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TRAFFIC FLOW SIMULATION USING CORSIM

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ABSTRACT

This paper presents an overview of the concept and features of the CORSIM traffic simulation program and the TSIS package that provides an integrated, user-friendly interface and environment for executing CORSIM. The new functions and feature of CORSIM and TSIS in the most recent release are highlighted. Several successful TSIS/CORSIM applications are used to demonstrate that CORSIM is a very effective tool to perform traffic operations analysis and to evaluate new ITS technologies.

1 INTRODUCTION

Traffic flow simulation has been an effective method to assess traffic conditions for various designing alternatives of transportation facilities. It has emerged as an important evaluation tool for Intelligent Transportation System (ITS) strategies in recent years.

There are two major types of traffic simulation models:

- Macroscopic traffic flow simulation: Flow-density relationship is used to govern vehicle movement. Individual vehicles are not tracked in the model.
- Microscopic traffic simulation: Each individual vehicle is tracked. A vehicle's movement in the system is determined by the characteristics of the driver, vehicle performance, and its interactions with network geometrics and surrounding vehicles.

Macroscopic models lack the capability of modeling complicated roadway geometry changes and detailed functions and features of traffic control and management types such as actuated control and freeway ramp metering. As the result, microscopic traffic simulation is more widely used to perform traffic operations analysis and evaluate the merits of new traffic control and management technologies. The heart and soul of a microscopic traffic simulation is the car-following and lane-changing logic.

Several new traffic simulations have emerged in recent years and have been successfully applied to traffic operations analysis. They include

- INTEGRATION
- VISSIM
- MITSIM
- WATSIM
- PARAMICS
- TRANSIMS

By far, CORSIM (CORridor SIMulation) is the most widely used microscopic traffic simulation program in U.S. and all over the world. It has become the standard and found thousands of applications in recent years. In addition to continuous enhancements to its logic, incomparable validation, verification, and calibration effort ensures that CORSIM results realistically reflect real world traffic flow.

2 DESCRIPTIONS OF CORSIM FEATURES

The initial development of CORSIM logic started in early 1970s. Under the sponsorship of FHWA (Federal Highway Administration), CORSIM program has undergone numerous major improvements and upgrades, both in simulation logic and software engineering. Its recent software engineering development was the introduction of TSIS (Traffic Software Integrated System) that provides an integrated, user-friendly interface and environment for executing the CORSIM traffic simulation model.

Both researchers and practitioners use CORSIM as a because of its solid foundation of traffic engineering modeling and analysis capability. It offers rich modeling

features that enable users to simulate traffic flow of a wide spectrum for practical or research applications. It has been ubiquitously accepted that CORSIM has specific strengths in the following area:

- Its ability to model complicated geometry conditions. CORSIM can handle virtually all complicated geometric conditions that practically exit in the field. Geometry conditions accepted by CORSIM include surface streets with different combinations of through lanes and turning pockets, multi-lane freeway segments, different types of on- and off-ramps. Due to its flexibility in coding each individual component of the network, CORSIM can simulate traffic operation of virtually all types of freeway interchanges, and all types of surface street intersections. Special geometry such as lane-drop and lane-add can also be modeled.
- Its ability to simulate different traffic conditions. CORSIM has been calibrated to accurately simulate a wide range of traffic conditions, from moderate demand to very congested conditions. CORSIM can also effectively simulate traffic flow during an incident, from queue buildup to recovery to normalcy. The ability to simulate over-congested traffic flow conditions gives CORSIM a unique advantage over traditional empirical/analytical methods. Most traditional methods such as ones described in the Highway Capacity Manual have serious limitation in accurately assessing traffic flow conditions when traffic demand is approaching the capacity of the facility. CORSIM however has the ability of predicting congestion development and dissipation with acceptable accuracy.
- Its ability to simulate different traffic control, management and operation. CORSIM can simulate different traffic control devices such as stop or yield sign control, fixed timing or actuated control at surface street intersections. It can also simulate freeway ramp metering, and HOV (High occupancy Vehicle) operation. CORSIM also has flexible bus operation simulation logic.
- Its ability to account for the interactions between different components of networks. CORSIM can simulate integrated networks with surface streets, freeway mainlines, and ramps as their components. Unlike most traditional methods that analyze traffic operations of each component separately, CORSIM is able to simulate the traffic flow of the network in an integrated fashion. This gives CORSIM the ability to simulate spill-back/spill-over situations. The congestion spill-over from one network component to another, such as queue spill-back from off-ramp to the freeway or from on-ramp to the surface street, can be modeled effectively.
- Its ability to interface with external control logic and programs. Through specially designed TSIS interface, CORSIM is able to communicate with external control logic and programs. A typical process of this interfacing ability application is as follows:

    - CORSIM moves vehicles in the network.
    - The vehicle information (speeds, positions, etc.) is sent to external control program via the special interface.
    - The external program makes control decisions based on vehicle information.
    - Control decisions are then sent back to CORSIM via the special interface. The control decisions immediately affect vehicle movement.

