CS685 : Autonomous Robotics Submissions

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Homework 7

Question 1 : Submitted on paper in class

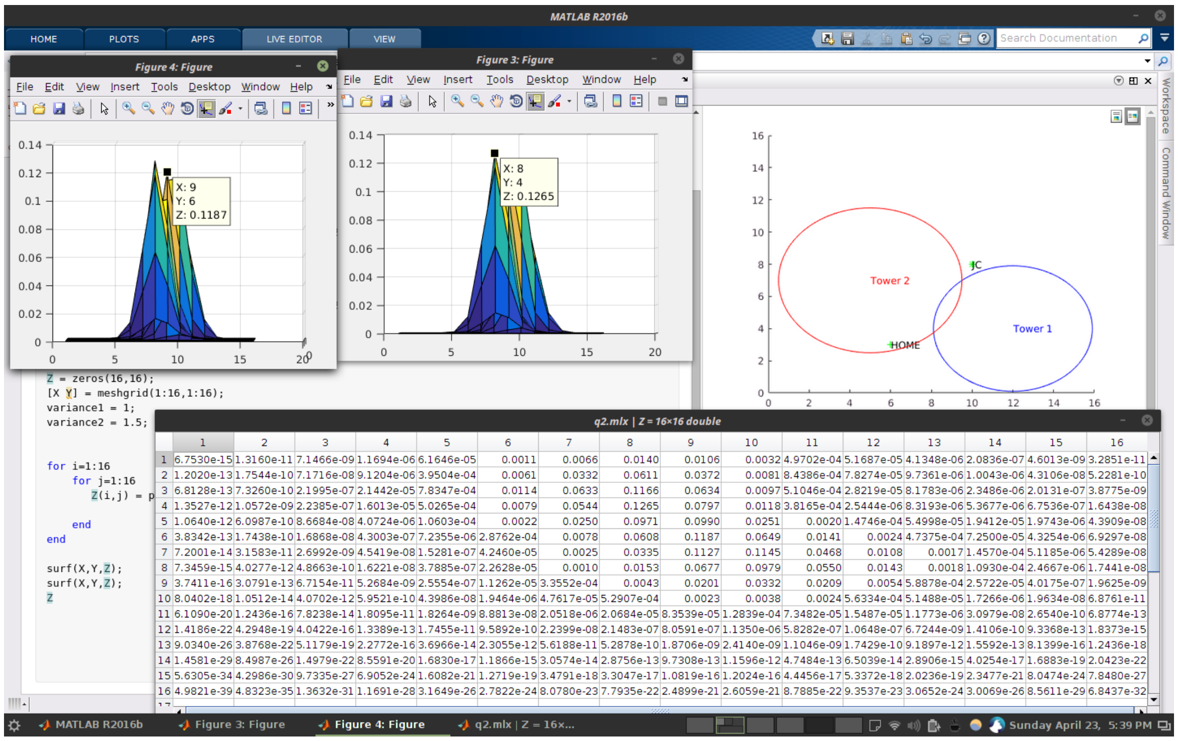
Question 2-A : Script

```
JC = [10 8];
hold on
axis([0 16 0 16])
plot(JC(1),JC(2),'g*');
text(JC(1),JC(2),'JC');


HOME = [6,3];
plot(HOME(1),HOME(2),'g+');
text(HOME(1),HOME(2),'HOME');

T1 = [12 4];
r1 = 3.9;
rectangle('Position',[T1(1)-r1 T1(2)-r1 2*r1 2*r1],'Curvature',[1,1],'EdgeColor','b');
text(T1(1),T1(2),'Tower 1','Color','blue')

T2 = [5 7];
r2 = 4.5;
rectangle('Position',[T2(1)-r2 T2(2)-r2 2*r2 2*r2],'Curvature',[1,1],'EdgeColor','r');
text(T2(1),T2(2),'Tower 2','Color','red')

hold off;

Z = zeros(16,16);
[X Y] = meshgrid(1:16,1:16);
variance1 = 1;
variance2 = 1.5;


for i=1:16
    for j=1:16
       Z(i,j) = prob_calc([X(i,j) Y(i,j)],T1,T2,r1,r2,variance1,variance2);

    end
end

surf(X,Y,Z);
surf(X,Y,Z);
Z
```

