ICE Phase I test Results Using Multiscale Variable Multisector Method

Hyeong In Choi & **Daniel Daehoon Kim**

Seoul National University

IriTech Inc.

Iritech Inc.

The Object of This Presentation

- Establish the bottom line performance yardstick
- Investigate how enabling algorithms affect the accuracy
  - Iris & Pupil Border Detection
  - Occlusion Location Estimation
  - Image Quality Measure
- Examine the accuracy and robustness of iris recognition algorithms under various circumstances
- Study how to reject bad images in order to achieve (almost) separation

Iritech Inc.

Classification of Tests

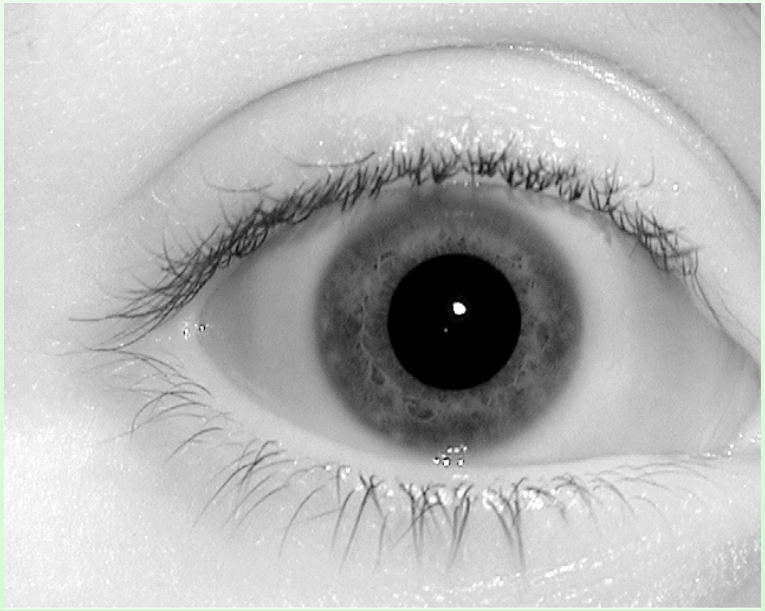
	Iris & Pupil Border Detection	Occlusion Location Estimation	Image Selection
Type A	Manual	Manual	Manual
Type B	Automatic	Manual	Manual
Type C	Automatic	Manual	Automatic by IQ Measure
Type D	Automatic	Automatic	Automatic by IQ Measure

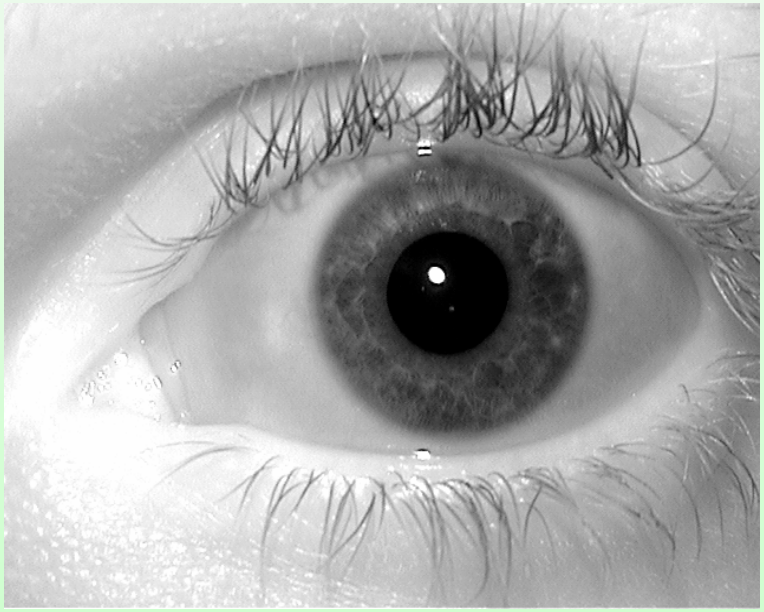
Iritech Inc.

