

Driver Behavior Model for ITS Evaluation System

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In this paper, we introduce a driver behavior model that can show realistic behaviors of vehicle. We have developed the system which links macroscopic traffic simulator (TS) with driving simulator (DS). This system can evaluate various ITS services by observing and analyzing both the behavior of DS driver and the effect on the traffic situation. In this system, the behavior of vehicles controlled by this system is required to be similar to that of real vehicles. We construct the driver behavior model which contains sub-modules for perception of information about nearby vehicles, judgment and action selection, the modules are applied for various situations. Using this driver behavior model and a vehicle dynamics model, we can simulate realistic vehicle behavior decided by interactions with neighboring vehicles.

Keywords: ITS, simulator, driver behavior model

1. Introduction

Driver behavior model is an important issue in microscopic traffic simulation. Driver behaviors are typically composed of car-following behavior, lane changing behavior and free running behavior.

P. G. Gipps presented his car-following model for computer simulation in 1981 [1]. This model is derived by setting limits on the performance of driver and vehicle and using these limits to calculate a safe speed with respect to the preceding vehicle. It is presumed that the driver of the following vehicle can bring his vehicle to a safe stop when the vehicle ahead came to a sudden stop. X. Fang et al identified gain parameters of PD controller car-following model based on real traffic data, and reported the PD controller car-following model is a realistic and efficient model by comparing the simulation results with the experimental results [2].

Lane changing behavior is complicated and difficult to design its model because of involving a high level of interaction between the vehicles. P. G. Gipps proposed a lane change decision model [3]. This model was represented as a flow chart which consists of some questions about the factors that are assumed to influence drivers to change lanes. P. Hidas proposed a classification of the maneuver into free, forced, and cooperative lane changes based on observed traffic data, and developed the lane change model incorporating explicit modeling of vehicle interactions using intelligent agent concepts [4].

Many other driver behavior models are proposed which are implemented in microscopic traffic simulators such as MITSIM, AIMSUN and Paramics. However, the major problems of traffic simulator such as computational

performance, the accuracy of models in representing the traffic flow have not been solved yet.

We have developed the Mixed Reality Traffic Experiment Space [5] [6] [7]. As shown in Figure 1, this system consists of systematic connections between a Virtual Experiment Laboratory (VEL), which connects a macroscopic traffic simulator (TS) with a driving simulator (DS) via a microscopic traffic simulator KAKUMO, and the Real Observation Laboratory (ROL), which observes and analyzes real traffic environment.

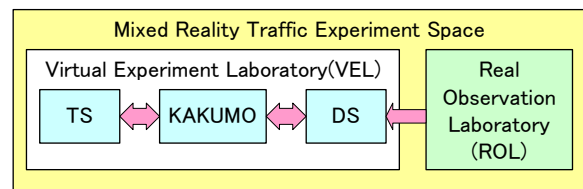


Figure 1. Structure of Mixed Reality Traffic Experiment Space

This system creates a realistic virtual traffic space using the traffic situation produced by the TS and the surrounding image compounded computer graphics and real images observed by the ROL. In this system, the behaviors of the DS driver can be observed and analyzed. Reflecting the behavior of the DS vehicle to the TS, the effects of behavior of one driver on the traffic situation can be analyzed. Using this system, we can evaluate various ITS services by observing and analyzing both the behavior of the DS driver and the effect on the traffic situation.

In order that this system becomes useful, the vehicles around the DS vehicle should show realistic behaviors, so that the DS driver has no incompatibility about surrounding vehicles, and the behaviors of

surrounding vehicles of the DS vehicle should be consistent with real traffic flow macroscopically.

In this paper, we introduce a driver behavior model which generates the behaviors of vehicle, car-following behavior, lane changing behavior, free running behavior and so on. This model decides next behavior of a vehicle based on traffic situation, and calculates operations for executing the behavior. The behavior of vehicle is generated by the operation and a vehicle dynamics model.

This paper is organized as follows. Section 2 explains the role and requirements of KAKUMO. Section 3 details the structure and algorithm of the driver behavior model proposed. Section 4 describes the vehicle dynamics model. Section 5 shows results of macroscopic valid experiment and performance experiment. Section 6 provides conclusion and discusses future work.

