

Application of ITS Technology to Railway Vehicles

Fund: The special fund of Institute of Industrial Science

Background

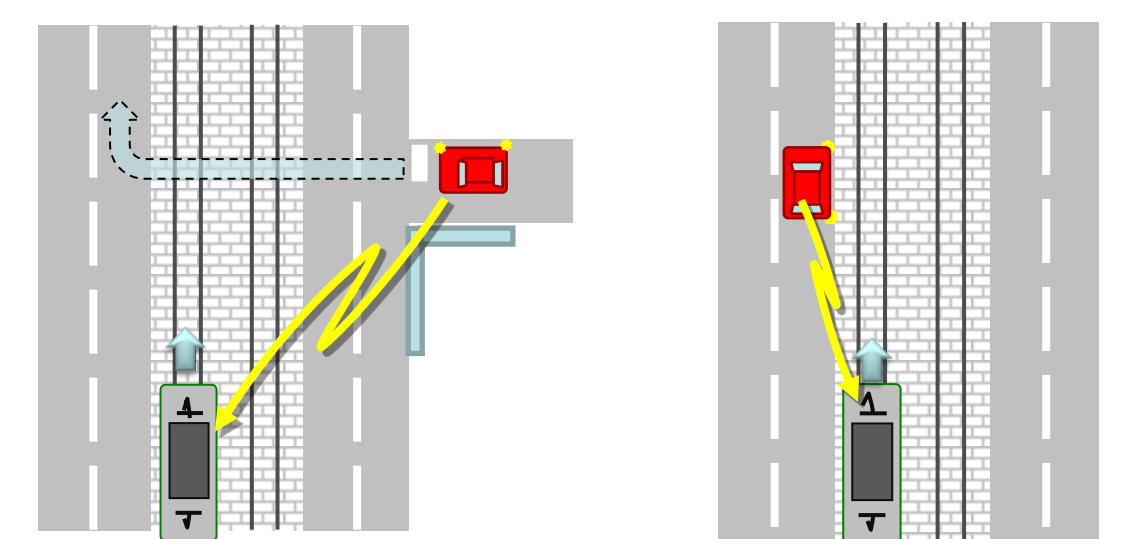
Platooning of trucks (NEDO)



Platooning has been attracting attention of researchers in automobile field as one of the effective way to achieve automatic driving. Traffic volume can be increased by shortening the intervals and flexible transport and logistic services can be achieved.

Hiroshima ASV (Collaborated with Mazda, Hiroshima Electric Railway, and National traffic Safety and Environment Laboratory)

The tram and the car give alarms to the drivers when the car crosses the track using vehicle to vehicle communication.



Aims

1. To apply automatic platooning drive to trams to achieve safe and efficient transportation.
2. To propose the control scheme for the tram platooning.
3. To examine the performance through numerical simulations.

Control method

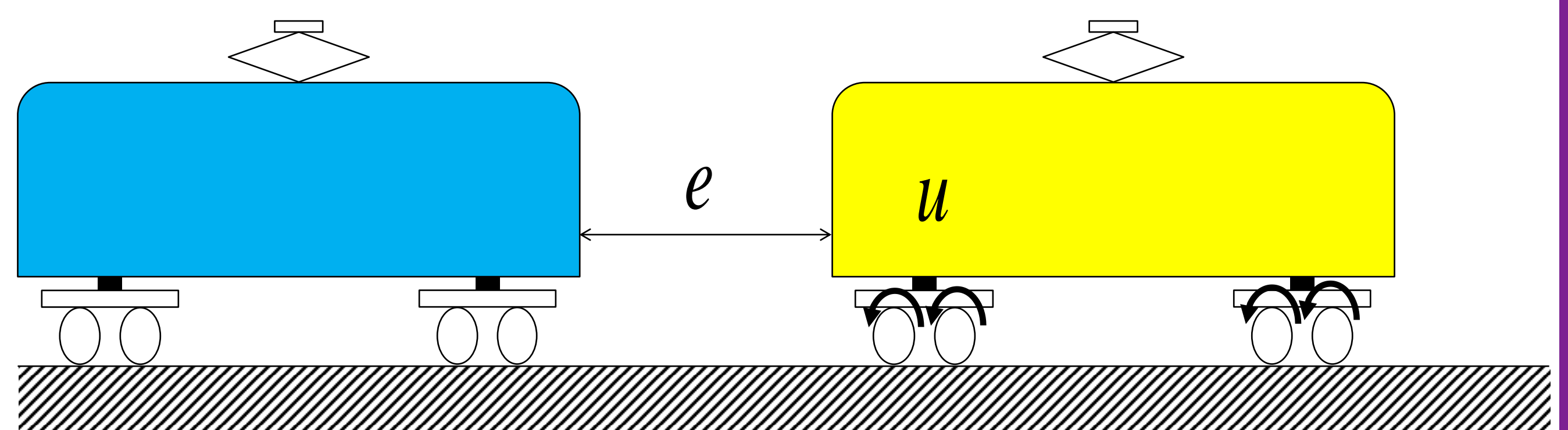
$$u(t) = -\frac{r}{4} \left\{ c\dot{e}(t) + ke(t) + p \int_{t_0}^t e(t)dt \right\}$$

