

The Control Effect of Traffic Information on Traffic Assignment

Junqiang Guo, Bingzhong Ren

Department of Information and Electrical Engineering,
Shandong University of Science and Technology, Jinan 250031, P.R. China.

guojunqiang2008@163.com

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Abstract. The VISSUM and VISSIM simulation models are setup according to the real road network of Park City, Utah, U.S. The OD matrix is calibrated by the field turning counts. The effects of in-trip real-time information on traffic improvement are studied through microsimulation. Tests have shown that under adaptive traffic control signal, the in-trip real time information has negative feedback effect, and the traffic flows become stable. The information distribution parameters including frequency, delay and proportion of drivers using the information exhibits a window effect. Within the widows, total travel time decreases more than 10%, and total delay decreases more than 20%. The conclusion is that by carefully selecting the distribution parameters of real-time information, the traffic situation of this road network could be improved.

Introduction

Many countries have developed their Intelligent Traffic System(ITS) plan and their own technology standard, such as the United States[1,2], Japan[3] and China. Advanced Traveler Information System(ATIS) is an important part of Intelligent Traffic System. It utilizes communications instruments, like internetwork, television, broadcast, variable information board or in-car computer to provide travelers with information about traffic conditions.

After receiving the information about traffic conditions, travelers may have one of these choices: cancel the travel plan, select another transit mode, another trip route, or change departing time. Thus traffic information may change the traffic requirement and traffic assignment at some extent. If the traffic information can be used correctly, the traffic flow distribution will be changed, and the traffic throng is elevated.

In city road network, most crossroads have traffic signals, and drivers must move according the signal. The basic city traffic elements include driver and car, road network structure, and driver's response to traffic information. Fig. 1 illustrates the feedback effect of traffic information on traffic status. Cars move as a traffic flow under the signal control, the status information feedback to drivers, and drivers respond to the information by rerouting, thus the traffic flow is redistributed.

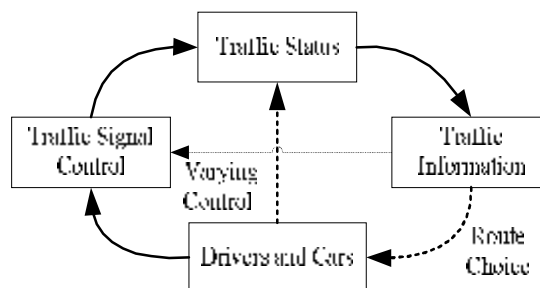


Figure 1. The Feedback of Traffic Information to Traffic Status

Many researchers have studied the interaction between traffic information and traffic flow. An investigation finds that in all drivers using traffic information, about 34% drivers changed part route, and 22% drivers changed their route completely[4]. A simple 4 nodes road network model is setup, and mathematical calculation is taken to analyze the traffic flow distribution. The conclusion is a contradiction between individual and collective goal, that the information of a new road adding in the road network, caused traffic flow redistribution and new traffic throng[5]. An everyday commuting two route choice example is simulated to study the effect of dynamic information on traffic flow stability. The research finds that with the delayed traffic information, the traffic flow becomes instable[6].

The real-time traffic information is available with the modern communications technology. With the feedback of correct traffic information, maybe the traffic flow in a road network could distribute more evenly in space and time, and the traffic throng is elevated in city road.

The development of simulation software and computer technology makes the simulation of real traffic network available. Simulation method is widely used in traffic plan and traffic evaluation[7]. The signal crossroad is analyzed by simulation software[8]. Traffic assignment and signal timing in road network are simulated[9]. A real road network is simulated in which the total travel time and total delay time are studied after traffic control changing from fixed timing to car activated control[10].

Objectives and Hypothesis

The objective of research is to study the total travel time and total delay time change under traffic control signal responding the traffic flow changing in a city road network when traffic information is broadcasted. We want to know that, providing drivers with in-trip traffic information, whether there is improvement of traffic flow, and how much improvement it brings. The relations between the traffic status and the traffic information broadcast frequency, time delay and the proportion of drivers responding the information are analyzed to find the best traffic information broadcast parameters for alleviating traffic throng in a city road network.

The research hypothesis is based on the concept of traffic equilibrium under signal control, that in mutual consistent flow-control equilibrium, user choices are such that all routes carrying flow have the same cost, and signal-setter's decisions are such that all phases receiving green time sustain the same pressure[11]. In such circumstance, the administer change the signals according to traffic status, and the drivers select their routes and departure time according to the traffic information received.

Suppose that driver's route choice standard is minimum cost, and the cost in this research is travel time. Radom route choice model is taken, most drivers chose the minimum travel time route, and there are some drivers select the others routes. When detour route exceeds 2.5 times the shortest route, the driver tends to maintain the selected route.

