%% Load data

% bag = rosbag('C:\Users\jknaup3\Downloads\beta\_autorally7\_2019-07-19-10-43-36.bag');

% bag = rosbag('C:\Users\jknaup3\Downloads\beta\_autorally7\_2019-07-24-09-49-15.bag');

bag = rosbag('C:\Users\jknaup3\Downloads\beta\_autorally4\_2018-03-29-15-34-10\_split0.bag');

% bag = rosbag('C:\Users\jknaup3\Downloads\beta\_autorally4\_2018-03-29-11-57-43.bag');

% chassis\_states = select(bag, 'Topic', '/chassisState');

% [chassis\_state\_ts, chassis\_state\_cols] = timeseries(chassis\_states);

% wheel\_odoms = select(bag, 'Topic', '/wheel\_odom');

% [wheel\_odom\_ts, wheel\_odom\_cols] = timeseries(wheel\_odoms);

wheel\_speeds = select(bag, 'Topic', '/wheelSpeeds');

[wheel\_speed\_ts, wheel\_speed\_cols] = timeseries(wheel\_speeds);

poses = select(bag, 'Topic', '/pose\_estimate');

[pose\_ts, pose\_cols] = timeseries(poses);

imu = select(bag, 'Topic', 'imu/imu');

[imu\_ts, imu\_cols] = timeseries(imu);

% CA = select(bag, 'Topic', '/MAP\_CA/mapCA');

% [CA\_ts, CA\_cols] = timeseries(CA);

chassis = select(bag, 'Topic', '/chassisState');

[chassis\_ts, chassis\_cols] = timeseries(chassis);

%% Map CA

Rw=0.359;

wheel\_radius = 0.095;

vx = CA\_ts.Data(:,1);

vy = CA\_ts.Data(:,2);

wF = CA\_ts.Data(:,3) / wheel\_radius;

wR = CA\_ts.Data(:,4) / wheel\_radius;

wz = CA\_ts.Data(:,5);

s\_raw = CA\_ts.Data(:,6);

lap = CA\_ts.Data(:,14);

track\_length = CA\_ts.Data(1,16);

s = s\_raw + lap \* track\_length - lap(1)\*track\_length; %- s\_raw(1)

ey = CA\_ts.Data(:,7);

epsi = CA\_ts.Data(:,8);

X = CA\_ts.Data(:,11);

Y = CA\_ts.Data(:,12);

Yaw = CA\_ts.Data(:,13);

Yaw = unwrap(Yaw);

time\_ca = CA\_ts.Time - CA\_ts.Time(1);

curvature = CA\_ts.Data(:,9);

% figure;

% subplot(4,2,1);

% plot(time\_ca, vx);

% subplot(4,2,2);

% plot(time\_ca, vy);

% subplot(4,2,3);

% plot(time\_ca, wz);

% subplot(4,2,4);

% plot(time\_ca, wF);

% subplot(4,2,5);

% plot(time\_ca, wR);

% subplot(4,2,6);

% plot(time\_ca, epsi);

% subplot(4,2,7);

% plot(time\_ca, ey);

% subplot(4,2,8);

% plot(time\_ca, s);

% plot(CA\_ts.Data(:,11), CA\_ts.Data(:,12), '.')

%% Control

steering = -pi / 180 \* chassis\_ts.Data(:,1);

throttle = chassis\_ts.Data(:,2);

% time\_chassis = chassis\_ts.Time - CA\_ts.Time(1);

% figure;

% plot(time\_chassis, steering);

% hold on

% plot(time\_chassis, throttle);

% hold off

%% acceleration

a\_x = imu\_ts.Data(:, 11);

a\_y = imu\_ts.Data(:, 12);

a\_z = imu\_ts.Data(:, 13);

% time\_imu = imu\_ts.Time - CA\_ts.Time(1);

%% others

wheel\_radius = 0.095;

wF = (wheel\_speed\_ts.Data(:,1) + wheel\_speed\_ts.Data(:,2)) / 2 / wheel\_radius;

wR = (wheel\_speed\_ts.Data(:,3) + wheel\_speed\_ts.Data(:,4)) / 2 / wheel\_radius;

X = pose\_ts.Data(:, 4);

Y = pose\_ts.Data(:, 5);

wz = pose\_ts.Data(:,16);

quats = pose\_ts.Data(:,7:10);

euls = quat2eul(quats);

PitchAngle = abs(euls(:,1))-pi;

RollAngle = euls(:,2);

YawAngle = euls(:,3);

Yaw = unwrap(YawAngle) + 2\*pi;

% Yaw = YawAngle;

vx = pose\_ts.Data(:,11).\*cos(Yaw)+pose\_ts.Data(:,12).\*sin(Yaw);

vy = pose\_ts.Data(:,11).\*-sin(YawAngle)+pose\_ts.Data(:,12).\*cos(YawAngle);

time\_pose = pose\_ts.Time - pose\_ts.Time(1);

time\_ca = time\_pose;

time\_imu = imu\_ts.Time - pose\_ts.Time(1);

time\_wheel\_speed = wheel\_speed\_ts.Time - pose\_ts.Time(1);

time\_chassis = chassis\_ts.Time - pose\_ts.Time(1);

