Driver Workload Management based on GENIVI Driver Workload Assessor

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July, 2014
Agenda

• The Need To Manage Workload
• Workload Management
• Workload Management in a GENIVI Architecture
• Workload Level Definition of GENIVI Driver Workload Assessor
• Workload Management Use Case
• Demonstration of GENIVI Driver Workload Assessor
The Need To Manage Workload
Trends: Increasing Workload

Increasing Workload:
• The vehicle is becoming an increasingly complex environment
  o Rapid increase in the number of systems the driver can control
Trends: Increasing Workload

Increasing Workload:
• The vehicle is becoming an increasingly complex environment
  o More devices are being brought into the vehicle with which the driver may interact
  o ….. with access to more services outside the vehicle
Society’s Concern:
• Society is concerned that Driver Workload and Distraction leads to accidents

Trends: Society’s Concern

Society’s Concern:

- Society is concerned that Driver Workload and Distraction leads to accidents
  - Most regions are introducing guidelines or regulation to counteract Driver Workload and Distraction by limiting driver interaction with HMI & Systems

ESOP: Commission of the European Communities
Recommendation on Safe and Efficient In-Vehicle Information and Communication Systems (2007)
Update of the European Statement of Principles on Human Machine Interface

JAMA: Japan Automobile Manufacturers Association Guidelines for In-Vehicle Display Systems, Version 3.0, 2004


Voluntary guidelines reduce visual-manual distraction - the greatest safety risk to drivers in NHTSA's new study

NHTSA’s Driver Distraction Guidelines

DOT 37-13   Tuesday, April 23, 2013
Customer (Driver) Demand:

- People are becoming increasingly used to being Continually Connected and for information to be always available.
- Drivers want to be free to use their technology throughout their journey
  - Drivers are NOT always fully occupied with driving – we also have clear roads and low workload situations – we have variety - One size does not fit all.

- We have to be able to manage things smartly. If we don’t allow this
  - Drivers will be dissatisfied.
  - Driver will find ways to over-ride restrictions or use CE devices stand-alone.

Therefore we need to manage HMI according to the situation.
Workload Management
A Smart Solution:

- To maximise Customer Contentment within an ethos of Safe-Use, access to functions must be managed according to Driver Workload ……
Workload Manager

Workload Assessment:

- We don’t have a clever device that can directly measure the workload and the capacity to manage additional tasks.
- Therefore until technology advances, we must estimate workload from other indicators.
Driver Distraction, Workload and a Driver’s Capacity:

- Driver Distraction and High Workload are often viewed as the same thing.
- They both contribute to the same problem but are different factors.
  - A driver will have a finite **capacity** to undertake Physical, Visual and Cognitive Tasks.
  - A driver’s **capacity** will be partly taken up by the **workload** of the **primary task** (Driving the Vehicle).

- A driver may be **distracted** from the Primary Task by **driver distraction**.
  - **Beneficial Distractions** (such as informative warnings)
  - **Unhelpful Distractions** which only distract the Primary Task of Driving (such as texting, using a cell phone)
The Driving Task & Capacity for Distractions:

- A Driver’s Capacity is finite.
- This will vary from one driver to another.

A Driver’s Capacity is partially utilised by the constant Workload of the Basic Driving Task.

Available Capacity is the remaining Capacity for additional Workload.

HMI Applications Deliver:
- Information Workload
- Notification Workload
- Entertainment Workload

…and may require:
- User Input Workload
Management of Workload

### Available Capacity

<table>
<thead>
<tr>
<th>Situation Dependent Driving Task</th>
<th>Basic Driving Task</th>
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</thead>
<tbody>
<tr>
<td>Application 4</td>
<td>Application 1</td>
</tr>
<tr>
<td>Application 3</td>
<td>Application 2</td>
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<tr>
<td>Application 2</td>
<td>Application 3</td>
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### Available Capacity

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<td>Application 1</td>
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</tr>
<tr>
<td>Application 1</td>
<td>Application 3</td>
</tr>
</tbody>
</table>

### Driver's Total Capacity

- **Basic Driving Task**
- **Situation Dependent Driving Task**

### Managed Workload

- Applications are delivered to the driver according to priority and available capacity.
- Applications modify their input and output to minimise workload while driving.
- Application interaction contained within available capacity.

### Unmanaged Workload

- Applications are started and interact with the driver in an uncontrolled manner.
- If too many are added and the driving workload is high, the driver's capacity is exceeded.

### Application Overload

- Overload!