Simulation Model

The PTV Vision software VISUM 11.0 and VISSIM 5.0 is used in this research. VISUM is a travel demand modeling software, and is used for Origin-Demand(OD) matrix correction in this paper. VISSIM is a microscopic traffic simulator, and is used to emulate realistic traffic system here.

VISSUM and VISSIM software are widely used as a research tool. The OD matrix correction module in VISSUM is studied, and proved it a reliable matrix correction tool[12]. The reliability of VISSIM simulation is compared in different circumstances, and the conclusion is that it is a reliable micro simulation tool[13].

Park City road network is used as a research network. There are 14 signal crossroads, which uses Adaptive Traffic Controls, Split Cycle Offset Optimization Technique (SCOOT), as traffic control signal. According to the road network, a VISSUM simulation model is setup as Fig. 2, in which there are 376 links, 54 OD pairs, 1082 turns and 125 detectors. A VISSIM simulation model is setup as Fig. 3, in which there are 108 parking lots, 182 signal heads, 226 detectors, 1594 links/connectors, 260 data collecting points, and 220 nodes.

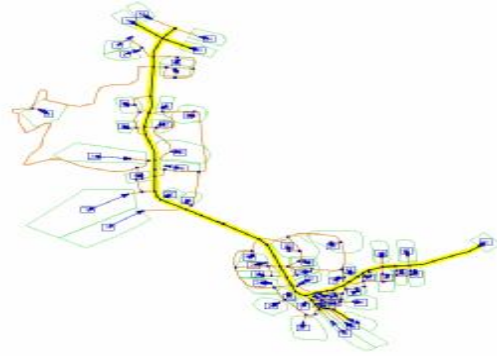


Figure 2. VISSUM Simulation Model

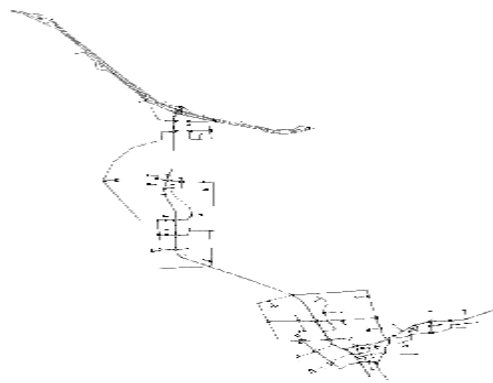


Figure 3. VISSIM Simulation Model

The field count data of turned cars are used to correct OD matrix. 125 data is collected at the intersections. After 10 iterations OD matrix-correction and assignment in VISUM simulation model, an OD matrix is obtained, with R^2 of 0.98 for modeled data vs. field counts. Fig. 4 and Fig. 5 depict the scattered plot for modeled versus count data for initial and calibrated OD matrices.

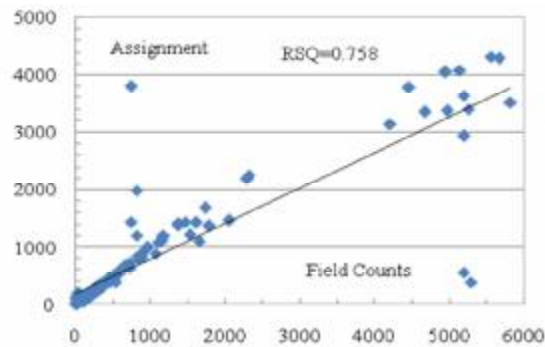


Figure 4. Modeled vs. Field Counts From Initial OD Matrix

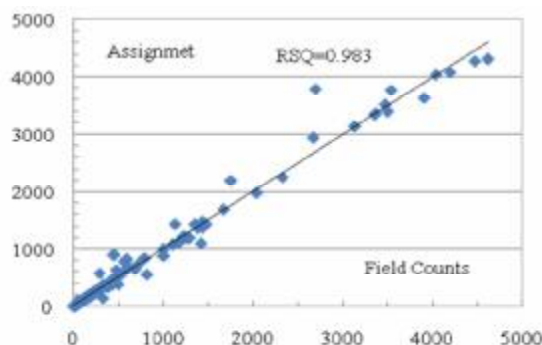


Figure 5. Modeled vs. Field Counts From Calibrated OD Matrix

The traffic information collecting and processing need time and the information transmission to driver need time also. Moreover, drivers need time to make rerouting decision after received information, and to move cars forming traffic flow. The traffic flow has a time delay with traffic information. The time delay is equivalent to delayed broadcasting traffic information in the simulation. There are three information broadcasting parameters, frequency, delay and proportion of drivers using the information. Nine test scenarios are designed as Table 1.

