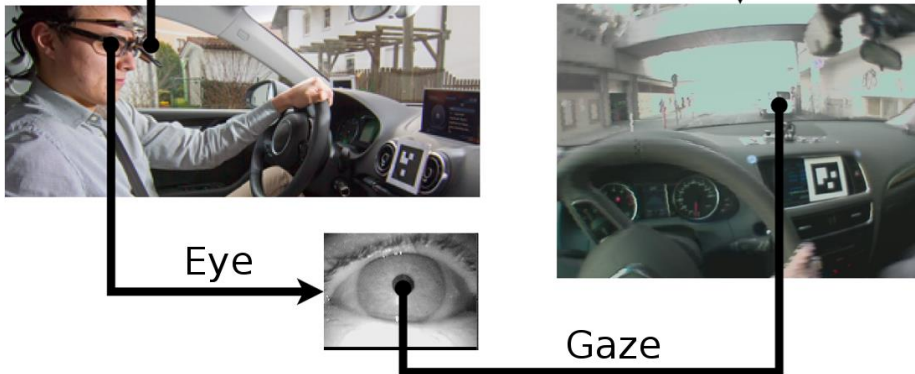


Evaluation of State-of-the-Art Pupil Detection Algorithms on Remote Eye Images

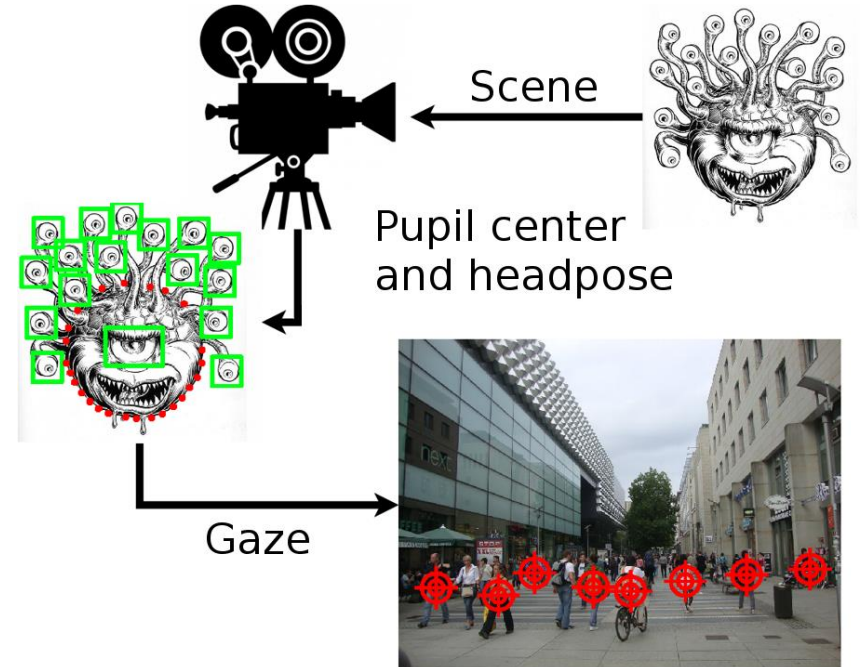


Motivation

Head mounted Scene



Remote





Motivation

Advantages remote eye tracking:

- Larger field of application
- Non-invasive (nothing attached to the subject)
- No restriction to the subject

New Challenges:

- Face detection
- Eye detection
- Head pose estimation
- Low resolution eye images



Data sets

BioID:

- 1521 grayscale images
- Resolution 384x286 pixel
- 23 subjects

O. Jesorsky, K. J Kirchberg, and Robert W. F. 2001. Robust face detection using the hausdorff distance. In Audio-and video-based biometric person authentication. Springer, 90–95.

