The Impact of Preprocessing on Deep Representations for Iris Recognition on Unconstrained Environments

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SIBGRAPI, 2018

UFPR

Visão Robótica Imagem

Eye regions

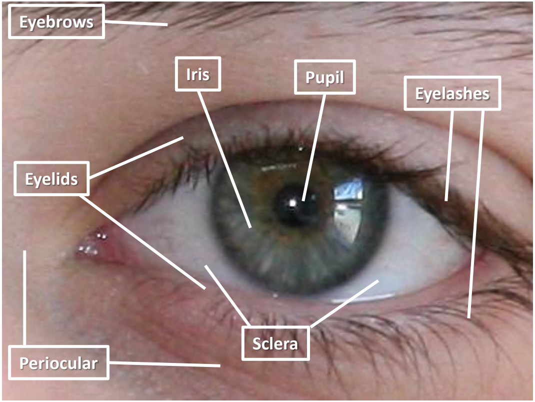
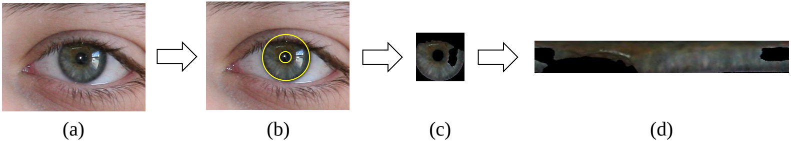


Image from NICE.II dataset [Proença and Alexandre, 2012].

Iris recognition steps:

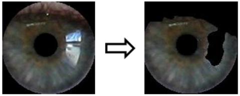
1. Image acquisition;
2. Preprocessing:



3. Feature extraction;
4. Matching;

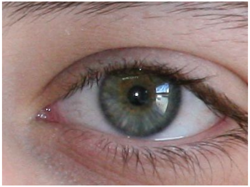
Image Preprocessing

Segmentation: Winner of the NICE.I contest [Tan et al., 2010].



Normalization: Rubber sheet model [Daugman, 1993].

Image Preprocessing

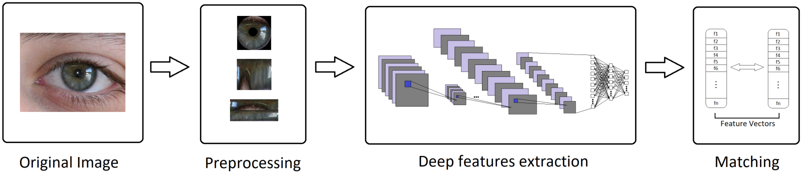


Original Image

Non-Segmented

Segmented

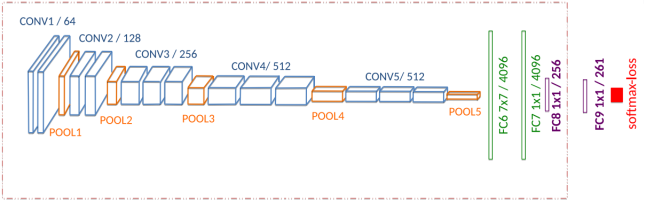
Recognition System



CNN models

- VGG16: convolution, activation(ReLu), pooling and fully connected layers.
- ResNet-50: residual information.
- Architecture modification: fully-connected layer with 256 neurons.

MODIFIED VGG

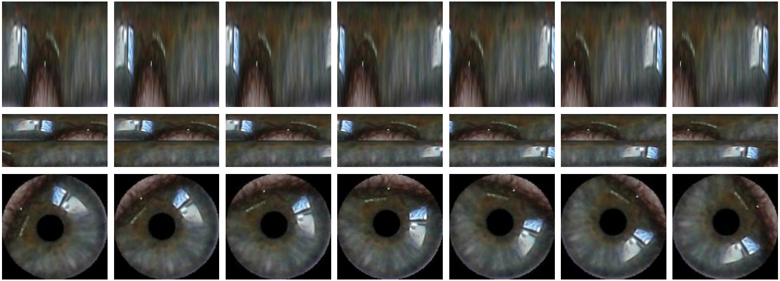


Adapted from [Luz et al., 2017].

CNN models training

- Transfer learning from the face domain (VGGFace) with fine-tuning (do not freezing any weights).
- Data augmentation - rotation.
- 30 epochs: 10 with $lr = 0.001$ and 20 with $lr = 0.0005$.
- SGD optimizer;
- Feature extractor training - SoftMax (identification)

Data Augmentation



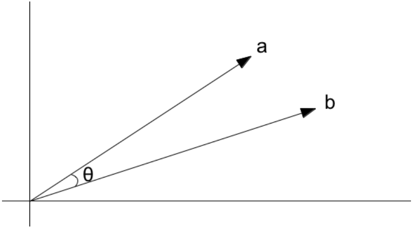
(-60) (-40) (-20) (original) (20) (40) (60)

Dataset

- NICE.II official contest database and protocol:
  - Training: 1000 images from 171 classes;
  - Testing: 1000 images from 150 classes;

