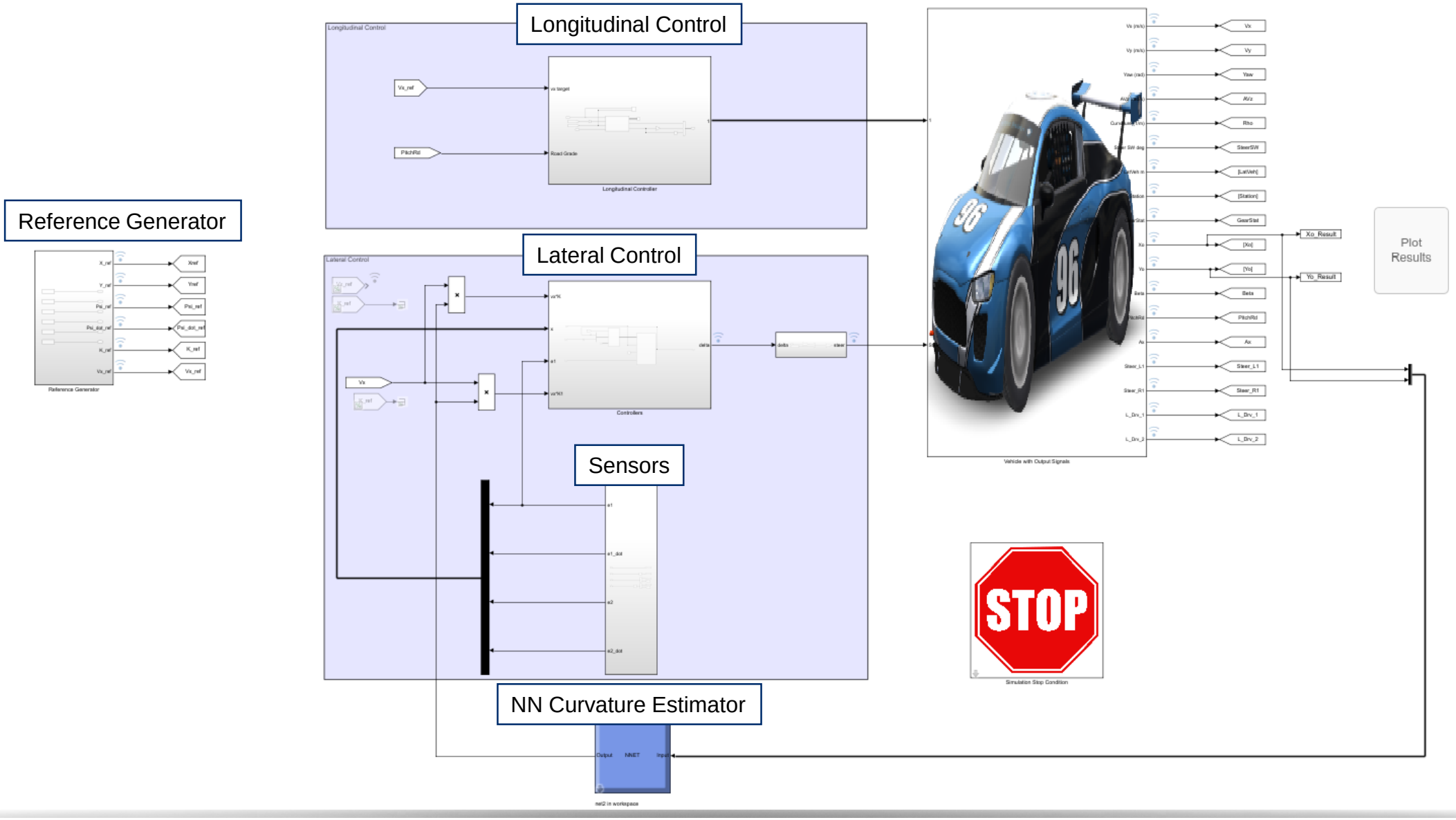
MARMARA UNIVERSITY

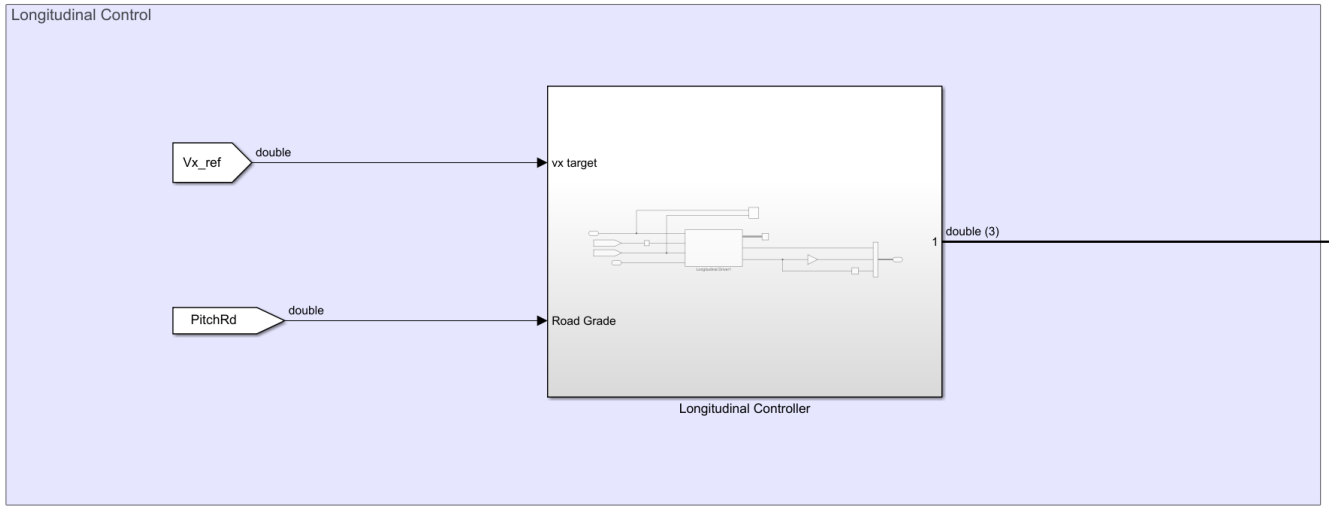
Tez İlerleme Raporu

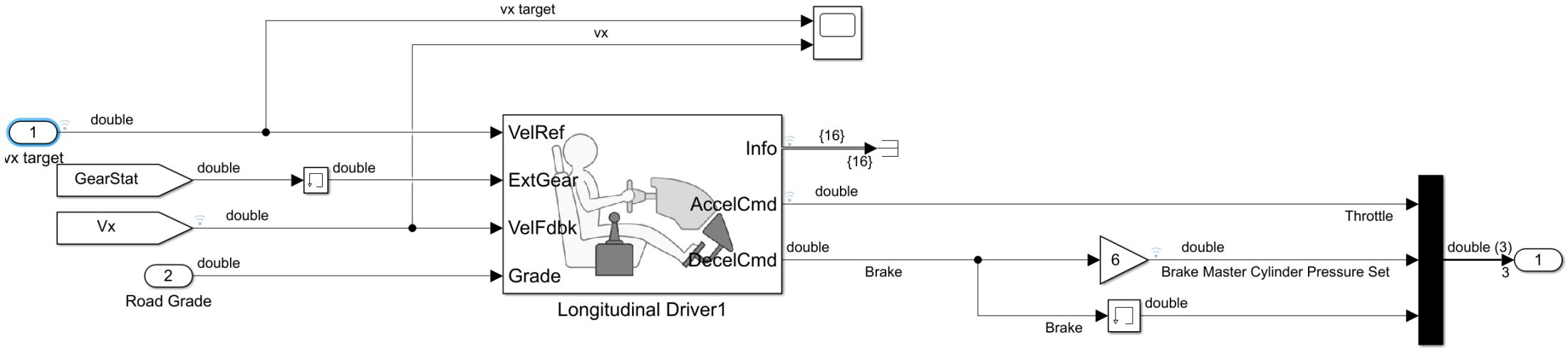
17.11.2021

CONTROL SCHEME

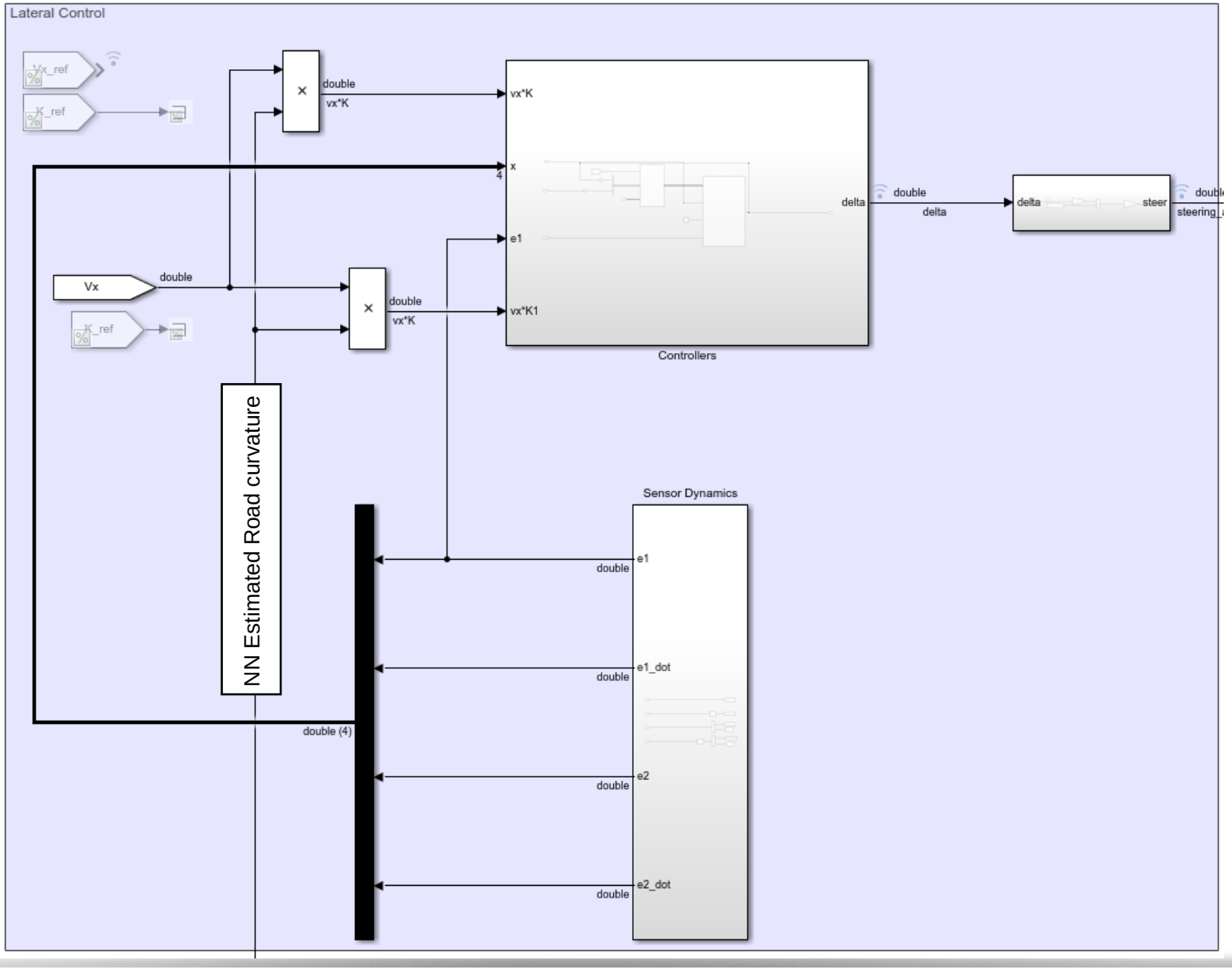


LONGITUDINAL CONTROL

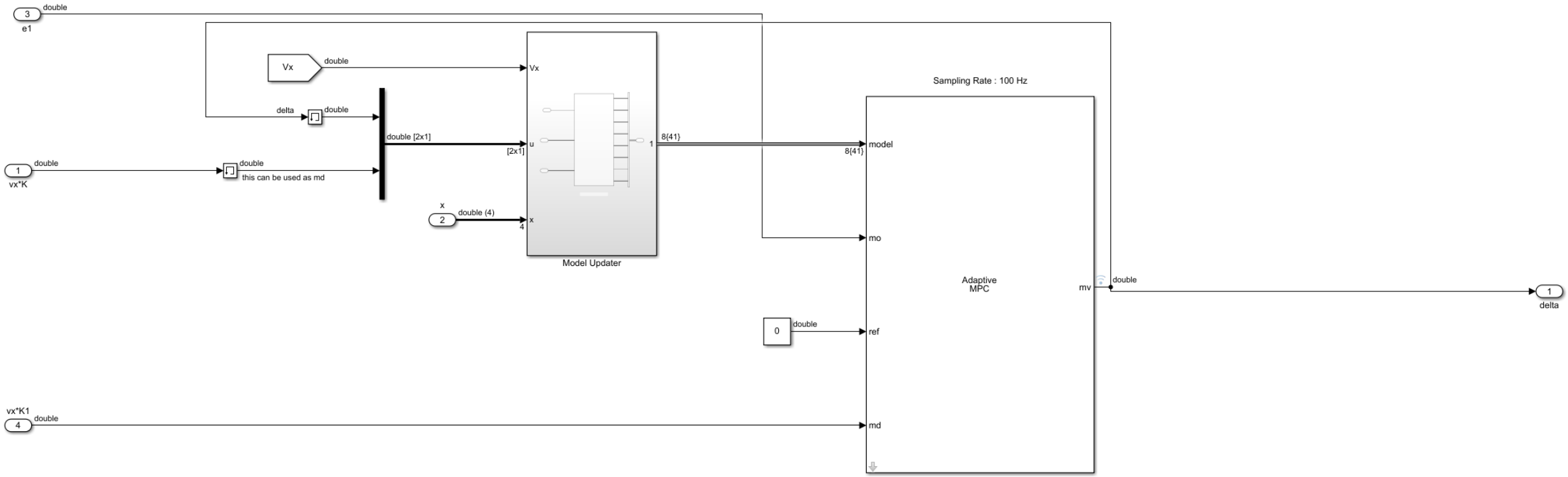




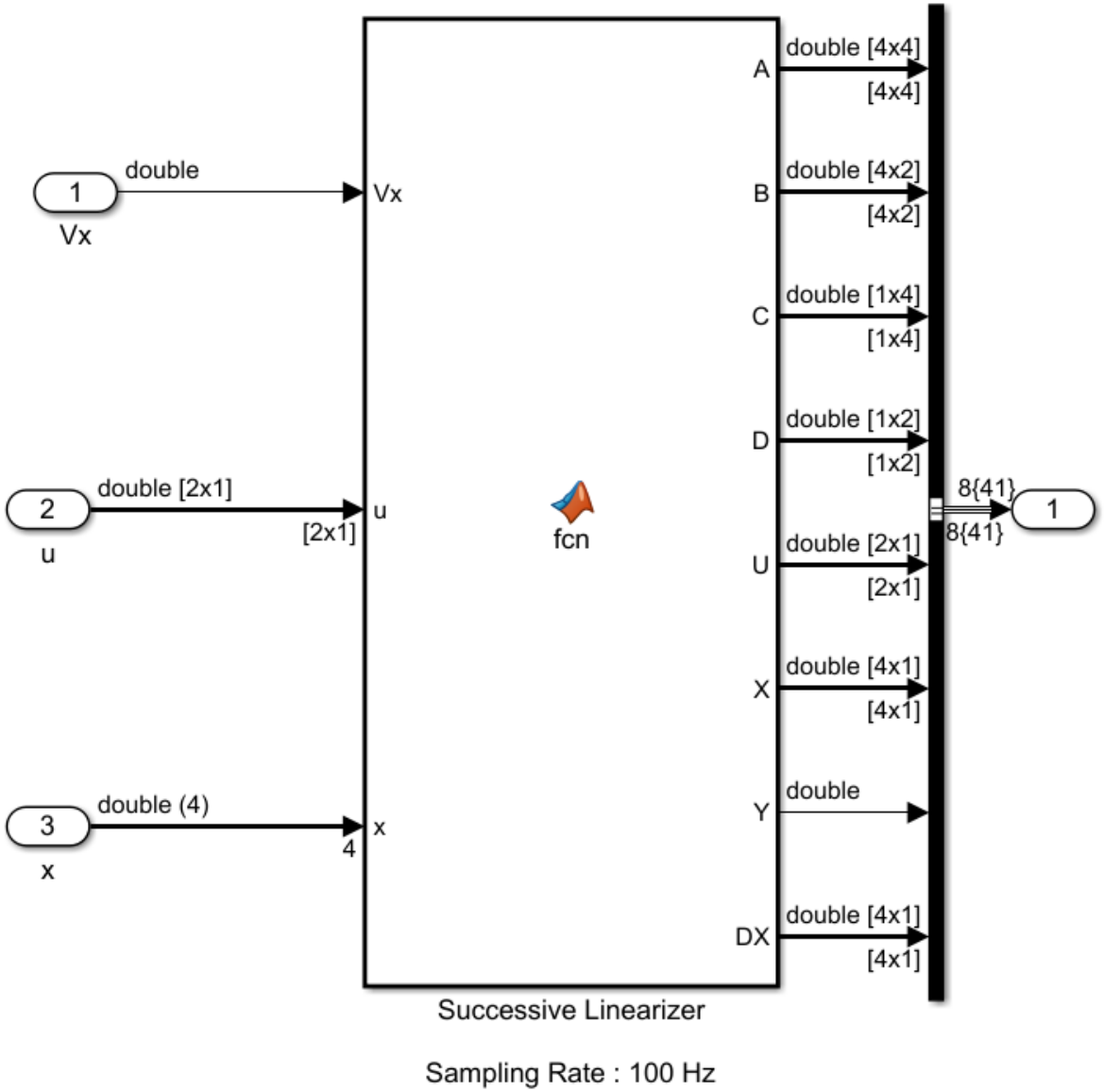
LATERAL CONTROL



LATERAL CONTROL



MODEL UPDATER



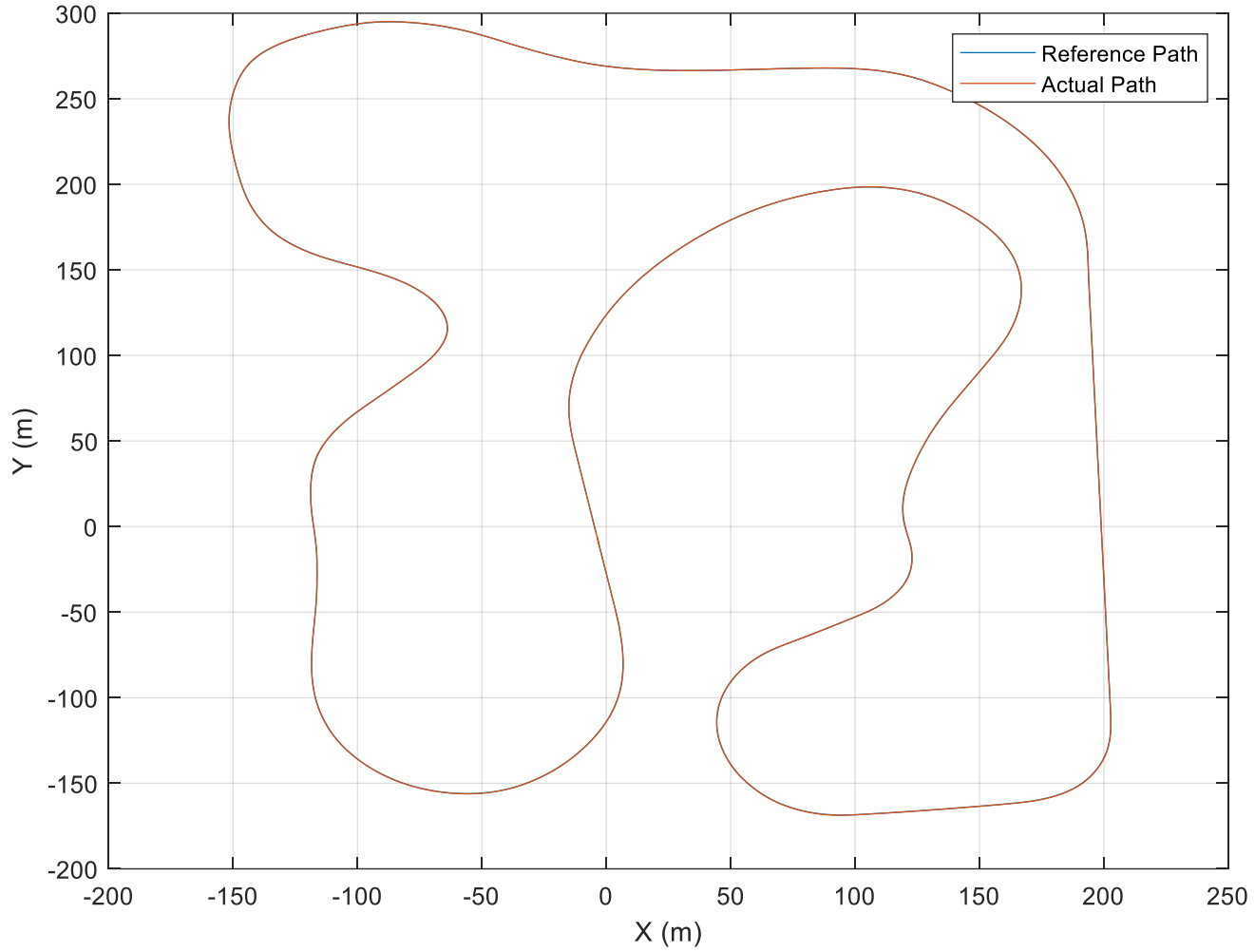

```
function [A,B,C,D,U,X,Y,DX] = fcn(Vx,u,x)

coder.extrinsic('c2d');
coder.extrinsic('ss');

A = zeros(4,4);
B = zeros(4,2);
C = zeros(1,4);
D = zeros(1,2);

Ts = 0.01;
m = 1200; %kg
lf = 1.455; %m
lr = 1.195; %m
Iz = 1065.2; % kg-m^2

%
Cf = [335431.802941654];
Cr = [556485.037312196];

a22 = -1 * (2*Cf + 2*Cr)/(m*Vx) ;
a23 =  (2*Cf + 2*Cr)/m ;