GI4E:

- 1236 RGB images
- Resolution 800 x600
- 103 subjects

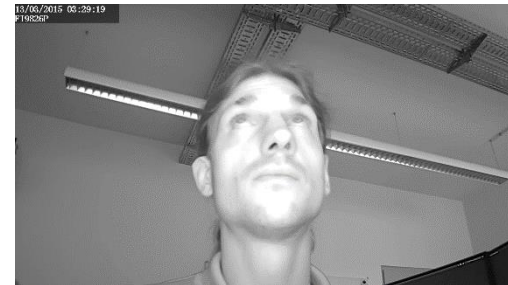
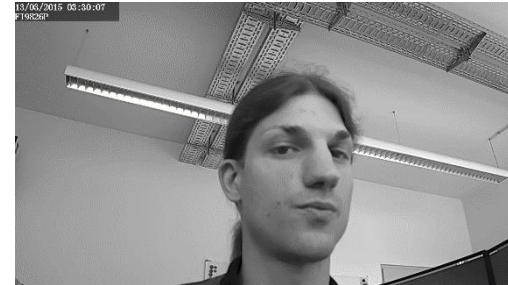
A. Villanueva, V. Ponz, L. Sesma-Sanchez, M. Ariz, S. Porta, and R. Cabeza. 2013. Hybrid method based on topography for robust detection of iris center and eye corners. ACM Transactions on Multimedia Computing, Communications, and Applications (TOMM) 9, 4 (2013), 25.



Data sets

New data set:

- 445 gray scale (infrared and converted from RGB)
- Resolution 1280x960
- 2 subjects
- Recorded in an office environment (FOSCAM FL9826P)





Data sets (challenges)

New data set:



Pupil covered
By reflection



Off-axial camera
perspective



Pupil
indistinguishable
from iris

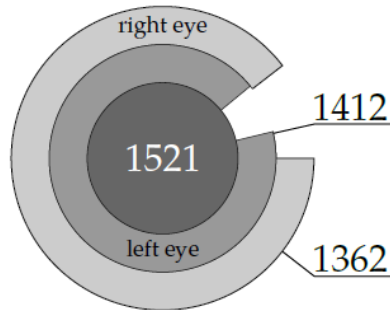


Bright pupil
effect

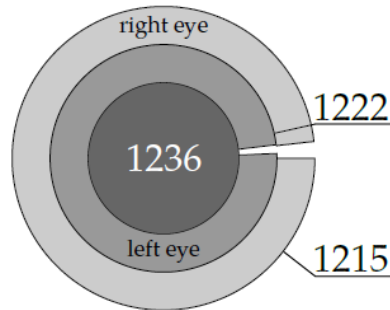


Data set comparison

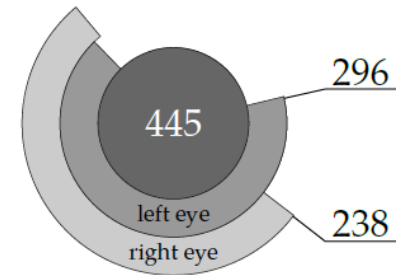
Eye detection rates of the OpenCV Haar Cascade (HC) for each data set.



BiID



GI4E



New data set



Evaluation procedure

Head mounted algorithms:

Swirski, ExCuSe, SET, EISE, Starburst

Remote algorithms:

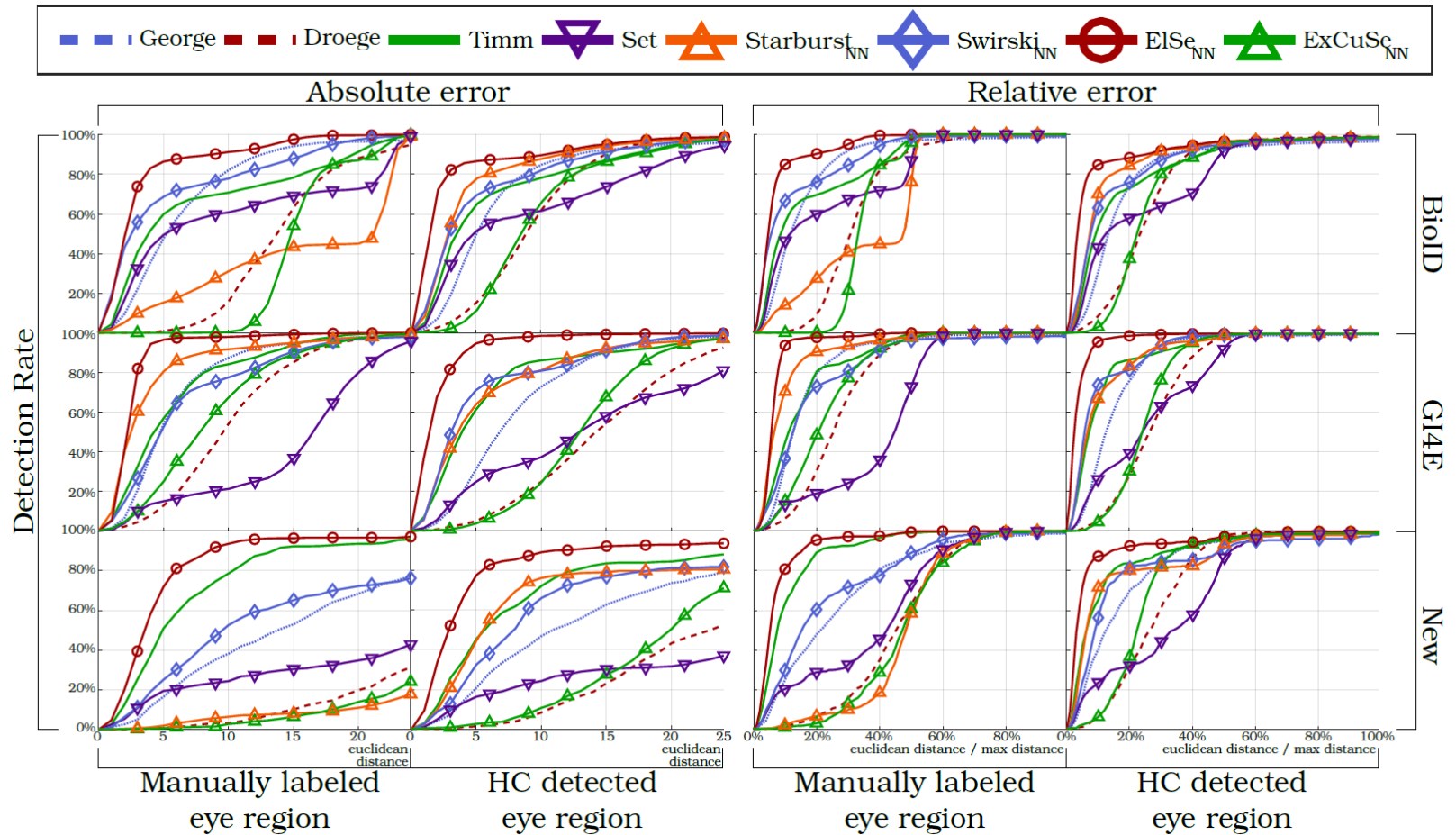
Droege and Paulus, Timm and Barth, George and Routray

Evaluation on labeled boxes and HC detected boxes.

	BioID		GI4E		New	
	Man. labeled	HC detected	Man. labeled	HC detected	Man. labeled	HC detected
Minimum	20x40	12x18	20.5x20.9	26x39	22x30	35.1x49.7
Maximum	20x40	35x52	26.7x44.9	42x62	47x99	79x118
Mean	20x40	21.2x31.8	22x31.2	30.1x45.2	24.5x60.8	49.8x74.5
Median	20x40	21x32	21.5x30.7	30x45	22x61	49x74



Results





Results

	BioID		Gl4E		New	
	Man. labeled	HC detected	Man. labeled	HC detected	Man. labeled	HC detected
George	0.772	0.884	0.794	0.760	0.479	0.703
Droege	0.096	0.739	0.304	0.283	0.066	0.316
Timm	0.696	0.823	0.806	0.867	0.891	0.838
SET	0.599	0.638	0.189	0.395	0.288	0.323
Starburst	0.273	0.915	0.904	0.835	0.066	0.802
Swirski	0.759	0.799	0.729	0.815	0.605	0.814
EISe	0.907	0.939	0.983	0.898	0.927	0.933
ExCuSe	0.011	0.796	0.484	0.311	0.037	0.065

Relative error of 20% (~15 pixel)



Conclusion

- New data set with 445 gray scale images (infrared, concerted)
- Data set contains normal and challenging images
- Comparison of data sets based on HC detection rate
- Comparison of head mounted and remote algorithms
- Evaluation on labeled and detected(HC) eye boxes



Thank you for your
attention!