Indian Institute of Technology Patna

Robot Motion Planning
Assignment 2

Submitted by
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2011MT07

Submitted to
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Aim:

1. To Make an R^2configuration space of size 100m × 100m, and define an additive potential field with attractive potential as a combination of conic as well as quadratic potential and repulsive potential determined using Brushfire algorithm.

2. Determine the gradient of the potential function.

3. Display the gradient vector field using arrows. The arrows should be made at (1,1), (2,1)…(100,1), (1,2), (2,2)…(100,2),…(100,100) with the length of each arrow representing the magnitude of the gradient and direction of the arrow the direction of the gradient.

4. Implement a gradient descent approach to calculate a path from any given start point to goal location using the results in above aims. Assume that start and goal location will never be specified on any obstacles

Apparatus / Pre-Requisites / Component:

Matlab R2020b

Description:

1. First I give input as the configuration space.

2. And then create this configuration space into 100 m*100 m. And take pixel size 4*4 which make total pixel 25*25.

3. After that with the help of brushfire algorithm, I find the distances.

4. Now with the help of equation of attractive potential and gradient of attractive potential and similarly with the help of equation of repulsive potential and gradient of repulsive potential. We will find the same respectively.

$$U_{\mathrm{att}}(q) = \begin{cases} \frac{1}{2}\zeta d^2(q, q_{\mathrm{goal}}), & d(q, q_{\mathrm{goal}}) \le d^*_{\mathrm{goal}}, \\ d^*_{\mathrm{goal}}\zeta d(q, q_{\mathrm{goal}}) - \frac{1}{2}\zeta (d^*_{\mathrm{goal}})^2, & d(q, q_{\mathrm{goal}}) > d^*_{\mathrm{goal}}. \end{cases}$$

$$\nabla U_{\mathrm{att}}(q) = \begin{cases} \zeta(q - q_{\mathrm{goal}}), & d(q, q_{\mathrm{goal}}) \le d^*_{\mathrm{goal}}, \\ \frac{d^*_{\mathrm{goal}}\zeta(q - q_{\mathrm{goal}})}{d(q, q_{\mathrm{goal}})}, & d(q, q_{\mathrm{goal}}) > d^*_{\mathrm{goal}}, \end{cases}$$

$$U_{\mathrm{rep}}(q) = \begin{cases} \frac{1}{2}\eta \left(\frac{1}{D(q)} - \frac{1}{Q^*}\right)^2, & D(q) \le Q^*, \\ 0, & D(q) > Q^*, \end{cases}$$

$$\nabla U_{\mathrm{rep}}(q) = \begin{cases} \eta \left(\frac{1}{Q^*} - \frac{1}{D(q)}\right) \frac{1}{D^2(q)} \nabla D(q), & D(q) \le Q^*, \\ 0, & D(q) > Q^*, \end{cases}$$

