Simultaneous Iris and Periocular Region Detection Using Coarse Annotations

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Content

Biometry

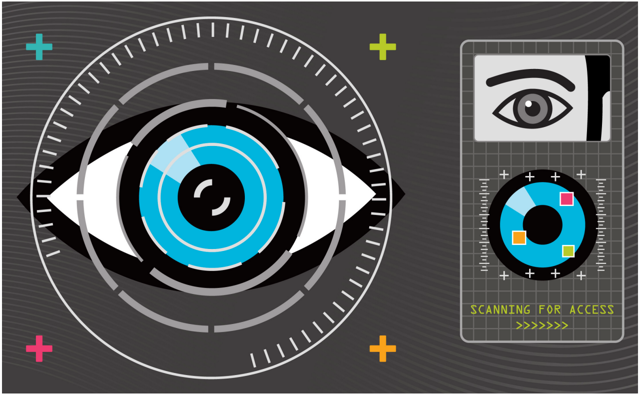


Figure: Biometry system example

Eye Regions

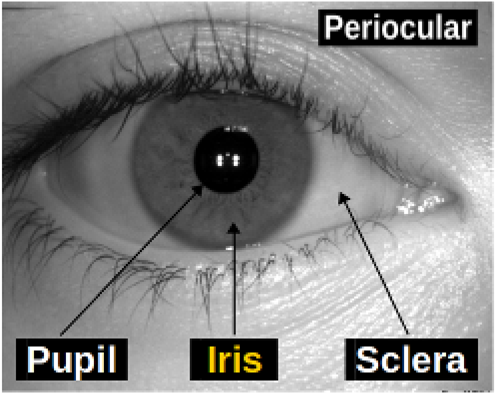
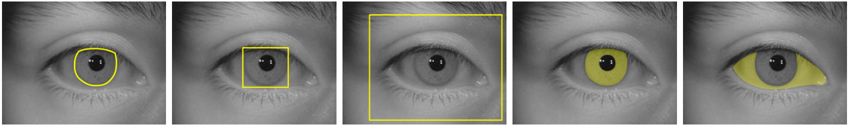


Figure: Eye regions

Eye Regions Delimitation



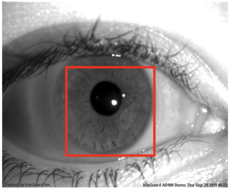
(a) (b) (c) (d) (e)

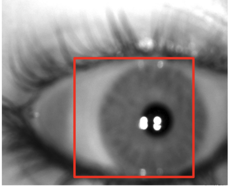
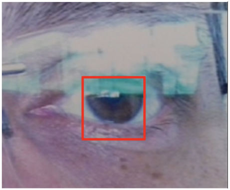
Figure: Detection and segmentation samples: (a) circular iris detection; (b) rectangular iris detection; (c) eye detection; (d) iris segmentation; (e) sclera segmentation;

Motivation

- Poor results of current available approaches on some scenarios, such as non controlled environment
- The importance of periocular region on biometrics

Poor Iris Detection Samples



Hypotheses

Is possible enhance the periocular region components detection by using a simultaneous detection approach?

Literature Overview I

Table: Iris region detection approaches I

Author(s)	Detection Approach	Database	Metrics	Best Result %
[1]	Integro-Differential Operator	Own Database	N/A	N/A
[2]	Integro-Differential Operator and the Hough-Transform	Own Database	N/A	N/A
[3]	Integro-Differential Operator	CASIA-IrisV1	Accuracy	98.00
[4]	Integro-Differential and Vector Field Convolution (VFC)	CASIA-IrisV2	Accuracy	98.85
[5]	Integro-Differential and momentum-based level	CASIA-IrisV2	Accuracy	98.53

[1] J. G. Daugman. “High confidence visual recognition of persons by a test of statistical independence”. In: *IEEE TPAMI* 15.11 (Nov. 1993), pp. 1148–1161.

[2] R. P. Wildes. “Iris recognition: an emerging biometric technology”. In: *Proceedings of the IEEE* 85.9 (Sept. 1997), pp. 1348–1363.

[3] José Luis Gil Rodríguez and Yaniel Díaz Rubio. “A New Method for Iris Pupil Contour Delimitation and Its Application in Iris Texture Parameter Estimation”. In: *Progress in Pattern Recognition, Image Analysis and Applications*. Berlin, Heidelberg, 2005, pp. 631–641.

[4] L. Zhou et al. “A new effective algorithm for iris location”. In: *IEEE ROBIO*. Dec. 2013, pp. 1790–1795.

[5] W. Zhang and Y. Ma. “A new approach for iris localization based on an improved level set method”. In: *11th ICCWAMTIP*. Dec. 2014, pp. 309–312.

