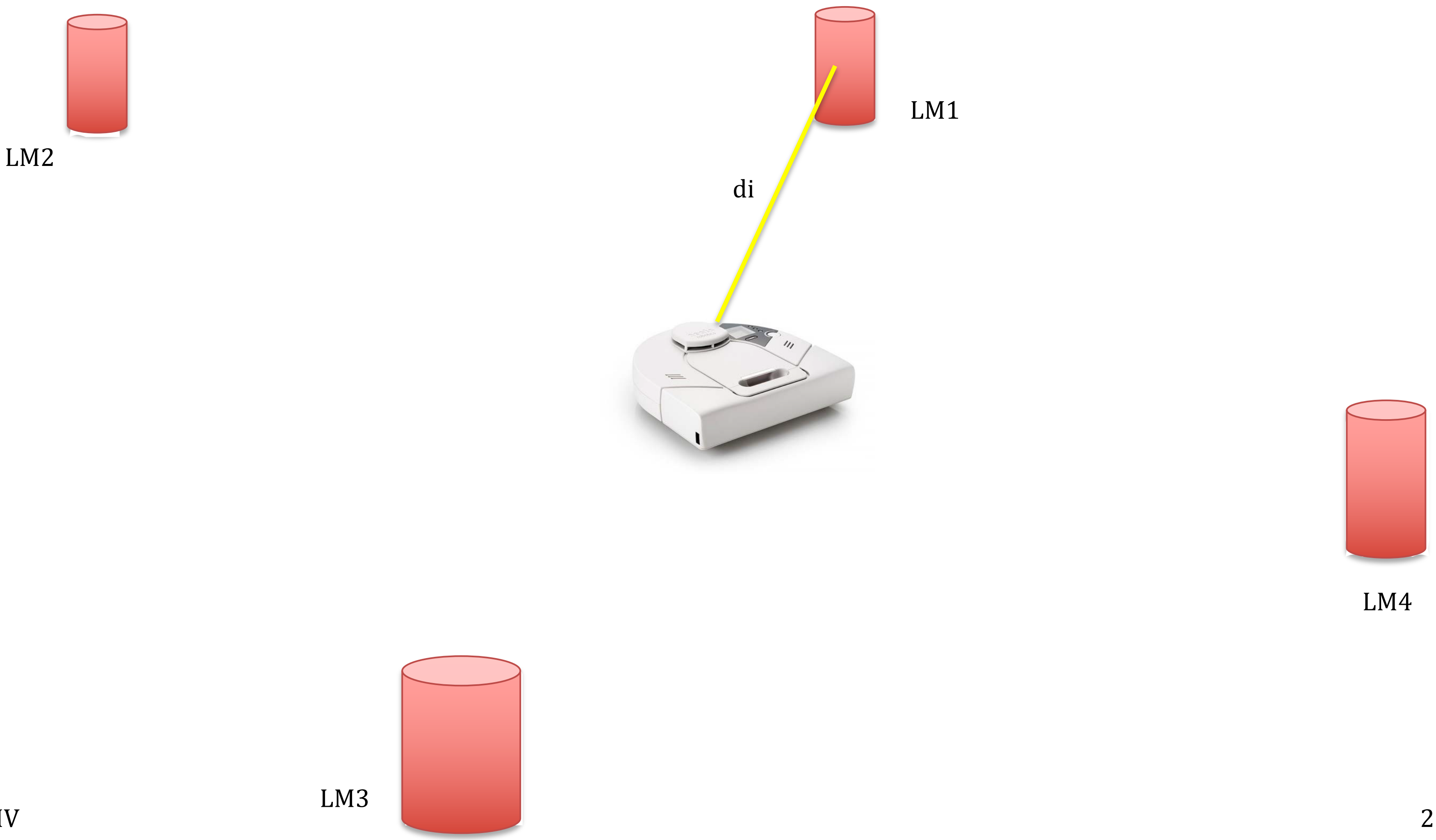
Departament d'Enginyeria de Sistemes, Automàtica i Informàtica Industrial
UNIVERSITAT POLITÈCNICA DE CATALUNYA

LOCALIZATION LAB

The experiment.

