An oculomotor signature as a fraud-resistant tool for biometric verification.

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Abstract

Instant access to personal data is a double-edged sword and it has transformed society. It enhances convenience and interpersonal interactions through social media, while also making us all more vulnerable to identity theft and cybercrime. The need for hack-resistant biometric authentication is greater than ever. Previous studies have demonstrated that eye movements differ between individuals, so the characterization eye movements might provide a highly secure and convenient approach to personal identification, because eye movements are generated by the owner's living brain in real-time, and are therefore extremely difficult to imitate by hackers.

To study the potential of eye movements as a biometric tool, we characterized the eye movements of 18 participants. We examined an entire battery of oculomotor behaviors, including the unconscious eye movements that occur during ocular fixation; this resulted in a high precision oculomotor signature that can identify individuals. We show that one-versus-one machine-learning classification, applied with a nearest neighbor statistic, yielded an accuracy of >99% based with ~25 minute sessions, during which participants executed fixations, visual pursuits, free viewing of images, etc. Even if we just examine the ~3 minutes in which participants executed the fixation task by itself, discrimination accuracy was higher than 96%. When we further split the fixation data randomly into 30 sec chunks, we obtained a remarkably high accuracy of 92%.

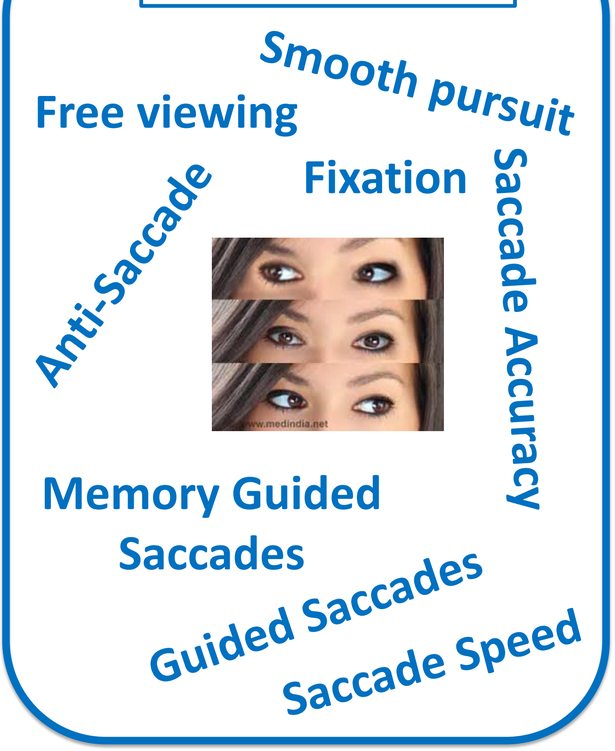
Because eye-trackers provide improved spatial and temporal resolution with each new generation, we expect that both accuracy and the minimum sample duration necessary for reliable oculomotor biometric verification can be further optimized.

Goal

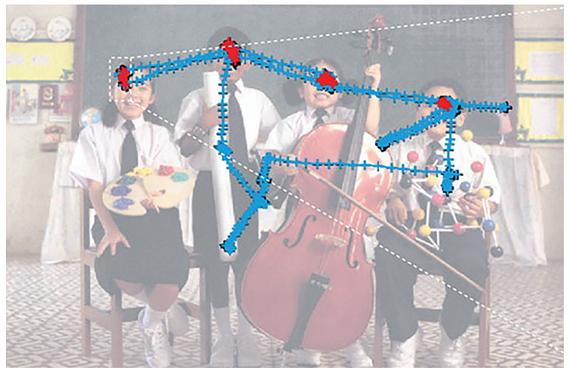
We demonstrate that standard eye tracking data can reliably predict the identity of an individual when analyzed appropriately.

Approach

Visual Tasks (~3 min. per task)

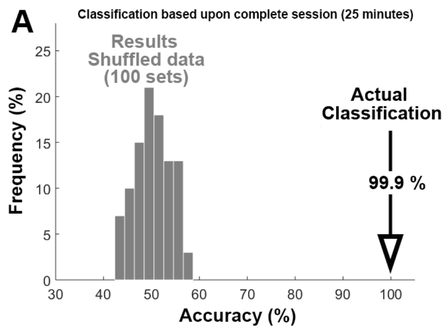


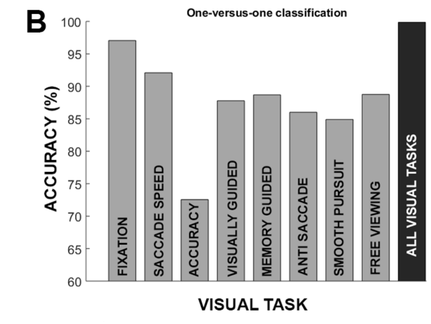
Variables

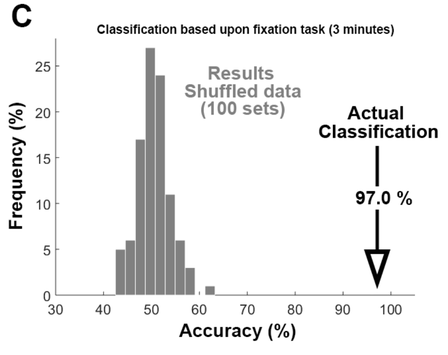


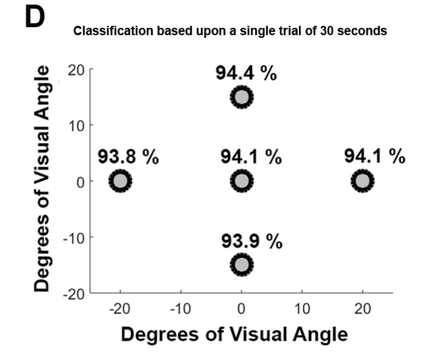
Velocity – Eye blinks – Magnitude – Direction – Orientation – Reaction time, etc.

Discriminator - Results









(A) Using a KNN (k=1) one-on-one classifier we achieved a near perfect classification based on the 25 minute sessions.**(B)** Classification accuracy remained high within each behavioral task (~3 minutes each). **(C)** Accuracy was especially high for the fixation task. **(D)** Using only 30 secs of the data from the fixation task nevertheless yields high accuracy irrespective of gaze position.

Conclusions

We achieve a high accuracy, even with a sampling duration of only 30 seconds. Using a unique combination of oculomotor tasks, movement kinetics and discriminators, we confirmed the potential of using an oculomotor signature as a fraud-resistant tool for biometric verification.

Future directions

We will improve accuracy further while minimizing sample duration; for instance by including fixational eye movements that are even smaller than microsaccades (ocular drift and ocular tremor).

Acknowledgments

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