Collaborative Vehicle Control for the Autonomous Bus Platoons near Bus Stops

Master‘s Thesis of Yumeng Fang

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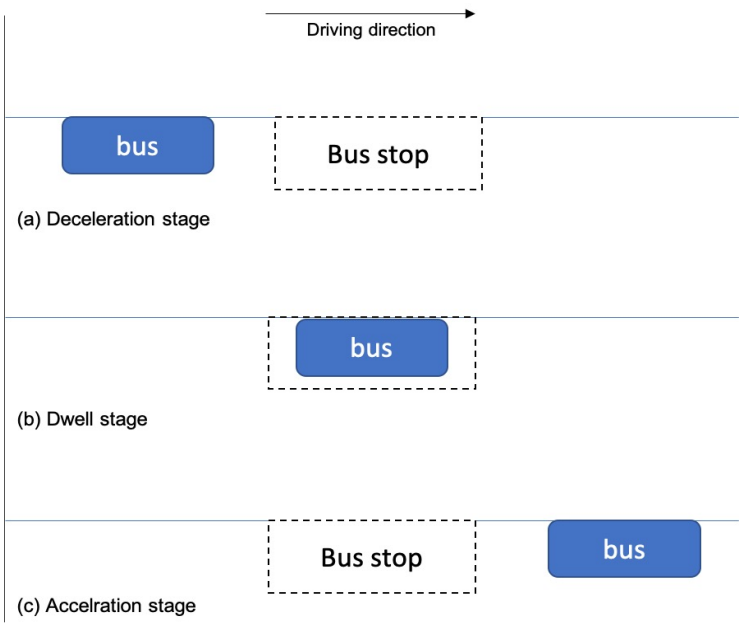


There are four time components for bus operation near bus stops:

1. Deceleration time
2. Dwell time
    - Passenger activity time
    - Dead time
3. Acceleration time
4. Delay time

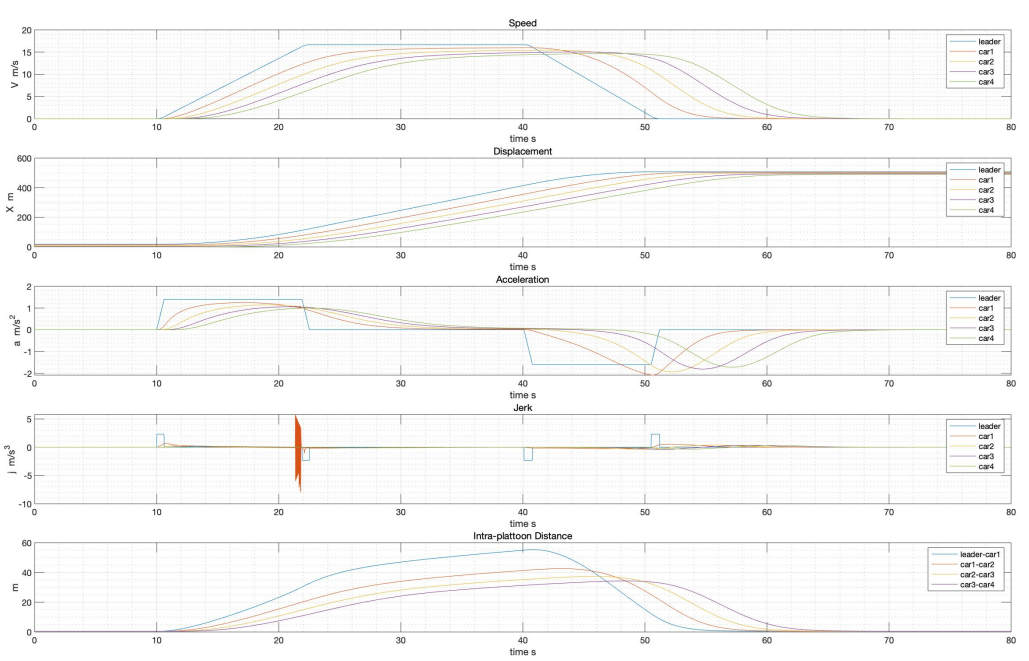
However, for autonomous bus platoons, the dead time is redefined. It includes:

- Time difference for all autonomous buses in the platoon starts to accelerate
- Time difference for all autonomous buses in the platoon reaches a full stop
- Time for buses opening and closing doors

The EIDM (Enhanced Intelligent Driver Model) is selected as the original model to do the enhancement since it is an “intelligent” model with a crash-free characteristic. Besides, it has more realistic behaviour than the IDM (Intelligent Driver Model) at a critical situation.

The picture on the right shows the simulation results of the EIDM under a scenario where there are two bus stops with 500 meters distance. The maximum acceleration, minimum deceleration and cruising speed are 1.4m/s², -1.6m/s² and 60km/h. The problems of this model are:

1. The following buses fail to meet the desired velocity v_0.
2. The intra-platoon distance during cruising is continuously increasing and relativity large.
3. The following buses have a slow response to the lead bus.



Models	Time difference (start to accelerate)	Time difference (full stop)	Time of travelling 500m	Intra-platoon distance (cruising)		Intra-platoon distance (dwelling)	
Original EIDM	3.38 s	15.38 s	57.2 s	Continuously increasing		0.5m	
Improved EIDM	1.15 s	2.89 s	45.54 s	Mean	SD	Mean	SD
				9.36 m	0.0016	0.5 m	0
Zero-T strategy	0.37 s	0.05 s	43.25 s	Mean	SD	Mean	SD
				5.42 m	0.31	0.32 m	0.003
The kinetic-based model	0 s	0 s	42.89 s	Mean	SD	Mean	SD
				5 m	0	0.5 m	0

The master’s thesis proposed three models to solve the problems mentioned above.

1. The improved EIDM
    - The easiest one to implement
    - Owns smooth transition of the jerk
2. The Zero-T strategy
    - Keep most of the advantages of the EIDM
    - Almost zero time difference for acceleration and approaching a full stop
3. The kinetic-based model
    - The intra-platoon distance at the cruising stage is controllable
    - Tailored to meet the requirements of autonomous bus platoon near bus stops