Biometric Eye Model and Ray Tracing for Improved Iris Recognition

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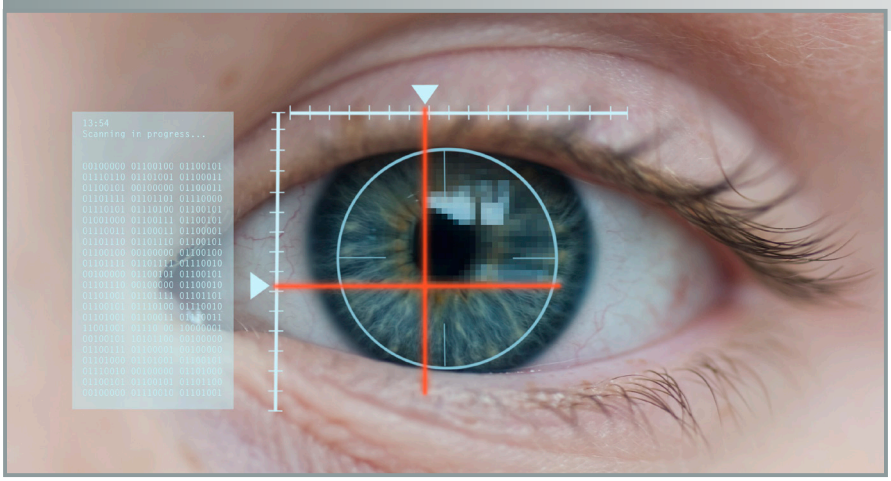

Technology Summary

Iris recognition has proven to be an accurate and reliable biometric, especially as a means of verifying personal identity. However, iris recognition is limited by the quality of the images presented to the analysis system. Ideal images are typically direct, on-axis frontal views of the iris. Recognition of nonideal images, such as off-axis images, is still an unsolved problem. ORNL researchers have developed a new biometric eye model and a method to accurately convert off-axis images to frontal views. Accurate iris recognition was obtained with the original image as much as 70 degrees off axis.

Previous work that has addressed off-axis images has significant drawbacks or requires major modifications to current identification workflows, and none considers what ORNL researchers observed and call the "limbic effect." The limbus is a semitransparent area of the eye that significantly occludes regions of the iris in frontal images and in images that are off axis beyond 25 degrees. Hence, at any angle, even frontal, some of the iris is occluded by the limbus. This research demonstrates that taking the limbic effect into account when converting an off-axis image to a frontal image improves the accuracy of the image significantly, especially for off-axis angles of more than 30 degrees.

This work used a generalized human eye model and ray-tracing techniques, in which an image is generated by tracing light through pixels in an image plane and simulating the effects of its encounters with virtual objects. The eye model was used to (1) compute a general nonrigid transformation to reconstruct the iris from off-axis and refraction deformations and (2) render a frontal view of the reconstructed iris.

The research for the up to 70 degrees off-axis results was conducted with synthetic eyes and demonstrates the importance of biologically/optically accurate correction that does not currently exist and establishes an upper best-case limit on how much improvement is possible. The approach used for experiments with real eyes performed better than the state of the art. Future work will focus on measuring the performance of the method and comparing the model to real-world data.

Advantages

- Performs accurate iris recognition with the original image as much as 70 degrees off axis
- Works using existing plug and play methods and algorithms
- Takes into account iris regions occluded by the limbus

Potential Applications

- Access to secure buildings
- Access to home or personal information
- Identification of persons of interest
- Identification of individuals by law enforcement
- Identification of potential clients

Patent

Hector J. Santos-Villalobos, David S. Bolme, and Chris Bensing Boehnen. *Frontal View Reconstruction for Iris Recognition,* US Patent 8,958,608, issued February 17, 2015.

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