A data driven method to extract visual time-sharing sequences from naturalistic driving data

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An attentive driver has an up-to-date model of the surroundings of the vehicle, maintained by sampling information from the road ahead, the sides of the vehicle, the rear view mirrors and the dashboard instruments. Occasionally, the driver also looks at less traffic relevant targets such as a passenger, a navigation device or a mobile phone. While looking at these subsidiary targets, the mental model of the traffic scene becomes less accurate as a function of time (Senders et al. 1967). For this reason, drivers are unwilling to look away from the road ahead, and resort to using several shorter glances to obtain the sought information from other targets (Zwahlen et al. 1988).This switching between the road view ahead and other targets is often referred to as visual time-sharing.

Visual time-sharing analyses have been restricted to additional tasks with well-defined start and end points. We introduce a method to automatically extract visual time-sharing sequences directly from eye tracking data. This facilitates investigations of systems providing continuous information without well-defined start and end points. Further, it becomes possible to investigate time-sharing behaviour with other types of glance targets such as the mirrors.

Eye tracking data from an on-road study with 12 participants (about 100 hours of driving), aimed to test an in-vehicle information system, is used here for illustration. We define a visual time-sharing sequence based on the time duration between glances towards the target of interest. Analyses of return-time maps and within-sequence reduction in percentage time looking forward suggests that four seconds is an appropriate maximum between-glance duration when grouping glances into visual time-sharing sequences. Analyses of the extracted visual time-sharing sequences indicate that the number of glances within a sequence provide an indication of the complexity of the visual information sampled, and also that transition matrices based on sequences, as compared to glances, provide important complementary information, since the obscuring effect of frequent repeated glances to the same target are removed.

In conclusion, grouping glances to the same target into visual time-sharing sequences, such that one sequence describes one distinct information sampling occurrence, adds an additional layer of information to glance analyses. The generalization of visual time-sharing extraction allows analysis of non-task related targets. It provides a valuable tool to extend glance analyses to include information about tactical glance behaviour, especially when more detailed environmental information is available.

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