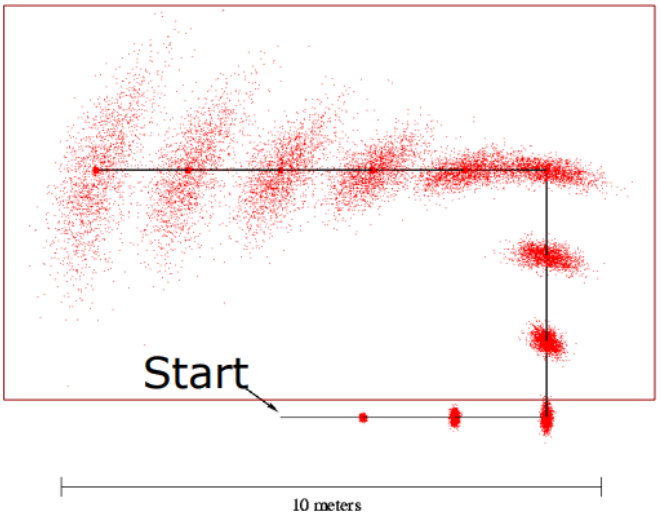
Homework 5 Guide

Homework 4

Problem 1: Please generate samples of the odometry-based motion model (N=500).



1: **Algorithm sample_motion_model_odometry(u_t, x_{t-1}):**

2: $\delta_{\text{rot1}} = \text{atan2}(\bar{y}' - \bar{y}, \bar{x}' - \bar{x}) - \bar{\theta}$

3: $\delta_{\text{trans}} = \sqrt{(\bar{x} - \bar{x}')^2 + (\bar{y} - \bar{y}')^2}$

4: $\delta_{\text{rot2}} = \bar{\theta}' - \bar{\theta} - \delta_{\text{rot1}}$

5: $\hat{\delta}_{\text{rot1}} = \delta_{\text{rot1}} - \textbf{sample}(\alpha_1 \delta^2_{\text{rot1}} + \alpha_2 \delta^2_{\text{trans}})$

6: $\hat{\delta}_{\text{trans}} = \delta_{\text{trans}} - \textbf{sample}(\alpha_3 \delta^2_{\text{trans}} + \alpha_4 \, \delta^2_{\text{rot1}} + \alpha_4 \, \delta^2_{\text{rot2}})$

7: $\hat{\delta}_{\text{rot2}} = \delta_{\text{rot2}} - \textbf{sample}(\alpha_1 \delta^2_{\text{rot2}} + \alpha_2 \delta^2_{\text{trans}})$

8: $x' = x + \hat{\delta}_{\text{trans}} \, \cos(\theta + \hat{\delta}_{\text{rot1}})$

9: $y' = y + \hat{\delta}_{\text{trans}} \, \sin(\theta + \hat{\delta}_{\text{rot1}})$

10: $\theta' = \theta + \hat{\delta}_{\text{rot1}} + \hat{\delta}_{\text{rot2}}$

11: *return* $x_t = (x', y', \theta')^T$

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%Algolrithm motion_model_odometry with Normal Distribution Noise

clc
close all

%Initial setting of mobile robot
x =
y =
theta =

a1 =
a2 =
a3 =
a4 =

%This is an example setting, you can set it up on your own.
trajectory_data = zeros(3,500,30);
odom = zeros(3,30);
odom(:,:) = NaN;
odom(:,1:3)= 0;

trajectory_data(:,:,:) = NaN;
```

```
trajectory_data(:,:,1) = 0;

n = 1;
t = 2;

