EDGE: The "Eye in the Woods" Image-based Face Detection and Recognition System

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BTI Institute
Borders • Trade • Immigration
A Department of Homeland Security Center of Excellence
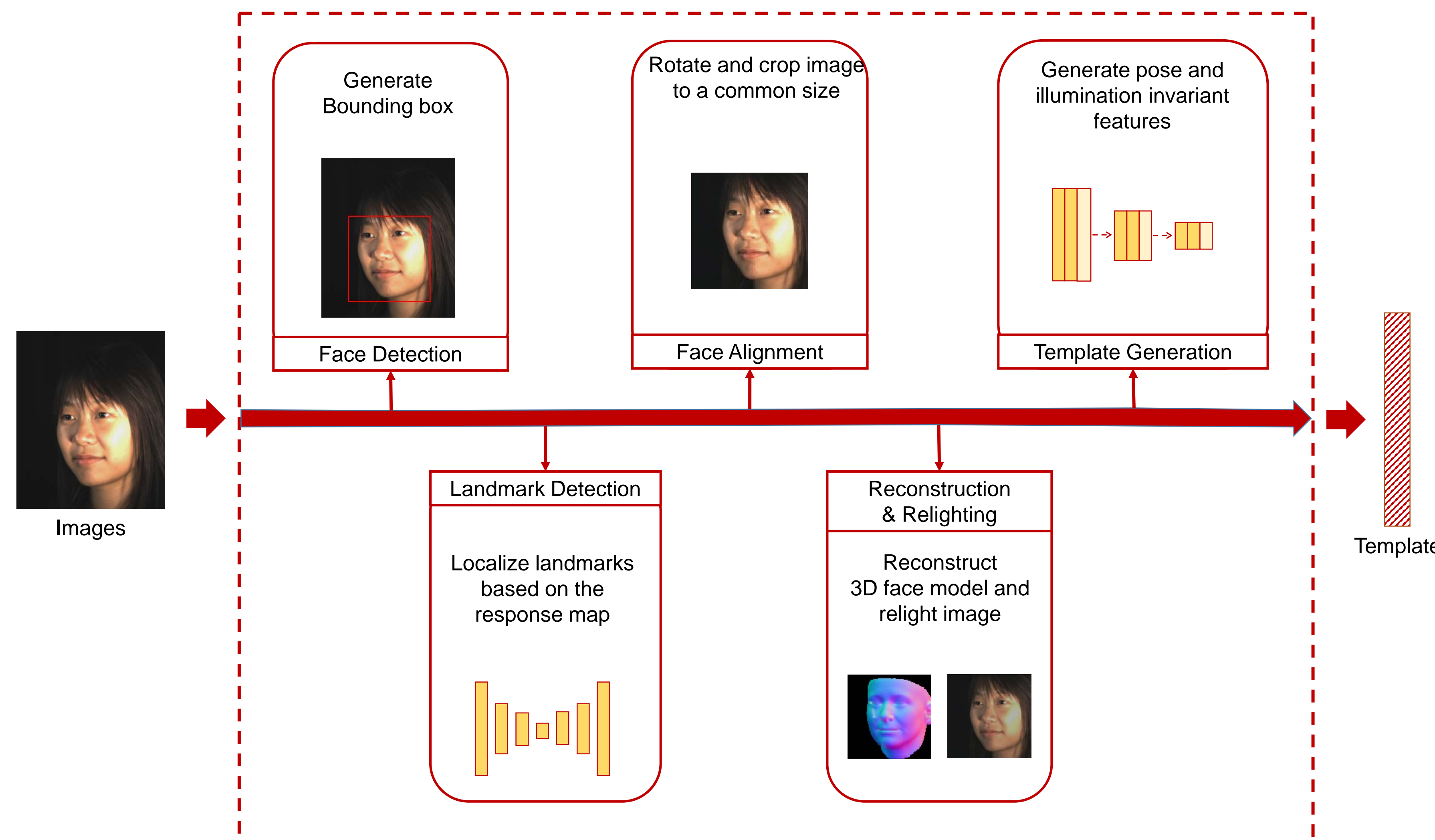
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Homeland Security Challenge

