A new Model of the Road Traffic System Simulator PIMTRACS on the PIM

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Abstract: PIMTRACS, which the authors have previously developed, is a road traffic control system simulator on the PIM. PIM stands for Parallel Inference Machine. It was developed under the close cooperation of Yaskawa Electric Corporation (Japan) and Flavors Technology Inc. (USA). It has an innovative architecture and excellent Graphical User Interface (GUI) environment. PIM is a computer system comprised of a number of parallel processor units called "cell" and global shared memory. The program assigned to each cell is called "tile" and is executed synchronously in a fixed cycle. The road traffic system is comprised of a number of elements or entities such as roads (lanes), traffic signals and vehicles. Each instance is assigned to a tile in PIM and processed in parallel. In the simulation of a large scale road traffic system, the number of tiles required in the run is enormous, thereby necessitating a large PIM. Another problem that we have to take into consideration is how to optimize the assignment of instances to tiles. In the previous version of PIMTRACS, several vehicles made up a group and the system did not use the parallel characteristic of PIM enough. Therefore, we improved the independence of each module, and so now the system treats parallel characteristics of all vehicles individually. In this way, we can execute a more sophisticated simulation.

Keywords: Simulation; Road; Traffic; PIM

1. INTRODUCTION

The authors have developed a road traffic system simulator PIMTRACS whitch has pursued effective and useful simulation methodology through "the parallelization of various independent entities" of road traffic system using parallel computer (PIM).

In modern society, vehicles assume an important responsibility in areas such as commuter/freight transportation, for which the related demand is increasing rapidly. The road traffic network which is in charge of traffic flow, is also growing daily. A recent trend is the revision of road facilities and the increase in the number of lanes.

The problem, especially in Japan, is the rapid population increase in urban areas and the insufficient supply of lanes; this causes chronic traffic congestion. Various studies have been conducted to solve these problems and computer simulation is one methodology being used. But the traffic system itself is complicated and the duplicated characteristics of continuity and discreteness of road traffic have prevented a reasonable solution, even when computer simulation has been applied. A difficult problem is the existence of many independent entities such as vehicles, pedestrians, roads, and signal facilities. Conventional computers have not always been able to describe such a model. Modelling through priority description has been a temporary expedient, but has not been completely successful.

One of the countermeasures we have taken is the utilization of PIM. PIM is essentially a computer system suitable for handling parallel events. PIMTRACS is an acronym for the Traffic Simulation System used by PIM. It has enabled the approximate representation of road traffic.

2. A BRIEFING OF PIM

The growth of road traffic systems and the increase of users' needs have promoted the expansion of application software of computer systems, and it has also given birth to the reduced productivity and maintenancability.
PIM is an innovative parallel-processing machine developed in close cooperation of Yasukawa Electric Corporation (Japan) and Flavors Technology Inc.

(USA). It has quite an innovative architecture and GUI (Graphical User Interface) environment. The use of PIM provides a new software engineering methodology and greatly improves the productivity and maintenance-ability of application software(Yaskawa and Yamamoto[1997]).

The main features of PIM are as follows:

- Reduction of response time by way of parallel synchronous processing
- Effective support of system design and maintenance under the integrated development environment
- Free program modification in an online environment
- Easy programming through natural language
- Flexible extension of computer systems according to the application system scale

PIM system is composed of units called 'tile', which simplify the modularization of the system. Thus, PIM enables a new system configuration and is considered an ideal computer system equipped with compact and excellent facility, high reliabilities, productivity and maintenanceability.

3. THE PIMTRACS CONCEPT

In PIMTRACS a model is composed as shown in Figure 1; it describes each region and vehicle in parallel.

