Maneuver Planning for Autonomous Vehicles with MPC Controller

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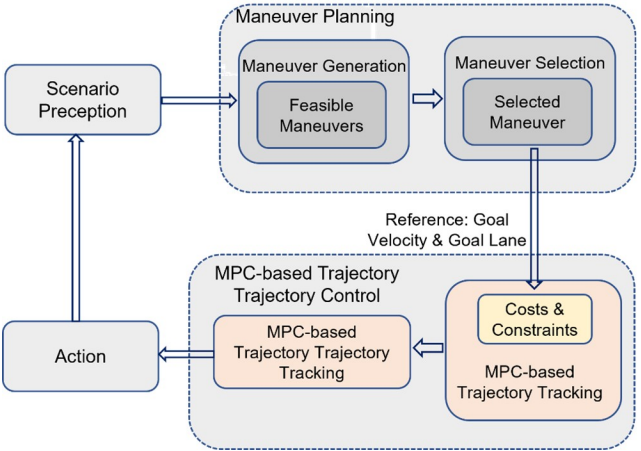
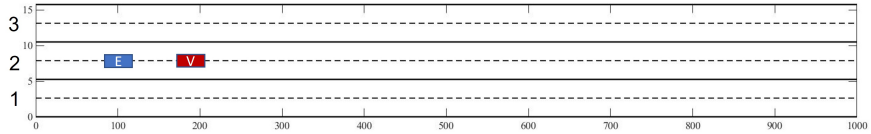
Introduction



Framework for Autonomous vehicles

Traffic Information



Highway			
Lane Num.	3	Lane width	5.25 m
Speed limit	14 m/s~ 70 m/s		
rec. Speed	30 m/s~36 m/s		

Vehicle			
Width	1.83 m	Length	3 m
Acc.	$-9\ m/s^2 \sim 6\ m/s^2$		
Steering Rate	$-0.5\ m/s^2 \sim 0.5\ m/s^2$		

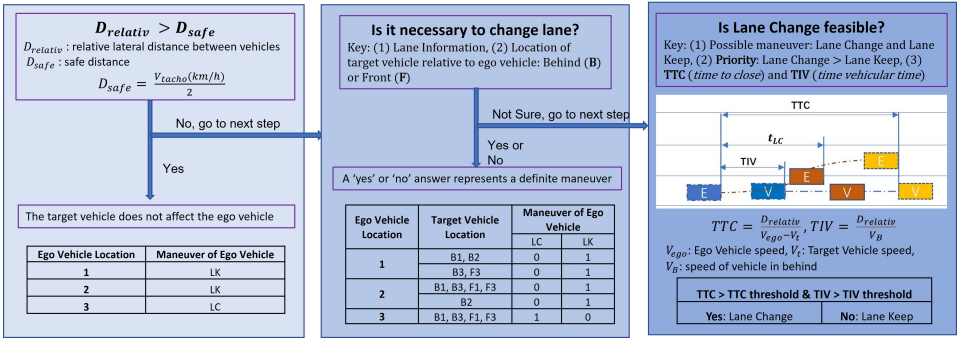
Initial Condition				
	Lateral location	Longitudinal location	Lateral speed	Longitudinal speed
Ego Vehicle	100 m	7.875 m	30 m/s	0 m/s
Target Vehicle	190 m	7.875 m	20 m/s	0 m/s

Maneuver Planning

Lane Change or Lane Keep

Key idea: Multi-level Screening

1. Step: Can the target vehicle affect the ego vehicle ?
2. Step: Is it necessary to change lane ?
3. Step: Is lane change feasible ?



Different Maneuver Update Frequency

$$Cost_j = \sum_{i=1}^{N-1}(\hat{x}_i - x_{ref}))^2 + (\hat{x}_N - x_{ref})^2$$

j : MPC iteration step
i : Prediction step in N step horizon
$\hat{x}_i$: predicted state of ego vehicle
x_{ref}: Goal lane or goal velocity

8 Groups of Frequency Setting

1) Maneuver update at every 10 iterations
2) Maneuver update at every 5 iterations
3) Maneuver update at every 2 iterations
4) **Maneuver update at each iteration**

If $mod(j, a) == 0$ *% a = 10, 5, 2, 1*
maneuver planning
update x_{ref}
end
Calculate cost

5) Maneuver update at every 10 prediction steps at each iteration
6) Maneuver update at every 5 prediction steps at each iteration
7) Maneuver update at every 2 prediction steps at each iteration
8) **Maneuver update at each prediction step at each iteration**

If $mod(i, a) == 0$ *% a = 10, 5, 2, 1*
Predict state of the target vehicle
maneuver planning
update x_{ref}
end

Conclusion

Maneuver update at certain iterations

- Reduced interaction between vehicles
- Low mission success rate
- Not recommended

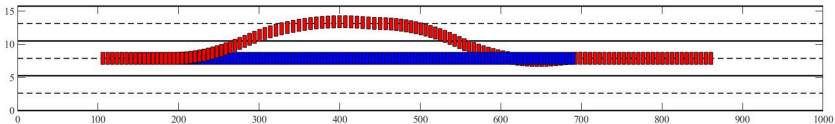
Maneuver update at each iteration

- High mission success rate
- Recommended

Maneuver update at certain prediction steps at each iteration

- Addition of the impact of predictive scenarios in maneuver planning
- High mission success rate
- Recommended

Thanks for your attention



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