a24 = (-2*Cf*lf + 2*Cr*lr)/(m*Vx);
a42 = -1 * (2*Cf*lf - 2*Cr*lr)/(Iz*Vx);
a43 = (2*Cf*lf - 2*Cr*lr)/Iz;
a44 = -1 * (2*Cf*lf^2 + 2*Cr*lr^2)/(Iz*Vx);
```

```
b1_21 = 2*Cf/m;
b1_41 = 2*Cf*lf/Iz;

b2_21 = (-1*(2*Cf*lf - 2*Cr*lr)/(m*Vx)) - Vx;
b2_41 = (-1*(2*Cf*lf^2 + 2*Cr*lr^2)/(Iz*Vx));

Ac = [0,    1,     0,     0;
      0,    a22,   a23,   a24;
      0,    0,     0,     1;
      0,    a42,   a43,   a44];
Bc = [0,       0;
      b1_21,   b2_21;
      0,       0;
      b1_41,   b2_41];

Cc = [1 0 0 0];
Dc = [0 0];


%% Discretize continous model using zero order hold on the inputs
% anda sample of Ts seconds

nx = 4;
nu = 2;

M = expm([[Ac Bc]*Ts; zeros(nu, nx+nu)]);

A = M(1:nx, 1:nx);
B = M(1:nx, nx+1:nx+nu);
C = Cc;
D = Dc;


X = x;
U = u;
Y = (C*x + D*u);
DX = (A*x+B*u) - x;
```