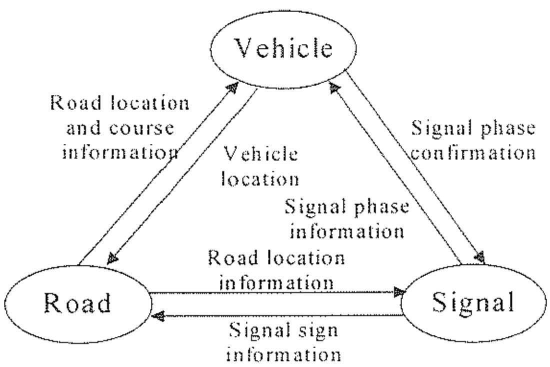


Figure 1. The PIMTRACS concept.

So far, many road traffic simulators have been developed, but most were process-oriented simulators in which one among numerous independent entities was taken up and processed. Other entities were represented, but they interrupted the main entity. Some computers have parallel processing capability, but in general most of them require large-scale facilities like workstations or supercomputers.

Our Macintosh PIM operates in a personal computer environment, but the computers must be equipped with hardware facilities over a certain standard. It operates on a far smaller scale and has parallel processing capability. It is considered to be effective in road traffic system simulation.

3.1 New PIMTRACS System Concept

This system controls all information with Overall Control Management (Figure 2). To improve the parallel of each component and to enable efficient simulation we changed to this system. It is able to access global memory of PIM independently (Figure 3).

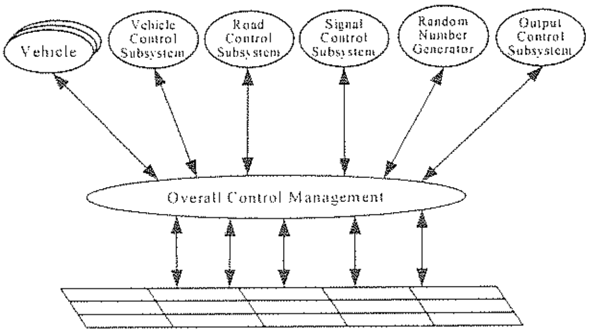


Figure 2. Previous overall configuration.

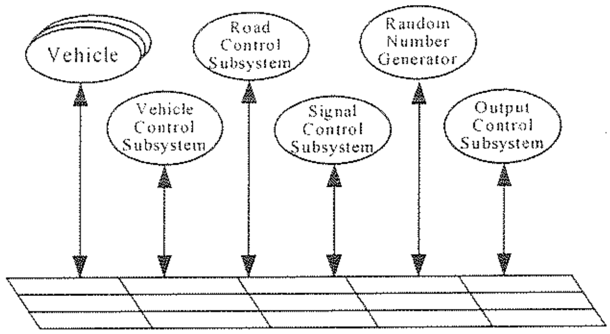


Figure 3. New overall configuration.

3.2 Road Control Subsystem

The study's standpoint has changed from individual-vehicle-oriented modelling to the vehicle-existence-road-location-oriented. Thus, all roads have been divided into road sections, separated by intersections and the intersections themselves have been given particular numbers according to direction and lane. The first place is the lane number and the other places are the numbers of the roads. Figure 4 shows an example(Takahashi et.al.[1988]).

A road is divided into 5 meter units, which enhances the flexibility of road description and contributes to the generalization of the simulation system.

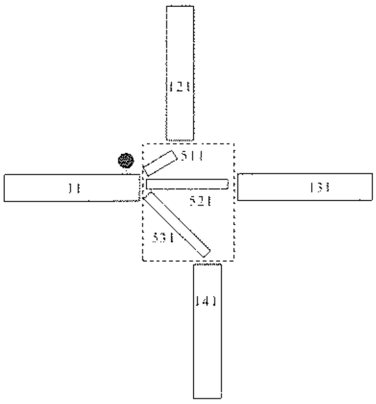


Figure 4. The representation of roads and an intersection.

4. A TEST MODEL AND SIMULATION EXECUTION BY PIM

4.1 Test Model

To begin with a test model was built and simulation was executed with it. The test model contains one intersection, illustrated in Figure5 (Figure 6) (Takahashi et.al.[1988]).

The test model contains one intersection. The measuring point of time occupancy (Ot) was seleced at the intermediate location of road 11 (100 meters from the intersection) and a simulation was executed with variable traffic generation.

