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NSTDA

ขับเคลื่อนวิทยาศาสตร์และเทคโนโลยี
ด้วย **AI** เพื่อประเทศไทยที่ยั่งยืน
*AI-driven Science and Technology
for Sustainable Thailand*



NAC2025
20th NSTDA Annual Conference
การประชุมวิชาการประจำปี สวทช. ครั้งที่ ๒๐

26-28
มีนาคม 2568

อุทยานวิทยาศาสตร์ประเทศไทย



Enhancing Iris Verification through Multiple Distance Measurement Fusion and Enrollment Screening Mechanism

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SIIT
SINCE 1992

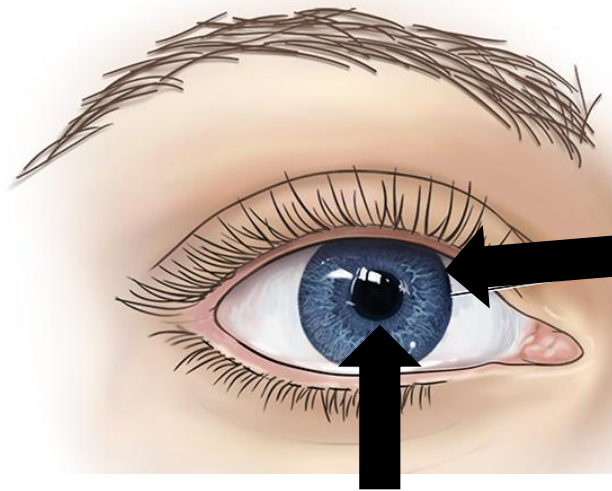
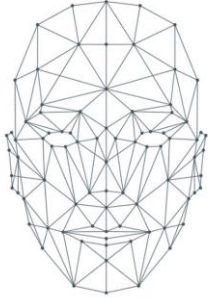
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Institute of
SCIENCE TOKYO
Advancing science and human wellbeing

Outline

- Introduction
- Research Objective
- Proposed Method
- Experiment & Results
- Q&A

Introduction



IRIS

PUPIL



Image Ref:

Aging – Add Life (add-life.org)

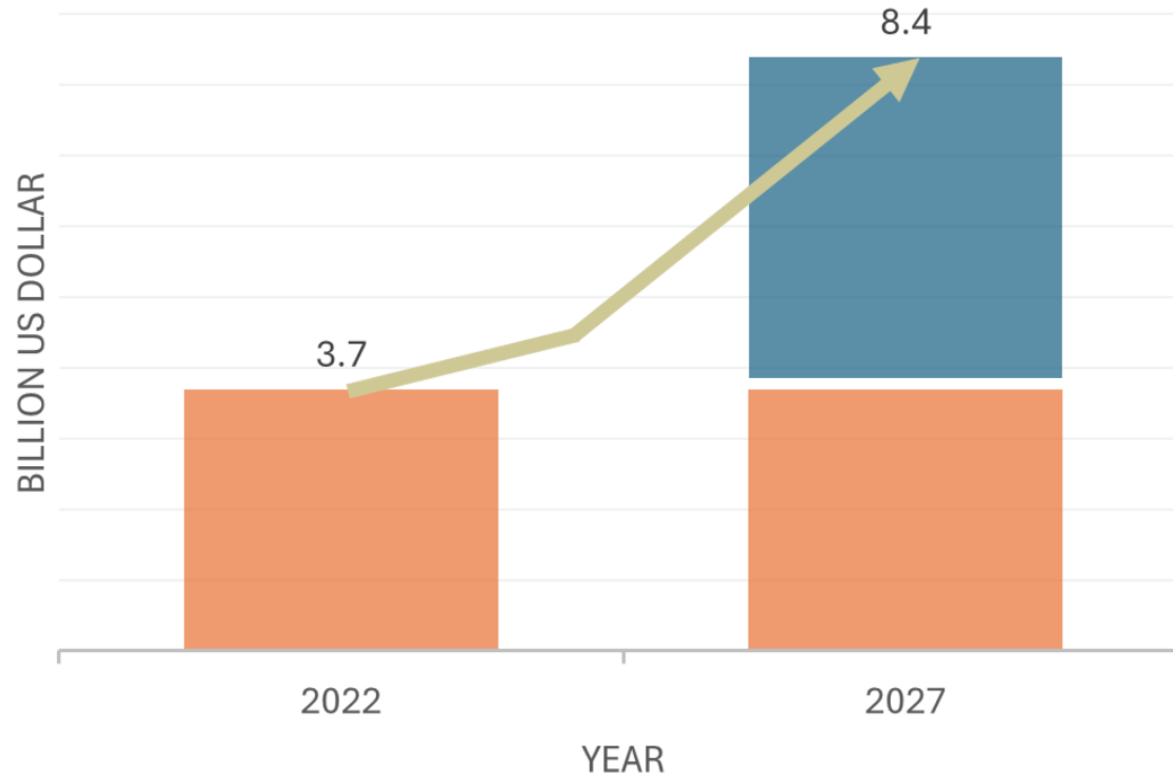
Fingerprint – Vecteezy (vecteezy.com)

Facial – Springer (springer.com)

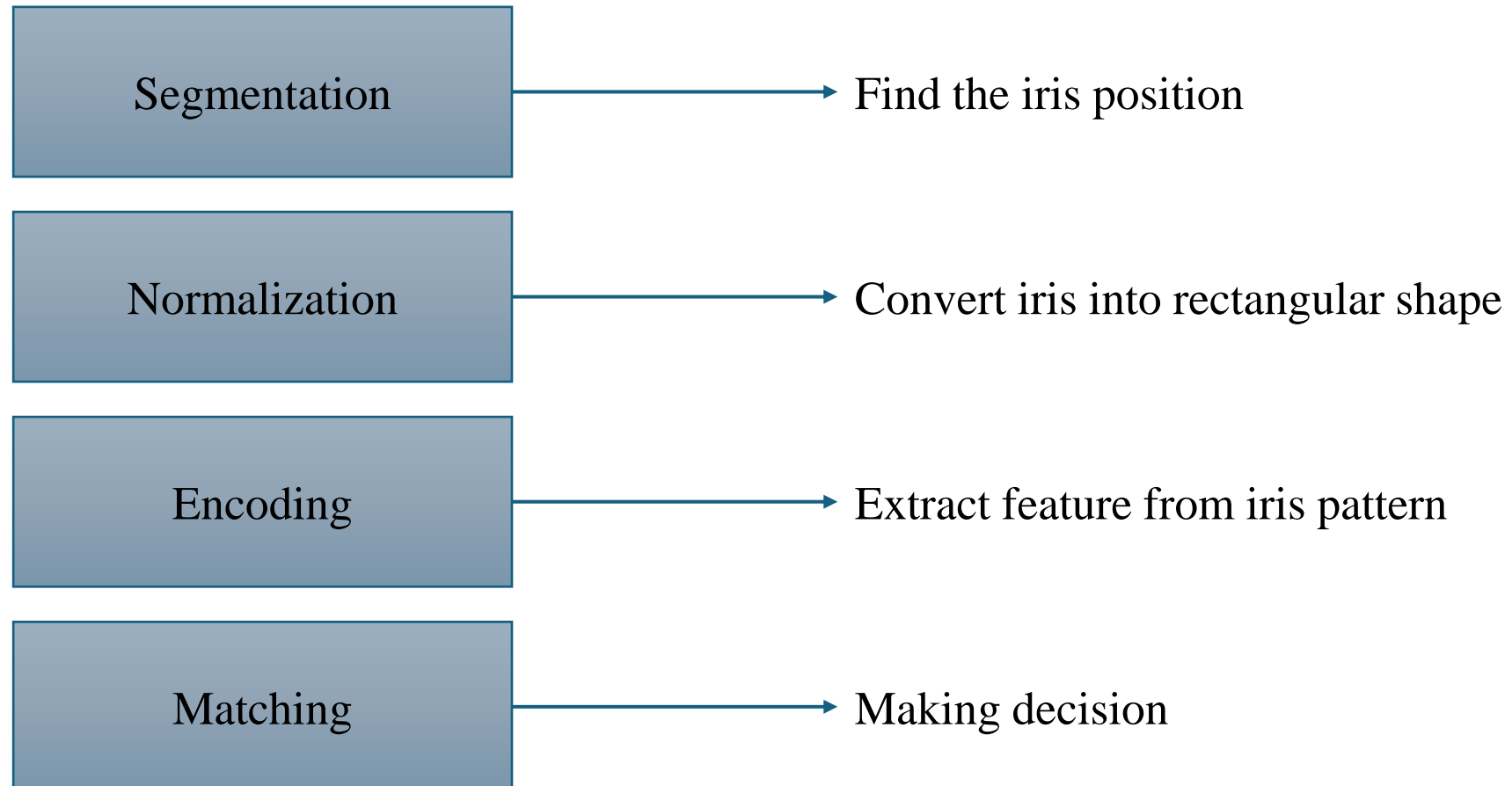
Voice ID Elimination – Adept Forensics (adeptforensics.com)

