TEXAS SOUTHERN UNIVERSITY

Project Summary Report 4317-S
Project 0-4317: Airport Related Traffic and Mobile Emission Implications

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PROJECT SUMMARY REPORT

# Summary Report on Airport Related Traffic and Mobile Emission Implications

Air transportation has grown in a very rapid speed in the past decades. The number of the air travelers is projected to increase significantly in the next number of years. One of the impacts of the growth in air transportation is its contribution to traffic congestion and air pollution problems in areas around the airport.

The current practice in the urban transportation planning process does not address the traffic and emission problems around the airport appropriately. The airport is simply treated as a special generator in the travel demand forecasting and the emissions estimation. Travel demands, to and from the airport, are forecasted based on the traditional four-step sequential procedure. Emission factors are generated from the emission factor model MOBILE, which virtually reflects the average urban highway driving conditions. This type of modeling practice is unable to capture the unique driving behaviors, parking, and curbside vehicle activities at the airport. The errors of estimated mobile-source emissions in the planning process for the airports are unavoidable.

The objectives of this research are: (1) to develop a microscopic simulation framework (See Figure 1) to study the traffic and emissions around the airport terminal areas; (2) to develop a feasible and effective approach to calibrate the simulation model; and (3) to

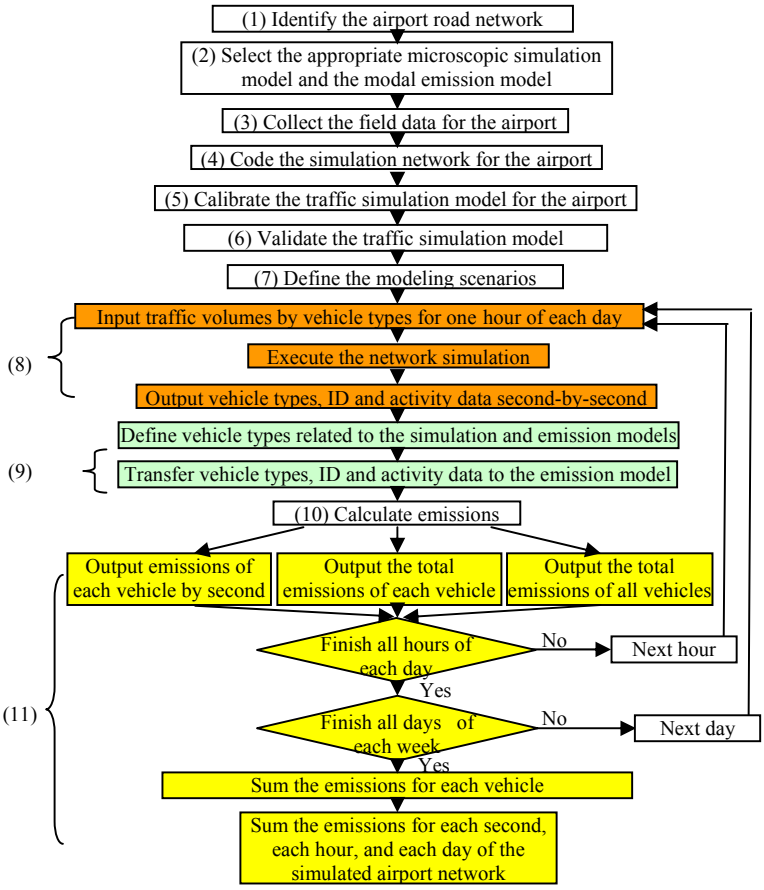


FIGURE 1 The microscopic framework.

evaluate the integrated framework with a case study.

## Microscopic Framework…

The developed microscopic framework integrates a microscopic traffic simulation model and a modal emission model, which can be used to assist in the operational-level analysis of the mobile-source emission implications around the airport. The components of the framework include: (1) identifying the airport road network; (2) selecting the appropriate microscopic traffic simulation model and the modal emission model; (3) collecting the field data for the airport; (4) coding the simulation network for the airport; (5) calibrating the traffic simulation model for the airport; (6) validating the traffic simulation model; (7) defining the modeling scenarios; (8) executing the network simulation; (9) transferring the traffic simulation outputs to the modal emission model in an automatic manner; (10) calculating emissions of each vehicle second by second; and (11) summing the emissions for all scenarios.