5. Now we can find the total potential and gradient of total potential. By considering this equation

$$U = U_{att} + 2.5 * U_{rep}$$

Weightage of U_{rep} 2.5

6. Now we can find the path with the help of gradient descent approach.

List of parameters & their values

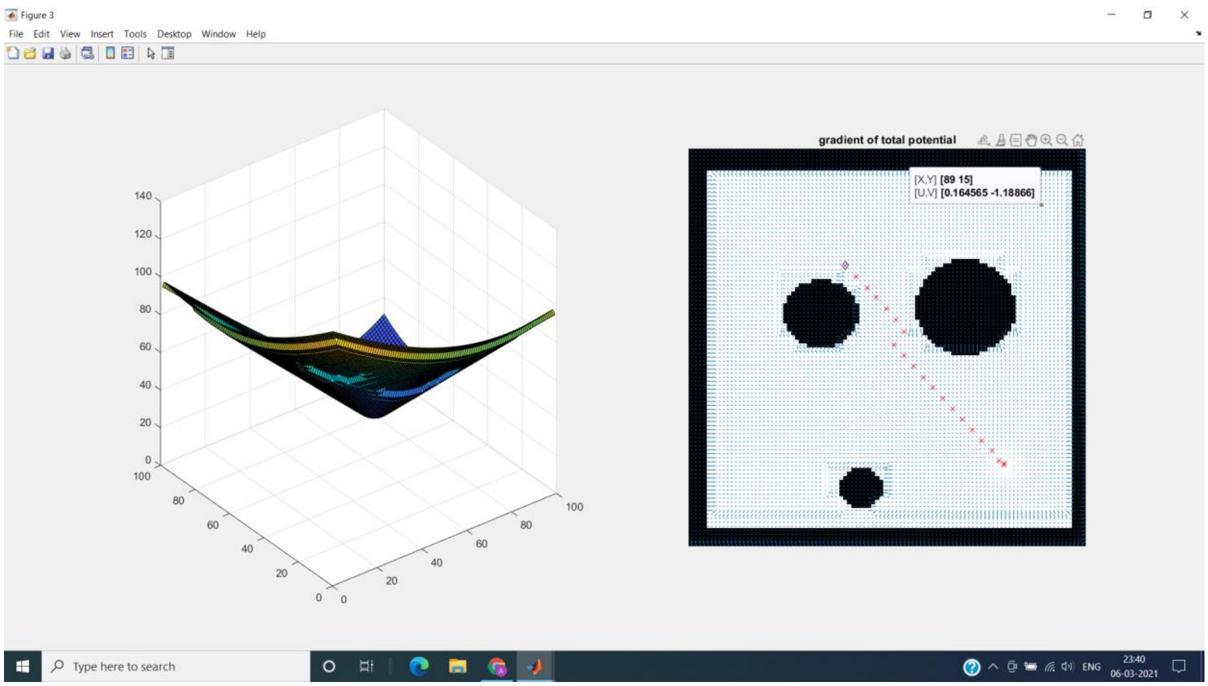
η	5
ξ	0.1
Q*	4
d*	6

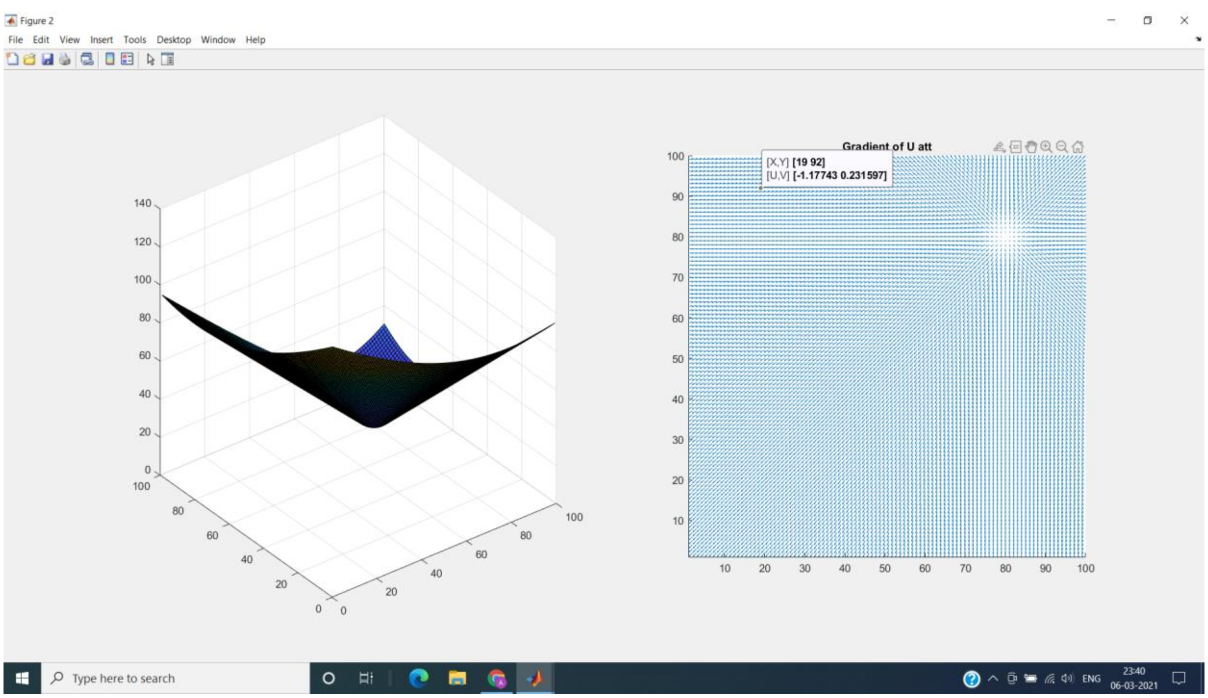
Output :