Iris – Cleveland Clinic (clevelandclinic.org)

Iris Recognition Market Share

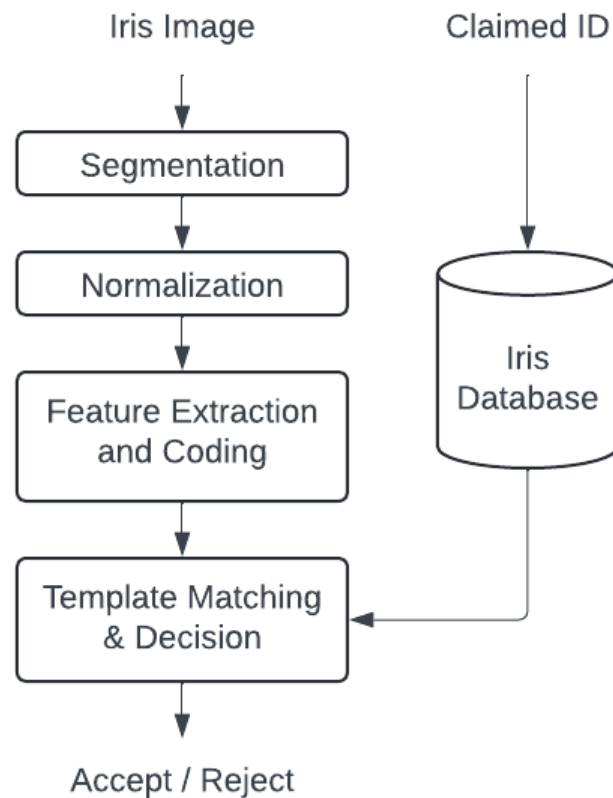


Daugman's Iris Verification Framework



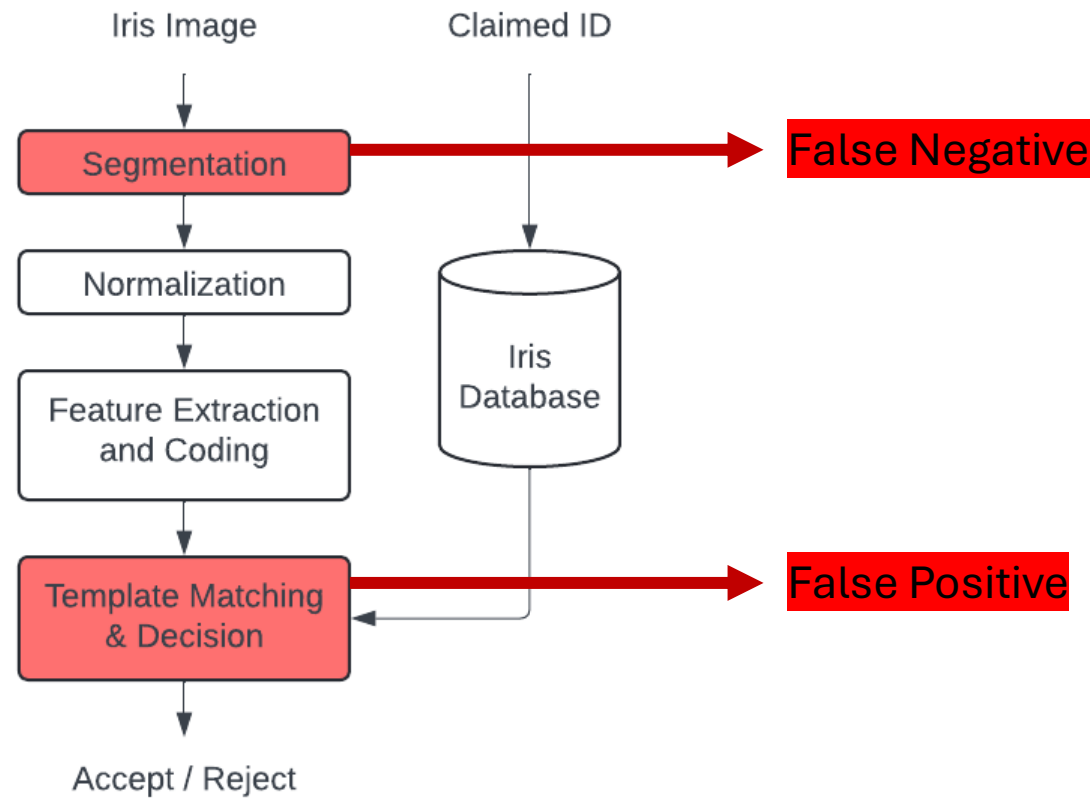
Research Objective

Improve overall accuracy by decrease the false prediction



Research Objective

Improve overall accuracy by decrease the false prediction



Segmentation

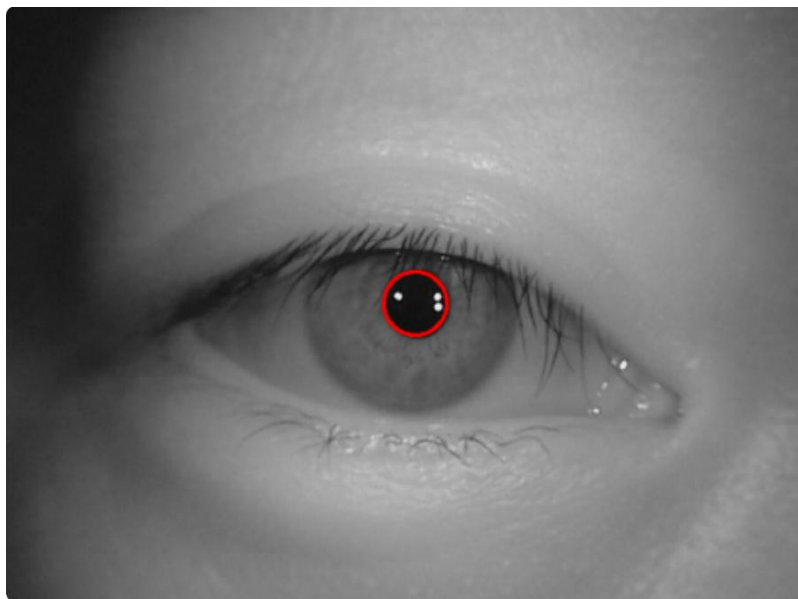
Normalization

Encoding

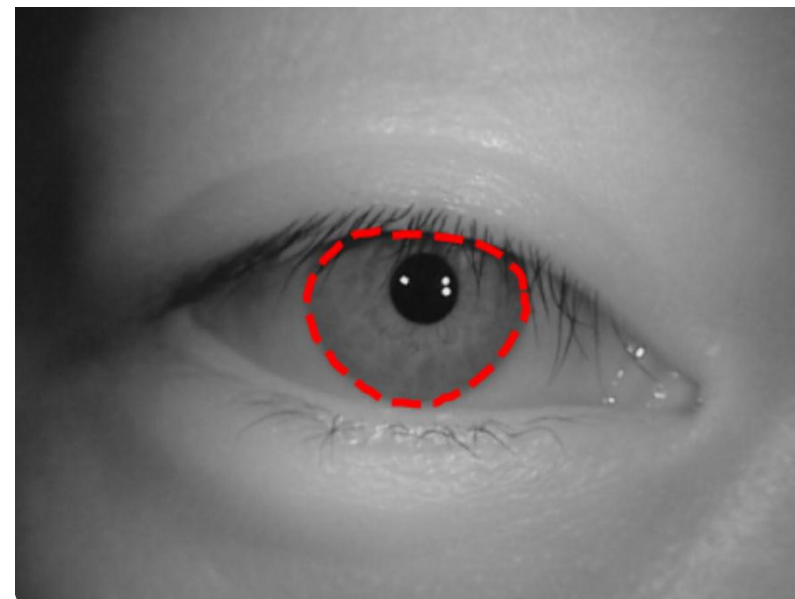
Matching

Daugman's Segmentation

Hough Circle
For
pupil segmentation



Active Contour
For
iris segmentation



Ref: John Daugman. How iris recognition works. In The essential guide to image processing.

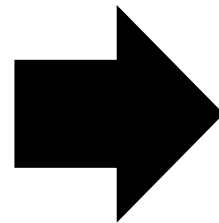
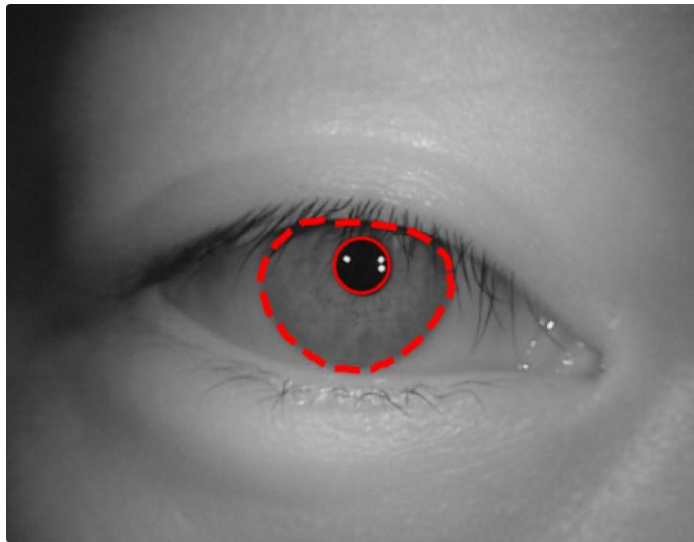
Daugman's Normalization

