Eye Region Detection by Likelihood Combination for Improving Iris Authentication

Master-Double Degree Program

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3. Eye Region Detection
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6. Conclusion

1. Abstract

We proposed a new eye region detection method to improve iris authentication using the likelihood combination.

1. The likelihood images are created by AKAZE feature matching and Template matching.
2. The cut eye region image obtained from likelihood combination method is given as input to an iris authentication system.
3. We perform the analysis of the proposed eye region detection method using the public dataset (CASIA-v4-Distance).

2. Introduction

Person identification is considered as an important issue to achieve a safe and secure society.

- For person identification purpose, the person's possession of token(key or ID card), possession of knowledge(password) and biometrics are used.
- Biometrics has been popular as a reliable identity management system since only the user oneself is necessary for authentication.
  - A biometric system provides automatic recognition of an individual based on unique features or characteristics possessed by the individual.
  - Some Examples of biometrics are DNA, fingerprint, face, retina, iris, gait, keystroke, signature and so on.

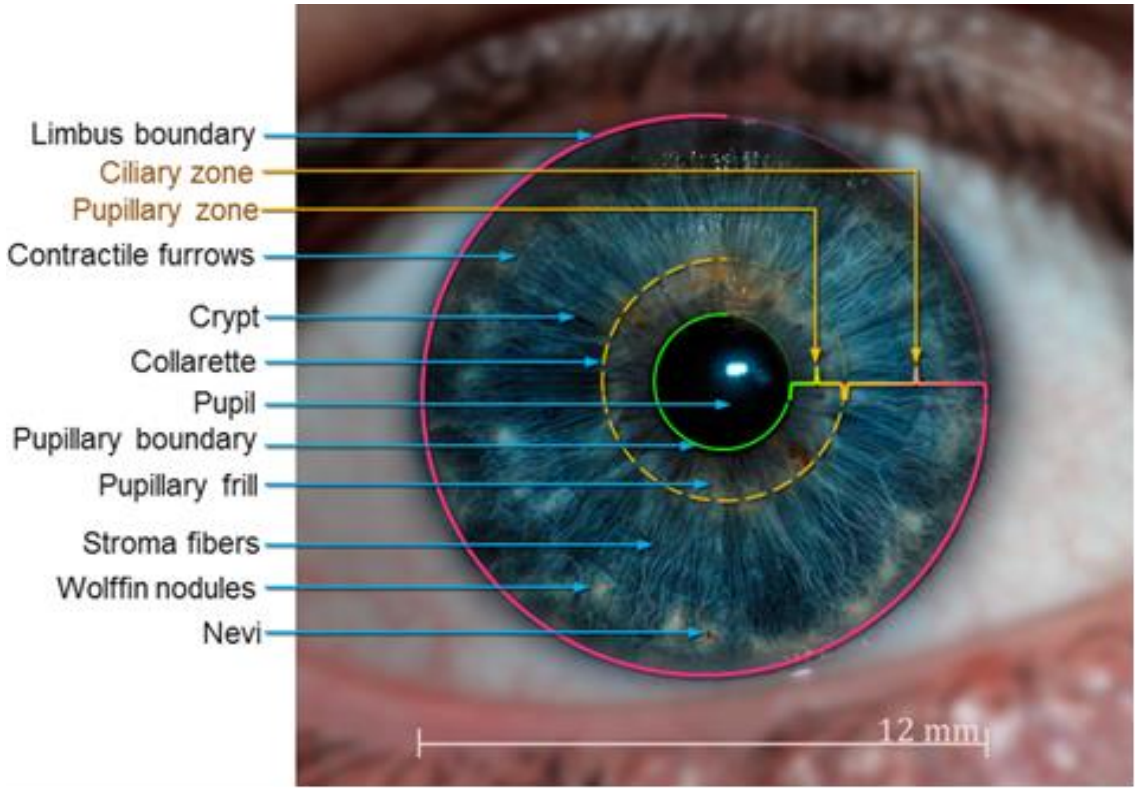
Comparison of Some Biometric traits

Features	Biometric Traits	Permanence	Performance
Behavioural features	Gait	Low	Low
	Signature/ Hand writing	Low	Low
Physiological features	Fingerprint	Medium	Medium
	Palm print	Medium	Medium
	Face	Medium	Low
	Retina	High	High
	Iris	High	High

Biometric Features

What is IRIS?

- **Iris** is an externally visible internal organ protected by eyelid, eyelash and cornea.
- The human iris is the annular part between pupil and sclera and iris has texture features.



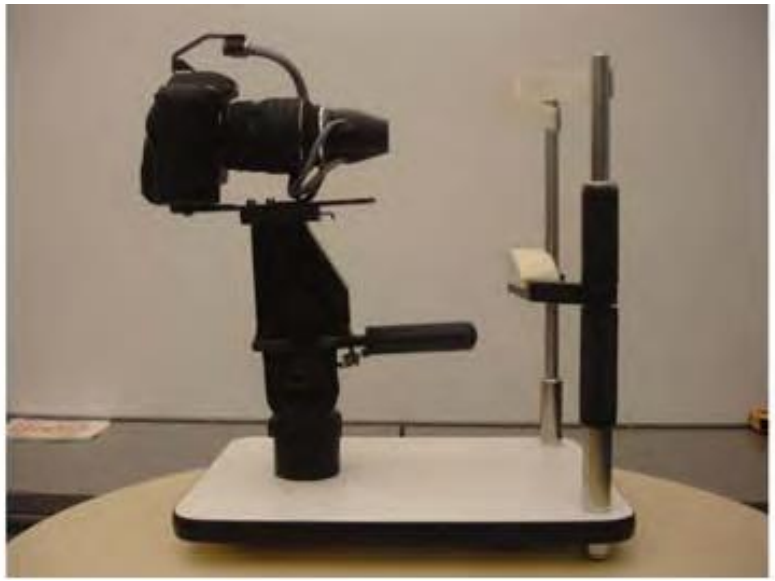
A sample Iris image

Iris Recognition

- Biometric technology
- Unique features
- Rarely hurt
- Safe, reliable and convenient
- Widely used

Constrained Environment

- The users are **constrained** to stay at a fixed location of the head and starring at a spot.
- The iris images are captured at a fixed short distance and fixed arranged lighting condition.
- The resulting images taken under such environment have very good quality.

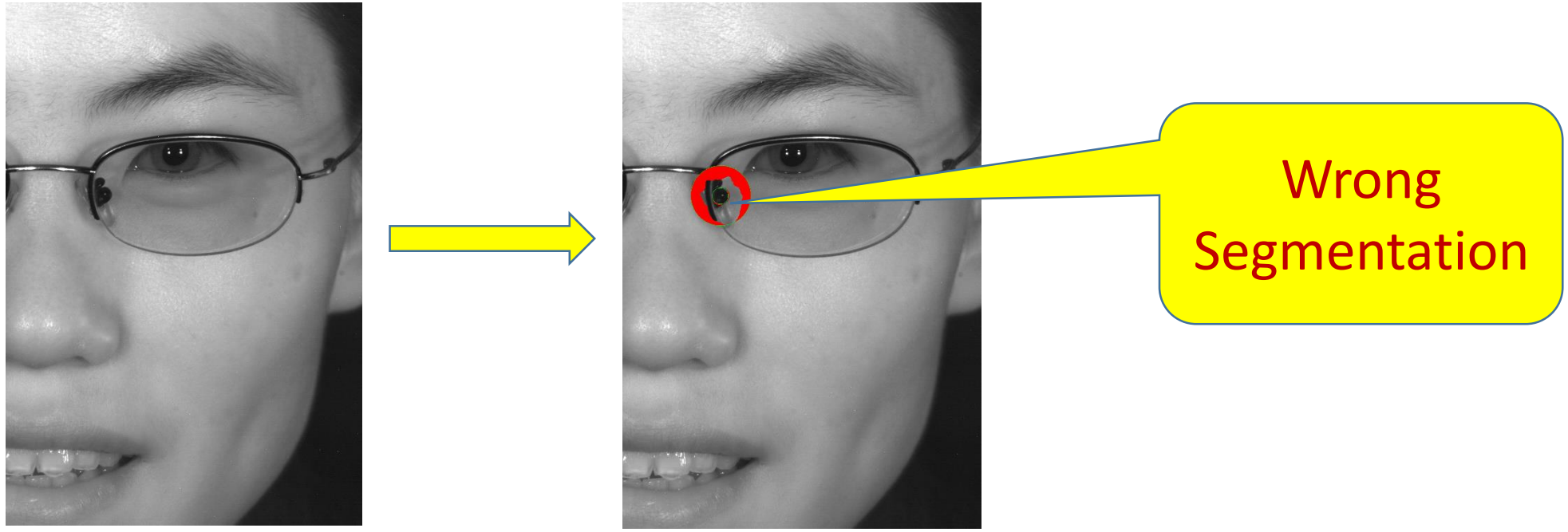


Less Constrained Environment

- Few constraints are imposed on the users.
- The freedom of user's movement and position lead to differences in resolution, illumination and eye poses.
- These images have suffered from blurring, specular reflection especially on the glasses, so the quality of image is **worse**.

