TMC Operator Training Using Microscopic Simulation

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Background

- **TMC**
  - Traffic condition monitoring and traffic management.

- **Primary function**
  - Incident management
    - Detect incidents
    - Quickly take appropriate action to reduce congestion
  - Essential ITS strategy

- **TMC usually integrated with various field elements**
  - Vehicle detectors
  - CCTV
  - Ramp meters
  - CMS
  - Highway advisory radio (HAR).
Presented at 2008 North American Paramics User Group Meeting

Incident management process in California

1. Incident occurs

2. CHP gets incident info; update incident info in CHP CAD

3. TMC operators verify & assess the incident

4. Operators respond to incidents: dispatch staff; send info to CMS, media, HAR.
Motivation

- Caltrans has a state TMC operator training program,
  - Enhance the skills and enrich traffic management experiences of TMC operators in a simulated, off-line environment.

- First-generation of TMC simulator
  - Implemented at California Polytechnic State University San Luis Obispo
  - Used to train TMC operators and CHP officers from 1994 to 2004.
  - Shortcoming: needs to be more realistic for training purposes

- Second-generation TMC simulator
  - Developed from 2004 to 2005
  - Caltrans ATMS Testbed at University of California Irvine.
  - Microscopic traffic simulation is utilized to provide traffic data for other modules
System requirements

• Duplicate the standardized TMC software systems and data feeds found in California TMCs in an off-line environment
• TMC operators can be trained using various pre-defined incident scenarios
• Functions
  – Display traffic data from simulation on ATMS
  – Simulate various pre-defined incidents
  – Simulate vehicle diversion
Micro-simulation selection: Paramics

- Paramics models traffic systems at fine details of roads, individual drivers, and vehicles.
- Powerful Application programming Interface (API)
  - Make it possible to fully control the traffic network simulation
- Paramics are able to model field elements
  - Loop detectors
  - CMS
  - Incidents
- Paramics can model the following through API
  - Controllable incidents
  - CCTV cameras
  - Drivers’ responses to incidents, messages
  - Vehicle diversion
How to model ITS: Application Programming Interfaces
PARAMICS API

Main simulation loop

function calls:
vehicle related..
link related..
and others

API

Plugins

functions

user-defined programs

Other applications /APIs

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PARAMICS Plug-in Development

Provided API Library

Developed API Library

Advanced Algorithms

ATMIS Modules

Signal

Ramp

Routing

Demand

CORBA

Databases

XML

Data Handling

Adaptive Signal Control

Adaptive Ramp Metering

Dynamic Network Loading
Display detector data from simulation on ATMS

• “Reverse engineering” the detector data collection and communication with TMC in the real world

• Establishment of a “virtual” connection between ATMS and Paramics:
  – Every 30 sec,
    • Aggregated detector data
    • Packed up aggregated detector data based on the Semi-Actuated Traffic Metering System (SATMS) protocol
    • Poll data from controller based on Front End Processor (FEP) protocol,
    • Transmitted to ATMS for display via Remote Procedure Call (RPC).
Display detector data from simulation on ATMS
Camera modeling

- Real world: TMC operators check traffic conditions at each CCTV camera location through
  - ATMS’ camera function
  - Video wall composed of pre-set CCTV video sources
- TMC operator training system:
  - Report the traveling speeds at specific camera locations
  - Associate a snapshot image or video clip of the corresponding traffic condition with each CCTV camera
    - Snapshot image: viewed through ATMS
    - Video clip: viewed through video wall
- Camera modeling
  - Cameras in the field have pan, zoom, and tilt functions
    - An area-wide traffic sensor
  - Cameras in Paramics are assumed to have a fixed zoom level,
    - Its view is defined as a section of freeway (i.e. one link, part of a link or several links).
    - Speed at a camera location
      - Defined as the average speed of vehicles within the view of the camera
  - Speed data are report every 30 sec to TMC simulation manager
Incident modeling

- Real world:
  - Incidents have different severity
- TMC operator training system
  - Pre-defined incidents with different severity will need to be modeled.
  - Have flexibility to model various traffic incidents
  - Incidents must be changeable and controllable, as frequently as every 30 sec
- Incident model
  - Parameters
    - Incident location, including freeway, direction, and milepost number
    - Incident type
    - Number of lanes affected
    - Incident status, e.g., new, changed (indicating a change in the number of affected lanes) or cleared
- Incident model implementation
  - Emulate these incidents by controlling the speeds of vehicles on affected and neighboring lanes according to incident type and the status of the incident.
Diversion modeling

• Real world
  – TMC operators may post messages on CMSs in order to divert traffic during traffic incidents and/or traffic congestion

• TMC operator training system
  – Trainer evaluates the strength of diversion messages
  – Paramics implements a certain diversion

• Diversion model
  – Parameters
    • Initial route (i.e., which route the vehicle is on)
    • Original path (i.e., which route travelers has planned to take);
    • Diversion path (i.e., new route);
    • Percentage of the group of travelers to divert.

• Diversion implementation
  – Path based routing plugin
TMC Simulation manager and Paramics interface

- **Communication**
  - Internet Protocol (IP) Socket communication
  - Communication interval: 30 sec

- **Data**
  - Extensible Markup Language (XML) format
    - Data exchanged between them uses

- **Data from TMC simulation manager to Paramics**
  - Current clock
  - Incident data
  - Diversion data
  - List of camera locations for speed data request

- **Upon receiving the data, Paramics will also do the following**
  - Send speed data from Paramics to TMC simulation manager
  - Invoke appropriate plugin modules to emulate given activities
    - Incidents
    - Vehicle diversion
Study site

- City of Irvine, Orange County, California,
  - 18-mile I-5,
  - 12-mile I-405, and
  - 10-mile SR-55
During simulation, aggregated detector data are continuously collected from Paramics every 30 sec and then sent to ATMS to display.
The simulation manager shows that an incident starts.
Paramics emulates the incident, which causes the occurrence of traffic congestion, indicated by the yellow circles in Paramics.
Accordingly, ATMS immediately shows red colors for detectors within the problematic area.
Incident verification and response

- Verify incidents
  - ATMS
  - Cameras
  - CHP CAD
- Communicate with other staff
- Evaluate incidents’ severity
- Monitor incidents
- Response
  - Dispatching appropriate personnel to the field
  - Informing motorists via CMS, HAR and media
Students continue to monitor incidents
Response to incidents: diversion?

• If incidents are becoming more serious
  – Determine diversion routes and
  – post diversion messages to CMSs
Students post diversion messages to CMSs
Trainor evaluates the strength of the diversion messages with the resultant diversion routes and their associated diversion rate.
What will happen next

• Paramics simulates diversion.
• Vehicle diversion leads to the decrease of traffic congestion
• Students continue to monitor incidents
• Students find the effects of the traffic management by monitoring traffic condition via
  – ATMS
  – Camera
Conclusion

• TMC simulator provides an interactive environment where actions students take to manage an incident affect the simulated traffic in the system and students see the results of their activity.

• TMC operators from different districts can get trained together and they can effectively exchange experiences and learn skills from each other.

• Six training classes have been successfully performed since the completion of the system.
Project team

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Thank you!

Questions & Comments