Segmentation

Normalization

Encoding

Matching



Ref: John Daugman. How iris recognition works. In The essential guide to image processing.

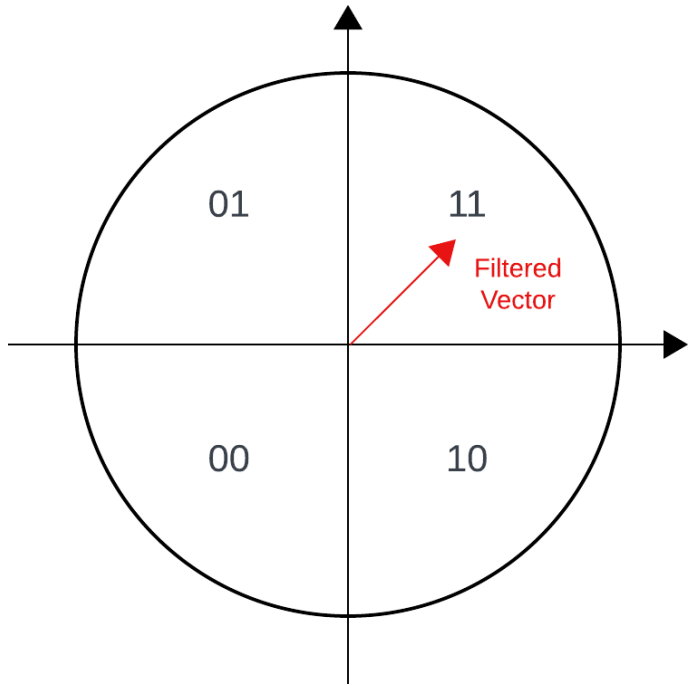
Segmentation

Normalization

Encoding

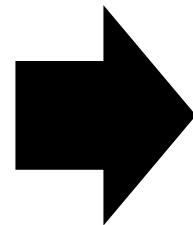
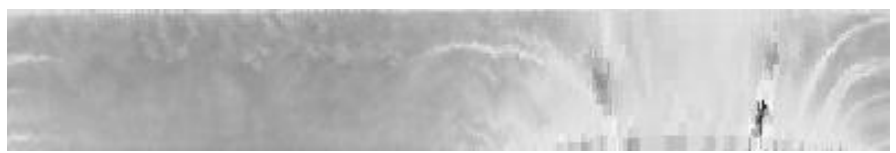
Matching

Daugman's Encoding



Log-Gabor Filter

$$G(f) = \exp\left(\frac{-(\log(f/f_0))^2}{2(\log(\sigma/f_0))^2}\right)$$



Ref: John Daugman. How iris recognition works. In The essential guide to image processing.

Segmentation

Normalization

Encoding

Matching

Daugman's Matching

template 1					
1	0	1	0	1	0

template 2					
1	0	0	1	1	0

Hamming Distance = $2 / 6 = 0.3333$

Tuned Threshold (0.4633)



Ref: John Daugman. How iris recognition works. In The essential guide to image processing.