Image characteristics

» Diverse image qualities

- Sharp



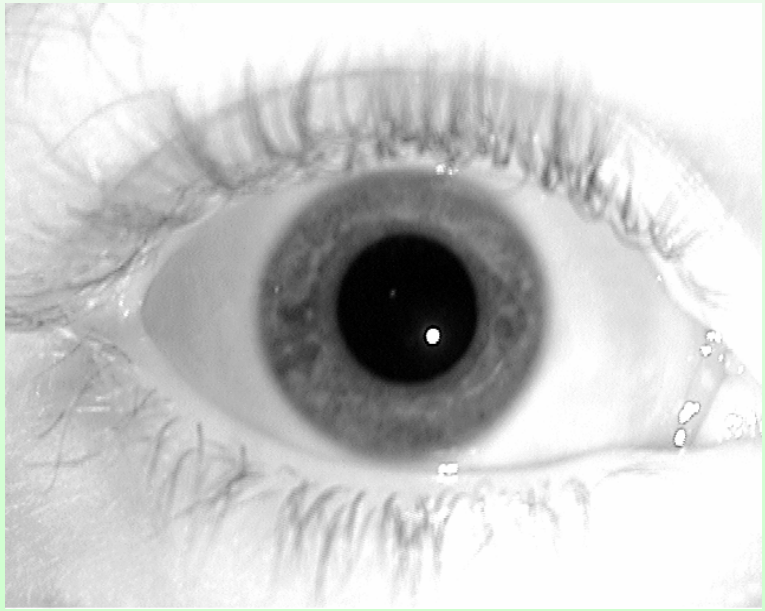


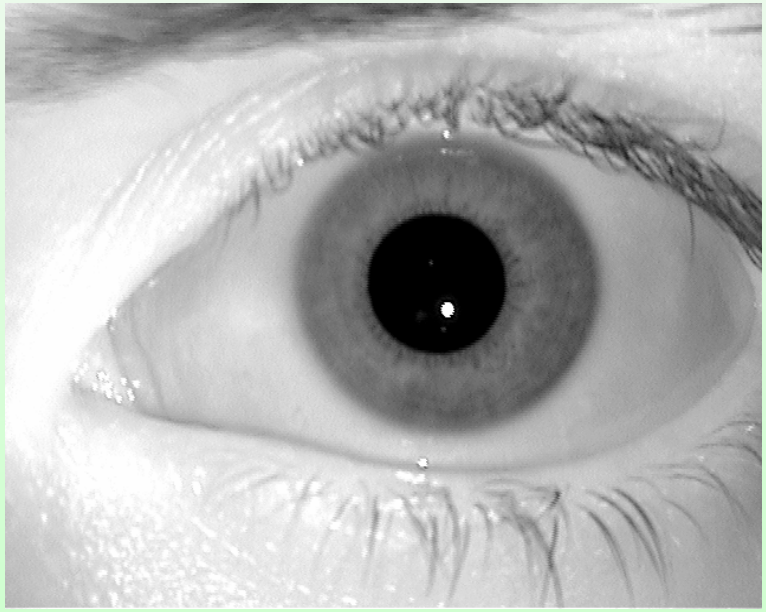
Iritech Inc.

