A STUDY ON DYNAMIC USER OPTIMAL TRAFFIC ASSIGNMENT PROBLEM

Nagoya Univ. Member S. Kawakami, Graduate Student Z.K. Liu

1 INTRODUCTION

Methods of performing dynamic traffic assignment need to simulate traffic conditions on urban road network during rush-hour or a day. Dynamic assignment models can be used to investigate whether, and to what extent, urban traffic congestion and the related impacts, such as fuel consumption and pollution, can be reduced by shifting work trip departure times. Dynamic assignment procedures will also play an important role in the development of real-time in-vehicle route guidance. Therefore, many researcheres have spent great effort on this problem since 1970. However, no method, which can be efficiently used to practical problem, has been developed untill now. Almost all work to date on dynamic assignment problem has considered to simulate very idealized network. Merchant and Nemhauser (1978) formulated a nonconvex system-optimal version of the dynamic traffic assignment problem in which there can be multiple origins but only one destination. Wie et al (1990) presented a continuous time optimal control model, but no method to solve that model has been developed. Here we will develop a simulation method which can be used to solve the dynamic user optimal traffic assignment problems on multidestination networks. Test results showed that this method is practical and efficient to solve the dynamic assignment problem.

2. DYNAMIC USER OPTIMUM

In dynamic assignment problems, there are two kinds of user optimum. First one is:

Traffic conditions in dynamic network are predictable and travel makers are aware of these conditions (e.g. by historical experience), travel makers make their route choice decisions according to future traffic conditions and the predicted travel time.

Second user optimum is: Traffic conditions in dynamic network are not predictable (e.g. due to accidents, weather conditions, demand fluctuating from day to day); Travel makers can get complete information on current states of the network at each instant. They continuously update their route choices according to the current states of the network to minimize their individual travel costs.

B.W.Wie et al.(1990) explained the second dynamic user optimum and the corresponding behavioral assumption . In his paper he also developed a continuous time optimal control model which conforms to the second user optimum. The vital problem for the model is that there is no corresponding method to solve that model now. M. Papageorgiou (1990) gave a detail analysis to the first and second user optimum. He also presented some ideas about how to solve second user optimum, but no practical method was developed in his paper. The relationship between first user optimum and second one was stated by Papageorgiou as below: Although at first view the two kinds of dynamic user optimum may appear completely different from each other, the resulting traffic conditions may be identical, and two dfferent user optimum definitions may lead to similar results. We hold the same idea as Papageorgiou's. We think that the difference between two kinds of user optimum may be not great, especially in the case that each O-D traffic flow increases or decreases proportionally or near proportionaly. The method presented here is to solve the second user equilibrium. As for the first user optimum, we are studying the solution method for that case now.

3. THE METHOD FOR DYNAMIC TRAFFIC ASSIGNMENT

First, the relationship between travel cost and traffic volume is taken as link performance function. That is:

$$t_a(t)=f(x_a(t)) \quad (1)$$

where: $x_a(t)$ is the number of vehicles on link a at instant t

$t_a(t)$ is the travel cost of link a at instant t

A systematic description of the method is given as follows:

Divide the time period (0 T) into many short time intervals, say 1-minute time intervals. Let each O-D pair O_i-D_j continuously generates traffic volume in each time interval according to the given dynamic O-D travel demand. After a traffic volume TV_{ijt} is generated, it chooses the shortest path from its origin to its destination according to the current travel cost of each link and begin to travel along the first link on the shortest path; Each traffic volume $TV_{ijt'}$ generated before current time interval continuously updates its route choice according to the current shortest path from its current located node to its destination whenever it exits from a link and arrives at a node; Simulanteously, computer continuously traces on which link every TV_{ijt} is travelling at present time interval and calculates the time when TV_{ijt} will arrive at the head node of the link. Therefore, the traffic volume and travel cost of each link at each time interval can be calculated, and the total cost for each TV_{ijt} to travel from its origin to its destination can also be calculated consequently. In order to implement above procedures, the shortest path from each node to each destination need to be updated in every time interval. It seems to be a little time consuming, but it is not unbearable. For our test problem, which includes 24 zones, 24 nodes and 76 one-way links, and we divide 3-hour time period into 180 1-minute intervals to run the test problem, the CPU time is only 7.8 seconds on FACOM M-780 .

4. EVALUATION OF TEST RESULTS

Here, we use a dynamic traffic flow as input. The travel costs of some links in different time intervals are shown in Fig. 1 and the total travel costs between some O-D pairs in different time intervals are depicted in Fig.2

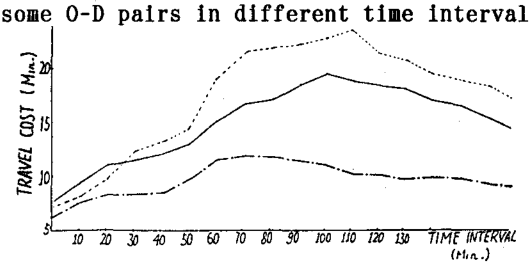

Fig.1 Tavel Cost On Some Links

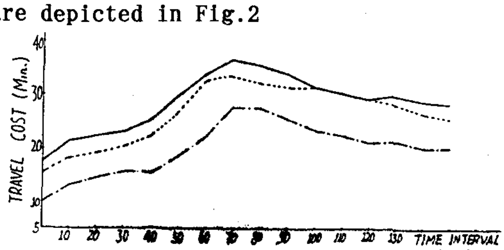

Fig.2 Travel Cost Of Typical O-D Pairs

From Fig.1 and Fig.2, it can be seen that the changing trends of travel costs conform to general case of dynamic traffic assignment.

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