BRIDGE O DOOOOM

Plotting the path

```
beta = 0.2
```

```
beta = 0.2000
```

```
points = linspace(0, 3.2, 1000);
x = 0.3960 * cos(2.65*(1.4 + points));
y = -0.99 * sin(1.4 + points);
syms u r t

u = beta * t
```

```
u =
```

$$\frac{t}{5}$$

```
r_i = 0.3960 * cos(2.65*(1.4 + u))
```

```
r_i =
```

$$\frac{99\cos\left(\frac{53\,t}{100}+\frac{371}{100}\right)}{250}$$

```
r_j = -0.99 * sin(1.4 + u)
```

```
r_j =
```

$$-\frac{99\sin\left(\frac{t}{5}+\frac{7}{5}\right)}{100}$$

```
r_k = 0 * u
```

```
r_k = 0
```

```
assume(t,'real')
r = [r_i, r_j, r_k];
drdu = diff(r,t);
T_hat = simplify(drdu./norm(drdu))
```

```
T_hat =
```

$$\left(-\frac{53\sin\left(\frac{53\,t}{100}+\frac{371}{100}\right)}{\sigma_1}\quad -\frac{50\cos\left(\frac{t}{5}+\frac{7}{5}\right)}{\sigma_1}\quad 0\right)$$

where

$$\sigma_1=\sqrt{2500\cos\left(\frac{t}{5}+\frac{7}{5}\right)^2+2809\sin\left(\frac{53\,t}{100}+\frac{371}{100}\right)^2}$$

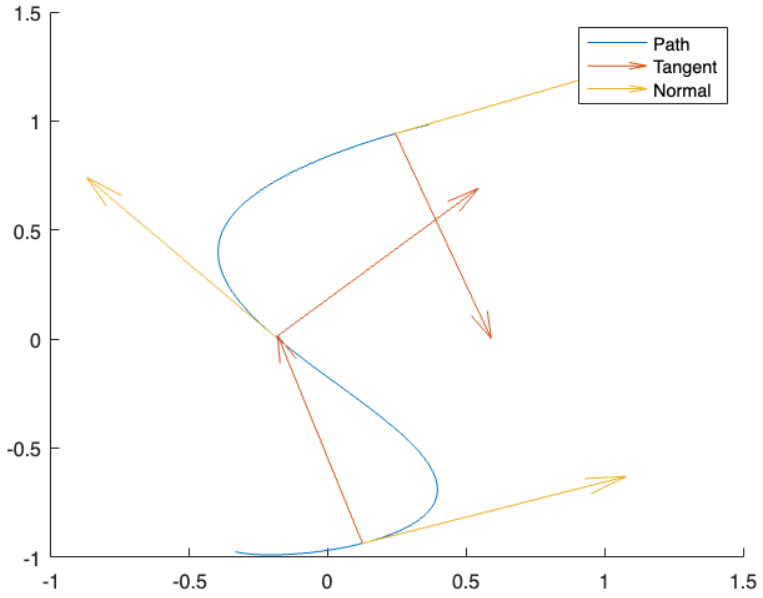
```
dT_hatdu=diff(T_hat,t);
N_hat=dT_hatdu/norm(dT_hatdu);
N_hat=simplify(N_hat);

vecs = transpose(linspace(0.5, 3, 3));
vecs_x = 0.3960 * cos(2.65*(1.4 + vecs));
vecs_y = -0.99 * sin(1.4 + vecs);
N = eval(subs(N_hat,vecs/beta))
```

```
N = 3×3
   -0.3061    0.9520         0
    0.7310    0.6824         0
    0.3456   -0.9384         0
```

```
T = eval(subs(T_hat, vecs/beta))
```

```
T = 3×3
    0.9520    0.3061         0
   -0.6824    0.7310         0
    0.9384    0.3456         0
```

```
f = figure();
hold on
plot(x,y)
quiver(vecs_x, vecs_y, N(:,1), N(:, 2))
quiver(vecs_x, vecs_y, T(:,1), T(:, 2))
legend("Path","Tangent","Normal")
```