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Workload Management in a GENIVI Architecture
Workload Management in a GENIVI Architecture

- A workload manager has 2 key functions
  - GENIVI Driver Workload Assessor
    - To assess the current level of driver workload
      - Monitoring available input sources
      - Assessing current workload
      - Providing a rating of current workload to be used by HMI Control and Apps
  - GENIVI Application Manager, Popup Manager
    - To control the HMI to support but not overload the driver
      - Prioritising Information
      - Withholding Applications/Information
      - Instructing Applications to adopt a “Driving Friendly” HMI mode

Defined the interface between Driver Workload Assessor and Application/Popup Manager
Workload Level definition of GENIVI Driver Workload Assessor
Assessed Workload

Definition of Assessed Workload Levels:
• In order that HMI may be managed we need to define levels of Driver Workload.
• It is important to make a definition of the levels of workload to which a driver is subject that:
  o Offers Consistency of Workload Assessment
  o Provides a useable number of Workload Levels
    [Enough to discriminate, Few enough to avoid confused HMI control]
  o Clear definition of each Workload Level for use by developers of Automotive Apps and HMI Control software
Definition of Assessed Workload Levels

- Definition of Workload Levels that meets these criteria:
  - 5 Levels are considered optimum
    - Enough to discriminate
    - Few enough to avoid confused HMI control

<table>
<thead>
<tr>
<th>Workload Level</th>
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<tr>
<td>5</td>
<td><strong>Workload Extremely High</strong>: At or beyond the driver’s capacity for safe control of the vehicle. No capacity for any additional tasks.</td>
</tr>
<tr>
<td>4</td>
<td><strong>Workload High</strong>: Little spare capacity. Level of effort allows little capacity for additional tasks without compromising the driving task</td>
</tr>
<tr>
<td>3</td>
<td><strong>Workload Moderate</strong>: Enough spare capacity for some tasks that have been optimised for the driving situation. Unlimited additional tasks cannot be accommodated</td>
</tr>
<tr>
<td>2</td>
<td><strong>Workload Low</strong>: Sufficient spare capacity for attention to additional tasks that do not demand continual concentration</td>
</tr>
<tr>
<td>1</td>
<td><strong>Workload Insignificant</strong>: Zero or almost zero driving workload with enough spare capacity for all desirable additional tasks</td>
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</table>
Application Response to Workload:

- Not all applications require the same level of attention from the driver
- Therefore different applications may be permitted or restricted at different levels of workload

It is envisaged that:

- An application will normally use 3 states for operation / information provision
  - Prohibited / Highly-Limited information
  - Partially Permitted
  - Fully Permitted
- Segmentation of workload level will differ according to application

Examples of Segmentation

Application A
Low additional loading

Application B
High additional loading

Application C
Moderate additional loading
Workload Management

Use Case
Workload Management Use Case

Without Workload Manager

Constant-speed driving
Approaching turning point
Turning point

Operation isn’t available at all even if it is safe now

How dangerous! This is not good timing to receive call

Ring! Ring!

With Workload Manager

Constant-speed driving
Approaching turning point
Turning point

Easy GUI operation is available
Receive call at appropriate timing

Delayed Notification
Ring! Ring!

Workload Level is HIGH

How dangerous! This is not good timing to receive call

Turning point

Conventional HMI operation permission based on state (MOVING / STOPPING)

- Speed: Moving
- Phone App: Fully Permitted
- User Input: Prohibited

Flexible HMI behaviour control based on driver’s workload level

- Workload Level: 3 Mid
- Speed: Accel
- Phone App: Fully Permitted
- User Input: Partially Permitted
GENIVI Driver Workload Assessor Demonstration
Components GENIVI already defined
  e.g. Vehicle Interface Component
    (Automotive EG)
  Other vehicle-specific inputs will be permitted

- No specific inputs will be defined
- Only outputs will be defined.
Architecture of Driver Workload Assessor Demonstration

- **Driver Workload Assessor**: Simple Workload Assessor Component to demonstrate output of workload in response to input. **GENIVI Compliant**
- **Ubuntu12.04 (Virtual box)**: Linux Environment to run Workload Assessor
- **Dummy Component to act as GENIVI Vehicle Interface**: Provides vehicle signals to DWA
- **Vehicle Information Sender**: Simple application to simulate vehicle signals used in Simple DWA algorithm
- **Dummy HMI Application**: (for this demonstration of the POC) to visually demonstrate App response to DWA output

**Diagram Details**
- **Driver Workload Assessor**
- **Dummy Vehicle Interface**
- **Dummy HMI App**
- **Vehicle Information Sender**
- **TCP/IP**

**System Setup**
- **Win7 32bit (host)**
Conclusions

- To safely manage HMI, IVI should be controlled according to Driver Workload.

- GENIVI adopted 5-level definition of driver workload.

- GENIVI Driver Workload Assessor allows the application developers to provide “safer” applications.
Thank you
Questions?

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