e : Error between the target gap and the current gap

c : D gain of the controller, k : P gain of the controller

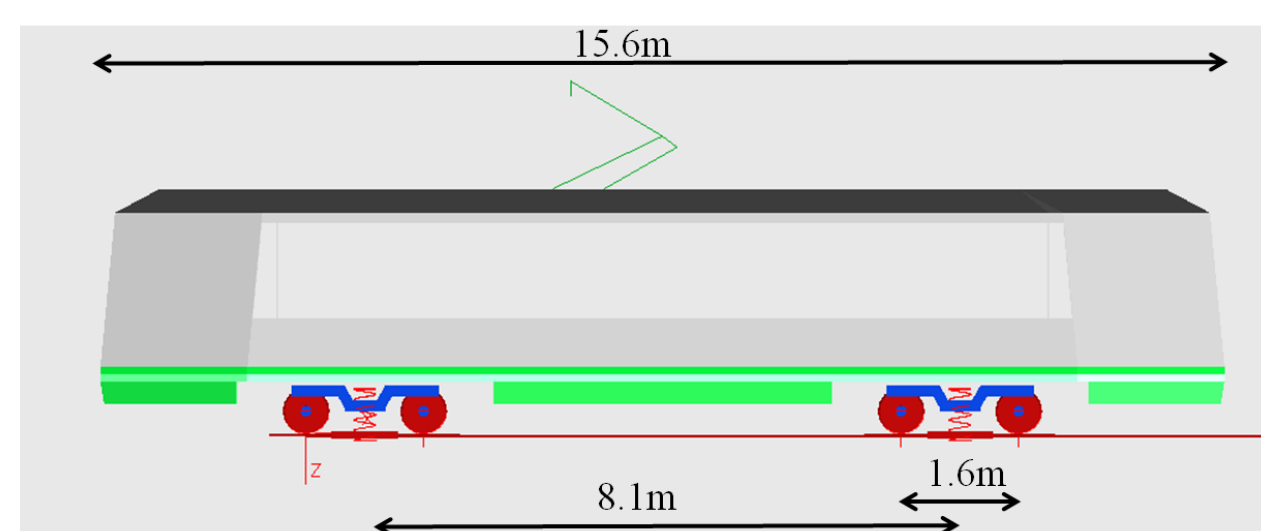
p : I gain of the controller, u : Control input: driving force of the motor

The target gap is determined from the target time gap, 0.2s, and the velocity of the following car.