Plotting the velocities

```
vel = diff(r, t)
```

vel =

$$\left(-\frac{5247\sin\left(\frac{53t}{100}+\frac{371}{100}\right)}{25000} \quad -\frac{99\cos\left(\frac{t}{5}+\frac{7}{5}\right)}{500} \quad 0\right)$$

```
diff(T_hat)
```

ans =

$$\left(-\frac{2809\cos\left(\frac{53t}{100}+\frac{371}{100}\right)}{100\sqrt{\sigma_2}}-\frac{53\sigma_3\sigma_1}{2{\sigma_2}^{3/2}} \quad \frac{10\sin\left(\frac{t}{5}+\frac{7}{5}\right)}{\sqrt{\sigma_2}}-\frac{25\cos\left(\frac{t}{5}+\frac{7}{5}\right)\sigma_1}{{\sigma_2}^{3/2}} \quad 0\right)$$

where

$$\sigma_1 = 1000\cos\left(\frac{t}{5}+\frac{7}{5}\right)\sin\left(\frac{t}{5}+\frac{7}{5}\right)-\frac{148877\cos\left(\frac{53t}{100}+\frac{371}{100}\right)\sigma_3}{50}$$

$$\sigma_2 = 2500\cos\left(\frac{t}{5}+\frac{7}{5}\right)^2+2809{\sigma_3}^2$$

$$\sigma_3 = \sin\left(\frac{53t}{100}+\frac{371}{100}\right)$$

```
omega = cross(T_hat, diff(T_hat))
```

omega =

$$\begin{pmatrix} 0 & 0 & -\dfrac{50\,\sigma_4\left(\dfrac{2809\cos\left(\frac{53\,t}{100}+\frac{371}{100}\right)}{100\,\sqrt{\sigma_2}}+\dfrac{53\,\sigma_3\,\sigma_1}{2\,{\sigma_2}^{3/2}}\right)}{\sqrt{\sigma_2}}-\dfrac{53\,\sigma_3\left(\dfrac{10\sin\left(\frac{t}{5}+\frac{7}{5}\right)}{\sqrt{\sigma_2}}-\dfrac{25\,\sigma_4\,\sigma_1}{{\sigma_2}^{3/2}}\right)}{\sqrt{\sigma_2}} \end{pmatrix}$$

where

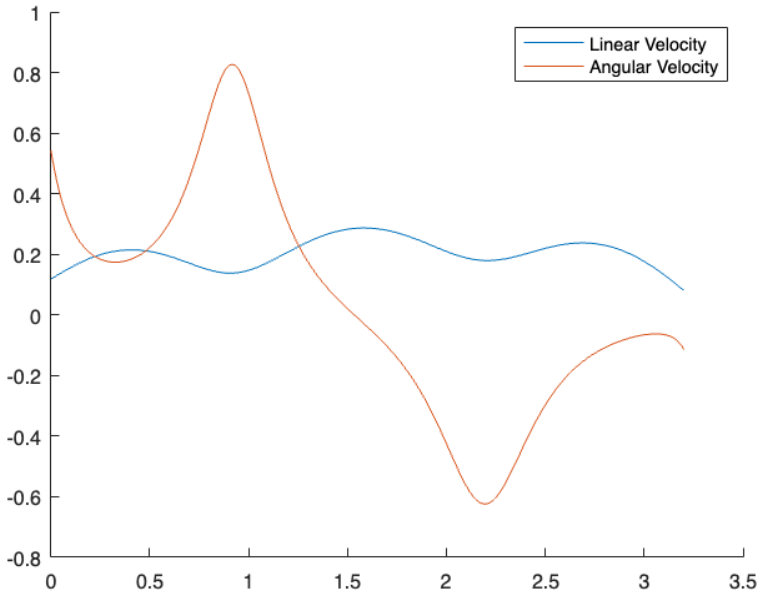
$$\sigma_1 = 1000\,\sigma_4\sin\left(\frac{t}{5}+\frac{7}{5}\right)-\frac{148877\cos\left(\frac{53\,t}{100}+\frac{371}{100}\right)\sigma_3}{50}$$

$$\sigma_2 = 2500\,{\sigma_4}^2+2809\,{\sigma_3}^2$$

$$\sigma_3 = \sin\left(\frac{53\,t}{100}+\frac{371}{100}\right)$$

$$\sigma_4 = \cos\left(\frac{t}{5}+\frac{7}{5}\right)$$

```
V_n = (eval(subs(vel, transpose(points)/beta)));
V_n = sqrt(sum(V_n.^2,2));
ang_vel = eval(subs(omega, transpose(points)/beta));
figure;
hold on
plot(points, V_n)
plot(points, ang_vel(:, 3))
legend("Linear Velocity", "Angular Velocity")
```