I used a Neato Robot in a simplify environment to log the robot and laser information while driving it to perform a trajectory



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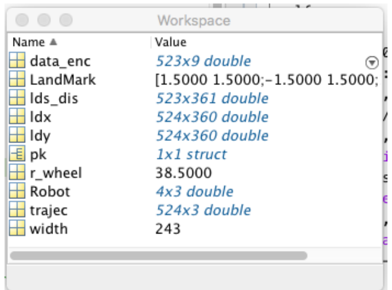
Getting inside

<table>
<tr><th></th><th>What to do</th><th>Description</th><th>What to read or practice or integrate</th></tr>
<tr><td>1</td><td>Getting familiar with logged dat of the in Workspace</td><td>
</td><td>
<table>
<tr><td>data_enc</td><td>Contains all the encoders information.
Has 9 columns which represents:
Timestamp, LeftWheel_RPM, RightWheel_RPM, LeftWheel_Load%, RightWheel_Load%, LeftWheel_PositionInMM, RightWheel_PositionInMM, LeftWheel_Speed, RightWheel_Speed</td></tr>
<tr><td>lds_dis</td><td>Contains the laser information. Has 361 columns which represents:
Timestamp, DistInMM (For each line, one record for each degree 0-359)</td></tr>
<tr><td>Lndmrk
Ldx
ldy</td><td>Contains the measured landmarks. LanMark has two columns which represents x and y coordinates.
ldx and ldy are separated variables</td></tr>
<tr><td>pk</td><td>Is the covariance matrix for each point in the trajectory. Is a data estructure.</td></tr>
<tr><td>r_wheel</td><td>Is the radius of the wheels in mm.</td></tr>
<tr><td>trajec</td><td>Contains the calculated trajectory. Has 3 columns</td></tr>
<tr><td>width</td><td>Is the wheel axes distance of the robot in mm.</td></tr>
</table>
</td></tr>
</table>

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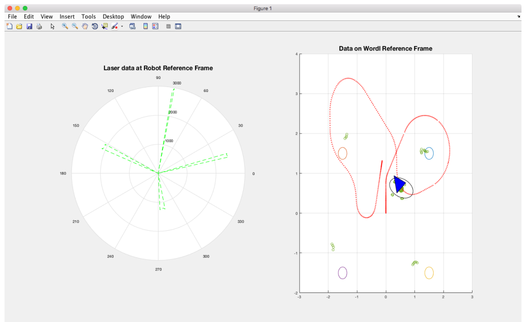
<table>
<tr><th></th><th>What to do</th><th>Description</th><th>What to read or practice or integrate</th></tr>
<tr><td>2</td><td>Getting familiar with the script to plot information.</td><td>
</td><td>x = inputdlg('Enter step time to visualize',... %Introducing the snapshot to visualize
                'Input', [1 20]);
index = str2num(x{:})
Robot= [0 -0.2 0 1;0.4 0 0 1;0 0.2 0 1]';% The Robot icon is a triangle
for index=1:522 % Use the for loop to see a movie
t = 0: 2*pi/359 : 2*pi;
P = polar(t, 4.5 * ones(size(t)));% to fix the limits
set(P, 'Visible', 'off')
polar(t, lds_dis (index,2:361), '--g'); % Ploting the laser data wrt Robot frame
title ('Laser data at Robot Reference Frame','FontWeight','bold','FontSize',16)
subplot(1,2,2)
title ('Data on Wordl Reference Frame', 'FontWeight','bold','FontSize',16)
axis([-3 3 -2 4])
grid on
hold on
for i=1:4 % plotting the 4 Land Marks
circle (LandMark(i,:)',0.15)
end
scatter(ldx(index,:), ldy(index,:)) % plotting the land mark seen by the Robot wrt wordl reference frame
plot (trajec(:,1), trajec(:,2), 'r.','LineWidth',1.5) % Plotting the trajectory
Robot_tr=transl(trajec(index,1),trajec(index,2),0)*trotz(mod(trajec(index,3)+pi/2,2*pi))*Robot;% moving the robot
patch(Robot_tr(1,:), Robot_tr(2,:),'b');
plot_ellipse(pk.signals.values(1:2,1:2,index),[trajec(index,1), trajec(index,2)],'g'); % Plotting the covariance matrix
pause(0.1);
clf
end</td></tr>
</table>