2. KAKUMO

The driver behavior model explained in this paper is implemented on microscopic traffic simulator KAKUMO. KAKUMO is a part of the VEL and it has a role to absorb the difference of specifications between the TS and the DS. Table1 shows the difference of specifications of the TS, KAKUMO and the DS.

Table1. Differences of TS, KAKUMO and DS

	Traffic Simulator (TS)	KAKUMO	Driving Simulator (DS)
Area scale	Wide Area (Within a radius of several hundred metre to several km)	A part of the TS area that covers the DS area	A part of the KAKUMO area that covers driver's view
Time scanning	1Hz	20Hz	60Hz
Precision of network data	1 m	1 cm	1 cm
Movement theory of vehicles	By flow quantity calculation	By the acceleration and speed	By the scenario (not equipped theory)

The TS simulates the traffic situations in a wide-area network such as a whole city every one second. In the TS, traffic is modeled as a continuous flow and the speed of vehicles is calculated by using speed-density relations. The DS simulates the microscopic behavior of a vehicle according to the DS driver's operations in real time. The surrounding images are represented every 1/60 second.

KAKUMO simulates the behaviors of vehicles in a KAKUMO area, which is a part of the TS network area, precisely at 1/20 second intervals. The behaviors of vehicles controlled by KAKUMO are sent to the DS, interpolated to every 1/60 second and projected as surrounding vehicles in the visual system of the DS. Figure 2 shows the functions of KAKUMO.

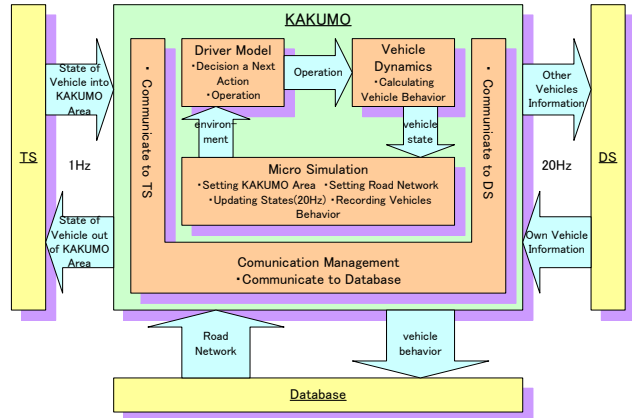


Figure 2. Functions of KAKUMO

KAKUMO needs to satisfy three requirements as follows.

1) High-precision behaviors of vehicles

The behaviors of vehicles which are calculated using the driver behavior model and the vehicle dynamics model on KAKUMO must be similar to those of real vehicles so that the DS driver has no incompatibility about surrounding vehicles.

2) Macroscopic consistency with real traffic situation

KAKUMO simulates the behaviors of vehicles in the KAKUMO area, which is a part of TS area. Therefore, the traffic situations simulated by KAKUMO must be accordance with those by the TS macroscopically.

3) Computational performance

KAKUMO is planned to control about 500 vehicles simultaneously in the KAKUMO area. Therefore, the calculation of the driver behavior model and the vehicle dynamics model for 500 vehicles must complete within 1/20 second.

3. Driver Behavior Model

3.1. Structure of the Driver Behavior Model

The driver behavior model we proposed is composed of a cognition module and some action modules. The cognition module recognizes the position and velocity of surrounding vehicles. The cognitive errors of a driver can be implemented in this module. At present cognition module, the simple cognitive error model is implemented, in which the recognized position and relative velocity of surrounding vehicles include random errors.

The action modules decide next behavior based on the recognized traffic situation, and calculate operations for executing the behavior. Figure 3 shows the driver behavior model for expressway, which has the action modules of left lane change, right lane change, car-following and free-running.

