Augmenting Landmarks During the Head-Up Provision of In-Vehicle Navigation Advice

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ABSTRACT

The use of landmarks during the provision of directions can greatly improve drivers’ route-following performance. However, the successful integration of landmarks within in-vehicle navigation systems is predicated on the acquisition and deployment of good quality landmarks, as defined by their visibility, uniqueness, permanence, location etc., and their accurate and succinct depiction on in-vehicle displays and during accompanying verbal messages. Notwithstanding the inherent variability in the quality and propensity of landmarks within the driving environment, attending to in-vehicle displays and verbal messages while driving can distract drivers and heighten their visual and cognitive workload. Furthermore, vocal utterances are transient and can be littered with paralinguistic cues that can influence a driver’s interpretation of what is said. In this paper, a driving simulator study is described aiming to investigate the augmentation of landmarks during the head up provision of route guidance advice – a potential solution to some of these problems. Twenty participants undertook four drives utilising a navigation system presented on a head up display (HUD) in which navigational instructions were presented as either: conventional distance-to-turn information; on-road arrows; or augmented landmarks (either an arrow pointing to the landmark or a box enclosing the landmark adjacent to the required turning). Participants demonstrated significant performance improvements while using the augmented landmark ‘box’ compared to the conventional distance-to-turn information, with response times and success rates enhanced by 43.1% and 26.2%, respectively. Moreover, there were significant reductions in eyes off-the-road time when using this approach, and it also attracted the lowest subjective ratings of workload. The authors conclude that there are significant benefits to augmenting landmarks during the head-up provision of in-car navigation advice.

KEYWORDS

Augmented Reality, Head-Up Displays, Landmarks, Navigation Systems

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**INTRODUCTION**

**Landmarks**

Landmarks are frequently cited during the ad hoc provision of directions. Combined with directional instructions such as “turn right”, landmarks can ease route-following by indicating when and where these actions should be taken. The omnipresence of landmarks within the natural driving environment means that they are ideal candidates to aid the task of navigating when driving in unfamiliar areas and can also provide reassurance when travelling through familiar areas (Burnett et al., 2001). There has therefore been significant research interest regarding the inclusion of landmarks as navigational cues within in-vehicle navigation systems (IVNS). This research has consistently demonstrated that augmenting navigation systems with landmarks improves their usability and utility, and aids route-following. For example, in comparison with conventional distance-to-turn systems, the addition of landmark cues has been shown to improve navigation performance, significantly reducing navigational decision time and errors (Phillips, 1999; May and Ross, 2006). The use of landmarks within route guidance also reduces the frequency of glances to an in-vehicle display, thereby reducing eyes-off-road time (May and Ross, 2006; Phillips, 1999), and has been shown to improve engagement with the environment and promote enhanced spatial learning (May et al., 2005; Leshed et al., 2008). Additionally, improvements in driving performance and increases in driver confidence have been highlighted when using landmark-enhanced IVNS to navigate, and this can lead to reduced reliance on the technology, compared with conventional presentations of route advice (Burnett et al., 2001; May and Ross, 2006).

However, defining what makes a good landmark for navigational purposes can be difficult. Part of the difficulty of selecting suitable candidates lies in the fact that, although some features that make a landmark good for navigation are quantifiable (e.g. advance visibility, spatial extent and permanence), many others have a subjective element (such as semantic salience, uniqueness and usefulness of location) and can therefore only be ‘quantified’ in a specific context (Burnett et al., 2001, May et al., 2005). A common consensus is that ‘good’ navigational landmarks should be permanent (in form and labelling), easily visible, unique, have a useful location, and be easily identifiable. Examples of ‘good’ landmarks may therefore include: traffic-lights, petrol stations, public houses, churches, schools and railway stations (Burnett et al., 2001). Nevertheless, in certain situations, such landmarks may be of limited value for navigational purposes. For example, a distinctive building may be obscured by summer vegetation making it indistinguishable, or several sets of traffic-lights may exist in close proximity to each other making them difficult to differentiate by drivers (Burnett et al., 2001). Further difficulty can exist in selecting and identifying the most appropriate landmark in complex, or high density urban road networks, when numerous ‘good’ candidates may be present, and, while some areas may have an abundance of good landmarks, other areas may be void of suitable candidates.

**Route Presentation**

Understanding how best to present navigational advice to drivers (whether augmented with landmarks or not) is a high priority on the research agenda, with protagonists commonly comparing visual and auditory delivery methods, although the provision of haptic cues to guide drivers is increasingly the focus of more recent explorations (e.g. Hwang and Ryu, 2010). There is common consensus that auditory, speech-based delivery of navigational instructions is less distracting to drivers, as there is no visual component to interfere with the driving task, and it has also been suggested that drivers are better able to divide their attention cross-modally between ear and eye than intramodally (Jonsson, Harris and Nass, 2008). Nevertheless, issues of cognitive distraction persist during the verbal delivery
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