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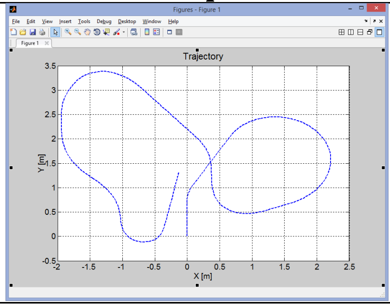
	What to do	Description	What to read or practice or integrate
3	Implement your own pose integration algortihm and compare results		Use the matlab code of the previous Lab's to generate the trajectory. Compare resulkts
4	Add some noise to the odometry	$v = \begin{pmatrix} \sigma_d^2 & 0 \\ 0 & \sigma_\theta^2 \end{pmatrix}$ $odo = \begin{pmatrix} \frac{R+L}{2} \\ \frac{R-L}{2S} \end{pmatrix} + randn(2,1)^T * v$	Add noise to the trajectory. Use different noise covariance matrix, display the ellipses and compare results.

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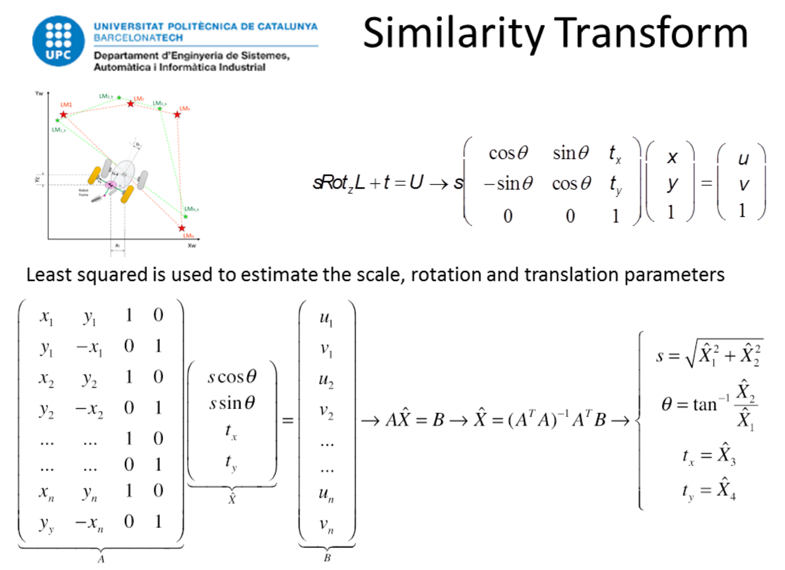


```
LandMark = [  1.5,1.5; -1.5,1.5; -1.5,-1.5;  1.5, -1.5]';
figure
axis ([-2 2 -2 2])
scatter(LandMark(1,:),LandMark(2,:),200, 'r','filled');
grid on

% Translate an rotate the Land Marks
alpha = pi/16 % Rotate pi/16 rad --> 22.5 degrees
tx = 0.1; % Translate
ty = 0.2;
RotzTxy = [cos(alpha), sin(alpha), tx;...
       -sin(alpha), cos(alpha), ty;...
        0,          0,          1];
newLM = RotzTxy*[LandMark;ones(1,4)];

hold on;
scatter(newLM(1,:), newLM(2,:),200, 'b','filled');
```

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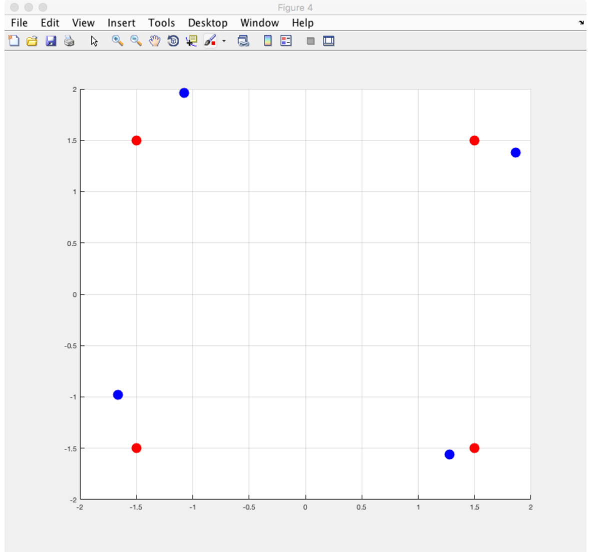


```
% Similarity transform
function [ tx,ty,tita,s]=SimilarityTransform(LandMark,newLM)
assert(size( LandMark , 2) == size(detected, 2));
%Build Matrix A
A = [];
for i=1:size( LandMark , 2)
    A = [A;[ LandMark (1,i), LandMark (2,i),1,0]];
    A = [A;[ LandMark (2,i),-LandMark (1,i),0,1]];
end
B = [];%Build Matrix B
for i=1:size( newLM , 2)
    B = [B;  newLM (1,i);  newLM (2,i)];
end
%Compute tx ty i tita
X = inv((A'*A))*A'*B;
Tx_ST = X(3);
Ty_ST= X(4);
alpha_ST = atan2(X(2),X(1))*180/pi;
end
```

