PERFORMANCE COMPARISON OF AIMSUN2 AND CORSIM FOR CONGESTED AND UNCONGESTED FREEWAY TRAFFIC CONDITIONS

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ABSTRACT
Two microscopic simulation models CORSIM (Corridor simulation model) and AIMSUN2 (Advanced Interactive Microscopic Simulator for Urban and Non-Urban Networks) were compared for modeling of congested and uncongested freeway networks with on-ramps. The measures of effectiveness (MOE’S) compared includes flow, speed, and density. CORSIM and AIMSUN showed comparable results for uncongested conditions but results for congested conditions showed some distinct differences.

KEYWORDS
AIMSUN2, CORSIM, traffic congestion, microscopic simulation

1. INTRODUCTION
Computer simulation is a common tool in the area of traffic control and management, mainly because of its flexibility, safe and economic execution, and its extensive outputs. In the context of traffic control and management, simulation is defined as a numerical technique for conducting computer experiments which may include stochastic characteristics and involve mathematical models that describe the behavior of traffic over extended periods of real time (t). In traffic engineering, simulation models are important tools for traffic control and are handy for the analysis of complex transportation systems which are difficult to create in real life. Simulation experiments can be tried and tested without any disruption to traffic in a real network, and it can also avoid costly construction and/or disruption of traffic. Simulation models can give traffic engineers an overall picture of traffic and its behavior that is may not be possible in the real world. The success of the simulation depends upon the soundness and realism of its internal logic, and the real world data used to calibrate it.

Traffic simulation models can be classified as either microscopic, macroscopic or mesoscopic. A microscopic simulation model is based on individual vehicles with varying characteristics and multiple classes. Vehicle positions are updated using car-following logic and lane changing rules including stochastic components. Variability in driver behavior and vehicle dynamics is explicitly modeled. Examples of microscopic simulation models include INRAS, CORSIM, PARAMICS, AIMSUN2, TRANSIMS, VISSIM, MITSIM. In macroscopic simulation models, vehicles are moved based on analytical representation of traffic stream. No individual vehicles are modeled. Popular macroscopic simulation models include FREFLO, AUTOS, METANET. In mesoscopic simulation models, vehicles move at the prevailing speed in the section. Speeds remain the same for all the vehicles in the section, and are modified when the vehicle exits the section. Individual vehicles are modeled only for their route choice. DYNASMART, DYNAMIT, INTEGRATION are example of mesoscopic simulation model.

The objective of this paper is to compare the performance of the two microscopic simulation models CORSIM and AIMSUN2 in congested and uncongested traffic conditions of uninterrupted flow facilities (freeways). The paper aims to highlight the notable differences between the two programs and identify points of strengths (or pitfalls) in each program when used for uninterrupted flow conditions. Comparison was made by coding congested and uncongested conditions on a freeway section with on-ramp. The freeway section with on ramp was selected to enable the evaluation of the car following and lane changing models of both microscopic models. Simulated volumes were compared with actual input volumes in the models in order to observe how closely each model can simulate traffic. The two models were compared based on their reported flow, speed, and density values.

2. PROBLEM STATEMENT
A large number of simulation models are available in the market. Different models utilize different techniques or numerical algorithms to represent vehicle characteristics and real world processes like car-following behavior and driver response to lane changing and traffic control devices. It is not easy to make a decision on which model
is appropriate for what condition, or how to calibrate a
interpreted correctly, it is important for the analyst to
understand some of the basic logic and assumptions upon
which the results are based. In this study, the performance
of the two microscopic simulation models CORSIM
(CORridor Simulation Model) (2) and AIMSUN2
(Advanced Interactive Microscopic Simulator for Urban
and Non- Urban Networks) (3) are compared for
modeling of congested and uncongested conditions on
freeway sections.

3. LITERATURE REVIEW

CORSIM is one of the most popular microscopic
simulation model used in North America, and AIMSUN2
is a fairly well accepted microscopic simulation model in
European countries. A significant amount of work has
been done to compare CORSIM with other microscopic
simulation models, but not with AIMSUN2. CORSIM
default values were calibrated and validated on the basis
of field data collected in the 1970s and some values have
been updated following FHWA studies (4). Bloomberg
and Dale (5) described a comparison of CORSIM and
VISSIM on congested arterial network. They compared
throughput and total travel time for each section and
conclude that both models are appropriate for modeling
congested arterial street conditions. Both models
produced similar throughput for the upstream section of a
signalized intersection, and the relative travel time was
consistent between the two models. Rilett and Kim (4)
compared performance of CORSIM with TRANSIMS on
a Diamond interchange. They experiment with different
phasing schemes, cycle lengths, intersection lengths,
offsets and demands. They concluded that CORSIM is
sensitive to the type of phasing scheme and give best
result for lag-lag phasing scheme. Wang and Prevedouros
(6) compared CORSIM with WATSIM and INTEGRATION
for freeway networks and concluded that all three models
produced satisfactory and comparable results.