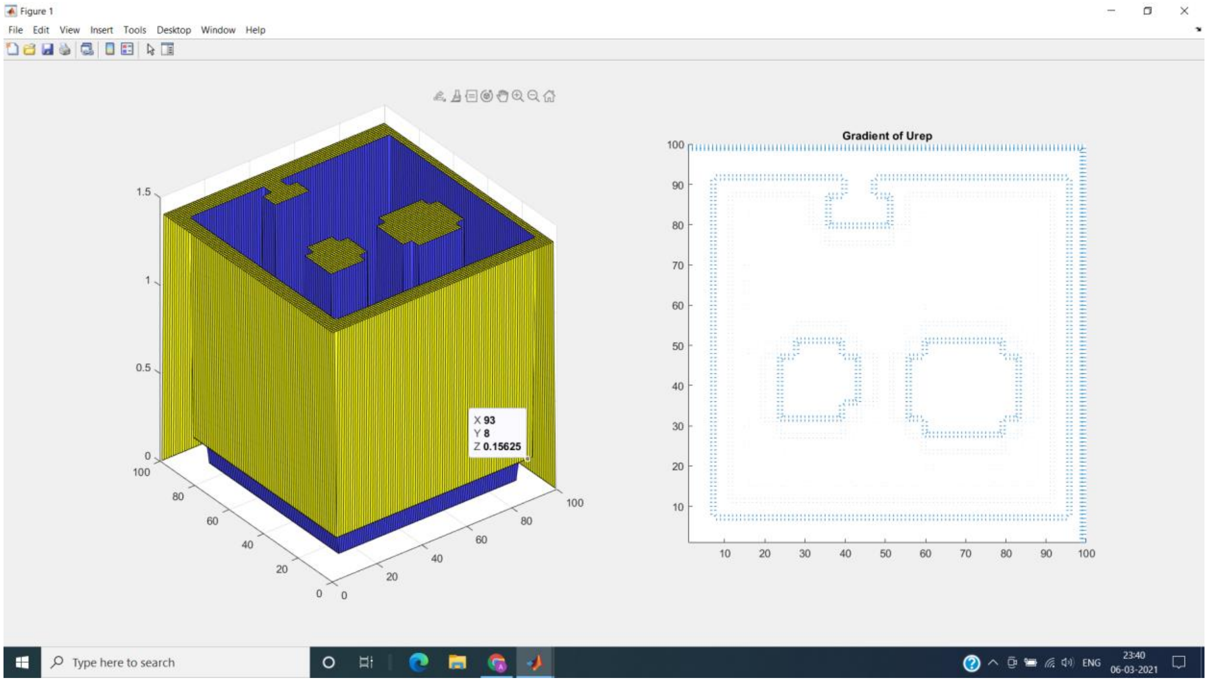
With the different values of q_{start} and q_{goal} the following output come.

