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RESEARCH OF URBAN MICROSCOPIC TRAFFIC SIMULATION SYSTEM

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Abstract: The author developed an urban microscopic traffic simulation system. It mainly involves vehicle generation model, network model, traffic regulation model, signal control model, vehicle action model and route choice model. The system's flowchart and modeling method are illuminated. The three-dimensional visual part of this simulation system is realized on graphic workstation OCTANE.

Key Words: Urban Traffic, Microscopic, Simulation, Modeling

1. INTRODUCTION

During the past fifty years, the research of traffic flow model is always hot. From the initial LW model, to the later physical-psychics model and CA model, there are lots of traffic flow theories and models appeared. In the past, the research is focused on the macroscopic traffic flow model, which discusses the relationships among the traffic flow main parameters----speed, flow and density. With the development of computer science and due to the need of traffic simulation, the hotpoint is transferred to microscopic models. Microscopic traffic flow model calculates position, speed and acceleration of every vehicle in net at every moment. It can provide great deal of information to traffic management and simulation.

The author develops an urban microscopic traffic simulation system, which mainly involves vehicle generation model, network model, traffic regulation model, signal control model, vehicle action model and route choice model. And the three-dimensional visual part of this simulation system is realized on graphic workstation OCTANE.

2. MODELLING OF URBAN MICROSCOPIC TRAFFIC SIMULATION SYSTEM

2.1 Vehicle Generation Model

The vehicle generation model is the basic model of this system. And it is also the start of the whole simulation processing. Here, the vehicle generation model is presented below:

$$t_{n+1} = t_n - \frac{\ln(r_n)}{\lambda} \qquad \lambda > 0, 0 < r_n \leq 1 \tag{1}$$

where,

t_{n+1} = departure time for the vehicle n+1;

t_n = departure time for the vehicle n;

λ = departure rate;

r_n = a random number uniformly distributed between (0; 1].

2.2 Network Model

In this paper, the system represents road network with three self-constructing data structures. They are node, link and lane. A node is either an intersection of several roadways or an origin and/or destination where vehicles enter or leave the simulated network. A link is a directional roadway that connects nodes. And one link contains several lanes.

2.3 Traffic Regulation Model

Normal urban traffic rules are lane turning restriction, vehicle type restriction and speed limit. These can be realized by adding data element to the data structure link.

2.4 Signal Control Model

Signal control model need to describe the phase design, cycle and green time of an intersection traffic signal control system. In this paper, author uses self-constructing data structure signal and structure light. The structure light describes phase difference, red time, green time and yellow time of one phase. Each signal contains several lights.

2.5 Vehicle Action Model

Car following and lane changing are the two behaviors of vehicle well known in traffic system. Car following model describes how the behavior of the front vehicle affects the follow. There is a safety distance between these two vehicles. The authors suppose that the front vehicle and the following vehicle have three position states. They are list below.

a. free driving state: the distance between two vehicles is large enough. Then the follow driver can drive under his desire speed or the lane speed limit;
b. emergent state: the distance between two vehicles is smaller than the safety distance. The following driver must decelerate the speed to avoid collusions;
c. car following state: the follow driver is within the effecting area of the front vehicle. Then the behavior of the following diver must be accordant with the front driver.

When driving on a multilane segment, drivers often change lanes to improve speed. The lane changing model is used to describe this phenomenon. This model supposes that before lane change, driver must judge the front gap and rear gap on the target lane. Only when both of the front and rear gaps are acceptable, driver can change lane. The lane changing model can be simply illuminated as below.

a. if the front or rear gap is smaller than the minimize acceptance gap, then reject to change lane during such gap;
b. if the front and the rear gaps are both larger than the minimize acceptance gap, then change lane.

2.6 Route Choice Model

Route choice model selects the shortest total-travel-time trip by the vehicle OD. This path can be decided before trip. And it can also be dynamic choose during the trip. The author selects the dynamic route choice mode. The decision is based on the road's length, lanes, current average speed and whether it has a traffic signal.

3. BUILDING VISUAL SIMULATION

The three-dimensional visual part of this simulation system is realized on graphic workstation OCTANE. There are two key software on this workstation, which are Vega and MultiGen II Pro. Vega is a software environment for virtual reality and real-time simulation application. It supports rapid prototyping of complex visual simulations. And MultiGen II pro is a three-dimensional graphics editor under X Windows^{TM} users interface. Let you create and modify visual system database in an intuitive "what you see is what you get" environment. The figure 1 is the simulation system running pictures.

