Navigation and Route Guidance Function Accessibility While Driving

Introduction

Navigation and Route Guidance Systems have some functions that can take significantly more time to use than conventional controls and displays such as the headlights, windshield wipers, the speedometer, the fuel gauge, or the radio (Kurokawa, 1990; Green, 1998, Tijerina, Parmer and Goodman, 1998). Consequently, there are concerns that interacting with navigation and route guidance systems could unduly distract drivers from the primary task of driving. Automated route planning provided by such systems is a convenience for drivers and reduces their pre-trip workload. Driving with route guidance may offer some safety benefit, but special care should be taken in the design of these systems to limit the distraction due to the visual demands placed on the driver while the vehicle is in motion.

1. Scope

This document applies to both Original Equipment Manufacturer and aftermarket route-guidance and navigation system functions for passenger vehicles. It establishes two alternative procedures, a static method and an interrupted vision method, for determining which navigation and route guidance functions should be accessible to the driver while the vehicle is in motion. These methods apply only to the presentation of visual information and the use of manual control inputs to accomplish a navigation or route guidance task.

The document does not apply to visual monitoring tasks which do not require a manual control input, such as route following. Voice-activated controls or passenger operation of controls are also excluded.

There are currently no compelling data that would support the extension of this document to in-vehicle systems other than navigation systems.

2. *Normative References*

2.1 Applicable Publications

The following Standards and Recommended Practices contain provisions that are referenced in this text and therefore are provisions of SAE J2364. At the time of publication, the editions listed were current. All document are subject to revision, and parties to agreements based on this section of J2364 are encouraged to investigate the possibility of applying the most recent editions of the standards listed in this section. SAE maintains a list of currently valid standards.

2.1.1 SAE PUBLICATIONS

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J287—Driver Hand Controls Reach, Volume 3
SAE J1050—Describing and Measuring the Driver's Field of View, Volume 3
SAE J2396—Definitions and Experimental Measures Related to the Specification of Driver Visual Behavior Using Video Based Techniques
SAE J2365—Calculation of the Time to Complete In-Vehicle Navigation and Route Guidance Tasks

3. *Definitions*

For the purposes of this Document, the following definitions apply.

3.1 Accessible by the Driver

Feature is accessible by a driver when:

1. the controls to complete the task are within reach of the unconstrained driver as defined by SAE J287**; and**
2. the display is visible with head movement as defined by SAE J1050; **and**
3. the system is operable by the driver.

3.2 Computationally-Interrupted Task

Task where the driver must wait 1.5 seconds or more for the driver interface to respond to a driver input in order to complete a task such as when an off-board computer is queried. (See Section 5 for measurement procedure.)

3.3 Control

Device used to enter information into a vehicle system.

3.4 Display

Device that presents information to a driver, typically by visual or auditory means.

3.5   Driver Interface

Means by which a driver interacts with a vehicle or vehicle subsystem.

NOTE—The driver interface typically includes one or more controls and/or displays, as well as the system's operating logic.

3.6   Glance Duration

Time from the moment at which the direction of gaze moves towards a target (e.g., the interior mirror) to the moment it moves away from it.

NOTE—This includes transition time to that target per SAE J2396.

3.7   Goal

System end state sought by a driver.

Examples of goals include: obtaining guidance to a particular destination; providing greater magnification of a map display; determining the location of a point of interest; and canceling route guidance.

Example of what is not a goal: Entering part of a destination address without having the route calculated for that does not achieve the system end state of being provided with route guidance.

3.8   Navigation System

System that identifies the current position of a vehicle on the earth's surface and may provide guidance to a destination.

NOTE—Information that may be provided includes the road being driven, the location of crossroads, the heading or compass directions, the distance to a destination, and other items.

3.9   Occlusion Interval

Time a driver display or interface is not visible.

NOTE—This can be the shutter closed time using occlusion goggles, or the time the display is not available if display blanking is used.

3.10   Occlusion Total Shutter Closed Time

Total time that the view of the display is occluded.

NOTE—Occlusion can be either by physical means or display blanking, during a trial.

NOTE—This is the sum of the total shutter closed times during a trial

3.11 Occlusion Total Shutter Open Time

Sum of the total shutter open times during a trial.

3.12 Occlusion Total Task Time

Total time required to complete a given task using the Interrupted Vision method.

3.13 Route Guidance System

System that automatically selects a path to a user-specified destination and usually also provides directions to a destination by indicating the streets and roadways comprising the path using graphics, text, voice, or other means. Route guidance may be a feature of a navigation system.