AIMSUN2 is a new program and has fewer
applications in Europe and New Zealand. AIMSUN2
was developed by Barcelo and Ferrer (7) at the
polytechnic university of Catalunya in Barcelona. Hughe
(8) described AIMSUN2 simulation on a congested
freeway network and noted that the AIMSUN2 appears to
provide a high degree of realism in simulating congested
traffic flows on freeways. Barcelo et al (9) described
modeling of advanced transport telematic applications
like ramp metering, variable message signs, detector
measurements, incident management and simulation of
vehicle guidance with AIMSUN2. Adams and Yu (10)
evaluated the AIMSUN2 simulation model for supporting
of ITS development and noted that AIMSUN2 contains a
wide range of ITS applications and provides user-friendly
interface. Center for Traffic Simulation (CTR) at the
Swedish Royal institute of Technology tested four
dynamic models (CORSIM, AIMSUN2,
model for specific conditions. If a model results are to be
INTEGRATION, CONTRAM-I) and noted that
AIMSUN2 is advantageous to all others as the system is
open and more adapted to ITS than the other tested
systems, whereas CORSIM can model traffic control
measures but does not support route choice (11). Casas et
al described the dynamic simulation capabilities of
AIMSUN 2 (12).

4. EXPERIMENTAL SETUP

The following experimental setup was used to evaluate
the performance of the two microscopic simulation
models AIMSUN2 and CORSIM in this study. Two
traffic-network scenarios were generated to observe the
performance of the models. Freeways with congested and
uncongested conditions were coded. The freeway section
was selected as that in the study by Wang and
Prevedouros (6) in which CORSIM was compared with
INTEGRATION and WATSIM. The network geometry
and traffic data for the congested and uncongested
conditions is shown in Figures 1 and 2, respectively. The
entire freeway section was 1255m long and was divided
into 8 links. The merging ramp is connected to the
freeway in Link 7. The on ramp traffic is controlled by a
signalized intersection. The freeway was divided into
short Links to compare the two model results over
specific locations on the network.

Lane capacity for FRESIM (the freeway
component of CORSIM) is only specified indirectly. An
array of 10 car-following parameters indirectly determine
the lane capacity in FRESIM (13). The value of 0.8 to 1.7
was used in car-following sensitivity factors for 10 driver
types. In AIMSUN2 one can define the lane capacity
directly. A capacity of 2100 vphpl was used.

Initially three independent runs were made with
different random seed numbers for each of the two
programs. For CORSIM the random seed numbers were
changed manually after being selected from a Random
number table (more recent versions of CORSIM support
automatic generation of random numbers). AIMSUN2 can
automatically generate the desired number of independent
runs without interference from the user. With 1 mile/hr
allowable error for speed and 95% confidence, three runs
were sufficient. The results presented are the averages of
the three runs.

![Figure 1: Network for case study 1, Freeway with on
ramp congested conditions](image-url)
5. RESULTS

For the freeway, the following measures were used to evaluate and compare the performance of both programs: actual/simulated volumes, flow, speed and density. Results for the freeway congested and uncongested scenarios are presented next.

5.1 Case Study 1: Freeway Congested Conditions

The network geometry and data input for this case study are shown in Figure 1.

5.1.1 Actual and simulated volumes

The difference between actual (input) and simulated traffic volume for both simulation models is shown in Table 1. Both of CORSIM and AIMSUN simulated (i.e., outputted) less traffic than the input traffic demand. The results from both programs are very close with the largest difference for the two programs being for Link 6 which is immediately upstream of the section that has the on-ramp. This could be an indication that differences between the two programs are more pronounced in areas of higher traffic interaction. However, more MOEs should be consulted before such conclusion is finalized.