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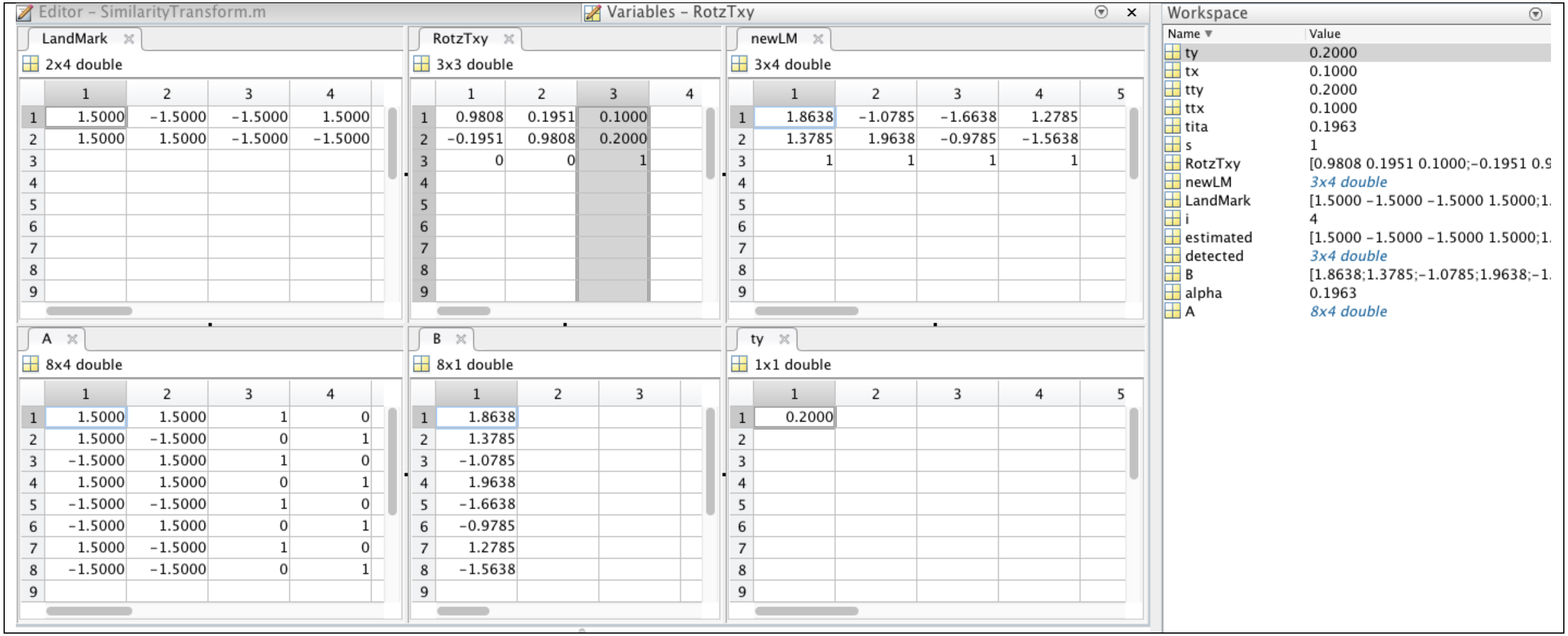

