2012 DOE Vehicle Technologies Program Review

Look-ahead Driver Feedback and Powertrain Management

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Overview

Timeline

• Start: 10/2011
• Finish: 9/2014
• 15% complete

Budget

• Total project funding
  • DOE: $914k
  • Cost Share: $238k
  • $367K (DoE)
• Next Phase: 1/2013-1/2014
  • $308k (DoE)

Barriers

• Driver acceptance
• Safety concerns
• Cost effectiveness

Partners

• UMTRI
  • Driver interface, pilot test
• ORNL:
  • Tech consulting & evaluation
• Con-Way Freight
  • End user
Relevance

- Overall Project Objective
  - Develop and demonstrate on real vehicles a driver assistance technology to reduce commercial fleet average fuel consumption by at least 2%

- Phase 1 Goals
  - Develop functional requirement specifications
  - Identify driver scenarios that impacts fuel consumption the most
  - Develop feedback strategy for target scenarios
  - Develop candidate driver interface and scenarios for driving simulator workload study
Approach

• Built upon existing and next-gen sensor and information technology
  • Will assess the impact of various options and their commercialization potential
• Scenario-specific feedback strategy
  • Leverage over 600k miles of naturalistic driving data from a recent DoT study
  • Separate environment caused inefficiency from driver caused inefficiency
• A combination of powertrain control and advisory feedback
  • Maximize fuel saving potential with minimum distraction
# Key Milestones in Phase I

<table>
<thead>
<tr>
<th>Month/Year</th>
<th>Milestone or Go/No-go Decision</th>
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<tbody>
<tr>
<td>1/2012</td>
<td>Milestone: Decide on target driving scenarios for fuel consumption impact analysis</td>
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<tr>
<td>3/2012</td>
<td>Milestone: Completion of look-ahead controller hardware design</td>
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<tr>
<td>6/2012</td>
<td>Milestone: Identify and prioritize the driving scenarios that have the most impact on fuel consumption</td>
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<tr>
<td>9/2012</td>
<td>Milestone: Completion of functional requirement specifications development</td>
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<tr>
<td>12/2012</td>
<td>Milestone: Completion of the development of driver interface candidates and the simulation study plan</td>
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<tr>
<td>12/2012</td>
<td>Go/No-go: Demonstrate through simulation the feasibility of the technology and the target fuel economy improvement</td>
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Technical Accomplishments and Progress

• Task 2.1: Voice-of-customer collection and functional requirements development
  • Interviewed one large trucking company
    • Acknowledged large fuel economy variation among drivers
    • Showed strong willingness to try the proposed technology
  • Evaluated various implementation options
    • Identified the minimum integration requirements with existing transmission and engine controls
  • Worked with sensor and map suppliers to define required features and communication interface
Technical Accomplishments and Progress

- Task 2.2: High fuel-consumption impact scenario identification
  - Defined scenarios of interest based on simulation and sampled field test data
  - Extracted grade & curve events for exposure and impact analysis

<table>
<thead>
<tr>
<th>Scenario of interest</th>
<th>High exposure*</th>
<th>High impact*</th>
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</thead>
<tbody>
<tr>
<td>Up-speed transition</td>
<td>√√</td>
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</tr>
<tr>
<td>Speed-keeping on grade</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Speed-keeping on curves</td>
<td>?</td>
<td>√</td>
</tr>
<tr>
<td>Speed-keeping in traffic</td>
<td>√</td>
<td>√√</td>
</tr>
<tr>
<td>Down-speed transition</td>
<td>?</td>
<td>√</td>
</tr>
</tbody>
</table>

*High exposure scenarios: Scenario that accounts for significant fuel consumption
**High impact scenarios: Scenarios that driver behavior can cause large fuel efficiency variation
Technical Accomplishments and Progress

• Task 3.1: Look-ahead System Development
  • Narrowed down hardware design to two candidates
  • Initiated integration of the DSRC devices (for V2V and V2I communication) - bench test completed
  • Initiated analysis on software integration with transmission controller (for vehicles with auto transmission)

* Dedicated Short Range Communication
Collaborations

• Partners
  • UMTRI:
    • Collaborated on scenario exposure and impact analysis
    • Collaborated on driver interface development
  • ORNL:
    • Exchanged experience on previous heavy-truck related studies and truck fuel efficiency measurement

• Others
  • USDot Volpe Center
    • Helped on identifying additional field test data that can potentially be beneficial to the project
  • USDot Michigan Test Bed (V2x Communication)
    • Helped on V2x communication integration
  • NavTeq
    • Collaborated on system design and map integration
Future Work

• Remaining of Phase I
  • Complete functional requirement specifications development
  • Decide on feedback strategy based on the analysis and prioritization on high fuel consumption impact scenarios
  • Develop candidate driver interfaces and scenarios for driving simulator workload study

• Phase II
  • Down select and finalize driver interface
  • Finalize the prototype look-ahead system and integrate it onto pilot vehicles
  • Develop and verify the data acquisition system for the pilot vehicles
Summary

• Objective: Improve commercial fleet fuel efficiency by at least 2%
• A scenario-specific approach
  • A combination of advisory feedback and power control based on specific strategies for target scenarios to maximize fuel saving with minimum distraction
• Phase I progress is on-track and we are well positioned to continue the research in Phase II
  • Engaging with target end users to confirm the needs and to guide functional requirements development → paving the path for commercialization
  • Leveraging over 600k miles of naturalistic driving data from a previous study to identify high fuel consumption impact scenarios
  • Engaging with sensor and map suppliers to seek cost effective system design
  • Using the prototype truck to identify and address system design and retrofit risks upfront