The Actual Simulation of Road Traffics by PIMTRACS (The Traffic Simulation System by PIM)

1)Michiya TAKAHASHI 2)Youhei HIBIYA 1)Takahiro FUCHISAWA
1)Toshio NAKANISHI 2)Tomokazu FUJIKURA

1)Seikei University 2)Kyosan Electoric MFG. CO.,LTD.

Abstract The article describes the actual simulation of road traffics by PIMTRACS and the performance evaluation of traffic flow control according to the difference of signal control systems. In the simulation of road traffic system, how to represent the roads themselves and their network, the vehicles and signal facilities is essential and their mutual relationships should also be taken into consideration. It should be noted that the related information becomes enormous depending upon the road network scale. In the actual, practical model building and simulation execution it is indispensable to incorporate the bulky information effectively into the model and make the best use of them.

The computer system PIM(Parallel Inference Machine) features the object-oriented characteristics. PIMTRACS makes the most of it and realized the description of microscopic vehicle behaviors. In our system a model of fundamental vehicle is built firstly and it is possible to generate a group of vehicles easily by making copies of the fundamental vehicle, and also to generate various vehicles of all kinds through the alteration of parameters. The signal and road representation is made in the similar way.

The traffic flow is generally affected by the signal control patterns. The relationship of both factors is often surveyed through the statistical methodology such as occupancies, V-Q, and so on, but in actual cases, it is required to observe the system status chronologically in detail. PIMTRACS have taken it into consideration and on-line and interactive features have been incorporated. The graphical presentation of queues is an example.

This paper reports the model structure based on the actual roads. The traffic flow and its related input data like individual vehicle data, the signal pattern information, and also the simulation execution based on them and its evaluation.

Another important purpose of our study is the more efficient use of PIM for road traffic flow simulation.

1. INTRODUCTION

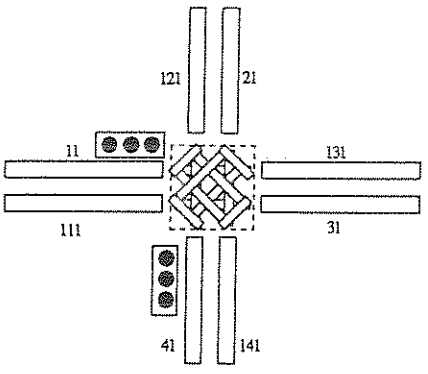
As stated in the paper "The Development of Road Traffic Simulator (PIMTRACS) by PIM", PIMTRACS is a general purpose road traffic system simulator implemented with Parallel Inference Machine (PIM). PIM is a computer system developped on the new and innovative architecture and it is very important that a simulator implemented newly with such an advanced parallel-processing-oriented computer system should be verified as to its validity through actual simulation.

The article includes a report of actual simulation execution with PIMTRACS and related consideration.

2. A TEST MODELS AND SIMULATION EXECUTION BY PIM

2.1 Test Model 1

To begin with, a test model was built and simulation was executed with it. The test model is a model with one intersection illustrated in Fig. 1.



Outflow	Intersection	Inflow
11	511	121
11	521	131
11	531	141
21	541	131
21	551	141
21	561	111
31	571	141
31	581	111
31	591	121
41	601	111
41	611	121
41	621	131

Fig.1 One intersection model

The measuring point of time occupancy (Ot) was seleced at the intermediate location of the road 11 (100 meters apart from the intersection) and a simulation was executed with variable traffic generation.
Fixed initial conditions with the model are as follows

a)Signal intervals (cycle and split)
For road 11, 31 ----- 40 seconds green, 5 seconds yellow (30 seconds red)
For road 21, 41 ---- 20 seconds green, 5 seconds yellow (50 seconds red)
For both ----- 5 second red

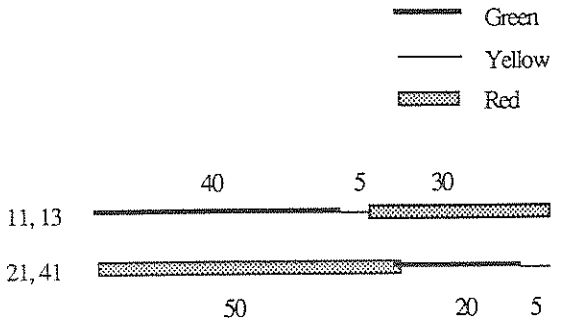


Fig.2 Signal Time Chart

b)Simulation execution time
Warm up hours *1 ----- 30 minutes
Effective simulation hours ----- 30 minutes

c)Simulation cycle time ----- 0.1 sec.