%% resample

tf=floor(max([time\_ca(end), time\_chassis(end), time\_wheel\_speed(end), time\_imu(end)]));

ti = floor(min([time\_ca(1), time\_chassis(1), time\_wheel\_speed(1), time\_imu(1)]));

tf = tf-ti;

dt=0.001;

t3=( 0:dt:tf )';

lth=length(t3);

mthd='pchip';

vx=interp1(time\_ca,vx,t3,mthd);

vy=interp1(time\_ca,vy,t3,mthd);

wz=interp1(time\_ca,wz,t3,mthd);

wF=interp1(time\_wheel\_speed,wF,t3,mthd);

wR=interp1(time\_wheel\_speed,wR,t3,mthd);

% epsi=interp1(time\_ca,epsi,t3,mthd);

% ey=interp1(time\_ca,ey,t3,mthd);

% s=interp1(time\_ca,s,t3,mthd);

X=interp1(time\_ca,X,t3,mthd);

Y=interp1(time\_ca,Y,t3,mthd);

Yaw=interp1(time\_ca,Yaw,t3,mthd);

% curvature=interp1(time\_ca,curvature,t3,'nearest');

% curvature(isnan(curvature)) = 0;

steering=interp1(time\_chassis,steering,t3,mthd);

throttle=interp1(time\_chassis,throttle,t3,mthd);

a\_x=interp1(time\_imu,a\_x,t3,mthd);

a\_y=interp1(time\_imu,a\_y,t3,mthd);

a\_z=interp1(time\_imu,a\_z,t3,mthd);

% steering=medfilt1(steering,200);

% throttle=medfilt1(throttle,500);

wz=medfilt1(wz, 500);

wF=medfilt1(wF,500);

wR=medfilt1(wR,500);

vx=medfilt1(vx,500);

vy=medfilt1(vy,500);

a\_x=medfilt1(a\_x,500);

a\_y=medfilt1(a\_y,200);

a\_z=medfilt1(a\_z,1000);

%%

N=2000;

figure;

subplot(4,2,1);

plot(t3(N:end-1000), vx(N:end-1000));

legend('True vx','Simulated vx');

subplot(4,2,2);

plot(t3(N:end-1000), vy(N:end-1000));

legend('True vy','Simulated vy');

subplot(4,2,3);

plot(t3(N:end-1000), wz(N:end-1000));

legend('True wz','Simulated wz');

subplot(4,2,4);

plot(t3(N:end-1000), wF(N:end-1000));

legend('True wF','Simulated wF');

subplot(4,2,5);

plot(t3(N:end-1000), wR(N:end-1000));

legend('True wR','Simulated wR');

subplot(4,2,6);

plot(t3(N:end-1000), Yaw(N:end-1000));

legend('True Yaw','Simulated Yaw');

subplot(4,2,7);

plot(t3(N:end-1000), X(N:end-1000));

legend('True X','Simulated X');

subplot(4,2,8);

plot(t3(N:end-1000), Y(N:end-1000));

legend('True Y','Simulated Y');

figure;

plot(t3, steering);

hold on

plot(t3, throttle);

hold on

%%

states = [vx'; vy'; wz'; wF'; wR'; Yaw'; X'; Y'];

inputs = [steering'; throttle'];

%%

subplot(4,2,1);

legend('True vx','Simulated vx');

xlabel('t (s)');

ylabel('m/s')

subplot(4,2,2);

legend('True vy','Simulated vy');

xlabel('t (s)');

ylabel('m/s');

subplot(4,2,3);

legend('True wz','Simulated wz');

xlabel('t (s)');

ylabel('rad/s');

subplot(4,2,4);

legend('True wF','Simulated wF');

xlabel('t (s)');

ylabel('rad/s');

subplot(4,2,5);

legend('True wR','Simulated wR');

xlabel('t (s)');

ylabel('rad/s');

subplot(4,2,6);

legend('True Yaw','Simulated Yaw');

xlabel('t (s)');

ylabel('rad');

subplot(4,2,7);

legend('True X','Simulated X');

xlabel('t (s)');

ylabel('m');

subplot(4,2,8);

legend('True Y','Simulated Y');

xlabel('t (s)');

ylabel('m');

%% acceleration plotting

% figure;

% subplot(2,2,1);

% plot(t3(N:end-1000), a\_x(N:end-1000));

% subplot(2,2,2);

% plot(t3(N:end-1000), a\_y(N:end-1000));

% subplot(2,2,3);

% plot(t3(N:end-1000), a\_z(N:end-1000));

a = [a\_x'; a\_y'; a\_z'];

% forces = medfilt1(forces,500);

figure;

subplot(2, 1, 1);

hold on

plot(t3(N:end-1000), a(1, N:end-1000))

forces(1, :)=medfilt1(forces(1,:),200);

forces(4, :)=medfilt1(forces(2,:),200);

% plot(t3(N:end-1000), forces(1, N:end-1000) + forces(4, N:end-1000))

plot(t3(N:end-1000), forces(7, N:end-1000))

legend('m\*a\_x', 'f\_x')

xlabel('t (s)')

ylabel('F (N)')

subplot(2, 1, 2);

hold on

forces(2, :)=medfilt1(forces(2,:),200);

forces(5, :)=medfilt1(forces(5,:),200);

plot(t3(N:end-1000), -a(2, N:end-1000))

% plot(t3(N:end-1000), forces(2, N:end-1000) + forces(5, N:end-1000))

plot(t3(N:end-1000), forces(8, N:end-1000));

legend('m\*a\_y', 'f\_y')

xlabel('t (s)')

ylabel('F (N)')