Periocular Biometrics: Databases, Algorithms and Directions

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COST Action IC1106

Periocular Biometrics

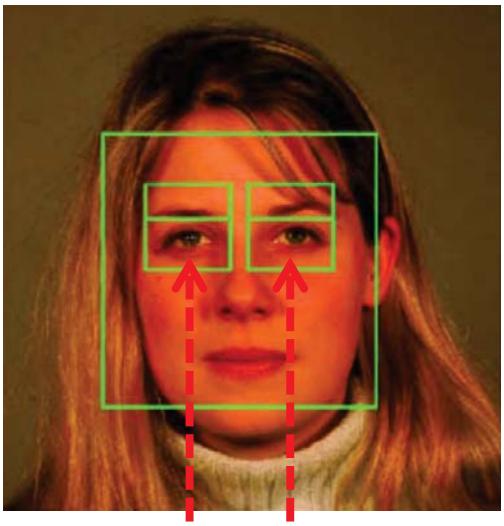
Key Issues

Features Used for Recognition

Existing Databases

Other Tasks (besides recognition)

Future Challenges



PERIOCULAR REGION
face region in the immediate vicinity of the eye
(including eyes, eyelids, eyelashes and eyebrows)

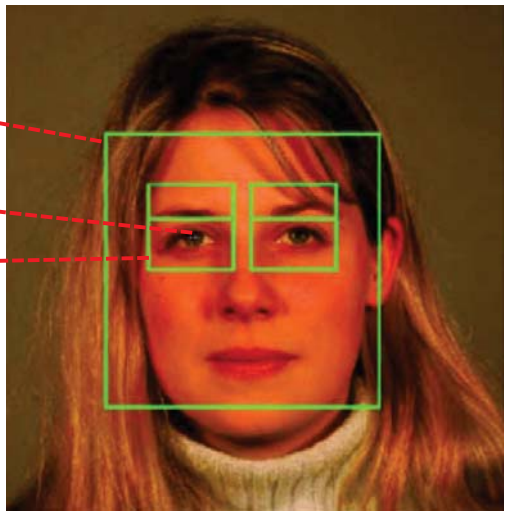
Periocular Biometrics

Levels of facial analysis

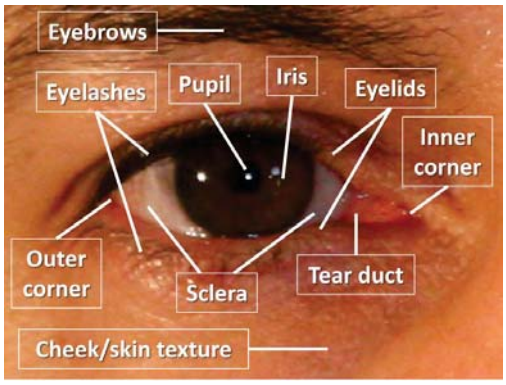
"Far": whole face

"Close": iris texture

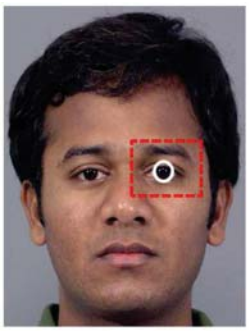
"Medium": periocular

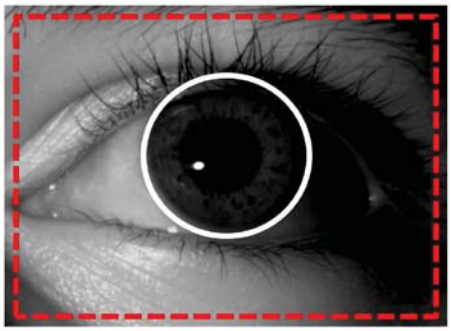


ELEMENTS OF PERIOCULAR REGION



Periocular Biometrics: Key Issues





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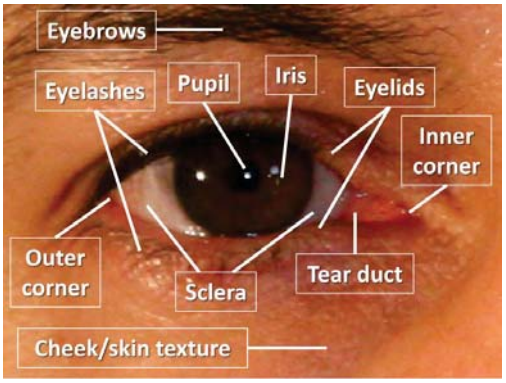
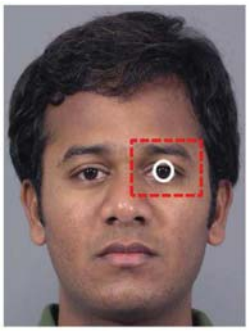
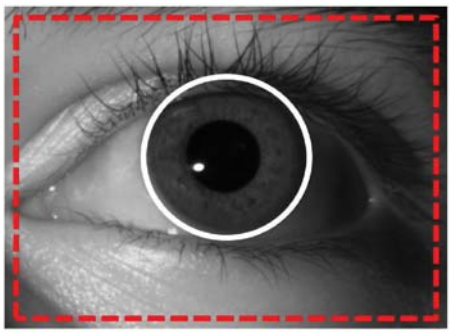


ACCURACY