Table 1 Test Scenarios

| Test scenarios | Frequency (Seconds) | Delay (Seconds) | Proportion of Drivers |
|----------------|---------------------|-----------------|-----------------------|
| 0 | no | no | no |
| 1 | 1200 | 10 | % 0~100% |
| 2 | 120 | 10 | % 0~100% |
| 3 | 10~3600 | 10 | 80% |
| 4 | 10 ~3600 | 10 | 20% |
| 5 | 120 | 5 ~120 | 20% |
| 6 | 1200 | 10 ~1200 | 20% |
| 7 | 120 | 5 ~120 | 80% |
| 8 | 1200 | 10 ~1200 | 80% |

Results and Discussion

From the traffic administration point of view, the minimum total travel time and the minimum total delay time are expected. Each simulation of test scenario in Table 1 is run 100 times. From test scenario 0 to test scenario 8, total travel time and total delay time of the road network are calculated. The average total travel time and total delay time from test scenario 1 to test scenario 8 are compared with the values of test scenario 0. The improvement of total travel time and total delay time is depicted in Fig. 6 to Fig. 9.

Taking total travel time decreasing 10% and total delay time reducing 20% as a standard, the frequency, delay or proportion of drivers has window effect with the tow other parameters fixed.

It is can be seen in Figure 6 to Figure 8 that total travel time and total delay time are increasing at some points, and the maximum value is 7.7%.

For the road network studied, the traffic information has a control effect on traffic assignment. Under SCOOT Adaptive Traffic Controls, the real-time information makes traffic flow more stable and improves both total travel time and total delay time if the information broadcasting parameters were properly selected.

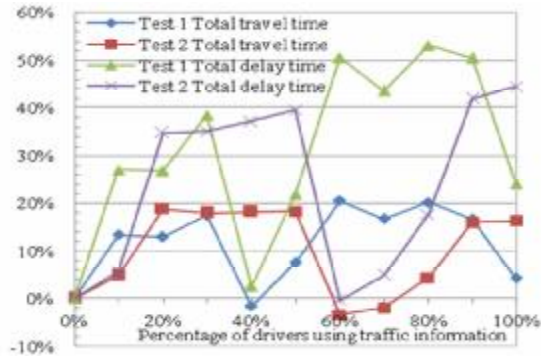


Figure 6. Total Travel Time and Total Delay Improvement of Test Scenario 1 and 2

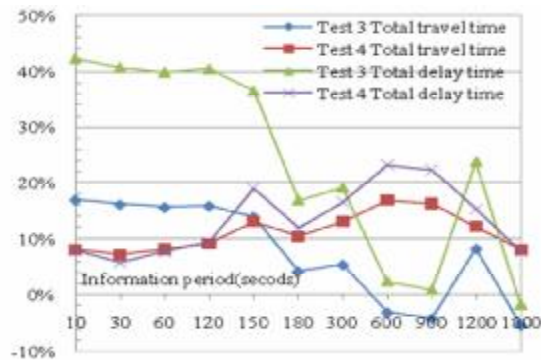


Figure 7. Total Travel Time and Total Delay Improvement of Test Scenario 3 and 4

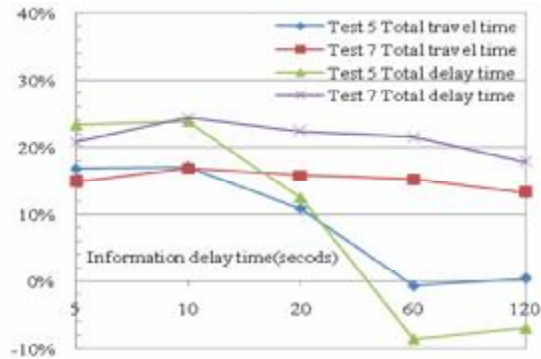


Figure 8. Total Travel Time and Total Delay Improvement of Test Scenario 5 and 7

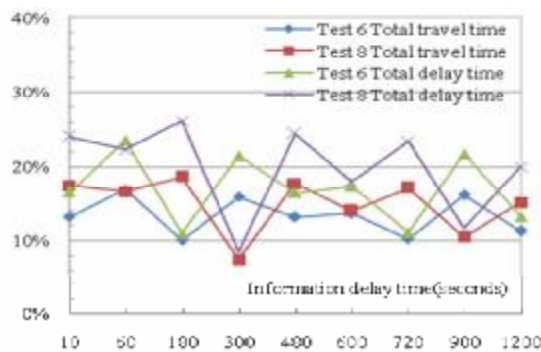


Figure 9. Total Travel Time and Total Delay Improvement of Test Scenario 6 and 8

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