Function : prob_calc

```
function [ probability ] = prob_calc(current_pos, x1,x2, d1,d2,variance1,variance2)

calcd0 = sqrt((current_pos(1)-x1(1))^2  + (current_pos(2)-x1(2))^2);

calcd1 = sqrt((current_pos(1)-x2(1))^2  + (current_pos(2)-x2(2))^2);

prob1 = 1/sqrt(2*pi*(sqrt(variance1))^2) * exp(-((calcd0-d1)-0).^2 / (2*(sqrt(variance1))^2));
prob2 = 1/sqrt(2*pi*(sqrt(variance2))^2) * exp(-((calcd1-d2)-0).^2 / (2*(sqrt(variance2))^2));
probability = prob1*prob2;

end
```

Plots Click image to view full size.



```
Z = zeros(16,16);
[X Y] = meshgrid(1:16,1:16);
variance1 = 1;
variance2 = 1.5;


for i=1:16
    for j=1:16
        Z(i,j) = p

    end
end

surf(X,Y,Z);
surf(X,Y,Z);
Z
```

	1	2	3	4	5	6	7	8
1	6.7530e-15	1.3160e-11	7.1466e-09	1.1694e-06	6.1646e-05	0.0011	0.0066	0.0140
2	1.2020e-13	1.7544e-10	7.1716e-08	9.1204e-06	3.9504e-04	0.0061	0.0332	0.0611
3	6.8128e-13	7.3260e-10	2.1995e-07	2.1442e-05	7.8347e-04	0.0114	0.0633	0.1166
4	1.3527e-12	1.0572e-09	2.2385e-07	1.6013e-05	5.0265e-04	0.0079	0.0544	0.1265
5	1.0640e-12	6.0987e-10	8.6684e-08	4.0724e-06	1.0603e-04	0.0022	0.0250	0.0971
6	3.8342e-13	1.7438e-10	1.6868e-08	4.3003e-07	7.2355e-06	2.8762e-04	0.0078	0.0608
7	7.2001e-14	3.1583e-11	2.6992e-09	4.5419e-08	1.5281e-07	4.2460e-05	0.0025	0.0335
8	7.3459e-15	4.0277e-12	4.8663e-10	1.6221e-08	3.7885e-07	2.2628e-05	0.0010	0.0153
9	3.7411e-16	3.0791e-13	6.7154e-11	5.2684e-09	2.5554e-07	1.1262e-05	3.3552e-04	0.0043
10	8.0402e-18	1.0512e-14	4.0702e-12	5.9521e-10	4.3986e-08	1.9464e-06	4.7617e-05	5.2907e-04
11	6.1090e-20	1.2436e-16	7.8238e-14	1.8095e-11	1.8264e-09	8.8813e-08	2.0518e-06	2.0684e-05
12	1.4186e-22	4.2948e-19	4.0422e-16	1.3389e-13	1.7455e-11	9.5892e-10	2.2399e-08	2.1483e-07
13	9.0340e-26	3.8768e-22	5.1179e-19	2.2772e-16	3.6966e-14	2.3055e-12	5.6188e-11	5.2878e-10
14	1.4581e-29	8.4987e-26	1.4979e-22	8.5591e-20	1.6830e-17	1.1866e-15	3.0574e-14	2.8756e-13
15	5.6305e-34	4.2986e-30	9.7335e-27	6.9052e-24	1.6082e-21	1.2719e-19	3.4791e-18	3.3047e-17
16	4.9821e-39	4.8323e-35	1.3632e-31	1.1691e-28	3.1649e-26	2.7822e-24	8.0780e-23	7.7935e-22