- Identify border crossers to enable dispatchers to alert agents in the field
- Limited success matching images where a person's face is partially visible due to pose or illumination
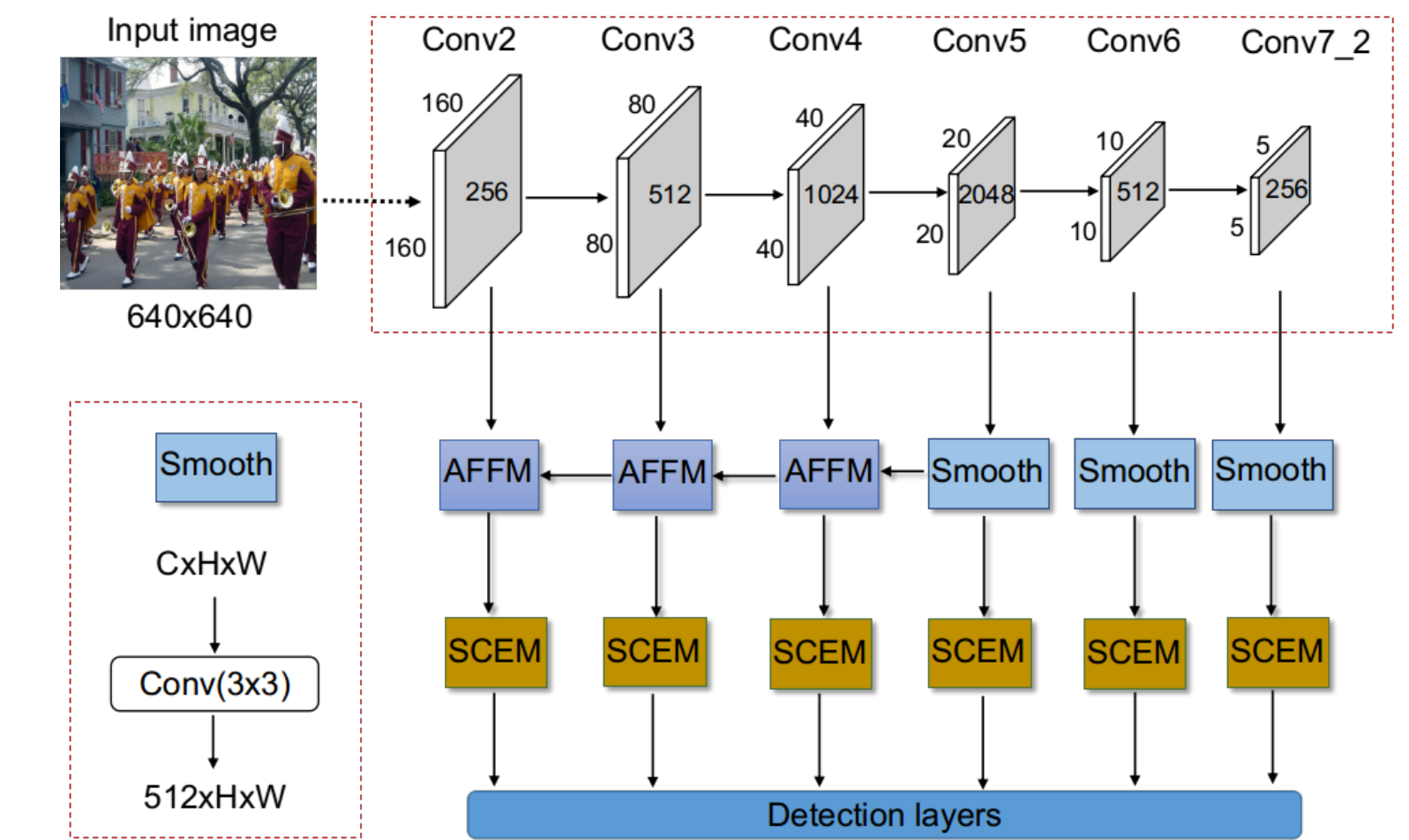

