Report File
Assignment 2

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Potential Planner

Given The potential functions for attractiveness and repulsiveness, we find their respective gradient to get the attractive and repulsive force.

The following functions are defined for a point on a coordinate plane **'q'**. This point is represented in terms of the x, y coordinates. Therefore,

$$\mathbb{R}^2 \ni q = \{(x, y) \in \mathbb{R} \times \mathbb{R}\}$$

Attractive potential and gradient:

$$U_{att}(q) = \begin{cases} \frac{1}{2}\chi d^2(q, q_{goal}), & d(q, q_{goal}) \leq d^*_{goal} \\ d^*_{goal}\ \chi\, d(q, q_{goal}) - \frac{1}{2}\chi (d^*_{goal})^2, & otherwise \end{cases}$$

$$\nabla U_{att}(q) = \begin{cases} \chi(q - q_{goal}), & d(q, q_{goal}) \leq d^*_{goal} \\ \dfrac{d^*_{goal}\ \chi(q - q_{goal})}{d(q, q_{goal})}, & otherwise \end{cases}$$

$$\because \chi = 0.8, d^*_{goal} = 2$$

$$and\ d(a, b) \Rightarrow euclidian\ distance\ between\ a, b$$

$$\therefore\ \nabla U_{att}(x, y) = \begin{cases} 0.8(x - x_{goal}), 0.8(y - y_{goal}), & d(q, q_{goal}) \leq 2 \\ \dfrac{1.6(x - x_{goal})}{d(q, q_{goal})}, \dfrac{1.6(y - y_{goal})}{d(q, q_{goal})}, & otherwise \end{cases}$$

Similarly, the obstacle provides a repulsive potential given by:

$$U_{rep}(q) = \begin{cases} \frac{1}{2}\eta\left(\frac{1}{d(q)} - \frac{1}{Q^*}\right), & d(q) \leq Q^* \\ 0, & otherwise \end{cases}$$

$$\therefore \nabla U_{rep}(q) = \begin{cases} \eta\left(\frac{1}{Q^*} - \frac{1}{d(q)}\right)\frac{1}{d^3(q)}(q - q_{goal}), & d(q) \leq Q^* \\ 0, & otherwise \end{cases}$$

$$where\ d(q)\ is\ the\ shortest\ distance\ to\ the\ obstacle$$

$$given\ \eta = 0.8, Q^* = 2$$

$$\therefore \nabla U_{rep}(x,y) = \begin{cases} 0.8\left(\frac{1}{2} - \frac{1}{d(q)}\right)\frac{1}{d^3(q)}\left(x - x_{goal}\right), 0.8\left(\frac{1}{2} - \frac{1}{d(q)}\right)\frac{1}{d^3(q)}\left(y - y_{goal}\right); d(q) \leq 2 \\ 0, \quad otherwise \end{cases}$$

At every location of the robot, the attractive and repulsive forces are hence calculated as the sum total of the negative of attractive gradient by the goal, negative of repulsive gradient by each obstacle. This is then normalised and the robot moves by one step size in the direction of the force.

All the above are done using the following functions present in the **helper.py** file.

- **attPotential(q, g):** This function takes the points q and g as inputs. They represent the current robot position and the goal position respectively. The function gives out the attractive force vectors as output.
- **repPotential(q, P):** This function takes the points q and polynomial P as inputs. They represent the current robot position and the obstacle. The function gives out the repulsive force vectors as output.
- **normalise(q):** This function is meant to take in the sum for the force vectors as input and give out normalised vectors for the robot to move.

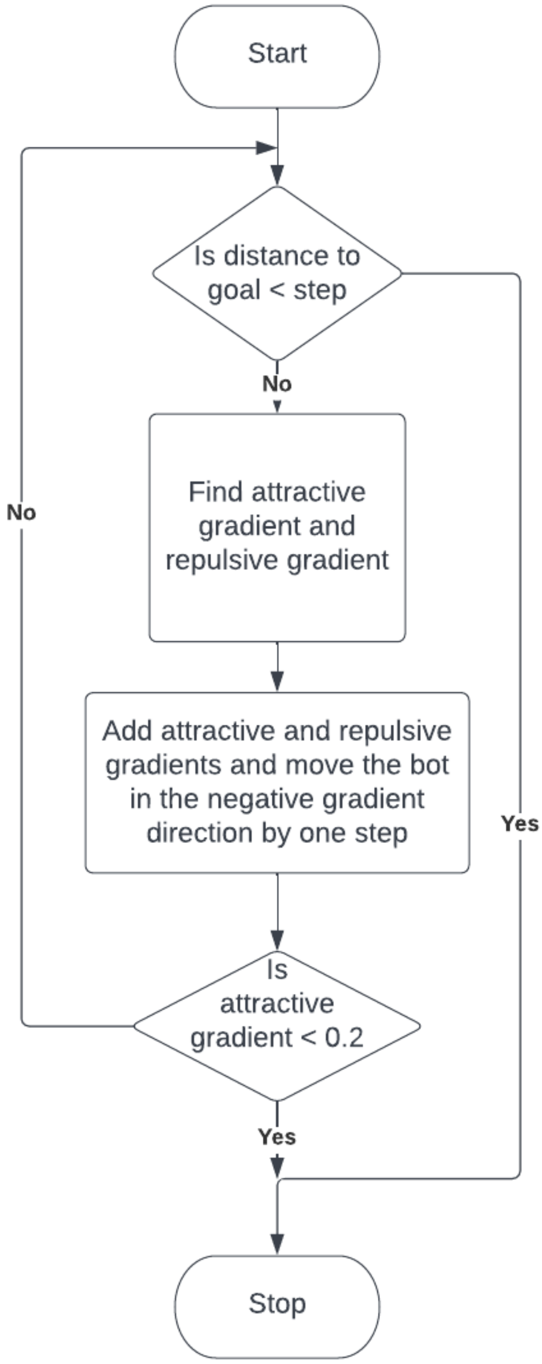
Some deviations from ideal potential planner:

- In an ideal scenario the goal location would be at 0 potential. And the robot would stop when potential is 0 or is very close to zero.
- However, in our setting, the goal is very close to an obstacle and hence not at zero potential.

- Therefore, the robot starts to oscillate near to the goal (a local minima) and does not reach the goal.
- To avoid such oscillations and to stop the program near the oscillatory point, and additional condition is included in the program to end when the attractive force is < 0.2.

Flowchart:

The flowchart to the algorithm used in the program is as follows:



Results:

The following figures show the path taken by the robot to reach near the goal and the absolute distance to the goal as a function of time: