Similiarity assessment of eye movements on dynamic scenes

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The problem of comparing eye movement recordings frequently arises in many areas of vision research. Several solutions have been proposed for the analysis of eye movements on static images, but only few attempts have been made at comparing recordings on dynamic scenes.

Here, we present a novel method for assessing gaze similiarity on dynamic input. We propose that eye movements need to be analyzed at three structural levels. First, the so-called micro-level describes the time-dependent sequence of fixations, saccades, and smooth pursuit movements. Individual properties of a subject's oculomotor system such as pursuit gain can be measured on this level.

Second, the macro-level simply consists of a time series (x,y,t) that represents the gaze coordinates as recorded by an eye tracker.

Finally, the object level is characterized by the sequence of observed objects. Information about what constituted an object was extracted by means of cluster analysis on a large set of eye movement recordings. Regions that several subjects fixated simultaneously were labeled as objects, thus yielding a robust, high-level representation of the scene.

We tested the performance of our method on natural outdoor scenes as well as artificially generated sequences. The artificial sequences showed single dots following linear and sinusoidal trajectories. Due to their simple nature, these sequences also allowed us to precisely define what constituted similar and dissimilar eye movement patterns.

Results show that on both the micro- and the macro-level, scan paths may differ significantly even if they are caused by the same stimulus. For example, when two scan paths are to be classified as being recorded on the same stimulus or not, a mean Euclidean distance threshold of almost 7 degrees yields the smallest error rate.

On the object level, we achieve robustness against these individual differences in, for example, pursuit quality by pooling over a large number of subjects. This level also gives an intuitive description of scan path similarity. Nevertheless, it remains an open question how to take the temporal order of object fixations into account.