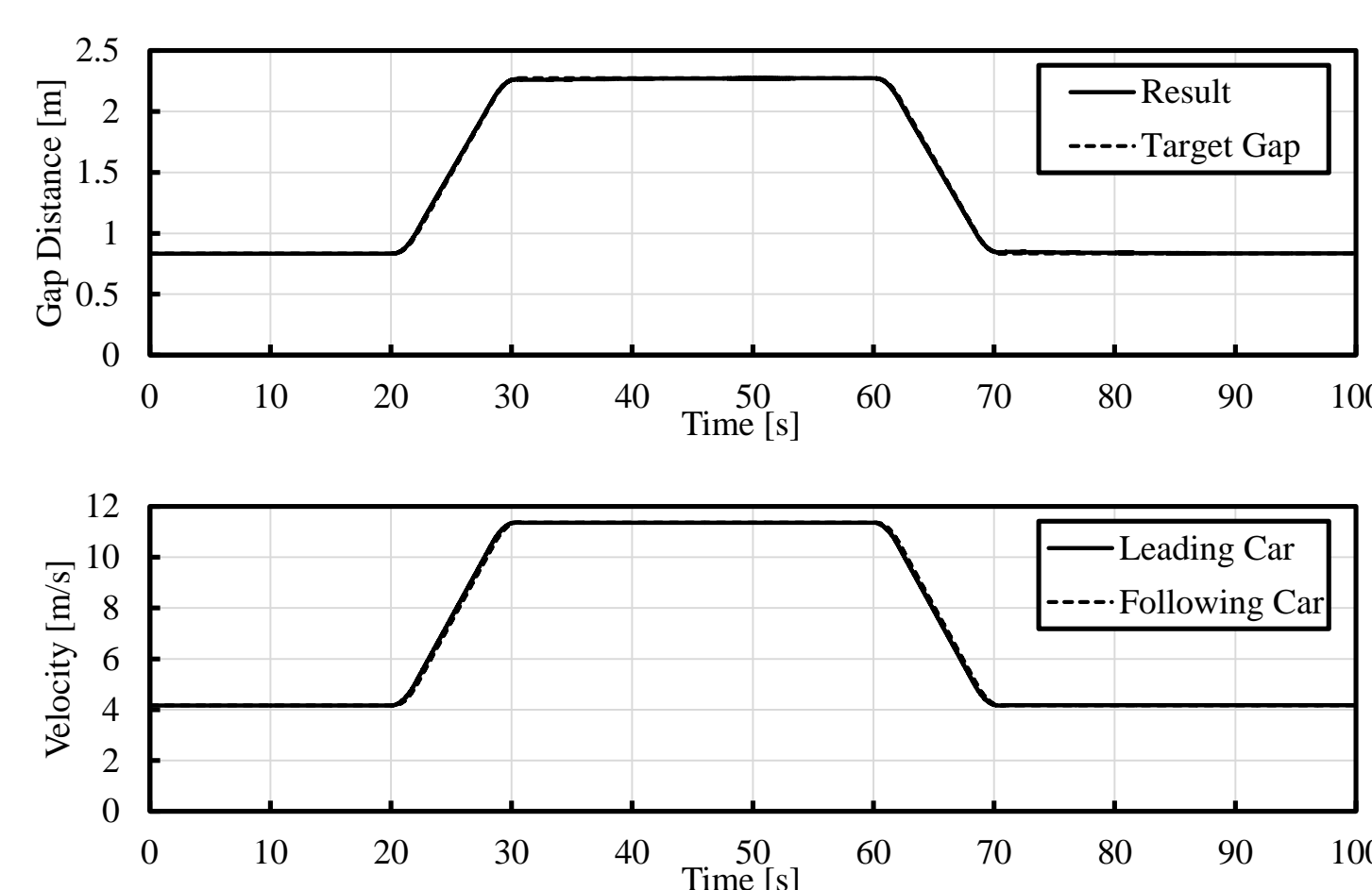
Numerical simulations

Numerical simulations were conducted using SIMPACK.