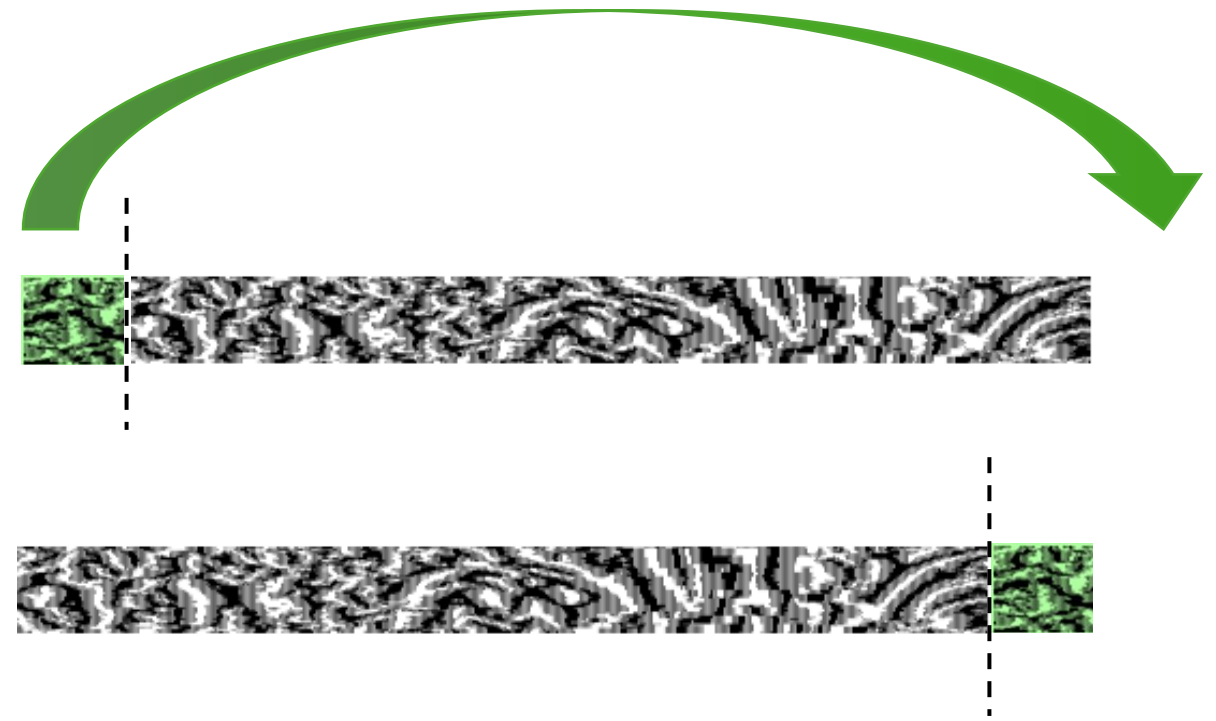
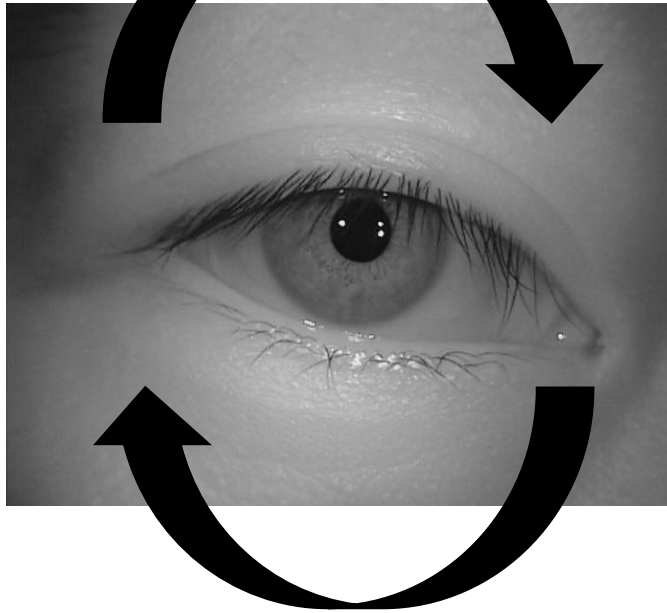
Daugman's Template Shifting

Segmentation

Normalization

Encoding

Matching



Ref: John Daugman. How iris recognition works. In The essential guide to image processing.

Segmentation

Normalization

Encoding

Matching

Daugman's Template Shifting

template 1	template 2	Hamming Distance = 3 / 6 = 0.5000
1 0 1 0 1 1	1 0 0 1 1 0	
template 1 shifted 1	template 2	Hamming Distance = 2 / 6 = 0.3333
1 1 0 1 0 1	1 0 0 1 1 0	
template 1 shifted 2	template 2	Hamming Distance = 3 / 6 = 0.5000
1 1 1 0 1 0	1 0 0 1 1 0	
template 1 shifted 3	template 2	Hamming Distance = 5 / 6 = 0.8333
0 1 1 1 0 1	1 0 0 1 1 0	

Ref: John Daugman. How iris recognition works. In The essential guide to image processing.

Our previous work

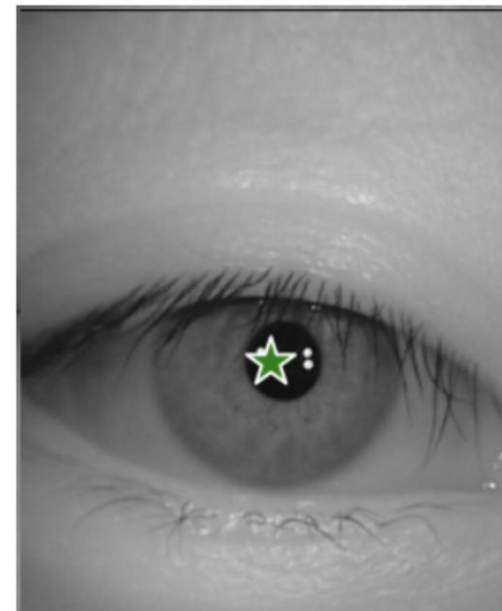
Segmentation

Normalization

Encoding

Matching

Segment Anything Model (SAM)



Ref: Improving iris verification systems using sam-enhanced segmentation and neural network strengthened template matching.

Segmentation

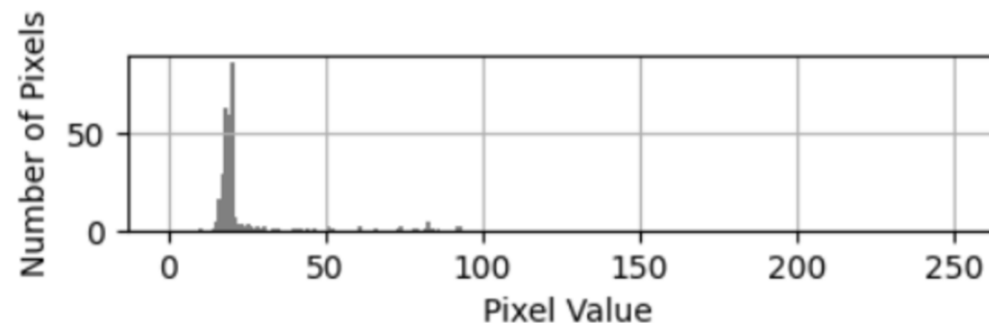
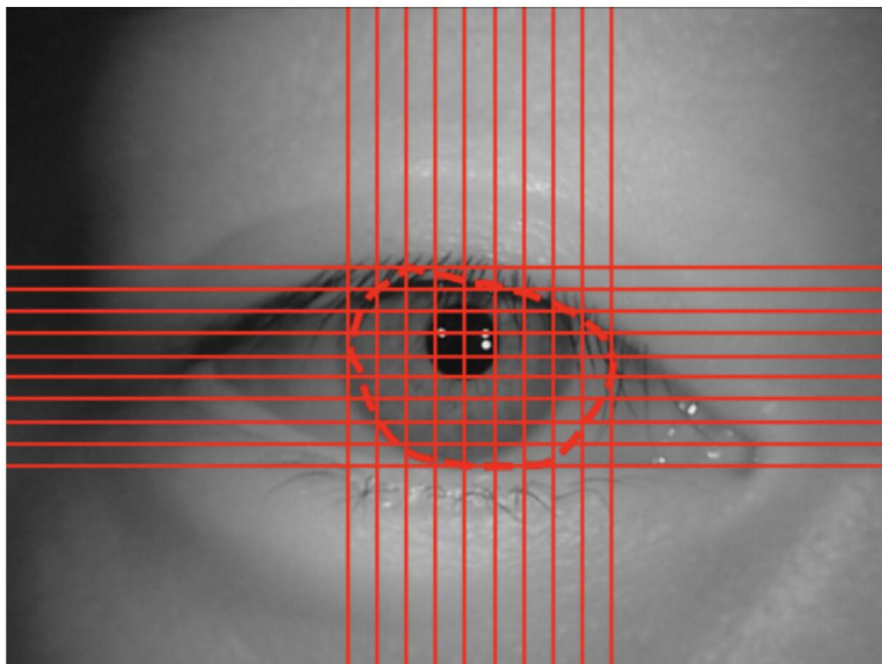
Normalization

Encoding

Matching

Our previous work

Select initial point for SAM



Ref: Improving iris verification systems using sam-enhanced segmentation and neural network strengthened template matching.

