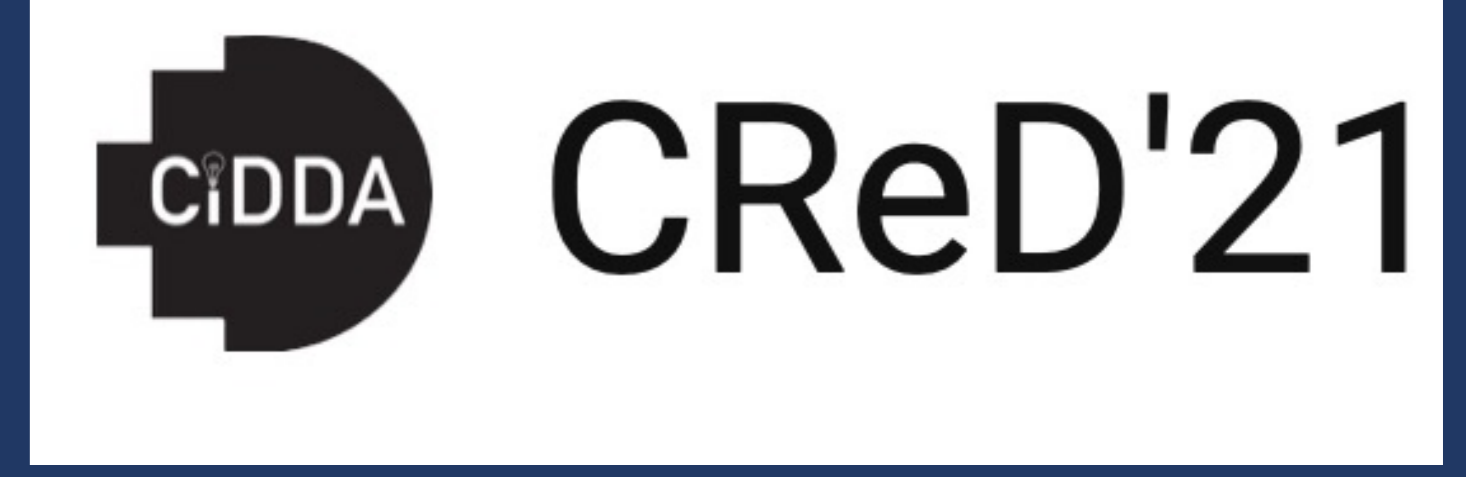


Failure of affine-based reconstruction attack in reconstructing vascular feature points

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Introduction

One inverse biometric method that has been very successful in reconstructing face images applies an affine transformation to model the face recognition algorithm. This method is general and could apply to templates extracted from other biometric characteristics. We propose two formats to apply this method to spatial point patterns extracted from retina and hand images and test its performance on reconstructing such sparse templates. We also apply this method on retinal vascular images. The results show that the reconstructed point pattern templates and the reconstructed retinal images are not similar enough to their original targeted references to be accepted by point pattern comparison algorithms as matches.

