Application of Traffic Simulation SOUND

to the Tokyo Metropolitan Network

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SUMMARY

This study introduces an application of traffic simulation SOUND developed at the University of Tokyo to model the Tokyo metropolitan network. The purpose of this study is to demonstrate the applicability of the traffic simulation model to a substantially large scale network, and to suggest the use of traffic simulators for various network-wide analyses instead of sticking to the static traffic assignment. The area of the Tokyo metropolitan network covers about the 50-km radius from the centre of Tokyo and the network consists of more than 170 thousand links, to which conventionally static assignment has been applied for planning analyses.

INTRODUCTION

The purpose of this study is to demonstrate the applicability of the traffic simulation model to a substantially large scale network, and to suggest the use of traffic simulators for various network-wide analyses instead of sticking with the static traffic assignment. In this study, we show the application of the traffic simulation model SOUND which is developed in Kuwahara Laboratory to Tokyo metropolitan network which consists of more than 170 thousand links.

For the analysis of traffic management, for instance travel demand analysis, the changes of travel time and the length of traffic jam are important for the estimation of delay of the vehicles. In our traffic simulation, dynamic travel time and jam length data can be estimated.

From another perspective, the significant advancement of personal computers makes it possible to apply traffic simulation to the large scale network. Improvement of the simulation model itself is also a significant point. The calculation speed of personal computers is getting faster so rapidly that we can run traffic simulation on the large network even on the personal computer. This means that everyone can analyze the performance measures and impact of transport policies very easily.

The advantage of our study is that we apply dynamic traffic simulation to the Tokyo metropolitan network, which is substantially large. In the static analysis, we cannot describe the dynamic effects of traffic jams accurately. For this reason, dynamic traffic simulation is required for the analysis of traffic management. Since traffic jams greatly affect the delay of vehicles in the real world, we should consider the dynamic effects of traffic jams when we assume the delay of vehicles.

When we develop this large scale simulation, we can apply this simulation to several kinds of studies: new road infrastructure development, network wide traffic management such as road pricing, distance base toll, strict on street parking enforcement and area wide signal control.

From next part, we would like to explain the detail of our traffic simulation and how we prepared the data. The last part of this paper we will show you that we can apply traffic simulation to such a large network.

Study area and network

Our target area is the Tokyo metropolitan region which is shown in Fig. 1 target area: Tokyo metropolitan area. This region includes 5 prefectures and has about 350 million people. The area of the Tokyo metropolitan network covers about 50km radius from the center of Tokyo.

The road network data used in this study is the whole Tokyo metropolitan area, shown in Fig. 2: whole network. The network consists of 167,944 links and 83,698 nodes.

We prepared two types of network; the dense network and sparse network. The former network is for the target area and the latter one is for the surrounding area.

The reason why we prepared two types of network is that in the target area we should prepare dense network so that we can simulate the behavior of cars and for the surrounding area, we should prepare the network because traffic from and to the surrounding area should be considered in the simulation. The dense network consists of expressways, national highways, prefectural highways and city roads. The sparse network consists of only expressways and national highways.