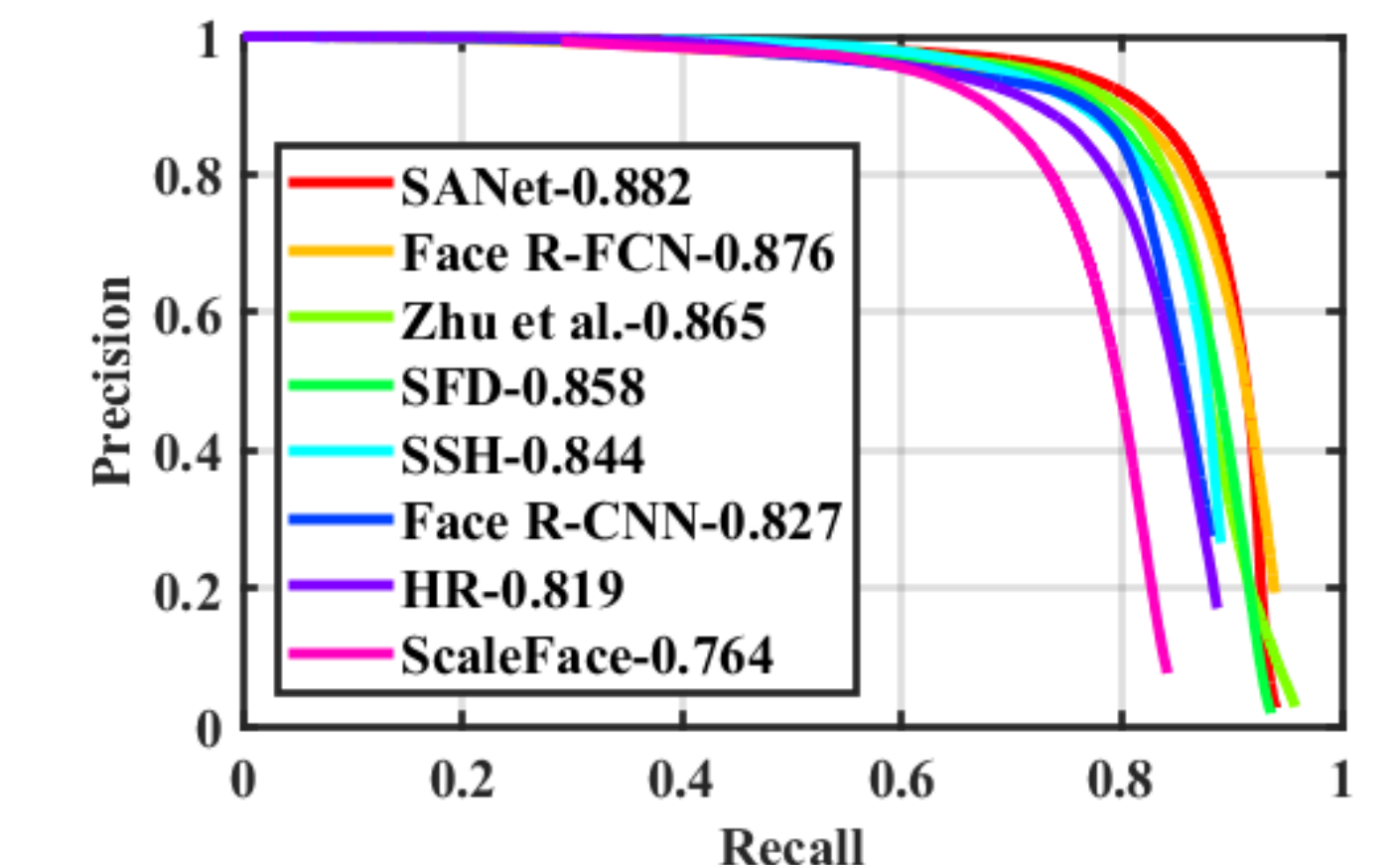Illegal border crossers [1]

