FHWA Traffic Analysis Tools & NGSIM Program

University of Idaho

presented by
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Presentation Overview

- FHWA Traffic Analysis Tools Program
- Overview of NGSIM Research
- NG-VIDEO
FHWA Traffic Analysis Tools Program
Why Care About Traffic Analysis?

Why waste time on modeling when the answer is obvious… add more lanes!
Why Care About Traffic Analysis?

- Multi-million dollar decisions are being made
- Transportation budgets are tight, so need the most efficient solution (best “bang for your buck”)

- Solutions are increasingly difficult
  - Not just choosing number of lanes anymore
  - Looking at innovative solutions:
    - HOV/HOT lanes
    - ITS Solutions
    - Complex merges/weaves
    - Complex signal timing
    - Impacts on entire corridors/regions
FHWA Role in Traffic Analysis

- Assessed user needs and current simulation market:
  - Viable market in traffic simulation packages
  - Still gaps in functionality that require algorithm development
  - Users not sure how valid the models are, or how they compute their results – “black box”

- FHWA decision:
  - Maintain a strong presence and role in traffic simulation
  - Do not compete with private sector software development market; instead act as market facilitator
  - Provide open, freely distributed products to benefit entire traffic community – users, vendors, researchers
FHWA Traffic Analysis Tools Program

- **Goal #1: Wider use and acceptance of tools**
  - FHWA Traffic Analysis Toolbox
  - Training Courses and Workshops

- **Goal #2: More trusted results**
  - Next Generation Simulation (NGSIM) program
  - Dynamic Traffic Assignment (DTA) program
  - ITS Deployment Analysis System (IDAS)
FHWA Traffic Analysis Tools Program

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  - *FHWA Traffic Analysis Toolbox*
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FHWA Traffic Analysis Toolbox

- **Purpose:** Provide guidance, recommendations, and examples on the proper selection and use of traffic analysis tools

- **Six Volume Set:**
  1. Traffic Analysis Primer
  2. Decision Methodology
  3. Simulation Guidelines
  4. CORSIM Guidelines
  5. Case Studies
  6. Interpreting MOEs

- **Download from TAT Website:**
FHWA Traffic Analysis Process

1. Scope Project
2. Data Collection
3. Base Model Development
4. Error Checking
5. Model Calibration
6. Alternatives Analysis
7. Final Report
Next Generation Simulation (NGSIM) Program
NGSIM Goals

Goals

- Improve the quality, trust, and use of simulation tools
- Foster an environment of public-private cooperation
- Influence and stimulate the commercial modeling market
NGSIM End Products

- Develop a core of driver behavior algorithms
  - Core model algorithms, not GUI or data processing/tools
  - Open source for free public use
  - Supporting documentation and validation data

- Collect new data sets to support algorithm development

- Distribute algorithms and data sets freely on NGSIM repository
NGSIM Pathway to Success

Data Collection

Algorithm Development

Direct NGSIM Activities

Public-Private Partnership

Impact on Commercial Simulation Market

Better Models Enable Better Decisions

Better Transportation Investment Decisions
NGSIM Repository
http://ngsim.fhwa.dot.gov
NGSIM Stakeholder Groups

- **Traffic Modelers**
  - Represent researchers and others that develop theoretical models

- **Software Developers**
  - Represent private vendors responsible for development of commercial software

- **Model Users**
  - Represent end users of simulation tools (i.e. state DOTs, local agencies, consultants)
NGSIM Datasets

- NGSIM data are high-value vehicle trajectory data
  - Near 100% of all vehicle position traced at 0.1 sec intervals
  - Detailed lane position and disposition to other vehicles
  - Expensive to collect, few non-NGSIM data sets exist
  - Trajectory data are the key required data for micro-level simulation development and validation
Dataset Usage – Lane Changes
Dataset Usage - Shockwaves
**Freeway Dataset: I-80 in San Francisco**

- 12-lane freeway with HOV lane
- 0.5 KM of freeway weaving/merging section
- Commuter traffic
- Collected:
  - NB and SB
  - 5 hours in each of AM and PM peak periods
- Processed:
  - NB PM - 45 minutes
  - At congestion and transition
**Freeway Dataset: US 101 in Los Angeles**

- 10-lane freeway
- 0.64 KM of freeway weaving/merging section
- Next to Universal Studios
- Commuter and tourist traffic

**Collected:**
- NB: 7 hours in PM peak period
- SB: 5 hours in each of AM and PM peak periods

**Processed:**
- SB AM – 45 minutes (at congestion and transition)
Arterial Dataset: Lankershim Blvd. in Los Angeles

- 10-lane arterial
- 0.5 KM of arterial section with 4 signalized intersections
- Collected in June 2005:
  - 5 hours in each of AM and PM peak periods
- Processed:
  - 30 minutes in both directions during AM peak
Dataset Contents

- 45 minutes of vehicle trajectories
  - Near 100% of vehicles every 1/10 seconds

- Contents
  - Vehicle trajectory data
  - Raw and processed video
  - Aerial orthorectified photos
  - CAD diagram and GIS files
  - Detector data
  - Signal timings and signs
  - Weather information
  - Open source license
NGSIM vehicle detection/tracking software

- Publicly available at NGSIM website soon

Inputs
- XML File
  - AVI Files
    - Source Video
    - Rectified Video
- Calibration Parameters
  - Camera Matrix (focal length, principal point)
  - Distortion Parameters (lens)
  - Rotation and Translation (world coordinates)
- Shadow Parameters