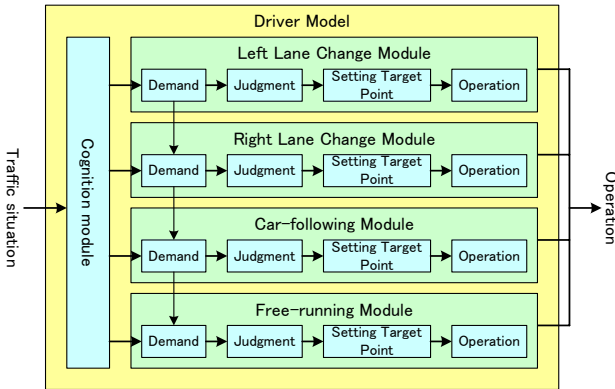


Figure 3. Structure of Driver Behavior Model

In each action module, demand, judgment, setting target point and operation sub-modules are defined. Demand sub-module has the function to ascertain whether the action of the module is required or not, based on information from the cognition module. If the action is required, the output of demand sub-module is “true”, and judgment, setting target point and operation sub-modules of the module are executed. In judgment sub-module, whether the action of the module is possible to carry out immediately in the surrounding traffic situation is judged. In setting target point sub-module, a virtual target point is set according to the rules of selected action module. The virtual target point is the model of driver’s viewpoint and represents his (her) intended position and velocity of his (her) vehicle after a short-time. For example, in car-following module, the virtual target point is set to forward vehicle, and in free-running module, set ahead of the center of present lane. In operation sub-module, the amount of operation such as acceleration/brake pedal operation is calculated by the feedback controller which drives a vehicle to follow the virtual target point.

The merits of this model’s structure are as follows.

- The amount of calculation is reduced by calculating only the sub-modules of the action module selected by demand sub-module.
- It is easy to add a new action. By adding new action modules, new actions can be defined and executed.

3.2. Algorithm of Driver Behavior Model

The procedure of the driver behavior model for calculating operation is presented in Figure 4. In this figure, left lane change module, right lane change module, car-following module and free-running module in this order are ascertained whether the action is required or not.

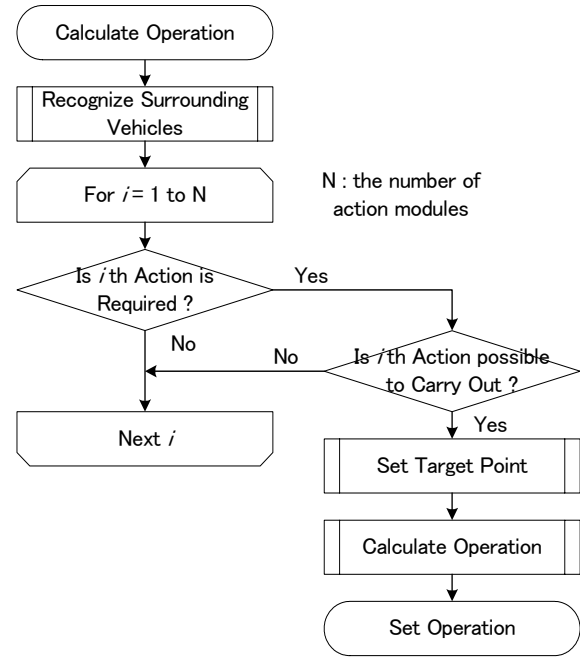


Figure 4. Flow-chart of the Driver Behavior Model

Next, the sub-modules of demand, judgment, setting target point and operation of each action module are explained in detail.

3.2.1. Car-following Module

Demand: The output of demand sub-module becomes “true” if the situation of the subject vehicle meets any of following conditions.

- 1) Forward vehicle of present lane exists and the distance between the subject vehicle and the forward vehicle is shorter than the desired distance, which is defined as a function of the subject vehicle’s velocity.
- 2) There is a vehicle ahead in the lane to the left (right), which wishes to lane change to the right (left), and the distance from the subject vehicle to this forward vehicle is shorter than the desired distance.

Judgment: The output of judgment sub-module is true always.

Setting target point: Virtual target point is set ahead of the subject vehicle in the present lane. The distance from the subject vehicle to the virtual target point is equal to a distance from the subject vehicle to a target vehicle, which is defined as the nearest vehicle of followings.

- a) Forward vehicle on the present lane,
- b) Forward vehicle on the lane to the left (right), which wishes to lane change to the right (left).

The velocity of the target vehicle is substituted for the velocity of the virtual target point. If the velocity of target vehicle is bigger than the desired velocity of the subject vehicle, the velocity of the virtual target point is set to the desired velocity of the subject vehicle.