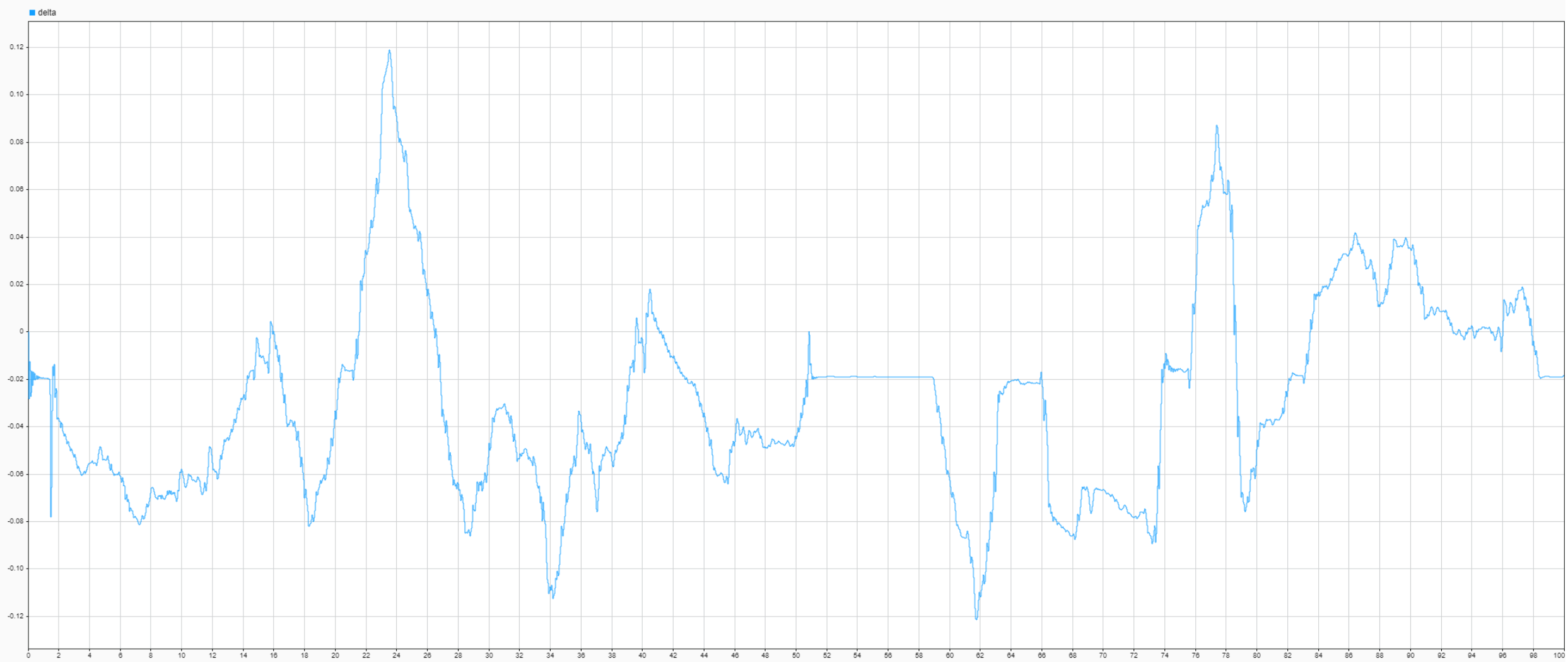
RESULTS

Video Link: https://www.youtube.com/watch?v=0tQecIS5ofY

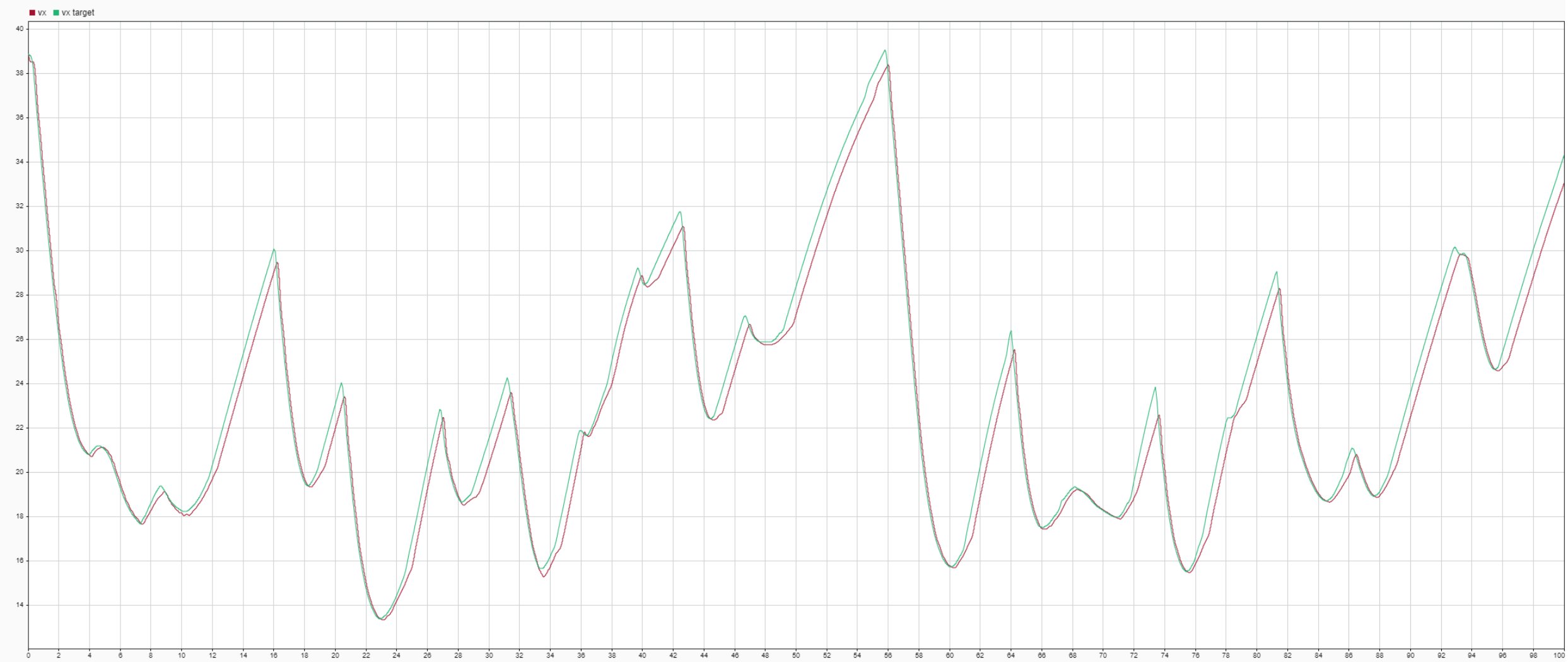
TRACKING PERFORMANCE



DELTA (STEERING ANGLE (RAD))

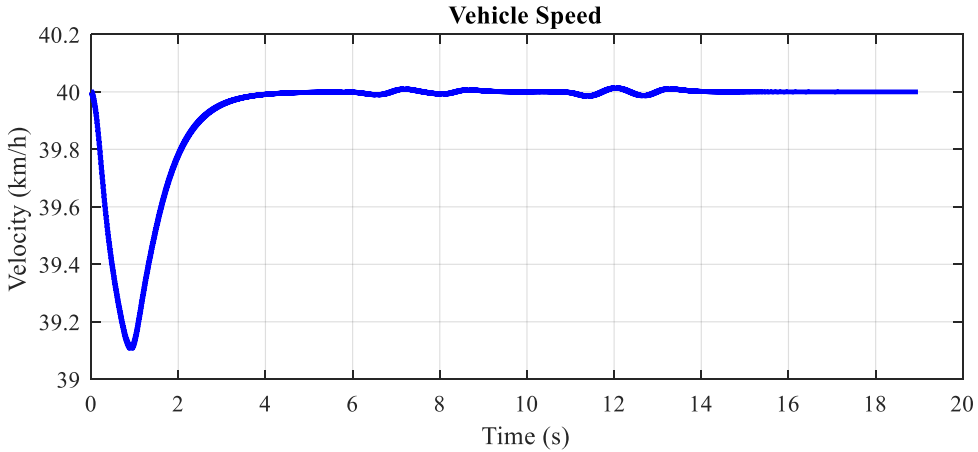


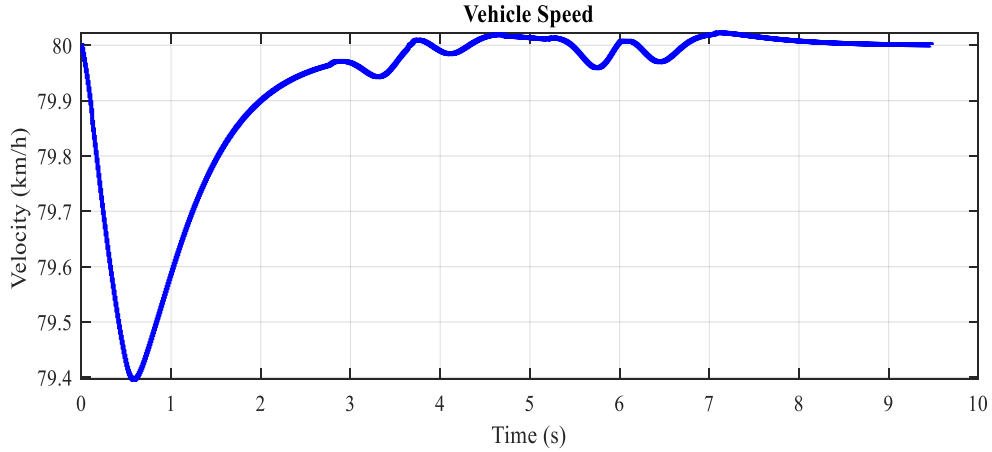
VELOCITY TRACKING (M/S)