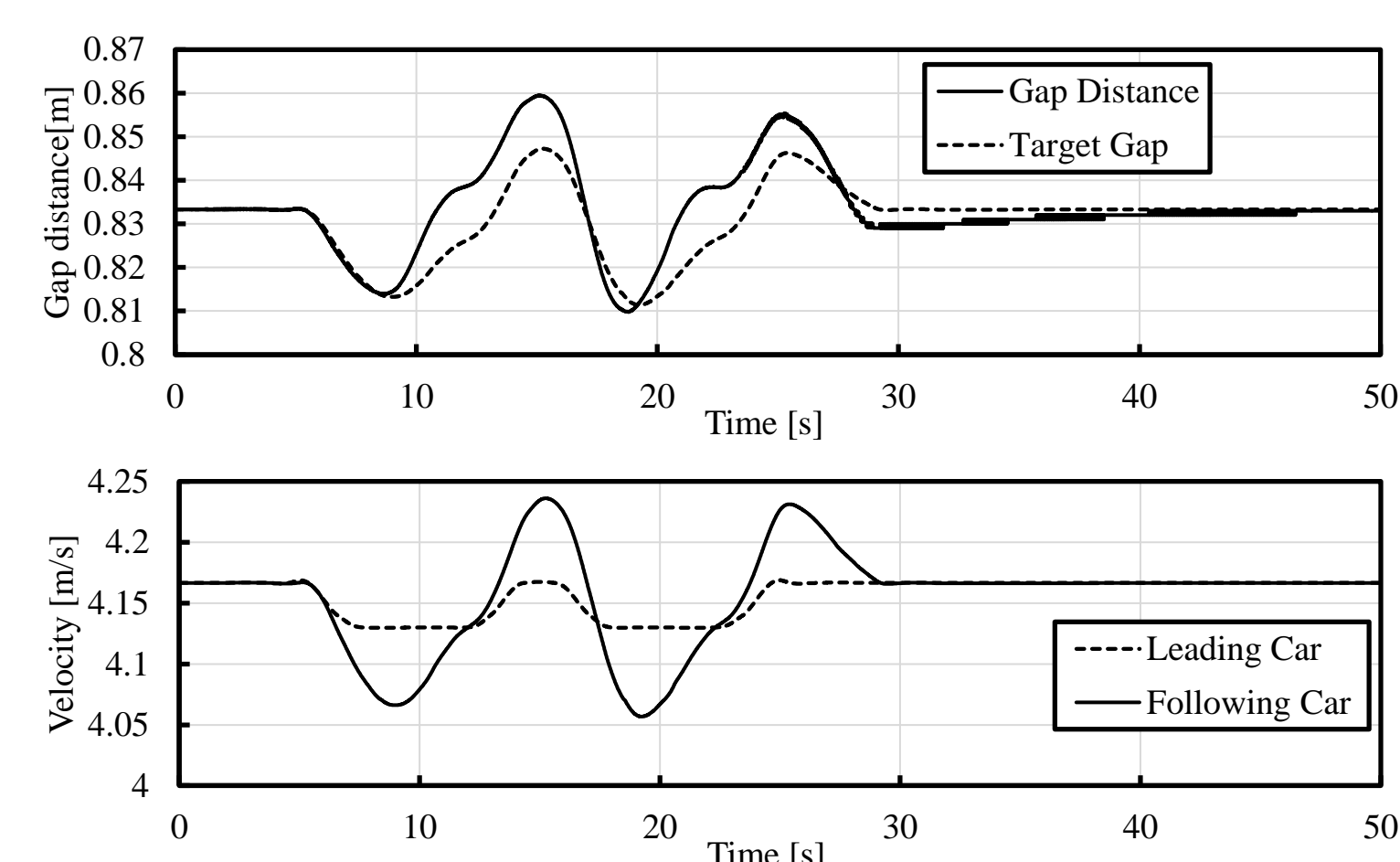


Mass of vehicle : 20t

Straight line at 15 and 40km/h, the target time gap is 0.2s.