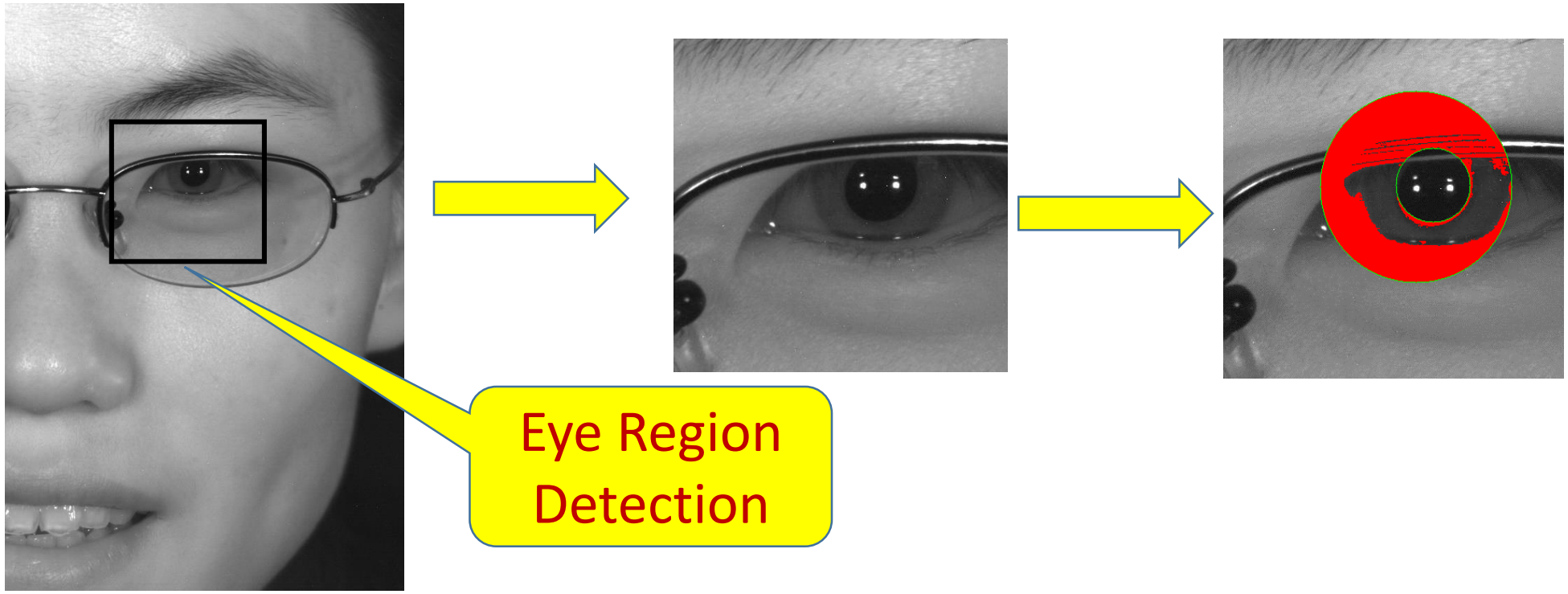
Problem

For images taken under less constrained environment, the segmentation procedure tends to segment the iris wrongly on other organs from the face.



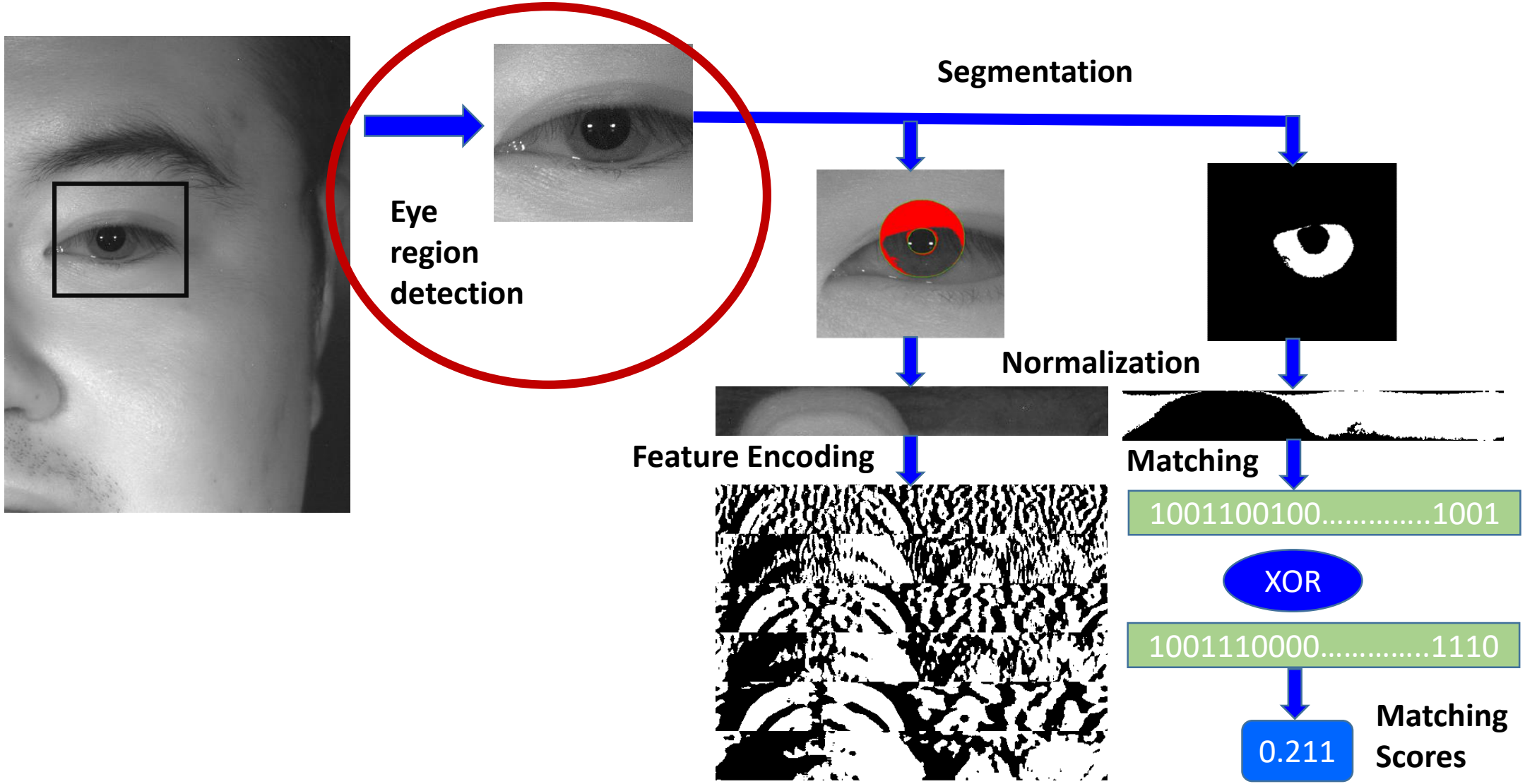
Solution

We added an eye region detection stage before iris segmentation and the eye region is detected using likelihood combination method.



3.Eye Region Detection

The Overall System

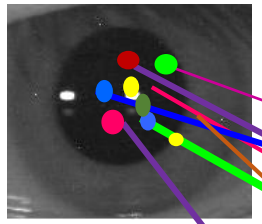


Eye Region Detection

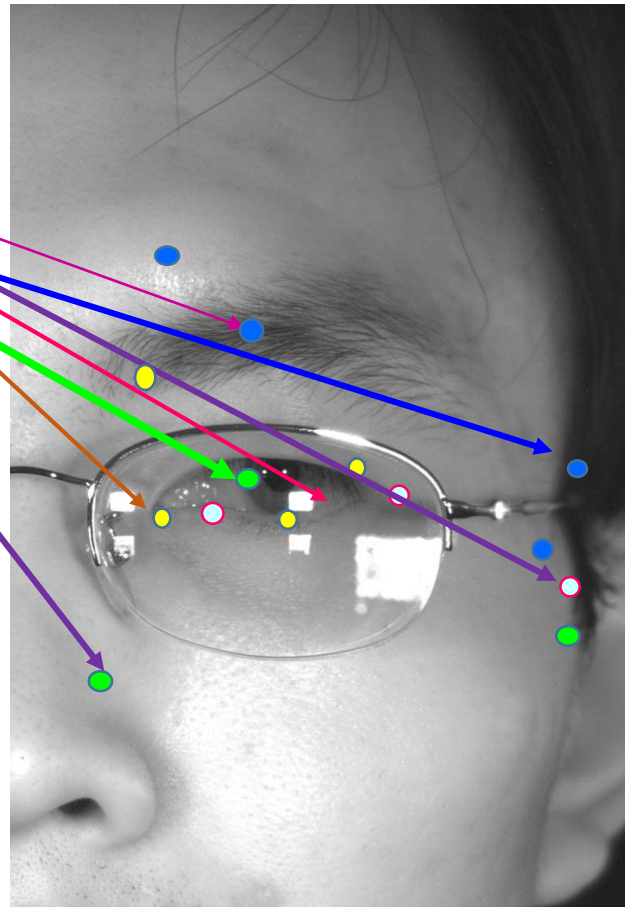
- We firstly divide the face images into left and right half face images.
- For each half face images, we apply
    1. **AKAZE feature matching**
    2. **Template matching**

to build likelihood images based on the correlated, matched feature points.