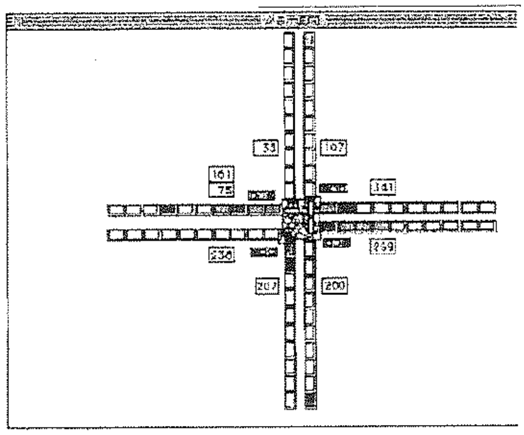


Figure 6. Display output.

Fixed initial conditions with the model are as follows;

.Signal intervals (cycle and sprit)
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

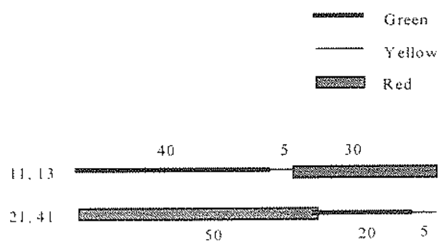
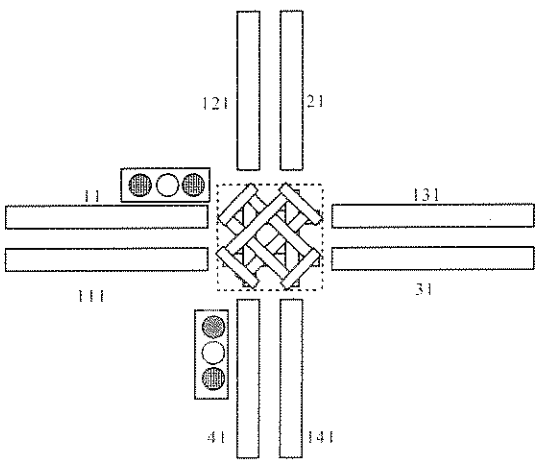


Figure 7. Signal Time Chart.



Outflow	Inter-section	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

Figure 5. One intersection model.

.Simulation execution time

Warm up hours ---- 30 minutes

Effective simulation hours ---- 30 minutes

.Simulation cycle time ----- 0.1 sec.

Vehicles were generated in conformance with the statistics shown in the traffic flow rate and time occupancy (Figure 8). Figure 8 shows that the time occupancy is approximately proportional to the traffic flow rate when time occupancy is between 0 and 30.

But the traffic theory shows that this property is lost if time occupancy exceeds 30. The data sampled from an actual field around the linear line and the tendency became more and more unpredictable. So we chose a normal condition for our simulation model and could obtain a result which conformed well with traffic theory. This assured us that PIMTRACS works well with enough modelling validity.

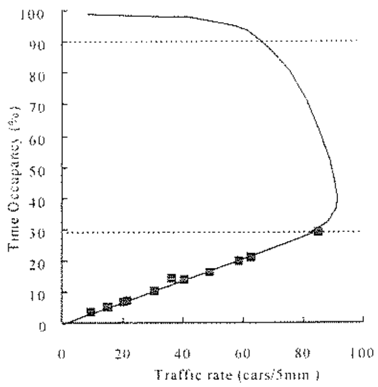


Figure 8. Traffic rate vs. time occupancy.

5. COMPARISON BETWEEN PREVIOUS SYSTEM AND NEW ONE

We compared a previous system and a new one by using the test model. The new system was faster than the previous one as shown in Table 1.

Table 1. Comparison between previous system and new one (sec.)

A previous system	a new system
25.4	24.2

6. CONCLUSIONS

In this study, we could obtain a result which conformed well with traffic theory. Then, we found that the performance was improved by improving algorism. In this case, we would rather improve the performance of PIMTRACS than reinforce a parallel function.

7. ACKNOWLEDGEMENTS

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