Approach / Methodology

Generate Bounding box — Face Detection

Rotate and crop image to a common size — Face Alignment

Generate pose and illumination invariant features — Template Generation

Images

Landmark Detection: Localize landmarks based on the response map

Reconstruction & Relighting: Reconstruct 3D face model and relight image

Template

References

[1] https://www.youtube.com/watch?v=BWJbazGLhH4
[2] L. Shi, X. Xu, and I. A. Kakadiaris, Smoothed Attention Network for Single Stage Face Detector, In Proc. International Conference on Biometrics, Crete, Greece, Jun. 4-7, 2019.
[2] H. Le and I. A. Kakadiaris. Illumination-invariant Face Recognition with Deep Relit Face Images. In Proc. Winter Conference on Applications of Computer Vision, Waikoloa Village, Hawaii, Jan. 2019.
[4] Y. Wu, I.A. Kakadiaris, "Occlusion-guided compact template learning for ensemble deep network- based pose invariant face recognition," In Proc. IAPR international conference on biometrics, Crete, Greece, pp. 1-8, June 4-7, 2019.
[5] X. Xu, N. Sarafianos, and I. A. Kakadiaris. On Improving the Generalization of Face Recognition in the Presence of Occlusions, In Proc. IEEE International Conference on Computer Vision, Seoul, Korea, Oct. 27 - Nov. 2, 2019 (Under Review).

Acknowledgements

Outcomes / Results

Face Detection: SANet [2]

Input image 640x640

SANet employs attention-mechanism feature fusion and context enhancement to improve the performance of detecting small faces.