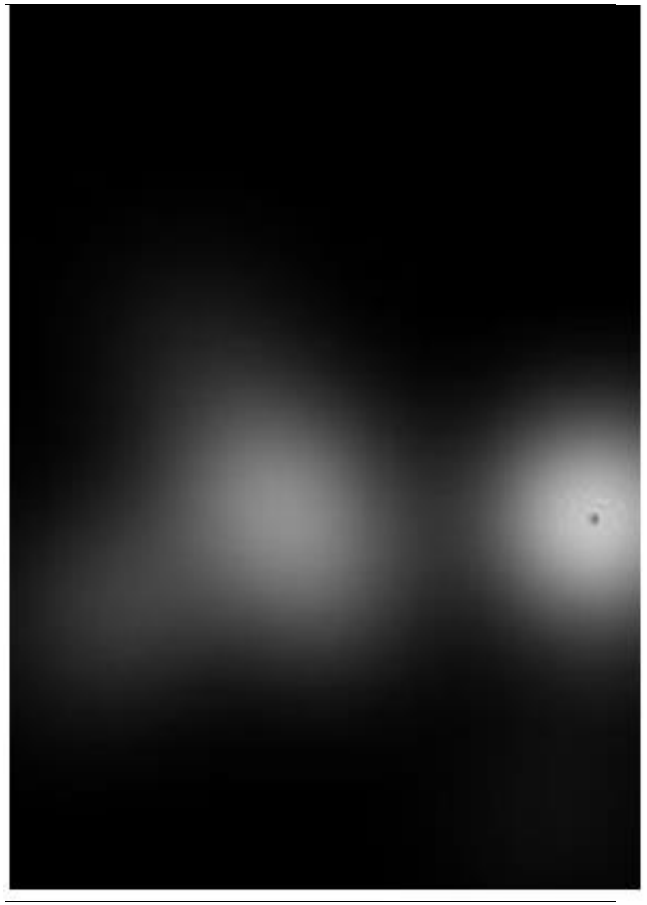
AKAZE Feature Point Detection



Sample Eye Image



Feature point detection by AKAZE



Likelihood image by AKAZE

Likelihood Creation by AKAZE

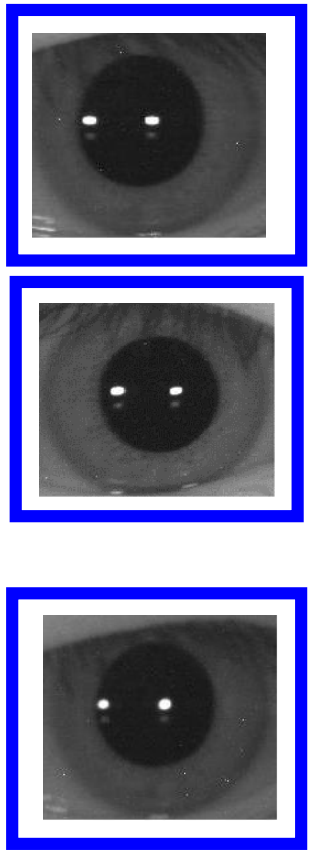
Gaussian Distribution Weight

Let F = $\{f_i\}$ be the set of the coordinate of correlated feature points.

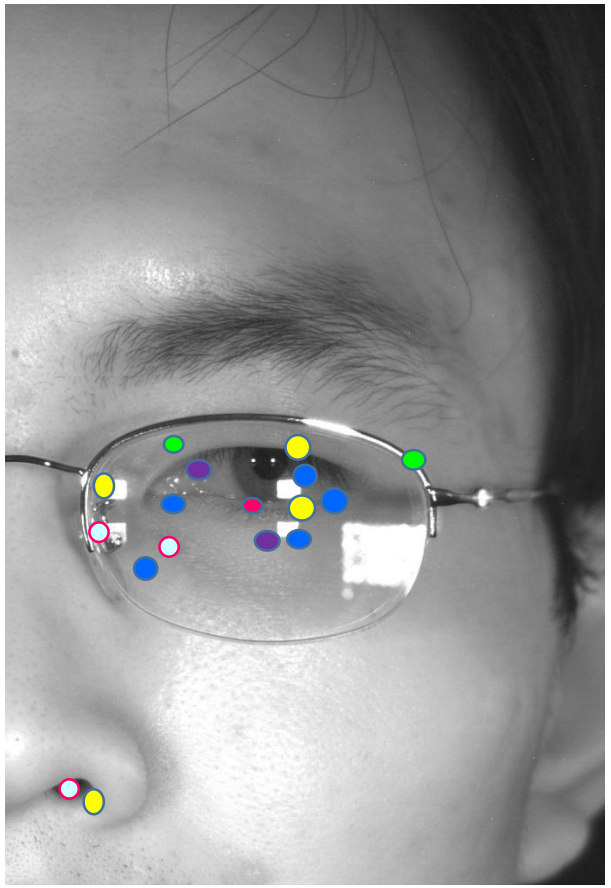
$$L(x) = \exp[\frac{(x - f_i)^2}{2\,\sigma^2}]$$

where σ is the standard deviation(we set σ = 250), x is the pixel coordinate.

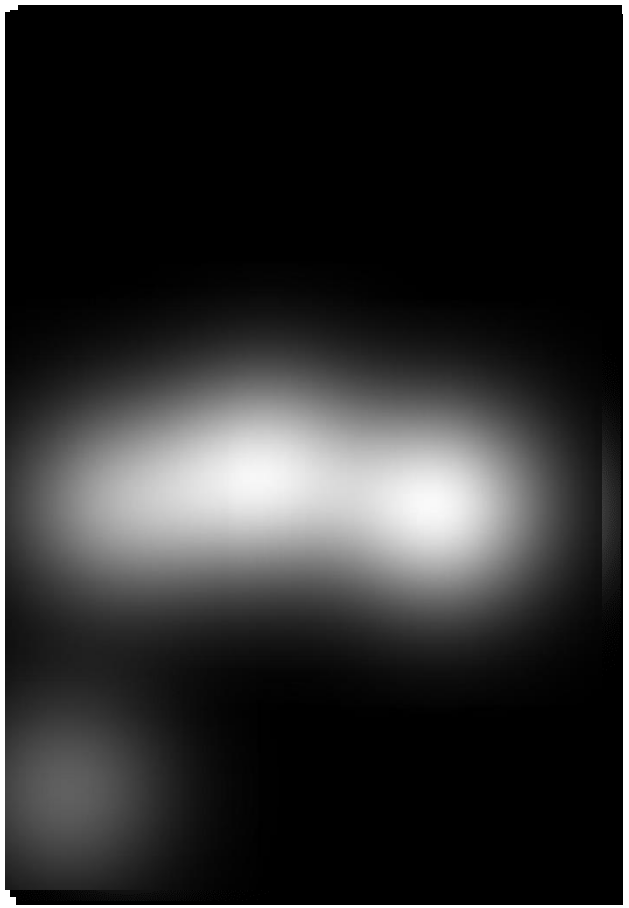
Likelihood Creation Template Matching



Template Images



Template matching



Likelihood Image

Location of feature points at different regions

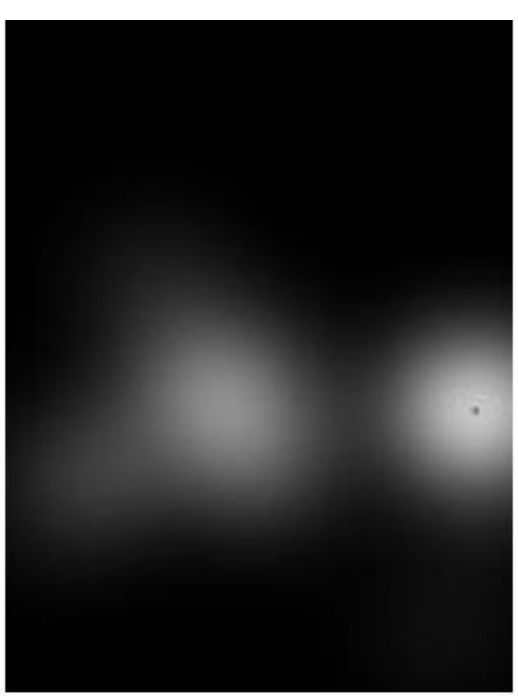
AKAZE feature matching and Template matching locates matched points on different regions.

Regions	AKAZE feature points	Template matched points
Near rim	-	3
Nose pad	4	-
Pad arm	5	-
Nostril	1	-
Nose	2	-
Eyebrows	-	2
Forehead	-	1
Iris	4	5

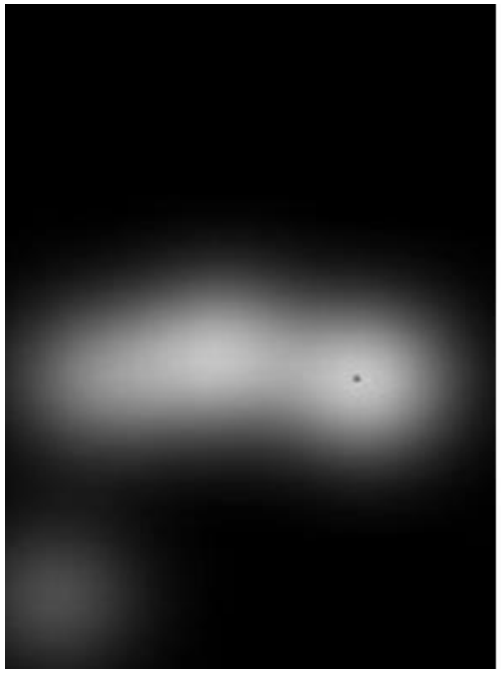
Likelihood Combination

- For some cases, both method indicates the eye region as the second highest peak in the likelihood images.
- Combining two second highest peaks can generate a highest peak.
- We combine AKAZE and Template matching likelihood images to be more correctly detected the eye region.

