Robotics Assignment 2

Lavanya Verma (lavanya18155@iiitd.ac.in)

December 2, 2020

1. Bidirectional RRT

I used a slight variant of bidirectional rrt. In each iteration one node gets added to each tree, after adding it, computations check whether any node from counter tree is closer than a certain threshold. If yes, connect the trees. Run parameters.m to load map parameters, then rrt_rob_2.m.

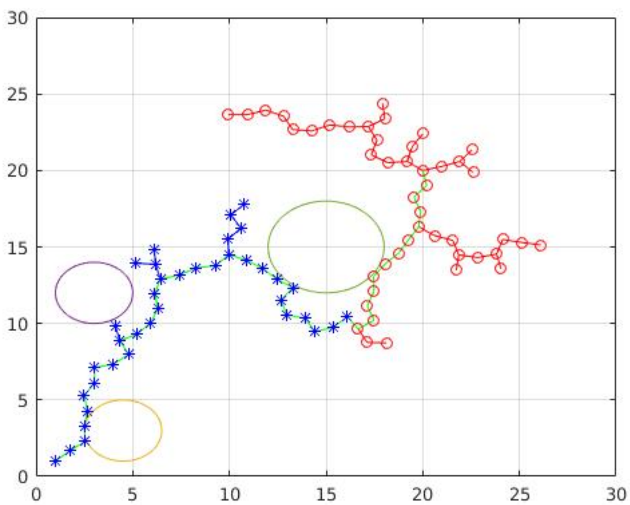

Figure 1: Bidirectional RRT

2. Potential field

Paraboloidic Potential function:

$$
\begin{aligned}
q &= \begin{bmatrix} x \\ y \end{bmatrix} \\
e &= \begin{bmatrix} x_g - x \\ y_g - y \end{bmatrix} \\
U_{att} &= 0.5 K_a e^T e \\
&= 0.5 K_a \|e\|^2 \\
\dot{q} &= -\frac{d(U_{att})}{dq} \\
&= k_a e
\end{aligned}
$$

$$U_o = \begin{cases} \frac{n}{2}\left(\frac{1}{p(q)} - \frac{1}{p_o}\right)^2 & , p(q) \leq p_o \\ 0 & , p(q) > po \end{cases}$$

$$p(q) = \sqrt{(x_o - x)^2 - (y_o - y)^2}$$

$$-\frac{d(U_o)}{dq} = -\frac{n}{p^3}\left[\frac{1}{p} - \frac{1}{p_o}\right]\begin{bmatrix}(x_o - x)\\(y_o - y)\end{bmatrix};\ p \leq p_o$$

$$\dot{q} = -\frac{d(U_{att} + U_o)}{d(q)}$$

Figure 2 shows the quiver plot of vector field. Circular boundaries depict the counter plot. Red boundary is the path traced by a point object whose dynamics is given by $\dot{q}$.

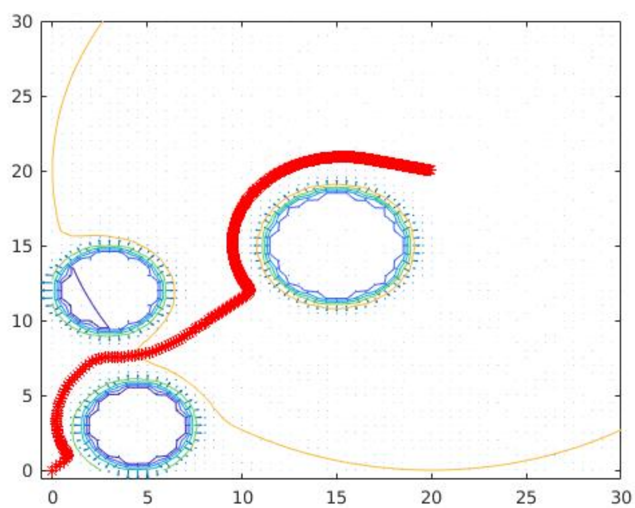

Figure 2: Quiver, Contour plot of paraboloidic field

Figure 3 shows the surf plot of potential function plotted against X and Y. Z-Axis depicts the U(q). Parameters used in simulation:

Parameter	Value
p_o	3
n	10000
ka	10
t_{step}	0.001
distance threshold	0.1
Step size for occupancy grid	0.5
iterations	792