Table 1: Simulated and actual traffic volumes for congested conditions

<table>
<thead>
<tr>
<th>LINK ID</th>
<th>Actual input volume (vph)</th>
<th>Simulated volume CORSIM (vph)</th>
<th>Percentage Difference CORSIM</th>
<th>Simulated volume AIMSUN (vph)</th>
<th>Percentage Difference AIMSUN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6500</td>
<td>5677</td>
<td>12.47</td>
<td>5707</td>
<td>12.21</td>
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<td>6500</td>
<td>5682</td>
<td>12.59</td>
<td>5692</td>
<td>12.43</td>
</tr>
<tr>
<td>3</td>
<td>6500</td>
<td>5683</td>
<td>12.57</td>
<td>5671</td>
<td>12.75</td>
</tr>
<tr>
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<td>6500</td>
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<td>12.54</td>
<td>5651</td>
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<tr>
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<td>6500</td>
<td>5686</td>
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<td>7</td>
<td>7826</td>
<td>6028</td>
<td>23</td>
<td>6041</td>
<td>22</td>
</tr>
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<td>6028</td>
<td>23</td>
<td>6019</td>
<td>23.31</td>
</tr>
</tbody>
</table>

Table I also shows that the percentage difference between the actual and simulated traffic increased as the traffic volumes increased. Part of this difference is expected since the sections capacity is fixed whereby excess demand is filtered “out”. For AIMSUN2, a per lane capacity of 2100 vphpl was directly specified in the inputs. For CORSIM, the capacity is only indirectly controlled; drivers’ car-following sensitivities were changed to produce a capacity of 2100 vphpl. Accordingly, link capacities were 6300 vph which is 200 vph less than the 6500vph inputted demand. Yet, the differences between the actual (input) and simulated volumes by both models were much more than 200 vph (the differences were in excess of 800 vph, and were more than that for the section at and downstream of the on-ramp). This difference might be attributed to the lane changing maneuvers.

Another interesting observation is the spatial trend of the difference between actual and simulated volumes. The differences for CORSIM results decreased steadily beginning with the first section until the section with the on-ramp. For AIMSUN2, the opposite trend is seen (Figure 3). However, the slope of the trend line is very small (this is not considering sections at and beyond the on-ramp).

5.1.2 Traffic flow

Flow rates of both programs for all system links are shown in Figure 4. The difference in volume varies by link. It increases up until Section 7 before it starts to go down. It plausible that the two programs have differences in responding to increased traffic interaction. In this case the increased interaction is caused by either more frequent lane changes and/or less stable flow as traffic approaches the merge area in Section 7.

Moving in a downstream direction, results of the two programs show opposite trends. CORSIM’s flows increase slightly up until Section 7 and then a large jump is observed caused by the on-ramp inflow. For AIMSUN2, the flow decreases gradually before it increases sharply at Section 7. Consistent with earlier observations, the largest difference between CORSIM and AIMSUN2 flow rates is for Section 6, which is immediately upstream of the section with the on-ramp. This trend may have to do with how each program processes traffic as it enters the system, although for both programs we specified that traffic should “enter” the system uniformly.
The car-following model implemented in AIMSUN2 is based on the Gipps model (3). It can be considered as informal development of Gipps empirical model, in which the model parameters are not global but determined by the influence of local parameters depending on the type of driver, geometry of the section and influence of vehicles on the adjacent lanes. The model contains two components: acceleration and deceleration. “The first represents the intention of the vehicle to achieve a certain desired speed, while the second reproduces the limitations imposed by the preceding vehicle to achieve a certain desired speed” (3). CORSIM uses the PITT algorithm developed by the University of Pittsburgh. PITT algorithm is a combination of Northwestern algorithm and UTCS collision avoidance feature (14). The main parameter is the sensitivity factor “k”, which is a function of driver type.

5.1.3 Speed

The trend of the speed values for CORSIM and AIMSUN are very similar (Figure 5). The difference in values is more in sections upstream of the disturbance (i.e., the on-ramp in section 7) but became very close at and beyond section 7. The interesting part is the increase in speed, even beyond that of the upstream sections. That increase was accompanied by a proportionate decrease in density (Figure 6). Once again, the more pronounced difference between the outcomes of the two programs upstream of the on-ramp seem to indicate that the differences in their car-following and lane changing logics are more sensitive to traffic disturbances when more lane changing maneuvers and/or more accelerate/decelerate become necessary.

