigation.

When you have finished this exercise you will be able to:

- Make a wavefront planner.
- Use the result to drive an SMR along the found route.

Evaluation

The results from each part of the exercise must be presented on the homepage.

Wavefront planner (grassfire).

The wavefront planner is a simple grid based planner (AMR p381). It starts at the goal point and marks the distance to the goalpoint in all the neighbour cells. Then take all these cells and mark their neighbour cells with their distance to the goal cell. Continue like this until the startcell is reached or no more accessible neighbour cells exist. If the start cell is reached a route from the start cell to the goal cell can be found by always going to the neighbour cell with lowest distance to the goal. The neighbour cell may be found using either 4-point connectivity or 8-point connectivity.

The task of the exercise is to implement a wavefront planner in matlab. The basic map is an array with zeros for free space and ones for obstacles. The algorithm may easily be solved using a fifo-queue to hold the cells that need examination.

1. Implement a queue that can hold cell coordinates and a function to insert an element and a function to retrieve an element.
2. Implement a function that can find the neighbours of a cell using 8-point connectivity.
3. Implement a function 'makewave' that calculates the distance grid using the following pseudo code:

insert the goalpoint into the queue and write 2 at its mapposition

while more points in the queue and start cell not reached

 extract point cp from queue

 for all neighbour points nbi of cp

```

d=map(cp)+dist(nbi)
if map(nbi)== 0
    map(nbi)=d
    insert nbi in queue
else
    if (map(nbi) > d)
        map(nbi)=d
    end
end
endfor
endwhile

```

dist(nbi) is 1.41 if nbi is a 'diagonal' neighbour else it is 1.

4. Implement a function findroute that searches the distancemap made by makewave and finds the route from the starting point to the goal point.
5. Demonstrate the functions on the map `map=zeros(10,10)` `map(1:7,3)=ones(7,1)`
`map(3:10)=ones(8,1)` `goal=[2,2]` `start=[9,9]`
6. Try the method on the smr using a 5 cm grid and the command

`drive x y th :($targetdist < 0)`

to go from gridpoint to gridpoint. (x and y is the position of the centre of the next gridpoint and th is the direction towards it). Your matlab planner should generate a SMRCI script that stores the waypoints in arrays and then drives through all the way points with the drive command.

7. Use your planner to circumnavigate a cardboard box with the size 28 X 48 cm. The SMR should start 1 m before the box and end one meter after the box. The box should be dilated with 20 cm (half width of the SMR + 5 cm). Use the matlab command `imdilate` to dilate the map before planning. The structuring element should be a matrix of the form:

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