1. q_{start} 40, 30

q_{goal} 80, 80

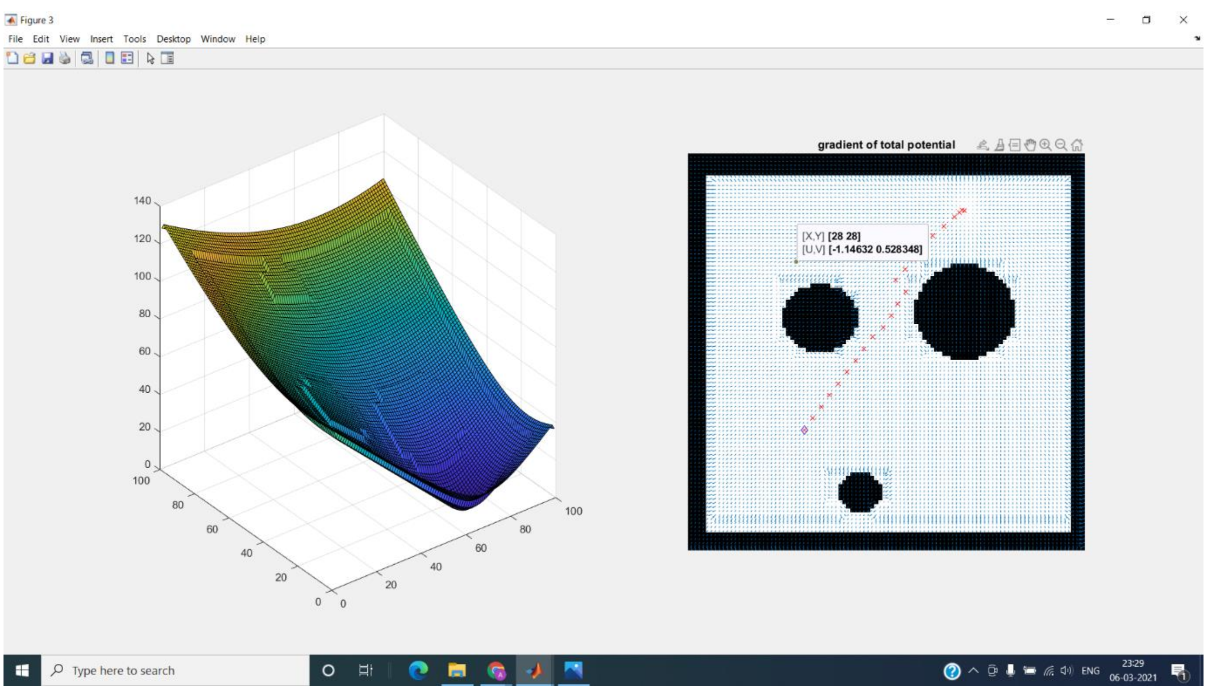


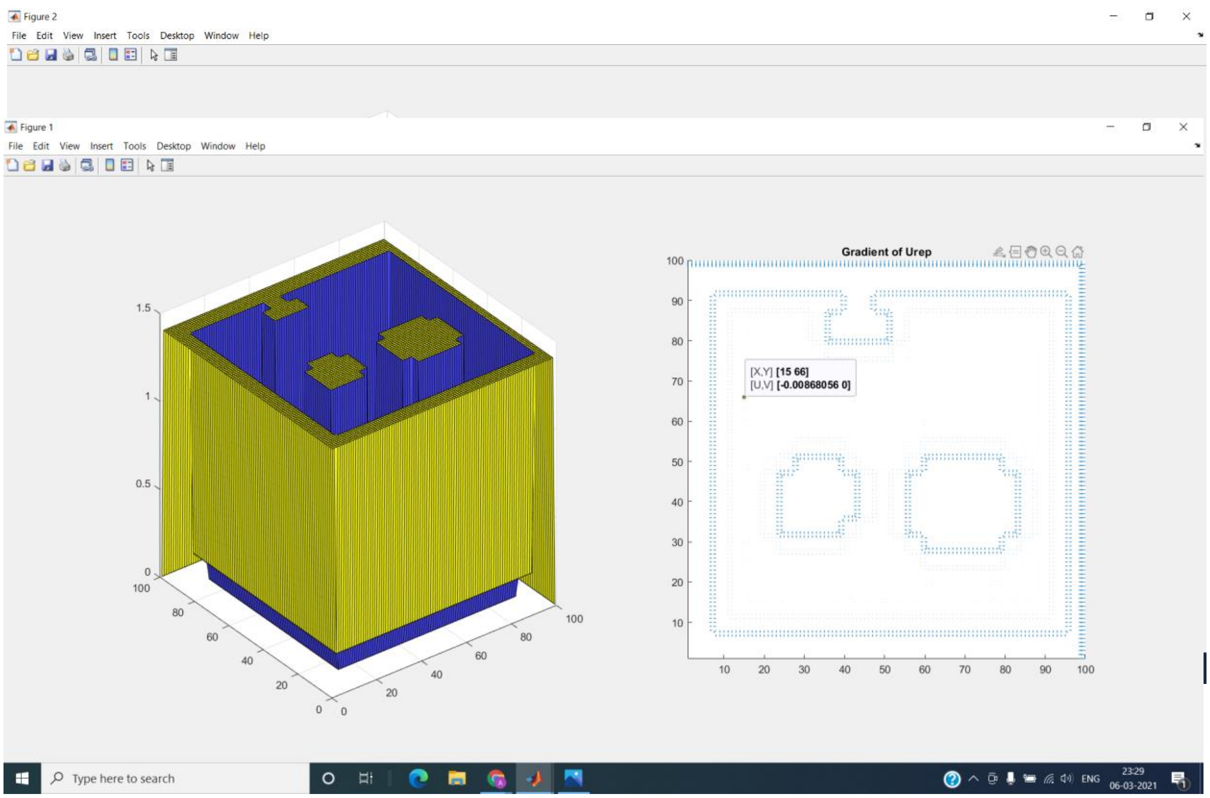




2. q_{start} 30, 70

   q_{goal} 70, 20





3. q_{start} 30, 70

q_{goal} 70, 20