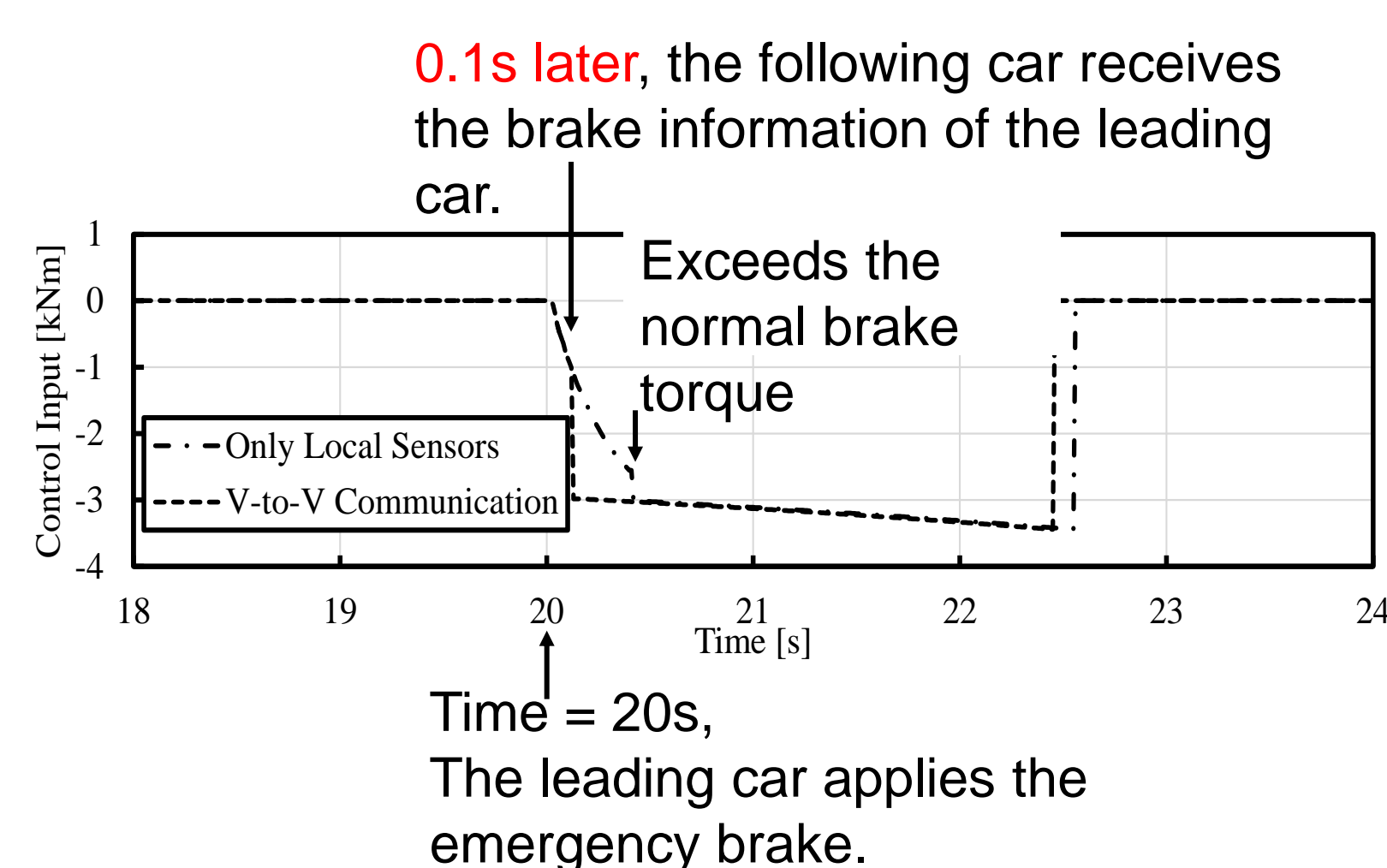


S-shaped curve at 15km/h, the target gap is 0.2s.