	9	10	11	12	13	14	15	16
1	0.0106	0.0032	4.9702e-04	5.1687e-05	4.1348e-06	2.0836e-07	4.6013e-09	3.2851e-11
2	0.0372	0.0081	8.4386e-04	7.8274e-05	9.7361e-06	1.0043e-06	4.3106e-08	5.2281e-10
3	0.0634	0.0097	5.1046e-04	2.8219e-05	8.1783e-06	2.3486e-06	2.0131e-07	3.8775e-09
4	0.0797	0.0118	3.8165e-04	2.5444e-06	8.3193e-06	5.3677e-06	6.7536e-07	1.6438e-08
5	0.0990	0.0251	0.0020	1.4746e-04	5.4998e-05	1.9412e-05	1.9743e-06	4.3909e-08
6	0.1187	0.0649	0.0141	0.0024	4.7375e-04	7.2500e-05	4.3254e-06	6.9297e-08
7	0.1127	0.1145	0.0468	0.0108	0.0017	1.4570e-04	5.1185e-06	5.4289e-08
8	0.0677	0.0979	0.0550	0.0143	0.0018	1.0930e-04	2.4667e-06	1.7441e-08
9	0.0201	0.0332	0.0209	0.0054	5.8878e-04	2.5722e-05	4.0175e-07	1.9625e-09
10	0.0023	0.0038	0.0024	5.6334e-04	5.1488e-05	1.7266e-06	1.9634e-08	6.8761e-11
11	8.3539e-05	1.2839e-04	7.3482e-05	1.5487e-05	1.1773e-06	3.0979e-08	2.6540e-10	6.8774e-13
12	8.0591e-07	1.1350e-06	5.8282e-07	1.0648e-07	6.7244e-09	1.4106e-10	9.3368e-13	1.8373e-15
13	1.8706e-09	2.4140e-09	1.1046e-09	1.7429e-10	9.1897e-12	1.5592e-13	8.1399e-16	1.2436e-18
14	9.7308e-13	1.1596e-12	4.7484e-13	6.5039e-14	2.8906e-15	4.0254e-17	1.6883e-19	2.0423e-22
15	1.0819e-16	1.2024e-16	4.4456e-17	5.3372e-18	2.0236e-19	2.3477e-21	8.0474e-24	7.8480e-27
16	2.4899e-21	2.6059e-21	8.7885e-22	9.3537e-23	3.0652e-24	3.0069e-26	8.5611e-29	6.8437e-32

Description :