Database

Automatic Detection & Tracking

- Accurate
  - yes: Vehicle Trajectory Data
  - no: Alerts

Manual Corrections

Vehicle Trajectory Data

Alerts
**NGSIM Algorithm Focus**

- **Pre-Trip**
- **Strategic En-Route**
- **Tactical Route Execution**
- **Operational Driving**
- **Vehicle Control**

Time to Make/Execute Decision:
- **Macroscopic**: 30 seconds
- **Nanoscopic**: 5 seconds
NGSIM Algorithm Prioritization

Rank Most Critical Scenarios

1. Lane selection on arterials
2. Oversaturated freeways
3. Freeway lane distribution
4. Weaving sections
5. 2-way left hand turn lanes
6. Response to VMS
7. Pedestrians
8. Heavy vehicles
9. Work zone behavior
10. Effects of incidents
11. Freeway interchanges
12. Urban grid
13. Roundabouts
14. Freeway geometry
15. Transit operations
16. Unsafe maneuvers
17. Uncontrolled movements
18. HOV lane usage
19. Illegal Maneuvers
20. Stop line behavior

- March 2003 Stakeholder Workshop
  - 35+ critical scenarios identified by users where current tools are deficient
  - Poor accuracy under congested conditions is a pervasive concern

- Current NGSIM efforts focus on top 4 critical scenarios
Freeway Lane Selection Algorithm

Algorithm Development

- Existing lane changing models only consider lanes to immediate left or right
- New model incorporates *target lane concept* – drivers may move to a “worse” adjacent lane on way to a “better” target lane
- This behavior is especially noticeable with unlimited access HOV lanes

Tested/validated in commercial simulation models

- Collaborative effort with three commercial simulation vendors (Aimsun, Paramics, Vissim)
- Cube DynaSim and TransModeler have also tested in their commercial models
**Observations VI: it really works**

- **HOV-Modeling in VISSIM (without NGSIM algorithm)**
  - HOV lane defined by restricting the use to vehicle class HOV
  - normally no explicit incentive for HOV vehicles to go to HOV lane
  - tricky modeling possible to bring more HOV vehicles to the HOV lane, but difficult to calibrate

- **HOV lane modeling is significantly improved**
  - explicit guiding of HOV vehicles to the HOV lane
Additional NGSIM Algorithms (Currently Under Development)

- **Cooperative/forced freeway merging**
  - Explicitly consider cooperation and competition in merging at congested freeway merging and weaving areas

- **Arterial lane selection**
  - Consider both pre-emptive/tactical lane positioning behaviors and more aggressive overtaking behaviors on congested arterial corridors

- **Oversaturated freeway flow**
  - Focus on car-following and lane-changing behaviors during congested, stop-and-go conditions
Using the site:
• Register, via the front page
• View the ‘documents’ section for relevant downloads
• Check the site weekly for news and events updates
• Participate in discussion forum
Additional Slides
**NGSIM Market Assessment**

**Algorithm Prioritization (Demand)**
- Prioritize the core algorithm categories in terms of research needs to improve the quality and performance of simulation tools

**Algorithm Assessment (Supply)**
- Categorize, assess and evaluate behavioral algorithms from both theoretical and implementation perspectives
# Prioritization of Algorithm Scenarios

<table>
<thead>
<tr>
<th>Ref #</th>
<th>Scenario Name</th>
<th>Importance</th>
<th>Gaps</th>
<th>Success</th>
<th>Data</th>
<th>Weighted Sum</th>
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Market Assessment Synthesis

Behavioral Algorithm Categories

- Strategic
- Tactical
- Operational

Research & Documentation

- Low
- High

Lane Changing
Gap Acceptance
Queue Discharge
Acceleration
Transit
Pedestrian
Mixed-Mode
Cooperative Behaviors
Merging
Route Modification
Parking
Emergency Response

1 Tactical
2 Operational
3 Strategic
Prototype Data Collection

Cameras mounted here
Data Prototype - Schematic

Prototype coverage (1 KM)
Extracting Vehicle Trajectories
Historical Background

1952  J. Wardrop, TRL England  Intersection Delay

1956  D. Gerlough, UCLA  Microscopic Modeling, "cells"

1960's  A. May, UC Berkeley  Macroscopic Models, Corridor Control

1970's  FHWA, UTCS Experiment  UTCS-1 (NETSIM), TRAF
        TRL, England  TRANSYT, CONTRAM

1981  TRB Special Report 194 : Over 40 simulation models

1980's  Technology/Mainstreaming  PCs/Graphics

1990's  "Advanced"/Systems/Corridors/ITS CORSIM, INTEGRATION,….

2000's  "Market Forces”  Over 70 simulation models

History of Simulation Development


Macro
- PASSER
- TRANSYT
- CONTRAM
- FREFLO NETFLO
- CORFLO
- Synchro

Meso
- DYNASMART-X DynaMIT-R
- DYNASMART-P (DynaMIT-P)
- Commercial Vendors Microsimulation

Micro
- UTCS-1
- TRAF-NETSIM
- INTRAS
- FRESIM
- TSIS-CORSIM

Year

U.S. Department of Transportation
Federal Highway Administration
Emergence of Microsimulation Market

Available Software


U.S. Software Licenses

May 2002: 1,200
Nov. 2004: 1,600

+33%