Segmentation

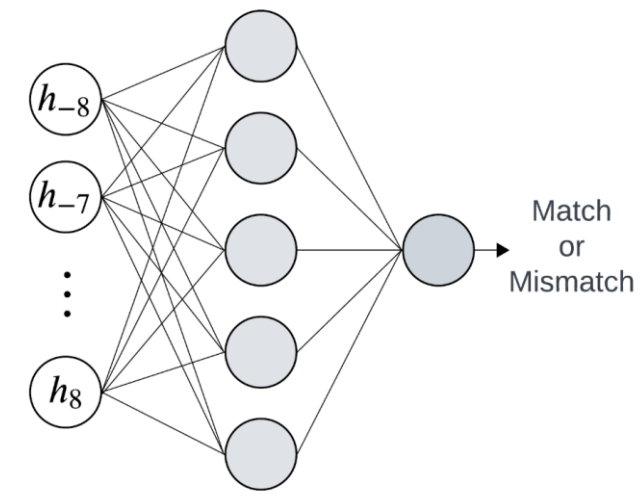
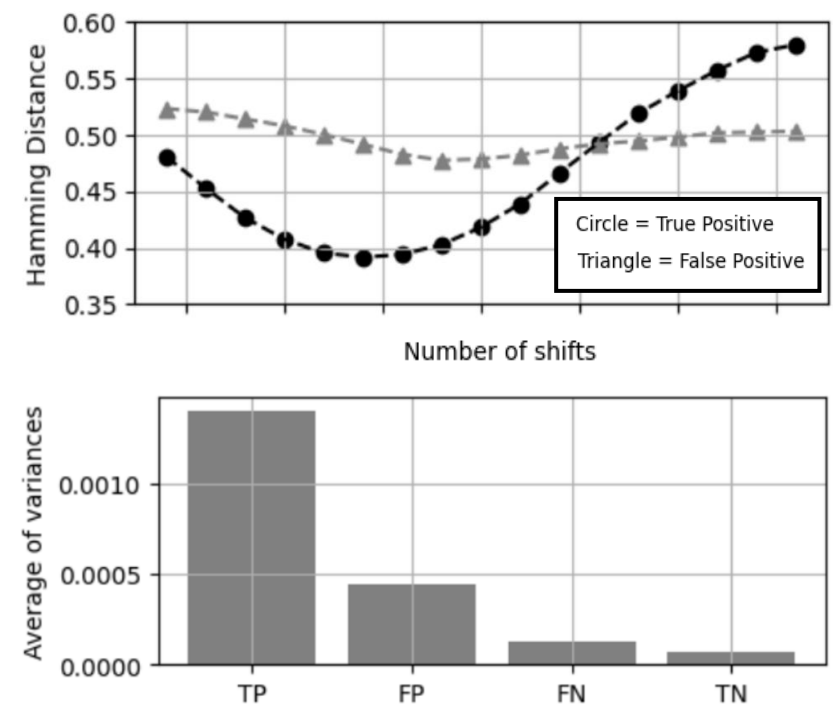
Normalization

Encoding

Matching

Our previous work

Neural network & Template shifting combination



Ref: Improving iris verification systems using sam-enhanced segmentation and neural network strengthened template matching.

