RRT - Real-Time Randomised Path Planning Algorithm

1. GUI explained

1. Select Map - select one of 5 provided maps
2. Open Map - opens new window with map
3. Specify Start and Finish - select radio button and click with the mouse on the map to place start (green) and finish (red) points
4. Distance to target thresh - threshold value defining how close the point has to get to the target to assume, that finish has been reached and stop the simulation
5. Step size - defines the length (distance covered) of each step
6. Max iterations - how many iterations will be done before stopping the program in case no target was found in that time
7. Goal probability - threshold defining what is the chance that finish point will be chosen as next target point. Larger value - higher chance
8. Simulation speed - option to slow down the simulation. For manual mode - once started, press any key to perform next step
9. Start - start the simulation
10. Explain - opens this help document

2. Algorithm explained

Real-Time Randomised Path Planning (RRT) is probabilistic method based on tree-like structures. It analyses the environment (map) by growing the structure towards the finish point as well as random direction.

The algorithm repeats same steps for a specified number of times - iterations. Each step the following actions are carried out:

First, a temporary target is chosen randomly. Goal probability value has large impact in this action: it determines the chance that the finish point will be chosen as a temporary target. The default value 0.1 means that there is 10% chance (every 10th time) of finish point being selected. On other occasions, random point within map boundaries is chosen, it might even mean going to the opposite direction than needed.

Once the temporary target is chosen, nearest node of the tree has to be found. This is done by checking every node (branch) of a tree, which contains x and y coordinates and its parent. Euclidean (straight line) distance is found between the two. The closest one is chosen to be extended further.

Third step is to extend the tree, by creating a new branch from selected node towards the temporary target. Step size determines the length of new branch. Sometimes the new extension can hit the obstacle, in this case it is discarded. Otherwise, the new branch is added to the tree structure as a child of previously selected nearest node.

Each iteration, distance between nearest branch and finish point is checked, to see if it came within the given target distance threshold. If it did, program is stopped, as the path was found. The shortest path can be traced back by looking at the hierarchy of tree - checking parents of nodes until starting point is reached.

Main criteria determining the efficiency of RRT is goal probability value as mentioned before. Best results were achieved by using 0.1-0.2, however it depends on the environment and location of start and finish points. If there are a lot of obstacles in between, it is likely that lower value will perform better. However, if there are none, or very few obstacles, higher value will be more efficient, because correct direction will be chosen more often.