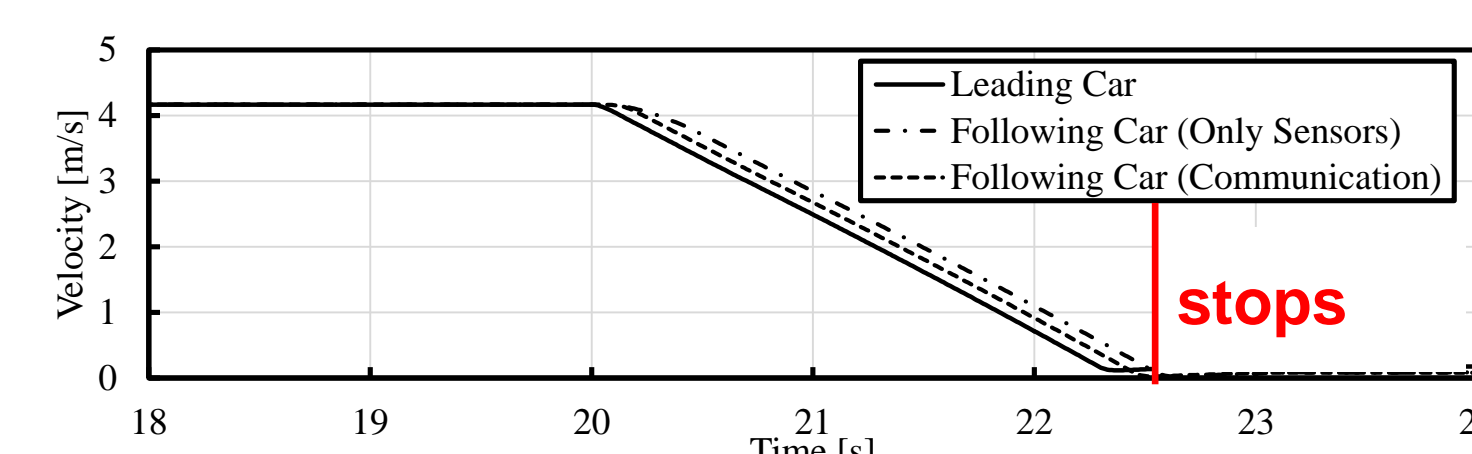
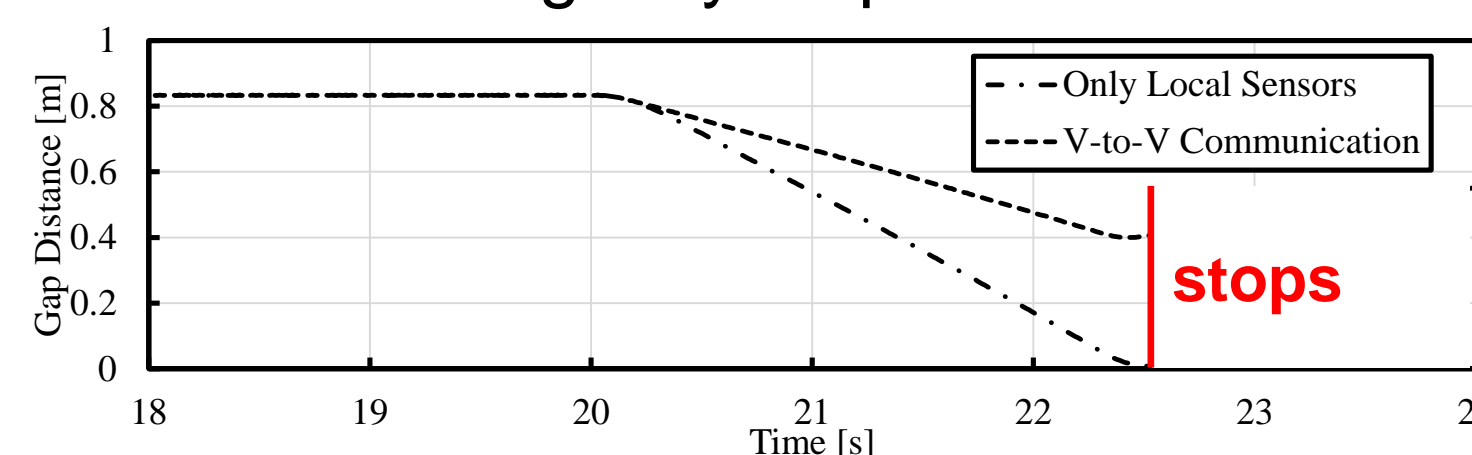