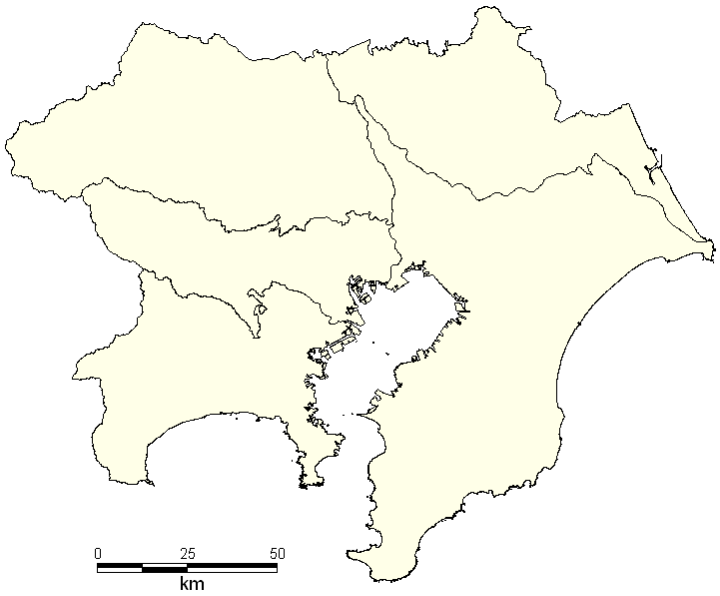

Fig. 1 target area: Tokyo metropolitan area

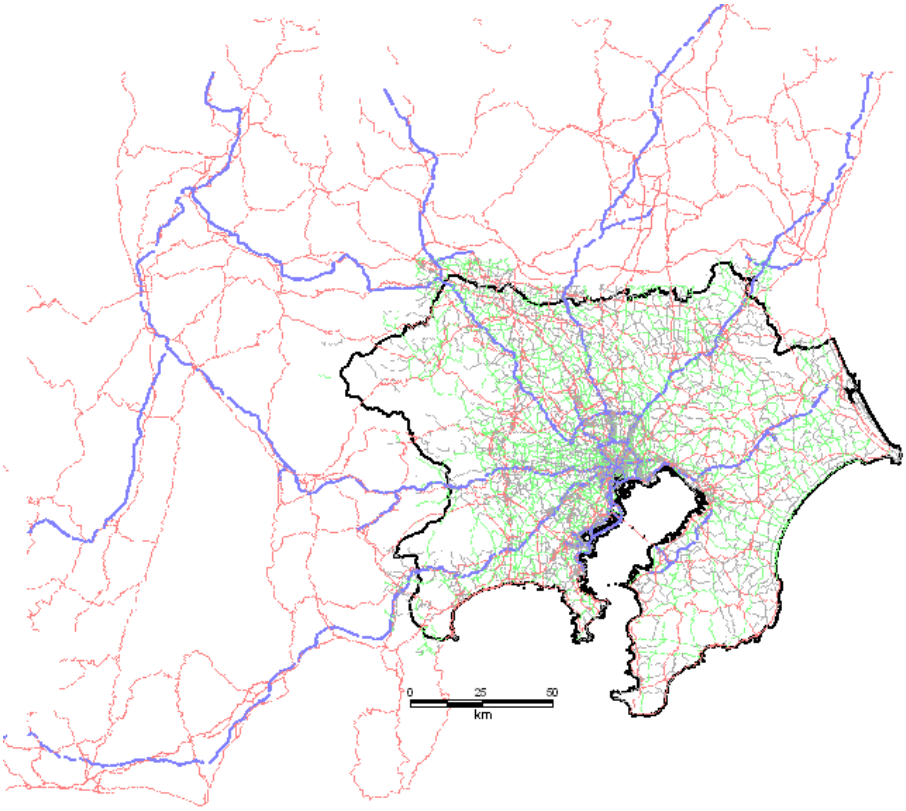

Fig. 2: whole network

(the area enclosed by a thick line is the target area)

Zone polygons

For this simulation, we used the B zones of road traffic census which is provided by Ministry of Land, Infrastructure and Transport(MLIT). Fig. 3 shows the zone polygons and the network (in dotted red lines) used in this study in the center of Tokyo metropolitan region. The size of the most zone polygons shown in bold lines range from 1 km^2 to 100 km^2. In the center of Tokyo, the zone polygon size is smaller and in the rural area, size is bigger. In our target area, there are 646 zones, and we prepared 16 more zones for the surrounding area.