%Setting the trajectory parameters
while (t <= 30 )


if t < 10
    delta_rot1 = 0;

    delta_trans =50;

    delta_rot2 = 0;


elseif (t >= 10)&&(t < 12)
    delta_rot1 = 0;

    delta_trans = 50;

    delta_rot2 = pi/4;




elseif (t >= 12)&&(t < 20)
    delta_rot1 = 0;

    delta_trans = 50;

    delta_rot2 = 0;




elseif (t >= 20)&&(t < 22)
    delta_rot1 = 0;

    delta_trans = 50;
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```
    delta_rot2 = pi/4;


elseif (t >= 22)&&(t <= 30)
    delta_rot1 = 0;

    delta_trans = 50;

    delta_rot2 = 0;


end


for n = 1: 500
% Do your sampling

n = n + 1;

end



t = t + 1;


if t < 10

    delta_rot1 = 0;

    delta_trans =50;

    delta_rot2 = 0;

    odom(1,t) = odom(1,t-1) + delta_trans;

    odom(2,t) = odom(2,t-1);

    odom(3,t) = odom(3,t-1) + delta_rot1 + delta_rot2;
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```
elseif (t >= 10)&&(t < 12)
    delta_rot1 = 0;

    delta_trans = 50;

    delta_rot2 = deg2rad(45);

    odom(1,t) = odom(1,t-1) + delta_trans * cos(theta + delta_rot1);

    odom(2,t) = odom(2,t-1) + delta_trans * sin(theta + delta_rot1);

    odom(3,t) = odom(3,t-1) + delta_rot1 + delta_rot2;


elseif (t >= 12)&&(t < 20)
    delta_rot1 = 0;

    delta_trans = 50;

    delta_rot2 = 0;

    odom(1,t) = odom(1,t-1);

    odom(2,t) = odom(2,t-1) + delta_trans;

    odom(3,t) = odom(3,t-1) + delta_rot1 + delta_rot2;


elseif (t >= 20)&&(t < 22)
    delta_rot1 = 0;

    delta_trans = 50;

    delta_rot2 = deg2rad(45);

    odom(1,t) = odom(1,t-1) + delta_trans * cos(theta + delta_rot1);

    odom(2,t) = odom(2,t-1) + delta_trans * sin(theta + delta_rot1);

    odom(3,t) = odom(3,t-1) + delta_rot1 + delta_rot2;
```

```
elseif (t >= 22)&&(t <= 31)
    delta_rot1 = 0;

    delta_trans = 50;

    delta_rot2 = 0;

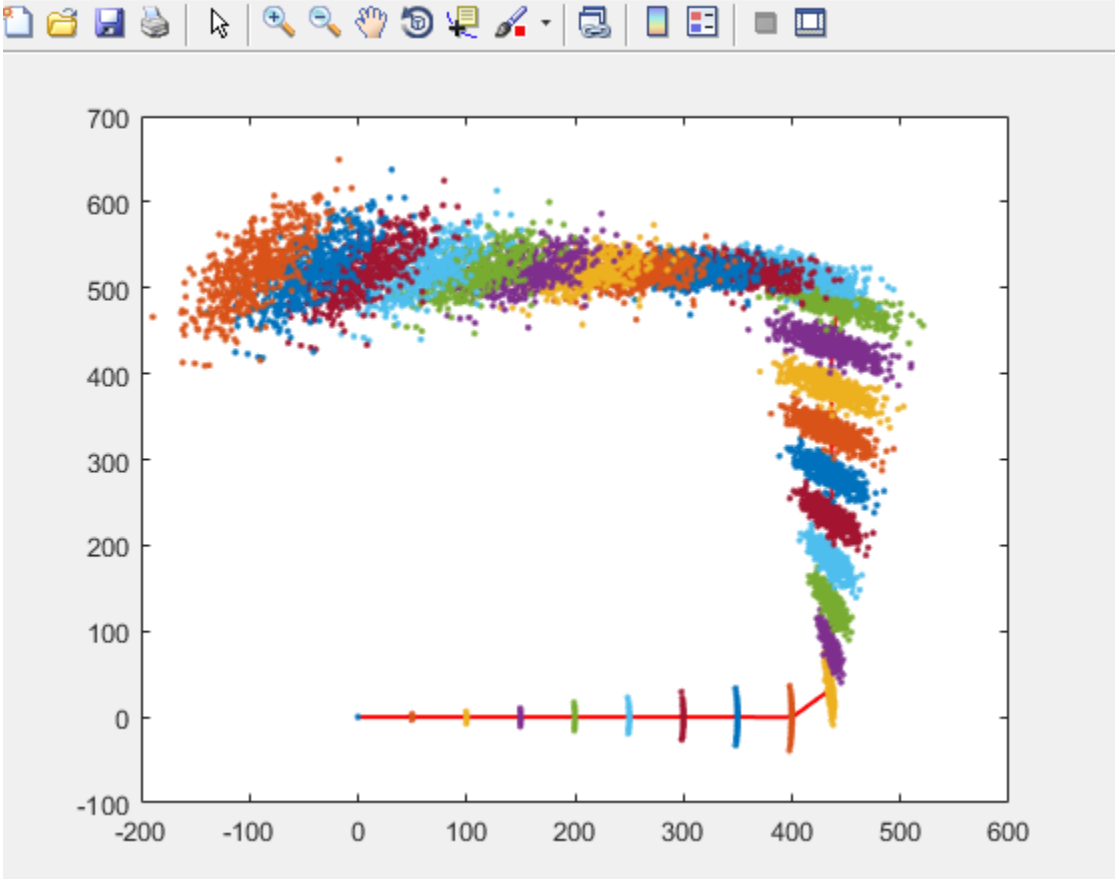
    odom(1,t) = odom(1,t-1) + delta_trans * cos(-pi);