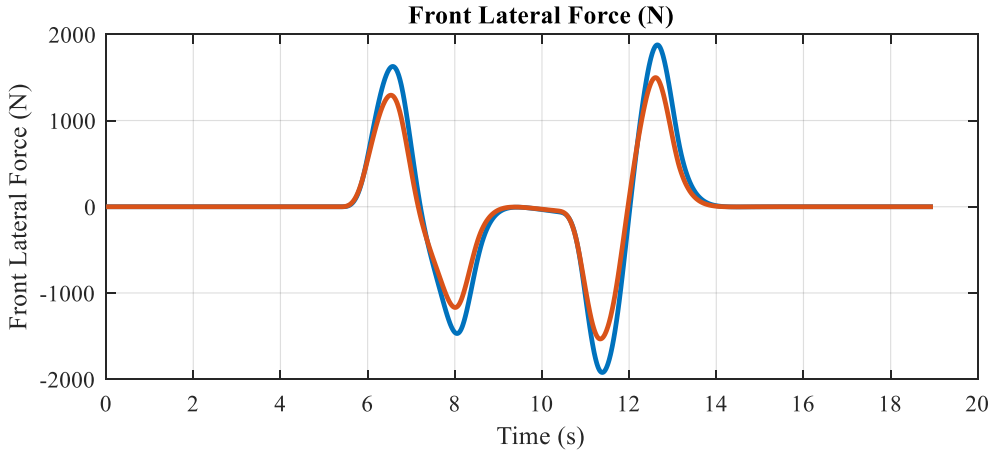


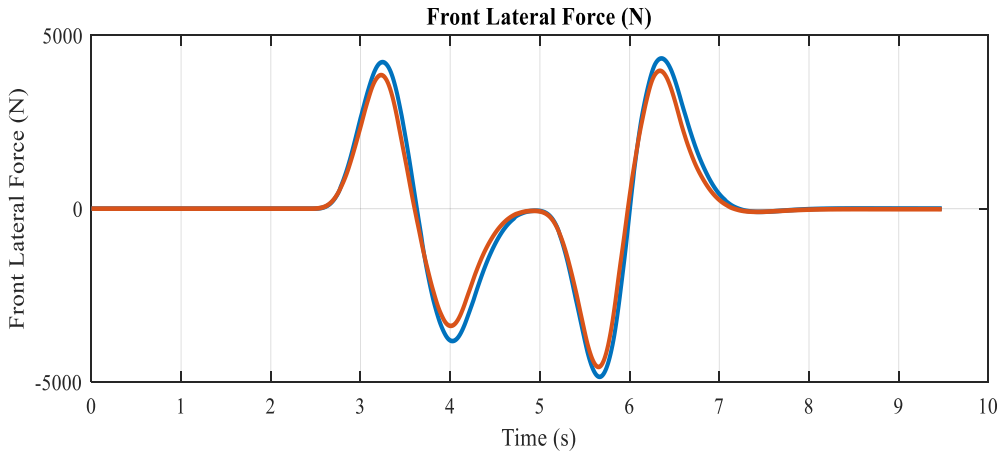
THROTTLE & BRAKE (NO SIGN, NORMALIZED)

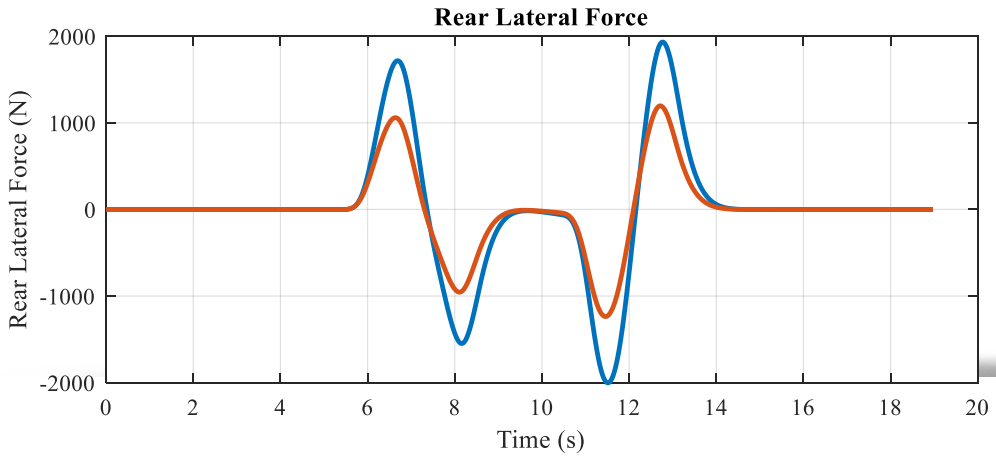
LATERAL DEVIATION FROM PATH (M)

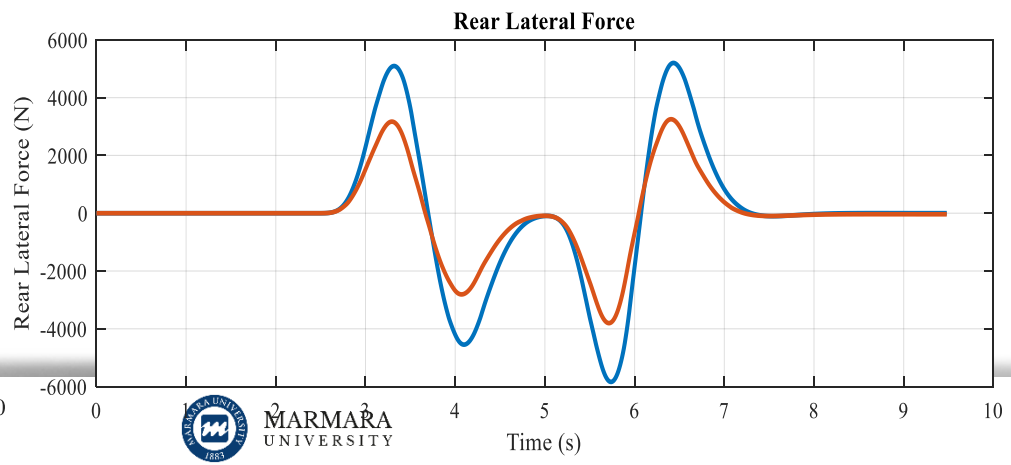

Vehicle Speed
Velocity (km/h)
Time (s)

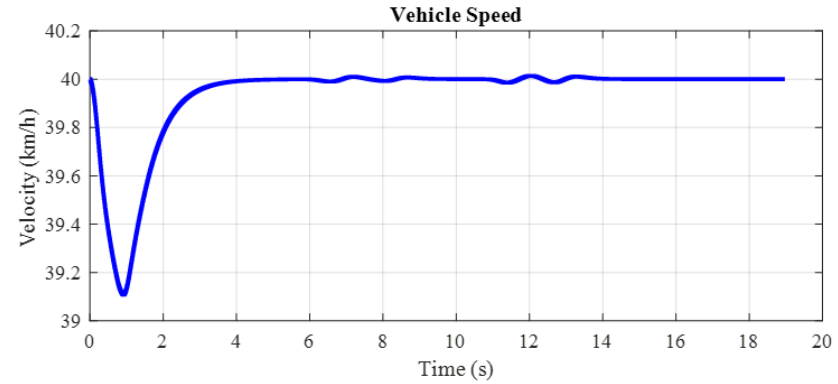

Vehicle Speed
Velocity (km/h)
Time (s)

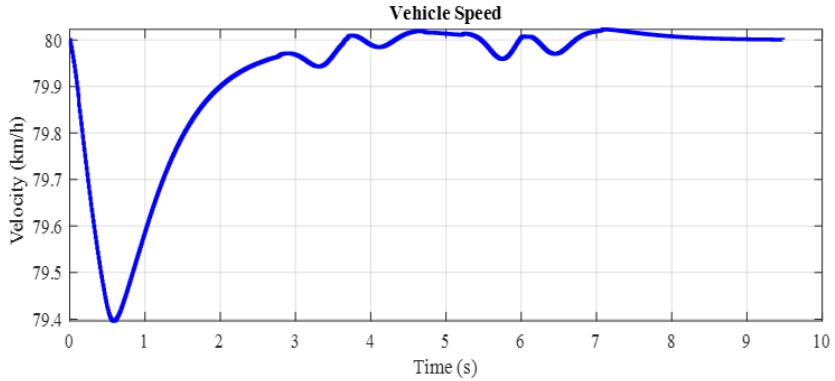

Front Lateral Force (N)
Front Lateral Force (N)
Time (s)

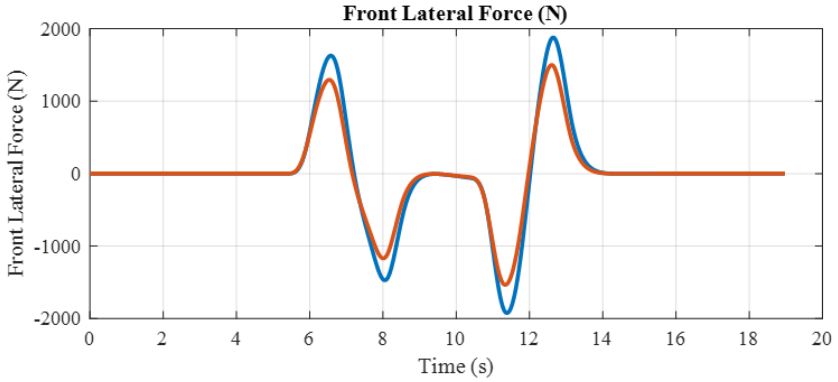

Front Lateral Force (N)
Front Lateral Force (N)
Time (s)

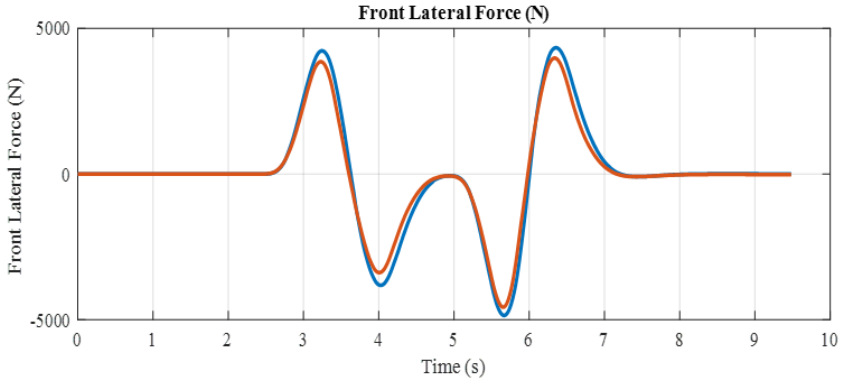

Rear Lateral Force
Rear Lateral Force (N)
Time (s)