Weightage of U_{rep} 2.5

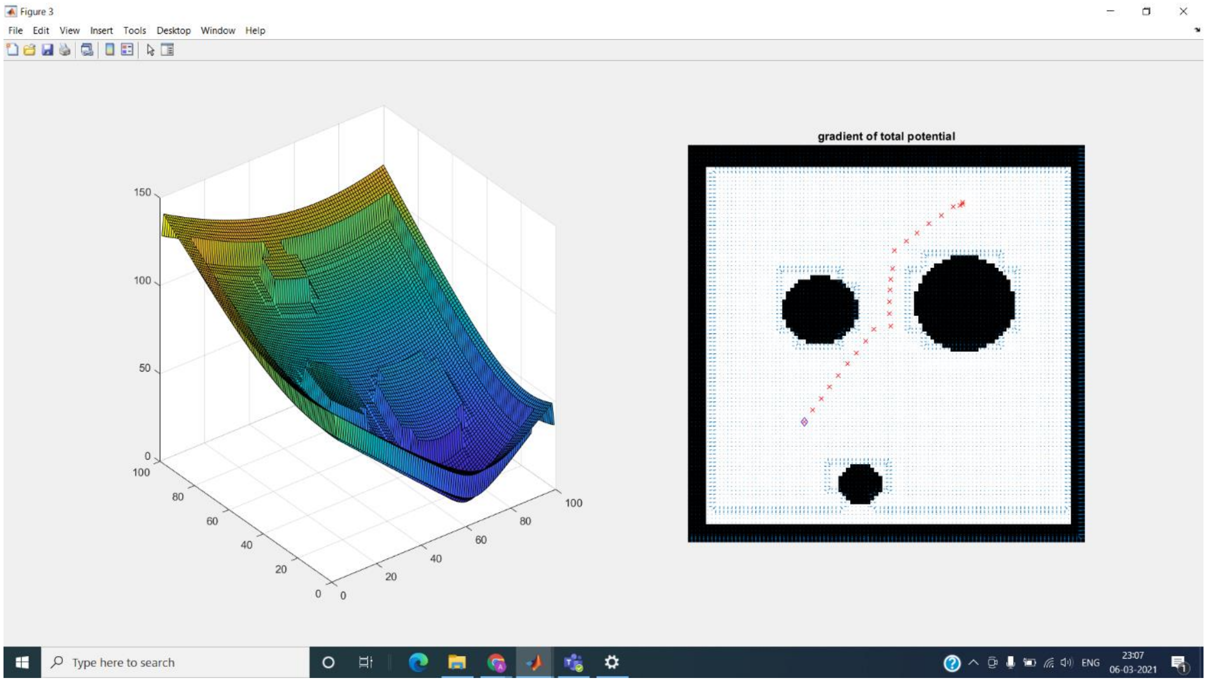


Figure 3
File Edit View Insert Tools Desktop Window Help
gradient of total potential
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06-03-2021