Literature Overview II

Table: Iris region detection approaches II

Author(s)	Detection Approach	Database	Metrics	Best Result %
[1]	QMA-OWA	CASIA-IrisV3	Accuracy	98.00
[2]	Dual-threshold and Hough-Transform	CASIA-IrisV3-Twins	Accuracy	98.00
[3]	Iterative searching	CASIA-IrisV1 and CASIA-IrisV3	Accuracy	98.08
[4]	Convolutional Neural Network (CNN)	IIIT-D CLI	Accuracy	98.33
		NDCLD15		98.54
		MobBIOfake		98.90
		NDCCL		99.05
		CASIA-IrisV3 Interval		97.10
		BERC mobile-iris database		99.71

[1] Y. Alvarez-Betancourt and M. Garcia-Silvente. “A fast Iris location based on aggregating gradient approximation using QMA-OWA operator”. In: *IEEE FUZZ*. July 2010, pp. 1–8.

[2] Wang Cui et al. “A rapid iris location algorithm based on embedded”. In: *IEEE CSIP*. IEEE. 2012, pp. 233–236.

[3] L. Su et al. “Iris location based on regional property and iterative searching”. In: *IEEE ICMA*. Aug. 2017, pp. 1064–1068.

[4] Evair Severo et al. “A Benchmark for Iris Location and a Deep Learning Detector Evaluation”. In: *IJCNN*. July 2018, pp. 1–7.

Literature Overview III

Table: Periocular region detection approaches

Author(s)	Detection Approach	Database	Metrics	Best Result %
[1]	Anthropometry of the human face	FRGC	N/A	N/A
[2]	Active Shape Models (ASM)	Private	N/A	N/A
[3]	Average of Synthetic Exact Filters (ASEF)	Private	N/A	N/A
[4]	Local Eyebrow Active Shape Model (LE-ASM)	AR and MBGC	N/A	N/A
[5]	Markov Random Field (MRF)	UBIRIS.v2 subset	N/A	N/A

[1] Unsang Park et al. "Periocular biometrics in the visible spectrum". In: *IEEE TIFS* 6.1 (2011), pp. 96–106.

[2] F. Juefei-Xu and M. Savvides. "Unconstrained periocular biometric acquisition and recognition using COTS PTZ camera for uncooperative and non-cooperative subjects". In: *IEEE WACV*. Jan. 2012, pp. 201–208.

[3] G. Mahalingam, K. Ricanek, and A. M. Albert. "Investigating the Periocular-Based Face Recognition Across Gender Transformation". In: *IEEE TIFS* 9.12 (2014), pp. 2180–2192.

[4] T. H. N. Le, U. Prabhu, and M. Savvides. "A novel eyebrow segmentation and eyebrow shape-based identification". In: *IEEE IJCB*. 2014, pp. 1–8.

[5] H. Proença, J. C. Neves, and G. Santos. "Segmenting the periocular region using a hierarchical graphical model fed by texture/shape information and geometrical constraints". In: *IEEE IJCB*. 2014, pp. 1–7.

Detection Approaches

- You Only Look Once (YOLO) [1]
- Faster Region-Based Convolutional Neural Network (Faster-RCNN) [2]
- Feature Pyramid Network (FPN) [3]

[1] Joseph Redmon et al. “You only look once: Unified, real-time object detection”. In: *Proceedings of the IEEE conference on computer vision and pattern recognition*. 2016, pp. 779–788.

[2] Shaoqing Ren et al. “Faster R-CNN: Towards Real-time Object Detection with Region Proposal Networks”. In: *Proceedings of the 28th International Conference on Neural Information Processing Systems - Volume 1*. NIPS'15. Montreal, Canada: MIT Press, 2015, pp. 91–99.

[3] T. Lin et al. “Feature Pyramid Networks for Object Detection”. In: *2017 IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*. July 2017, pp. 936–944.

Faster+FPN

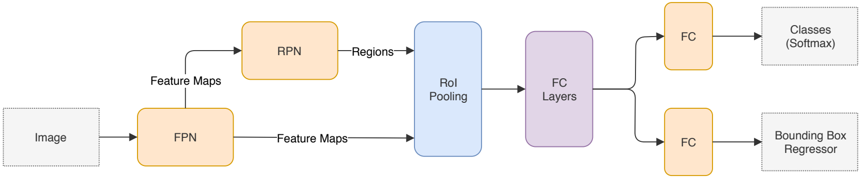
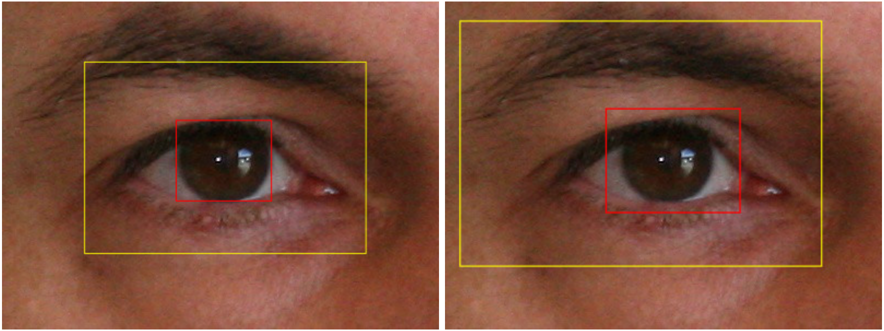


