EVALUATION OF ON-STREET PARKING SCHEME USING VIRTUAL REALITY TRAFFIC EXPERIMENT SYSTEM

Shinji TANAKA[1], Masao KUWAHARA[2]

Abstract. A well-ordered on-street parking scheme in Japanese cities is highly desired to support urban social activities. This research studies the feasibility of making on-street parking space on a surface street in an aspect of efficiency and safety using the virtual reality traffic experiment system, which is an integrated system of driving simulator and traffic simulator. It can examine driving behavior around on-street parking as well as analyze traffic flow. For the safety evaluation, testee experiments by reproducing several patterns of .parking spaces were conducted. The analyzed result of obtained driving behavior data will be utilized for the vehicle behavior model in the traffic simulation part.

1. Introduction

In Japan, parking has been regarded to be treated off street and basically prohibited to park on street because it may cause traffic congestions and sometimes traffic accidents in a city. However, since urban business and commercial activities depend on on-street parking greatly, this gap between institution and actual situation leads to a lot of problems like illegal parking and even disordered status of traffic. Therefore, to admit the role of on-street parking and to make parking space on street will be highly desired.

To allow on-street parking on arterial streets, it is quite important to ensure traffic capacity as well as safety between parked vehicles and passing vehicles. In this study, the authors focus on examining the efficiency and safety aspect of on-street parking space using virtual reality traffic experiment system, which is an integrated system of diving simulator and microscopic traffic simulator.

[1] Institute of Industrial Science, University of Tokyo,
[2] Center for Collaborative Research, University of Tokyo,
4-6-1 Komaba, Meguro-ku, Tokyo, 153-8505, Japan,
(stanaka, kuwahara)@iis.u-tokyo.ac.jp

2. Proposed On-street Parking Scheme

As for traffic congestion in urban area, the bottleneck is almost always at a signalized intersection, because limited amount of green time has to be allocated among different directions of traffic. Therefore, on-street parking around an intersection which reduces the road capacity significantly should be strictly controlled. In other words, there is a possibility to allow parking at a straight section between intersections. According to this idea, the authors propose to make on-street parking space between intersections as shown in Figure 1.

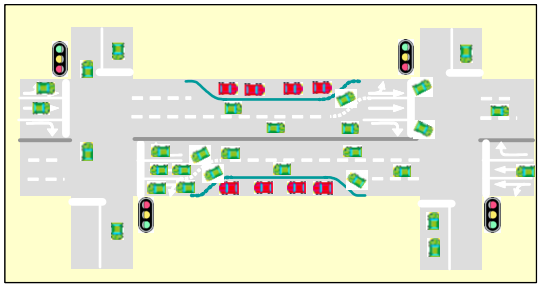

Figure 1. Proposed on-street parking space

This on-street parking scheme is designed inside road space, therefore before entering this section, the width for passing vehicles has to be narrowed, which may sometimes cause dangerous situations. However in the current situation in Japan, there are a lot of disordered illegal parking vehicles almost everywhere including near intersections, this concentrated parking could be a better solution. Anyway, to implement this kind of parking scheme, it is necessary to examine the safety of vehicles' behavior around this parking section like merging, lane changing etc. And also, the effect of congestion alleviation by this scheme should be evaluated.

3. Virtual Reality Traffic Experiment System

The virtual reality traffic experiment system, which is an integrated system of a 6 axis motion driving simulator and a microscopic traffic simulator, has been developed in Sustainable ITS Project, University of Tokyo. Figure 2 shows the appearance of the current system and the details are explained in reference [1], [2]. The system can reproduce a realistic interaction between a driven vehicle by a testee and surrounding vehicles by microscopic traffic simulator and can observe his driving behavior in several scenarios under fully controlled environment.

For the safety evaluation of the proposed on-street parking scheme, a prototype model of surrounding vehicle behavior at the parking section is newly developed and introduced to this system.

Figure 2. Virtual Reality Experiment System

4. Experiment

For the safety evaluation, we designed an experiment that has testees drive in a situation with on-street parking. 3 patterns of on-street parking spaces are prepared and compared as follows.

4.1. Current lane marking (pattern A)

Figure 3 shows a lane marking which does not intend that parking vehicles should be outside of through traffic lanes. This marking actually imitates the current situation where illegal parking occurs.