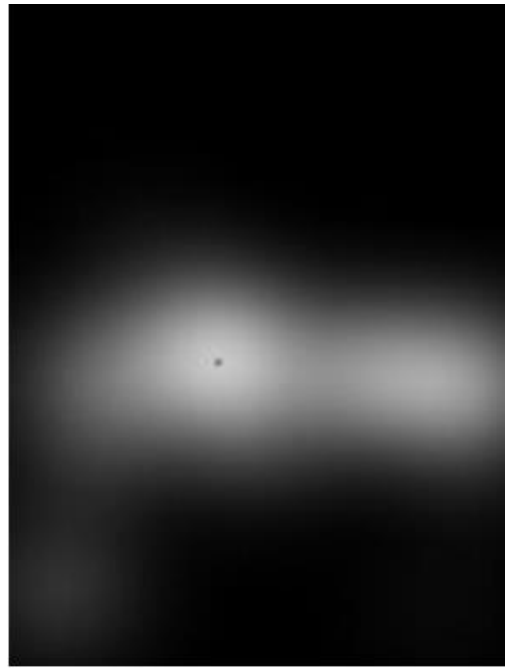
Likelihood Combination method



AKAZE



Template matching

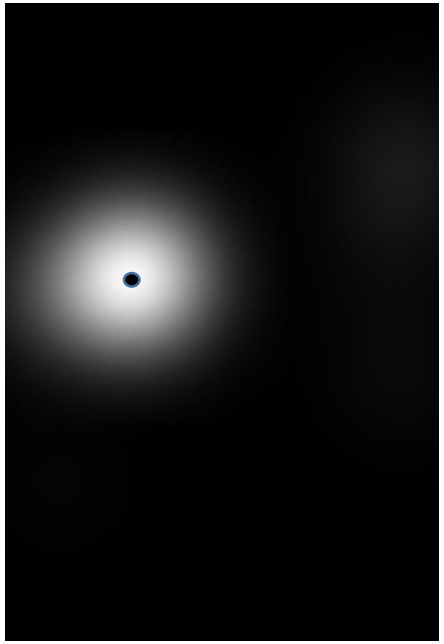


Combined Likelihood

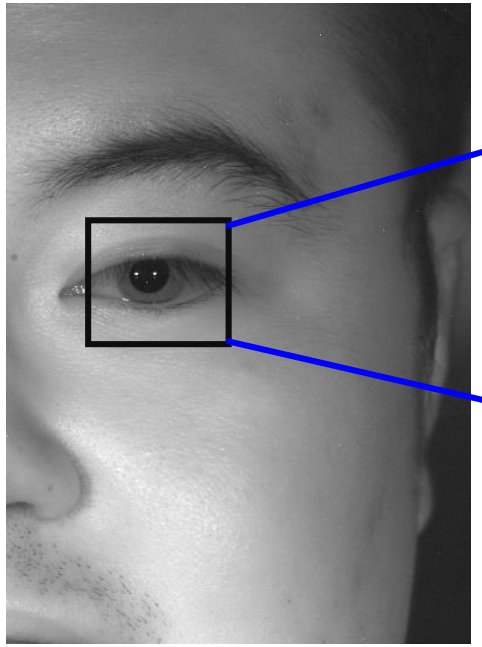
The likelihood images

Cut Image from Combined Likelihood

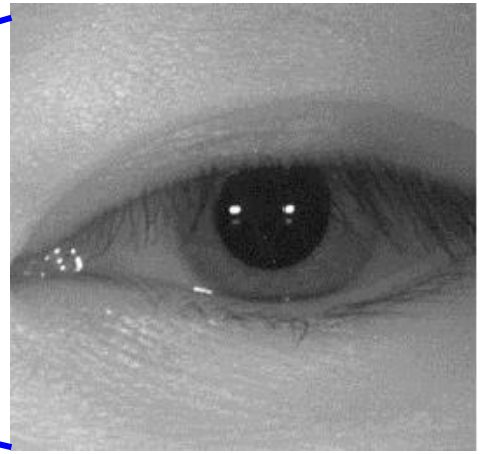
- Maximum location in the combined likelihood image.
- fixed size (400 × 400)



Combined Likelihood Image



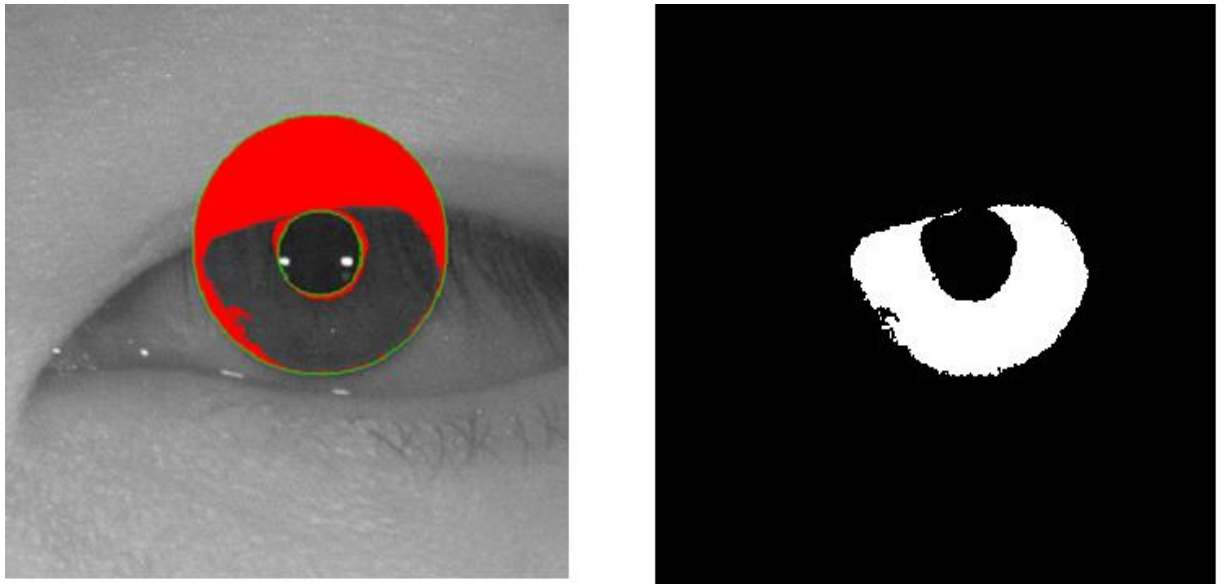
Original Image



The cut image

Iris Segmentation

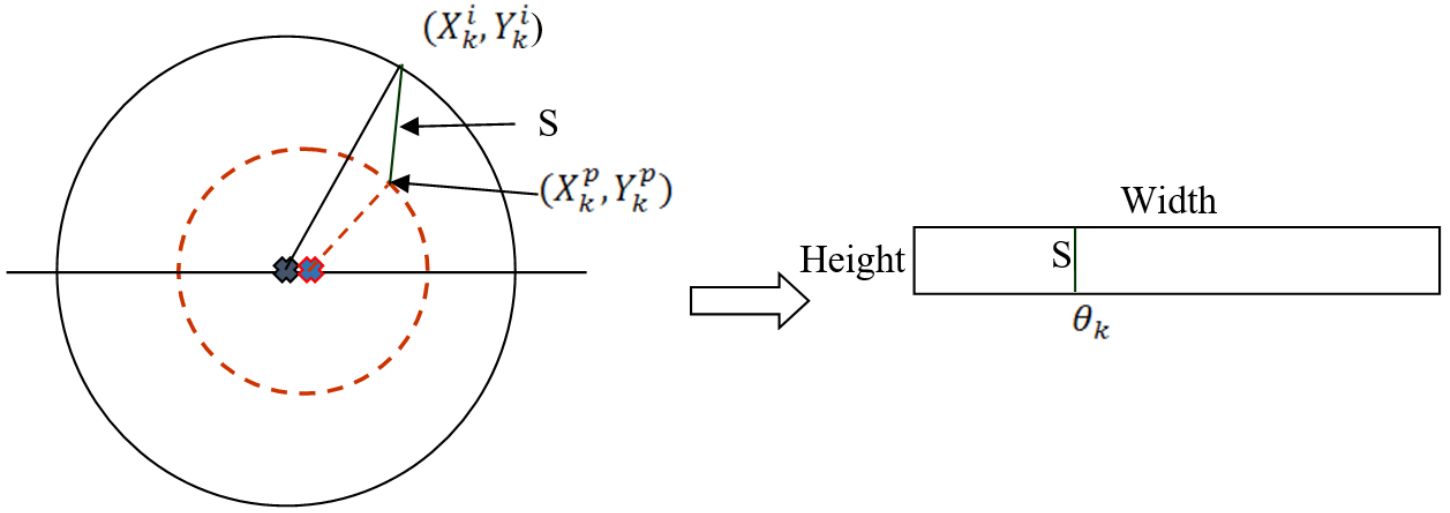
- The segmentation stage aims at finding accurate contours of iris, that is inner boundary (pupil/iris) and outer boundary (iris/sclera).
- The pupil is localized by two criteria: “pupil is the disc shape black area” and “iris has circular edge contours”.