Operation: The amount of operations such as acceleration/brake pedal operation are calculated by the feedback controller which keeps the distance to the virtual target point at a desired distance and keeps velocity of the subject vehicle at the velocity of the virtual target point.

$$\begin{aligned} acc &= k_p (D^T - D^{des}(V)) + k_d (V^T - V), \\ brk &= -1 \times acc \quad \text{if } acc < 0. \end{aligned} \quad (1)$$

where,

acc : Acceleration pedal operation amount

brk : Brake pedal operation amount

V^T : Velocity of the virtual target point

V : Velocity of the subject vehicle

D^T : Distance from the subject vehicle to the virtual target point

$D^{des}(V)$: Desired distance from the subject vehicle to the virtual target point at current velocity V

k_p, k_d : Feedback gains

When the velocity of the target vehicle is smaller than the desired velocity of the subject vehicle, the velocity of the subject vehicle becomes equal to the velocity of the target vehicle and keeps the distance between the target vehicle and the subject vehicle at the desired distance. When the velocity of the target vehicle is larger than the desired velocity of the subject vehicle, the velocity of the subject vehicle is set to the desired velocity of the subject vehicle and if the distance between the target vehicle and the subject vehicle is larger than desired distance, the output of demand sub module of car-following module becomes false and the behavior of subject vehicle becomes free-running.

The steering angle is calculated by the feedback controller which keeps the difference of angle of the subject vehicle and angle of direction from the subject vehicle to the virtual target point at zero and keeps the difference of position of the subject vehicle and position of the virtual target point in A-coordinate.

$$hdl = k_h (\theta^T - \theta) + k_a (p_A - p_A^T). \quad (2)$$

Where,

hdl : Angle of steering wheel

θ^T : Angle of the virtual target point

θ : Angle of the subject vehicle

p_A : Position of the subject vehicle in latitude coordinates

p_A^T : Position of the virtual target point in latitude coordinates

k_h, k_a : Feedback gains

LA-coordinate system is rectangular coordinate to represent position of vehicle. L-axis is parallel to road direction and A-axis is at right angles to road direction shown in Figure 5.

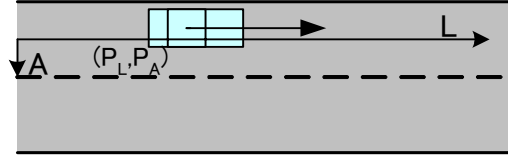


Figure 5. LA Coordinates

3.2.2. Free-running Module

Demand: The output of demand sub-module becomes “true” if the outputs of demand sub-module of all other modules are “false”.

Judgment: The output of judgment sub-module is true at all time.

Setting target point: Virtual target point is set at the desired distance ahead from the subject vehicle in the present lane. The desired velocity of the subject vehicle is substituted for the velocity of the virtual target point.

$$\begin{aligned} D^T &= D^{des}(V), \\ V^T &= V^{des}. \end{aligned} \quad (3)$$

where,

V^{des} : Desired velocity of the subject vehicle

Operation: Acceleration/brake pedal operation amount are calculated in the same way as in the car-following module.

$$\begin{aligned} acc &= k_p (D^T - D^{des}(V)) + k_d (V^T - V) \\ &= k_d (V^{des} - V), \end{aligned} \quad (4)$$

$$brk = -1 \times acc \quad \text{if } acc < 0.$$

The steering angle is calculated in the same way as in the car-following module.

3.2.3. Left (Right) Lane Change Module

Demand: The output of demand sub-module becomes “true” if the situation of the subject vehicle meets any of the following conditions.

- 1) Present lane is not connected the target path but left (right) lane is.
- 2) Forward vehicle runs slower than desired velocity of the subject vehicle.

Judgment: The output of judgment sub-module becomes “true” if the situation of the subject vehicle meets all following two conditions.

- 1) The distance from the subject vehicle to the forward vehicle on the lane to the left (right) is longer than the permissible distance which is defined as a function of the velocity of the subject vehicle relative to the forward vehicle on the lane to the left (right).
- 2) The distance from the subject vehicle to the rear vehicle in the lane to the left (right) is longer than the permissible distance.

Setting target point: The method to set a virtual target point varies according to action phases as in Figure 6.

