Iris recognition from low resolution photographs

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Introduction: Iris recognition

Pioneer: John Daugman

Useful because:

- Epigenetic trait
- Template aging problem
- Speed
- Ubiquity

Introduction: Algorithm

```
result = (A ^ B) & C & D;
```

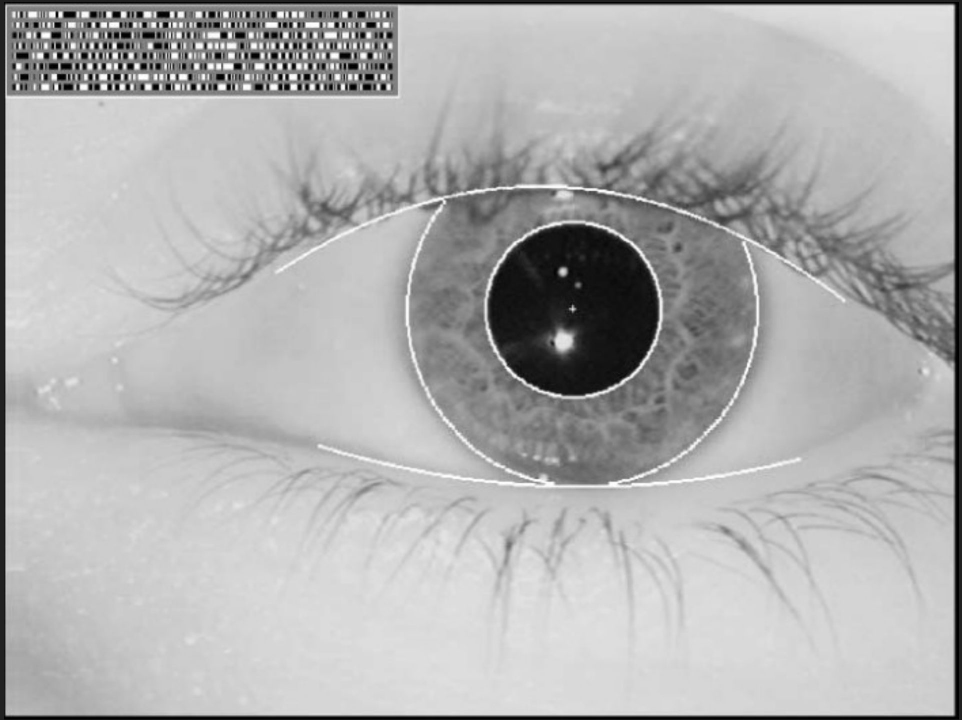
Detect iris using Hough transform

Mask for missing portions of the iris

Unroll using “rubber sheet model”

Create iris code using Gabor wavelets

Compare iris code with hamming distance



J. Daugman, “How Iris Recognition Works,” Essent. Guid. to Image Process., vol. 14, no. 1, pp. 715–739, 2009.

Introduction: Low resolution

Iris Recognition with a Database of Iris Images Obtained in Visible Light Using Smartphone Camera

Mateusz Trokielewicz, Ewelina Bartuzi, Kasia Michowska, Tosia Andrzejewska, Monika Selegrat

Reconstruction of Smartphone Images for Low Resolution Iris Recognition

Fernando Alonso-Fernandez, Reuben A. Farrugia, Josef Bigun

Research question

How does iris recognition perform when presented with near-infrared photographs taken at a distance compared to visible light images taken at a distance?

- How accurately can irises be identified in photographs taken in the visible light spectrum?
- How does distance to the camera affect the accuracy of iris identification in photographs taken in the visible light spectrum?
- How accurately can irises be identified in photographs taken in the near-infrared spectrum?
- How does distance to the camera affect the accuracy of iris identification in photographs taken in the near-infrared spectrum

Methodology: experiments

Matlab open source implementation of first Daugman algorithm

All experiments are done on a dataset of photographs and photos taken of my own irises.

Awkward moments

Methodology: experiments

Matlab open source implementation of first Daugman algorithm

All experiments are done on a dataset of photographs and photos taken of my own irises.

- Establish a baseline for both visible light and near-infrared light
- Take photo’s at a distance / simulate distance by blurring dataset photos
- Do this for both spectrums
- Run tests on new photos and compare results.