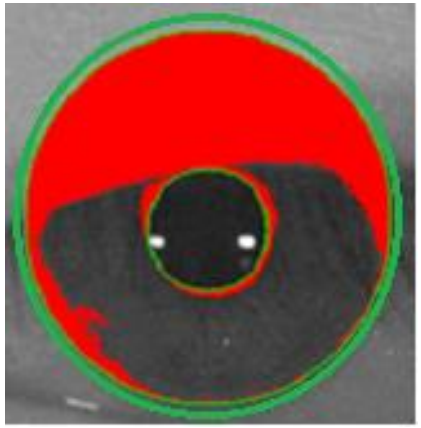
An example of iris segmentation result

Normalization

- The iris texture is transformed from Cartesian to polar coordinates with fixed radial and angular resolutions.
- The Daugman's rubber sheet model is applied for normalization.



Normalization

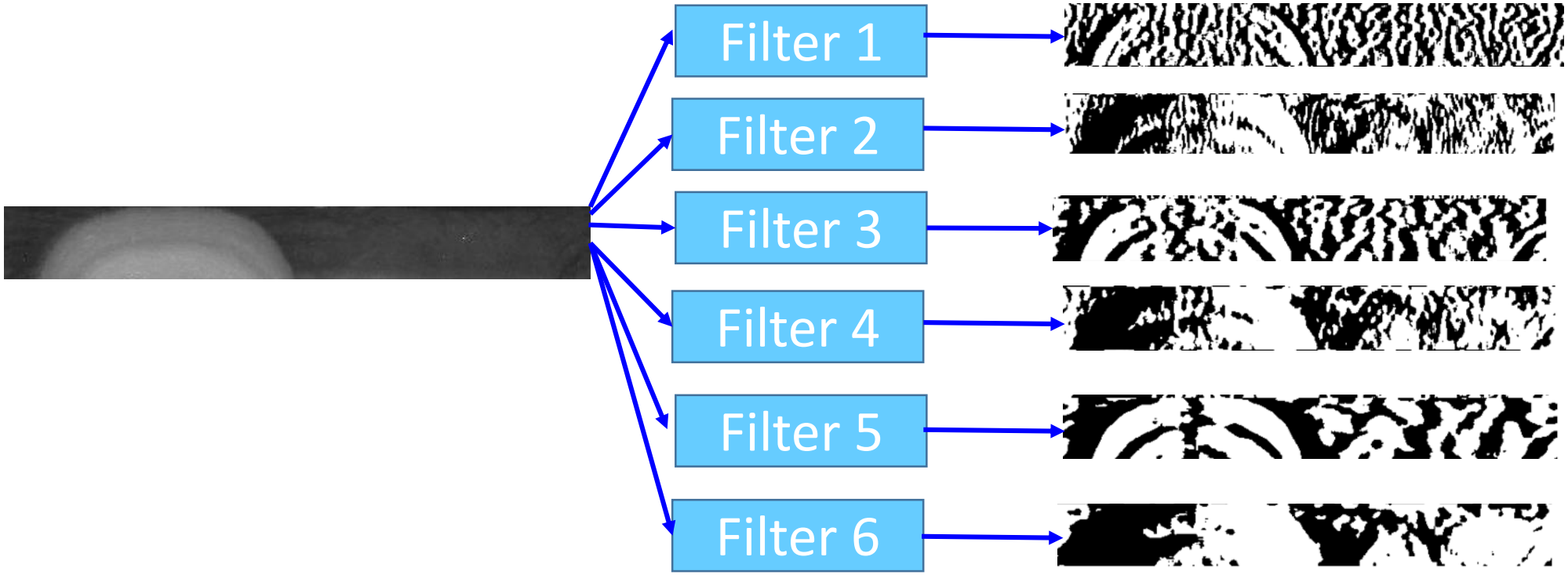


A normalized iris Image

A normalized mask

Feature Encoding

Features such as iris textures are extracted by a bank of the Gabor filters which is customizable in orientation and resolution.



Matching

Two eyes are compared using the Hamming distance between their iris codes.

The Hamming distance gives a measure of how many bits are the same between two bit patterns

$$HD = \frac{1}{N} \sum_{j=1}^{N} X_j (XOR)\, Y_j$$

XOR

1001100100……1001

XOR

1001110000……1110

0.211

Experiment Results

4. Experiment Results

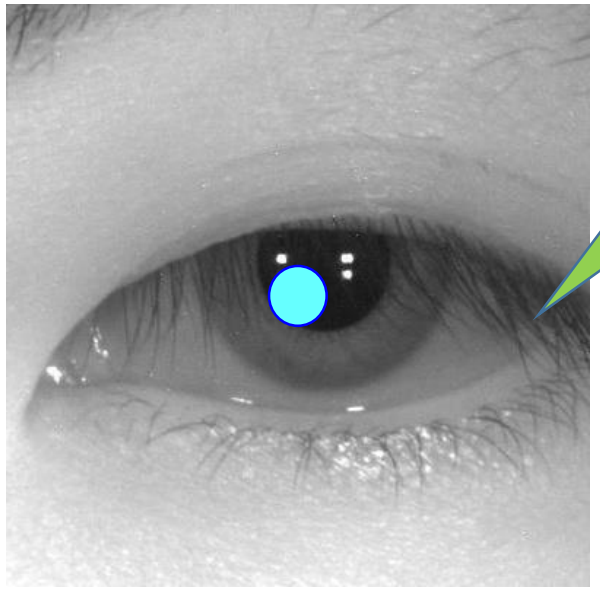
- Eye region detection results
- Segmentation results
- Iris Authentication results
    1. The Leave one out method
    2. Four-Gallery Images Test

Dataset

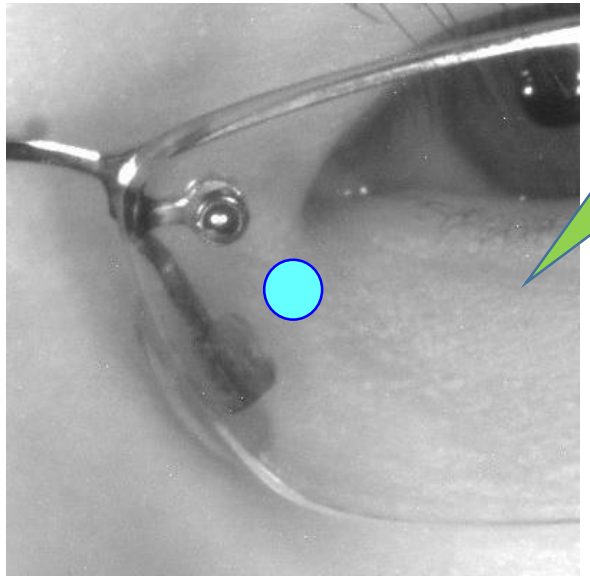
- The public data set of CASIA-v4-Distance (images has blurring, specular reflection on the iris region).
- 2567 face images taken at 3 meters distance
- 142 persons
- 9~20 face images/person.
- **5134** half face images

