DEEP LEARNING BASED OFF-ANGLE IRIS RECOGNITION

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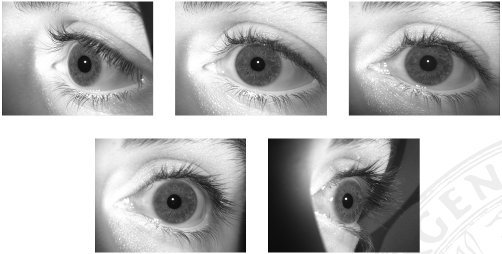
Introduction

- This research work is focused on application of deep-learning for off-angle iris recognition
- In specific we apply triplet loss technique [3] for the off-angle iris recognition (using this method we don't need retaining when a new subjects is added to the system)
- The research aims to address four main questions:
  - Q1: Are different gaze angles easier or harder for the recognition systems?
  - Q2: How tolerant are the iris recognition systems to off-angle iris data?
  - Q3: Which parts of the eye work best for the triplet-loss based CNNs?
  - Q4: Does gaze angle correction improve the results?

Methodology

- To find out if iris images with extreme gaze angles are harder to recognize, the EER is computed separately for the images of 11 different gaze angles $(-50°, -40°, \ldots, +40°, +50°)$



- To find out the impact of differences in the gaze angle between images on the results of recognition systems, we compute the EER using only similarity scores between images with a maximum gaze angle difference of θ with $\theta \in \{0°, 10°, 20°, 30°, 40°\}$

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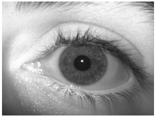
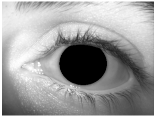
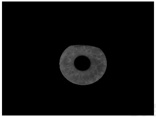
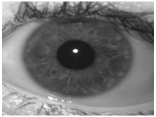
Methodology

- To find out which parts of the eye can be used for subject recognition we used: (1) full eye images, (2) images zoomed to the iris, (3) images with only the iris, (4) images where the iris is removed and (5) images of the normalized iris


- To determine if it is beneficial to correct the image gaze angles, we reprojected the off-angle images back to the frontal view [2]

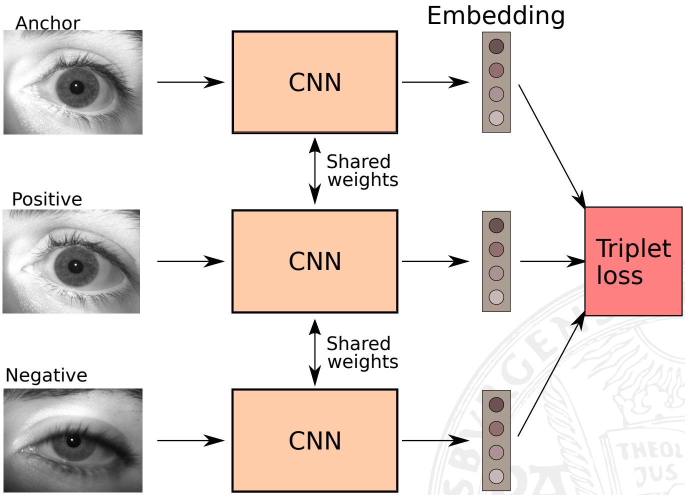
Triplet Loss CNNs

- The triplet loss takes two images belong to the same class (Anchor (A), image from the same class (Positive (P)) and an image belongs to a different class (Negative (N))
- The triplet loss trains the network to minimize the distance between the Anchor and the Positive and maximize the distance between the Anchor and the Negative
- The triplet loss then is calculated using the squared Euclidean distance:

$$L_{(A,P,N)} = \max(||f(A) - f(P)||^2 - ||f(A) - f(N)||^2 + \alpha, 0),$$

where α is a margin that is enforced between the positive and negative pairs and is set to $\alpha = 1$

