개인고속이동 시스템의 차량운행제어 알고리즘 검증을 위한 모의 장치 설계에 대한 연구

이준호† · 신경호* · 김용규*
한국철도기술연구원

A Design of the Evaluation Devices for the Vehicle Operational Control Algorithm of Personal Rapid Transit System

Jun-Ho Lee · Kyung-Ho Shin · Yong-Kyu Kim
Korea Railroad Research Institute

Abstract - In this paper we deal with a design of the evaluation system to assess the vehicle operational control algorithm for Personal Rapid Transit(PRT) system. PRT system is different from the conventional rail traffic system in such point that the station is off-line so as to guarantee a very short headway. In this study we propose a evaluation system to assess the performance of the proposed vehicle control algorithm. The evaluation system is composed of virtual vehicles, central control system, virtual wayside facilities, monitoring equipments. In order to test the proposed evaluation system a test algorithm is used, which has been simulated in the combined simulation system between Labview Simulation Interface Toolkit and Matlab/Simulink.

1. Introduction

Congestion at road and air pollution problems in urban areas have encouraged to develop innovative travel modes. A innovative new transportation system providing many of the convenient features of private car, what is called personal rapid transit(PRT) system, offers a possibility to overcome the above mentioned problems. In this paper we propose a novel method to construct an evaluation system for PRT vehicle control algorithm, using VME Bus type PowerPC process module, I/O board and monitoring device. The basic purpose of the evaluation system is to test if the simulated control algorithm is designed properly or not. For the test it is necessary to provide the virtual operational environment which is very similar to the real operational environment. The virtual operational environment will be discussed later.
First the paper presents the quadratic equation to produce the brake curve for the vehicle and then shows the vehicle control system for the simulation and proposes the evaluation system to test the simulated control algorithm. Finally we show the configuration of the virtual experimental set up to evaluate the simulated control algorithm.

2. Control System For Simulation

The test algorithm has simple scenario such as shown in flow diagram of Fig. 1. In Fig. 1 the initial values for the parameters should be set to calculate the speed patterns of the both vehicles. The both vehicles are assumed that if there is no any activation for the emergency brake the both vehicles run on the gudeway at a constant speed. However once the preceding vehicle activates the emergency brake the rear vehicle should activate its emergency brake as soon as it recognizes the activation of the emergency brake in the preceding vehicle. In order for the implementation of this simple scenario it is necessary to simulate the designed test algorithm for the debugging purpose. Fig. 2 shows the simulation model which runs on the Matlab/Simulink platform. In the figure the preceding vehicle speed pattern and the Rear vehicle speed pattern blocks calculate the speed pattern of each vehicle based on the parameter information transferred from the Initial set block.