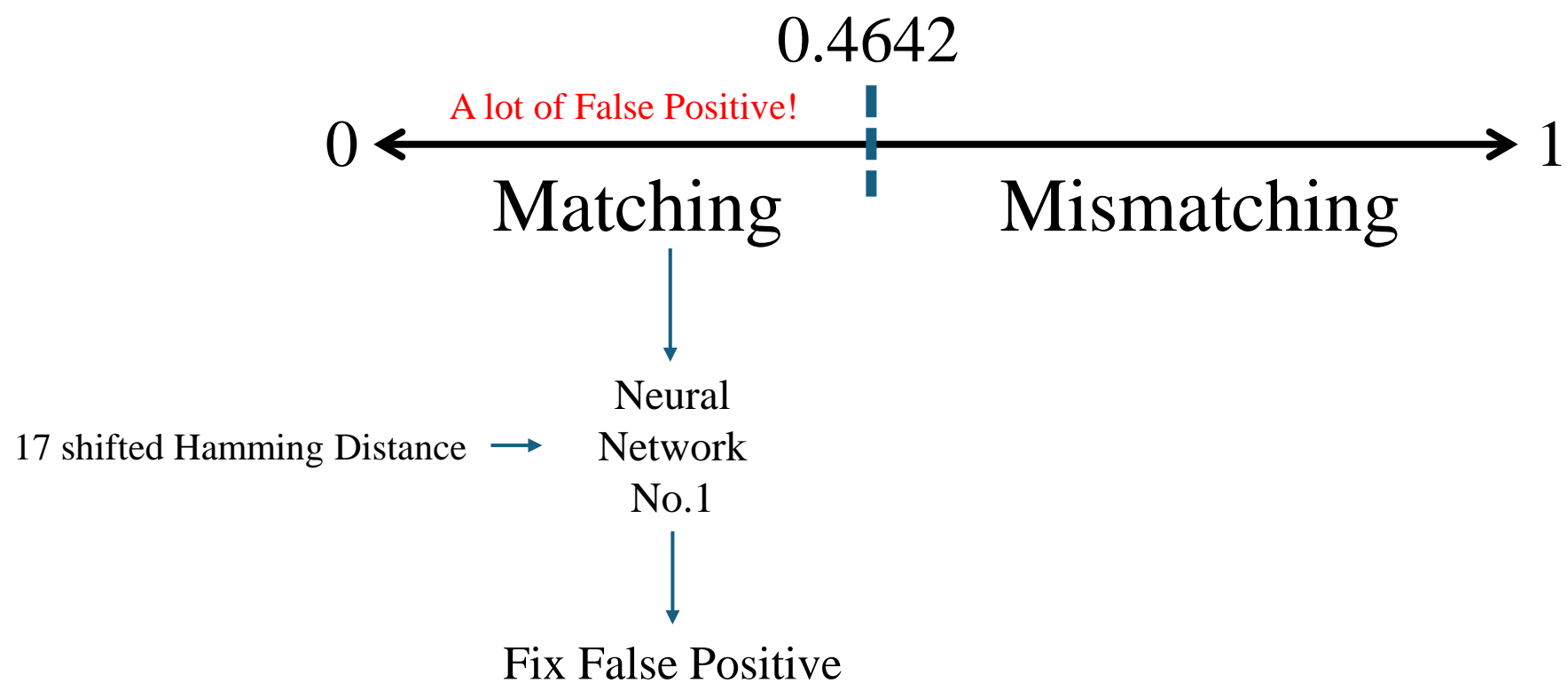
Our previous work

Segmentation

Normalization

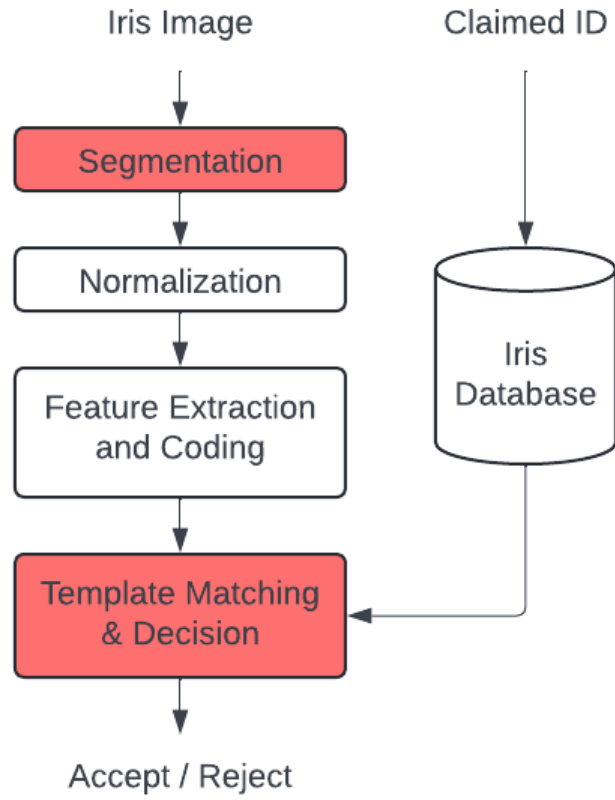
Encoding

Matching



Ref: Improving iris verification systems using sam-enhanced segmentation and neural network strengthened template matching.

Proposed Method



Segmentation

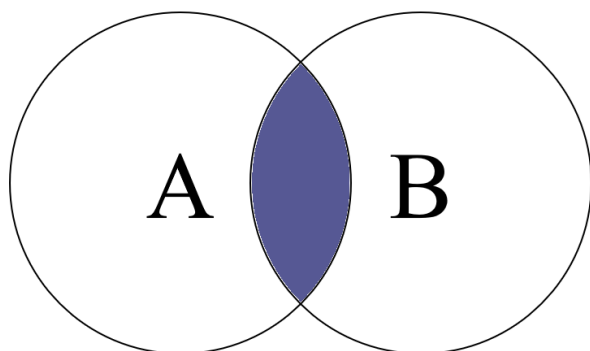
Normalization

Encoding

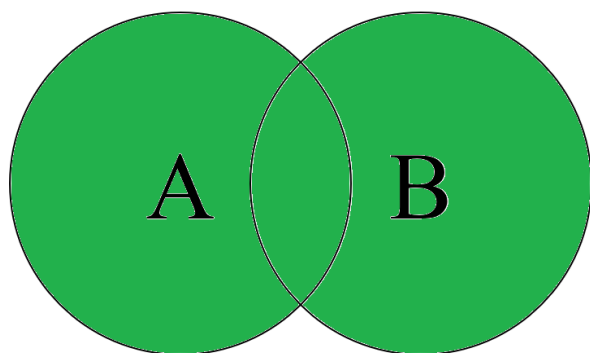
Matching

Other distance measurement

Jaccard Distance



Intersection (\cap)



Union (\cup)

$$J(A, B) = 1 - \frac{|A \cap B|}{|A \cup B|}$$

Other distance measurement

Pearson Correlation Coefficient

$$r = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2} \cdot \sqrt{\sum_{i=1}^n (y_i - \bar{y})^2}}$$