- ❑ Emerged as an **independent modality**
- ❑ Surprisingly **high discrimination ability**
- ❑ It can **complement** face or iris, if available

Periocular Biometrics: Key Issues





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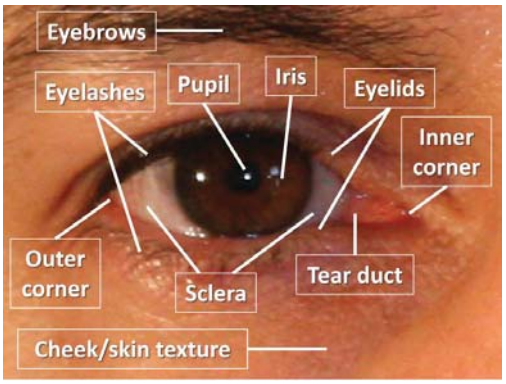
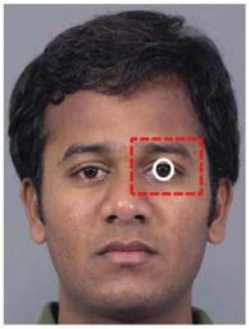
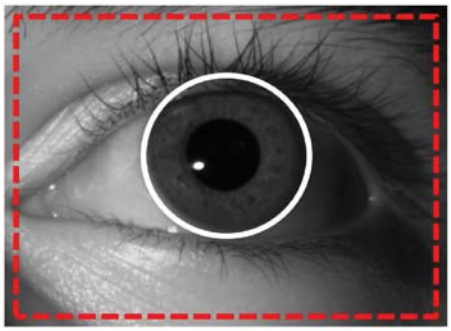


ACQUISITION

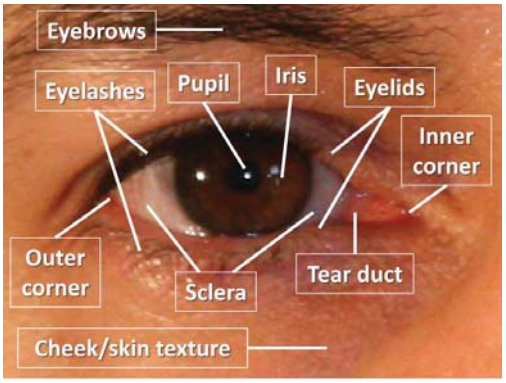
- ❑ Available over a wide range of **distances**
- ❑ Can be done with existing iris or face setups
- ❑ Interest boosted due to **social networks or surveillance**

Periocular Biometrics: Key Issues





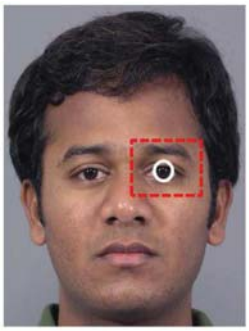
ELEMENTS OF PERIOCULAR REGION

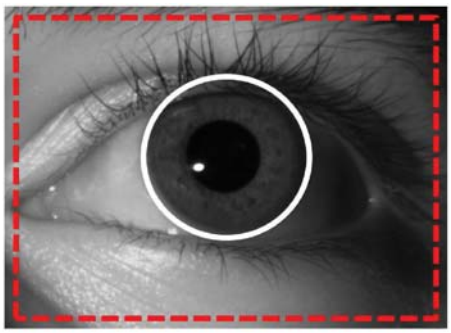


ROBUSTNESS

- ❑ More tolerant to **expression** changes, or **occlusion**
- ❑ Available under face occlusion or low resolution iris
- ❑ **No accurate location** required, as with iris
- ❑ Requirement of user **cooperation** can be relaxed