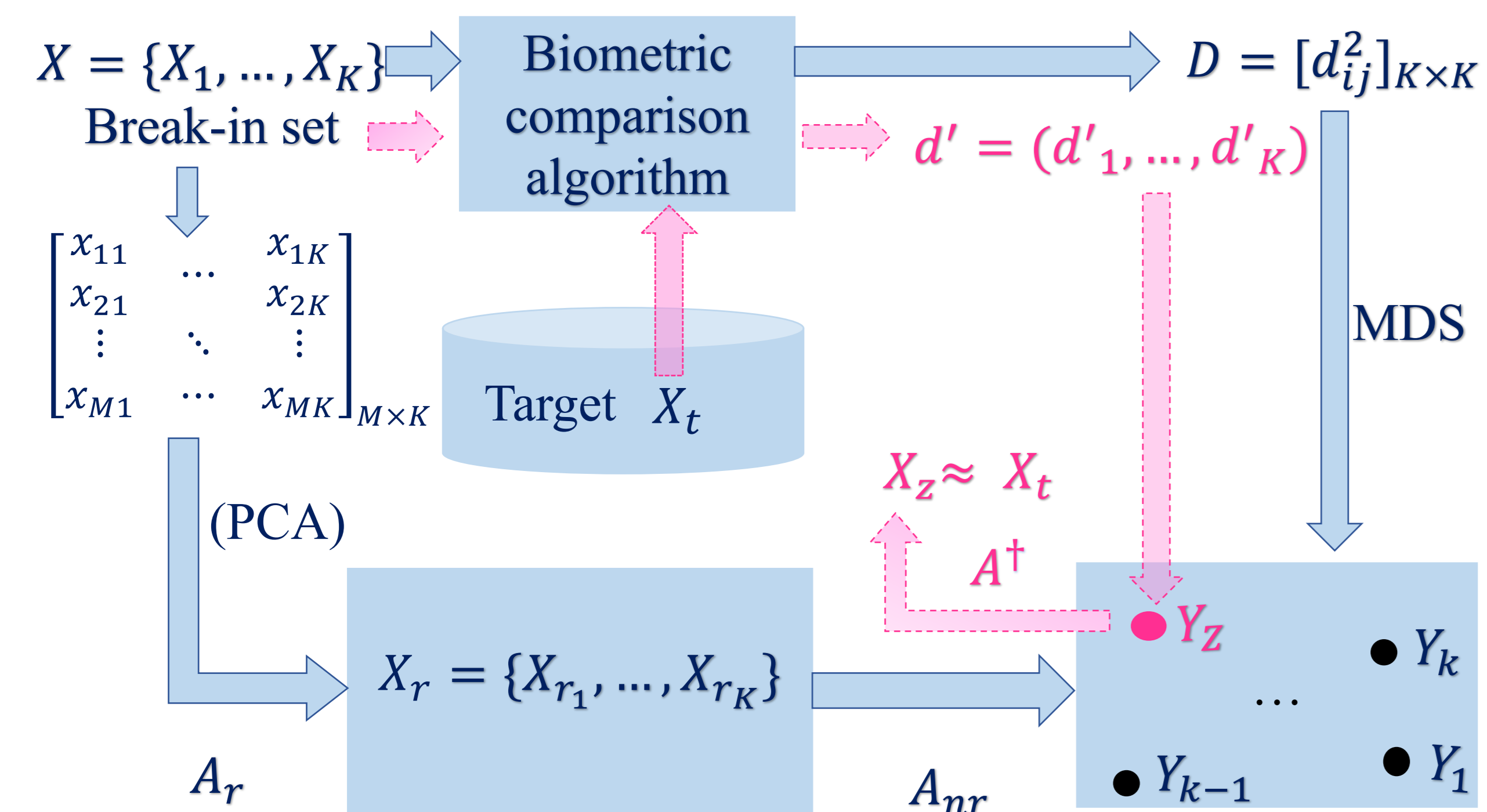
Methods

The MSK Reconstruction method [1] requires:

1. break-in set: A pool of imposter samples/templates
2. access to biometric recognition algorithm

The reconstruction is performed in two processes:

1. modelling the biometric recognition algorithm (blue diagram)
2. embedding and reconstructing the target (pink diagram)



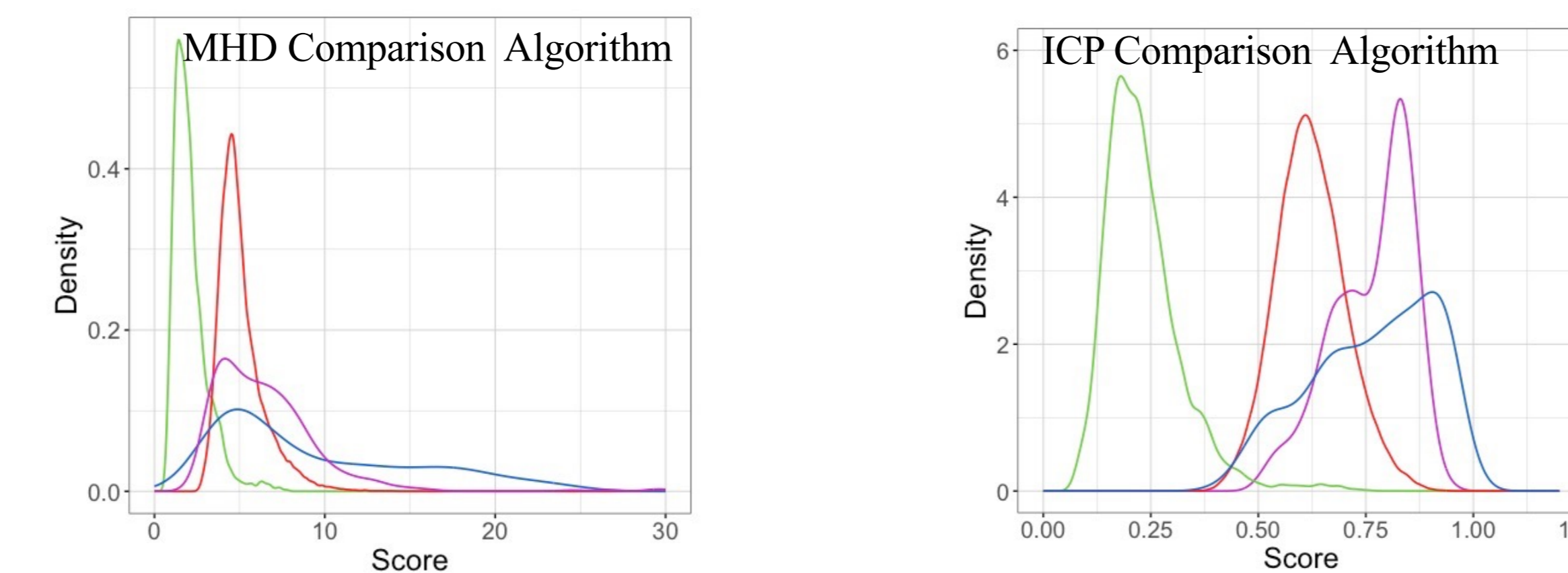
Affine approximation of the recognition algorithm: $A = A_{nr} \cdot A_r$

Adaption Formats

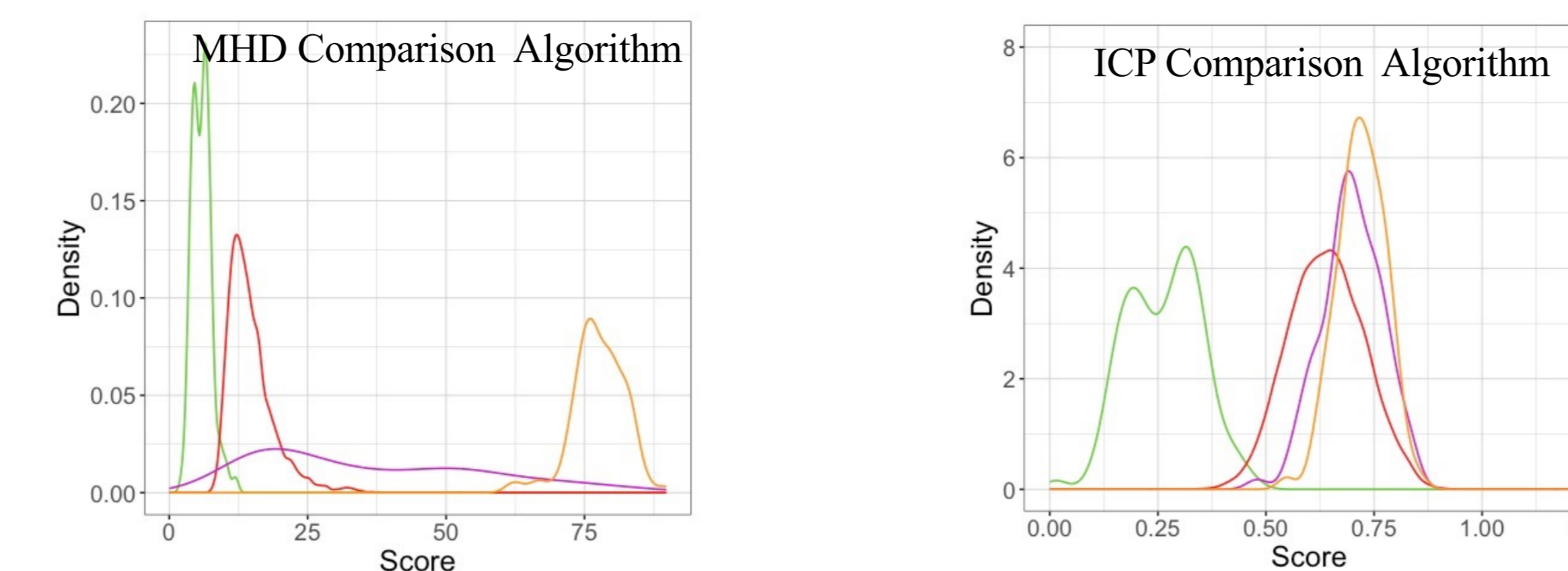
- 1) Reconstructing templates using binary image format [2]
- 2) Reconstructing templates using spatial coordinates format [2, 3]
- 3) Reconstructing retinal images [3]

Results

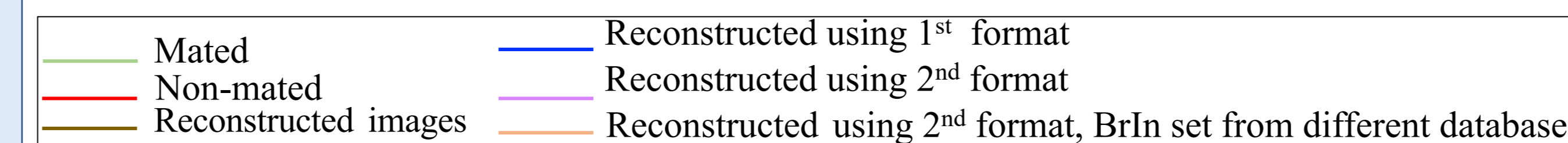
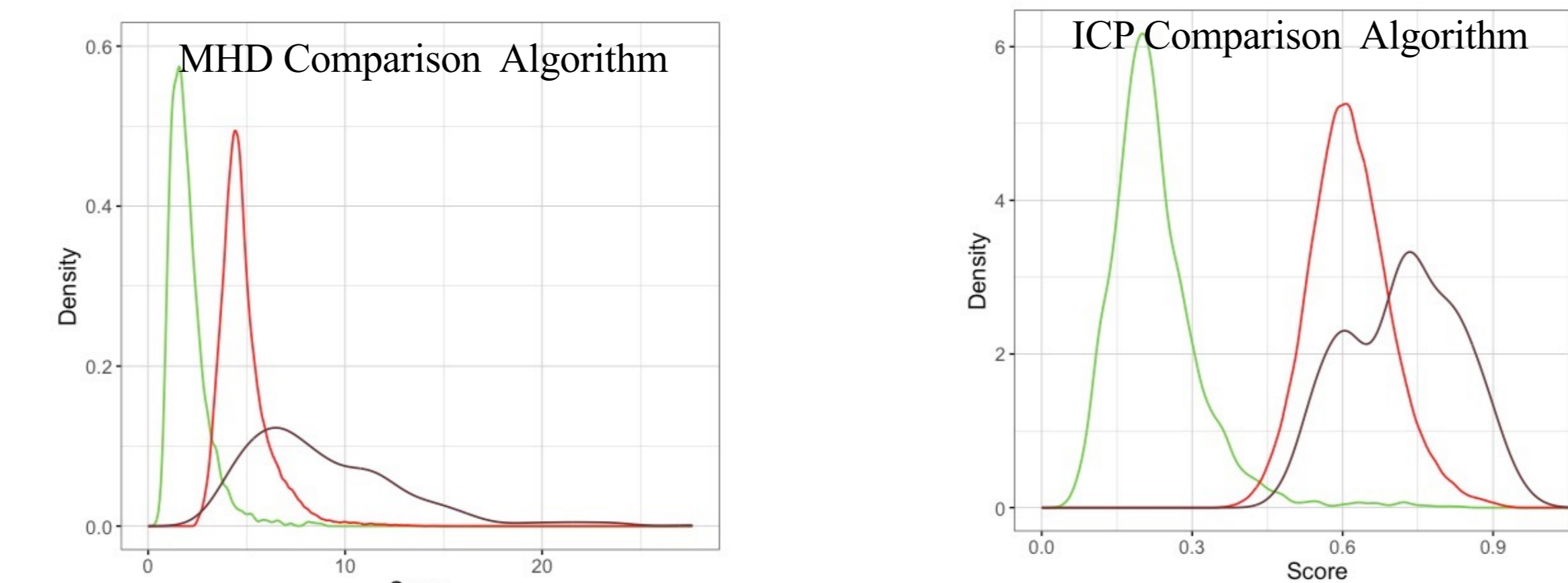
1) Result of reconstructing retinal templates:



2) Result of reconstructing hand templates:

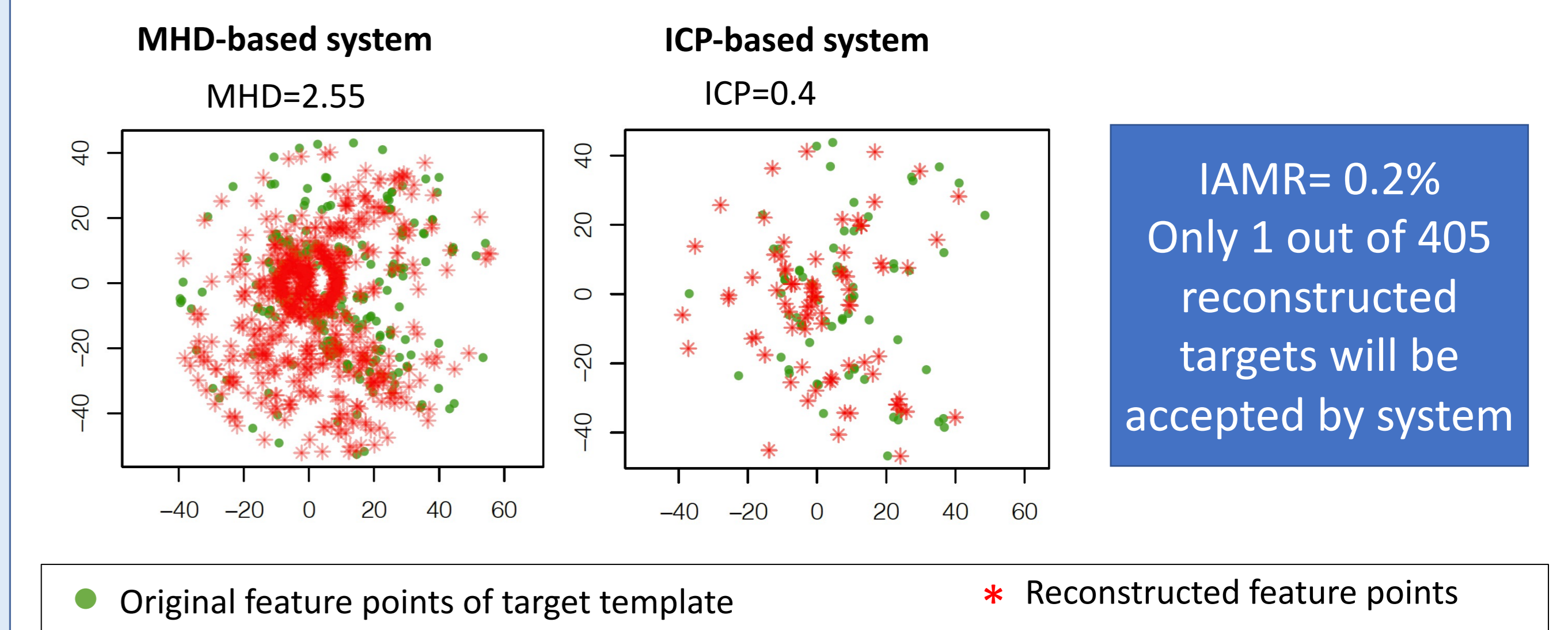


3) Result of reconstructing retinal images:

