Application of Mathematical Software in Modeling and Understanding of Traffic Flow

Ghulam H. Bham
Ph.D. Candidate
Department of Civil Engineering
University of Illinois at Urbana-Champaign
B-114 NCEL, 205 N. Mathews Avenue
Urbana, IL, USA
bham@uiuc.edu

Rahim F. Benekohal, Ph.D.
Professor
Department of Civil Engineering
University of Illinois at Urbana-Champaign
1205 NCEL, 205 N. Mathews Avenue
Urbana, IL, USA
rbenekoh@uiuc.edu

Abstract - The paper describes a computer-based visualization tool developed using a mathematical software for students to learn and understand the characteristics and behavior of traffic flow. Mathematica provides an integrated and easy to use environment for modeling and understanding of traffic flow models and observe different features of traffic flow in varying levels of sophistication. The tool is developed to stimulate student interest and motivate them to further refine these models and conduct experiments in traffic simulation.

I. INTRODUCTION

To teach fundamental and advanced concepts of traffic flow in a stimulating way to students and to provide effective teaching tools, a traffic simulation model developed using Mathematica is presented in this paper. CELLSIM [1,2,3], a microscopic traffic simulation model, developed by the authors is used to illustrate shock waves in traffic for different traffic conditions. The fundamental relationships of traffic flow as a result of stop and go condition of traffic is also described. It is anticipated that student's learning experience will be improved with visualization, animation, and demonstration of these examples.

CELLSIM is utilized in improving students understanding of concepts that are difficult to follow. Hands on use of CELLSIM can increase their reasoning of car-following concepts, driver behavior and vehicular characteristics. Compared to commercial traffic simulation programs like CORSIM [4], which is meant for professional use, CELLSIM can also provide insight on the process of traffic flow modeling. It can be used more interactively, is easy to use and further development and refinement of traffic flow models can be carried out because of access to the program's code.

II. BENEFITS OF USING MATHEMATICA

Modeling is an important part of education for students in many disciplines and simulation provides an appropriate tool to model systems that are difficult to model using analytical models. Simulation requires development of a computer program to execute the model. The output from the program requires analyses using statistical and visualization techniques. Simulation thus requires an environment in which computer programs are written, statistical analyses are conducted, graphs are plotted, and the system is animated to observe the results of the model. This type of integrated environment is available in several mathematical software packages such as Matlab®, MathCAD®, and Mathematica® to name a few. Use of these packages in modeling and simulation are thus increasing in popularity. These mathematical software packages provide a variety of functions, enormous computing power, and are user friendly. Moreover, they are easier to program in, than languages like C/C++ and Fortran.

Mathematica is used in this paper as a case study and other similar software packages can be used as well, since they are easier to learn and debug, compared to other programming languages. They provide a medium for experimenting without struggling with programming issues. These packages provide user friendly graphical interface as well. Mathematica is one such package that provides an environment where mathematical and other operations can be performed without the need to think about how the operations are actually carried out inside the computer.

1 This paper doesn't advocate the use of any particular commercial software. Mathematica is only used as an example for instruction based tool in traffic simulation.