Periocular Biometrics: Key Issues





SMARTPHONES

ATM ROBBERY

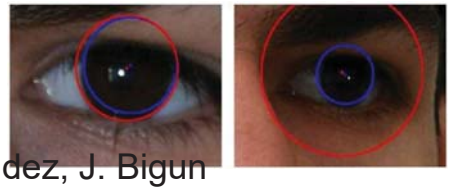
All this makes the periocular modality very suitable for **unconstrained biometrics**

- User's **own sensors** (smartphones, social networks)
- **Surveillance, Forensics**

"STOP & STARE"

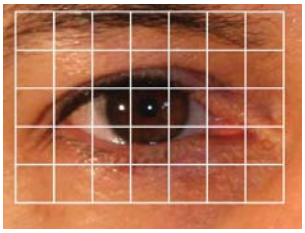
LONG DISTANCE

POOR IRIS SEGMENTATION

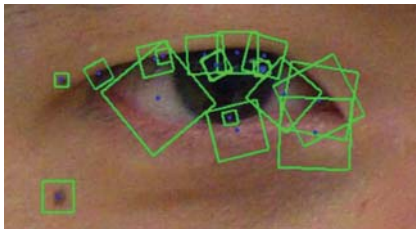


Periocular Biometrics: Recognition

"GLOBAL"



"LOCAL"



FEATURES EMPLOYED FOR RECOGNITION

GLOBAL

Textural

BGM	GIST	LPQ
BSIF	HOG, PHOG	NGC
CRBM	JDSR	PDM
DCT	Laws Masks	PIGP
DWT	LBP	SRC
Force fields	LMF	SRP
Gabor filters	LoG	Walsh masks

Shape
Eyelids
Eyebrows

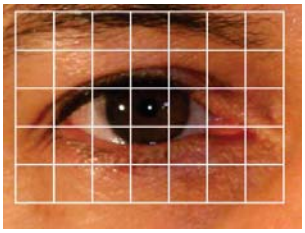
Color
LCH

LOCAL

BRISK
ORB
PILP
SAFE
SIFT
m-SIFT
SURF

Periocular Biometrics: Recognition

"GLOBAL"



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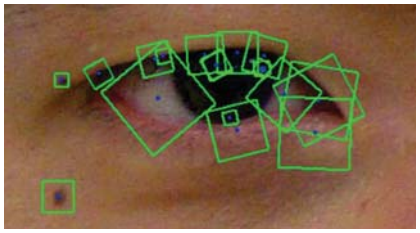

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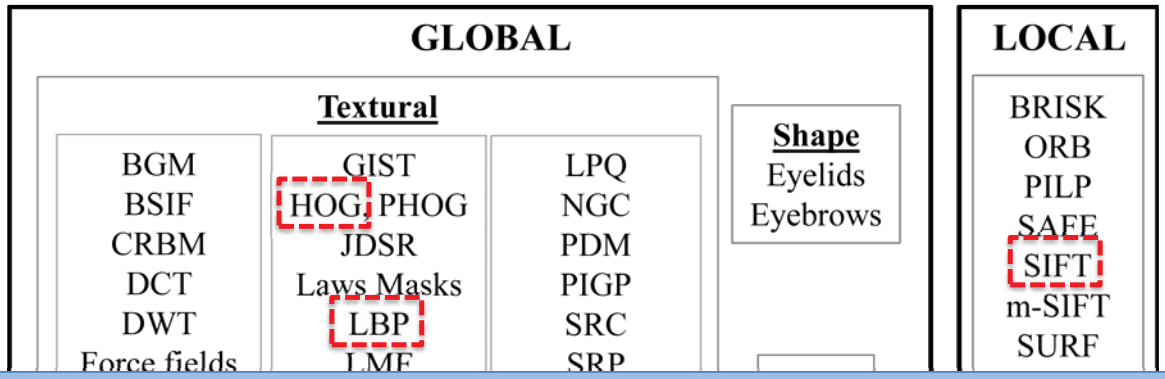


U. Park, A. Ross, A. Jain, Periocular biometrics in the visible spectrum: A feasibility study, in: Proc IEEE Intl Conf on Biometrics: Theory, Applications, and Systems, BTAS, 2009.