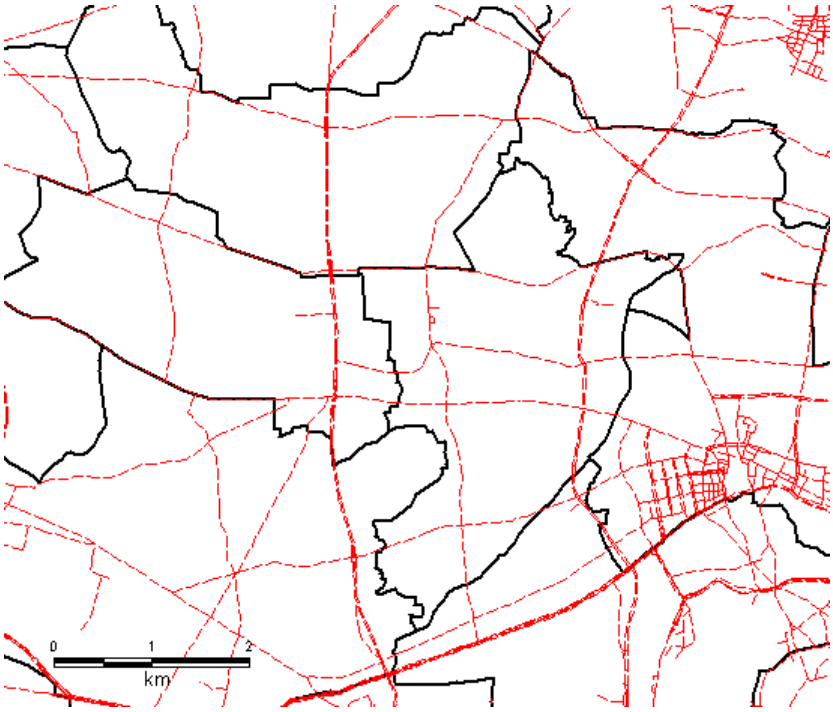

Fig. 3: Size of zone polygons

Traffic demand

In the first step of the traffic simulation, Origin-Destination trips are loaded by using the simulation model, SOUND (Yoshii, et al, 1995). As Origin-Destination volumes are required by SOUND, we use road traffic census data which is provided by Ministry of Land, Infrastructure and Transport every five years. In this study, we use the latest data which was collected in 1999.

Next I would like to describe the feature of this OD data. There are 677,494 trips. Sample rate of this survey is 2-3 percent. But this data cannot be used because of this fact. We expand this sample OD data to population OD data. From this survey, we prepared the OD tables of passenger cars and heavy vehicles.

SOUND model

In this study, SOUND (a Simulation model On Urban Networks with Dynamic route choice), which has been validated to reproduce various traffic condition reasonably well, is applied to Tokyo metropolitan network. SOUND is the traffic simulation model developed by Yoshii, et al, 1995.

SOUND can be applied to large urban road networks. It treats traffic using

meso-scopic flow expression and reasonably reproduces shockwave propagation. We made some substantial improvements to SOUND so that this can be applied to such a large network. The biggest one is that SOUND can reuse the memory. When we apply SOUND to the large network the input data becomes very large, that why we should reuse the memory.

Result

We used the personal computer with OS: WINDOWS XP; CPU: Pentium4 3.2GHz; Memory: 4GB. It took 6 hours and 40minutes to run this 24 hours simulation. Out of this total computation time, it took 3hours and 50 minutes to find the shortest path using logit model every 15 minutes. This means that more than half of the simulation hour is used for just finding the shortest path.

We can find that we can run such a big traffic simulation on the personal computer, but parameters of SOUND have not been well tuned based on the observed traffic conditions. To obtain adequate reproduceability, additional effort is required.

Conclusions

This study shows that substantially large network with 167,944 links, 83,698 nodes and 660 origin-destination nodes can be run on the personal computer. But this simulation is not calibrated. We should tune up this simulation.

There are several targets remained

1. We should develop the method to apply parameter tuning for such a large network.
2. It takes very long time to find the shortest path. We should find the good methods to reduce the time taken for finding the shortest path.
3. We should include signal data and traffic regulation information to the network.

Acknowledgement

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