MODELING METHODS FOR INTELLIGENT TRANSPORTATION SYSTEMS

Buriyev Sardor Norovich
(Assistant Teacher of Optical Communication Systems and Network Security Department, Karshi branch of the Tashkent University of Information Technologies)
Polvonov Kholbek Nematovich
(Senior Lecturer of Optical Communication Systems and Network Security Department, Karshi branch of the Tashkent University of Information Technologies)
Tursunov Akhmadjon Akmal ugli
(bachelor student Karshi branch of the Tashkent University of Information Technologies)

Abstract: *Transport systems and transport phenomena constitute very complex dynamic problems, in which simplified mathematical models are not sufficient for their analysis. More advanced methods and models are needed to analyze causality, coupling, feedback loops, and chaotic behavior in transportation problems. Traffic modeling can facilitate the efficient design and management of today's complex transportation systems. Mathematical models cannot always accurately describe the high complexity and dynamics of transport systems. Therefore, computer simulation models are developed and adjusted to describe the traffic flow characteristics in a given traffic network.*

Keywords: *Intelligent Transportation Systems (ITS), Traffic flow modeling, Macroscopic traffic flow models,*

INTRODUCTION

Efficient transportation systems lead to the efficient movement of goods and people, which significantly contributes to the quality of life in every society. At the center of every economic and social development, there is always a transport system. At the same time, traffic congestion is increasing worldwide due to motorization, urbanization, population growth, and changes in population density. It threatens the social and economic well-being of communities around the world. Recovery reduces the use of transport infrastructure and increases travel time, air pollution, and fuel consumption. Therefore, the management and control of transportation systems become a priority for every society, as it is a matter of human survival and well-being.

Traffic flow modeling

Traffic flow studies are carried out specifically to understand vehicle movements and to help prevent and resolve congestion problems. The first attempts to develop a mathematical theory of traffic flow date back to the 1930s [1], but despite ongoing research activities in this area, we still do not have a satisfactory mathematical theory to describe the actual conditions of traffic flow. This is because traffic events are complex and non-linear, depending on the interaction of a large number of vehicles. Furthermore, vehicles do not simply interact by obeying the laws of physics, but also influence the psychological reactions of human drivers. As a result, we observe chaotic phenomena such as cluster formation and backpropagating shock waves of vehicle velocity/density [2], which are difficult to accurately describe with mathematical models. According to a report by the Transportation Research Council , mathematical models of traffic flow can be classified as traffic flow characteristics models, human factor models, vehicle following models, and continuum. Flow models, macroscopic flow models, traffic impact models, unsignalized intersection models, signalized intersection models, and traffic simulation models. Below we briefly describe each of the above categories.

The theory of traffic flow characteristics includes a variety of mathematical models developed to describe the relationships between speed, flow, and concentration or density variables. Human factor modelling deals with the critical performance aspects of the human element in the context of a human-machine interactive system. These include responses to perceptual reaction time, movement control time, traffic control devices, the movement of other vehicles, road hazards, and how different segments of the population differ in performance. In addition, human factors theory deals with the type of control performance based on steering, braking, and speed control. The theory of human factors provides a basis for the development of the following models of cars. Car chase models consider how individual vehicles (and their drivers) follow each other. In general, they are developed from a stimulus-response relationship, where the response of successive drivers in a traffic flow is to speed up or slow down in proportion to the magnitude of the stimulus. Further vehicle models recognize that traffic consists of discrete particles or driver-vehicle units and that it is the interactions between these units that determine driver behaviour, which affects speed-flow-density patterns. On the other hand, continuum models are more concerned with the overall statistical behaviour of the transport flow than with the interactions between particles. Following the continuum model paradigm, macroscopic flow models abandon the microscopic view of traffic in terms of individual vehicles or individual system components (such as links or intersections) and instead focus on a macroscopic view of traffic in a network. accept the view. Macroscopic flow models take into account variables such as flow velocity, flow rate, and density and ignore the individual responses of vehicles. Traffic impact models [3] are related to road safety, fuel consumption, and air quality models. Road safety models describe the relationship between traffic flow and accident frequency. Signal-free crossing theory deals with gap perception theory and the direction distribution used in gap perception calculations. Traffic Flow at Signalized Intersections deals with the statistical theory of traffic flow to provide estimates of delays and queues at separated intersections, including the effects of upstream traffic lights. Traffic simulation modelling deals with the traffic models included in simulation packages and the procedures used to conduct simulation experiments.