Vehicle were generated in conformance with the statistics shown in the traffic flow rate and time occupancy (Fig.3). Fig.3 shows that the time occupancy is approximately proportional to the traffic flow rate so far as the occupancy lies between 0 and 30. But the traffic theory tells that this property is lost if the occupancy exceeds 30. The data sampled from actual field start to be scattered around the linear line and the tendency becomes more and more unpredictable. So our simulation model chose the normal condition and we could obtain simulation results which conform well to the traffic theory, which assured us that PIMTRACS works well with enough modelling validity.

2.2 Test Model 2

The second model took notice of waiting time of vehicles. The model itself is similar with model 1 with 1 intersection. Although the interval of vehicle generation was set to constant, variable signal intervals were incorporated for giving direct influence to traffic congestion. The 2 location on the road 11 and 21 were chosen as observation points of vehicle queue length and waiting time.

*1 the time period necessary to realize the stationary situation in a sense.

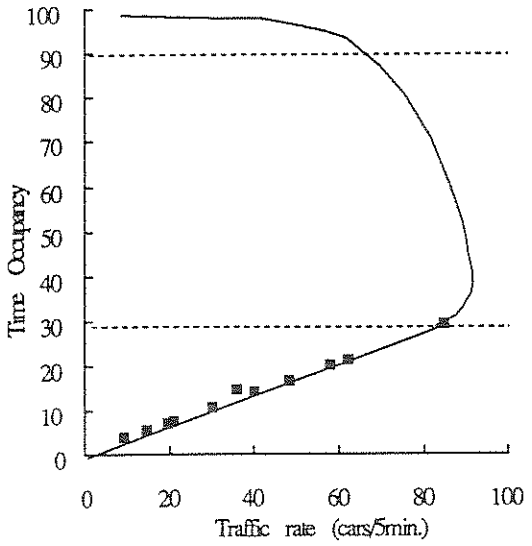


Fig.3 Traffic rate vs time occupancy

a)Vehicle generation intervals
Constant intervals were chosen as follows.
For road 11 10±1 sec.
For road 21 15±1 sec.
For road 31 15±1 sec.
For road 41 20±1 sec.

b)Simulation execution time
Warm up hours ----- 30 minutes
Effective simulation hours ----- 30 minutes

c)Simulation cycle time ----- 0.1 second

d)Signal intervals (for 4 simulation)
For road 11, 31 ----- (20,30,40,50) seconds green, 5 seconds yellow
For road 21, 41 ----- (20,30,40,50) seconds green, 5 seconds yellow
For both 5 seconds red

This is basically, the fixed cycle signal system. The signal for crossing traffic is adjusted by five seconds, that is the red signal phase for both.
The simulation results of this model show that the higher the average speed of road section is, the shorter the average queue length will be.

These results are considered to be very reasonable. They are shown in Fig.4

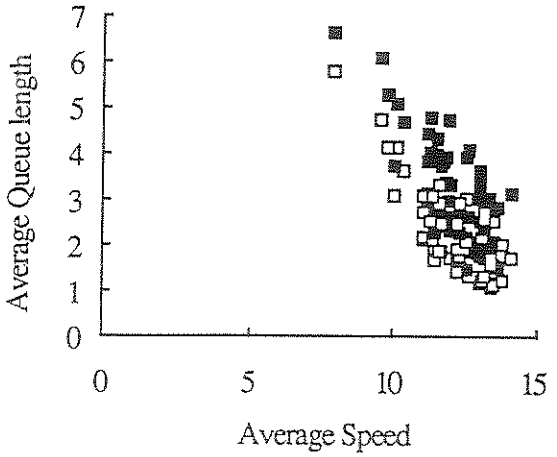


Fig.4 The average speed of road section vs. the average queue length

3.THE SIMULATION OF ACTUAL MODEL

The true validity check chould be through the simulation of actual model.

