Path Planning Project

The first project of Term 3, Path planning, was a challenging one as it tested our understanding of many of the concepts taught on class even from Term 2. The goal of this project is to estimate and plan our path on a highway with vehicles around us. Many parameters are checked continuously like acceleration, jerk, speed, lane distance, distance from other vehicles to make sure the car does not make any unwanted maneuvers resulting in collision. To make the ride comfortable, jerk and acceleration are always kept in check to make the ride as smooth as possible.

We receive the sensor information from the simulator which tells us the various parameters of the cars in our side of the road. The trajectory of the car is basically a set of points, 50 in our case and spaced at 0.02 secs apart in time.

The car has adhered to all the rules (jerk,acceleration,speed,lane keeping/changing) and drives at least 4.5 miles without any incident

Implementation Details:

We can separate our implementation details into separate categories

1. Get sensor data from surrounding cars/Estimation
   In order to drive safely, we need an estimate of surrounding moving objects(in our case, just the cars on our side of the road). We get each cars speed, frenet coordinates,vx and vy from the sensor. This information helps us to make sure we do not get too close to any vehicle. Lines 281-284 accomplish this.

2. Plan behavior based on sensor information
   Once we get the information regarding various parameters of each car, we decide which lane is the safes for us to be in. If we have a car in front of us, we can either move right or left if changing lanes is safe, otherwise we reduce sped to avoid collision. Lines 269-339 accomplish this behavior.

3. Generate Trajectory

Trajectory generation is based on our previous path, the behavior from step 2 and our car's coordinates. As the waypoints give the the csv file are 30 mts apart, we need a way to reduce this gap, so we interpolate the waypoints using spline library provided to us. We are using a set of 50 points here. The spline interpolates points from previous path and current path. The speed is adjusted on every trajectory point, instead of the whole trajectory for faster reaction time. This helps a lot when a car makes an unexpected turn in our lane at a very close distance. There is also a rotation is from car's local coordinates to normal coordinates to make math easier. Lines 406-459 accomplish this spline interpolation part while Lines 342-403 take care of the waypoint generation, conversion to XY coordinates from frenet. The reference velocity set here is 49.5 and the car starts its journey in middle lane (lane 1).
The car has drive more than 4.5 miles without any incident, staying in lane when needed and changing lanes as appropriate if there is a slower car ahead, keeping jerk and acceleration under the limits.