Figure: Faster+FPN

Annotations



(a) (b)

Figure: Examples of fine and coarse annotations of both the iris (red) and the periocular region (yellow).

Databases

Table: Databases overview

Database	Year	Images	Subjects	Resolution	Wavelength
CASIA-Iris-Interval	2010	2,639	249	320×280	Near-Infrared (NIR)
CASIA-Iris-Lamp	2010	16,212	411	640×480	NIR
CASIA-Iris-Thousand	2010	20,000	1,000	640×480	NIR
Cross-Eyed-VIS	2016	1,920	120	400×300	Visible (VIS)
CSIP*	2015	2,004	50	Various	VIS
MICHE-I*	2015	3,191	92	Various	VIS
MobBIO	2014	1,206	105	300×200	VIS
NICE-II	2010	2,000	n/a	400×300	VIS
PolyU-VIS	2017	6,270	209	640×480	VIS
UBIRIS.v2	2010	11,102	261	400×300	VIS
VISOB*	2016	95,046	550	Various	VIS
NIR		38,851			
VIS		122,739			
Total		161,590			

* Cross-sensor databases

Results I

Table: Periocular region detection results obtained by using single and simultaneous detection approaches.

Databases	IoU			
	YOLO V2		Faster+FPN	
	Simultaneous	Single	Simultaneous	Single
CASIA-Interval	92.65	96.19	96.69	**97.80**
CASIA-Lamp	97.15	96.02	**98.08**	97.71
CASIA-Thousand	95.92	96.44	**98.19**	98.19
Cross-Eyed-VIS	86.86	86.89	**92.74**	92.56
CSIP	91.61	91.76	84.97	**92.96**
MICHE-I	75.88	74.97	**83.66**	83.51
MobBIO	94.21	94.09	**95.50**	94.83
NICE:II	80.52	82.44	**86.91**	86.66
PolyU-VIS	93.57	77.95	**96.74**	96.41
UBIRIS.v2	78.98	80.03	85.19	**85.44**
VISOB	87.17	89.11	96.08	**96.35**

Results II

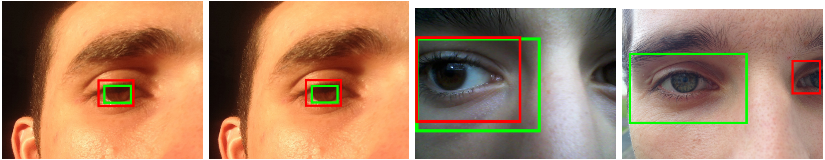
Table: Periocular region detection results obtained by using single and simultaneous detection approaches.

Databases	IoU			
	YOLO V2		Faster+FPN	
	Simultaneous	Single	Simultaneous	Single
CASIA-Interval	80.35	86.20	**94.77**	93.98
CASIA-Lamp	94.74	96.06	**97.47**	97.31
CASIA-Thousand	95.71	96.40	**97.72**	97.58
Cross-Eyed-VIS	85.73	86.40	90.39	**90.44**
CSIP	87.97	58.12	**91.61**	91.55
MICHE-I	80.32	72.07	86.27	**86.48**
MobBIO	91.52	91.40	**94.14**	93.79
NICE:II	83.39	84.83	**88.41**	78.20
PolyU-VIS	**93.81**	76.32	89.12	89.31
UBIRIS.v2	81.16	81.75	85.16	**85.26**
VISOB	85.04	81.32	**93.09**	92.80

Iris and Periocular Region Simultaneous Samples I

(a) Single-class (b) Two-class (c) Single-class (d) Two-class

Figure: Worst detections (in red) on the CSIP dataset regarding the ground truth annotations (in green).



(a) Single-class (b) Two-class (c) Single-class (d) Two-class

Figure: Worst detections (in red) on the MICHE-I dataset regarding the ground truth annotations (in green).

Contributions

- The review and study of the state-of-the-art
- More than $170,000$ coarse annotated images
- Was verified that the detection of the periocular region components was enhanced by using a simultaneous detection approach

Questions?

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http://www.inf.ufpr.br/drlucio/

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