Image characteristics

» Diverse image qualities

- Reasonably Sharp



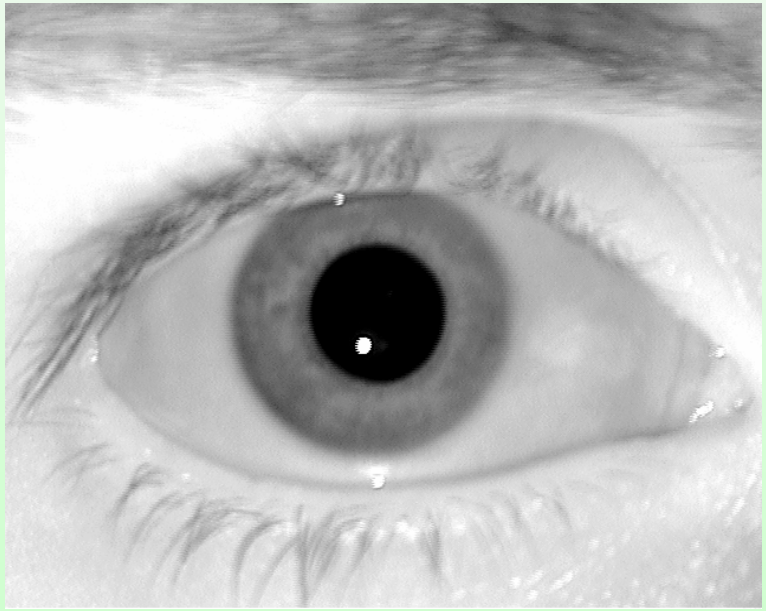


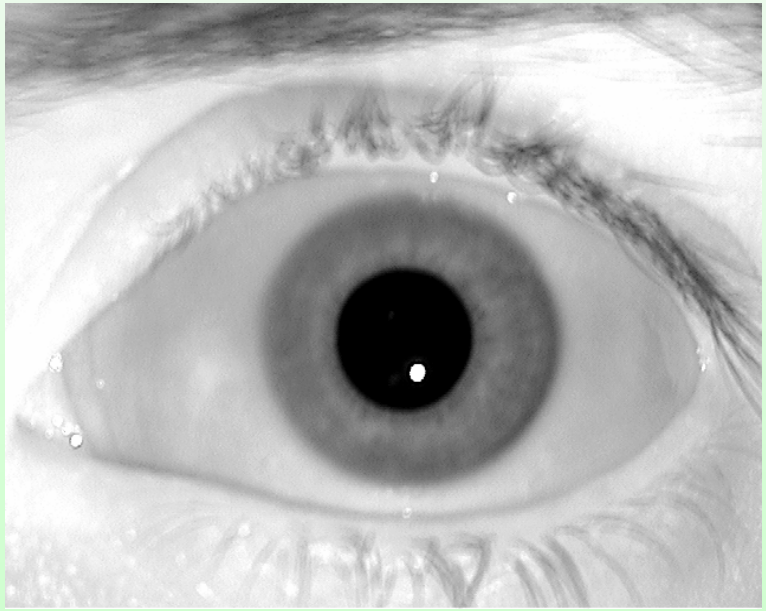
Iritech Inc.

Image characteristics

» Diverse image qualities

- Reasonably Blurry



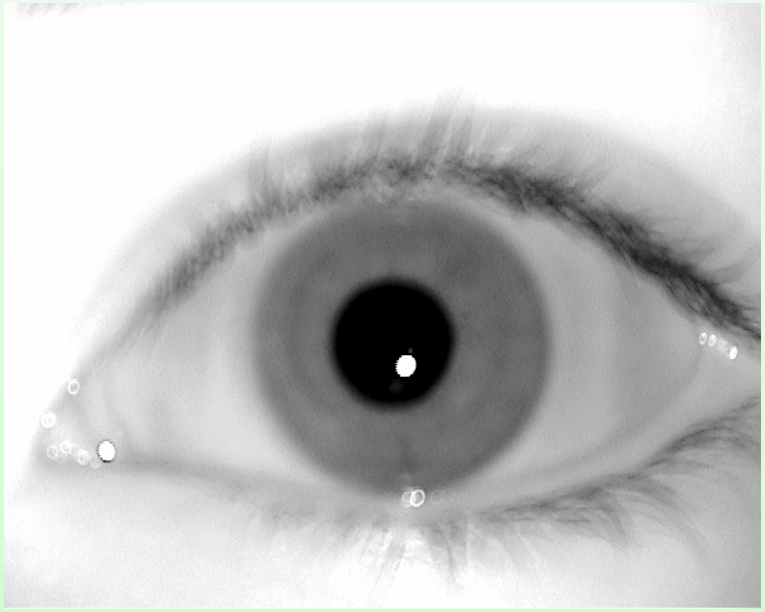


Iritech Inc.