4.1 Eye region detection results

- Check manually



Correctly Detected



Wrongly Detected

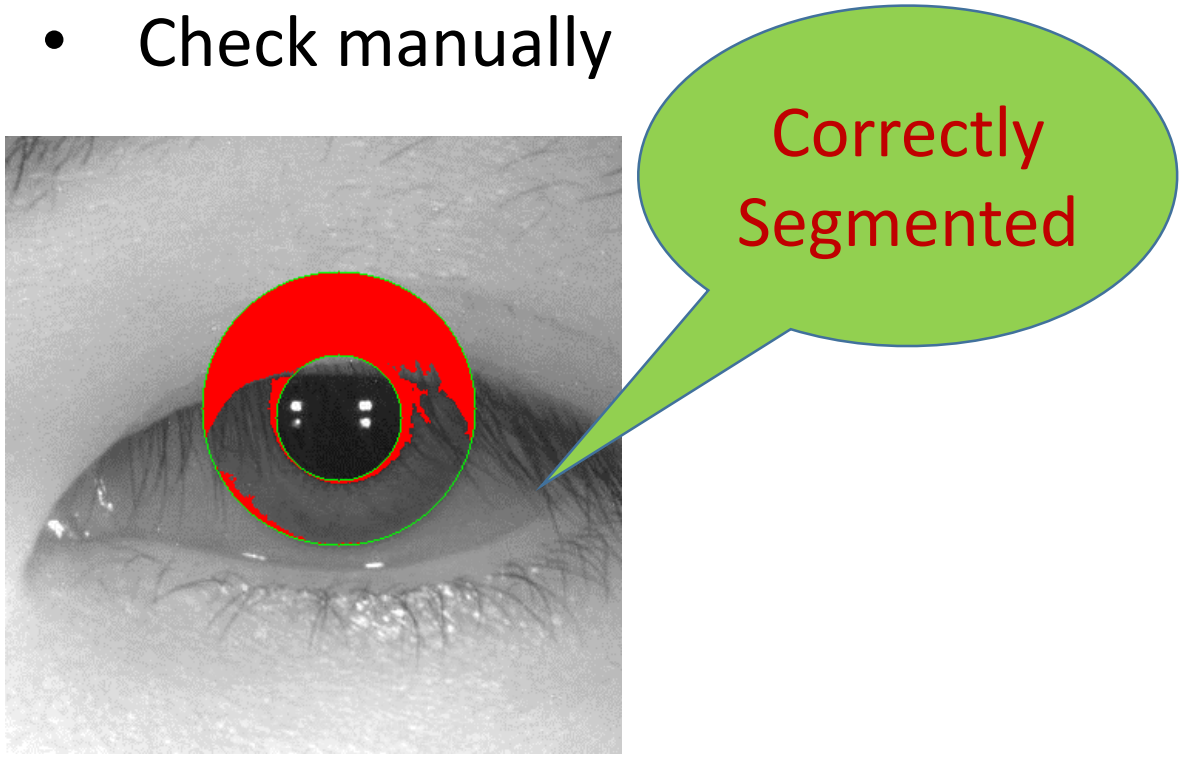
4.1 Eye region detection results

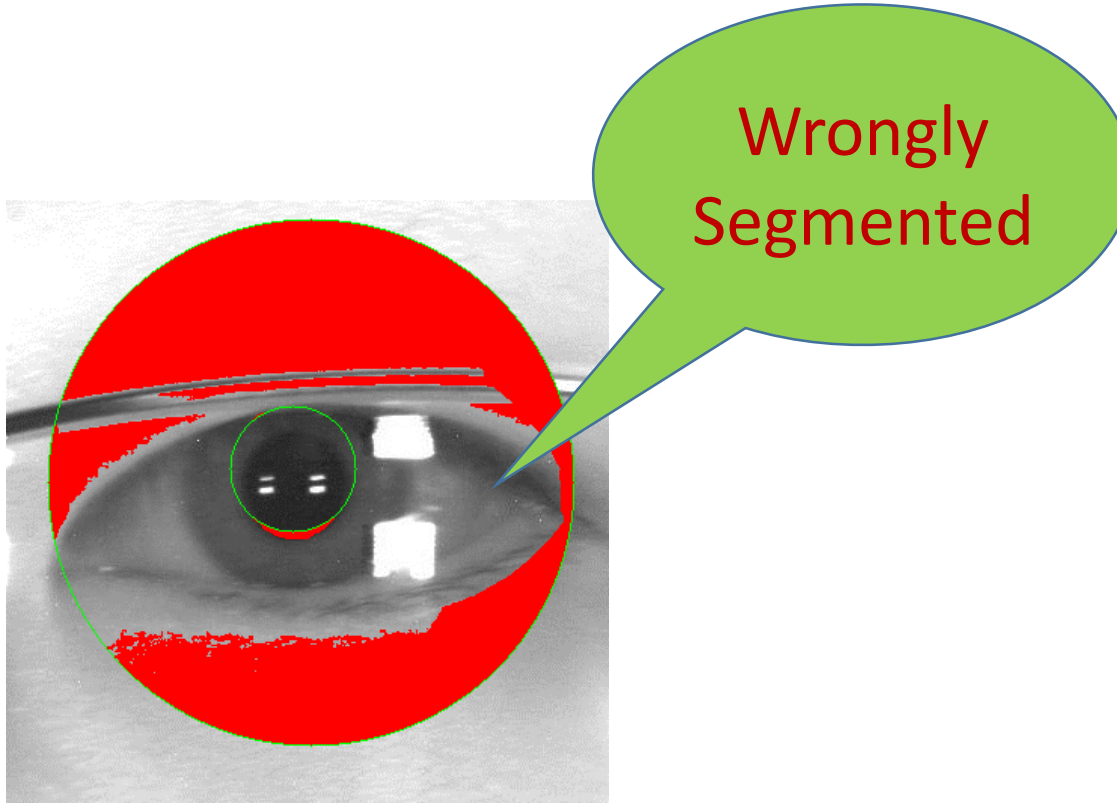
	Correctly Detected
OSIRIS	94.7%
AKAZE	97.8%
Template matching	96.2%
Combined Likelihood	98.4%

Our proposed method outperforms than OSIRIS, AKAZE, Template matching with the highest detection percentage.

4.2 The Segmentation results

- Check manually





4.2 The Segmentation results

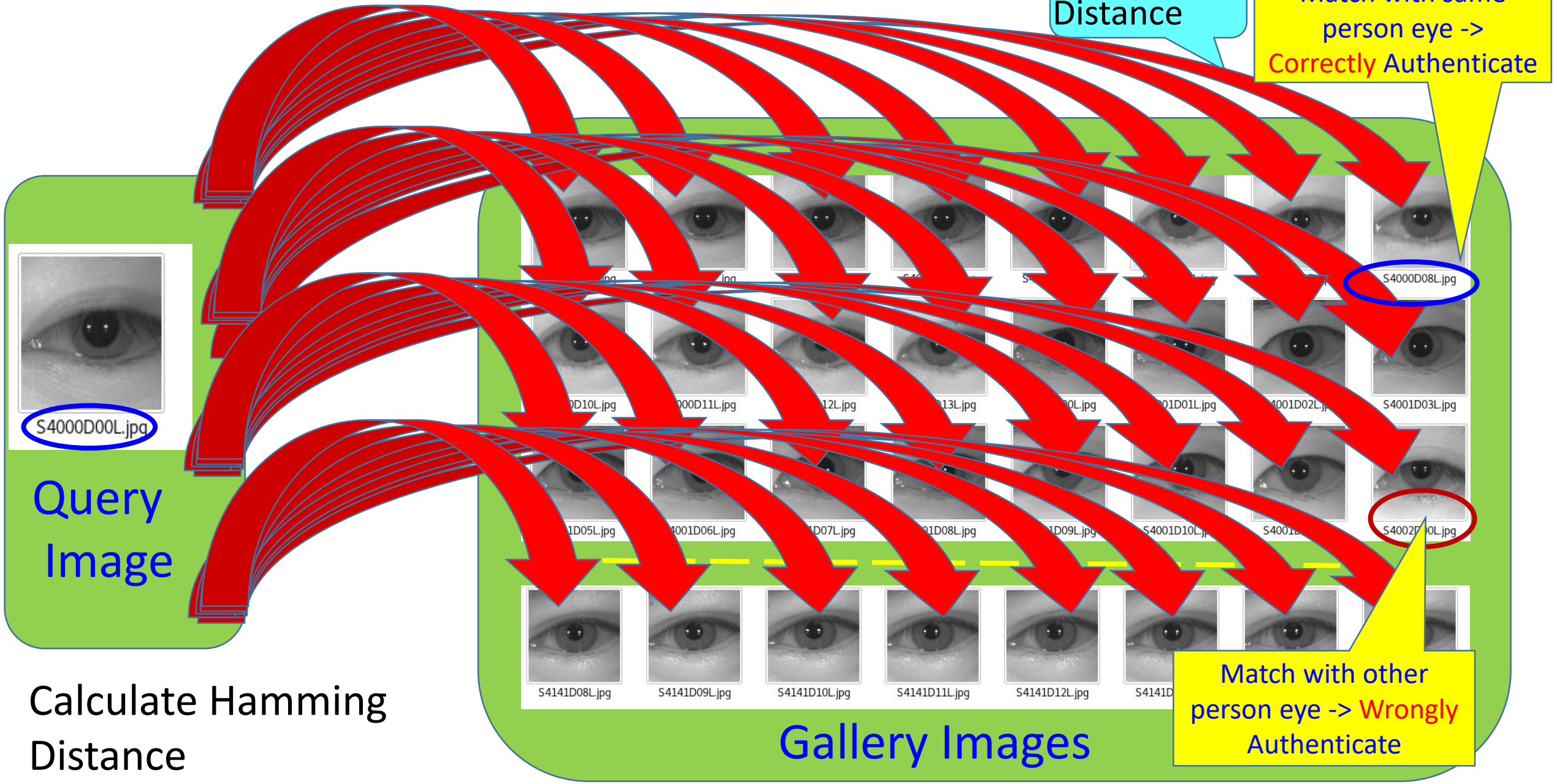
	Correctly Segmented
OSIRIS	85.5%
Combined Likelihood	87.7%

Our proposed method shows better segmentation result.