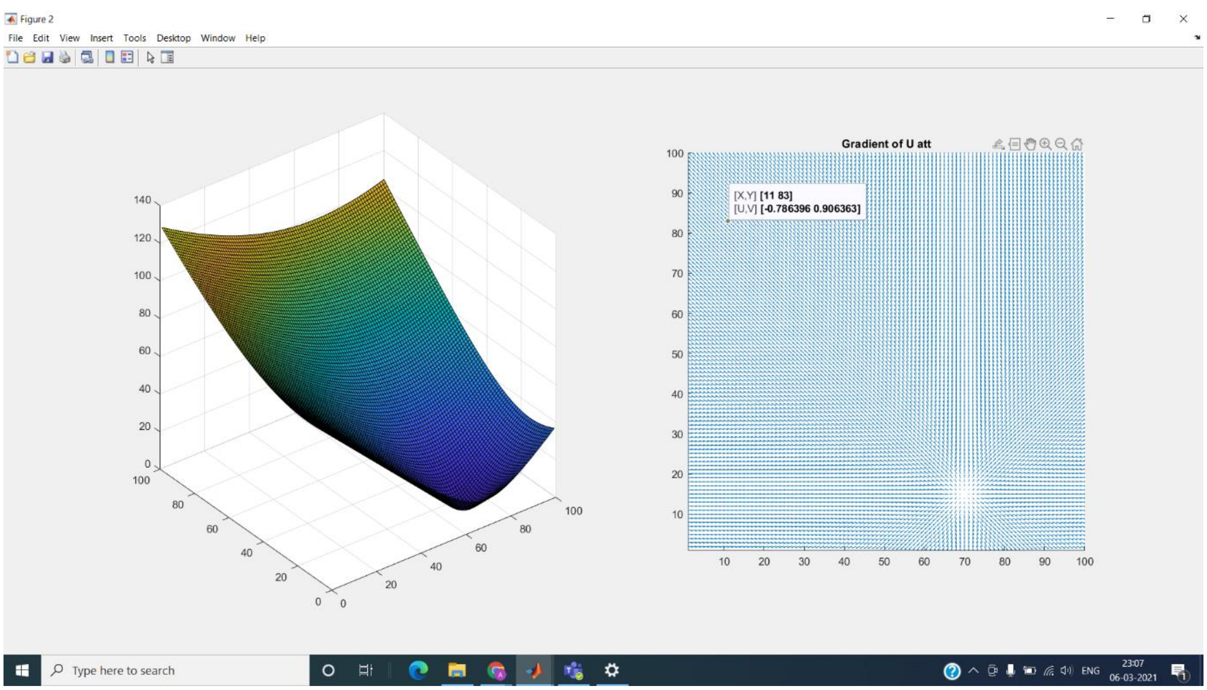
Figure 2
File Edit View Insert Tools Desktop Window Help
Gradient of U att
[X,Y] [11 83]
[U,V] [-0.786396 0.906363]
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06-03-2021

Conclusion:

1. In this approach of path finding the paths are very much defendant on many variable like η, ξ ,Q^* ,d^* etc.
2. In the first outcome, the path is little accurate. But it is not fully feasible because the paths breaks in middle of the start and goal point.
3. In the second case, I have changed the start and goal point but the path is same as previous one.
4. In the third case the, I have changed the weightage of repulsive potential from 2.5 to 10 and got a better path from previous outcome. In this case the path is passing from a sustainable distance from the obstacles which is good for robot motion.