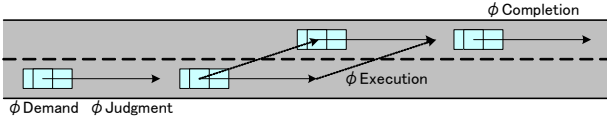


Figure 6. Action Phases and Virtual Target Point in Lane Changing.

When changing lane, drivers conduct a series of operations as follows.

1. Activate turn signal
2. Ascertain whether the distances to forward vehicle and to rear vehicle on neighboring lane are sufficient to change lane or not.
3. If the distances are judged to be sufficient, begin to change lane.
4. After lane changing, turn off turn signal.

In lane change module, the action phases are introduced which is composed of demand, judgment, execution and completion phases. Figure 7 shows the sequence of the action phases in lane changing. If the output of demand sub-module of the lane change module is “true”, the model enters the demand phase and turns on the turn signal. After T_1 seconds, the model enters the judgment phase and starts to judge whether the lane changing is able to be executed or not. When the result of judgment becomes true, the model enters the execution phase, and lane changing is executed for T_2 seconds. When lane changing is finished, the model enters the completion phase, and after T_3 seconds, turns off the turn signal. If the output of demand sub-module becomes “false” in judgment phase, the lane change action is canceled.

In this model, the turn signal is activated in demand phase because the signal is utilized to inform the surrounding vehicles, including the DS vehicle, of the subject vehicle's desire to make a lane change, although it is natural that the signal is activated in execution phase depending on circumstances.

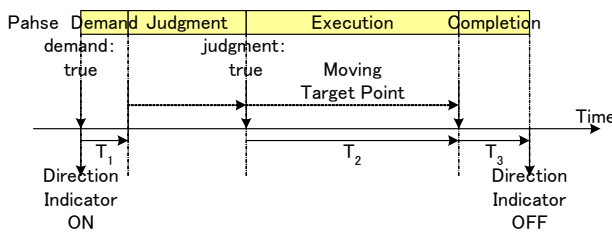


Figure 7. Transition of Action Phases

In the demand and judgment phases, the virtual target point is set ahead of the present lane. In the execution phase, the virtual target point is continuously moving from ahead of present lane to ahead of the lane to

the left (right). In the completion phase, the virtual target point is set ahead of the lane to the left (right).

1) If the virtual target point is set ahead of the present lane, the virtual target point is set to the distance ahead, which is the shortest of the followings.

- a) Desired distance from the subject vehicle to the virtual target point at current velocity $D^{des}(V)$
- b) Actual distance from the subject vehicle to the forward vehicle
- c) Distance from the subject vehicle to the forward vehicle on the lane to the left (right), which wishes to change lane to the right (left).

If the virtual target point is set on desired distance ahead, the velocity of the virtual target point is set to the desired velocity of the subject vehicle. Otherwise the velocity of the virtual target point is set to the velocity of the target vehicle. If the velocity of target vehicle is bigger than the subject vehicle's desired velocity, the desired velocity of the subject vehicle is substituted for the velocity of the virtual target point.

2) If the virtual target point is set ahead in the lane to the left (right), the virtual target point is set at a distance which is the shortest of the followings.

- a) Desired distance from the subject vehicle to the virtual target point at current velocity $D^{des}(V)$
- b) Distance from the subject vehicle to the forward vehicle in the lane to the left (right)
- c) Distance from the subject vehicle to forward vehicle on the present lane, which wishes to make a lane change to the left (right)

The velocity of the virtual target point is set in the same way to 1).

3) If the virtual target point is moving ahead from the present lane to the lane to the left (right), the virtual target point moves along a line segment connecting the two points, 1) the point on the present lane and 2) the point on the left (right) lane, which are calculated as mentioned above.

$$x^T = \frac{t}{T_2} x_F^T + \frac{T_2 - t}{T_2} x_{LF}^T, \quad (5)$$

$$y^T = \frac{t}{T_2} y_F^T + \frac{T_2 - t}{T_2} y_{LF}^T.$$

Where,

(x^T, y^T) : Position of the virtual target point

(x_F^T, y_F^T) : Position of the virtual target point on present lane which is calculated in 1)

(x_{LF}^T, y_{LF}^T) : Position of the virtual target point on lane to the left which is calculated in 2)