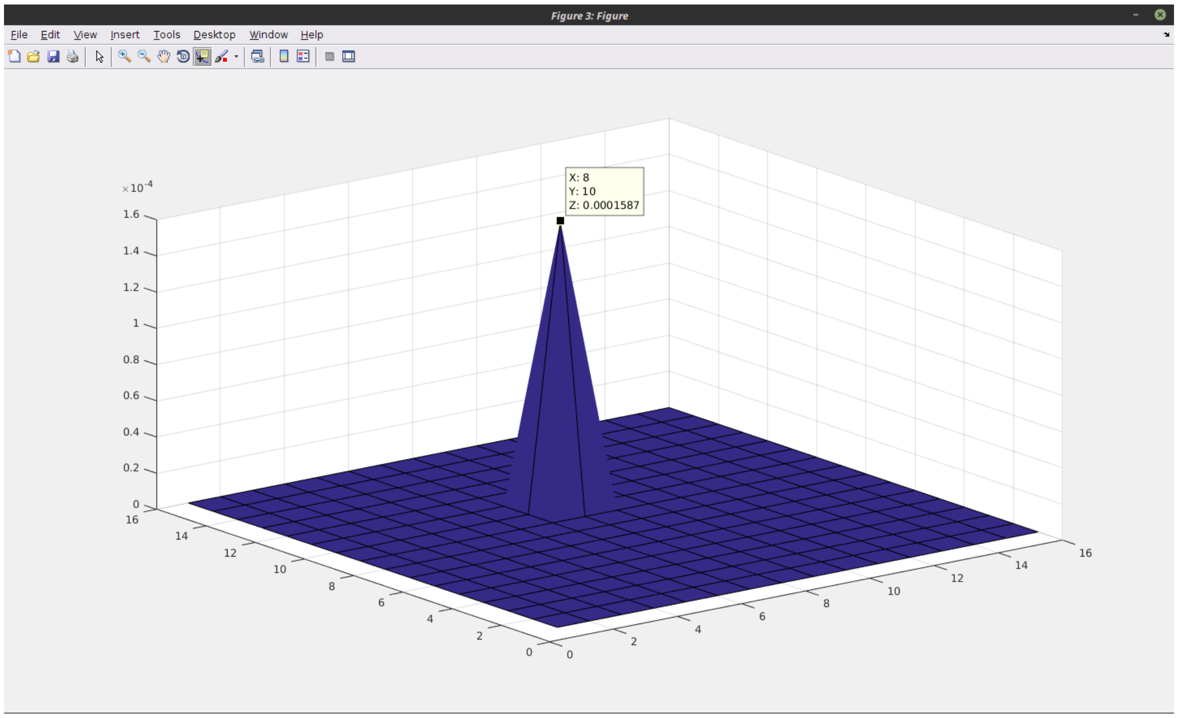
Her, since we have the distance from the curent position to the two towers, suppose d1 and d2 from the Towers 1 and 2 respectively, we can draw circles from with center at position of the tower and radius equal to the calculated distance. Now, here the required location must be equal to either of the points where the two circles intersect each other. But introducing a error, we can predict the position to be close to the intersection points. Now, for the entire 16x16 grid, we calculate the probability given the distances, where we note that the highest probability is at (8,4) followed by (9,6) as given in the image. As a proof, I have attached mesh for the measures and also the calculated probability matrix.

Question 2-B:

```
JC = [10 8];
hold on
axis([0 16 0 16])
plot(JC(1),JC(2),'g*');
text(JC(1),JC(2),'JC');


HOME = [6,3];
plot(HOME(1),HOME(2),'g+');
text(HOME(1),HOME(2),'HOME');

T1 = [12 4];
r1 = 3.9;
rectangle('Position',[T1(1)-r1 T1(2)-r1 2*r1 2*r1],'Curvature',[1,1],'EdgeColor','b');
text(T1(1),T1(2),'Tower 1','Color','blue')

T2 = [5 7];
r2 = 4.5;
rectangle('Position',[T2(1)-r2 T2(2)-r2 2*r2 2*r2],'Curvature',[1,1],'EdgeColor','r');
text(T2(1),T2(2),'Tower 2','Color','red')

hold off;

Z = zeros(16,16);
[X Y] = meshgrid(1:16,1:16);
variance1 = 1;
variance2 = 1.5;


for i=1:16
    for j=1:16
```

```
       Z(i,j) = prob_calc([X(i,j) Y(i,j)],T1,T2,r1,r2,variance1,variance2);

       if i == 6 && j == 3
          Z(i,j) = Z(i,j) * 0.7;
       elseif i == 10 && j == 8
          Z(i,j) = Z(i,j) * 0.3;
       else
           Z(i,j) = 0;
       end

    end
end

surf(X,Y,Z);

Z
```

Plots Click image to view full size.



Description :

For calculatingthe probabilities by using the prior knowledge, we multiply the probabilities of that location with the prior known probabilities. We can directly multiply them since these events are independent of each other. Now, here we observe that, the friends location is predicted to be (8,10) followed by (3,6) which is almost close to zero.