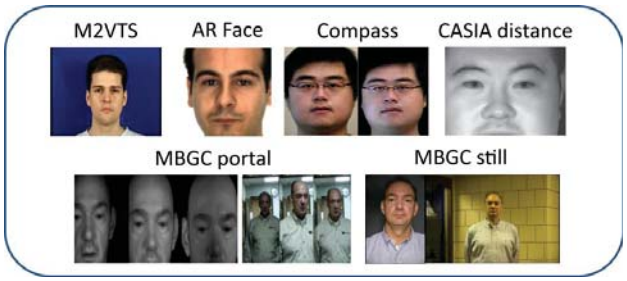
U. Park, R. Jillela, A. Ross, A.K. Jain, Periocular biometrics in the visible spectrum, IEEE TIFS, 6 (2011) 96–106

Periocular Biometrics: Databases

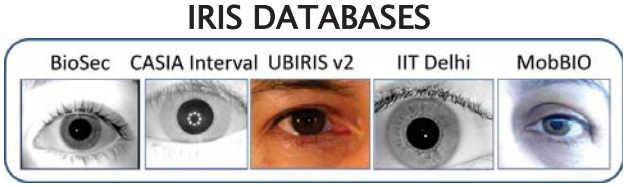
Most studies have taken existing face or iris databases, contaning:

- Still images & Videos…
- VW & NIR range…
- Variety of sensors…
  - ❑ Digital cameras
  - ❑ Webcams
  - ❑ Close-up iris scanners
  - ❑ Smartphones