In using emergency brake

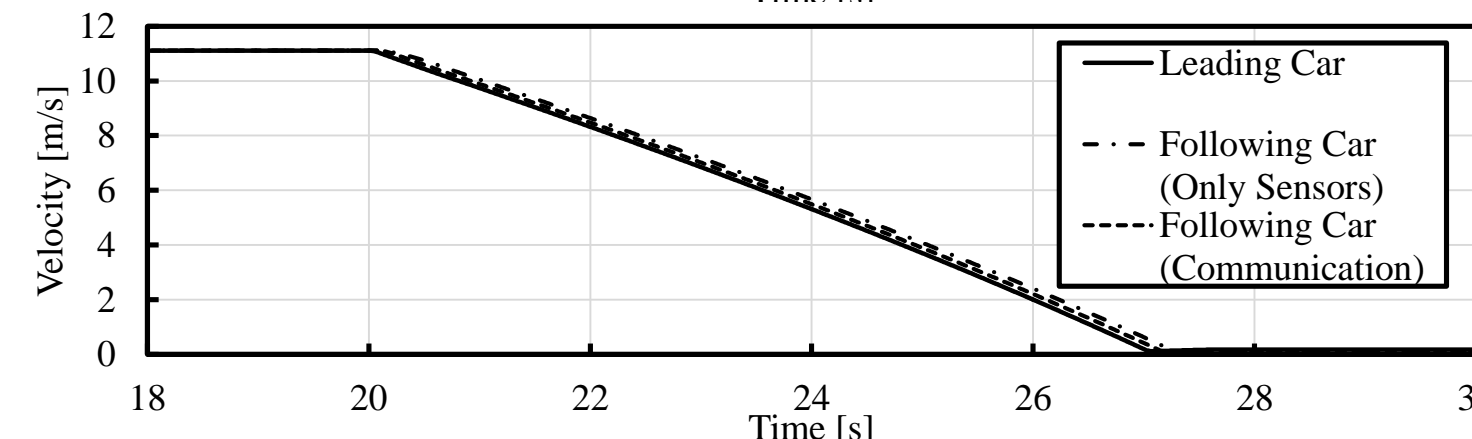
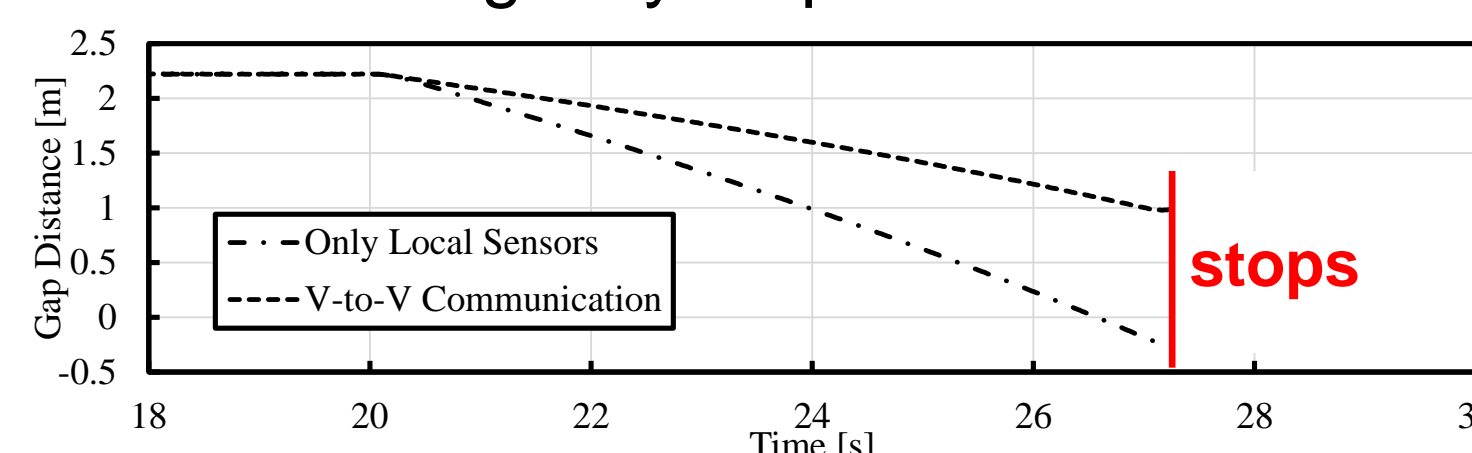
Two situations, using Vehicle to Vehicle communication transmitting the brake operation of the preceding car to the following or not, are tested. The following car is assumed to know the brake operation with 0.1s delay.