Image characteristics

» Diverse image qualities

- Quite Blurry

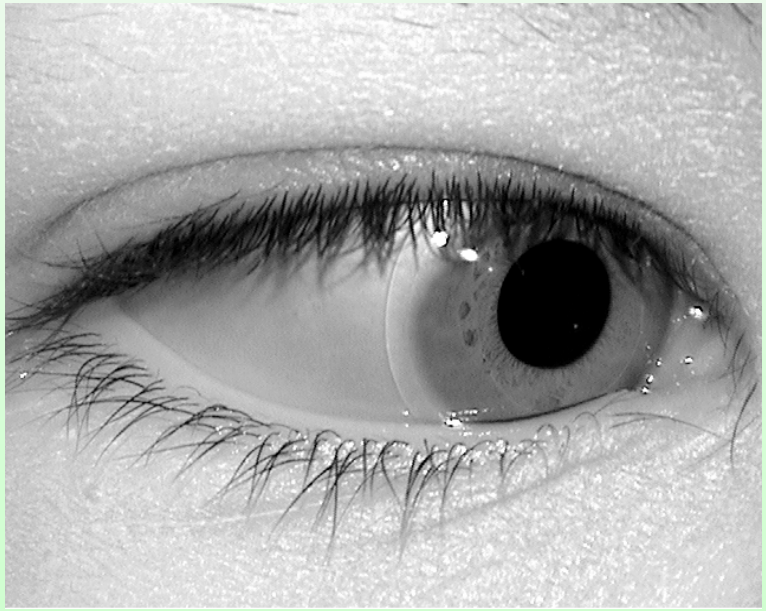


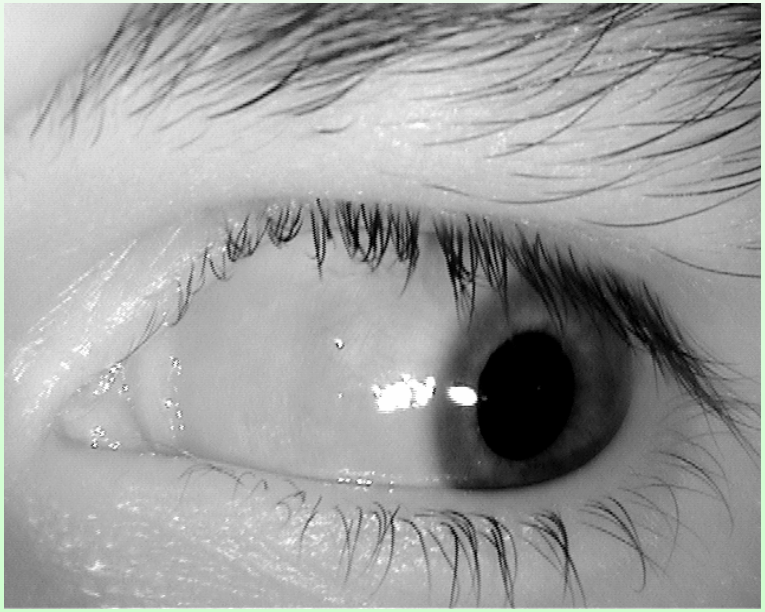
Iritech Inc.

Image characteristics

» Diverse image qualities

- Side Gazing





Iritech Inc.