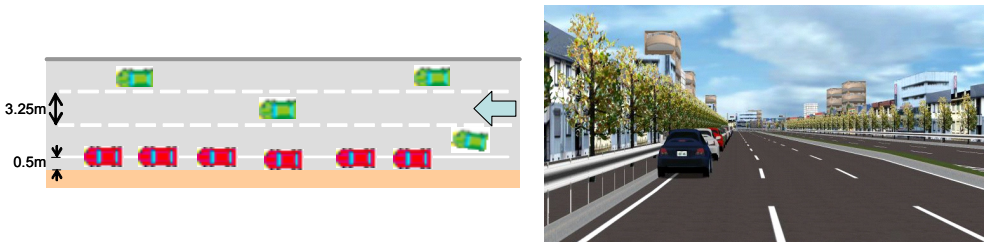

Figure 3. Current lane marking (pattern A)

4.2. Parking lane with lane width reduction (pattern B)

Figure 4 shows a lane marking which creates parking lane by reducing each lane width for through traffic. The number of lanes for through traffic is maintained.

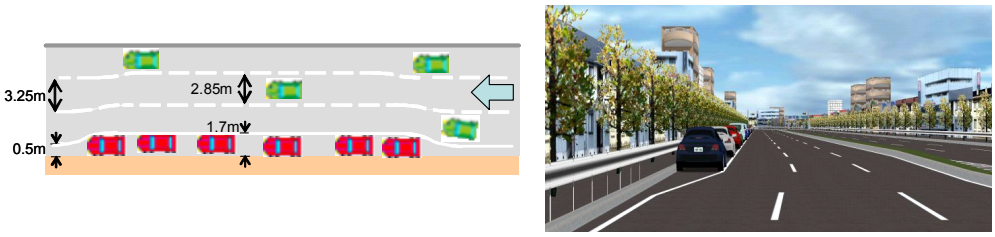

Figure 4. Lane width reduction (pattern B)

4.3. Parking lane with lane number reduction (pattern C)

Figure 5 shows a lane marking which creates parking lane by reducing number of lanes for through traffic. The lane width for through traffic is maintained or widened.

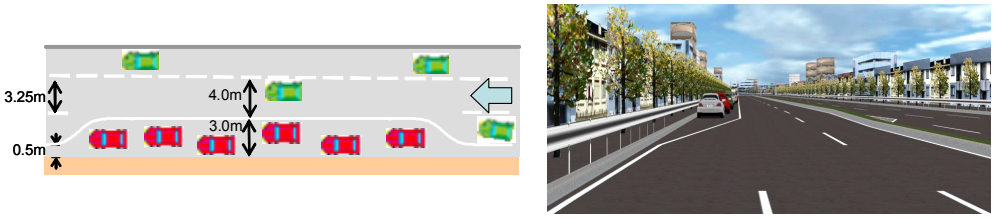

Figure 5. Lane number reduction (pattern C)

In the experiment, a testee is asked to drive a road stretch including these parking sections. Driving behavior data in every second are recorded and questionnaire survey is also done after driving. Here is an example of collected data.

Driving behavior data: vehicle's location, speed, acceleration/deceleration rate, steering angle, driver's eye point etc.
Questionnaire survey: subjective evaluation on safety, uneasiness etc.

5. Result

We have conducted the experiment inviting a few dozens of testees. Table 1 shows the number of testees of the experiment.

Total	46						
Gender	**Male:**	32			**Female:**	14	
Age	**20s:**	30	**30s:**	12	**40s:**	2	**50s:** 2

Table 1. Number of testees

Some of the results are shown in the following sections.

5.1. Driving trajectories

Figure 6 shows the driving trajectories by several testees in the pattern A. In this pattern, most of the drivers change their lane to the right completely although parked vehicles occupy less than half of the first lane. We can see the trajectories vary especially at the entrance point of the parking section.

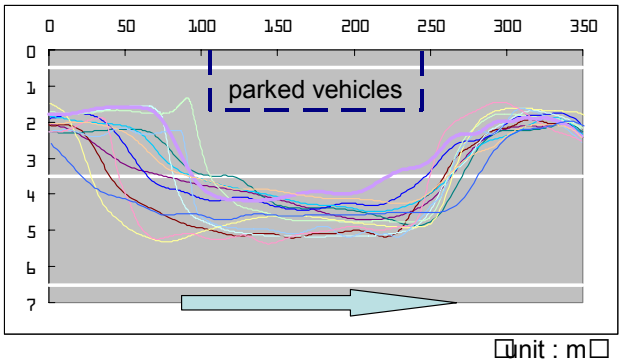

Figure 6. Driving trajectories

5.2. Analysis on individual data

Figure 7 shows a sequence of several driving data, that is, steering wheel angle, vehicle speed, acceleration / deceleration ratio and brake pedal stroke associated with vehicle trajectory. From this figure, we can see at the entrance point, the driver takes several actions, such as steering and accelerating / braking, in order to get into the adjacent lane. If these values exceed a certain threshold, it may cause some dangerous situation.