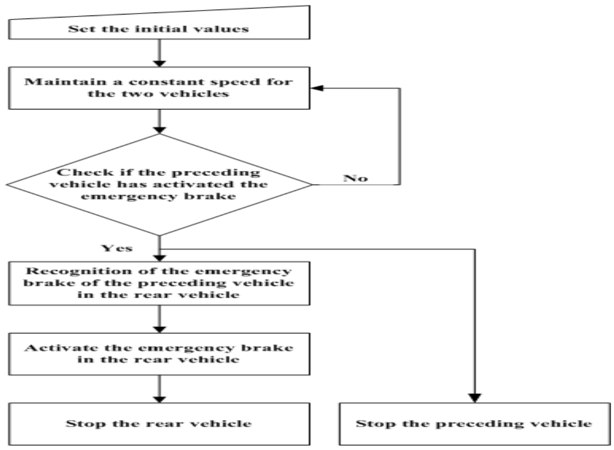

Fig 1. Task flow for the test algorithm

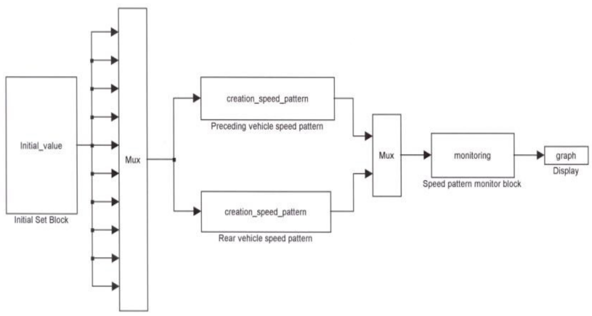

Fig 2. Simulation model

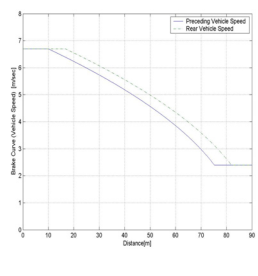

Fig 3. Brake curve for the normal state

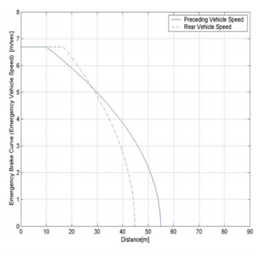

Fig 4. Brake curve for the emergency state

Fig 3 and Fig. 4 show the simulation results. Fig. 3 is for the case of normal state. In this figure we see 1[sec] time delay in the rear vehicle to activate the brake, which means 6.7[m] in distance, due to the time duration to recognize the emergency brake activation in the preceding vehicle. But both vehicles reach the same final vehicle speed, 2.4[m]. with 1[sec] time difference. It is because the vehicle control command has set 0.3[m/s^2] in both vehicles. In Fig. 4 speed patterns for the emergency state are shown. The rear vehicle activates its brake with 1[sec] time delay in comparison with the activation of the preceding vehicle. However the rear vehicle stops with some safe distance before the preceding vehicle dose.

3. Evaluation System

In this section we deal with the configuration of the proposed evaluation system which is composed of virtual vehicle, central control system, virtual wayside facilities and monitoring device as shown in Fig. 7. The virtual vehicles can be implemented by using the several laptop computers which has the programed functions producing and displaying the vehicle status information. The number of the laptop computers can be arbitrary decided based on the system design. The central control system calculates the speed pattern of each vehicle using the information transferred from the virtual vehicles. In this paper we employ MPC7410 microprocessor based VNE bus processor module of Motorola Inc. including RS-232 ports, ethernet ports and VMEVMI2536 I/O board. The ethernet ports are used to transfer the vehicle status information and the vehicle control information between the central control system and the virtual vehicles. The calculated results are transferred to the virtual wayside facilities that can be implemented using the PXI module of the National Instruments Corporation, by way of the RS-232 ports, I/O board and the relay block. The role of the virtual wayside facilities are to display the current status of each vehicle based on the information transferred from the central control system. The monitoring device is installed to check the status of the central control system, virtual wayside facilities and the virtual vehicles. It should be noted that we assumed there is no communication between the virtual vehicles to calculate the speed pattern using the on-board vehicle computer in the evaluation system. This is because we employed the centralized control method to control the vehicles, which means that the speed pattern for all vehicles are produced from the central control system

