Modelling vehicular interactions with opposing vehicles on two way two lane roads

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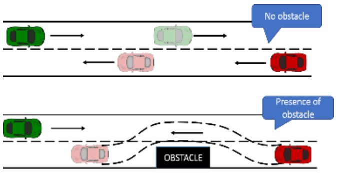
Passing manoeuvre on two lane roads

Vehicular movements on two way two lane roads differ significantly from other facilities due to the high frequency of conflicts between vehicles in opposing directions of travel. Presence of obstacles like parked vehicles causes an increase in the frequency of conflicts between the vehicles. The behavior of the passing vehicle affects the movement of the opposing vehicle and vice-versa. Hence this must be treated as an interaction. These conflicts have a significant impact on the **efficiency** as well as the **safety** of such road sections. This can be useful application for developing the **surrounding vehicle model** in driving simulators.



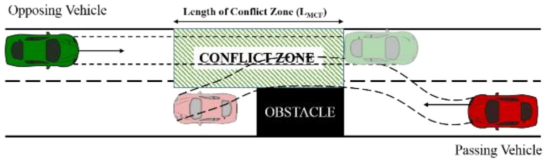
Model Development

The decisions of each vehicle involved is classified into three choices in this model. They are given as:

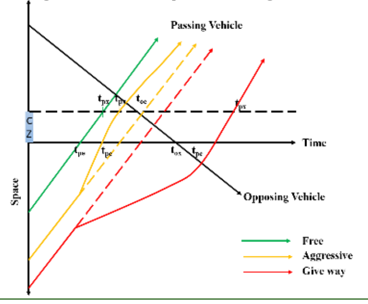
1) **Giving way** to the other vehicle by decelerating,

2) Employing **aggressive movement** by accelerating to complete the passing maneuver

3) **Moving freely** without any interaction



The **conflict zone** is defined as the area where there is a potential for both cars to collide if both assume that **priority** lies with them The three choices can be represented using the **time-space** diagram.



Mathematical formulation

In order to understand the nature of the model, it is important to evaluate the model analytically. The conditions for different choices are given as :

Choice	Passing Vehicle	Opposing Vehicle
Free	$t_{px} < t_{oe}$	$t_{ox} < t_{pe}$
Aggressive	$((t_{px} - t_{oe})/t_{px}) < \eta_p$	$((t_{ox} - t_{pe})/t_{ox}) < \eta_o$
Giveway	$((t_{px} - t_{oe})/t_{px}) > \eta_p$	$((t_{ox} - t_{pe})/t_{ox}) > \eta_o$

t_{pe} and t_{oe} are the expected entry time to conflict zone and t_{px} and t_{ox} are the expected exit times from conflict zone for the passing and opposing vehicle respectively. η is a parameter of the model.

Time Dependent Characteristics

To consider **interaction** between the vehicles, we need to consider the **time dependent** decisions of the vehicles as they keep updating their decisions depending upon changes in the system. There is a possibility of the collision of agents during interaction. It is important to analyze the condition at which such possibility of collision occurs. In order to analyze this, a **simulation program** was run to check the decisions of each vehicle for different input parameters.

Time-dependent decisions of the vehicles with different approaching speeds

Initial speed of opposing vehicle (km/hr)	43		41		39		37.5		36	
Decision	Passing	Opposing	Passing	Opposing	Passing	Opposing	Passing	Opposing	Passing	Opposing
T=0	G	G	G	G	G	G	G	G	G	G
T=3	G	G	G	G	G	F	G	G	G	G
T=6	G	F	G	F	G	F	G	F	F	G
T=9				F		F		F		G

F, A and G stand for free, aggressive and giveway respectively. The initial speed of the passing vehicle is set as 45km/hr and the distance of the vehicles from the obstacle is fixed as 150m. From the table, it can be observed that in all the cases, a **good collision avoidance behavior** is expected for the current parameter settings. The initial settings are chosen so that both vehicles obtain giveway initially.

Future Works

Certain cases exhibit **similar decision choices** for both vehicles. This can be attributed to the setting of the parameters which have to be analyzed carefully. Scenarios where both vehicles obtain give way behavior though unrealistic is safer as compared to scenarios where both vehicles obtain **aggressive behavior**. Hence, care has to be taken so as to avoid such kind of scenarios. The current model considers the vehicles to have perfect information but it is necessary to model under **imperfect information.** A **driving simulator experiment** is to be conducted for the calibration purposes of the model.