5.1.4 Density

Figure 6 shows link densities for both CORSIM and AIMSUN2. The information in the Figure is redundant since it can be generated from Figures 4 and 5. The Figure, nonetheless, help us understand how traffic properties evolved between the sections upstream. The increase at and past section 7 was “accommodated” through simultaneous decrease in density and an increase in speed. Both programs show similar trends. The largest difference in density is at the first link. That difference may have been in part due to how the two programs initialize traffic conditions. The user has more control over how much traffic and where the network will start with in AIMSUN2. Little of that control can be exercised with CORSIM.

5.2 Case Study 2: Freeway Uncongested Conditions

The network geometry and traffic input data for case study 2 are shown in Figure 2. The same measures as those in the congested case are examined.

5.2.1 Actual and simulated volumes

Actual and simulated volumes for the uncongested freeway scenario are shown in Table 2. Because the system had excess capacity, almost all demand was accommodated and allowed into the system. As such, the differences between the actual (input) and simulated volumes are almost negligible. However, as was the case with the congested conditions, the largest difference between the two programs is for link 6 which is the link...
upstream of the on-ramp disturbance. This further collaborate earlier observations that lane-changing and car-following logics for the two programs exhibit more differences in areas of disturbance.

TABLE 2
Simulated and actual traffic volumes for uncongested conditions

<table>
<thead>
<tr>
<th>LINK ID</th>
<th>Actual volume (vph)</th>
<th>Simulated volume CORSIM (vph)</th>
<th>Percentage Difference</th>
<th>Simulated volume AIMSUN (vph)</th>
<th>Percentage Difference</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
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<td>3996</td>
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<tr>
<td>3</td>
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<td>4</td>
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<td>3983</td>
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<td>4665</td>
<td>0.12</td>
<td>4613</td>
<td>1.25</td>
</tr>
</tbody>
</table>

5.2.2 Flow
Figure 7 shows the flow rates for both programs. The differences are very negligible. However more differences appear with speed and density as shown in Figures 8 and 9.

5.2.3 Speed
The trend of speed curves for CORSIM and AIMSUN2 are similar as shown in Figure 8. As the congested case, the differences are more for links upstream of the disturbance. The absolute differences between the values of the two programs are less than the congested case. The difference for the upstream links are on the order of 10 km/h (was on the order of 20 km/h for the congested case).

5.2.4 Density
Densities on system links are shown in Figure 9. The differences in densities between the two programs increased in the downstream direction with the maximum difference being for the on-ramp link. After that point the densities are very similar. Although part of this difference may be attributed to the differences in the car-following logics, the definition and way of estimating density is not exactly the same in both programs. The method of calculating density was explained earlier in case study 1 (congested conditions). Unlike the congested conditions, the difference in density here is less for the upstream sections and significantly more for the on-ramp section (Section 7). It seems that the density difference between the two programs becomes more pronounced in congested conditions.

6. CONCLUSION AND DISCUSSION
This study compared the simulation results of CORSIM and AIMSUN2 for uninterrupted flow facilities (freeways) under both congested and uncongested conditions. Every effort was exercised to ensure that input and default values are similar for both programs so as to minimize differences that are due to the programs’ own characteristics and properties. It is conceivable that a
small part of the difference revealed in this study may have been attributable to how each program goes about estimating its output values. Conscious effort was exerted to ensure that such differences are kept at minimum. Because no real world data were available to calibrate both programs at the time of this study, the outcomes of this study cannot be used to endorse one program over the other. However, the relative ease of use of AIMSUN2 and its facilities to simulate some ITS features (not tested in this study) were obvious.

Based on the results of the simulation experiments the following conclusions may be drawn:

CORSIM and AIMSUN2 produced satisfactory and comparable results for uncongested conditions for freeways. Both models showed some distinct differences for the congested condition. It is difficult to conclude which of the two programs is more accurate since we have no benchmark or field-measured data. The differences between the two programs were more pronounced in congested conditions with higher traffic interactions. The lane change and car following logics might be partly responsible for that.

It is easier to input traffic parameters in AIMSUN2 than CORSIM. AIMSUN2 contains wide range of ITS applications, and it has an interface with other ITS algorithms. AIMSUN2 provides detailed statistical output and graphics for each section. AIMSUN2 has user-friendly interface as compared to CORSIM. It is easy to define parameters like lane capacity, driver reaction time etc. in AIMSUN2, while in CORSIM there are arrays for each type of parameter.

REFERENCES

[2] TSIS version 5.0 user manual