Odometry Data

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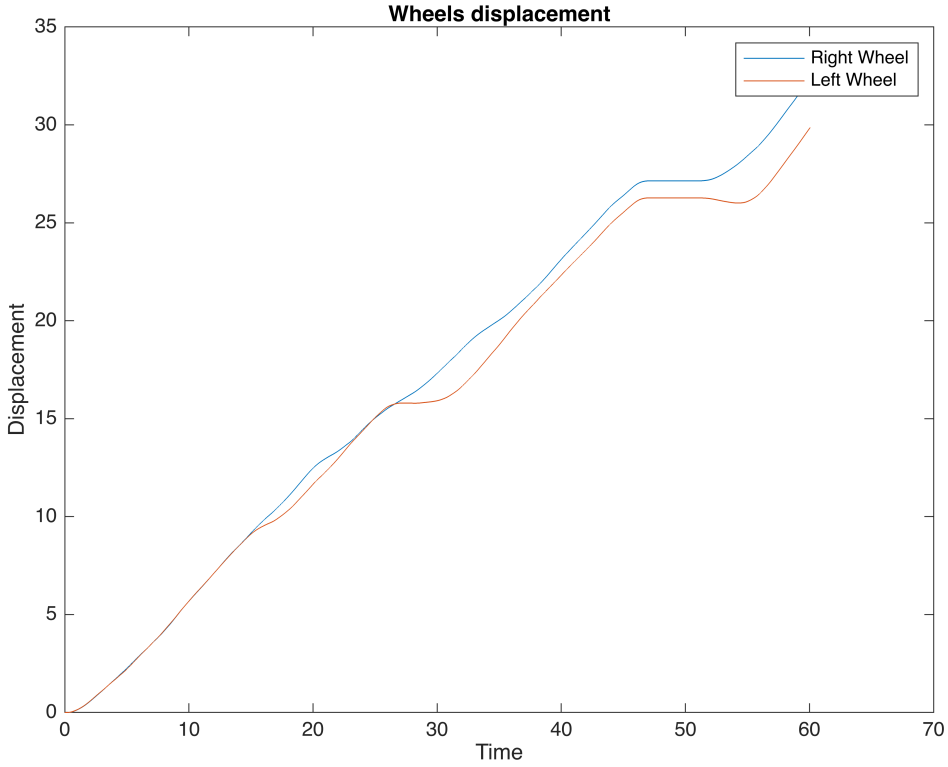
Load Data

```
clear
clf
load('Encoder_Data.mat')
```

Visualizing L&R info

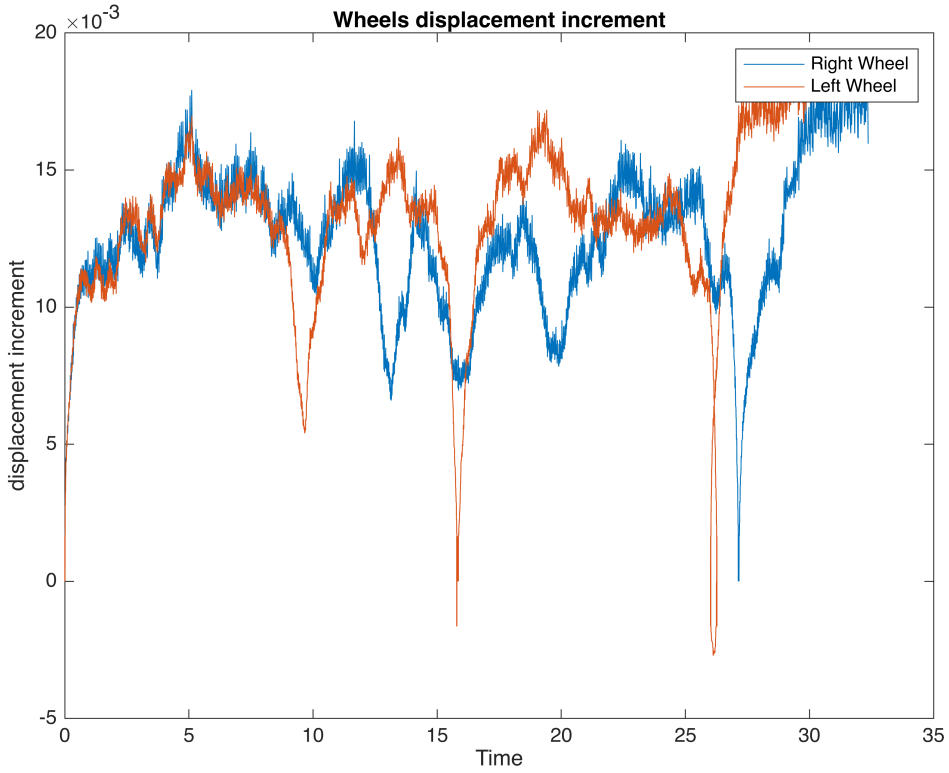
Use time values

```
plot(R_acu(:,1),R_acu(:,2))
hold on
plot(L_acu(:,1),L_acu(:,2))

title('Wheels displacement')
ylabel('Displacement')
xlabel('Time')
legend('Right Wheel', 'Left Wheel');
L_inc = diff(L_acu(:,2));
R_inc = diff(R_acu(:,2));
hold off
```