Image characteristics

» Diverse image qualities

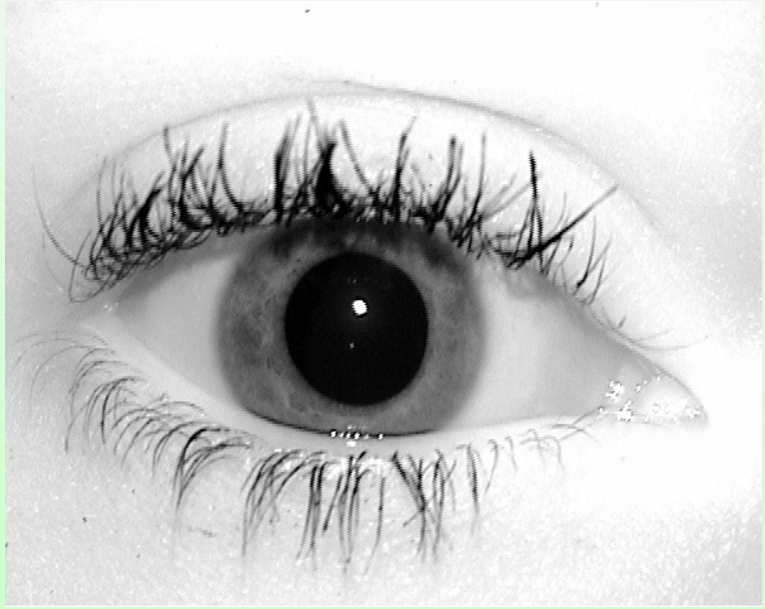
- Wearing Contact Lenses

Iritech Inc.

Image characteristics

» Diverse image qualities

- Reasonably Occluded



Iritech Inc.