VISSIM is the selected traffic simulation model and CMEM is the modal emission model. A computer program is developed in Microsoft Access to transfer data from VISSIM to CMEM automatically. The interface of CMEM is revised to calculate the emissions of each vehicle by second, and the total emissions of each vehicle and all vehicles. The defined modeling scenarios can be hourly, daily, weekly, monthly or yearly. The implementation of the framework requires the inputs of data of network configuration, traffic volumes by vehicle types, vehicle turning ratios at intersections, waiting time in front of terminal, instantaneous speeds and acceleration/deceleration.

## Calibration Approach…

As for the calibration of traffic-simulation model, the Genetic Algorithm (GA) based approach is developed to calibrate the 10 driving behavior parameters in VISSIM. The proposed GA-based approach defines the index of simulation accuracy as the Sum of Squared Error (SSE) between the vehicle speeds collected and the vehicle speeds simulated at pre-defined cross-selections at a 10-meter interval along the road. The objective of calibration is to minimize the SSE in obtaining the 10 optimal parameter values simultaneously. Figure 2 shows the process of the GA-based calibration approach. A computer program is developed in MATLAB to implement the process.

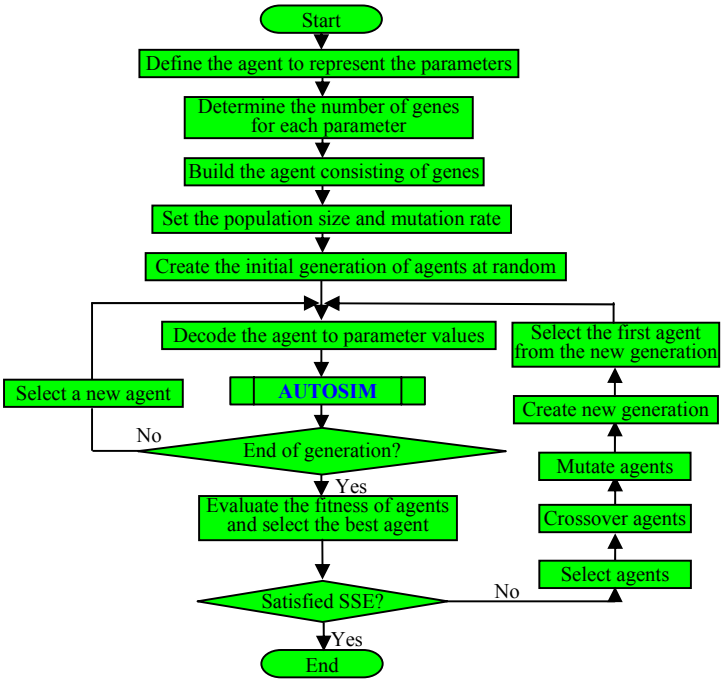


FIGURE 2 Process of GA-based calibration approach.

In Figure 2, the complex relationship between SSE and the 10 driving behavior parameters are expressed using a simulation procedure AUTOSIM, which generates SSE output with a set of inputs of 10 parameter values. A computer program is developed to implement AUTOSIM automatically.

## Case Study…

The case study of Intercontinental Airport of Houston (IAH) is conducted to implement the proposed microscopic framework and the calibration approach. The IAH road network has two entries and one exit, connecting five terminals, five parking lots and a hotel. The field data collected include: (1) the vehicle instantaneous speed on the loop using GPS; (2) traffic volumes and turn ratios by vehicle types; and (3) projected hourly traffic volumes of one week. The simulation network is coded in VISSIM. The computer program for the GA-based approach is run to calibrate the driving behavior parameters for the IAH network. The

research has found that the calibrated optimal values of the VISSIM driving behavior parameters result in a 50% decrease of the SSE value.

Traffic simulation with calibrated parameters is run for each hour of August 28, 2002. The revised CMEM is run to transfer data from VISSIM to CMEM, and calculate the emissions for each hour. There are three kinds of files obtained for the scenario of each hour. The first includes the emissions of each vehicle on a second basis. The second includes the total emissions of each vehicle during the simulation time period. The third includes the total amount of emissions of all vehicles in one simulation hour.