    The two-way data exchange via the interface operates in real-time. This unique interfacing feature opens the door for CORSIM to be used in evaluating new ITS (Intelligent Transportation Systems) technologies. This special feature has been successfully used in FHWA funded projects of evaluating RT-TRACS (Real-Time Traffic Adaptive Control) prototypes and ramp-metering strategies.
- Its ability to model time-varying traffic and control conditions. CORSIM uses Record Types (RTs) to organize data inputs for geometries, volume and pattern, surveillance and detecting devices, traffic control, engineering criteria, run control, and output requirements. CORSIM simulates the traffic conditions of a network over a period of time. The inputs accommodate specifications that not only differ from one point in the network to another, but that might also change with time. The time-varying portion of the simulation analysis is expressed as a sequence of "time periods" specified by the user. During each time period, CORSIM allows different traffic demand, and different traffic operations and control.

3 TRAFFIC SOFTWARE INTEGRATED SYSTEM (TSIS)

The Traffic Software Integrated System (TSIS) is an integrated suite of traffic models for input development (TRAFED), simulation (CORSIM), and animation (TRAFVU). The suite is somewhat analogous to Microsoft Office that integrates a word processor, presentation, and

spreadsheet. TSIS is widely recognized as one of the most successful analysis tools supported by FHWA. With the advent of TSIS, several tools were integrated into a common Windows interface that provides the user with a familiar look-and-feel compared to standard Windows applications.

The advantages of operating CORSIM within the TSIS environment include an intuitive, user-friendly graphical interface; scrollable screen input; better memory management; and on-line context-sensitive help that encompasses the TSIS, TRAFED, TRAFVU, and CORSIM User's Guides.

TSIS is designed to support CORSIM simulator, its input processor (TRAFED) and output processor (TRAFVU). The user can however extend TSIS functionality by adding other traffic engineering or analysis software tools that have been designed to conform to TSIS traffic tool interface.

4 TSIS VERSION 5.0 NEW FEATURES

The latest version of TSIS/CORSIM is Version 5.0. It is a revolutionary new product compared to its predecessor (TSIS 4.32). With the inclusion of input processor TRAFED, users will be able to create CORSIM simulation input files much easier and faster. It also greatly reduces the chances of having errors in the input files. TRAFED includes a translator that converts a graphically edited network into a CORSIM input (.trf) file, and can also convert an existing trf file into a TRFED (.tno) network on which graphical editing can be performed easily.

The following sections present an overview of new features in TSIS 5.0.

4.1 TSIS (TShell)

The software package known as TSIS has many new features including the introduction of the TSIS Input Editor known as TRAFED. The software that runs the TSIS package is known as TShell. It has many new features including:

- New Project View and New Output View. The Project view provides added flexibility in organizing and view project files. As different tools run in TSIS new output window tabs will be created that show messages passed by the tool in use to TSIS. This output can be logged for future use.
- Container/Server. TShell can now use tools that are OCXs in addition to executables and dynamically linked libraries. These OCXs can access the TShell interfaces to use TSIS for special purposes.
- Smart Editor. TSIS includes a text editor that understands the CORSIM trf file format. When a trf file is being edited with the editor, the output window will display text describing the entry field and record type where the cursor is currently. By clicking in the output window the specific entry field will be highlighted in the trf file. This make manually editing the text file much easier than previous text editors.
- Scripting. TShell includes an engine for running Visual Basic Scripts. These scripts can be written by the user to customize TSIS. Two sample scripts are included: One is a multi-run script that is used to repeatedly run CORSIM on a test case with different random number seeds; The other script runs CORSIM on many different test cases. Visual Basic Script language is widely used and makes TSIS truly a Traffic Software Integrated System that is user configurable.

4.2 CORSIM

Although Version 5.0 of CORSIM does not offer any new features, it does offer many enhancements to improve performance:

- Freeway High Occupancy Vehicle (HOV) lane operations have been finalized. There are also new inputs to specify what percentage of HOVs will use the HOV and a new input to specify where HOV vehicles begin to react to an off-ramp.
- The distribution of free-flow speed based on driver type can now be specified.
- Control delay MOE was added for Netsim intersections. This MOE can be used to calculate the Level of Service of an intersection or intersection approach using the HCM method.
- Detectors are now allowed on interface links.
- Any configuration involving stop sign control can be modeled. Previously some configurations involving stop sign control were not modeled correctly. Logic was also improved to model configurations involving both stop sign and yield sign control.
- The probability of joining spill-back now also applies to left turning vehicles. It previously applied to through vehicles only.
- The maximum number of Fresim detectors was increased from 300 to 600. The maximum number of Fresim detector stations was increased from 70 to 200.
- The change to the Netsim lane channelization code zero that was introduced in CORSIM 4.32 was removed.