    odom(2,t) = odom(2,t-1);

    odom(3,t) = odom(3,t-1) + delta_rot1 + delta_rot2;
end
end

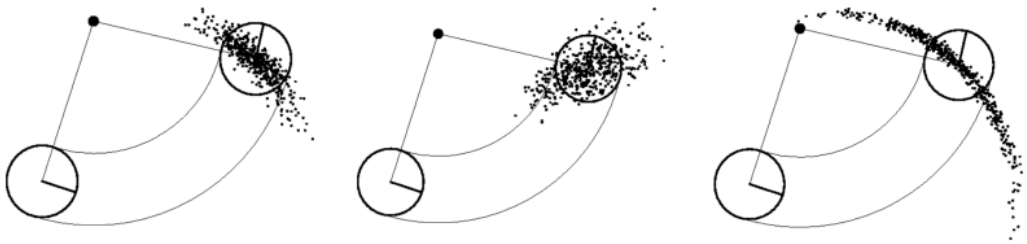
plot(odom(1,:),odom(2,:),'r','LineWidth',1.5);
pause(3);
hold on

for m = 1:30
  scatter(trajectory_data(1,5:500,m),trajectory_data(2,5:500,m),'.');
  pause(1);
  hold on
End
```



Homework 4

Problem 2: Please generate samples of the velocity-based motion model for following cases (N=500).



1: **Algorithm sample_motion_model_velocity(u_t, x_{t-1}):**

2: $\hat{v} = v + \textbf{sample}(\alpha_1 v^2 + \alpha_2 \omega^2)$

3: $\hat{\omega} = \omega + \textbf{sample}(\alpha_3 v^2 + \alpha_4 \omega^2)$

4: $\hat{\gamma} = \textbf{sample}(\alpha_5 v^2 + \alpha_6 \omega^2)$

5: $x' = x - \frac{\hat{v}}{\hat{\omega}} \sin\theta + \frac{\hat{v}}{\hat{\omega}} \, sin(\theta + \hat{\omega}\Delta t)$

