

An Exploration of Rapid Serial Visual Presentation for Automotive Applications

Michael Tschirhart
Visteon Corp.

Kathleen Ku
Visteon Corp.

ABSTRACT

Rapid Serial Visual Presentation (RSVP) refers to a method of displaying information in serial fashion on a display mounted at a fixed focal position relative to the viewer. RSVP is used in cognitive and perceptual psychology research and shows some promise in applications that involve reading text on displays. This preliminary research examines the potential for RSVP as a means of presenting driver information in automotive use cases. We investigated how RSVP influenced subjective impressions, participant recall of information, and the impact of its use while performing a simulated driving task. We describe the results of two studies and discuss future directions for research.

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INTRODUCTION

Presenting important information relevant to the driving experience is a primary component of automotive user interface design. Vehicles gauges and displays provide the driver different types of information about such things as the condition of the vehicle, media content details (e.g., song, artist, etc.), and perhaps even information about the context of the vehicle environment.

In recent years, the amount and diversity of information available to the driver has been growing. In addition to more sophisticated systems available on-board, the driver also has an increasing number of features and functions available that are enabled by increased mobile internet connectivity, whether accessed through embedded vehicle systems or via portable devices brought into the vehicles. This content proliferation presents a significant challenge to the automotive UI design. While incremental new features can bring desired new entertainment and/or other content into the vehicle, limitations in human information processing capacity represent an important constraint to unchecked proliferation of features in the vehicle cockpit.

Although active debate as to the importance and suitability of various kinds of features available to the driver will - and should - continue, a means to provide and present information in a more effective and efficient manner is inherently desirable.

The daunting challenge for user interaction design, then, is how to resolve the dilemma of helping the driver manage an increasing amount of information while simultaneously reducing the burden of that information to the driver's limited cognitive resources?

While new technologies like display-based instrument clusters provide some benefits in dynamic display and customizability, their implementation has been historically limited to static or extended presentation display time (sometimes between transitions to other "slower" transient states). To date, such systems often still rely on progressive increase in display real estate to present progressively increasing amounts of data (an inelegant solution). Even if used more efficiently to present more information, these solutions don't automatically address limitations brought on by the capacity constraints of the user.

In principle, there are two obvious ways to try to address the issue of potentially overwhelming information flow. The first is simply to present less information, which should free up resources that the driver can then use to focus on the primary driving task. Unfortunately, the driving task is one for which it is difficult to control the amount of information reaching the driver. The growing market for - and ecosystem of - devices and connections is likely to see this constraint worsen, rather than improve over the near and intermediate term. The second way is to improve the driver's ability to

handle that information. There are no obvious, wholesale ways to improve the driver's perceptual and information processing capabilities, although some means of information display via better information graphics appears promising.

RSVP offers certain benefits that may lend it to contribute to the development of such a solution. Traditional driver information displays and systems provide basic information to the driver. More recent changes in display technology allow the display of information to be more dynamic and customizable. The potential of RSVP for use in supporting electronic information viewing and use, particularly on small displays is well established (de Bruijn, O. and Spence, R., 2000). Previous research has shown that different approaches to RSVP, including rate-varying adaptive RSVP (Oquist & Goldstein, 2003) can lead to reading speed improvements on the order of 33% without significant comprehension or task load differences for short passages. Researchers have explored techniques for RSVP techniques for consumer digital video services (Wittenberg, et. al, 2003). Researchers have also explored different ways to improve the preference for and usability of RSVP (Castelhano & Muter, 2001) in a text reading use case, but consideration of the use of RSVP for potential in an automotive context is limited.

In RSVP, the rapid serial presentation approach allows the transmission of relatively large amounts of information on a comparatively small piece of display real estate. Display cost and packaging constraints are two factors that make such features desirable in the automotive context. In addition, RSVP is capable of reducing the amount of time spent on displaying information to the driver. Heuristics in vehicle system design often limit the amount of time that the driver's gaze is averted from the forward/road-facing direction (e.g., one or two seconds). Because even short savings in time can make a big difference in the driving conditions (a car travelling 70 mph covers over 100 feet in 1 second), even a seemingly modest time saving can offer potentially great practical benefit.

It is also important to note that RSVP may also have a couple of potentially significant drawbacks. One is that the rapid presentation may share characteristics with video. Video requires a relatively greater amount of information to be perceived and processed than a static or low complexity combination of static/still images. For this reason, complex motion video, etc. is generally not recommended for driver displays. Thus, it is conceivable that RSVP could be a potential net "distraction increaser," rendering any speed increase in information delivery ultimately unhelpful. Another is that certain processing complexity (e.g., attentional blink (Raymond, JE, Shapiro, KL, Arnell, KM, 1992) in which memory for certain data/information elements in the middle of a string of such elements are lost/missed. Although discussion remains as to what mechanism is responsible for this problem (STM capacity limitations versus some other process(es)) (Akyurek, E. & Hommel, B., 2006), the fact that it exists may present another critical issue.

The purpose of this investigation was to conduct an examination of RSVP to derive a preliminary assessment of whether the benefits of RSVP appear greater than the drawbacks in an automotive information display setting.

Two studies were undertaken to investigate the possible automotive application of RSVP. The first study was conducted in a desktop setting to determine key characteristics of RSVP and the second study was conducted with the use of a driving simulator to determine how RSVP may influence driving performance.