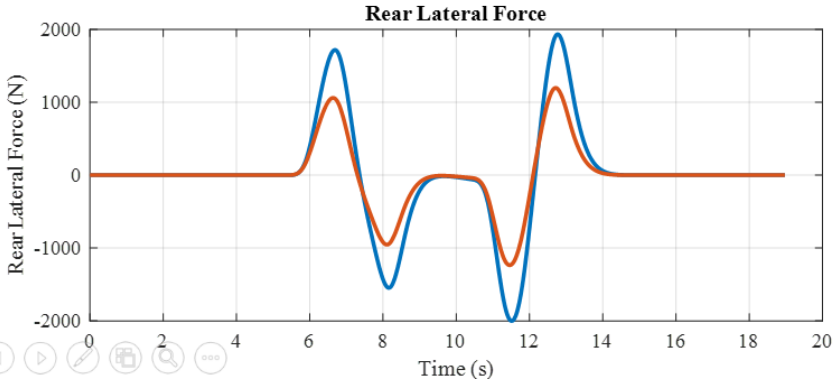

Rear Lateral Force
Rear Lateral Force (N)
Time (s)

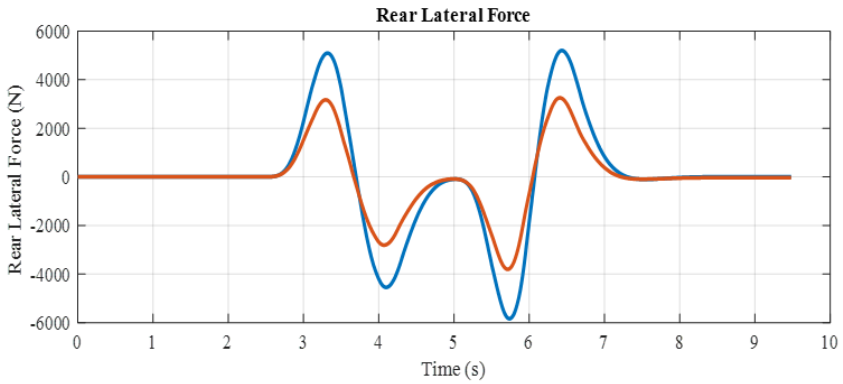

Vehicle Speed
Velocity (km/h)
Time (s)

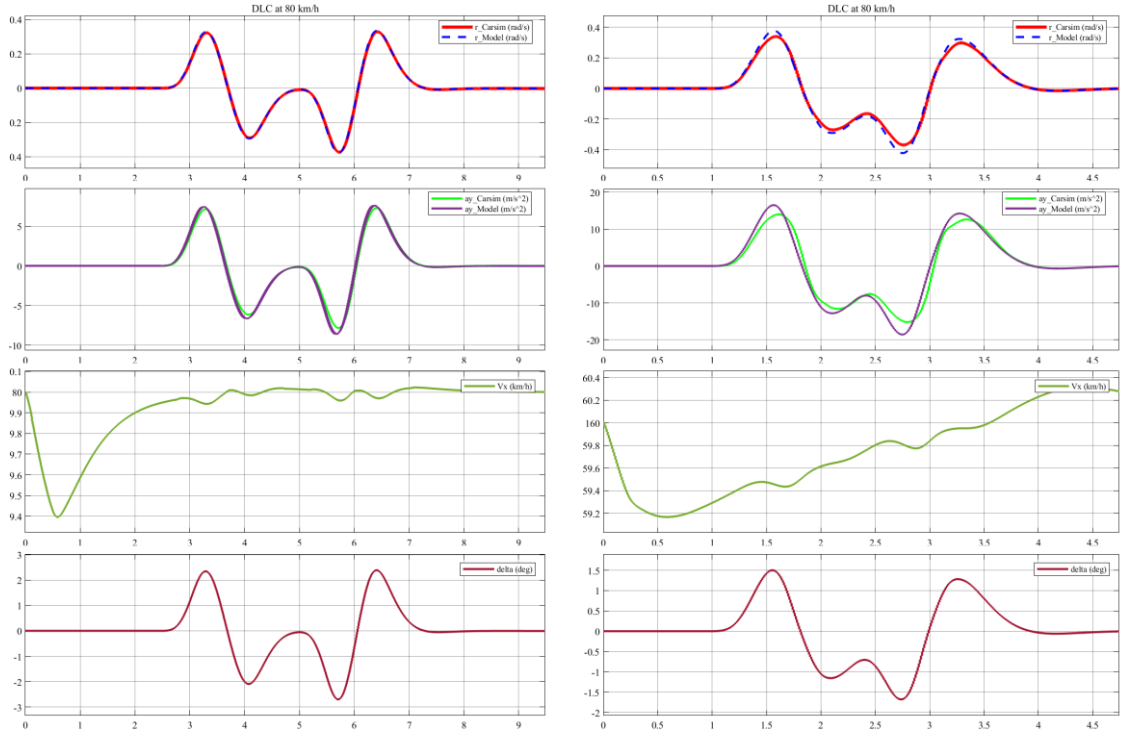

Vehicle Speed
Velocity (km/h)
Time (s)


Front Lateral Force (N)
Front Lateral Force (N)
Time (s)

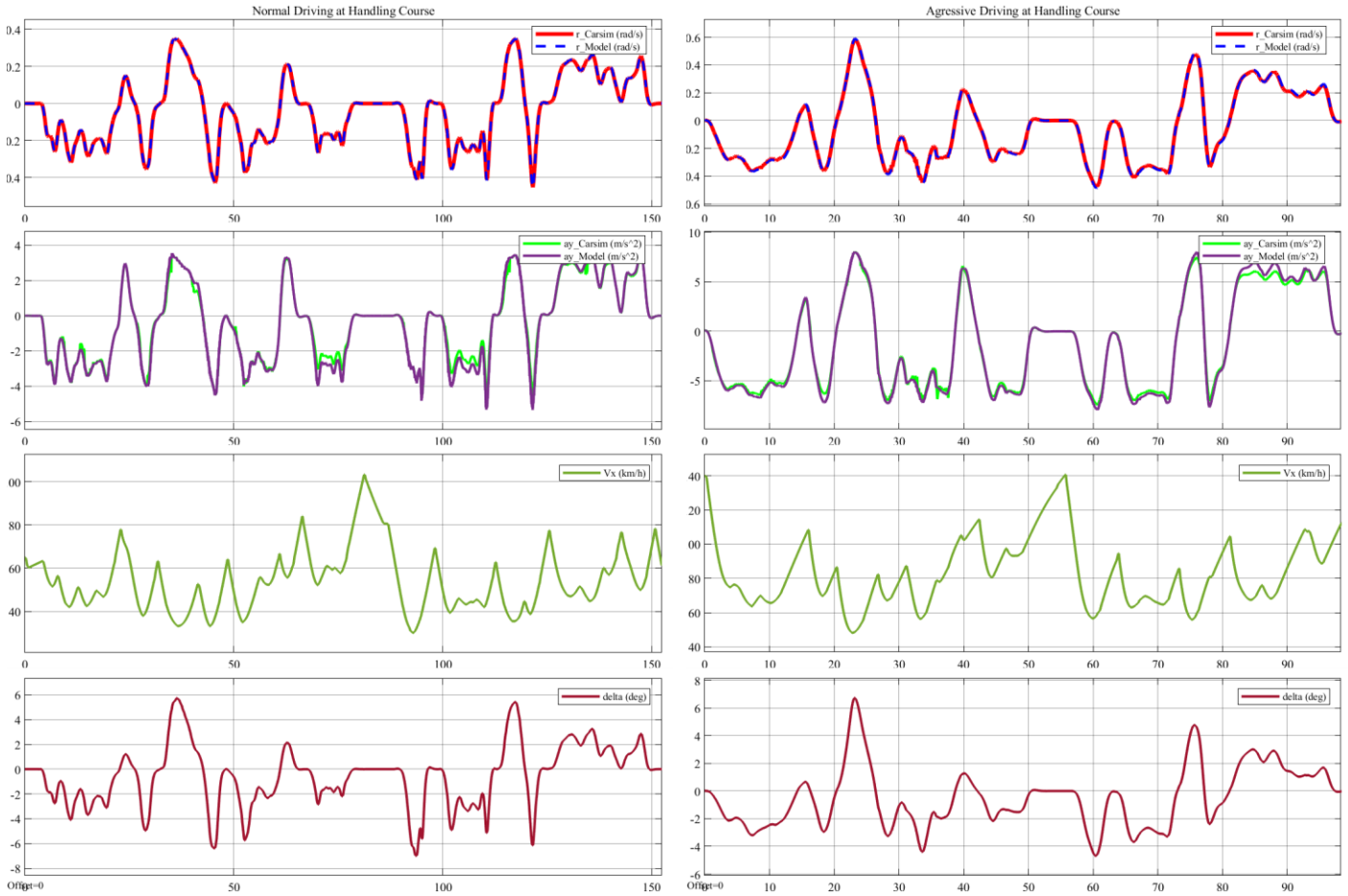

Front Lateral Force (N)
Front Lateral Force (N)
Time (s)

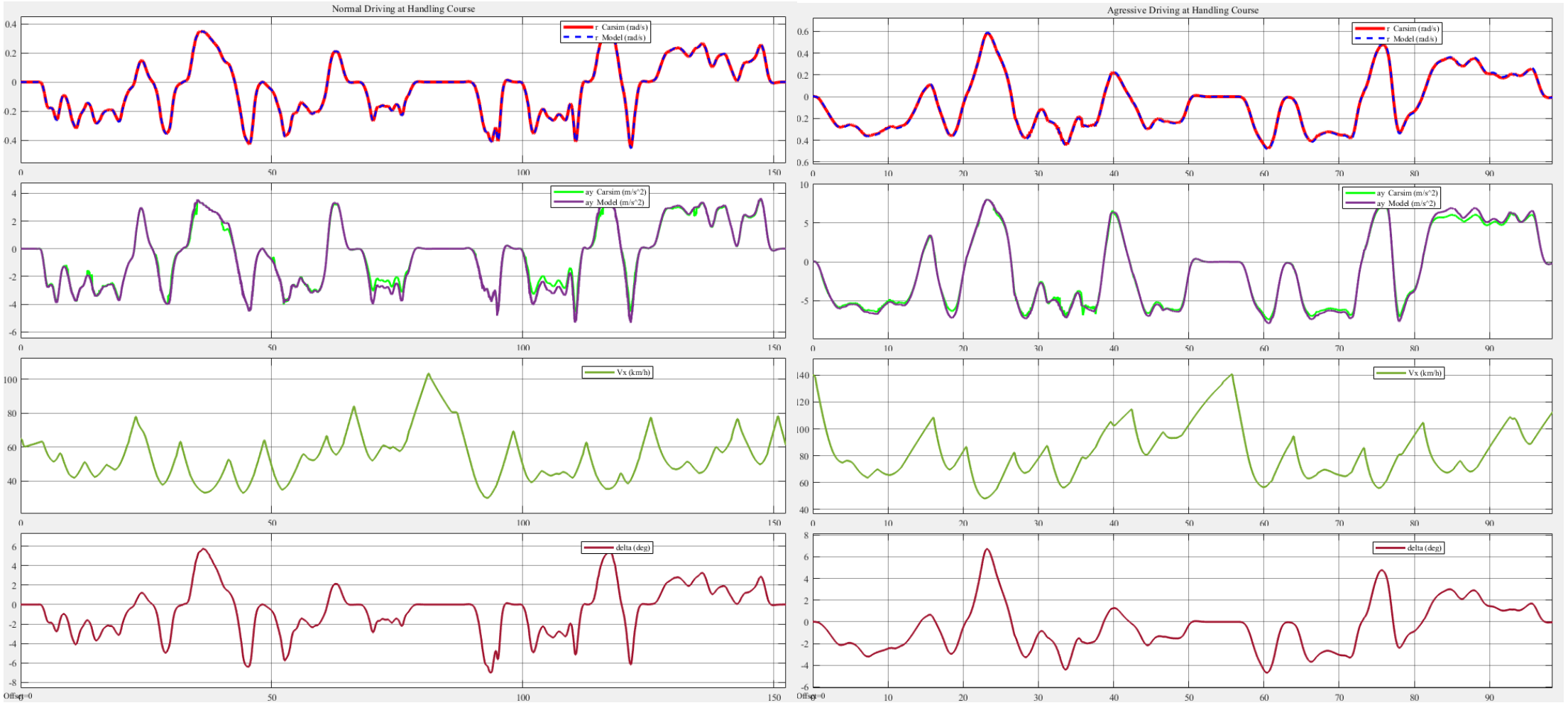

Rear Lateral Force
Rear Lateral Force (N)
Time (s)