Protocol and Matching

- Verification protocol (open world):
  - All against All:
  - 4,634 intra-class pairs;
  - 494,866 inter-class pairs;
- Metrics:
  - EER (Equal Error Rate): FAR = FRR;
  - Decidability: how well separated are intra- and inter-classes;
- Cosine distance metric;



Experiments Analysis

- CNN models: VGG16 and ResNet50;
- Normalization: 8:1, 4:2 and Non-Norm;
- Data Augmentation;
- Segmentation;
- Delineation;
- 30 repetitions;
- t-test for statistical difference;

Data Augmentation

Network	Norm.	DA	EER (%)	Decidability
VGG16	8 : 1		26.19 ± 1.95	1.3140 ± 0.1246
VGG16	8 : 1	✓	23.63 ± 1.33	1.4712 ± 0.0881
ResNet-50	8 : 1		24.38 ± 1.41	1.4297 ± 0.0916
ResNet-50	8 : 1	✓	19.18 ± 0.75	1.7988 ± 0.0552
VGG16	4 : 2		24.77 ± 1.42	1.4127 ± 0.1001
VGG16	4 : 2	✓	18.74 ± 0.89	1.8527 ± 0.0712
ResNet-50	4 : 2		22.78 ± 1.22	1.5307 ± 0.0853
ResNet-50	4 : 2	✓	17.11 ± 0.53	1.9822 ± 0.0482
VGG16	Non-Norm		23.32 ± 1.10	1.4891 ± 0.0740
VGG16	**Non-Norm**	✓	$\mathbf{17.49 \pm 0.90}$	$\mathbf{1.9529 \pm 0.0760}$
ResNet-50	Non-Norm		21.51 ± 0.97	1.6119 ± 0.0677
ResNet-50	**Non-Norm**	✓	$\mathbf{13.98 \pm 0.55}$	$\mathbf{2.2480 \pm 0.0528}$

*white rows represent that there is statistical difference between: Models, Normalization and DA.

Segmentation for noise removal

Network	Norm.	Seg.	EER (%)	Decidability
VGG16	8 : 1	✓	22.58 ± 1.07	1.5437 ± 0.0697
VGG16	8 : 1		23.63 ± 1.33	1.4712 ± 0.0881
ResNet-50	8 : 1	✓	20.68 ± 1.39	1.6801 ± 0.1071
ResNet-50	8 : 1		19.18 ± 0.75	1.7988 ± 0.0552
VGG16	4 : 2	✓	18.00 ± 0.93	1.9055 ± 0.0750
VGG16	4 : 2		18.74 ± 0.89	1.8527 ± 0.0712
ResNet-50	4 : 2	✓	17.44 ± 0.85	1.9450 ± 0.0803
ResNet-50	4 : 2		17.11 ± 0.53	1.9822 ± 0.0482
VGG16	Non-Norm	✓	$\mathbf{17.48 \pm 0.68}$	1.9439 ± 0.0589
VGG16	Non-Norm		17.49 ± 0.90	1.9529 ± 0.0760
ResNet-50	Non-Norm	✓	14.89 ± 0.78	2.1781 ± 0.0794
ResNet-50	**Non-Norm**		$\mathbf{13.98 \pm 0.55}$	$\mathbf{2.2480 \pm 0.0528}$

*painted rows represent that there is no statistical difference

Delineation

Delineated

Non-delineated (Bounding box)

Method	Delineated	EER (%)	Decidability
VGG16	✓	17.49 ± 0.90	1.9529 ± 0.0760
VGG16		17.52 ± 0.98	1.9652 ± 0.0790
Resnet-50	✓	13.98 ± 0.55	2.2480 ± 0.0528
Resnet-50		14.26 ± 0.47	2.2304 ± 0.0542

The state of the art comparison (Unpublished results)

Results on the NICE.II contest dataset.

Method	EER (%)	Decidability
Wang et al.[Wang et al., 2012]	19.00	1.8213
Silva et al.[Silva et al., 2018] (Best Model)	14.56	2.2200
Proposed ResNet-50	**13.98**	**2.2480**
Proposed ResNet-50 ensemble (5 models)	9.53	2.8132
Proposed ResNet-50 ensemble (10 models)	9.27	2.8538
Proposed ResNet-50 ensemble (20 models)	9.21	2.8643
Proposed ResNet-50 ensemble (30 models)	9.15	2.8725

Conclusion

- Data Augmentation by rotation significantly improved the results;
- Non-normalized iris achieved a better result;
- ResNet-50 reported better result than VGG16;
- Delineated and Non-delineated images reported no statistical difference.

Future work - Other databases

Database	Spectrum	Classes/Images	Resolution
CASIA-Lamp	NIR	819/16212	640 × 480
CASIA-Thousand	NIR	2000/20000	640 × 480
UbirisV2	VIS	522/11102	400 × 300
MICHE DB	VIS(3 sensors)	184/3732	2322 × 4128 to 640 × 480
CSIP	VIS(10 sensors)	100/2004	3264 × 2448 to 640 × 480
VISOB	VIS(3 sensors)	1100/158136	240 × 160
MobBio	VIS	210/1680	300 × 200

Thank you!

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