6: $y' = y + \frac{\hat{v}}{\hat{\omega}} \cos\theta - \frac{\hat{v}}{\hat{\omega}} \, cos(\theta + \hat{\omega}\Delta t)$

7: $\theta' = \theta + \hat{\omega}\Delta t + \hat{\gamma}\Delta t$

8: *return* $x_t = (x', y', \theta')^T$

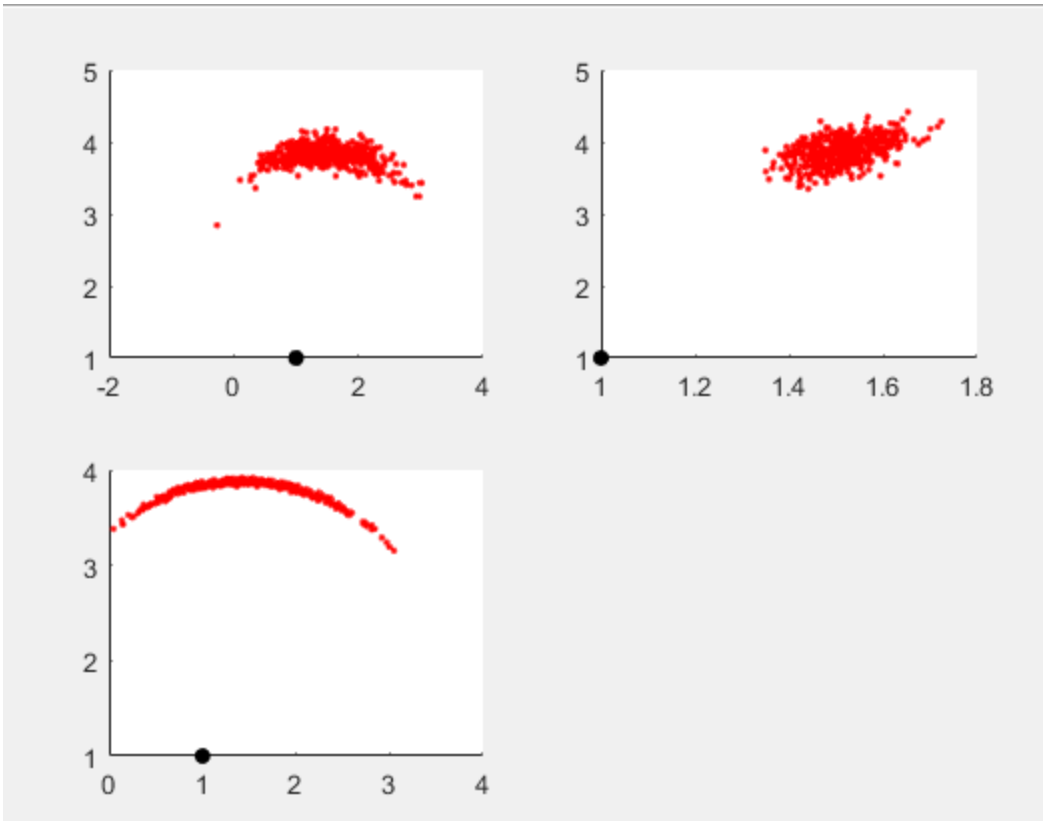
```
% Implement above algorithm


% 1, Setting up the parameters for the errors α

% 2, Setting up the initial v, w, r

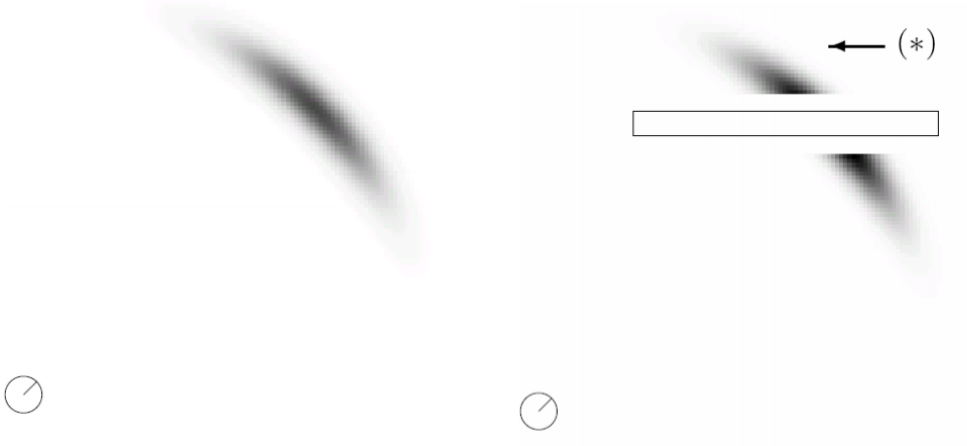
% 3, Calculate predicted x, y, theta

% 4, plot it
```



Homework 4

Problem 3: Please generate the map-consistent probability model in the following situation.



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% Base on the models above, considering that there will be no chances for
robot to be located on an obstacles.
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