Rear Lateral Force
Rear Lateral Force (N)
Time (s)

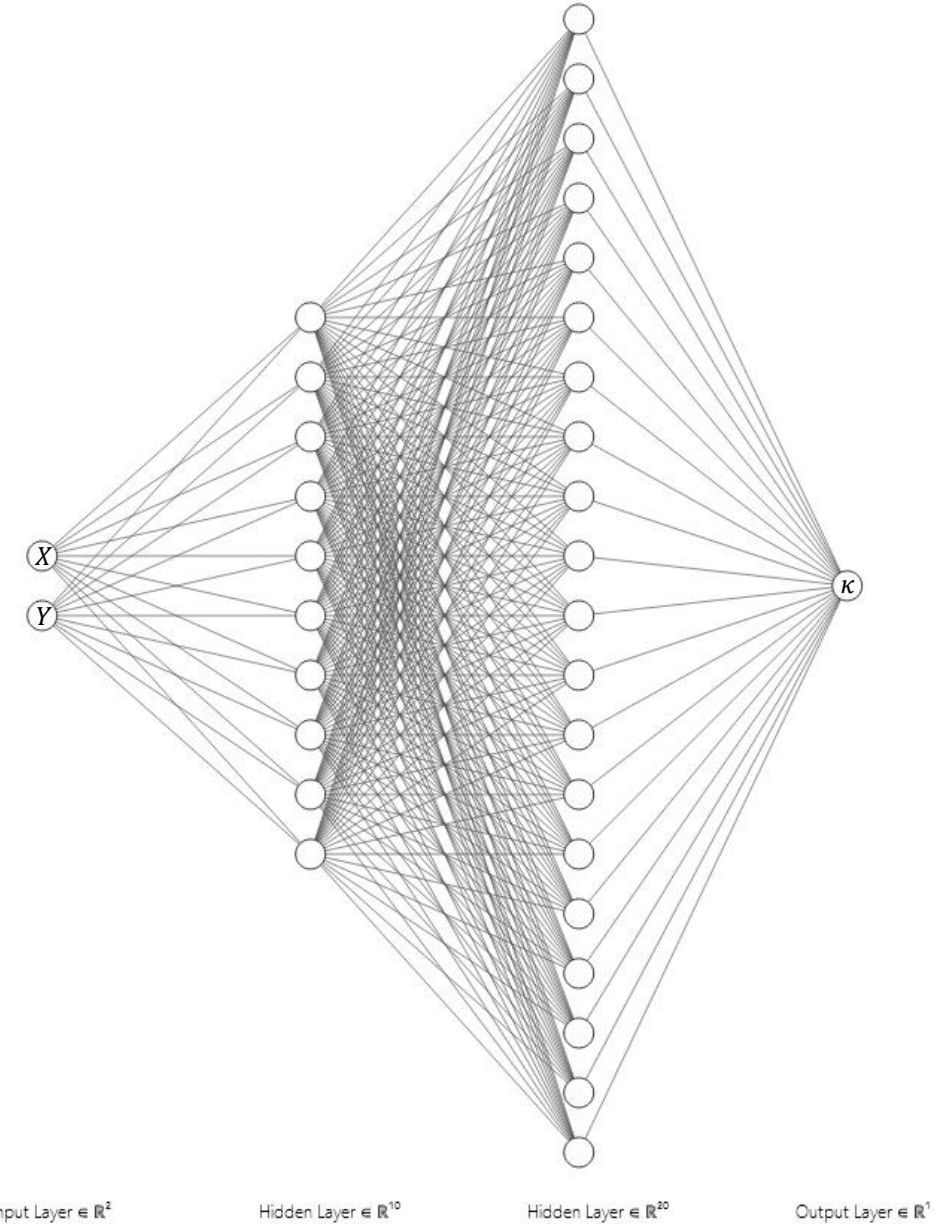

DLC at 80 km/h
r_Carsim (rad/s)
r_Model (rad/s)
ay_Carsim (m/s^2)
ay_Model (m/s^2)
Vx (km/h)
delta (deg)

DLC at 80 km/h
r_Carsim (rad/s)
r_Model (rad/s)
ay_Carsim (m/s^2)
ay_Model (m/s^2)
Vx (km/h)
delta (deg)

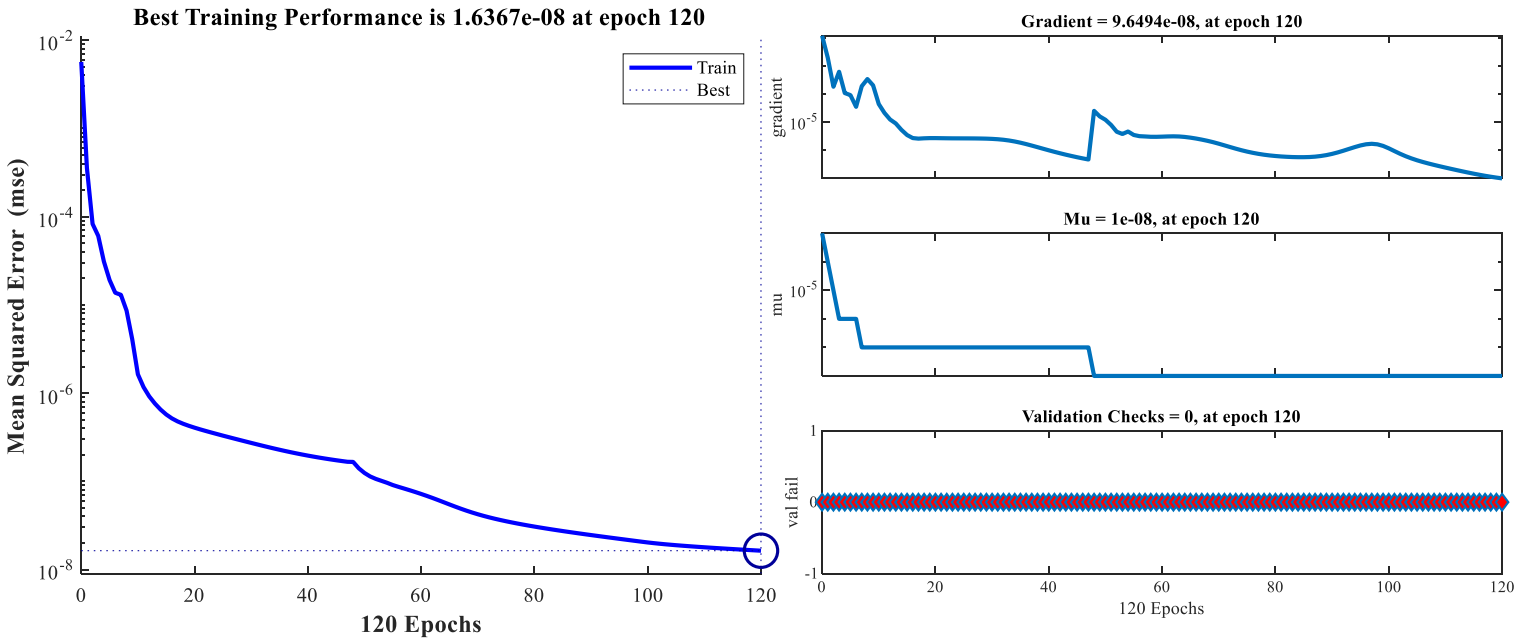

Normal Driving at Handling Course
r_Carsim (rad/s)
r_Model (rad/s)
ay_Carsim (m/s^2)
ay_Model (m/s^2)
Vx (km/h)
delta (deg)
Offset=0
Agressive Driving at Handling Course
r_Carsim (rad/s)
r_Model (rad/s)
ay_Carsim (m/s^2)
ay_Model (m/s^2)
Vx (km/h)
delta (deg)
Offset=0

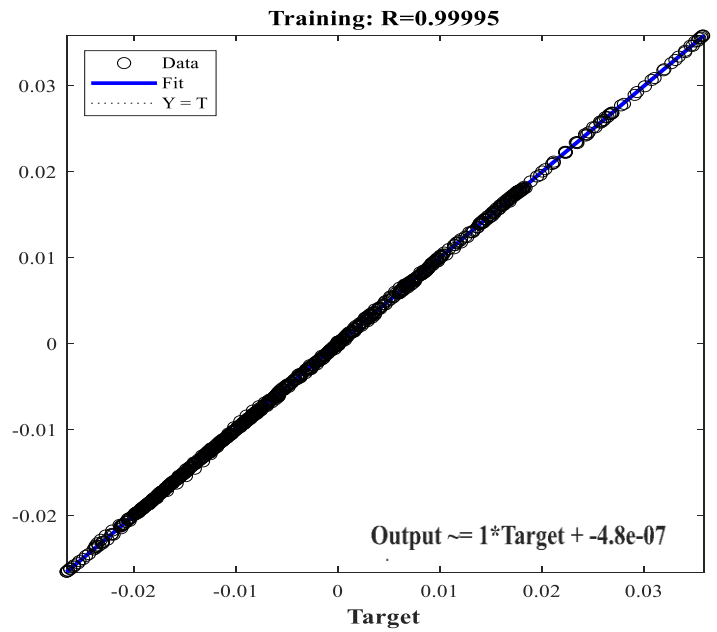

Normal Driving at Handling Course
r Carsim (rad/s)
r Model (rad/s)
ay Carsim (m/s^2)
ay Model (m/s^2)
Vx (km/h)
delta (deg)
Offset=0
Agressive Driving at Handling Course
r Carsim (rad/s)
r Model (rad/s)
ay Carsim (m/s^2)
ay Model (m/s^2)
Vx (km/h)
delta (deg)
Offset=0