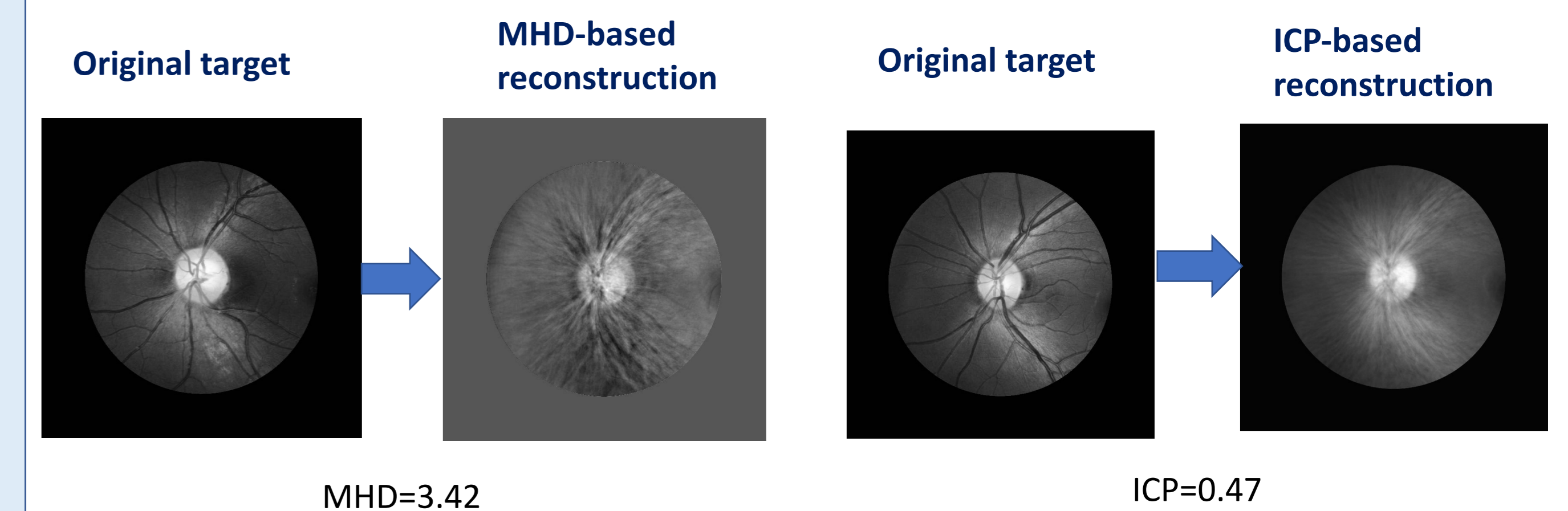


Results

- ❖ Best reconstructed templates (using binary image format):
- ✓ The only two retinal templates that will pass a system with FMR= 0.1%



- ❖ Best reconstructed retina images:



Conclusion

We applied the MSK algorithm to two formats of retina and hand point pattern templates and to retinal images. The performance of this attack on the tested vascular point pattern templates and the retinal vascular images is so poor that it could not be considered as a threat to privacy and security of the users and their templates. As future work, we would like to compare this attack to other types of biometric attacks that require different types of knowledge to be performed, particularly the attacks that are based on generative models.

References

- [1] P. Mohanty, S. Sarkar, and R. Kasturi, "Reconstruction of biometric image templates using match scores," April 24 2012. *US Patent* 8,165,352.
- [2] M. Sadeghpour, A. Arakala, S. A. Davis, and K. J. Horadam, "Application of affine-based reconstruction to retinal point patterns," in 2020 International Conference of the Biometrics Special Interest Group (BIOSIG), Sep 2020, pp.1-8.
- [3] M. Sadeghpour, A. Arakala, S. A. Davis, and K. J. Horadam, "Failure of Affine-based Reconstruction Attack in Regenerating Vascular Feature Points," *IET Biometrics*, Sep 2021; 10(5), pp. 497-517.