Abstract

Human eye movements are a powerful descriptor that can help researchers understand how people obtain and process information on computer displays. Existing studies on the analysis of eye tracking data have revealed some of the relationships between human eye movements and their underlying mental states (e.g., interests or intentions). However, understanding content browsing behavior in uncontrolled environments is still a challenge due to the complexity of eye movement patterns. Part of the issue is that human gaze is affected not only by browsers' states but also by the physical and semantic aspects of visual content. Moreover, same eye movement patterns can have different meanings depending on context in content browsing, which may change over time.

First, this study proposes a novel gaze analysis framework to understand the meaning of browsing behavior, which leverages information about the content creator's intentions. Visual content such as web pages, digital articles and catalogs are comprised of structures intentionally designed by content creators, which we refer to as *designed structure*. This study focuses on two design factors of designed structure: spatial structure of content elements (content layout), and their semantic relationships such as "being in a group". The framework was evaluated with an experiment involving twelve participants, wherein the participant's state was estimated from their browsing behavior. The results from the experiment show that the use of designed structure improves estimation accuracy of user states compared to other baseline methods.

Second, this study proposes a hierarchical content browsing model to manage diversity of eye movement patterns. In content browsing situations, human browsers may have different browsing contexts (which we refer to as *browsing states*) and context can change over time. To reveal the characteristics and temporal changes of browsing states in content browsing behavior, this study proposes a probabilistic model based on hidden semi-Markov model (HSMM) whose hidden states correspond to the browsing states. The proposed browsing state model is

trained and evaluated using gaze data that were collected from eight participants in an experimentally controlled catalog browsing situation. We analyze the estimated browsing states and demonstrate that they can contribute to improve the performance of browser interest estimation.

Finally, we adapt the proposed content browsing model to the analysis of choice behavior in digital catalog browsing. Findings from existing studies suggest that the consumer choice process consists of a few different browsing states such as *screening* and *evaluation*. The proposed approach consists of two steps. In the first step, we define and identify the browsing states based on how often a decision maker looks at the selected item (the item finally selected by a decision maker), which acts as a clue into the process of choice behavior. Our definition of browsing states is evaluated through eye tracking data to confirm that it can split the decision process into meaningful browsing states. In the second step, we train our browsing-state model using eye tracking data and corresponding identified browsing states via a supervised manner. Once the browsing state model is learned, we can estimate browsing states of newly observed eye tracking data without the information of the selected item. The latter method is evaluated by measuring how it can replicate the results by the former identification method that uses information of the selected item.