3.14 Shutter Closed Time

Time interval during which the subject cannot see the visual display when using an occlusion technique.

3.15 Shutter Open Time

Time interval during which the subject can see the visual display when using an occlusion technique.

3.16 Static Total Task Time

Total task time measured in a stationary vehicle, buck, or mock-up in which a subject is only performing the task of interest without interruption.

3.17 Task

Specific sequence of control operations leading to a goal at which the driver will normally persist until the goal is reached.

EXAMPLE—Obtaining guidance by entering a street address using the scrolling list method until route guidance is initiated.

3.18 Task Partitionability

Subdivision of a task into small time segments

3.19 Total Task Time

Total time to complete a task. (See Section 5 for the measurement procedure.)

3.20 Vehicle In Motion

Vehicle speed exceeds the minimum nonzero speed that can be reliably detected by the vehicle speed sensors.

3.21 Vision Interval

Time a driver display or interface is visible when using the interrupted vision method.

EXAMPLE—The shutter open time using occlusion goggles, or the display available time if display blanking is used.

4.   Background and Summary of the Methods

This document encourages interface designs that do not unduly distract drivers from the primary task of driving. The precise prediction of distraction-related crash risk induced by any particular driver interface is difficult, and is not provided by this practice. However, it can be reasonably stated that if drivers are not looking at the road (i.e., are looking inside the vehicle to operate a control or read a display) then the probability for a crash is increased (Wierwille, 1995).

Because direct measurement of eyes off-the-road time, i.e., glance time measurement, can be technically challenging and requires significant effort, two alternative evaluation and compliance procedures are provided: a Static Method and an Interrupted Vision Method. Either method can be used to determine which navigation functions should be accessible to the driver while the vehicle is in motion, depending on the needs and preferences of the evaluator.

4.1   Static Method

The Static Method determines the static total task time. In this method, the subject continuously uses the driver interface to accomplish the navigation/route guidance related task of interest. In brief, a sample of subjects, after practice, completes each task of interest several times using a stationary vehicle or buck with a functioning or simulated driver interface. The Static Method approximates the total glance time a driver will spend looking at the display of an in-vehicle device. The total time for one task is measured from the time the subject begins the task until the task is completed. The measured times are compared with a criterion to determine if the task for that interface may be performed while driving.

4.2   Interrupted Vision Method

The Interrupted Vision Method determines task partitionability using occlusion goggles or display blanking, and measuring occlusion total shutter open time. This method requires the subject to use the driver interface to accomplish the navigation/route guidance task of interest with the subject's view of the visual display being periodically occluded by blocking the subject's view or blanking the display.

The data collection protocol (subject sample size, number of practice and test trials, test context) to obtain the total task time is the same as that of the Static Method except that vision is periodically interrupted. The occlusion total shutter open time is compared with a criterion to determine if the task for that interface may be performed while driving.

4.3   Use of Either Method

Either method can be used; it is not necessary to use or satisfy both of them.

Static total task time provides a useful surrogate measure of visual distraction since it is easy to measure, it can be readily accomplished early in the product design process, and it can be estimated using SAE J2365 or other methods.

The Interrupted Vision Method approximates the situation where a driver is looking back and forth between the road and an in-vehicle interface, looking at each location for a brief period of time, as would occur in actual driving. The Interrupted Vision Method with its implicit test of partitionability can help to ensure that designs that require long single glance durations will not be able to comply with the Document. Setting up the Interrupted Vision Method may involve some additional equipment, software, and experimental complexity. However, the Interrupted Vision Method has the advantage of having higher face validity than the Static Method.

5.   Task Time Compliance Measurement Procedure for Either Method

The following procedure shall be used to determine total task time for either the Static Method or the Interrupted Vision Method.

5.1   Evaluation Setup

The navigation and route guidance driver interface under evaluation must be operational (prototype hardware or simulated) and the driver interface shall be fitted in the design intent location within a stationary vehicle, simulator buck, mockup or equivalent.

5.2   Subjects

The subjects shall be:

- Licensed drivers not familiar with, or technically knowledgeable about, the specific driver interface under investigation;
- Capable of operating the driver interface, learning and completing the test procedure, and
- 45 to 65 years of age.

5.3   Subject Sample Size

10 subjects shall be tested.

5.4   Subject Training

Prior to testing, each subject shall be trained in the use of the driver interface and the task of interest. Following training, each subject will be given five (5) practice trials for each task prior to testing.

5.5   Test Trials and Data Analysis

Each subject shall be tested individually. Three test trials shall be completed for each task. The data to be entered for the specific tasks in the three test trials shall be different from that in practice trials but equivalent in difficulty. Coaching is not allowed during test trials but feedback on errors is permitted when a task is completed. As each task is completed, the subject will be given the next task.