Question 3:

```
        xs=[];
ys=[];
thetas = [];
xT = [2.0;4.0;0.0];
uT = [pi/2;0.0;1.0];
alphaT = [0.1;0.1;0.01;0.01];

hold on;


for i=1:5000

    theta1 = uT(1)+randFromDistribution(0,alphaT(1)*abs(uT(1))+alphaT(2)*uT(3));

    theta2 = uT(3)+randFromDistribution(0,alphaT(3)*uT(3)+alphaT(4)*(abs(uT(1))+abs(uT(2))));

    theta3 = uT(2)+randFromDistribution(0,(alphaT(1)*abs(uT(2))+alphaT(2)*uT(3)));
    xs = [xs,xT(1)+theta2*cos(xT(3)+theta1)];
    ys = [ys,xT(2)+theta2*sin(xT(3)+theta1)];
    thetas = [thetas,xT(3)+theta1+theta3];

end

quiver(xs,ys,sin(thetas),cos(thetas),'Color','black');

quiver(xT(1),xT(2),sin(xT(3)),cos(xT(3)),'color','green');
hold off;
```

Function : randFromDistribution

```
function [ output ] = randFromDistribution(mean, variance )

% bounds : [-12,12]
max = sqrt(variance);
min = -max;

output = (sum(min + (max-min).*rand(12,1))/2)+mean;

end
```

Plots Click image to view full size.

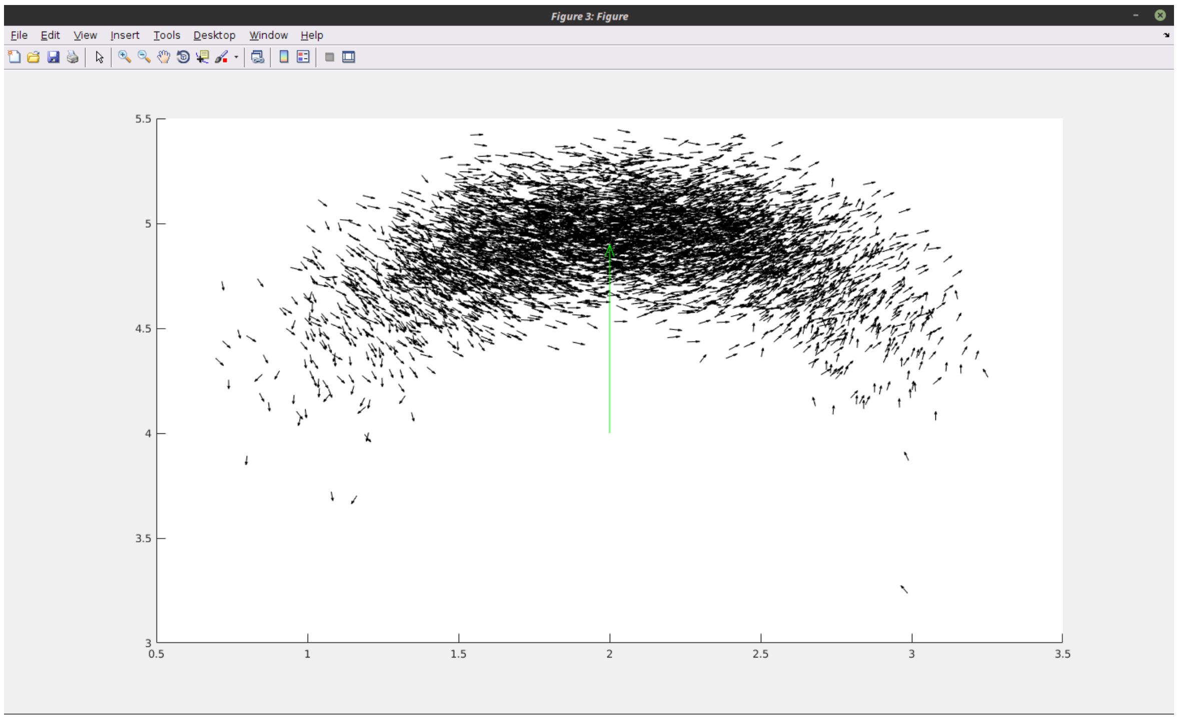


Figure 3: Figure
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