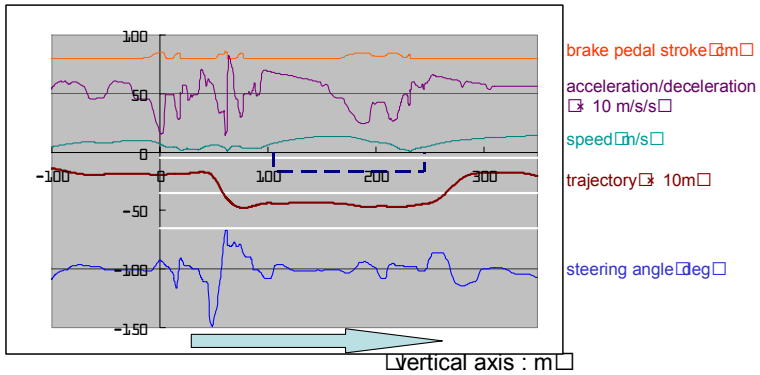

Figure 7. Individual driving data

5.3. Analysis on questionnaire

Subjective evaluation by testees is also done using questionnaire survey. Figure 8 shows whether testees felt dangerous or not on each of the patterns of lane marking Compared with pattern B and C, testees feel more dangerous in the pattern A, a situation of illegal parking.

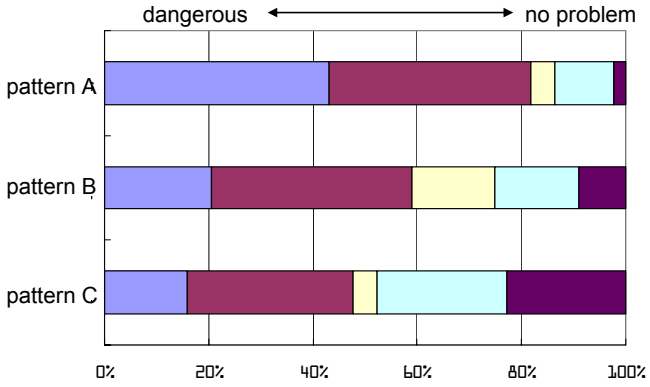

Figure 8. Subjective evaluation

Figure 9 shows the result asking which was the most preferable pattern of marking and why the pattern was preferred. Drivers who preferred the pattern B raised no need of lane change, while drivers for pattern C find an advantage in wide lane configuration.

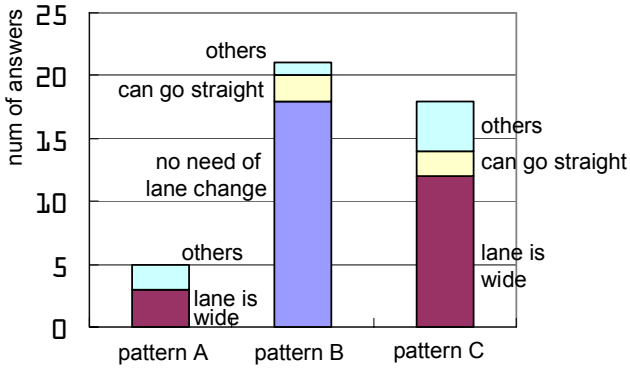

Figure 9. Reason of lane marking preference

6. Conclusion

From the analysis based on the experiment so far, testees feel uneasiness or danger in the pattern A, which is similar to illegal parking situation. Therefore, it would be justified to make some types of parking lane. We are continuing to analyze the driving data in more precise way, for example, considering relative relationship with surrounding vehicles. It may reveal which geometric design of parking lane is desirable and which location of the section potentially become dangerous, and so on.

The result of the data analysis will be used to update the vehicle behavior model in the microscopic traffic simulator of the virtual reality traffic experiment system. Then, it will be used to evaluate proposed parking scheme including traffic flow efficiency analysis.

References

[1] T. Shiraishi, H. Hanabusa, M. Kuwahara, E. Chung, S. Tanaka, H. Ueno, Y. Ohba M. Furukawa. K. Honda, K. Maruoak, T. Yamamoto: Development of a Microscopic Traffic Simulation Model for Interactive Traffic Environment, *12th ITS World Congress Proceedings,* 2004

[2] Y. Suda, Y. Takahashi, M. Onuki, H. Komine: Development of the Universal Driving Simulator for ITS researches, *13th ITS World Congress Proceedings,* 2005