$r = 1$: Positive Linear Relationship

$r = -1$: Negative Linear Relationship

$r = 0$: No Linear Relationship

Segmentation

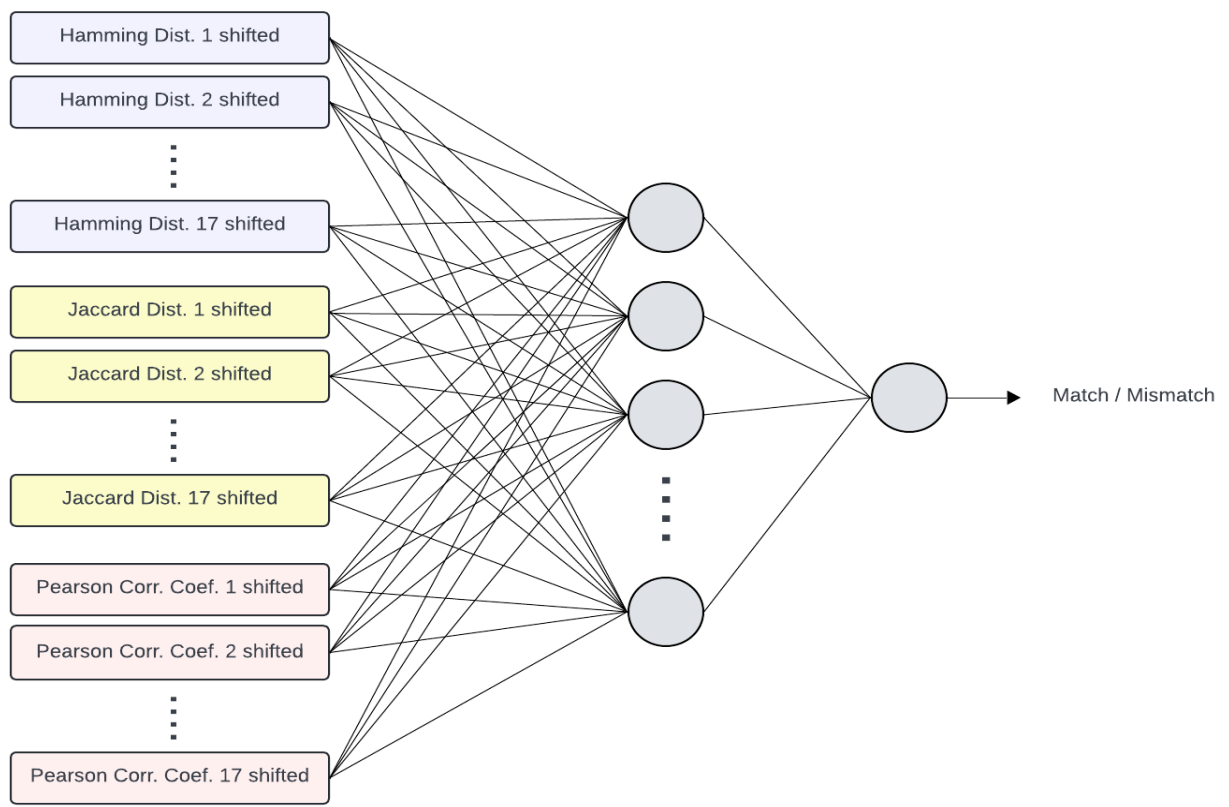
Normalization

Encoding

Matching

Other distance measurement

Neural Network Training of Multiple Distance Measurement



Segmentation

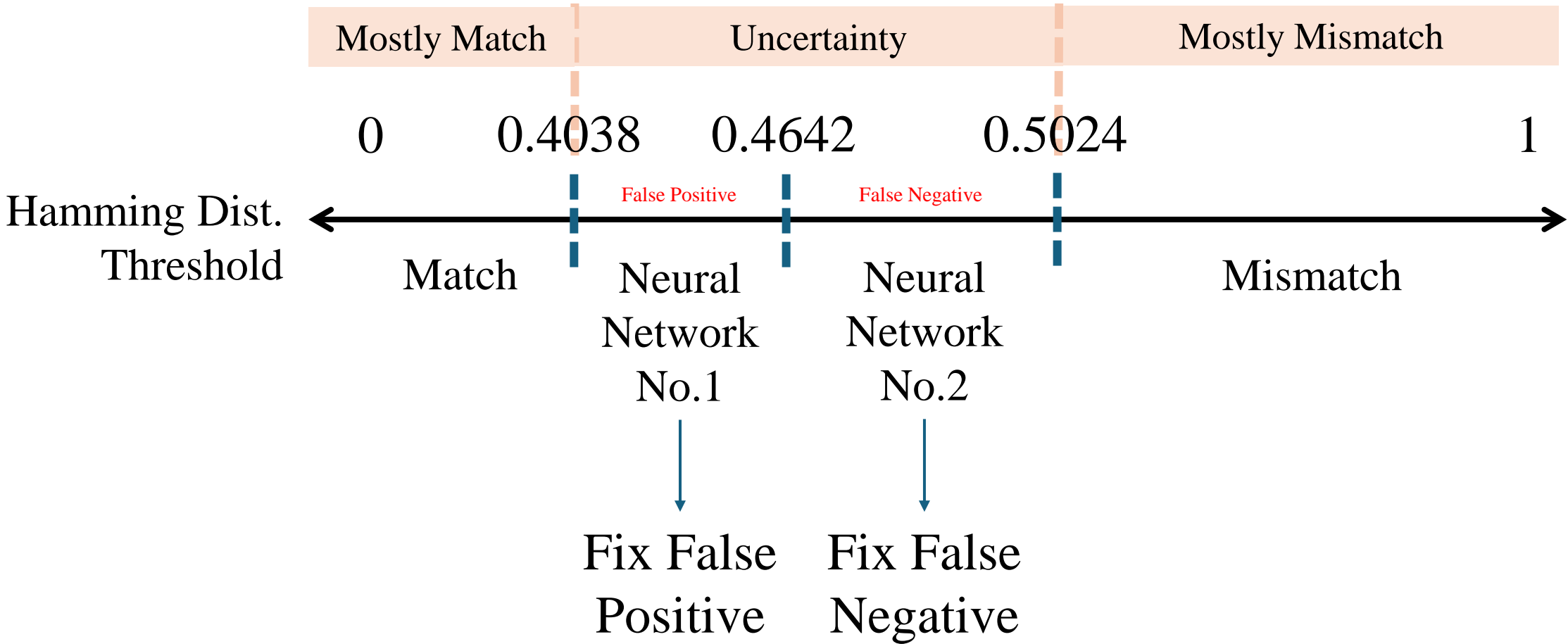
Normalization

Encoding

Matching

Other distance measurement

Overall distance system



Segmentation

Normalization

Encoding

Matching

Dataset

CASIA Iris Image Dataset Version 2 (CASIA-IrisV2), which contains 60 eyes; each contains 20 images in an indoor environment with a size of 640×480 pixels taken by CASIA-IrisCamV2



Other distance measurement

Overall distance system

Comparison of baseline method [4] and the improved method with multiple distance measurement fusion. Note that TP, FP, FN, and TN are true positives, false positives, false negatives, and true negatives, respectively.

	TP	FP	FN	TN	ACC	BAL ACC	Precision	Recall	F_1	$F_{0.5}$
Baseline [4]	6,698	353	2,615	696,506	0.9958	0.8594	0.9499	0.7192	0.8186	0.8927
improved method with multiple distance measurement fusion	13,038	4,436	1,388	1,266,466	0.9955	0.9501	0.7461	0.9038	0.8174	0.7731