Curvature estimation network

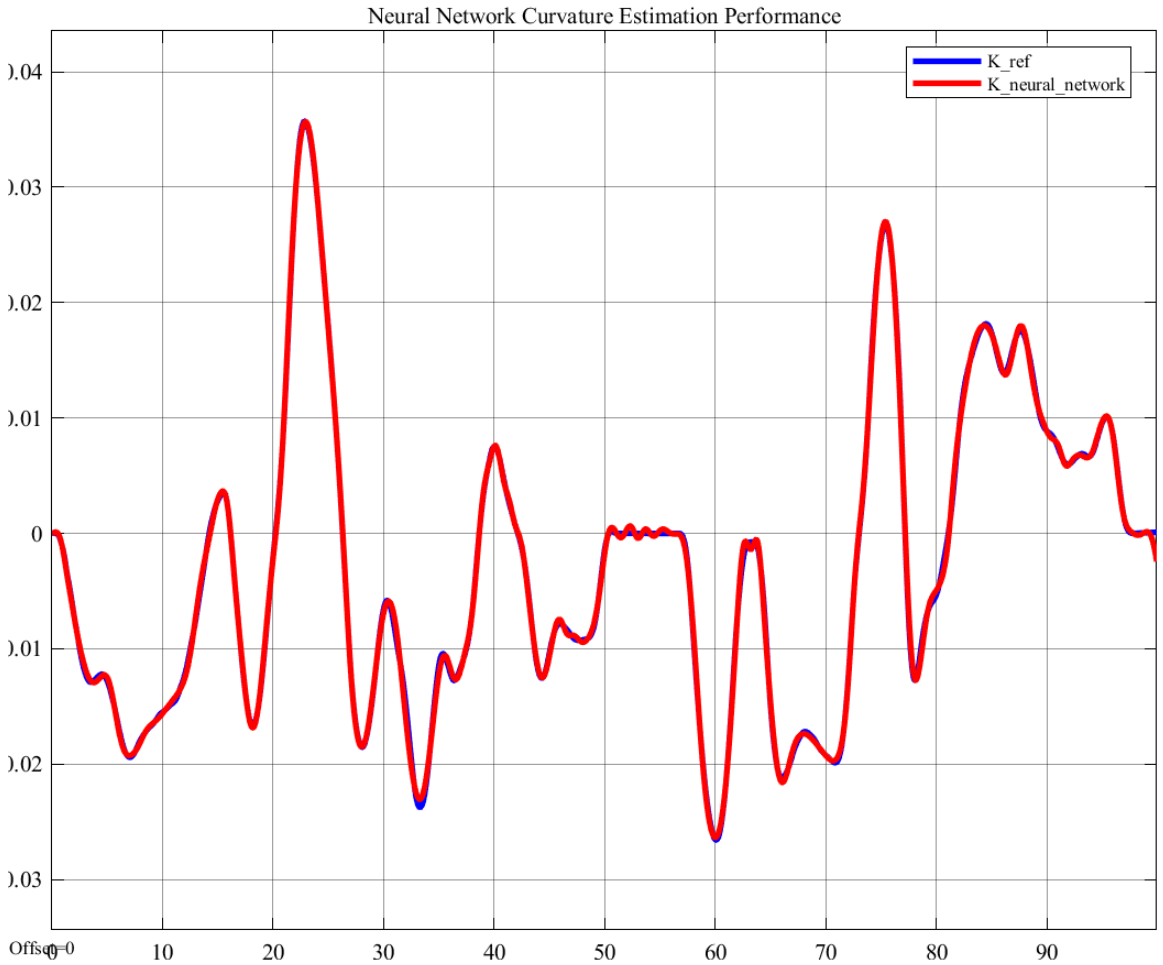


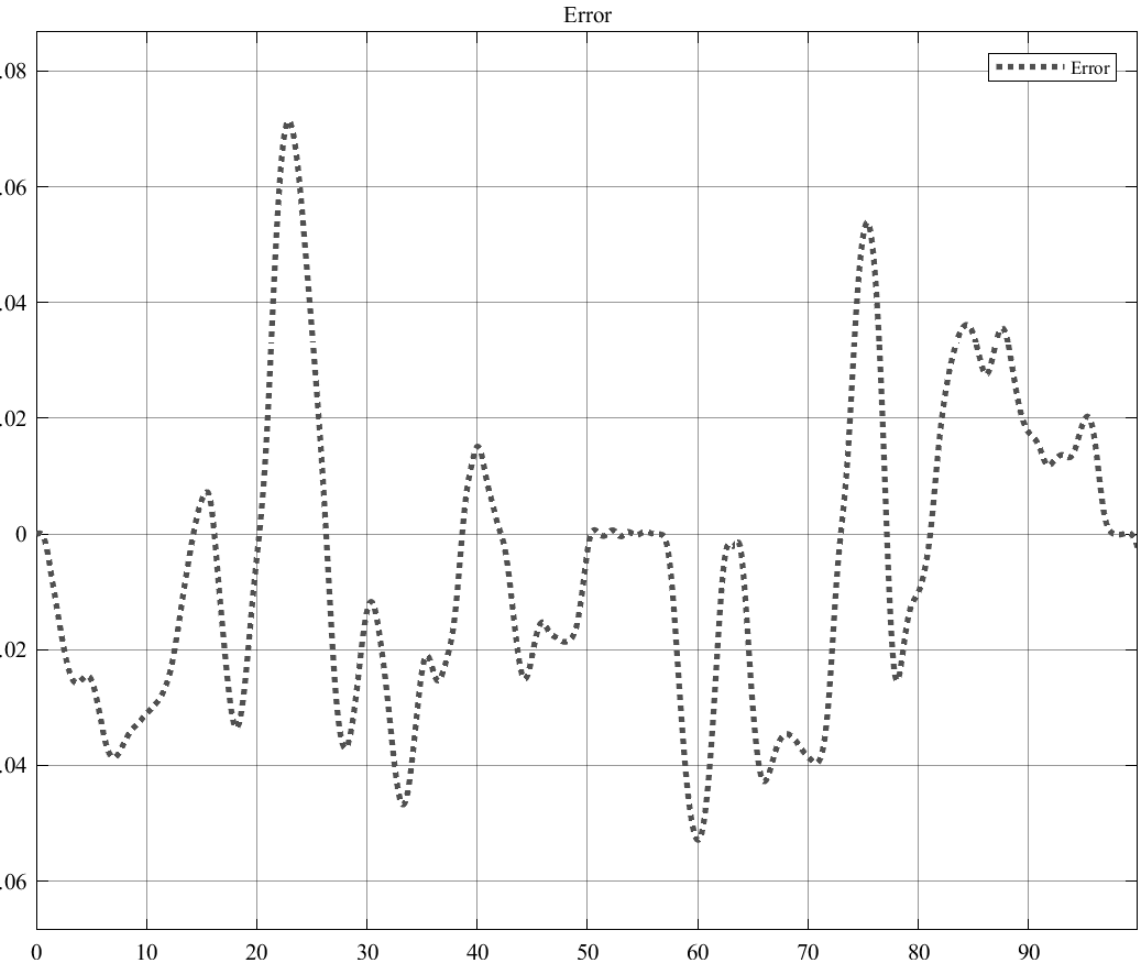
Results for curvature estimaton network

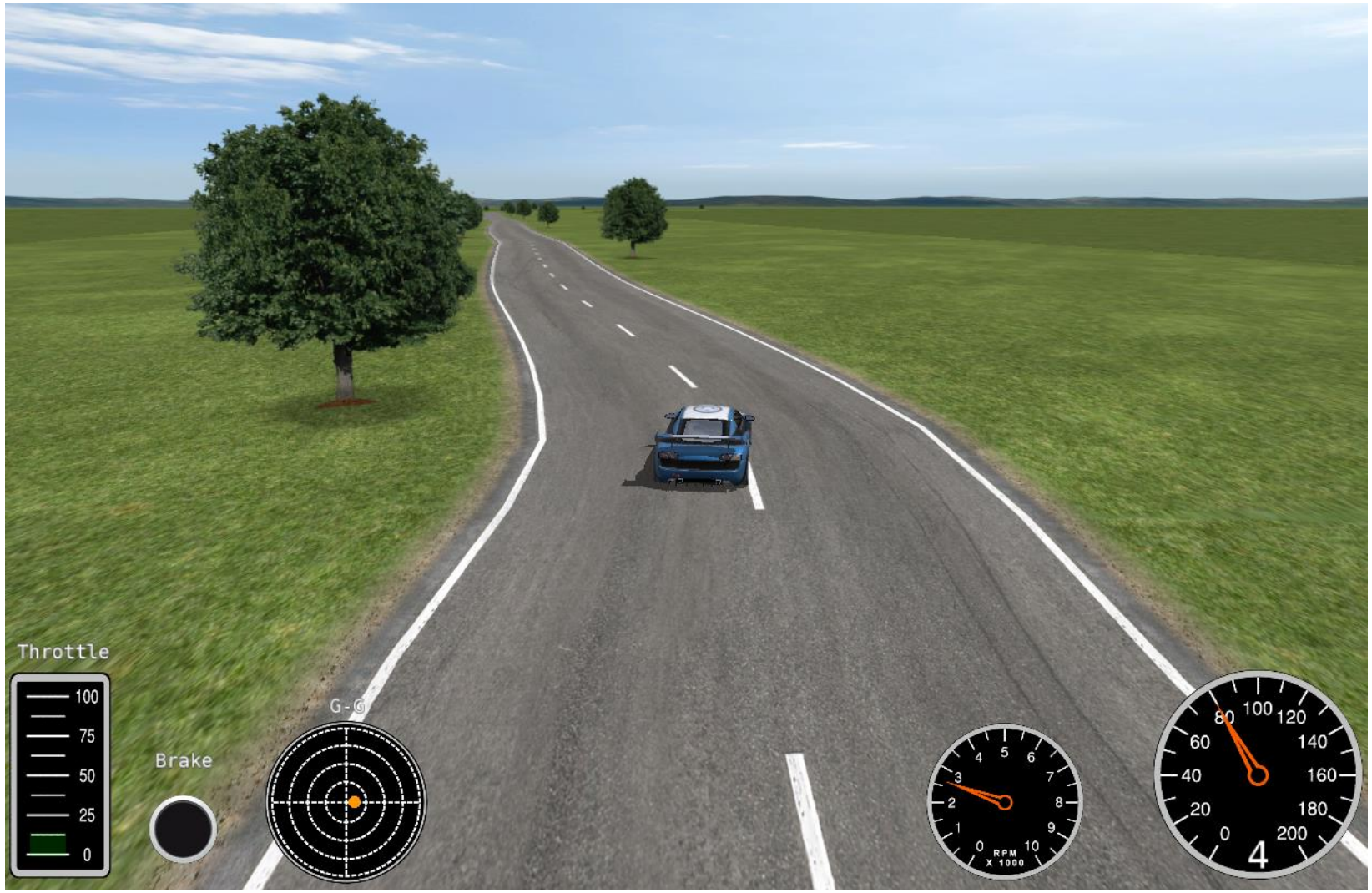


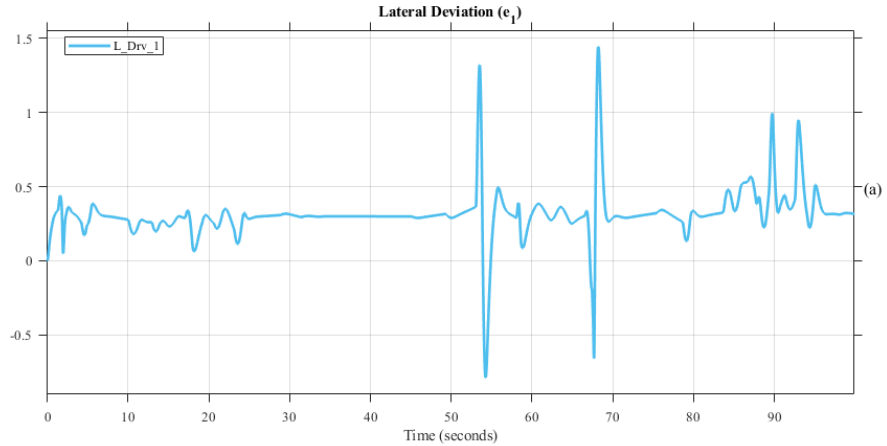


Results for curvature estimaton network

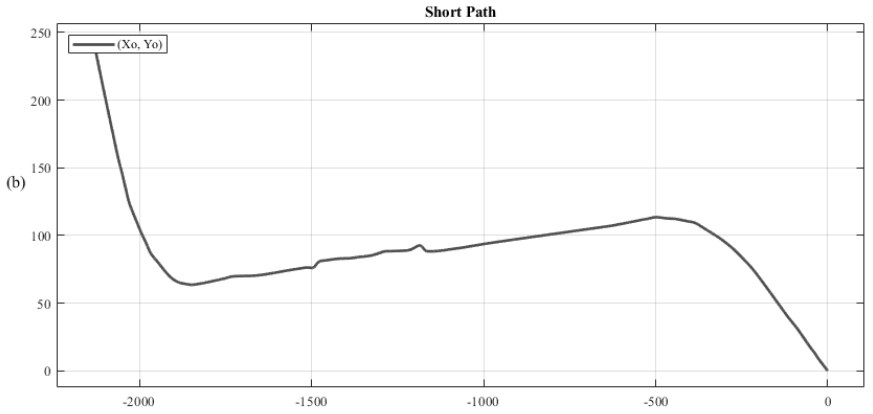




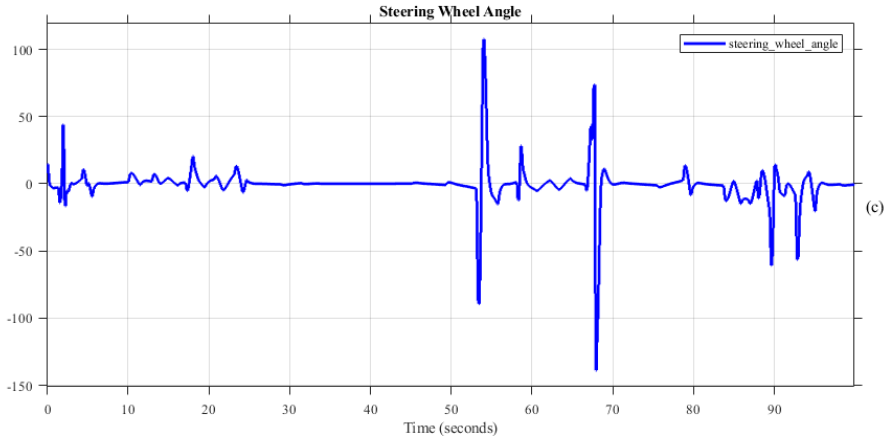

Throttle
100
75
50
25
0
Brake
G-G
RPM
X 1000
0
1
2
3
4
5
6
7
8
9
10
0
20
40
60
80
100
120
140
160
180
200
4


Lateral Deviation (e_1)
L_Drv_1
1.5
1
0.5
0
-0.5
0
10
20
30
40
50
60
70
80
90
Time (seconds)

