A New and Novel Method for Assessing Visual Clutter in the Driving Environment

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Abstract

This manuscript outlines a framework for objectively measuring the level of visual clutter along a defined driving route. Based on results of this assessment framework, practitioners can make informed recommendations to improve relatively high visual and sign clutter while maintaining an appropriate level of road user information and navigation guidance. Using this framework in this way will make a innovative contribution to road safety research in terms of (a) allowing us to identify road environments of high clutter and, in turn, (b) helping us assess how we can mitigate potential degradation in driving performance and safety deriving from clutter.

Background

Visual clutter is defined as the non-target or irrelevant information in a visual scene (Ho, Scialfa, Caird, & Graw, 2001). In the realm of driving, and road signage in particular, the level of visual clutter in a given scene is determined by the interactions between the amount and complexity of signage and specifically how difficult it is to detect important objects from the background (Edquist, 2008).

Excessive visual and sign clutter along a road contributes to driver distraction, obscures key navigation cues and increases workload for drivers. This can lead to a reduced ability to detect and react to critical driving tasks and can lead to an increased likelihood of driver errors; and, therefore, an adverse impact on road safety (Edquist, Horberry, Regan, & Johnston, 2007).

Rosenholtz, Li, and Nakano (2007) have developed special code using MATLAB, a high-performance mathematical and computation program, that can produce a numerical and visual measure of visual clutter for a given 'jpg' picture file. That is, for a given picture of a visual scene, this code can determine a clutter scalar (i.e., a visual clutter score) for the visual scene, where a higher score indicates a higher level of visual clutter.

Using the input picture file, the code can also produce a 'clutter map', which highlights the areas of the scene in which clutter is particularly high. These outputs allow two or more driving scenes to be compared based on their visual clutter. The code measures clutter based on the variance of features (e.g. colour, contrast) or 'feature congestion' in a visual scene, where a higher variance of features is associated with higher clutter (known as 'feature congestion'; Rosenholtz et al., 2007).

To the best of our knowledge, this manuscript is the first to document the use of this code in road safety research in terms of allowing the identification of road environments of high clutter (e.g. due to signs, redundant line markings etc.) and, in turn, help assess how to can mitigate potential degradations in driving performance safety.

Method

A proposed framework for objectively measuring visual/sign clutter was developed and described in Table 1.

Table 1. Framework to objectively measure visual clutter

Step no.	Description	Tasks
1	Survey route	A GPS-enabled video camera be positioned securely just below driver eye height on the front windscreen of the vehicle (just left of centre) and used to record video footage during the route survey. Sign locations will be mapped.
2	Identify road segments	Upon completion of the route survey, snapshots of the driver's view will be taken every 100m using the video footage recorded. These snapshots will be used as picture (.jpg) input files into MATLAB
3	Input into MATLAB	MATLAB will be used to compute Feature Congestion scalars (i.e. 'clutter' score) for each picture
4	Relative results of clutter measure	The clutter scores of each picture will be compared. Locations of high clutter (i.e. as having the highest clutter scores) will be noted Feature congestion clutter maps will be visually inspected
5	Identify elements contributing to clutter	Pictures of high clutter locations will be visually assessed, including feature congestion clutter maps Physical elements (e.g. signs, buildings) contributing to the clutter at these locations will be identified
6	Recommended areas for improvement	Review visual/sign clutter issues and propose changes to mitigate clutter and its potential effects on driver performance

Results

An example of the clutter map the MATLAB code provides is depicted in Figure 2 (with the input snapshot of the driving scene depicted in Figure 1). The clutter score, also provided by MATLAB, for this visual scene was considered relatively high. Upon inspection of the pictures by researchers, it was hypothesised that signs, line marking and buildings are all contributing to the relatively high clutter in this visual scene.

Figure 1. Snapshot of southbound travel approaching Sydney Harbour Bridge

Figure 2. Example of feature congestion clutter map using Figure 1 ('hotspots' indicate areas of relatively high clutter)

Discussion and Conclusion

To the best of our knowledge, this framework for objectively measuring the level of visual and sign clutter is novel in the road safety space. The framework can be applied to any defined driving route and, based on the results of the assessment, can be used to make informed recommendations to address the level of visual and sign clutter, while maintaining an appropriate level of road user information and navigation guidance.

References

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