Gaze-angle Impact on Iris Segmentation using CNNs

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Introduction

- Iris images captured by emerging stand-off iris recognition systems are more subject to off-angle distortions.
- Showing superior performance, convolutional neural networks are increasing being used for iris segmentation.

Problem Statement

- There is a significant lack of information about how these distortions affect the performance of such models.
- Having such knowledge available, we can figure out the proper segmentation strategy when dealing with iris images captured from different angles.
- It might turn out that CNN training has to be done specifically for a certain gaze angle (eye-gaze estimation algorithms required).
- Alternatively, it would be of advantage to improve the generalization capability of the networks, and thus eliminate the need for any further processing stages.
Eye Structures Effect on Iris Segmentation

- 3D structure of iris.
- Limbus occlusion.
- Perspective and refraction distortion.
- Missing iris boundary in extreme angles.
Experimental framework

**Database:** A database containing 4400 left eye iris images belonging to 40 subjects (captured from $-50^\circ$ (N50) to $+50^\circ$ (P50), with a $10^\circ$ step) is used. We divided the database into two parts (training and testing datasets).

**Segmentation evaluation and measures:** Nice1 (NICE protocol)\(^1\)

$$nice1 = \frac{1}{c \times r} \sum_{c'} \sum_{r'} O(c', r') \otimes C(c', r') \quad (1)$$

**Fully convolutional neural networks (FCNs):** Two different FCN architectures:

- A basic fully convolutional encoder-decoder network termed "SegNet"[1].
- A Fully convolutional network termed "RefineNet"[2].

\(^1\)http://nice1.di.ubi.pt/
Is Gaze-angle Specific Training Required

Experiments

- We trained the networks on iris images with identical gaze-angle (200 images per gaze-angle as in our training dataset).

- Then we conduct segmentation on the whole test dataset, differentiating and grouping results into the different gaze-angles available (first using SegNet).
Experiments

- We repeated the same experiments using RefineNet.
Experiments

- We trained the networks with: 50, 100, 150, 200, 250, and 300 pcs of N50 and P50 gaze-angle images respectively, testing on the remaining images.

- We also trained networks with increasing quantities of frontal images (P0), and then tested on the same N50 and P50 gaze-angle images.
Experiments

- We trained the networks with all (200 samples per gaze-angle), and half quantity (100 samples per gaze-angle) in our training set, and then tested the networks on all images in the testing data.
We compared the corresponding segmentation results to those obtained by applying 3 classical iris segmentation algorithms: active contours-GrabCut (A-Contour) [3], contrast-adjusted Hough transform (Caht) [4], and weighted adaptive hough and ellipsopolar transform (Wahet) [5].
Thank you, Remarks?
Vijay Badrinarayanan, Alex Kendall, and Roberto Cipolla.
Segnet: A deep convolutional encoder-decoder architecture for image segmentation.

Guosheng Lin, Milan Anton, Shen Chunhua, and Ian Reid.
Refinenet: Multi-path refinement networks for high-resolution semantic segmentation.

Sandipan Banerjee and Domingo Mery.
Iris segmentation using geodesic active contours and grabcut.
In *Revised Selected Papers of the PSIVT 2015 Workshops on Image and Video Technology*, volume 9555.

Christian Rathgeb, Andreas Uhl, and Peter Wild.

Andreas Uhl and Peter Wild.
Weighted adaptive hough and ellipsopolar transforms for real-time iris segmentation.