Triplet Loss CNNs

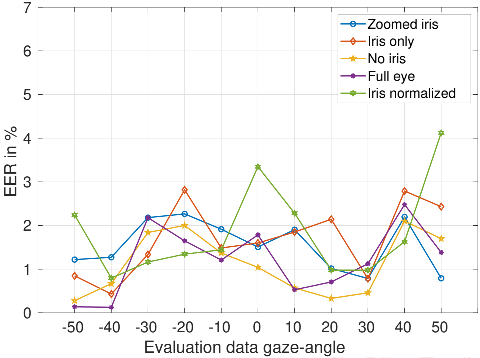


Experimental Framework

- **Dataset:** 4400 iris images captured from 40 subjects of an off-angle iris database (-50° to +50°)
- **Comparison methods:** The IrisSeg algorithm [1] and the WAHET algorithm [4] are two classical methods, and the Segmentation-CNN is a deep learning based method used in the experiments
- **Training approach:** We employ 2-fold cross validation to train and evaluate the CNNs. For this, we divide the whole database into two equal parts (20 subjects per fold)
- **Recognition metrics:** To quantify the recognition performance the Equal Error Rate (EER) is calculated (we report mean EER)

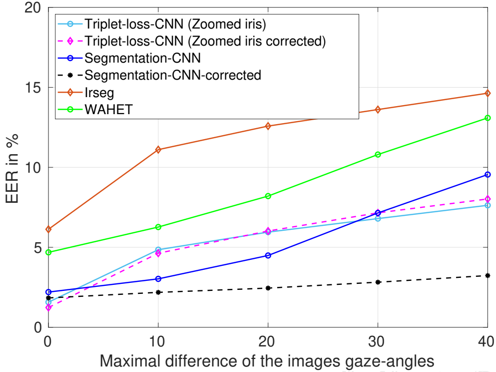
Answer to Q1:

- **Answer to Q1:** More extreme gaze angles do not worsen the results compared to lower gaze angles
- **Answer to Q3:** It does not really matter which parts of the eye are used

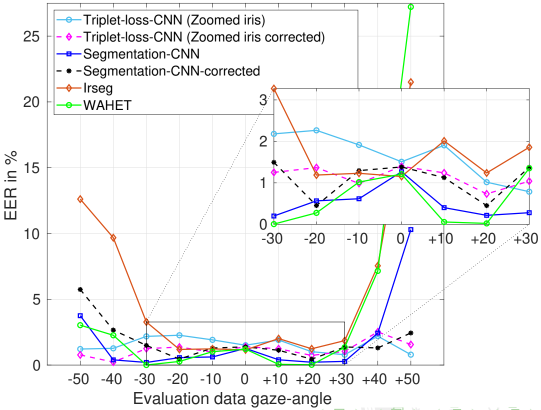


Answer to Q2:

- **Answer to Q2:** Higher differences in the gaze angles between images deteriorate the results of the proposed CNN approach, but to a lesser extent than the other methods. The Segmentation-CNN combined with gaze angle correction is better choice here



- **Answer to Q4:** Correcting the gaze angles improves the results slightly, but not consistently. At more extreme gaze angles the triplet loss CNN performs best and at lower gaze angles, Segmentation-CNN applied to the uncorrected image data



Conclusion

- The results of the proposed CNN approach did not decrease at stronger gaze angles, making it a better choice when dealing with more extreme off-angle iris images ($\geq 30°$)
- Higher differences in the gaze angles between images deteriorate the results of the proposed CNN approach ($EER \approx 2\%$ at $0°$ difference and $EER \approx 8\%$ at $40°$ difference), but to a lesser extent than most of the comparison methods
- It is not so important which parts of the eye images are used for subject recognition, as eventually the results remain similar
- Correcting the gaze angle did not really improve the triplet loss CNN results. However, the Segmentation-CNN method did clearly benefit from using rotation corrected data

End

THANK YOU!
ANY QUESTION?

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