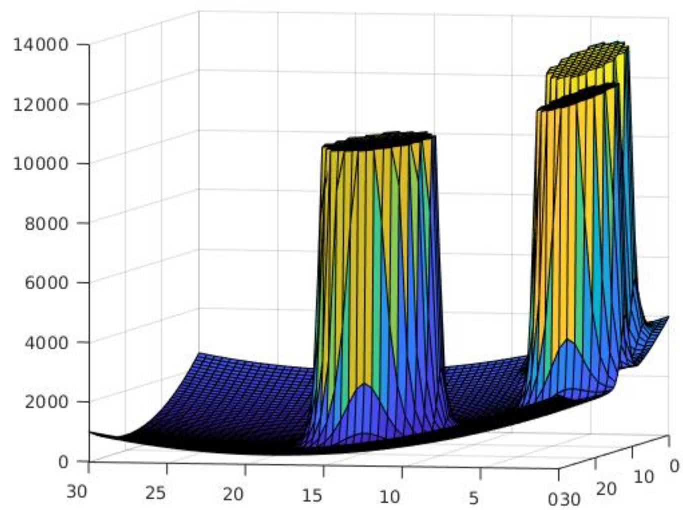

Figure 3: Paraboloidic Potential Function with repulsive potential

Conical Potential function:

$$q = \begin{bmatrix} x \\ y \end{bmatrix}$$
$$e = \begin{bmatrix} x_g - x \\ y_g - y \end{bmatrix}$$
$$U_{att} = K_a \|e\|$$
$$\dot{q} = -\frac{d(U_{att})}{dq}$$
$$= \frac{k_a}{\|e\|} e$$

$$U_o = \begin{cases} \frac{n}{2}\left(\frac{1}{p(q)} - \frac{1}{p_o}\right)^2 & , p(q) \le p_o \\ 0 & , p(q) > po \end{cases}$$

$$p(q) = \sqrt{(x_o - x)^2 - (y_o - y)^2}$$
$$-\frac{d(U_o)}{dq} = -\frac{n}{p^3}\left[\frac{1}{p} - \frac{1}{p_o}\right]\begin{bmatrix} (x_o - x) \\ (y_o - y) \end{bmatrix}; \; p \le p_o$$

$$\dot{q} = -\frac{d(U_{att} + U_o)}{d(q)}$$

Figure 5 shows the quiver plot of vector field. Circular boundaries depict the counter plot. Red boundary is the path traced by a point object whose dynamics is given by $\dot{q}$.

Figure 3 shows the surf plot of potential function plotted against X and Y. Z-Axis depicts the U(q). Parameters used in simulation: Run parameters.m, then conical_field.m / paraboloidic_field.m

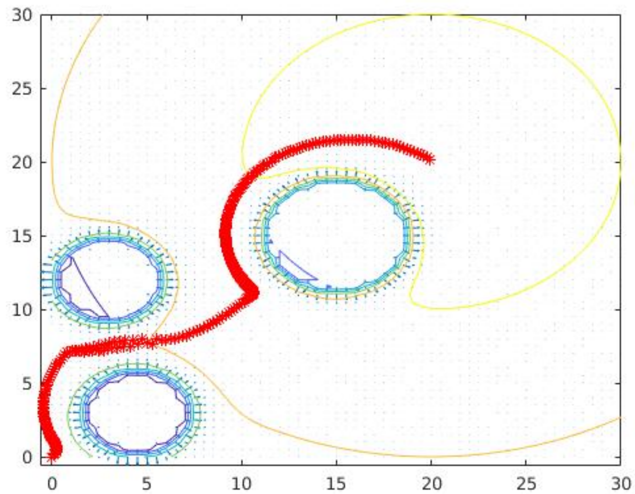

Figure 4: Quiver, Contour Plot, Traced Path

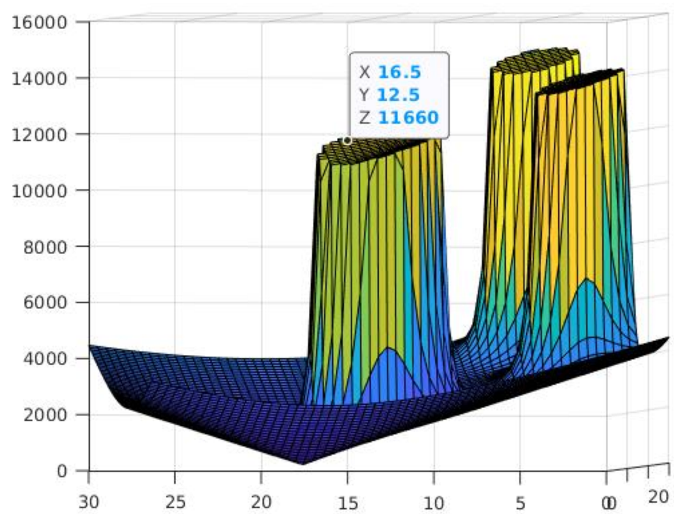

Figure 5: Conical Potential function with Repulsive Potential

Parameter	Value
p_o	5
n	10000
ka	200
t_{step}	0.001
distance threshold	0.1
Step size for occupancy grid	0.5
iterations	375