Each task that is desired to be accessible while the vehicle is in motion should be tested. The specific data to be entered for each of the three test trials should be unique but at a representative level of difficulty for that task.

The navigational database should represent the database planned for, or available in, the current production system.

5.6   Task Timing

Task timing is determined as follows:

- Start: The task is initiated by a verbal/audio command from the evaluator. The timing of a task starts as soon as the evaluator's command is completed. The visual display is set to the initial visual presentation for the task of interest, such as the main menu or main screen. The subject's hand can be on or near the control or the screen.
- Duration: Tasks are timed from beginning to end without interruption, including error times, except for computationally interrupted tasks.
- End: Timing ends with the beginning of system confirmation that the last operation is accepted and the driver's goal has been achieved.
- The logarithmic mean of the time for all 30 trials for a given task determines whether or not the criterion has been exceeded.

Calculation of task time:

Compute the log mean for all three (3) trials for all ten (10) subjects. Compare the value to the log of the required criterion given below.

$$(\Sigma_{j=1-10}(\Sigma_{i=1-3}(\log TTT_{ij})))/n < \log 15 \qquad \text{Static Method}$$

$$(\Sigma_{j=1-10}(\Sigma_{i=1-3}(\log TTT_{ij})))/n < \log 20 \qquad \text{Interrupted Vision Method}$$

The time assigned to the task time due to a computational interruption is determined as follows:

- If the computational interruption is less than 1.5 seconds, then entire computational interruption is included in the task time;
- If the computational interruption is greater than or equal to 1.5 seconds, without feedback indicating the computational interruption and estimated completion, then the entire computational interruption will be included in the task time; or
- If the computational interruption is greater than or equal to 1.5 seconds with feedback indicating a computational interruption and estimated completion, then only 1.5 seconds of the delay is included in the task time.

6.   *Static Method*

6.1   Compliance Measurement Procedure for Static Method

The procedure given in Section 5 shall be used to determine total task time compliance.

6.1.1   TEST EQUIPMENT AND TIMING

The times of each trial may be measured using the computer software that controls the driver interface. An alternative is to use a hand-held stopwatch that can be easy to implement and provide the desired accuracy.

6.2   Compliance Criterion for the Static Method

Any navigation function that is accessible by the driver while a vehicle is in motion shall have a static total task time of less than 15 seconds.

6.3   Estimation of Compliance

An estimate of the static total task time (and a prediction of compliance) may be determined using the calculation method in SAE J2365.

7.   *Interrupted Vision Method*

7.1   Compliance Measurement Procedure for Interrupted Vision Method

The procedure given in Section 5 shall be used, with the trial starting with the beginning of the first vision interval. Each trial consists of a continuous alternating sequence of a vision interval followed by an occlusion interval, with the trial ending when the task is completed or the trial is terminated because the subject is unable or unwilling to complete the task.

During the occlusion interval, neither the displays nor controls shall be visible, but operation of the controls is allowed. Most input would be expected to occur when the display is viewable. This protocol simulates drivers looking at the road but continuing to enter information if the interface allows.

A vision interval duration of 1.5 seconds on the display shall be used in the interrupted vision procedure. This is the shutter "open" time if occlusion goggles are used, or the "display on" time if display blanking is used. The shutter closed interval is recommended to be 1.5 sec, with values in the range of 1 to 2 sec being acceptable.

It is recommended that the ocular illumination levels during the vision and occlusion intervals be comparable so that significant dark/light adaptation of the subject's eyes is not required.

7.1.1   TEST EQUIPMENT AND TRIAL TIME RECORDING

Intermittent viewing of the display can be provided by any means, including (1) occlusion goggles (Milgram, 1987; Translucent Technologies, 2002), (2) display blanking, or (3) a shutter between the subject and display. Total shutter open time for each trial may be recorded by (1) a modified version of the software controlling the goggles or display blanking, (2) the software controlling the driver interface, or (3) other suitable means.

7.2 Compliance Criterion for the Interrupted Vision Method

Any navigation function that is accessible by the driver while a vehicle is in motion shall have an occlusion total shutter open time (or display on time) of no more than 20 seconds as determined using the Interrupted Vision Method.

7.3 Tasks Exempt from Compliance Criterion for the Interrupted Vision Method

Any navigation function task that has a static total task time of less than five seconds is not subject to the Interrupted Vision Method. The purpose of this method is to encourage driver vehicle interface designs that can be completed in a few, brief glances.

8. References

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