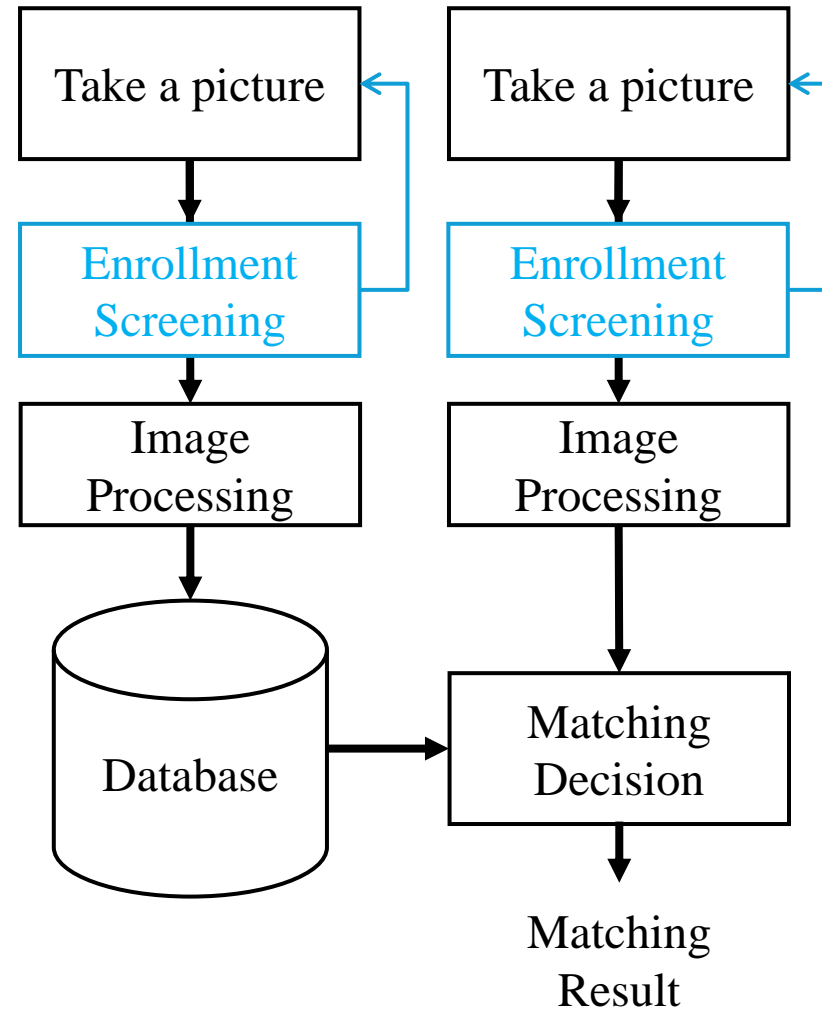
Enrollment Screening

Segmentation

Normalization

Encoding

Matching



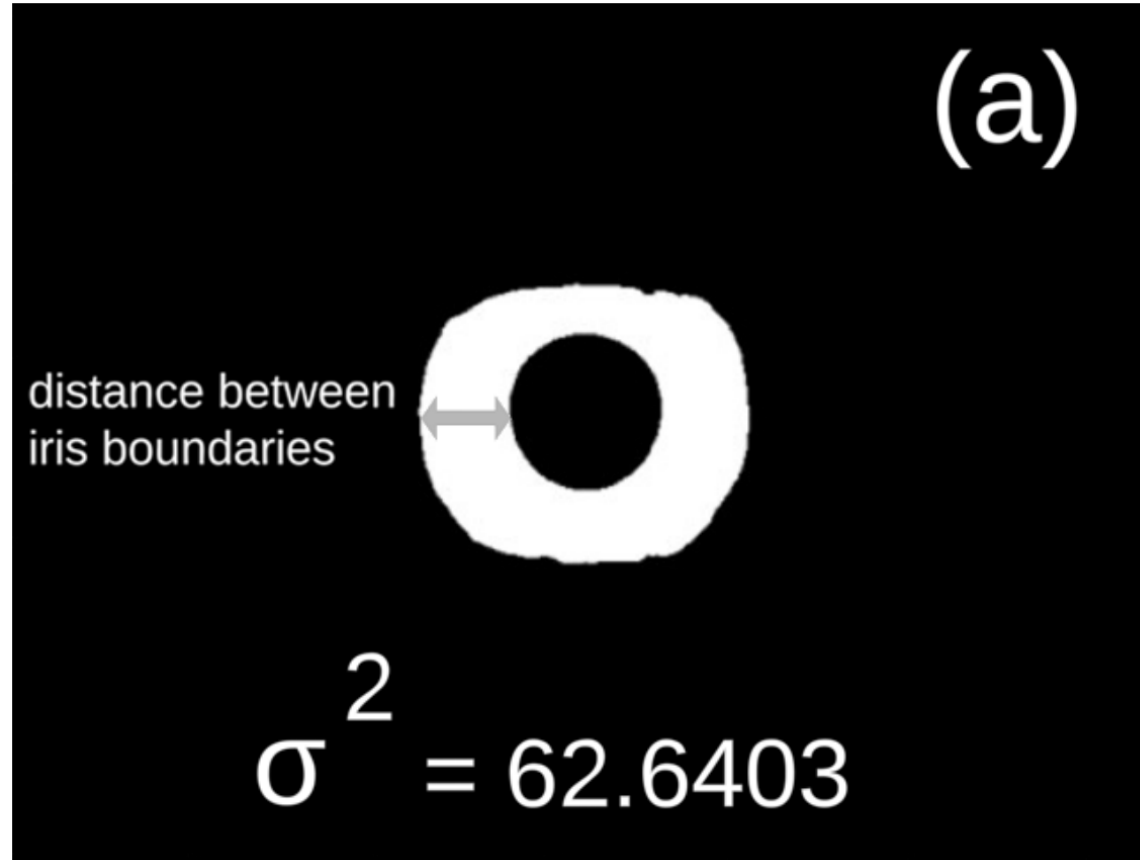
Enrollment Screening

Segmentation

Normalization

Encoding

Matching



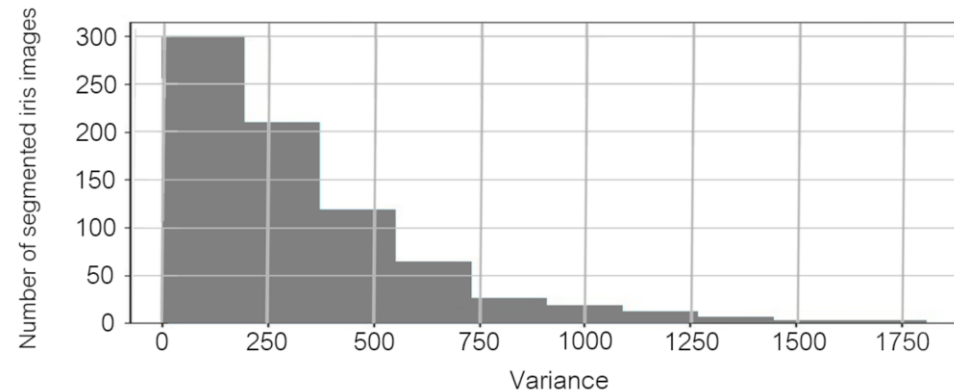
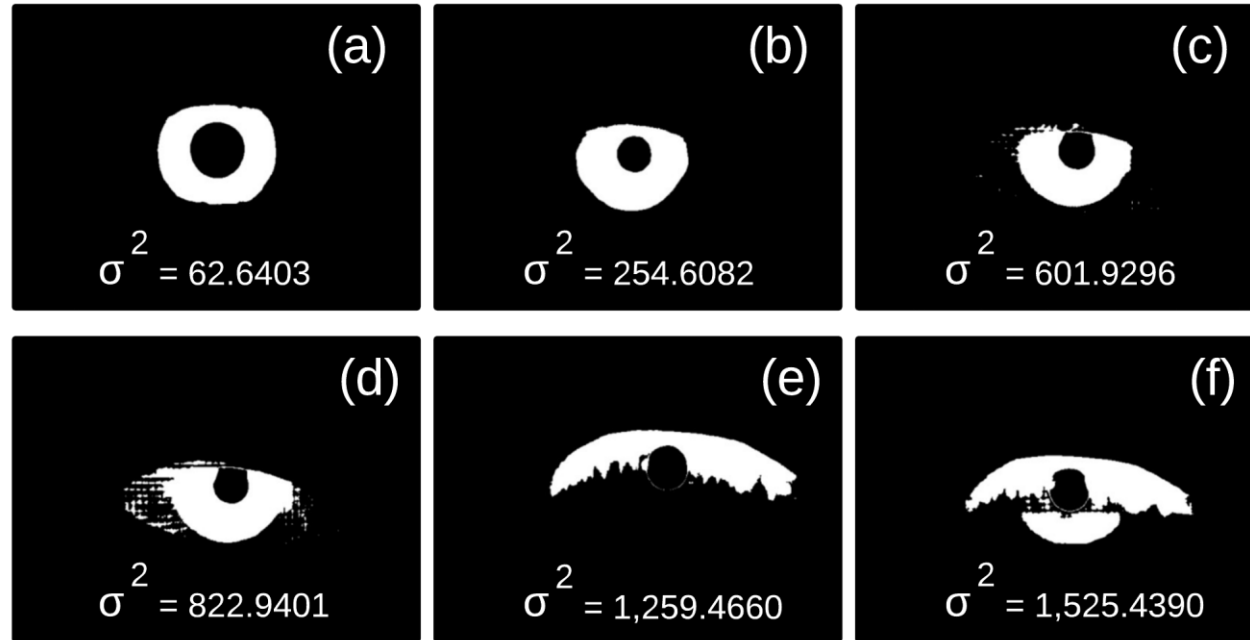
Enrollment Screening

Segmentation

Normalization

Encoding

Matching



Segmentation

Normalization

Encoding

Matching

Enrollment Screening

Performance comparison with different variance thresholds.

Variance Threshold	100	300	500	700	900	1,100	1,300	1,500
TP	5,340	8,483	11,077	12,163	12,598	12,843	12,962	12,993
FP	465	863	2,158	3,392	3,905	4,154	4,344	4,368
FN	332	435	701	962	1,109	1,198	1,323	1,343
TN	316,230	658,659	952,630	1,117,728	1,180,432	1,217,199	1,247,993	1,254,167
ACC	0.9975	0.9981	0.9970	0.9962	0.9958	0.9957	0.9955	0.9955
BAL ACC	0.9700	0.9750	0.9691	0.9618	0.9579	0.9556	0.9520	0.9514
Precision	0.9199	0.9077	0.8369	0.7819	0.7634	0.7556	0.7490	0.7484
Recall	0.9415	0.9512	0.9405	0.9267	0.9191	0.9147	0.9074	0.9063
F1	0.9306	0.9289	0.8857	0.8482	0.8340	0.8276	0.8206	0.8198
F0.5	0.9241	0.9161	0.8558	0.8072	0.7902	0.7828	0.7761	0.7754

	TP	FP	FN	TN	ACC	BAL ACC	Precision	Recall	F ₁	F _{0.5}
improved method with multiple distance measurement fusion	13,038	4,436	1,388	1,266,466	0.9955	0.9501	0.7461	0.9038	0.8174	0.7731

Conclusion

Improved Matching Algorithm

(Multiple Distance Measurement Fusion)

Accuracy > **0.03% Decreased**

Balanced Accuracy > **10% increased**

Precision > **20.38% Decreased**

Recall > **18.46% Increased**

F1 Score > **0.12% Decreased**

F0.5 Score > **12.41% Decreased**

Improved Segmentation Algorithm

(Enrollment Screening)

Accuracy > **0.07% Increased**

Balanced Accuracy > **2.49% Increased**

Precision > **26.16% Increased**

Recall > **4.74% Increased**

F1 Score > **11.15% Increased**

F0.5 Score > **14.3% Increased**



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**Thank You
So Much**

