



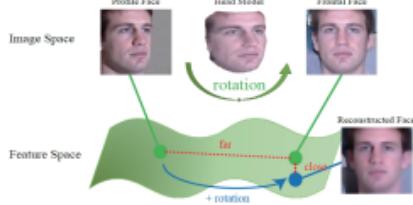
LARNet: Lie Algebra Residual Network for Face Recognition

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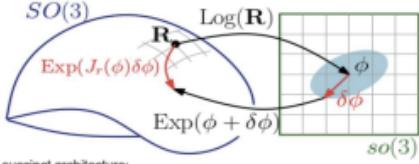
Introduction

A major challenge in practical face recognition applications lies in significant variations between profile and frontal faces. We explore how face rotation in the 3D space affects the deep feature generation process.

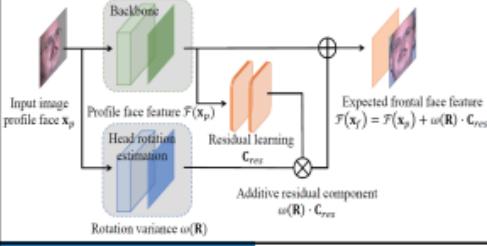


Method

A new tool Lie algebra Φ is introduced for the not completed closed rotation R .



Our succinct architecture:



Quantitative Evaluation

Quantitative evaluation on LFW-A dataset.

| Method | TAR@FAR=0.01 | TAR@FAR=0.01 | Rank-1 Acc. | Rank-5 Acc. |
|--|--------------|--------------|-------------|-------------|
| Wang et al. (2014) | 0.729 | 0.510 | 0.822 | 0.901 |
| Frontal Feature (Chen et al., 2016) | 0.819 | 0.656 | 0.936 | 0.935 |
| Multi-Person Avatars (Abdellatif et al., 2016) | 0.837 | — | 0.948 | 0.927 |
| DCNN Fusion (Z. Chen et al., 2016) | 0.838 | — | 0.903 | 0.965 |
| FMs (Masi et al., 2016) | 0.828 | 0.652 | 0.948 | 0.925 |
| Augmentation+RankNet (Masi et al., 2016b) | 0.888 | 0.725 | 0.906 | 0.962 |
| DeepID3 (Schroff et al., 2015) | 0.827 | 0.648 | 0.952 | 0.950 |
| TPR1 (Sankaranarayanan et al., 2017) | 0.900 | 0.813 | 0.952 | — |
| DB-GAN (Ren et al., 2017) | 0.871 | 0.699 | 0.903 | 0.935 |
| FF-GAN (Yin et al., 2017) | 0.852 | 0.661 | 0.902 | 0.954 |
| NAM (Yang et al., 2017) | 0.927 | 0.866 | 0.958 | 0.960 |
| Multi-Task Loss (Zisserman, 2018) | 0.628 | — | — | — |
| VGGFace2 (Cao et al., 2018) | 0.904 | — | — | — |
| Template Adaptation2 (Csurka et al., 2018) | 0.938 | — | 0.928 | — |
| DREAM (Cao et al., 2018) | 0.872 | 0.712 | 0.915 | 0.961 |
| SPGAN (Xie et al., 2018) | 0.904 | 0.836 | 0.959 | 0.959 |
| FFL with FR pretrain (x. J. Yu et al., 2019) | 0.864 | 0.744 | 0.893 | 0.947 |
| FFL (Shi & Jain, 2019) | 0.944 | — | — | — |
| Defface (Kong et al., 2020) | 0.902 | — | — | — |
| ResNet+Similar (Zhao et al., 2020) | 0.920 | 0.845 | — | — |
| HDDA (Wang et al., 2020) | 0.879 | 0.803 | 0.84 | 0.98 |
| CDA (Wang & Dong, 2020) | 0.911 | 0.823 | 0.956 | 0.997 |
| LARNet | 0.981 | 0.842 | 0.958 | 0.988 |
| LARNet+ | 0.981 | 0.874 | 0.948 | 0.971 |

Our results surpass many competitors in the recent 5 years under all 4 evaluation criteria:

- Identification task: 95% (Rank-1) & 97%+ (Rank-5) recognition accuracy
- Verification task: 95%+ (TAR@FAR=0.01) & 87%+ (TAR@FAR=0.001)

Quantitative evaluation on LFW, YTF, and CPLFW datasets.

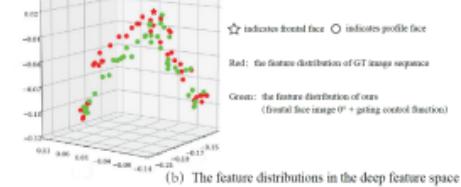
- Our method also outperforms on general face recognition datasets.

Visualization Result

Feature Representation: different-pose samples with the same identity.



(a) A ground-truth image sequence; pose variant is from -90° to 90°.



(b) The feature distributions in the deep feature space

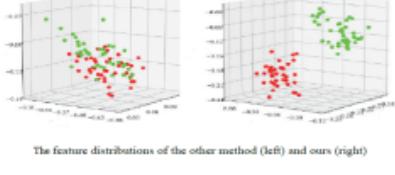
Feature Clustering: different-pose samples with the different identities.



false positive pair

frontal face data

profile face data



The feature distributions of the other method (left) and ours (right)

Reconstructed Faces:



| Method | LFW | YTF | CPLFW |
|----------------------------------|-------|-------|-------|
| HUMAN-Individual | 97.23 | — | 81.21 |
| HUMAN-Fusion | 99.88 | — | 85.24 |
| DeepID (Sun et al., 2014) | 99.47 | 93.20 | — |
| Deep Face (Trigano et al., 2014) | 97.35 | 99.4 | — |
| VGG Face (Pathak et al., 2015) | 98.95 | 97.30 | 93.57 |
| FaceNet (Schroff et al., 2015) | 99.63 | 95.10 | — |
| Birds (Li et al., 2015a) | 99.13 | — | — |
| Center Loss (Wen et al., 2016) | 99.28 | 94.9 | 85.48 |
| Range Loss (Zhang et al., 2017) | 99.53 | 93.70 | — |
| Margin Loss (Wen et al., 2017) | 99.42 | 95.98 | 95.08 |
| SphereFace (Liu et al., 2017) | 99.42 | 95.98 | 81.4 |
| SphereFace (Liu et al., 2017) | 99.42 | 95.98 | 90.30 |
| CoFace (Cao et al., 2018a) | 99.53 | 96.1 | — |
| CoFace+MS(MV2,8x8) | 99.73 | 97.6 | — |
| ArchFace (Deng et al., 2019) | 99.53 | — | 92.08 |
| ArcFace+MS(MV2,R100,L) | 99.83 | 98.02 | 95.45 |
| Ours LARNet | 99.38 | 96.55 | 95.51 |
| Ours LARNet+ | 99.71 | 97.63 | 94.25 |

Quantitative evaluation on CFP-FP dataset.

| Method | Verification (%) |
|---------------------------------|------------------|
| LARNet | 94.17 |
| CoFace (0.5) | 94.40 |
| Arface (0.5) | 94.04 |
| UFRFace (modules, MS(MV2, 0.5)) | 96.64 |
| UFRFace level | 98.92 |
| LARNet | 98.34 |
| LARNet+ | 99.21 |

The first result achieves 99%+ on the CFP-FP dataset.

The first result surpasses the reported human-level result.

Publication:

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