T_2 : Time to execute the lane change

t : Time from the time execution phase started ($0 \leq t \leq T_2$)

The velocity of the virtual target point is calculated from velocity of two points as follows.

$$V^T = \frac{t}{T_2} V_F^T + \frac{T_2 - t}{T_2} V_{LF}^T. \quad (6)$$

Where,

V_F^T : Velocity of the virtual target point on present lane

V_{LF}^T : Velocity of the virtual target point on the lane to the left (right)

Operation: The amount of operations such as acceleration/brake pedal operation are calculated by the feedback controller which keeps the distance to the virtual target point at a desired distance and keeps velocity of vehicle at velocity of the virtual target point.

$$acc = k_p (D^T - D^{des}(V)) + k_d (V^T - V), \quad (7)$$

$$brk = -1 \times acc \quad \text{if } acc < 0.$$

The steering angle is calculated by the feedback controller which keeps the difference of angle of the subject vehicle and angle of direction from the subject vehicle to the virtual target point at zero.

$$hdl = k_h (\theta^T - \theta). \quad (8)$$

4. Vehicle Dynamics Model

Vehicle dynamics model generates the state of the vehicle based on driver's operations, such as steering wheel and accelerator or brake pedal operation. In order to maintain calculation time in 1/20 second or less, the vehicle dynamics model explained in this paper are calculated with first-order differential equations.

The vehicle dynamics model is expressed in the following equations.

$$F = \begin{cases} k_1 acc - k_2 V - k_3 & acc > 0, \\ -k_4 brk - k_2 V - k_3 & brk > 0. \end{cases} \quad (9)$$

$$F = F + Mg \sin(\varphi) \cos(\Delta\theta),$$

$$V = V + \frac{F}{M} \Delta t,$$

$$X = X + V \cos(\theta) \Delta t,$$

$$Y = Y + V \sin(\theta) \Delta t,$$

$$\sigma_T = \sigma_S / 17.0,$$

$$\theta = \theta + \sigma_T V \Delta t.$$

Where,

F : Force to vehicle

M : Mass of vehicle

g : Acceleration of gravity

φ : Angle of inclination of road

$\Delta\theta$: Difference of angle of vehicle with angle of road.

$k_i (i = 1, \Lambda, 4)$: Feedback gain parameters

Δt : sampling time

(X, Y) : Position of vehicle

σ_T : Angle of tires

σ_S : Angle of steering wheel

First equation means that the force to a vehicle is calculated from acceleration/brake pedal operation amount and velocity of the vehicle. Second equation represents the effect of gravity in case that road is inclined. Third equation represents the transition of velocity of the vehicle. Forth and fifth equations represent the transition of position of the vehicle. Sixth equation means that angle of tires is calculated from angle of steering wheel. Seventh equation represents the transition of angle of the vehicle.

5. Experiment

In this section, we show the results of experiments which demonstrate that by using the proposed driver behavior model, KAKUMO satisfies the requirements.

As concerns accuracy of vehicle's behavior, by experiments of the Mixed Reality Traffic Experiment Space, we have acquired the estimations from the DS drivers that the behaviors of surrounding vehicles, which are controlled by the driver behavior model, are similar to those of real vehicles, and they rarely have incompatibility about neighboring vehicles.

Here, the results of experiments about the following two requirements are shown.

- Macroscopic consistency with real traffic situation
- Computational performance

5.1 Macroscopic Valid Experiment

The purpose of this experiment is to show the simulation result by KAKUMO is consistent with real traffic situation macroscopically. The simulation results of KAKUMO are compared with the actual measurement data about the traffic volume and the average velocity of vehicles (Q-V) correlation as a macroscopic index.

Figure 8 shows the object road, the Metropolitan Expressway Route No.3, between Takagicho and Tanimachi. The positions of detectors in simulation are represented as A, B, C, and junctions as 1, 2, 3 in this figure.

