# TERM-3 – PROJECT – 1 – PATH PLANNING PROJECT

## Contents



## 1 Objective

Objective of this project was to create a path planning algorithm that can provide trajectory for the car to follow. Also the trajectory should ensure that the car drives on the track and does not collide with other vehicles

## 2 Algorithm

The project uses the below algorithm:

1. Read the current position of Car and its Yaw (x,y,s,d,yaw) from the JSON file provided by simulator
2. Read the sensor fusion data of the nearby cars to track their position
3. For each of the identified vehicle do the following:
    a. Check its position to determine if these cars on the same side as the ego car
    b. If these cars are either on the right side or left side of the ego car lane and within distance of 30ms either ahead or behind.
4. If there is any car in the same lane that is within 30ms, then do the following
    a. If the car is not in the fastest lane (lane 0), then move to the next fast lane on the left side, provided there are no cars on that lane either ahead or behind within 30ms
    b. If the car is not in the slow lane (lane 2), then move to the next slow lane, as the vehicle is getting choked in traffic, provided there are no cars on that lane either ahead or behind
    c. If neither of two are not possible and lane cannot be changed, then slow down the vehicle and increase the speed only if the vehicles disappear from vicinity of 30ms
5. Safety algorithms - Following algorithms ensure safety of car and avoid any collision
    a. Predict the position of the other cars and not the current position.
    b. Reduce the speed of the ego car if lane change fails. But use the relative velocity times a factor of 0.0325 to reduce the speed

    c. This ensures that if the speed is not randomly reduced but based on the relative velocity.
    d. Absolute value is used in relative velocity to ensure that if any vehicle jumps in front of the ego vehicle, no collision happens
6. Algorithm to ensure unnecessary slowdown of vehicle:
    a. Whenever lane change is not possible and vehicle slows down, a lane change is checked after the vehicle moves out of vicinity of 30ms.
    b. This ensure that the vehicle do not unnecessarily tailgate the vehicle that is blocking the path and vehicle moves to next available lane and overtakes the car

7. Waypoint generation - The way point are generated based on below logic
    a. If the vehicle is in the start, then current position of car and previous position based on Yaw is calculated
    b. If the vehicle is already moving, last two previous positions are retrieved and its yaw is calculated
    c. Next three way points are calculated with a distance of 30ms. getXY function is used as Frenet co-ordinates are used to ensure that car can easily nagivate while staying in the lane
    d. All the five points are transformed to ensure that car moves in the x direction
    e. Spline is used for generating the remaining points that were not consumed by the car and hence a trajectory of 50 points are generated
    f. Target Y is calculated using the spline for a distance of 30ms and the 50 points are evenly distributed
    g. The points are rotated and pushed to controller so that trajectory is generated
8. Control of vehicle
    a. Staying in lane – Frenet coordinate is used to drive the car in required lane
    b. Controlling of speed – Speed is controlled by spacing the points generated by spline.
    c. Lane change. Lane change is managed by a variable Lane that is calculated as follows

| LANE | Lane description | Position |
|---|---|---|
| 0 | Fast Lane | 0 to 4 |
| 1 | Middle lane | 4 to 8 |
| 2 | Slow lane | 8 to 12 |

    d. The formula 2+4*lane is used to drive the car in center of lane

# 3 Rubric

- The code compiles correctly – Code compiles correctly without any error
- The car is able to drive at least 4.32 miles without incident. – Yes the car is able to drive without any incident
- The car drives according to the speed limit. – Yes. Maximum speed limit is 49.5mph
- Max Acceleration and Jerk are not Exceeded – Within limits
- Car does not have collisions – Algorithm ensure that vehicle is slow down if there are any changes of collision and also vehicle does not change lane if there are vehicles within 30 meters either ahead or behind
- The car stays in its lane, except for the time between changing lanes – The lane change happens smoothly
- The car is able to change lanes – The car changes lane if there are any cars that are blocking the way
- There is a reflection on how to generate paths – Yes. The Reflection is easily seen

# 4 Acknowledgement

Thanks to Udacity team for providing FAQ Video with starter code. It was very helpful