```
l = norm([0.285/2.0; 0.165/2.0])
```

```
l = 0.1647
```

```
r = 0.064/2
```

```
r = 0.0320
```

```
gamma = pi/4
```

```
gamma = 0.7854
```

```
% For Wheel 1
alpha1 = asin(0.1425/l)
```

```
alpha1 = 1.0460
```

```
beta1  = pi/2 - alpha1
```

```
beta1 = 0.5248
```

```
gamma1 = -gamma
```

```
gamma1 = -0.7854
```

```
% For Wheel 2
alpha2 = -asin(0.1425/l)
```

```
alpha2 = -1.0460
```

```
beta2  = -(pi/2 + alpha2) % (?)
```

```
beta2 = -0.5248
```

```
beta2  = pi + beta2
```

```
beta2 = 2.6168
```

```
gamma2 = gamma
```

```
gamma2 = 0.7854
```

```
% For Wheel 3
theta3 = asin(0.0825/l)
```

```
theta3 = 0.5248
```

```
alpha3 = pi/2 + theta3
```

```
alpha3 = 2.0956
```

```
beta3  = -theta3 % (?)
```

```
beta3 = -0.5248
```

```
gamma3 = gamma
```

```
gamma3 = 0.7854
```

```
% For Wheel 4
theta4 = asin(0.0825/l)
```

```
theta4 = 0.5248
```

```
alpha4 = -pi/2 - theta3
```

```
alpha4 = -2.0956
```

```
beta4  =  theta4 %  (?)
```

```
beta4 = 0.5248
```

```
beta4  = pi + beta4
```

```
beta4 = 3.6664
```

```
gamma4 = -gamma
```

```
gamma4 = -0.7854
```

```
%%
% Model of the robot
J11 = [ sin(alpha1+beta1+gamma1) -cos(alpha1+beta1+gamma1) (-l)*cos(beta1+gamma1) ];
J12 = [ sin(alpha2+beta2+gamma2) -cos(alpha2+beta2+gamma2) (-l)*cos(beta2+gamma2) ];
J13 = [ sin(alpha3+beta3+gamma3) -cos(alpha3+beta3+gamma3) (-l)*cos(beta3+gamma3) ];
J14 = [ sin(alpha4+beta4+gamma4) -cos(alpha4+beta4+gamma4) (-l)*cos(beta4+gamma4) ];

%%
% Matrix J1
J1 = [J11;J12;J13;J14]
```

```
J1 = 4×3
    0.7071   -0.7071   -0.1591
    0.7071    0.7071    0.1591
    0.7071    0.7071   -0.1591
    0.7071   -0.7071    0.1591
```

```
inv_J1 = pinv(J1)
```

```
inv_J1 = 3×4
    0.3536    0.3536    0.3536    0.3536
   -0.3536    0.3536    0.3536   -0.3536
   -1.5713    1.5713   -1.5713    1.5713
```

```
%%
% Matrix J2
J2 = r*eye(4)*cos(gamma) %CHECK IF MULTIPLY OR NOT
```

```
J2 = 4×4
    0.0226         0         0         0
```

```
         0    0.0226         0         0
         0         0    0.0226         0
         0         0         0    0.0226
```

```
%%
% Full model
% J1*E_r = J2*Phi

%%
% Odometry
syms phi_1 phi_2 phi_3 phi_4

phi_dot = [phi_1;phi_2;phi_3;phi_4];

E_r = pinv(J1)*J2
```

```
E_r = 3×4
    0.0080    0.0080    0.0080    0.0080
   -0.0080    0.0080    0.0080   -0.0080
   -0.0356    0.0356   -0.0356    0.0356
```

```
E_r = pinv(J1)*J2*phi_dot;

%%
% Commands
syms x_dot y_dot theta_dot

e_r = [x_dot;y_dot;theta_dot];
fix = [1;-1;1;-1];

phi_d = pinv(J2)*J1
```

```
phi_d = 4×3
   31.2500  -31.2500   -7.0312
   31.2500   31.2500    7.0312
   31.2500   31.2500   -7.0312
   31.2500  -31.2500    7.0312
```

```
phi_d = pinv(J2)*J1*e_r;

e_r   = [0.1;0;0];
phi_d = pinv(J2)*J1*e_r;
phi_d = phi_d
```

```
phi_d = 4×1
    3.1250
    3.1250
    3.1250
    3.1250
```

```
e_r   = [0;0.05;0];
phi_d = pinv(J2)*J1*e_r;
phi_d = phi_d
```

```
phi_d = 4×1
   -1.5625
```

```
    1.5625
    1.5625
   -1.5625
```

```
%e_r   = [1;-1;0];
%phi_d = pinv(J2)*J1*e_r;
%phi_d = fix.*phi_d

%e_r   = [0;0;1];
%phi_d = pinv(J2)*J1*e_r;
%phi_d = fix.*phi_d

% Odometry
phi_dot = [phi_1;phi_2;phi_3;phi_4];

E_r = pinv(J1)*J2
```

```
E_r = 3×4
    0.0080    0.0080    0.0080    0.0080
   -0.0080    0.0080    0.0080   -0.0080
   -0.0356    0.0356   -0.0356    0.0356
```

```
E_r = pinv(J1)*J2*phi_dot
```

E_r =

$$\begin{pmatrix} \frac{\phi_1}{125}+\frac{\phi_2}{125}+\frac{\phi_3}{125}+\frac{\phi_4}{125} \\ \frac{\phi_2}{125}-\frac{\phi_1}{125}+\frac{\phi_3}{125}-\frac{\phi_4}{125} \\ \frac{8\,\phi_2}{225}-\frac{8\,\phi_1}{225}-\frac{8\,\phi_3}{225}+\frac{8\,\phi_4}{225} \end{pmatrix}$$

```
syms yaw

E_I = [cos(yaw) -sin(yaw) 0;
       sin(yaw)  cos(yaw) 0;
          0         0     1];
e_r = [x_dot;y_dot;theta_dot]
```

e_r =

$$\begin{pmatrix} \dot{x} \\ \dot{y} \\ \dot{\theta} \end{pmatrix}$$

```
E_I = E_I * e_r
```

E_I =

$$\begin{pmatrix} \dot{x}\cos(\mathrm{yaw})-\dot{y}\sin(\mathrm{yaw}) \\ \dot{y}\cos(\mathrm{yaw})+\dot{x}\sin(\mathrm{yaw}) \\ \dot{\theta} \end{pmatrix}$$

```
%%
%Tests

phi_dot = [0.1;0.1;0.1;0.1];

E_r = pinv(J1)*J2*phi_dot
```

```
E_r = 3×1
    0.0032
    0.0000
    0.0000
```