4.3 Iris Authentication Results

4.3.1 Leave one out method

4.3.1. The Leave one out method



Calculate Hamming Distance

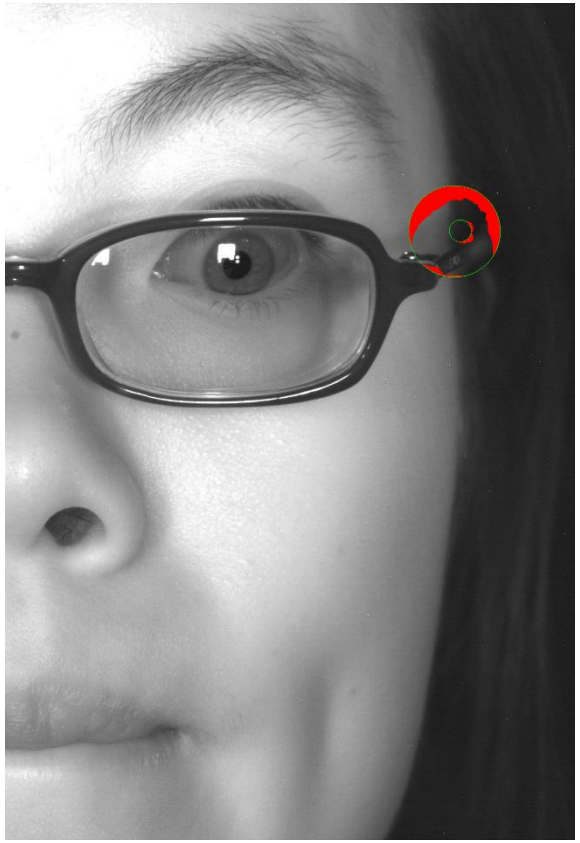
The Leave one out method Result

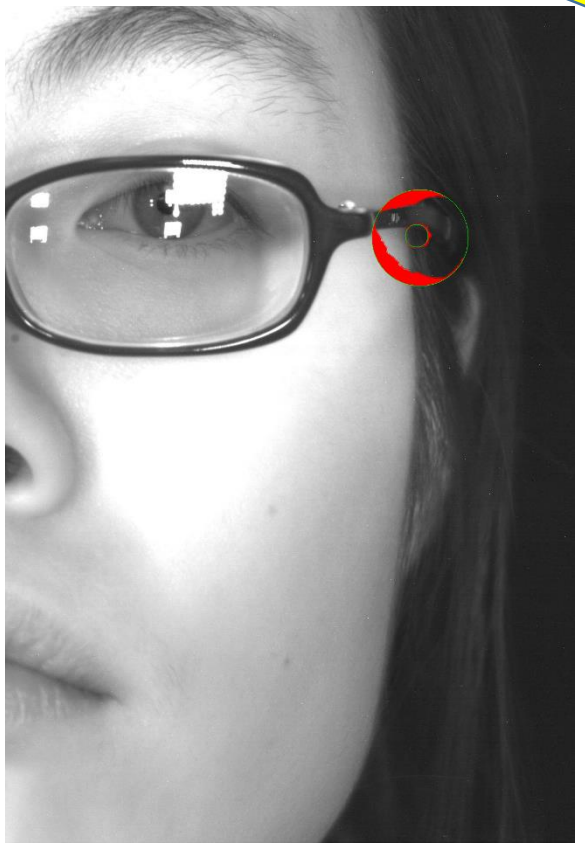
	Correctly Authenticated
OSIRIS	91.6%
Combined Likelihood	92.0%

The result is nearly same in this case.

Discussion for Leave one out method

As the different images of a same person are segmented wrongly and the wrongly segmented regions are very similar.
Same person's different segmented regions are matched each other





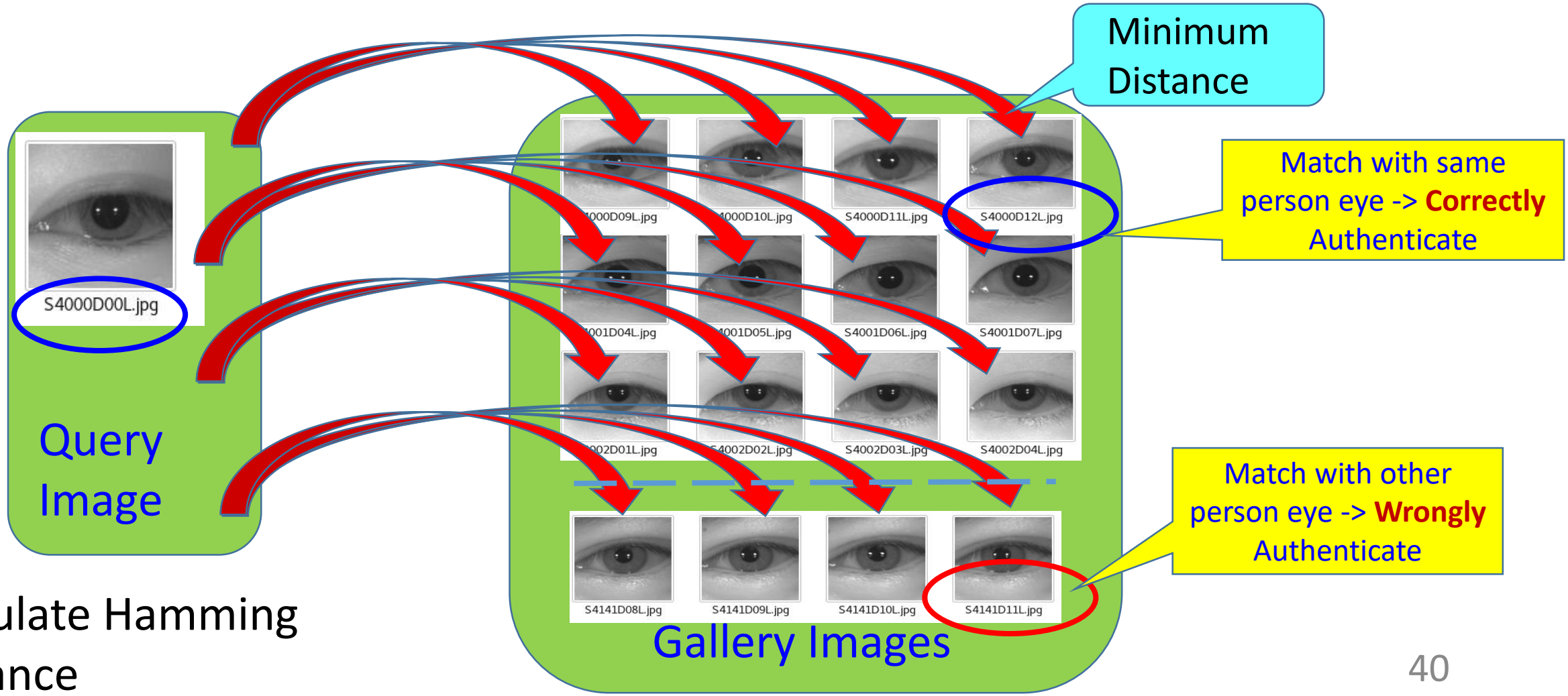
Match

4.3 Iris Authentication Results

4.3.2 Four- Gallery Image Test

4.3.2. Four- Gallery Image Test

- We choose correctly segmented four images for each person.
- We get total 1136 gallery images (142*4= 568 left and 568 right images)



Calculate Hamming Distance

The Overall Authentication results for Four- Gallery Images Test

	Correctly Authenticated
OSIRIS	77.1%
Combined Likelihood	80.2%

Our proposed method shows better authentication result than OSIRIS for Four-Gallery Images Test.