Methodology: Dataset

Warsaw Biobase Smartphone Iris v1

- Iphone 5S
- Visible light
- 68 persons
- 2 sessions
- Both left and right eye
- Varying number of photographs per session, per eye

Methodology: Camera

Trust spotlight pro

- Manual focus
- 1.3 megapixel
- Supposedly easy to take out IR-filter

Results: missing values

Missing values and usable values for each experiment

	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8
Failed measurements	0	283	10	510	1	125	58	266
Total comparisons	20	1400	100	1400	20	700	100	700
Usable measurements	20	1183	90	890	19	575	42	444

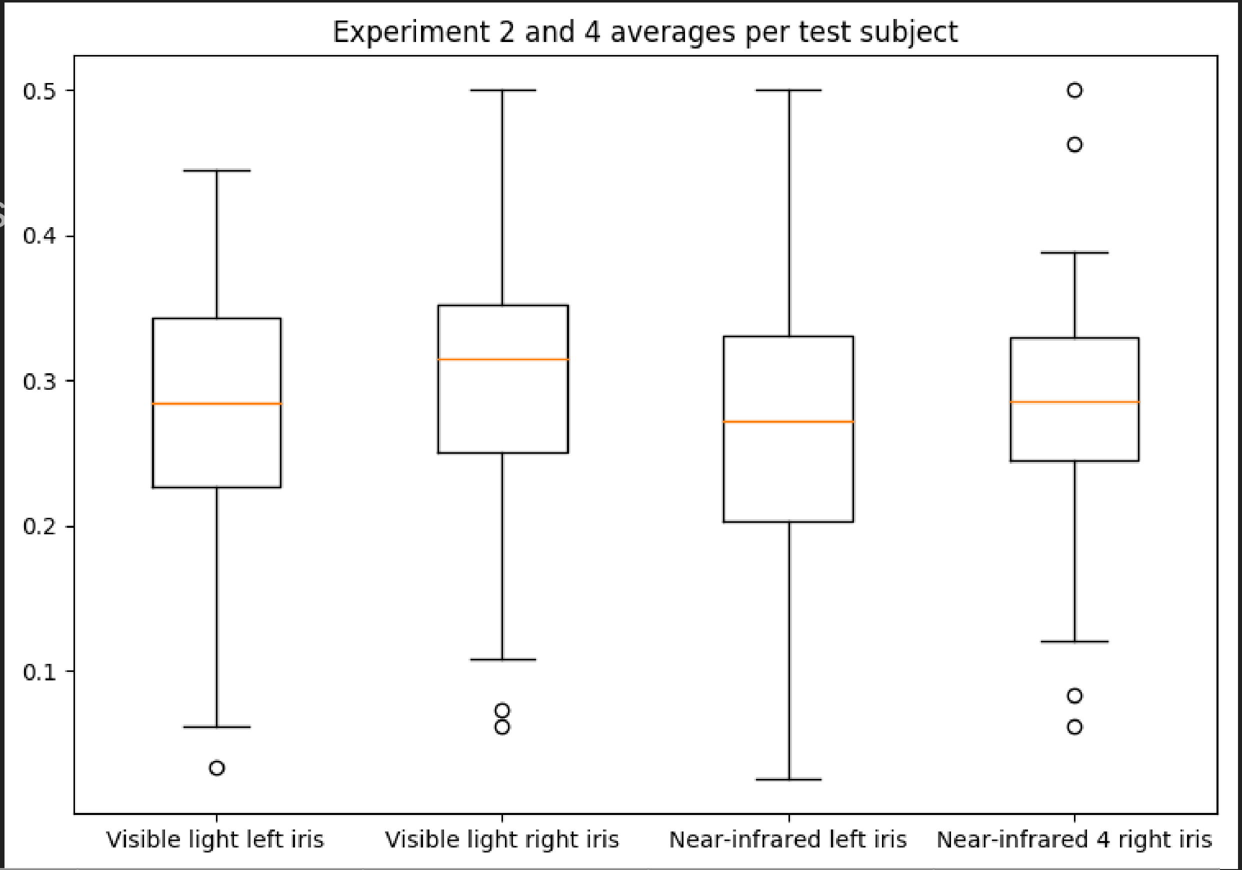
Results: self close-ups

Averages of comparisons between self photographs

	Visible light	Near infrared light
Left eye	0.391	0.349
Right eye	0.450	0.409

Results:

Averages of comparisons between photographs of the same iris



Averages:	0.283	0.299	0.268	0.291

Results:

Averages of self-photographs compared with self-photographs taken at a distance

	10cm	20cm	30cm	40cm	50cm	60cm	70cm	80cm	90cm	100cm
Left eye visible light	0.433	0.457	0.424	0.450	0.420		0.430	0.469	0.429	0.478
Left eye IR light	0.428	0.404		0.429	0.439		0.389		0.404	
Right eye visible light	0.427	0.422	0.410	0.455		0.420	0.432	0.440	0.463	0.455
Right eye infrared light		0.426		0.428	0.415		0.429	0.466	0.387	

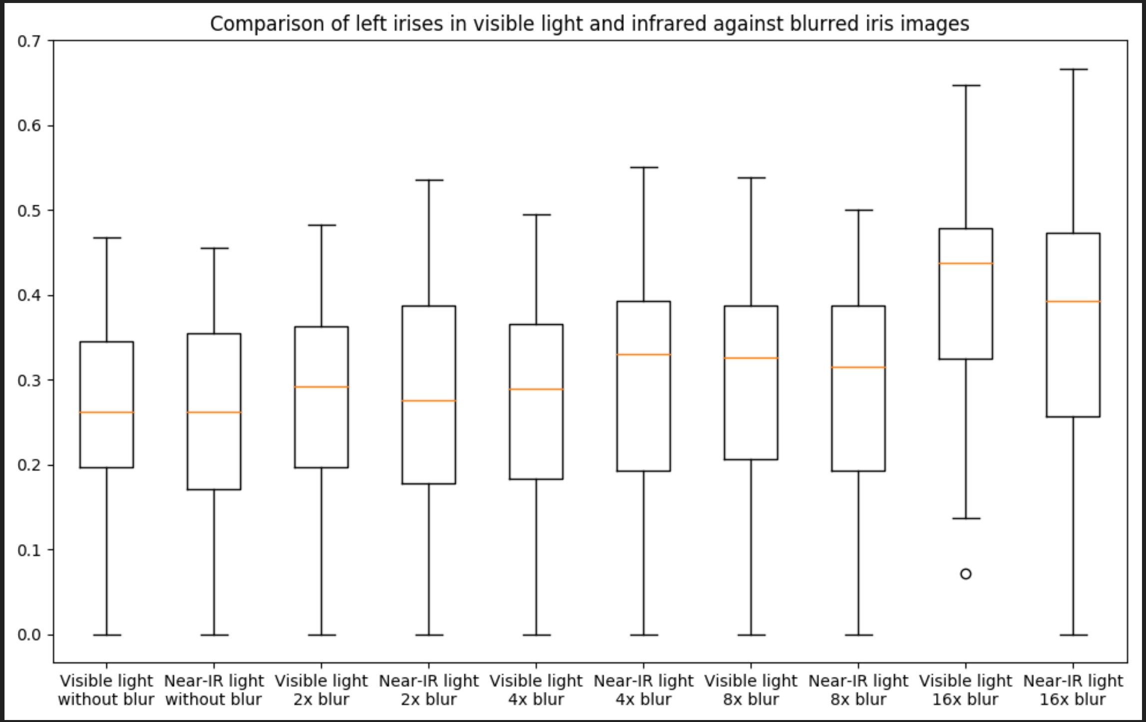
Results:

Averages of iris photograph comparison with iris photographs that are blurred to simulate distance

	Original	2x blur	4x blur	8x blur	16x blur
Left eye visible light	0.259	0.276	0.277	0.315	0.404
Left eye IR light	0.251	0.264	0.294	0.273	0.316
Right eye visible light	0.297	0.314	0.293	0.310	0.362
Right eye infrared light	0.286	0.299	0.281	0.289	0.285

