Data Acquisition & Field Test Data Analysis

Dave LeBlanc

IVBSS 2008 Public Meeting
April 10-11, 2008

Eagle Crest Resort & Conference Center
Ypsilanti, MI
Topics

• Overview – purpose of data collection
• Data archive overview
• Requirements on data
• Data acquisition
• Fleet monitoring
Data Acquisition System

Phase I
• Support Phase I development of IVBSS.
• Provide data during Phase I testing.

Phase II
• Provide data from extended pilot FOT and from FOT itself.
• Allow remote monitoring of test fleet (IVBSS performance & health, driving behavior)
Data Uses

- UMTRI –
  - monitoring fleet
  - analysis of experimental data (performance, acceptance, safety)
  - debriefing test subjects
- Visteon/Eaton/Cognex –
  - technology performance
- Volpe Center/USDOT –
  - quality assurance
  - analysis of experimental data
- Side benefit – data archive for future research
Data Archive –
“Raw” Objective Data

• Driver information

• Onboard data
  – Numerical (database)
  – Video
  – Audio

• Offboard data
  – Map & roadway feature databases
  – Weather data
Data Archive –
Processed Objective Data

• Cleansed data – smoothing/fusing, managing dropouts & outliers, bias removal, validating trips, etc.
• Driving context characterization using roadway data, weather data, time, etc.
• Characterization of events & scenarios of interest
• Building measures of system performance, potential safety impacts, facts possibly affecting driver acceptance

→ Additional data may exceed size of original raw numerical data
Data Archive – Subjective Data

• Pre-drive questionnaire
  – Driving style and behavior questionnaires completed prior to FOT participation

• Post-drive questionnaires
  – Completed after FOT participation: on-site and take home

• Driver debriefs
  – Review of a subset of warnings to rate for usefulness

• Focus groups
Data Archive –
Subjective Data: Questionnaires

• Pre-drive questionnaires
  – Driver style questionnaire (DSQ)
    • Evaluates 6 factors of drivers’ style: focus, calmness, social resistance, speed, deviance, and planning
  – Driver behavior questionnaire (DBQ)
    • Examines drivers’ errors, lapses, and violations
  – Drivers’ scores from DSQ and DBQ will be used in statistical models as predictors of IVBSS acceptance
Data Archive –
Subjective Data: Questionnaires
(continued)

• Post-drive questionnaires
  – Extensive evaluation of drivers’ opinions of IVBSS
  – Will evaluate safety, ease of use, comfort and convenience, and willingness to purchase
  – Two questionnaires
    • On-site: highest priority questions
    • Take home: questions of lesser priority
Requirements on Data Archive

- Complete and ‘auditable’ characterization of events & system performance
  - Highly robust & structured data set
  - Continuous 10 to 100 Hz logging (depending on subsystem)
  - ~400 signals on light vehicle and ~300 signals on heavy truck

- Video collection to provide analysts with situational context for FOT data, especially IVBSS-related events.
  - What was happening inside and outside the vehicle?
  - What did the IVBSS system react to?

- Secure from data loss, privacy concerns
Data Archive Formats & Size

• Format when archived:
  – Numerical: enterprise-level relational database
  – Video: MPEG-4 compressed video with indexing for synching with numerical data
    • Compression & frame rates vary by video stream
  – Audio: Compressed 64 kbps with indexing

• Size estimates are preliminary
  – Numerical – depends on radar – 1-2 terrabyte (TB) order of magnitude
  – Video – depends on compression levels – 10 TB?
Requirements on Data Archive

• Highly usable:
  – Analyst access to all data within seconds, including video
  – Analysis tools

• Sharing information between project team & independent evaluator
UMTRI integrated data collection and analysis

ACAS Project database

Test vehicle

DAS

Main Cpu

Data archive/server

Data DB

Analyst’s DBs

Participant DB

Phone DB

Visualization/analysis tools

- SQL analyzer
- DB manager
- Data browser
- Video viewer
- Desktop database
- Spreadsheet

Test vehicle

ACAS

Sensor Fusion Threat Radar...

DAS files to tables

Cell Phone

Forward camera

Face camera

Audio

Video Cpu

Video/Audio files

IVBSS 2008 Public Meeting April 10 -11, 2008

Eagle Crest Resort & Conference Center, Ypsilanti, MI
Data Acquisition System

- Two CPU system (CAN/radar + vision/audio)
- Automotive-grade hard disks
- CAN and J1939 buses – primary data sources
- Second GPS for analysis (differential)
- 5 cameras with video capture & compression
- Up to 7 radars
- Vehicle motion sensors
- GPRS/Edge cellular modem
- DAS power management system
Video Scenes – Representative Images
Monitoring the fleet

Track:
• health of IVBSS & data system
• usage of vehicle
• driver experience with IVBSS (alert types & experience)

Cellular modem:
• Trip characteristics, IVBSS actions, health information including histograms
Web-based interface for monitoring fleet

![Web-based interface for monitoring fleet](image)

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver</td>
<td>ABC</td>
</tr>
<tr>
<td>Trip</td>
<td>DEF</td>
</tr>
<tr>
<td>Status</td>
<td>Green</td>
</tr>
<tr>
<td>Distance</td>
<td>500 miles</td>
</tr>
<tr>
<td>Time</td>
<td>03:45</td>
</tr>
<tr>
<td>Speed</td>
<td>70 mph</td>
</tr>
<tr>
<td>Fuel</td>
<td>120 gallons</td>
</tr>
<tr>
<td>Battery</td>
<td>80%</td>
</tr>
<tr>
<td>Location</td>
<td>XYZ Street</td>
</tr>
</tbody>
</table>

**IVBSS 2008 Public Meeting**

April 10 -11, 2008

Eagle Crest Resort & Conference Center, Ypsilanti, MI
Summary

• Data archive – several types of data
• Extensions from previous FOT analyses:
  – More advanced data collection
  – Power through joining diverse types of data: onboard, offboard, driver information.
  – Driving treated as more ‘holistic’ than previous studies – context considered in more detail