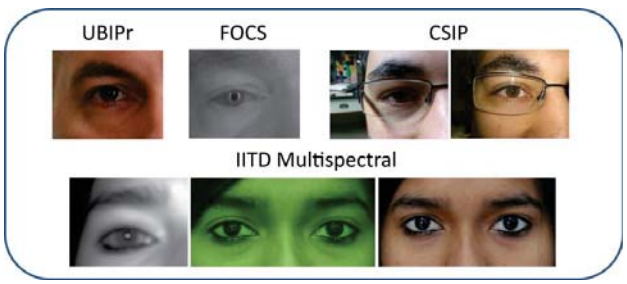
FACIAL DATABASES



IRIS DATABASES



PERIOCULAR DATABASES



Name	Subjects	Sessions	Data	Size	Illumination	Variability: Cross-spectr	Distance	Expression	Lightning	Occlusion	Pose	Best accuracy: EER	Rank-1
FACIAL DATABASES													
M2VTS [4]	37	5	185	286×350	V	N	N	Y	N	Y	Y	0.3%	n/a
AR [5]	126	2	4000	768×576	V	N	N	Y	Y	Y	N	n/a	76%
GTDB [6]	50	2-3	750	640×480	V	N	Y	Y	Y	N	Y	0.25%	89.2%
Caltech [7]	27	n/a	450	896×592	V	N	N	Y	Y	N	N	0.12%	n/a
FERET [8]	1199	15	14126	512×768	V	N	N	Y	Y	N	Y	0.22%	96.8%
CMU-H [9]	54	1-5	764	640×480	m	Y	N	N	Y	N	N	n/a	97.2%
FRGC [10]	741	1	36818	1200×1400	V	N	Y	Y	Y	N	N	0.09%	98.3%
MORPH [11]	515	2-5	1690	400×500	V	N	N	N	Y	Y	N	n/a	33.2%
PUT [12]	100	n/a	9971	2048×1536	V	N	N	Y	N	N	Y	0.09%	89.7%
MBGC v2 still [13]	437	n/a	3482	variable	V	N	Y	Y	Y	N	Y	0.20%	85%
MBGC v2 portal	114	n/a	628	2048×2048	N	Y	Y	N	Y	Y	N	0.21%	99.8%
	91	n/a	571	1440×1080	V							n/a	98.5%
Plastic Surgery [14]	900	2	1800	200×200	V	N	N	N	N	N	N	n/a	63.9%
ND-twins [15]	435	n/a	24050	600×400	V	N	N	Y	N	Y	Y	n/a	98.3%
Compass [16]	40	n/a	3200	128×128	V	N	Y	Y	N	Y	N	∼10%	n/a
FG-NET [17]	82	12	1002	400×500	V	N	Y	Y	N	Y	Y	0.6%	100%
CASIA Distance [18]	142	1	2567	2352×1728	N	N	N	N	N	N	N	n/a	67%
FaceExpressUBI [19]	184	2	90160	2056×2452	V	N	N	Y	Y	N	N	16%	n/a
IRIS DATABASES													
BioSec [20]	200	2	3200	480×640	N	N	N	N	N	N	N	10.56%	66%
CASIA Interval [18]	249	2	2655	280×320	N	N	N	N	N	N	N	8.45%	n/a
UBIRIS v2 [21]	261	2	11102	300×400	V	N	Y	N	Y	N	Y	9.5%	87.62%
IIT Delhi v1.0 [22]	224	1	2240	240×320	N	N	N	N	N	N	N	1.88%	n/a
MobBIO [23]	100	1	800	200×240	V	N	N	N	Y	N	Y	9.87%	75%
PERIOCULAR DATABASES													
UBIPr [24]	261	1-2	10950	var.	V	N	Y	N	Y	Y	Y	6.4%	99.75%
FOCS [3]	136	var.	9581	750×600	N	N	Y	N	Y	Y	Y	18.8%	97.75%
IMP [25]	62	n/a	620	640×480	N	Y	Y	N	Y	N	N	3.5%	n/a
			310	600×300	V								
			310	540×260	n								
CSIP [26]	50	n/a	2004	var.	V	Y	Y	N	Y	Y	Y	15.5%	n/a

'Illumination': V=VW, N=NIR, n=night, m=multispectral.
All databases have images, except M2VTS, CMU-H and MBGC v2 portal, which have videos.
'Best accuracy' is the best performance reported in the literature

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F. Al Public databases used in periocular research. 2016

Periocular Biometrics: Other Tasks

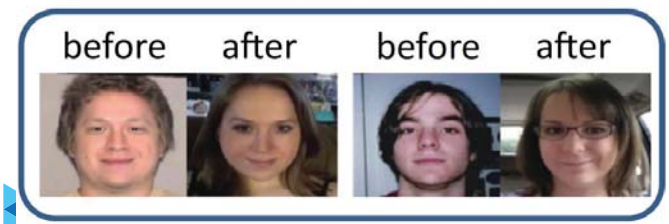
Soft-biometrics: classifying a person in broad categories to reduce search spaces

- Gender, ethnicity, age, height, hair color…
- Classification accuracy comparable to features from the entire face
- Additional information that can help to boost performance

Recognition before/after **plastic surgery or gender transformation**

- Periocular region outperforms other face components
- Full face matchers very sensitive to this type of changes

Gender transformation



Plastic surgery

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Periocular Biometrics: Conclusions and Challenges

Periocular biometrics has rapidly evolved to **competing with face or iris recognition**

- Uptake of face technologies in social networks, widespread use of surveillance cameras, forensics…

More tolerant than face to expression changes, blur, downsampling, occlusion or partial faces

- …which are prevalent in **surveillance or forensics**

Clearly superior to iris in difficult conditions (portals, far distance, smartphones, etc.) due to low res or VW lightning

- …which are prevalent in **relaxed or uncooperative setups**

Future issues include

- Large stand-off **distances** (surveillance)
- Matching of **heterogeneous data**
  - Cross-spectral, cross-modality: NIR iris vs. VW face
  - Cross-sensor: multiple cameras, own smartphones…
  - Exchange of data between agencies (forensics)

Periocular Biometrics: Conclusions and Challenges

F. Alonso-Fernandez, J. Bigun, "A Survey on Periocular Biometrics Research", Pattern Recognition Letters, in press

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