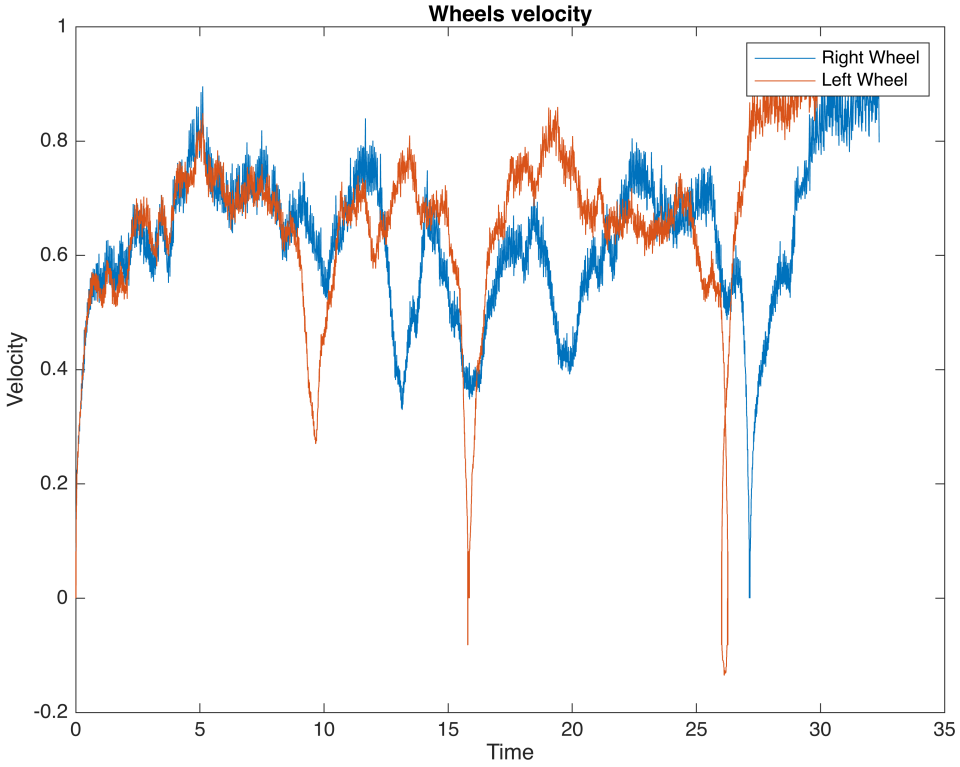
Visualize increment displacement

```
plot(R_acu(2:3004,2),R_inc(:))
hold on
plot(L_acu(2:3004,2), L_inc(:))

title('Wheels displacement increment')
ylabel('displacement increment')
xlabel('Time')
legend('Right Wheel', 'Left Wheel');
hold off
```



Visualize increment velocity

```
plot(R_acu(2:3004,2),R_inc(:)/Ts)
hold on
plot(L_acu(2:3004,2), L_inc(:)/Ts)

title('Wheels velocity')
ylabel('Velocity')
xlabel('Time')
legend('Right Wheel', 'Left Wheel');
hold off
```




```
clf % delete previous plots so we can hold on later and they don't all show up
```

Odometry

Compute δ_x and δ_ψ

```
delta_x= (R_inc+L_inc)/2;
delta_psi= (R_inc-L_inc)/(W);
```

Pose integration

Compare your results

Next pose; $\xi_{k+1} = \xi_k \tan sl_x(\delta_d) Rot_Z(\delta_\theta)$

```
Initial_pose = 4×4
          0    1.0000         0    8.6500
   -1.0000         0         0   17.2000
          0         0    1.0000         0
          0         0         0    1.0000
```

or using

$$\xi_{k+1} = \begin{pmatrix} p_{k+1} \\ \theta_{k+1} \end{pmatrix} = \begin{pmatrix} x_k + \delta_d c\theta_k \\ y_k + \delta_d s\theta_k \\ \theta_k + \delta_\theta \end{pmatrix}$$