The produced emissions of each vehicle shows that the emission profiles well reflect the trends of the acceleration-deceleration profile. The calculated emissions at IAH for August 28, 2002 are 52052.4 gram for CO, 5140.0 gram for HC, 11793.5 gram for NOx and 11760234.4 gram for $CO_2$. Figure 3 illustrates the hourly emission amounts generated from CMEM. As shown in the figure, a majority of emissions are emitted during 9:00 am - 20:00 pm.

We also projected this emissions amount for one week in August, the month of August, and the year of 2002 based on the projected traffic volumes. The results are shown in Figure 4. The emission results show that in the year of 2002, the vehicles going in and out of IAH terminal area totally generate 2948 tons for $CO_2$, 1.3 tons for HC, 13 tons for CO and 3.0 tons for NOx.

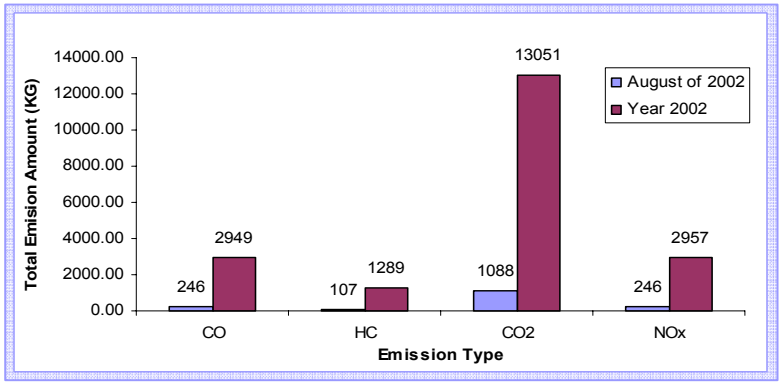


FIGURE 4 Various types of emission in August and year 2002.

## The Researchers Recommend…

In this research, the microscopic framework and the GA-based calibration approach are developed. The case study of IAH is conducted, which shows that the proposed microscopic framework and calibration approach efficient and practical.

It is recommended that the proposed microscopic framework can assist in the operational-level analysis of the mobile- source emission implications around the airport, as well as the overall airport design and planning. The GA-based calibration approach can be easily extended to networks other than airport roads. The forecasting is conducted.

It is suggested that in the future research, more parameters will be included into the index function of simulation including travel time, queue length, etc. More simulation models besides VISSIM can also be tested in the simulation process.

To increase the accuracy of the emission estimation, it is recommended the suitable on-board emission testing devices be used to detect the actual emissions of different types of vehicles, and then further calibrate the estimated emissions in the proposed framework.

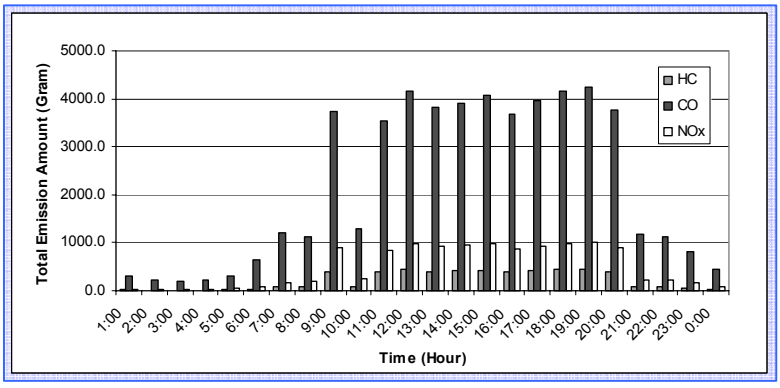


FIGURE 3 Hourly emission amounts for HC, CO and NOx.

## For More Details . . .

This research is documented in

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|---|---|
| Related Reports: | Report 4317, *Research Report on Airport Related Traffic and Mobile Emission Implications* |

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## TxDOT Implementation Status
## February 2004

No implementation by TxDOT is planned at this time. However, the researchers' simulation framework can be utilized by Metropolitan Planning Organizations and cities operating large commercial airports. The research report which contains the simulation framework is available through TxDOT's research library maintained by The University of Texas Center for Transportation Research at the address listed above.

**For more information, please contact: Andrew Griffith, P.E., RTI Research Engineer, at (512) 465-7403 or e-mail: agriffi@dot.state.tx.us.**

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