Precision-Recall: WIDER FACE (Hard Set)
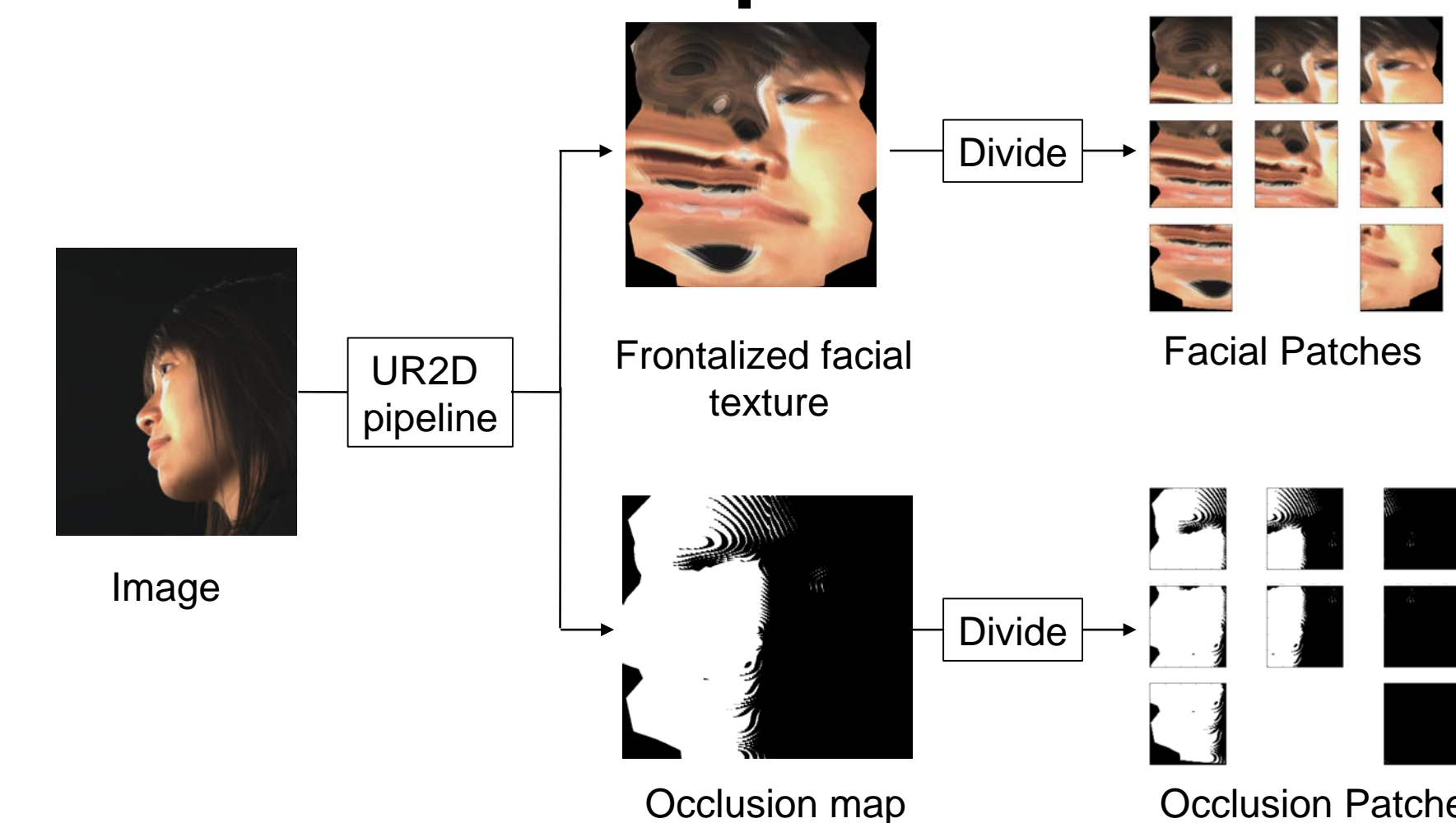