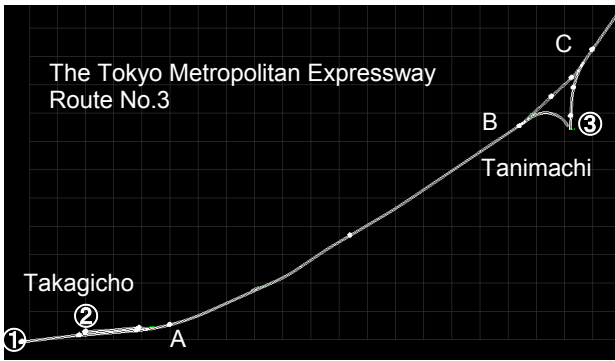


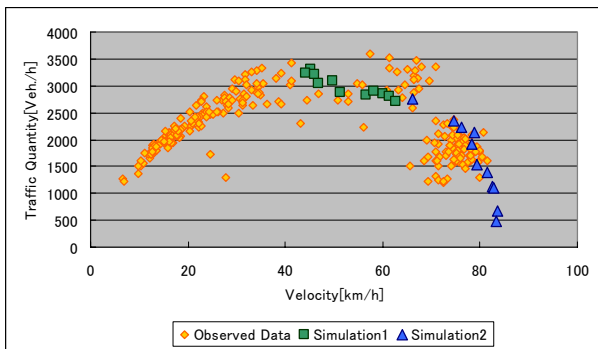
Figure 8. Object Road

In simulation 1, the traffic volumes observed at actual traffic sensors every 5 minutes flow into the junctions of KAKUMO, and in simulation 2, the traffic volumes are changed from 500 vehicles/hour/lane to 2500 vehicles/hour/lane incrementally at 10-minute intervals. Table2 shows the traffic volume into junctions.

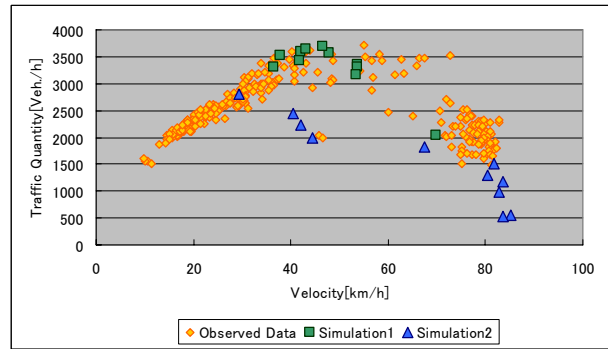
Table2. Traffic Volume (vehicles/h/lane) at Junctions

Simulation1				Simulation2			
Time	Junction			Time	Junction		
	①	②	③		①	②	③
7:30-7:35	1656	1668	1212	7:30-7:35	500	0	500
7:35-7:40	1560	1572	1488	7:35-7:40	500	0	500
7:40-7:45	1656	1656	1152	7:40-7:45	1000	0	1000
7:45-7:50	1452	1452	1404	7:45-7:50	1000	0	1000
7:50-7:55	1560	1560	1632	7:50-7:55	1500	0	1500
7:55-8:00	1464	1476	1644	7:55-8:00	1500	0	1500
8:00-8:05	1344	1356	1404	8:00-8:05	2000	0	2000
8:05-8:10	1416	1428	1716	8:05-8:10	2000	0	2000
8:10-8:15	1512	1524	1656	8:10-8:15	2500	0	2500
8:15-8:20	1464	1476	1620	8:15-8:20	2500	0	2500
8:20-8:25	1560	1560	1764				
8:25-8:30	1524	1524	1716				

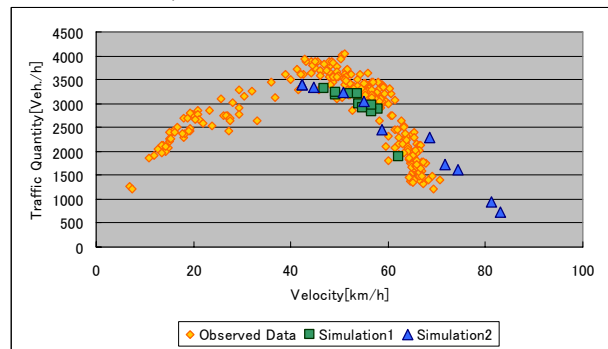
Figure 9 shows the Q-V curves of the simulation results. Actual measured data is a day's data, the number of vehicles and the average of speed of vehicles passing over detectors for 5-minutes.



a) Q-V Curve of Position A.



b) Q-V Curve of Position B.



c) Q-V Curve of Position C.