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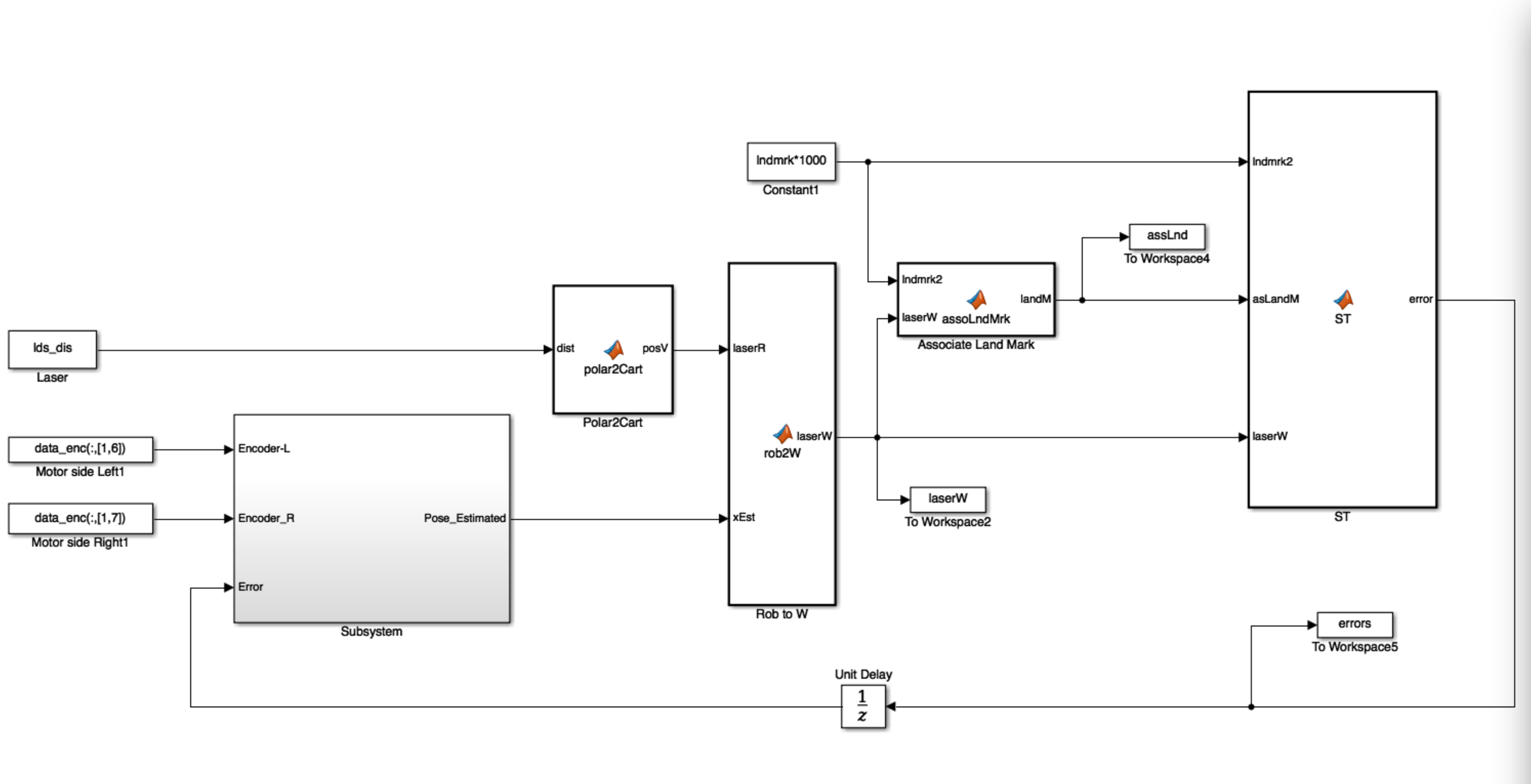
8	Suggested architecture	

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What to deliver:

A pdf report with figures, commented code and workspace variable you use for implementing the blocks of the suggested architecture.

Step	**Block**	Points
1	**Pose estimated.** A figure of a noisy trajectory with the ellipses representing the covariance error in position. Make a zoom in to see in detail. Add to the report the commented code you implemented.	1
2	**Polar 2 Cartesian.** A figure of the Land Mark seeing in Robot Reference Frame.	1
3	**Robot to World.** Generate the workspace *'laserW'* variable and and include in the report a figure of the Land Mark seeing in World Reference Frame.	2
4	**Associated Land Mark.** Filter out the lidar data by detecting the landMark (datacloud) and Identifying the LandMark (nearest_to). Add to the report a figure with colored Land Mark seeing by the Robot.	2
5	**Similarity Transform.** Adapt the Similarity Transform to output the error in pose given a time.	2

Note: Steps 1 to 5 can be done using Matlab script.