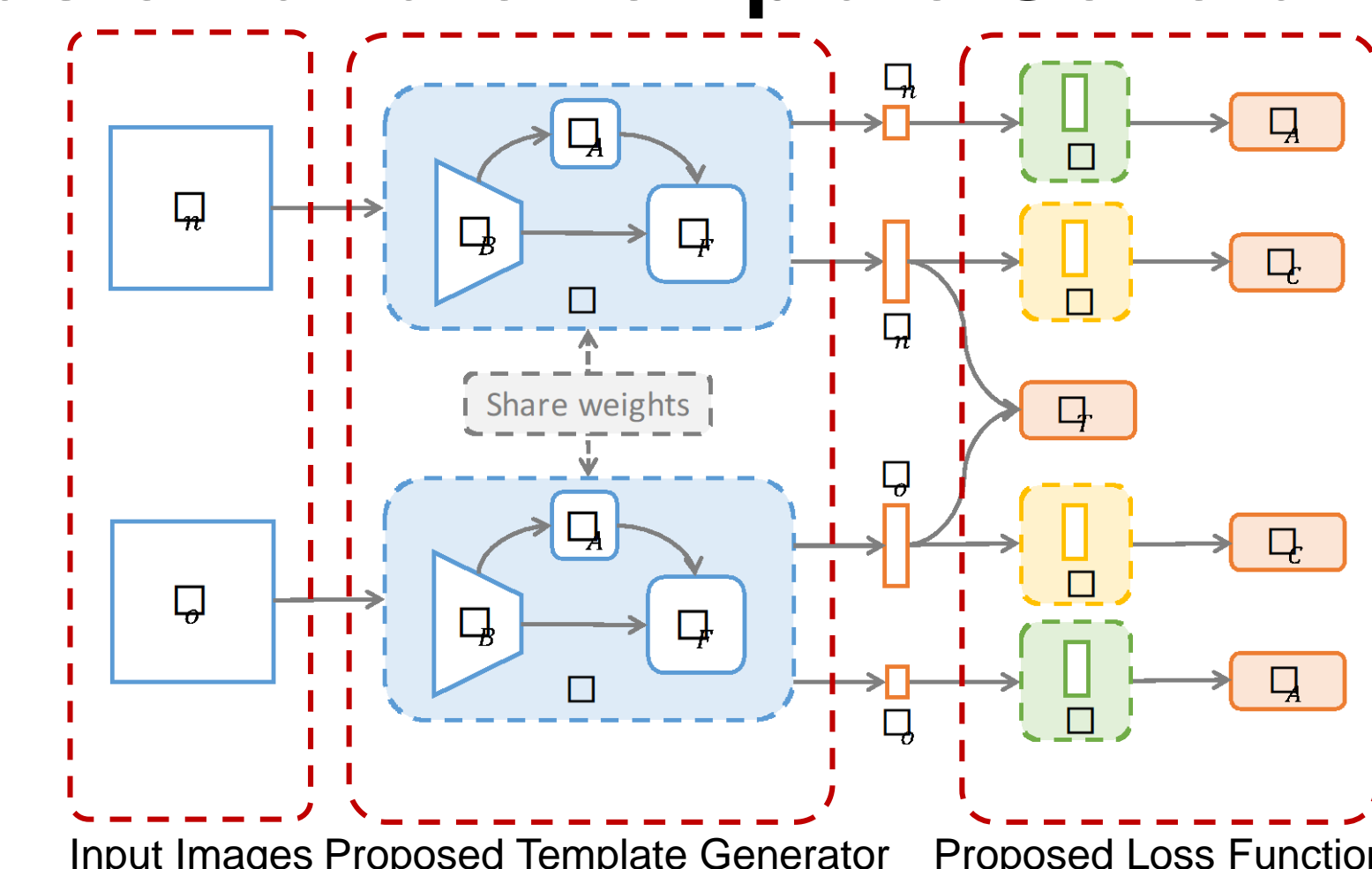