Emergency stop at 15km/h



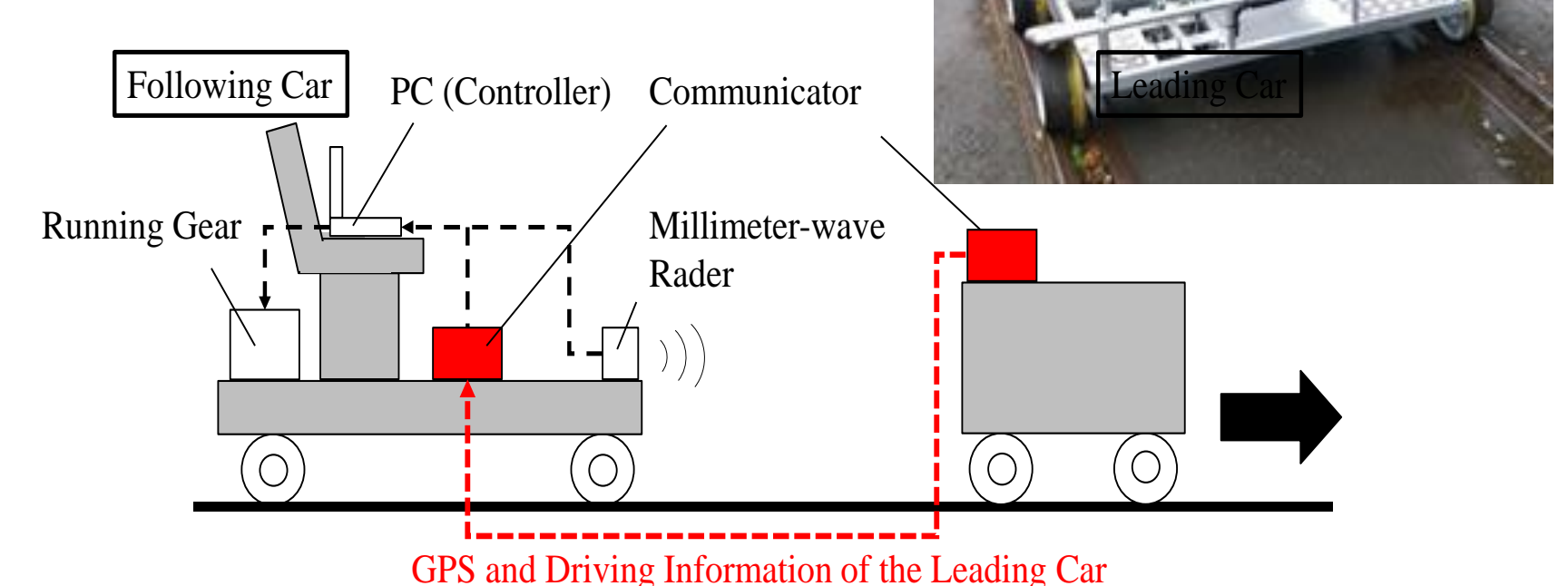
Emergency stop at 40km/h



Both at 15km/h and 40km/h, the apply of emergency brake is delayed to avoid the collision when using only local sensors. The V2V communication is needed to avoid the collision when travelling with the close gap time, 0.2s.

Future study

On-rail experiment will be conducted using the cart.



Publications

Fukumoto M., Ejiri K., Shimono K., Nakano K., 2015, Feasibility of Automatic Platooning of Tram Cars at Low Speed, STECH 2015, 10-12 November, Chiba, Japan.

Nakano K., Wakabayashi S., 2014, Feasibility Study on Following Control of Trams Through Numerical Simulations, The Second International Conference on Railway Technology: Research, Development and Maintenance, 8-11 April, Ajaccio, France.