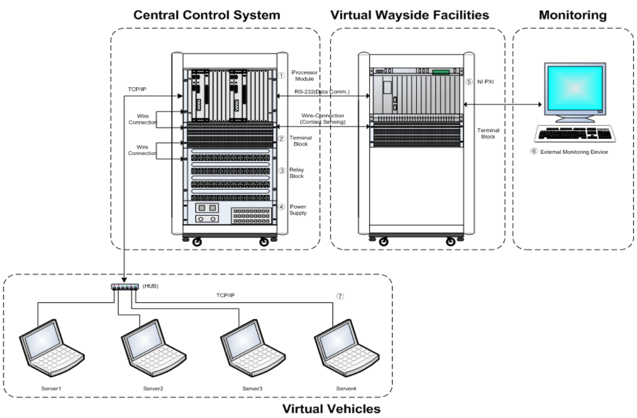

Fig 5. Simple configuration of the proposed evaluation system

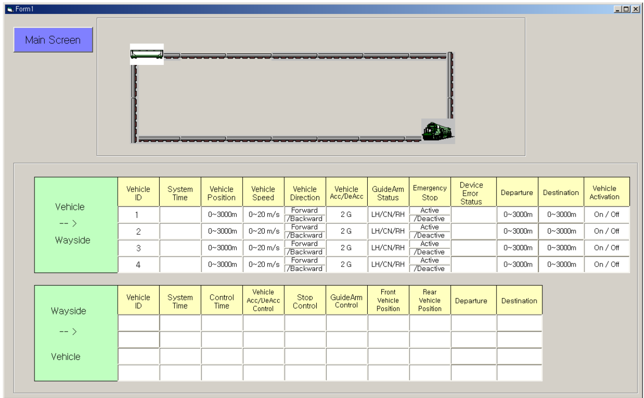

Fig. 6 Windows for data flow

Fig. 6 shows data flow of the proposed evaluation system Vehicle to wayside and wayside to vehicle blocks show each parameters which are needed for the control of the vehicle and for monitoring of the vehicle status, respectively.

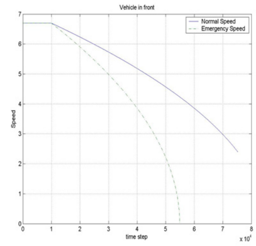

Fig. 7 Movement of the vehicle in front

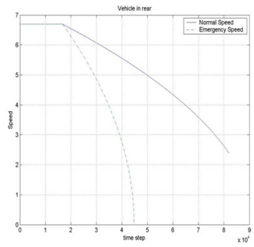

Fig. 8 Movement of the vehicle in rear

Fig 7 and 8 show the experimental results for the proposed evaluation system. In these figures we see that the proposed evaluation system works very well.

3. Conclusions

In this paper we provided the simple operational scenario for the test algorithm which has been simulated in the environment of Matlab/Simulink. The simulation results showed the operational scenario worked very well in the virtual simulation environment. Finally we proposed the configuration of the evaluation system to test the simulated test algorithm, which is very plausible to the real operational environment. Finally, we have shown the test results of the proposed evaluation system, which works very well.

References

[1]. Ollie Mikosza, Wayne D. Cottrell, "MISTER and other New-Generation Personal Rapid Transit Technology", *Transportation Research Board, 2007*

[2]. Jun-Ho Lee, Ducko Shin, Yong-Kyu Kim, "A Study on the Headway of the Personal Rapid Transit System", *Journal of the Korean Society for the Railway, Vol. 8, No. 6, pp. 586-591, 2005.*

[3]. Jun-Ho Lee, Kyung-Ho Shin, Jea-Ho Lee, Yong-Kyu Kim, "A Study on the Construction of a Control System for the Evaluation of the Speed Tracking Performance of the Personal Rapid Transit System", *Journal of the Korean Society for the Railway, Vol. 9, No. 4, pp. 449-454, 2006.*

[4]. Markus Theodor Szillat, "A Low-level PRT Microsimulation", *Ph. D. dissertation, University of Bristol, April 2001.*

[5]. Duncan Mackinnon, "High Capacity Personal Rapid Transit System Developments", *IEEE Transactions on Vehicular Technology, Vol. VT-24, No. 1, pp. 8-14, 1975*

[6]. J.E. Anderson, "Control of Personal Rapid Transit", *Telektronikk 1, 2003*

[7]. Bih-Yuan Ku, Jyh-Shing R. Jang, Shang-Lin Ho, "A modulized Train Performance Simulator for Rapid Transit DC Analysis", *Proceedings of the 2000 ASME/IEE Joint Railroad Conference, pp. 213-219, April, 2000.*