- Many existing features were significantly improved. Errors in Fresim collision avoidance, destination assignment and leader determination were eliminated. Fresim can now model a cloverleaf with full auxiliary lanes connecting the segments. That geometry, and any other geometry that forms a complete circle, would previously cause circular leader/follower chains that would produce fatal run time errors.

4.3 TRAFVU

Version 5.0 of ***TRAFVU*** offers the following new features:

- Roadway Drawing Improvements. Roadway drawing in version 5.0 is more robust and allows the user to more easily control the look of the network, including curvature and intersection connections.
- HTML Help. The ***TRAFVU*** on-line help for version 5.0 is supplied as a compiled HTML help file. This places the written User's Guide on-line, without having to modify the original document.
- Status Bar. Each network window within ***TRAFVU*** now has a status bar. The status bar is used to display the current network time and time period. The status bar also displays the current mouse position in network coordinates.
- New Tool Bar. ***TRAFVU*** tool bar has been modified to look more like a standard Windows tool bar and to match the tool bars in the other ***TSIS*** components.
- Case Reload. From the File pull-down menu, you can reload the currently active ***TRAFVU*** case. This is particularly useful when adjusting the CORSIM input file to achieve the desired network geometry.
- New Map Adornments. ***TRAFVU*** 5.0 now displays the following CORSIM features:
    - Warning signs (vehicle reaction point positions)
    - Truck lane markings
    - RTOR markings
- Dynamic Scrolling. Dynamic updating of the network map when using the window scroll bars is now the default behavior. If you have a less capable computer, you can disable this feature via the Options pull-down menu.

4.4 TRAFED

TRAFED itself is a new product contained in the TSIS package. It allows a user to easily create and edit CORSIM traffic networks. Some of the more interesting features of TRAFED are:

- Import an existing ASCII file, edit the network, and export the network to an ASCII file.
- Import a bitmap image of a network (e.g. Map or aerial photo) to use as a guide for laying out a network.
- Extend an existing network by connecting links to existing entry or exit nodes, which become internal nodes.
- Split existing links by dropping a node on an existing link to create two links.
- Edit most CORSIM input parameters by simply right clicking on the link or node and editing the data in the appropriate field.

5 TSIS/CORSIM SAMPLE APPLICATIONS

TSIS/CORSIM has been used in many practical applications. The following are three success stories of traffic simulation using TSIS/CORSIM.

5.1 HOV Showcase

This is a CORSIM simulation study of a freeway system conducted by Ball Aerospace. The application showcases all new HOV features that were recently incorporated into CORSOM. The network includes a stretch of I-405 from Culver Road to Bristol in Southern California. The case includes freeway sections with exclusive HOV lanes and non-exclusive portion, and on-ramps with fixed time ramp metering control and HOV bypass lanes.

CORSIM was able to simulate different HOV operation scenarios and ramp metering control.

5.2 RT-TRACS Evaluation

This surface street traffic simulation application is part of lab evaluation effort for FHWA funded project "Evaluation of Real-Time Traffic Adaptive Control System (RT-TRACS) Prototypes". This case is also a successful application of interfacing CORSIM with external program via special TSIS interface. CORSIM is used as an engine for vehicle generation, vehicle movement, and recording of vehicle actuations on detectors for advanced signal control. The vehicle information is passed to external RT-TRACS program through the interface. Control decisions are made by the external RT-TRACS program based on vehicle information it received. The control decisions in the form of signal states and phase changes are sent back to CORSIM. CORSIM then moves vehicles accordingly.

The lab simulation results matched field evaluation results very well. At the field evaluation stage, data was collected on Reston Parkway in Northern Virginia. Data

on delay, travel time, and intersection service condition was collected before the RT-TRACS prototype was installed, and also after the system was installed and turned on. CORSIM simulation accurately simulated and predicted traffic flow conditions for both before and after scenarios.

5.3 I-4 Case

This is a simulation study of integrated network with freeways and a surface street network. It was intended to assess whether the proposed improvements in the network would accommodate future demand increase along the I-4 corridor. Simulation runs were performed for both no-build and build scenarios with the projected future demand as the input of traffic volume in the network.

CORSIM was able to predict that with the proposed improvements the network would accommodate the future demand much better compared to the scenario that there would be no improvement on the facility. CORSOM was also able to show that to better serve the future demand, more improvements on physical facility and signal control are needed. For example, CORSIM simulation showed that the signal timing plan was not optimized for the high demand. Also, some more geometry changes such as increasing the number of turning lanes or increasing the length of turning bays would be needed to avoid congestion in some local areas.

6 CONCLUSION

Success applications of different scales have demonstrated that CORSIM is the most popular traffic simulation and widely accepted by the traffic engineering community. With a rich feature set CORSIM provides users with a versatile tool to conduct simulation in various traffic engineering studies. With constant effort being put on feature enhancement, validation, calibration, interfacing and software engineering development, CORSIM will play an even bigger role in the decision making process of developing advanced transportation systems.

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