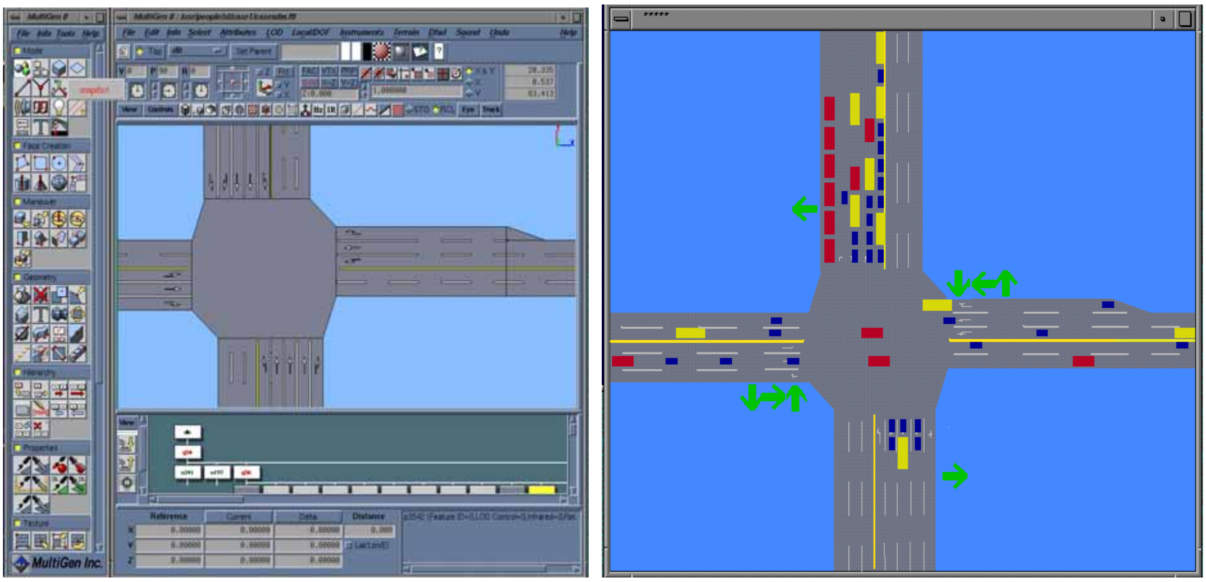

Figure 1. Traffic Simulation System Running Pictures

4. SYSTEM'S FLOWCHART

The system's flowchart is shown in the figure 2.

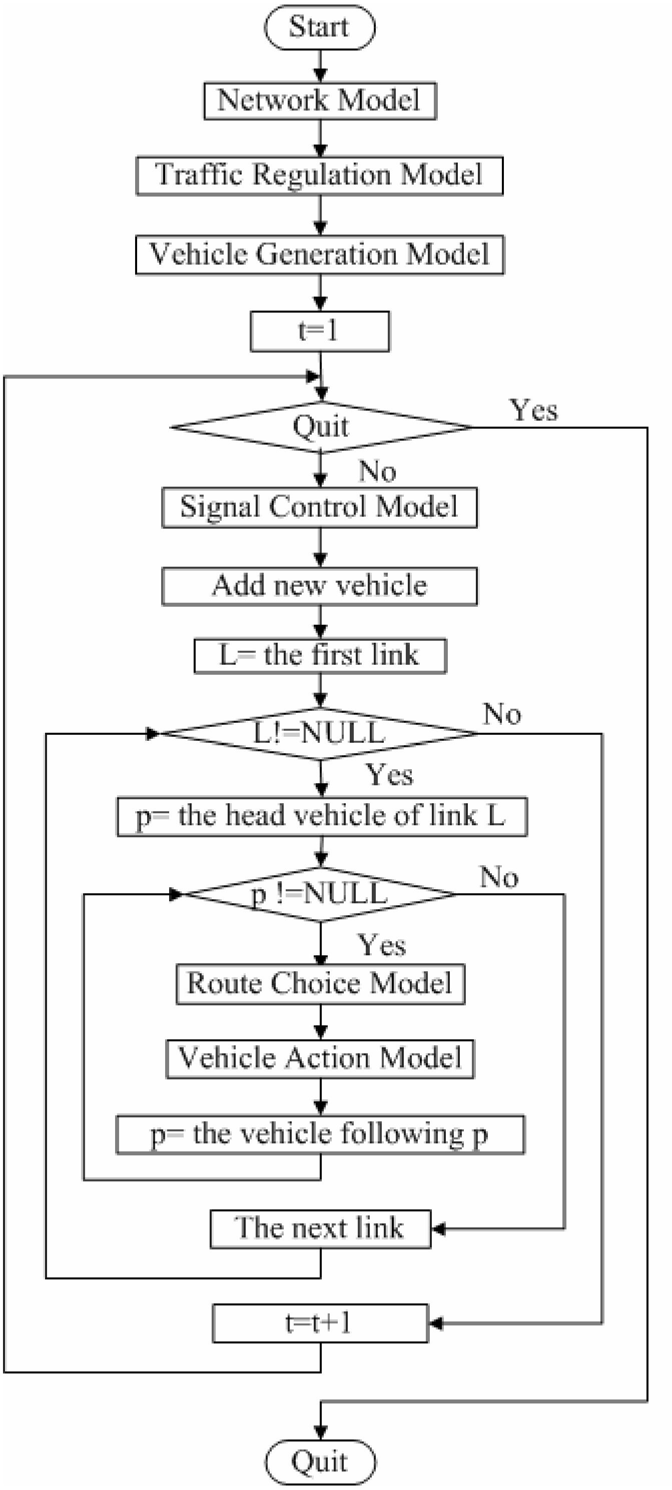

Figure 2. Traffic Simulation System's Flowchart

5. CONCLUSION

Urban microscopic traffic simulation system is a new hotspot in urban traffic research. In this paper, the author built such a traffic simulation system. It has extensive application domain, such as traffic control management evaluation, road net rebuilding evaluation etc.

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