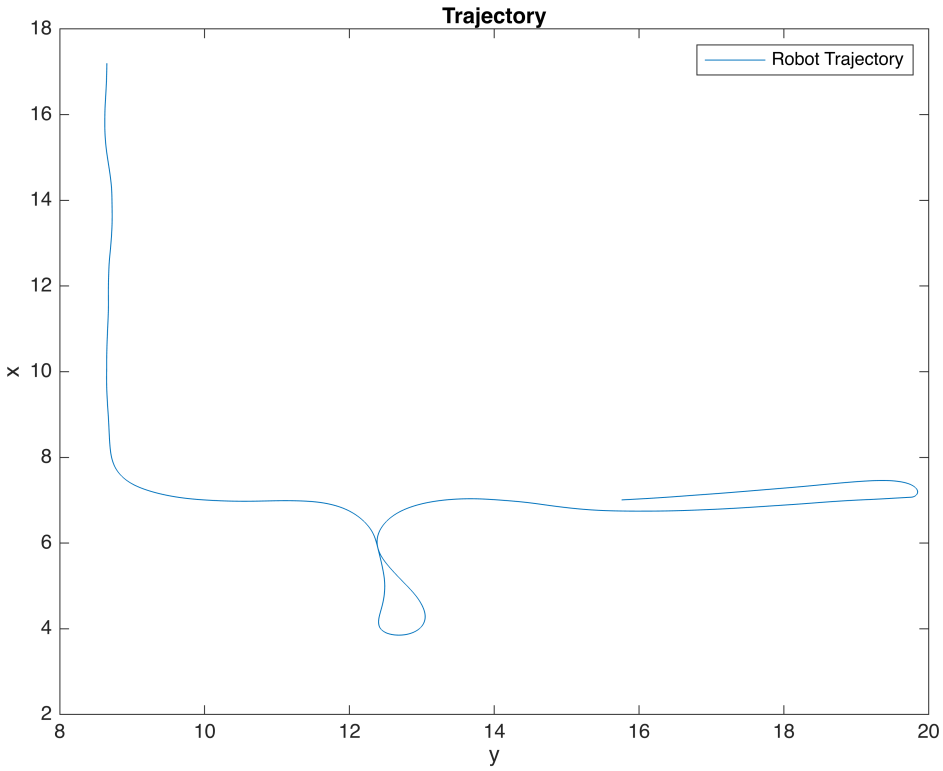
```
Initial_pose = transl(8.65,17.2,0)*trotz(-pi/2)
```

```
Initial_pose = 4×4
         0    1.0000         0    8.6500
   -1.0000         0         0   17.2000
         0         0    1.0000         0
         0         0         0    1.0000
```

```
time = R_acu(:,1);
Initial_position=transl(Initial_pose);
% Preallocate for speed
x = zeros(1,length(time)-1);
y = zeros(1,length(time)-1);
o = zeros(1,length(time)-1);

x(1)=Initial_position(1);
y(1)= Initial_position(2);
o(1)= -pi/2;

for i = 1:length(time)-1
    x(i+1) = x(i) + delta_x(i)*cos(o(i));
    y(i+1) = y(i) + delta_x(i)*sin(o(i));
    o(i+1) = mod(o(i) + delta_psi(i),pi*2);
end
```

```
plot(x,y)
```

```
title('Trajectory')
ylabel('x')
xlabel('y')
legend('Robot Trajectory');
hold on
```



Adding noise

Add noise to odometry

See the effect on the trajectory

```
% Add gaussian noise
noise_std = 0.01; % adjust as needed
delta_x_noisy = delta_x + noise_std * randn(size(delta_x));
delta_psi_noisy = delta_psi + noise_std * randn(size(delta_psi));

x_noisy = zeros(1,length(time)-1);
y_noisy = zeros(1,length(time)-1);
o_noisy = zeros(1,length(time)-1);

x_noisy(1) = Initial_position(1);
y_noisy(1) = Initial_position(2);
o_noisy(1) = -pi/2;

for i = 1:length(time)-1
    x_noisy(i+1) = x_noisy(i) + delta_x_noisy(i)*cos(o_noisy(i));
```

```
    y_noisy(i+1) = y_noisy(i) + delta_x_noisy(i)*sin(o_noisy(i));
    o_noisy(i+1) = mod(o_noisy(i) + delta_psi_noisy(i),pi*2);
end

plot(x_noisy,y_noisy)

title('Trajectory')
ylabel('x')
xlabel('y')
legend({'Ideal Trajectory', 'Noisy Trajectory'});
```