OSAC RESEARCH NEEDS ASSESSMENT FORM

Title of research need:	Iris Image Synthesis
Keywords:	iris image, generative artificial intelligence, data augmentations

R&D Need Rank: Low, Medium, High	High	**SAC Approved Date:**	January 9, 2026

Submitting subcommittee(s): Facial and Iris Identification – Iris Systems and Capture Task Group

Research Need Summary:

The purpose of these research needs is to build a stronger scientific foundation for forensic science standards. The information provided herein will help to evaluate and strengthen existing standards, and/or fill any standards related gaps. In the space below, please provide a brief narrative of the need to be addressed. This should include:

- The identity of any specific standards that would be affected/improved/evaluated
- A discussion on gaps that exist within the standards or standards related gaps that need to be filled
- How this work would fill those gaps
- An overview of any current or past research efforts that may be relevant to this effort
- A discussion regarding how this research might improve current laboratory capabilities and/or forensic services within the criminal justice system
- Any relevant references

Standards evaluated / adopted / referenced:

a) ISO/IEC 19794-6 (data interchange format for iris images)
b) ISO/IEC 29794-6 (specification of iris image quality metrics)

Identification of gaps:

a) Datasets of ISO/IEC 19794-6-compliant iris images representing both healthy/normal irises as well as various anomalies are sparse and unbalanced (with respect to anomaly type).
b) Studies are needed to evaluate whether realistic-looking ISO/IEC 19794-6-compliant iris images, synthesized by modern generative Artificial Intelligence models, offer significant value in the forensic context.

Relevant research efforts:

Early solutions to iris image synthesis used hand-crafted methods constrained by an understanding of eye anatomy to synthesize the iris texture of potentially non-existent subjects, with control of selected properties of the external appearance of the eye [1,2]. Iris images synthesized with these older methods were often not realistic-looking, and their value for both automatic iris recognition methods and forensic examination was limited. Recent solutions to iris image synthesis are almost exclusively based on data-driven deep learning models, such as Generative Adversarial Networks (GANs) [3,4] or diffusion models, which – due to higher flexibility in approximating distributions of training data – offer realistic-looking synthetic iris samples. These models can be conditioned by specific artifacts (e.g., textured contact lenses [5], eye injuries, or post-mortem decomposition artifacts [6]) to generate iris images mimicking selected anomalies.

Impact on forensic services:

Carefully designed and vetted solutions to synthesize ISO/IEC 19794-6-compliant iris images with and without selected anomalies may offer curated, privacy-safe datasets for reproducible algorithm evaluations and blind assessments of forensic examination procedures. Such datasets could include both samples that are as realistic as possible, and those that are not so realistic-looking. The former would expose human experts (and algorithms) to a wider variation of iris image properties or popular anomalies, while the latter could help them recognize what fake iris images look like, giving them clues in the future on how to determine if an image they're seeing is authentic or fake.

References:

[1] J. Cui, Y. Wang, J. Z. Huang, T. Tan and Z. Sun, "An iris image synthesis method based on PCA and super-resolution," International Conference on Pattern Recognition (ICPR), Cambridge, UK, 2004
[2] S. Shah and A. Ross, "Generating Synthetic Irises by Feature Agglomeration," International Conference on Image Processing (ICPR), Atlanta, GA, USA, 2006
[3] S. Yadav, C. Chen and A. Ross, "Synthesizing Iris Images Using RaSGAN With Application in Presentation Attack Detection," IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops (CVPRW), Long Beach, CA, USA, 2019
[4] P. Tinsley, A. Czajka and P. J. Flynn, "Haven't I Seen You Before? Assessing Identity Leakage in Synthetic Irises," IEEE International Joint Conference on Biometrics (IJCB), Abu Dhabi, United Arab Emirates, 2022
[5] M. Mitcheff, P. Tinsley and A. Czajka, "Privacy-Safe Iris Presentation Attack Detection," IEEE International Joint Conference on Biometrics (IJCB), Buffalo, NY, USA, 2024
[6] Rasel Ahmed Bhuiyan and Adam Czajka, “Forensic Iris Image Synthesis,” IEEE Winter Conference on Applications in Computer Vision (WACV), Waikoloa, HI, USA, 2024

This research need has been identified by one or more subcommittees of OSAC and is being provided as an informational resource to the community.