Left Right Velocities

```
V_L = V_n - ang_vel(:, 3) * 0.245/2
```

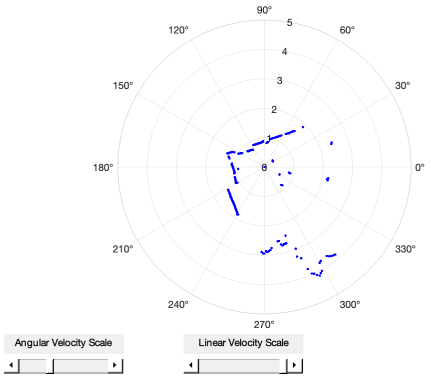
```
V_L = 1000×1
    0.0512
    0.0540
    0.0567
    0.0594
    0.0621
    0.0647
    0.0672
    0.0698
    0.0722
    0.0747
     ⋮
```

```
V_R = V_n + ang_vel(:, 3) * 0.245/2
```

```
V_R = 1000×1
    0.1846
    0.1843
    0.1841
    0.1839
    0.1838
    0.1837
    0.1837
    0.1837
    0.1837
    0.1838
     ⋮
```

```
drivetime = 0.2; % s for each velocity pair
```

```
% Assuming V_L and V_R are your original vectors of length 1000
new_length = 1000 / 10; % Target length after averaging

% Reshape and average V_L
V_L_reshaped = reshape(V_L, [10, new_length]);
V_L_short = mean(V_L_reshaped, 1);

% Reshape and average V_R
V_R_reshaped = reshape(V_R, [10, new_length]);
V_R_short = mean(V_R_reshaped, 1);

% [sensors,vels] = neatoSim(); % Uncomment for simulator
[sensors,vels] = neato('192.168.16.76'); % Uncomment for physical neato
```




```
fig = gcf;

for idx = 1:length(V_L_short)
    vl = V_L_short(idx);
    vr = V_R_short(idx);
    disp(['Running with vl = ', num2str(vl), ' and vr = ', num2str(vr)]);
    tic;
    t = toc;
    while t < drivetime
        t = toc; % Update t
        vels.lrWheelVelocitiesInMetersPerSecond = [vl, vr];
    end

    % Stop the robot after the drive time for the current velocity pair
    vels.lrWheelVelocitiesInMetersPerSecond = [0, 0];
    % pause(0.1);
end
```

```
Running with vl = 0.063206 and vr = 0.18391
Running with vl = 0.08721 and vr = 0.1849
Running with vl = 0.10764 and vr = 0.18868
Running with vl = 0.12518 and vr = 0.1941
Running with vl = 0.14026 and vr = 0.20034
Running with vl = 0.15318 and vr = 0.20682
Running with vl = 0.16411 and vr = 0.21314
```

```
Running with vl = 0.17316 and vr = 0.21901
Running with vl = 0.18041 and vr = 0.22423
Running with vl = 0.18589 and vr = 0.22866
Running with vl = 0.18963 and vr = 0.23222
Running with vl = 0.19164 and vr = 0.23485
Running with vl = 0.19194 and vr = 0.23654
Running with vl = 0.19054 and vr = 0.23734
Running with vl = 0.18746 and vr = 0.23728
Running with vl = 0.18271 and vr = 0.23648
Running with vl = 0.17631 and vr = 0.23506
Running with vl = 0.1683 and vr = 0.23319
Running with vl = 0.15871 and vr = 0.23108
Running with vl = 0.14759 and vr = 0.22899
Running with vl = 0.13502 and vr = 0.22718
Running with vl = 0.12116 and vr = 0.22597
Running with vl = 0.10625 and vr = 0.22563
Running with vl = 0.090682 and vr = 0.22637
Running with vl = 0.075123 and vr = 0.22824
Running with vl = 0.060558 and vr = 0.23103
Running with vl = 0.048314 and vr = 0.23422
Running with vl = 0.03991 and vr = 0.23703
Running with vl = 0.036696 and vr = 0.23872
Running with vl = 0.039392 and vr = 0.23889
Running with vl = 0.047806 and vr = 0.23774
Running with vl = 0.060933 and vr = 0.23596
Running with vl = 0.077356 and vr = 0.23442
Running with vl = 0.095678 and vr = 0.23383