Key questions: Is the idea of rapid serial information display a paradigm that drivers may be able to accept under certain conditions? Does the use of rapid serial information display appear appropriate to the driving context?

Under what conditions might the use of a rapid serial information display approach be acceptable to car drivers? What are some of the factors guiding their perception of such a system?

Under what conditions might the use of a rapid serial information display approach be suitable for the automotive use? How does the use of such a system affect the performance of a simulated driving task?

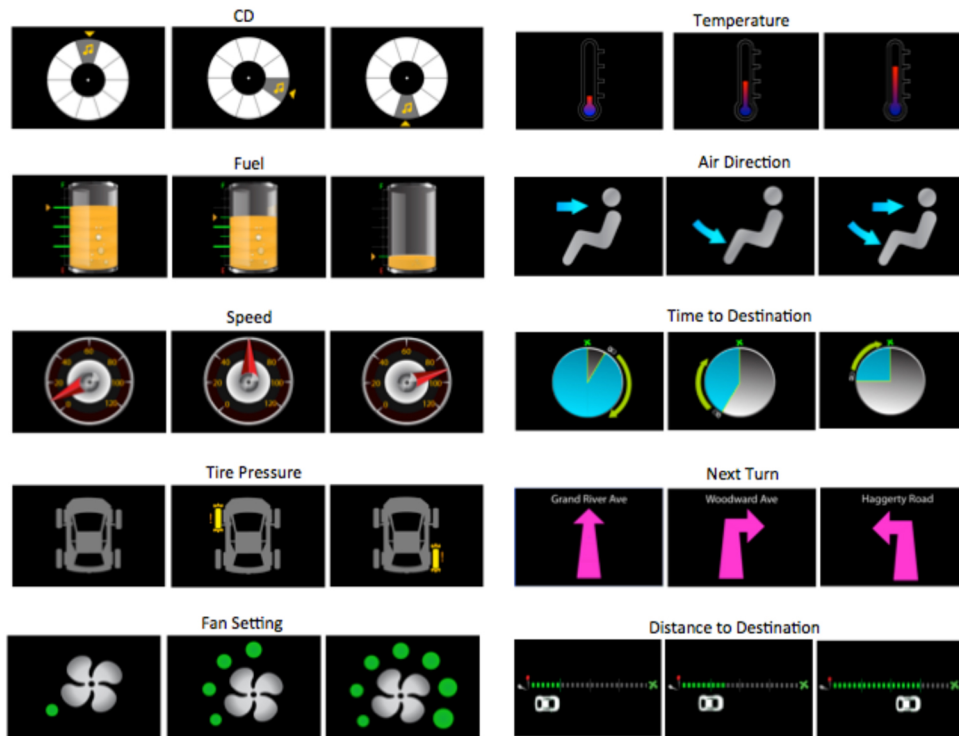
Theoretically, RSVP is interesting because it offer the possibility of reducing the perceptual resources required to deliver a fixed unit of information to a driver, thus keeping those resources available for allocation to the primary driving task.

The following key research questions in this research involve driver perception of - and performance with - RSVP implementations with a variety of characteristics.

- What is the nature of RSVP characteristic preferences?
- What are user's preliminary perceptions of RSVP for use in a driving context?
- What impressions do people have regarding the influence of RSVP on their driving experience?
- What implications does the use of RSVP have on driver performance?
- What other issues bear on the implementation of RSVP for automotive driver information applications?

This paper describes two studies undertaken to investigate perceptions of RSVP. The first study offers preliminary insight into consumer reactions to an automotive information display that uses RSVP. This study was conducted in a static (desktop) setting. The second study extended the approach of the first and offers additional insight into consumer perceptions and simulated driving performance while using a related RSVP implementation.

Table 1. Table of graphical vehicle information images



STATIC (DESKTOP) STUDY

Method

Apparatus

A smartphone app was developed to test the RSVP concept in the static test. The experimental variables (including the duration that images were displayed and the number of images presented in a series) for each run were modified using an experimenter setup button. Each run was triggered by touching a large launch button on the screen. The smartphone was hand-held in landscape orientation by the participant during both the pre-test and the static test.

Test design and procedure

A total of 7 participants participated in the preliminary static phase of the study. The mean age of the participants was 37.1 (range of 23 to 55 years old), with two female and five male participants.

The primary independent variables were image display time (3 levels: 100, 300, and 500 milliseconds) and number of images shown (3 levels: 3, 6, and 9 images) for a total of nine runs. The bounds on image display duration were set based on known perceptual limitations on the lower end and practical concerns at the top end. In order to observe any potential benefit, the series would need to operate faster than the typical glance time for normal operation. The bounds on the number of images were set based on a similar logic. 9 images were expected to be a reasonable upper bound and fewer than three images would risk defeating the purpose of this approach. The order of the number of images shown at

varying display times and the type of image shown was randomized.

There were a total of ten types of mainly graphical categories (see [Table 1](#), pg. 4)

- CD
- Fuel
- Speedometer
- Tire state
- Temperature
- Fan Speed
- Fan direction
- Time to destination
- Next turn
- Distance to destination

In addition, there were three status states in each category, for a total of 30 different images that could be potentially shown over nine runs.

To familiarize the participants with both the concept and the graphical images shown, each participant completed a pre-test. During the pre-test, participants were shown an image from each type of vehicle information category and asked to describe what they thought each image was, as well as what information it conveyed. The moderator then confirmed or revealed the correct answer. Following the pre-