Figure 9. Q-V Curves

The results of the simulation by KAKUMO are visually similar to the Q-V curves plotted by measured data. Therefore, the traffic situations simulated by KAKUMO seem to accord with actual traffic situations macroscopically.

The high traffic volume situation observed in reality was not able to be simulated by KAKUMO. It is thought that one of the causes is the deceleration of vehicles by interactions with neighboring vehicles at junctions.

5.2 Performance Experiment

The purpose of this experiment is to show the time to calculate the driver behavior model and the vehicle dynamics model is short efficiently. In this experiment, computer clock times before and after the calculation of the driver behavior model and the vehicle dynamics model of vehicles traveling in the KAKUMO area are recorded, and the difference between the two times is considered as the calculation time. The experimental environments are as follows:

Computer: DELL Dimension 8300
CPU: Intel Pentium4 3.0GHz
Memory: 1.0GB
Object road: The Tokyo Metropolitan Expressway Route No.3

The result of the experiment is shown in Figure 10. Suppose that there are 500 vehicles traveling in the

KAKUMO area, the calculation time is about 1.8 millisecond. It is thought that this time is short sufficiently, in spite that KAKUMO must communicate to the TS and the DS in addition to calculating the driver behavior model and the vehicle dynamics model within 1/20 second.

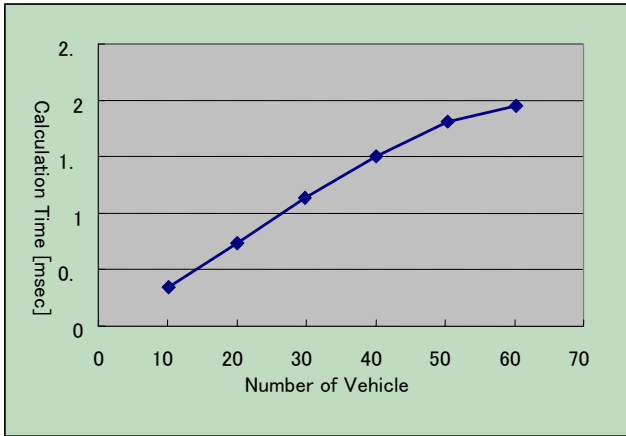


Figure 10. Relation of Number of Vehicles and Calculation Time

In this experiment, the result that the calculation time is short enough is obtained. However, the calculation time is varied by the conditions of simulation. If a road link is long and many vehicles are traveling on the road link, the calculation time becomes long. By adding new action modules, the calculation time increases. The methods to shorten the calculation time are proposed below.

1. Movement of the KAKUMO area: If the KAKUMO area can move according to the DS vehicle, the KAKUMO area and thus the number of vehicles in the area can be reduced, and the calculation time can be shortened in result.
2. Restriction of action modules: By restricting selectable action modules according to road configuration and traffic situation, the time to calculate behavior of vehicle can be shortened.

6. Conclusion

We have developed the ITS evaluation system, Mixed Reality Traffic Experiment Space, which links TS with DS and evaluates various ITS services by observing and analyzing both the behavior of the DS driver and the effect on the traffic situation. In this system, the behaviors of vehicles around the DS vehicle are required to be similar to those of real vehicles. In this paper, we proposed a driver behavior model which can generate realistic behaviors of vehicle. The proposed model is composed of a cognition module and some action modules. In this model, one action module is selected based on traffic situation information through the cognition module, and sub-modules of judgment, setting

target point and operation of the selected action module are executed. In setting target point sub-module, the virtual target point is set according to the rules of selected action module, and the amount of operations is calculated to follow this virtual target point. Experiments showed that the traffic situations simulated by the microscopic traffic simulator, which includes the proposed driver behavior model, accord with actual traffic situations macroscopically and the time to calculate the driver behavior model and the vehicle dynamics model is sufficiently short.

In the future, we plan to extend the driver behavior model to city streets by adding action modules to stop, go through, turn left and turn right and so on. We will create simulation environments which can simulate and estimate various traffic situations on all kinds of places in Mixed Reality Traffic Experiment Space.

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