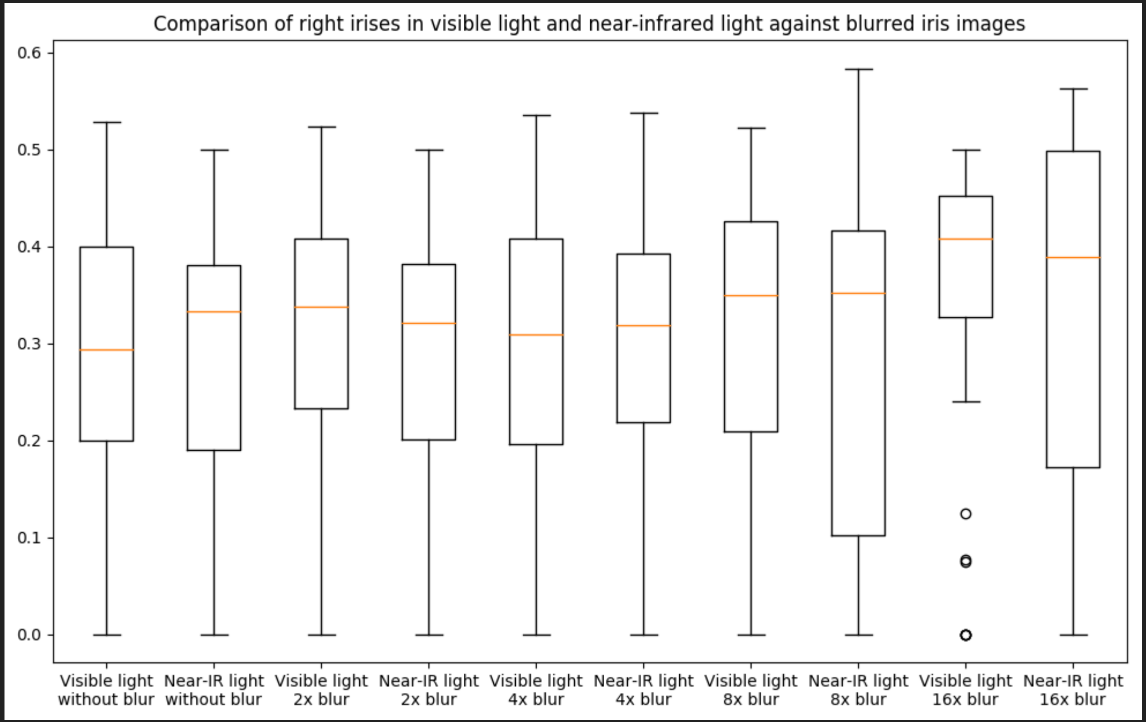
Results:

Absolute values of left irises compared to iris photographs blurred to simulate distance



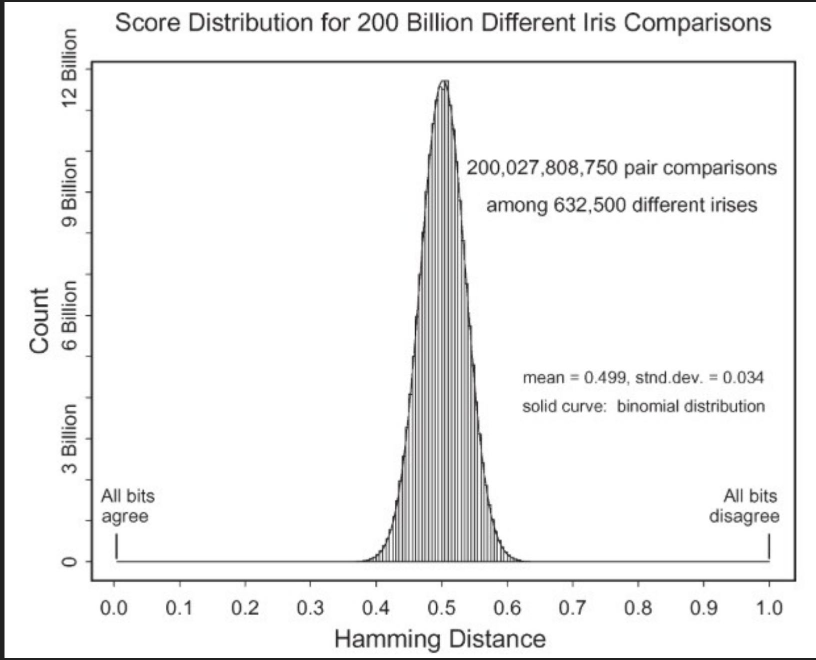
Results:

Absolute values of right irises compared to iris photographs blurred to simulate distance



Discussion

- Self-photographs likely indicates an image too poor for identification
- Red light does seem to offer slight improvement in recognition
- Specular reflection likely plays a larger role in real life scenarios
- Dataset was taken from specific demographic



J. Daugman, "New methods in iris recognition," IEEE Trans. Syst. Man, Cybern. Part B Cybern., vol. 37, no. 5, pp. 1167–1175, 2007.

Conclusion

Very low quality sensors are not suitable for iris recognition

A smartphone camera can do iris recognition at a moderate distance

Iris recognition can be done in visible light

Red light improves matching accuracy slightly

No conclusions can be drawn about the difference between gaussian blur and real physical distance

Future work

Ruling out identity instead of verifying identity

More ideal dataset

Exact research on the best wavelength for iris recognition

Converting iriscode back to an iris

Thank you for your attention