Thus an intersection and related roads of Kichijoji (The University of Seikei is located near by.) were chosen as an example model. The intersection in Fig.6 illustrates the crossing of Itsukaichi street and Seikei street.

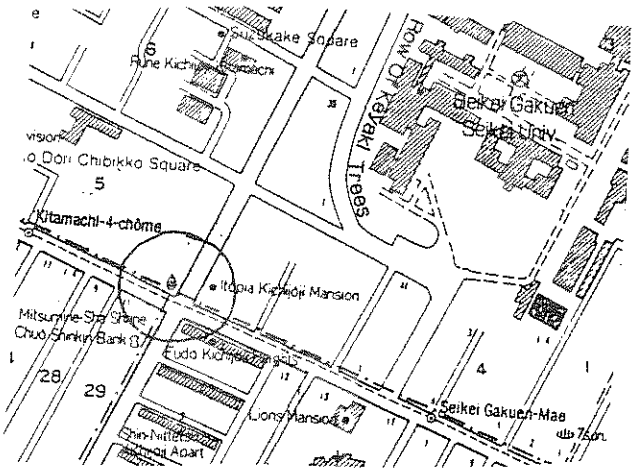


Fig.5 A map around Example Model

Both streets have 1 lane road for one direction, and only the road from left to right (Itsukaichi St.) has a right turn zone of about 30 meters (right turn cars have to wait here for some time until they find any safe moment without any oncoming cars.)

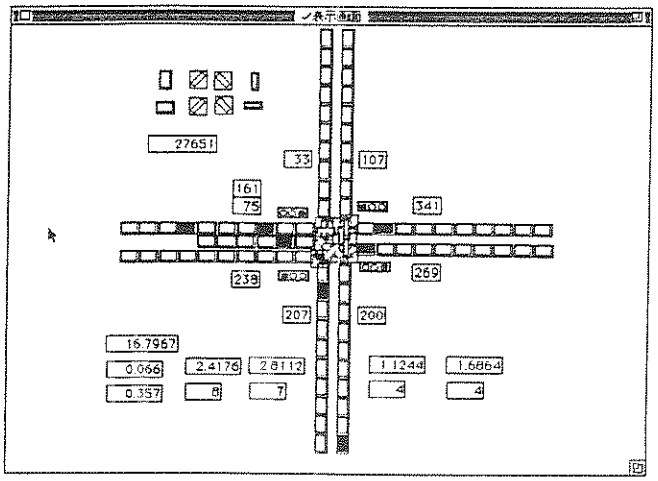


Fig.6 A Display Output of PIMTRACS

There is no bus stop and no special zone of no parking or no stopping which are usually found in front of police station or fire station. At this intersection right turns and left turns are not prohibited. The model includes the four wings of 75 meters road sections.

The related data were gathered manually by numbering counters because no video camera or other automatic means could be applicable owing to geographical or locational conditions.

a)Data collection date Jan. 17, 1997

b)Collection time zone 50 minutes between 11.20 a.m. and 0.10 p.m.

c)Weather fine

d)Measured items

Waiting line statistics owing to each red signal

The percentages of straight proceeding, right-turn, left-turn vehicles.

The inflow traffic volume into the intersection

Signal phase change time record

A model was built based on the collected and set-up data. The simulation time extended 60 minutes totalling 30 minutes warm up hours and 30 minutes effective simulation hours. The simulation cycle time was chosen to 1 second/cycle.

The simulation statistics extended the traffic flow volume for straght run, right and left turn vehicles, time occupancies at the locations 65 meters apart from the intersection in terms of inflow traffic in the road sections numbered 51, 52, 21, 31, 41 and queue statistics on the inflow road sec-

tions. The simulation results were compared with the actually measured field data. We got the traffic flow proportion at the intersection shown in Fig.7, which nearly coincided with the actually collected data.