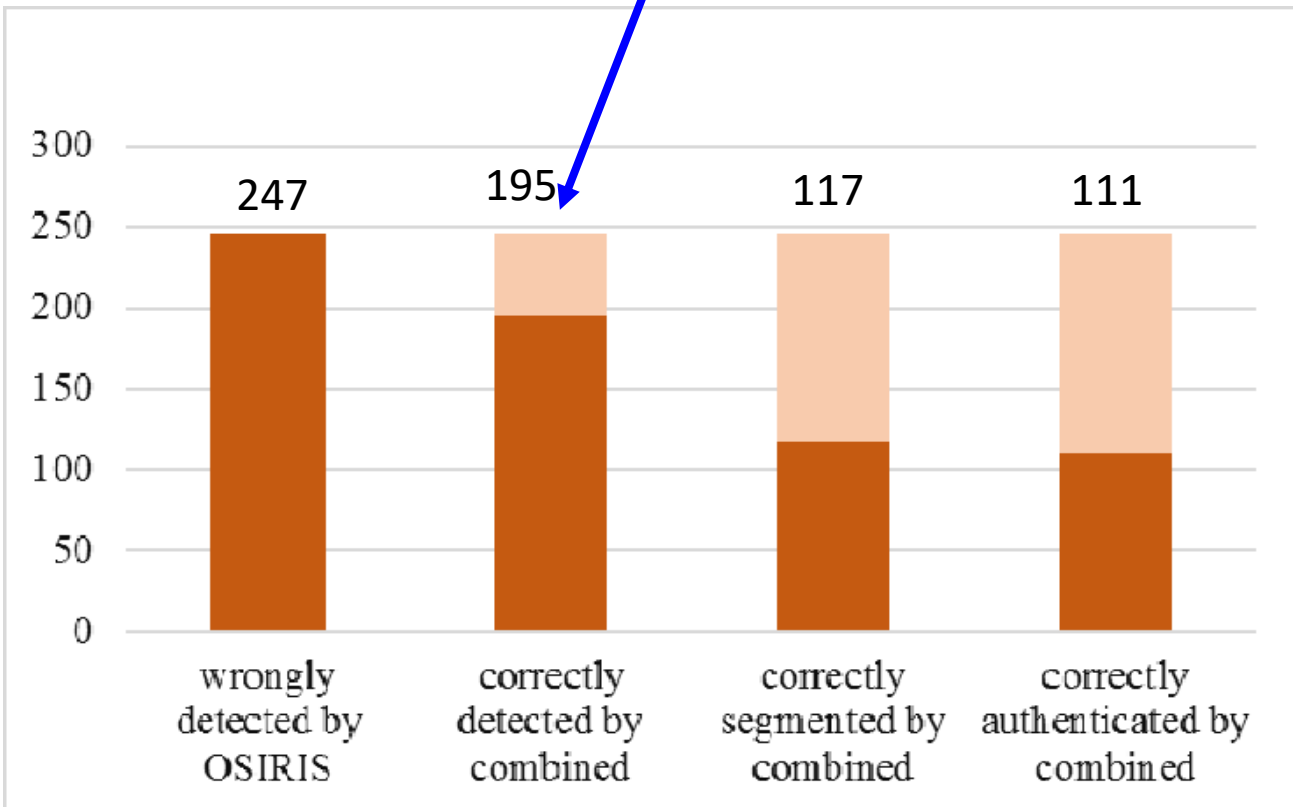
Discussion for Four- Gallery Image Test

As a Detail Experiment, we check the authentication result for wrongly detected images by OSIRIS.

- 247 wrongly detected images
- 195/247 images are correctly detected by our proposed method
- 117/195 images are correctly segmented
- 111/117 images are correctly authenticated

Discussion for Four- Gallery Image Test

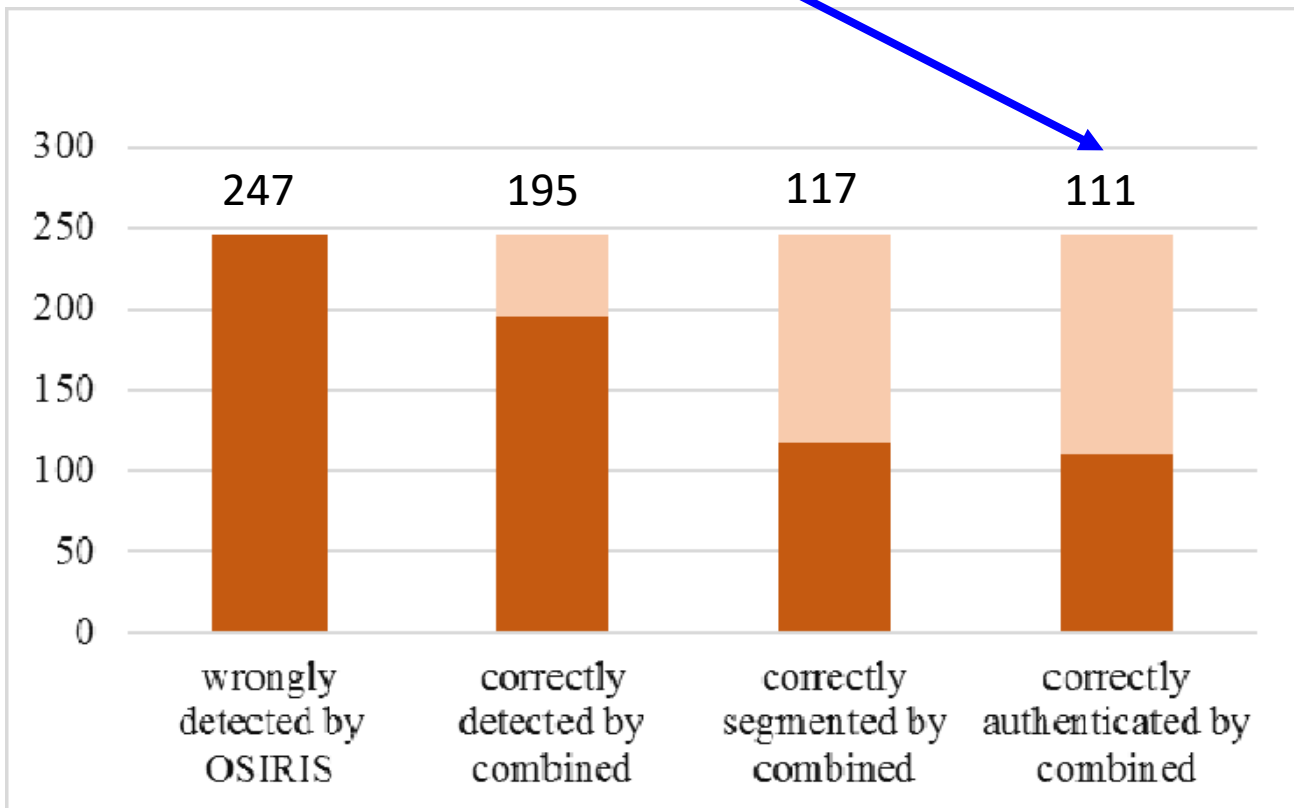
195/247(78.9%) images are correctly detected by our proposed method.



Our proposed method shows good detection result.

Discussion for Four- Gallery Image Test

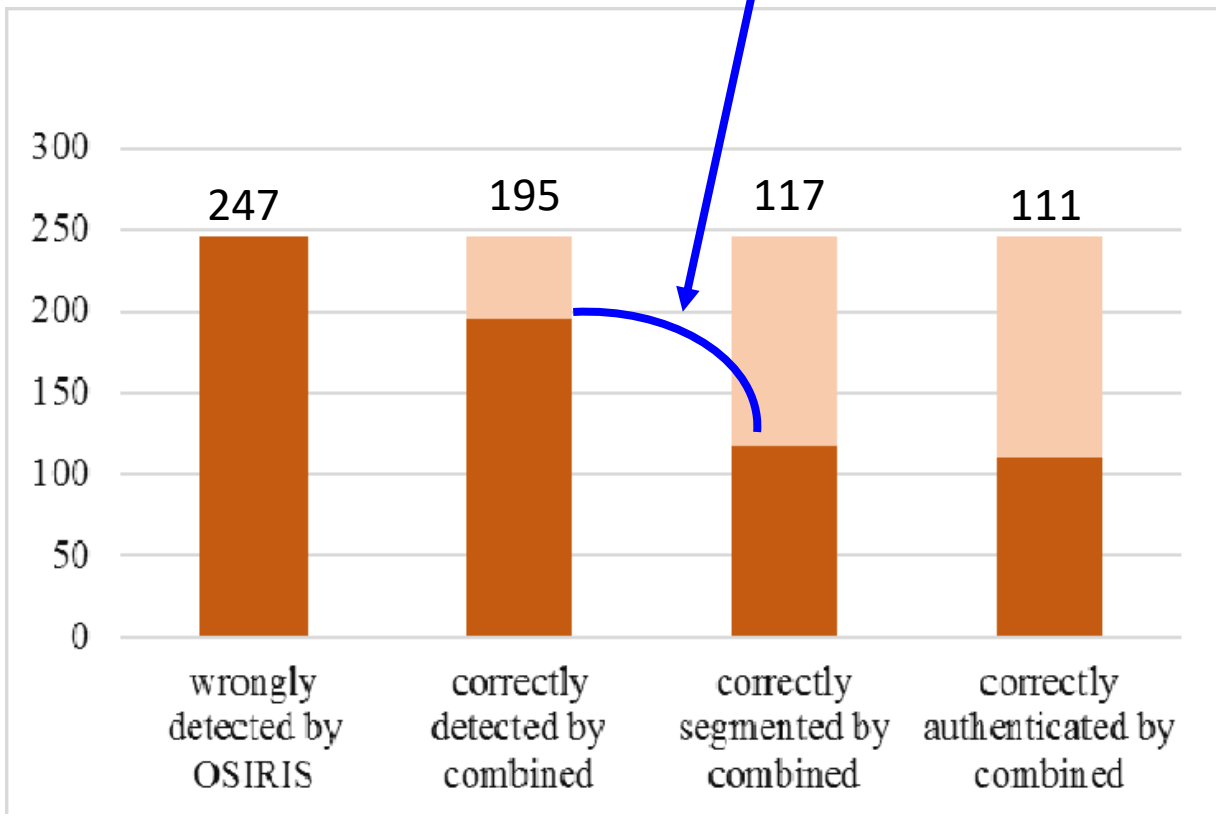
111/117(94.9%) images are correctly authenticated.



The result shows good performance since almost all correctly segmented images can authenticate correctly.

Discussion for Four- Gallery Image Test

If we can segment all detected images correctly, the authentication result will be higher.



6. Conclusion

We propose a new eye region detection method using likelihood image combination for improving iris authentication.

Our proposed method shows better results than OSIRIS.

Future work

- We will proceed the improvement on the segmentation procedure in order to improve the authentication accuracy.
- Another future work is to compare with other eye detectors like Adaboost proposed by Viola Jones.

Acknowledgment

- Fast and foremost, we would like to give a special thanks to University of Miyazaki for introducing Masters' Double Degree Program (DDP). And, we also deeply thanks to University of Computer Studies, Mandalay (UCSM) for the cooperation.
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Thank You So Much!