The microscopic model includes individual units with properties such as speed, acceleration, and individual driver-vehicle interactions. The vehicle modeling approach assumes that the driver adjusts his acceleration according to the driving conditions. means of transport. In these models, vehicle position is treated as a continuous function, and each vehicle is governed by an ODE that depends on the speed and distance of the vehicle in front. Another type of microscopic model involves the use of Cellular Automata or car jump models, which differ from the post-car approach in that they are entirely discrete-time models. They consider the road as a series of cells that are empty or occupied by a single vehicle. One such model is the Stochastic Traffic Cellular Automata.

On the other hand, macroscopic models focus on the study of traffic flow using a continuum approach, where the motion of individual vehicles is assumed to exhibit many attributes of fluid motion. As a result, vehicle dynamics are treated as fluid dynamics. This idea offers an advantage because detailed interactions are neglected and the model characteristics are shifted to more important parameters such as flow rate, concentration or transport density, and mean velocity, all of which are functions of one-dimensional space and time. is considered Models of this category are represented by partial differential equations. Modeling vehicle traffic through macroscopic models is achieved using fluid flow theory in a continuum that responds to local or non-local effects. Such models have fewer mathematical details than microscopic models. A disadvantage of macroscopic modeling is that the transport flow behaves like a fluid flow, which is a rough approximation to reality. Vehicles tend to interact with each other and are sensitive to local traffic disturbances, phenomena not described by macroscopic models. On the other hand, macroscopic models are suitable for studying large-scale problems and are computationally less intensive, especially after approximating the partial differential equation with a discrete-time finite-order equation.

Choosing the appropriate model depends on the level of detail required and the computing power available. Due to the development of computer technology in recent years, today's trend is towards the use of microscopic scale mathematical models, which include human factors and post-vehicle models as a unit of driver and vehicle motion.

Macroscopic traffic flow models

Macroscopic flow models adopt a macroscopic fluid view of traffic in a network, abandoning the actual view of traffic in terms of individual vehicles or individual system components, such as links or intersections. In this section, we review the fundamentals of vehicular traffic flow for a macroscopic modeling approach. The relationship between density, velocity, and flow is also presented. Then we derive the vehicle conservation equation, which is the basic governing equation for scalar macroscopic traffic flow models. Macroscopic models of traffic flow, whether they are a single equation or a system of equations, are based on the physical principle of conservation. If physical quantities remain the same during a process, these quantities are said to be conserved. Putting this principle into mathematical perspective, it becomes possible to predict future patterns of density and velocity.

More recently, is developed macroscopic traffic flow simulation models based on a space-time discretization of the conservation equation. Even though these models are capable of describing complicated traffic phenomena with considerable accuracy, their main limitations arise in their inability to accurately simulate severe traffic congestion situations, where the conservation equation does not represent the traffic flow so well.

On the other hand, if a good model can be found that satisfactorily describes the traffic flow for a particular traffic problem situation, it is appropriate to use macroscopic models. The advantage of macroscopic models is their flexibility, since detailed interactions are ignored and the characteristics of the model are shifted to important parameters such as flow rate, concentration or transport density, and average velocity. If the transport/traffic problem requires more detail and accuracy, for example when assessing the impact of closely spaced intersections or bus priority systems on the transport network, the microscopic models described in the next section should be referred to.

Conclusion

The modeling method is an essential element in the design, operation, and control of Intelligent Transportation Systems (ITS). Congestion problems in cities worldwide have drawn a high level of interest for better management and control of transportation systems. Of major importance are ITS systems that include advanced traffic management and control techniques. Such techniques include real-time traffic control measures and real-time traveler information and guidance systems whose purpose is to assist travelers in making departure time, mode, and route choice decisions. Transportation research is heading towards developing models and simulators for use in the planning, design, and operations, and control of such intelligent transportation systems.

REFERENCES:

1. Adams, W. F. (1937). Road traffic considered as a random series: Institution of Civil Engineers.
2. Bose, A., & Ioannou, P. (2000). Shock Waves in Mixed Traffic Flow.
3. Ardekani, S., Hauer, E., & Jamei, B. (1992). Traffic impact models. Chapter 7 in Traffic Flow Theory, Oak Bridge National Laboratory Report.