The waiting queue statistics for the signal red phases was compared between the simulation results and actual measured data, and some difference was found in terms of maximum queue length in the road 41 and the average waiting time in the road 31 between simulation results and actual measured data, but we judged that they are allowable gaps because the average queue length in the road 41 and the maximum queue length in the road 31 are almost the same between the two (Fig.8).

Thus we considered that PIMTRACS itself and the simulation model through it can bear the practical use in traffic flow simulation.

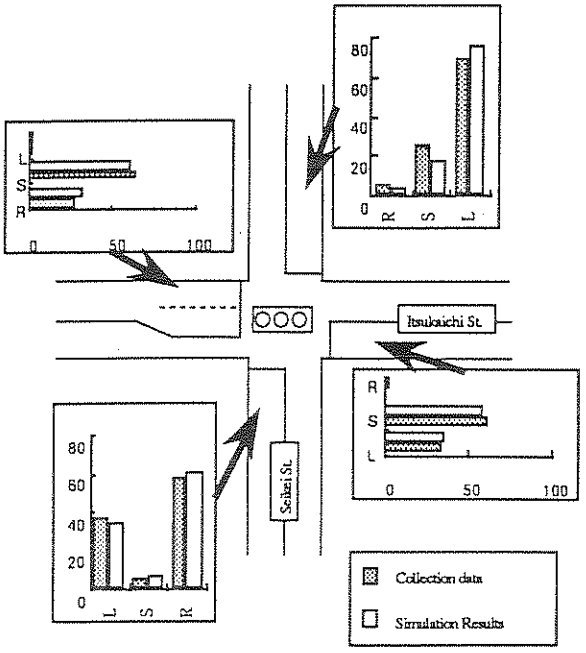


Fig.7 Traffic flow rate in turnning directions

4.CONCLUSION

We have reached the following conclusion through our study

1) The concurrent and parallel simulation of traffic flow composed of vehicles, roads and signals has come to realization through PIM.

2) Practical use or validity check of PIM has been ascertained through the simulation of hypothetical model of one intersection. The simulation has conformed to the conventional traffic flow theory.

3) The practical applicability of PIMTRACS has been verified through the simulation of an actual intersection model incoporated with various actual field data.

4) The required number of tiles used for our PIMTRACS has been reduced up to one-third of the model developed last year. We judge that PIMTRACS has been streamlined pretty well.

5) The visual representation and real time control of simulation run through GUI facility have been realized.

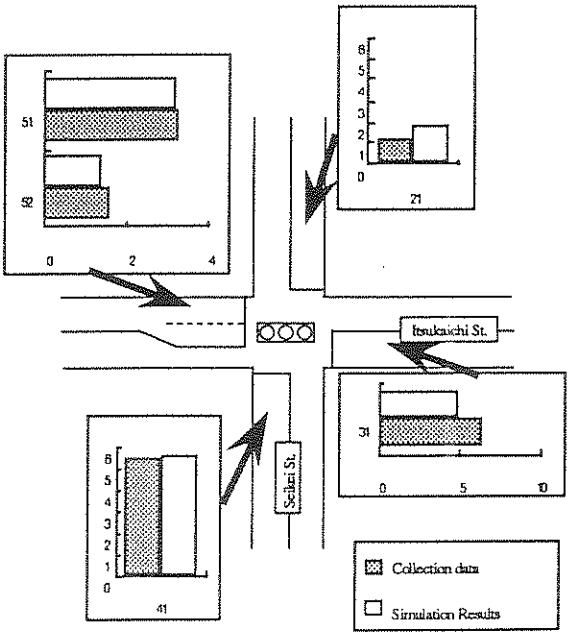


Fig.8 average queue length in each street

5.ACKNOWLEDGEMENTS

The authors express their appreciation to the members of Simulation Study Group and Yasukawa Electric Corp. for their contribution to this paper.

REFERENCES

Toshio Nakanishi, Computer Simulation 1977

Toshio Nakanishi, Simulation 1994

Uno Takaaki, Vehicle Movement and Chassis Mechanism 1994

Fukuda Tadashi, Traffic Engineering 1994

Kawakami Syougo Matsui Kan, Traffic Engineering 1987

Isii Ichirou, etc., Road Engineering 1993