Running with vl = 0.11478 and vr = 0.23459
Running with vl = 0.13388 and vr = 0.23677
Running with vl = 0.15248 and vr = 0.24023
Running with vl = 0.17026 and vr = 0.24471
Running with vl = 0.18705 and vr = 0.2499
Running with vl = 0.20274 and vr = 0.25547
Running with vl = 0.21725 and vr = 0.26114
Running with vl = 0.23054 and vr = 0.26663
Running with vl = 0.24256 and vr = 0.27172
Running with vl = 0.2533 and vr = 0.2762
Running with vl = 0.26273 and vr = 0.27992
Running with vl = 0.27084 and vr = 0.28272
Running with vl = 0.27763 and vr = 0.2845
Running with vl = 0.28312 and vr = 0.28517
Running with vl = 0.28732 and vr = 0.28466
Running with vl = 0.29027 and vr = 0.28291
Running with vl = 0.29202 and vr = 0.27989
Running with vl = 0.29264 and vr = 0.2756
Running with vl = 0.29221 and vr = 0.27002
Running with vl = 0.29083 and vr = 0.26318
Running with vl = 0.28863 and vr = 0.2551
Running with vl = 0.28575 and vr = 0.24584
Running with vl = 0.28233 and vr = 0.23546
Running with vl = 0.27857 and vr = 0.22404
Running with vl = 0.27466 and vr = 0.21172
Running with vl = 0.2708 and vr = 0.19862
Running with vl = 0.26719 and vr = 0.18495
Running with vl = 0.264 and vr = 0.17097
Running with vl = 0.26139 and vr = 0.15701
Running with vl = 0.25942 and vr = 0.1435
Running with vl = 0.25809 and vr = 0.13098
Running with vl = 0.25727 and vr = 0.12006
Running with vl = 0.25676 and vr = 0.1114
Running with vl = 0.25634 and vr = 0.10557
Running with vl = 0.2558 and vr = 0.10298
Running with vl = 0.25506 and vr = 0.10377
Running with vl = 0.25416 and vr = 0.10774
```

```
Running with vl = 0.25325 and vr = 0.11443
Running with vl = 0.25255 and vr = 0.12323
Running with vl = 0.25221 and vr = 0.13343
Running with vl = 0.25234 and vr = 0.14441
Running with vl = 0.25292 and vr = 0.15562
Running with vl = 0.25388 and vr = 0.1666
Running with vl = 0.25508 and vr = 0.17703
Running with vl = 0.25633 and vr = 0.18664
Running with vl = 0.25746 and vr = 0.19524
Running with vl = 0.25826 and vr = 0.20268
Running with vl = 0.25856 and vr = 0.20886
Running with vl = 0.25822 and vr = 0.21368
Running with vl = 0.25707 and vr = 0.2171
Running with vl = 0.25502 and vr = 0.21907
Running with vl = 0.25197 and vr = 0.21955
Running with vl = 0.24784 and vr = 0.21853
Running with vl = 0.24259 and vr = 0.21601
Running with vl = 0.23617 and vr = 0.212
Running with vl = 0.22857 and vr = 0.20651
Running with vl = 0.2198 and vr = 0.19956
Running with vl = 0.20988 and vr = 0.19119
Running with vl = 0.19885 and vr = 0.18145
Running with vl = 0.18677 and vr = 0.17037
Running with vl = 0.17372 and vr = 0.15799
Running with vl = 0.15981 and vr = 0.14435
Running with vl = 0.1452 and vr = 0.12946
Running with vl = 0.13012 and vr = 0.11326
Running with vl = 0.11495 and vr = 0.095567
Running with vl = 0.10041 and vr = 0.075882
```

```
close(fig); % Close the figure at the end of all iterations
```