- SANet-0.882
- Face R-FCN-0.876
- Zhu et al.-0.865
- SFD-0.858
- SSH-0.844
- Face R-CNN-0.827
- HR-0.819
- ScaleFace-0.764

Face Reconstruction and Relighting: FRnR [3]

Face Relighting

3DMM Reconstruction — FRnR — Coefficients $\alpha_s \alpha_e L$

Normal, Mask, Relit Images, Shading, Albedo
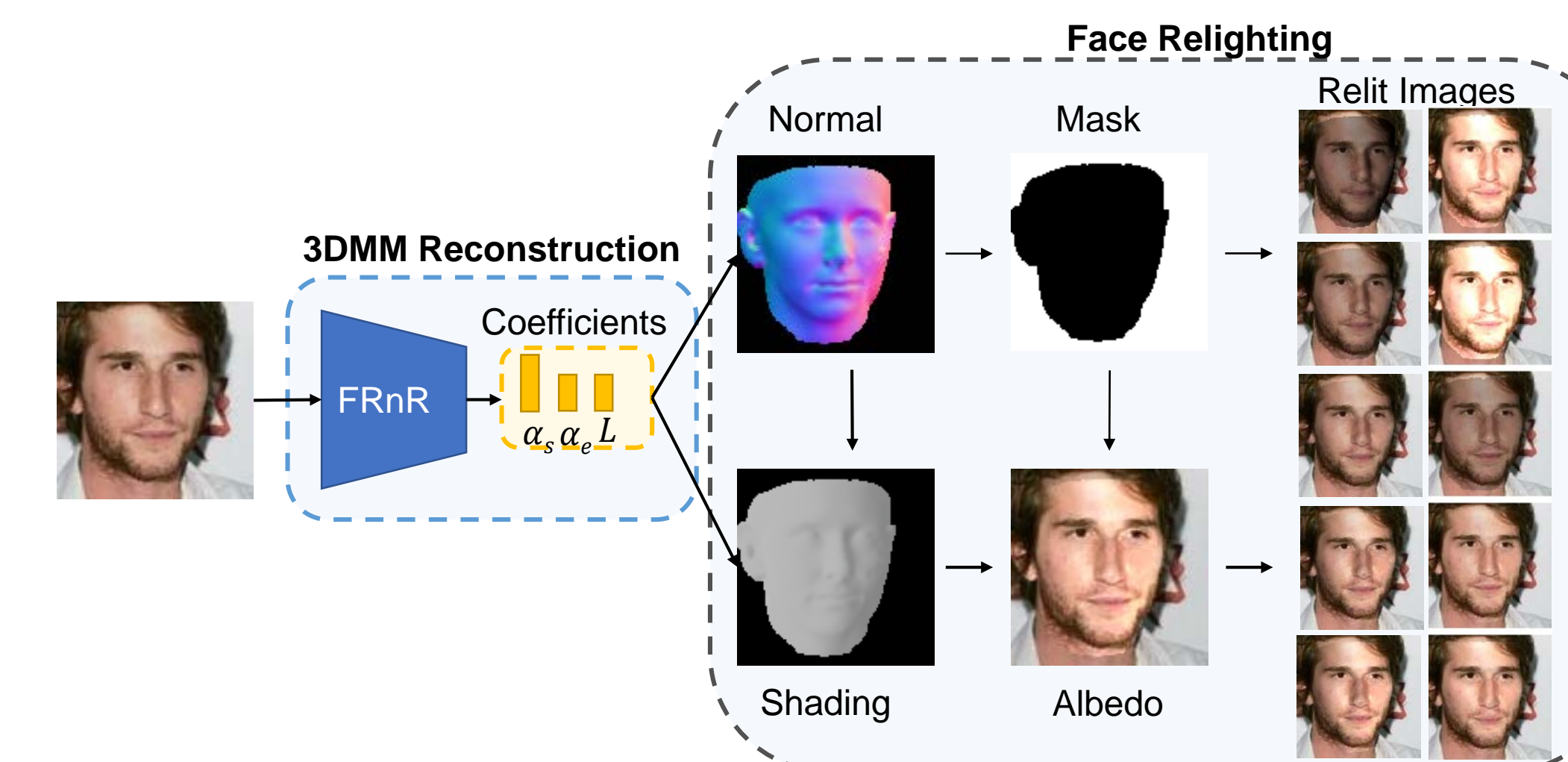
Rank-1 Identification Rate on UHDB31

Method	UHDB31.R0128			
	I01	I03	I05	Mean
ArcFace	87.60	90.32	87.51	88.48
ArcFace-FRnR	89.17	92.04	89.54	90.25

FRnR improved ArcFace in all set of illuminations by 2%.

Pose-Invariant Template Generation: OGCTL [4]

Image — UR2D pipeline — Frontalized facial texture — Divide — Facial Patches

Occlusion map — Divide — Occlusion Patches

Face verification performance on IARPA Janus IJB-C database
TAR (True Accept Rate %) against the FAR (False positive rate %)

Method	Tem. Size	FAR=10^{-3}	FAR=10^{-2}	FAR=10^{-1}
VGG-CNN	16KB	75.0	86.0	95.0
OGCTL	0.5KB	83.9	91.8	97.5

OGCTL template is 32 times smaller in size and 8% more accurate.

Occlusion-aware Template Generation: OREO [5]

Share weights

Input Images   Proposed Template Generator   Proposed Loss Functions

Face verification performance on IARPA Janus IJB-C database
TAR (True Accept Rate %) against the FAR (False positive rate %)

Method	1:1 Verification TAR (%) @ FAR=		
	10^{-3}	10^{-2}	10^{-1}
ArcFace	91.14	95.98	97.92
OREO	92.81	97.11	99.37

OREO improved ArcFace by at least 1%.