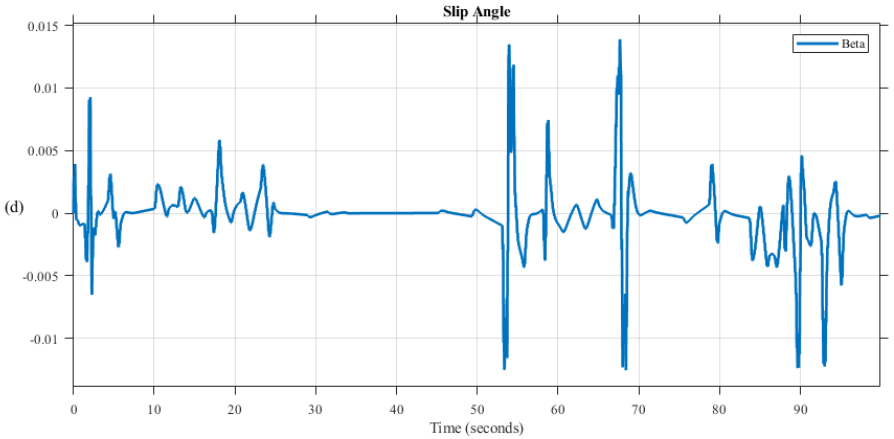
(a)


Short Path
(Xo, Yo)
250
200
150
100
50
0
-2000
-1500
-1000
-500
0

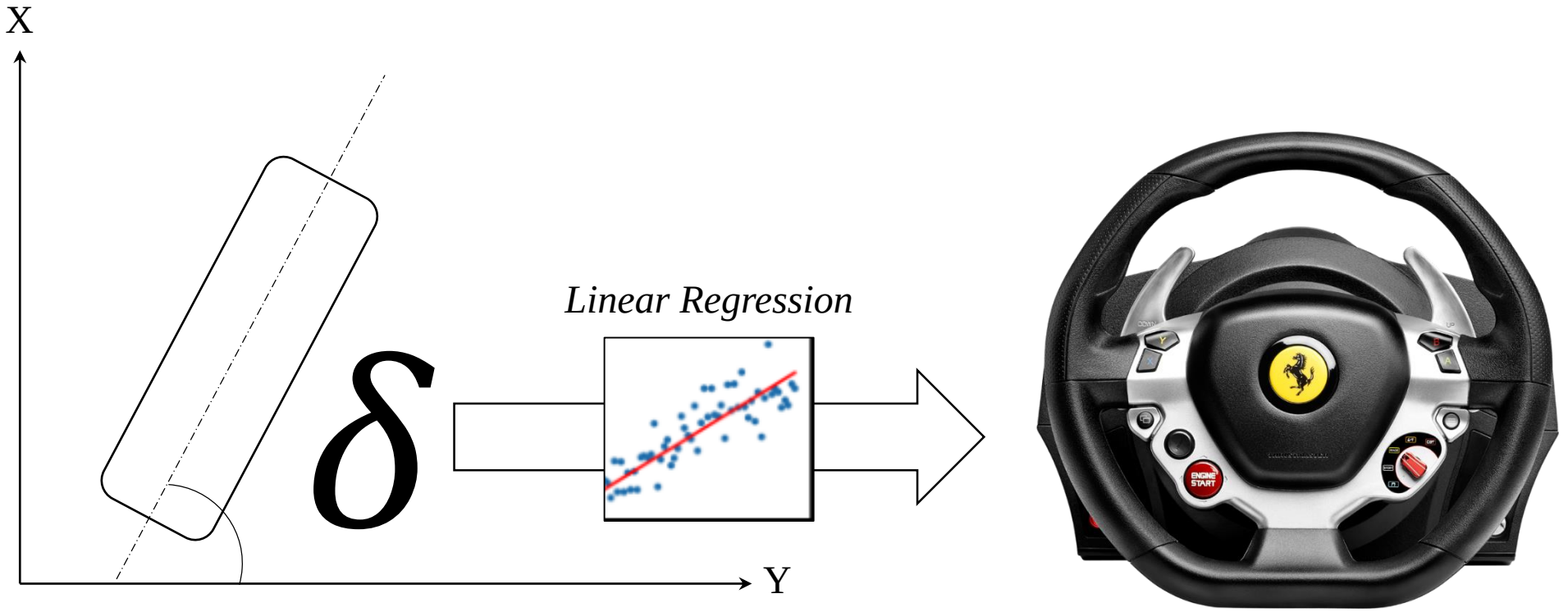
(b)


Steering Wheel Angle
steering_wheel_angle
100
50
0
-50
-100
-150
0
10
20
30
40
50
60
70
80
90
Time (seconds)

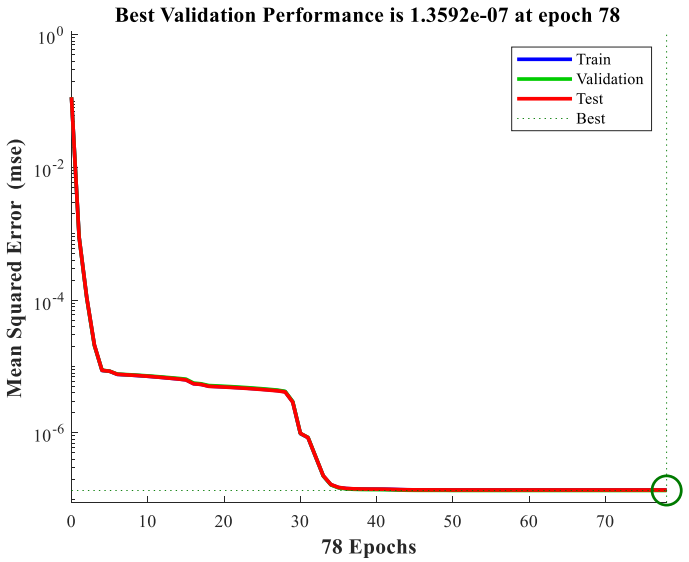
(c)

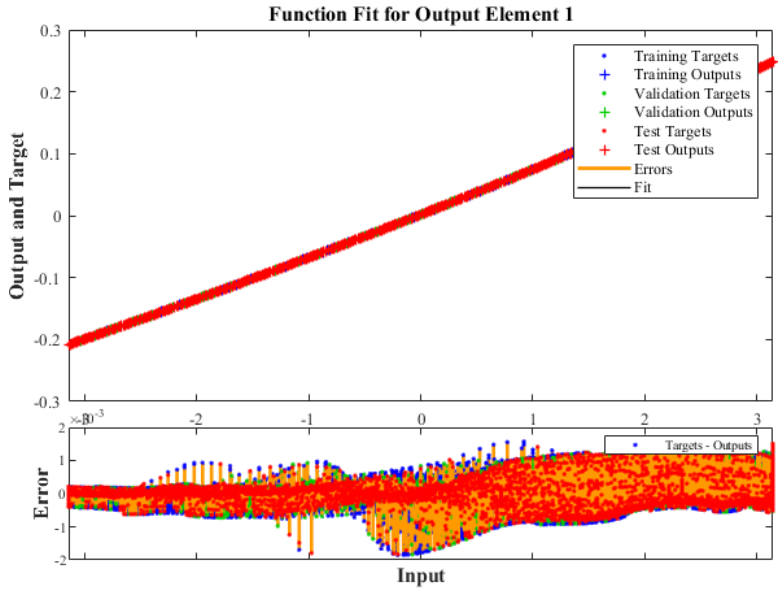

Slip Angle
Beta
0.015
0.01
0.005
0
-0.005
-0.01
0
10
20
30
40
50
60
70
80
90
Time (seconds)

(d)


X
δ
Linear Regression
Y

STEERIN TO WHEELS NEURAL NETWORK RESULTS





STEERIN TO WHEELS NEURAL NETWORK RESULTS