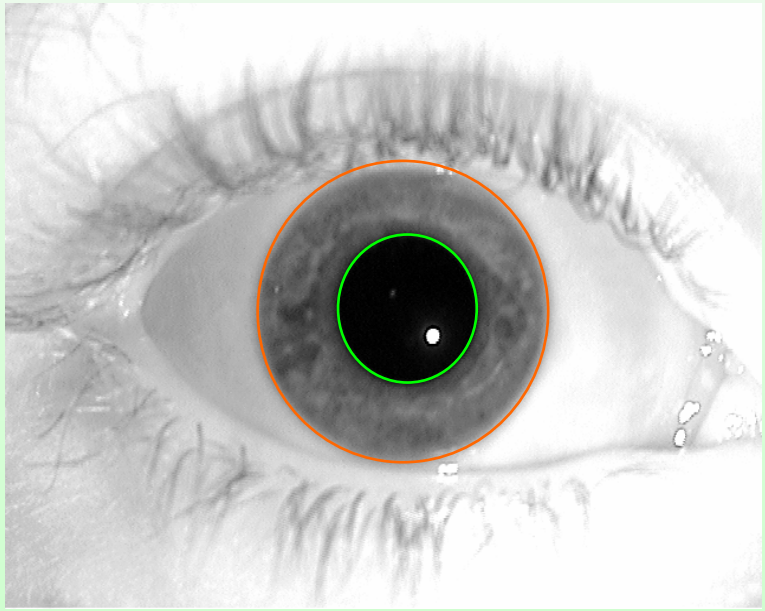
Image characteristics

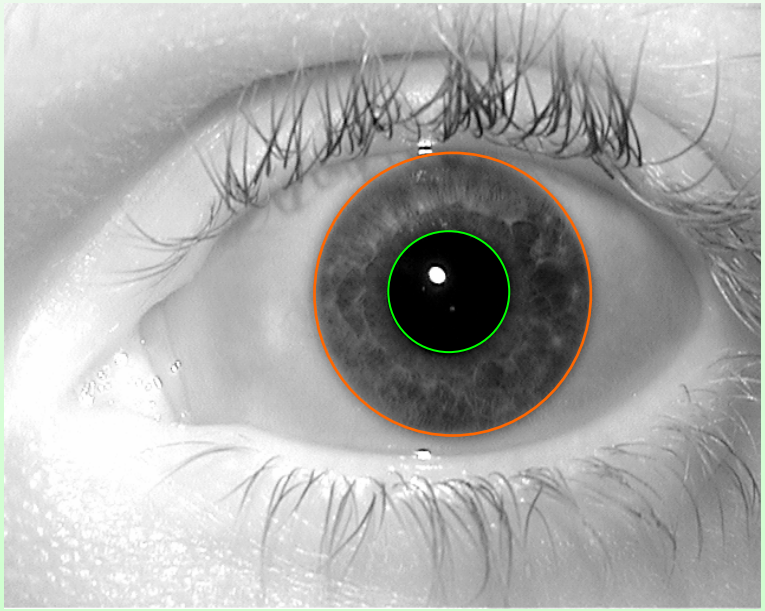
» Diverse image qualities

- Severely Occluded

Type A Test : Establishing the Bottom Line

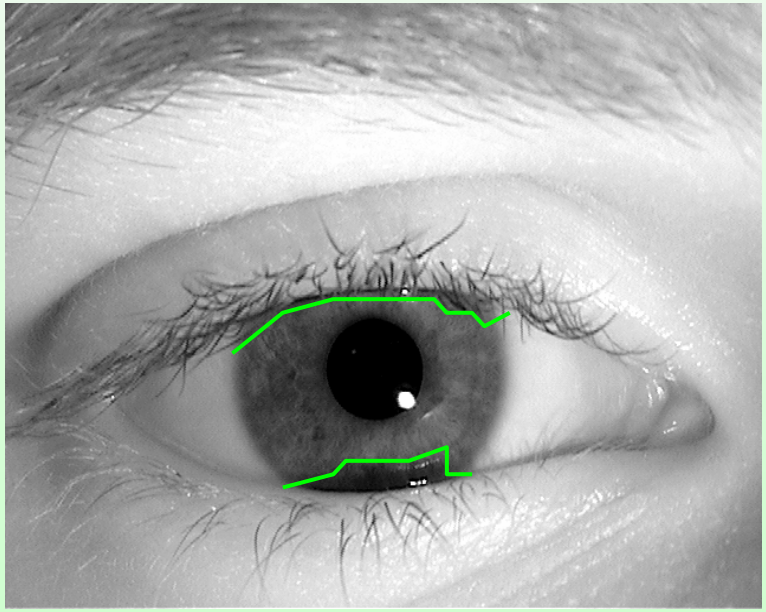
- Pupil/ Iris Border Detection : Manual

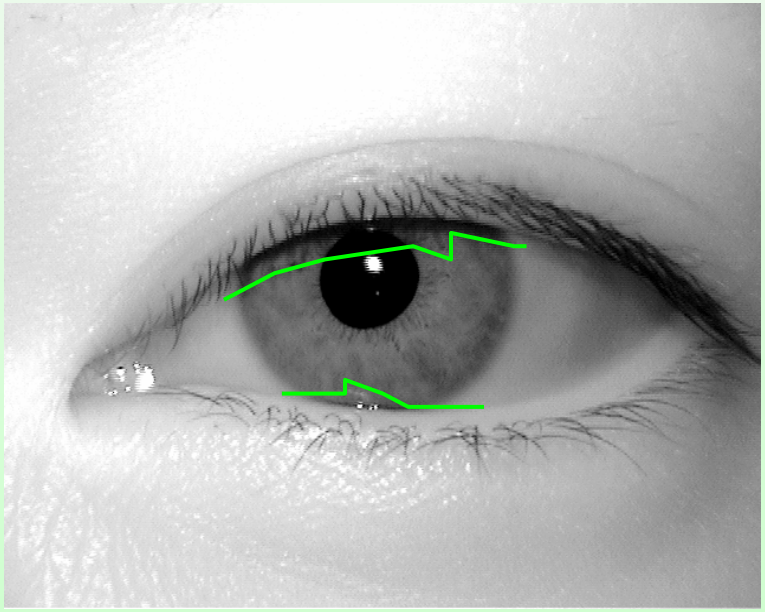




Type A Test : Establishing the Bottom Line

- Occlusion Location Estimation : Manual





Type A Test : Establishing the Bottom Line

- Image Selection
  - Group 1: All images
  - Group 2: All images except very blurry ones
  - Group 3: All images except side gazing ones
  - Group 4: All images except severely occluded one
  - Group 5: Intersection of groups 2, 3, and 4 above contains those images not rejected as very blurry, side gazing, or severely occluded

Iritech Inc.

Number of Images Rejected

	Group1	Group2	Group3	Group4	Group5
Right	0	9	5	8	22
Left	0	23	5	14	42

Iritech Inc.

Accuracy

	Group1	Group2	Group3	Group4	Group5
EER	0.0018	0.0015	0.0007	0.0016	0.0000
VR@FAR=0.001	0.9979	0.9984	0.9995	0.9983	1.0000

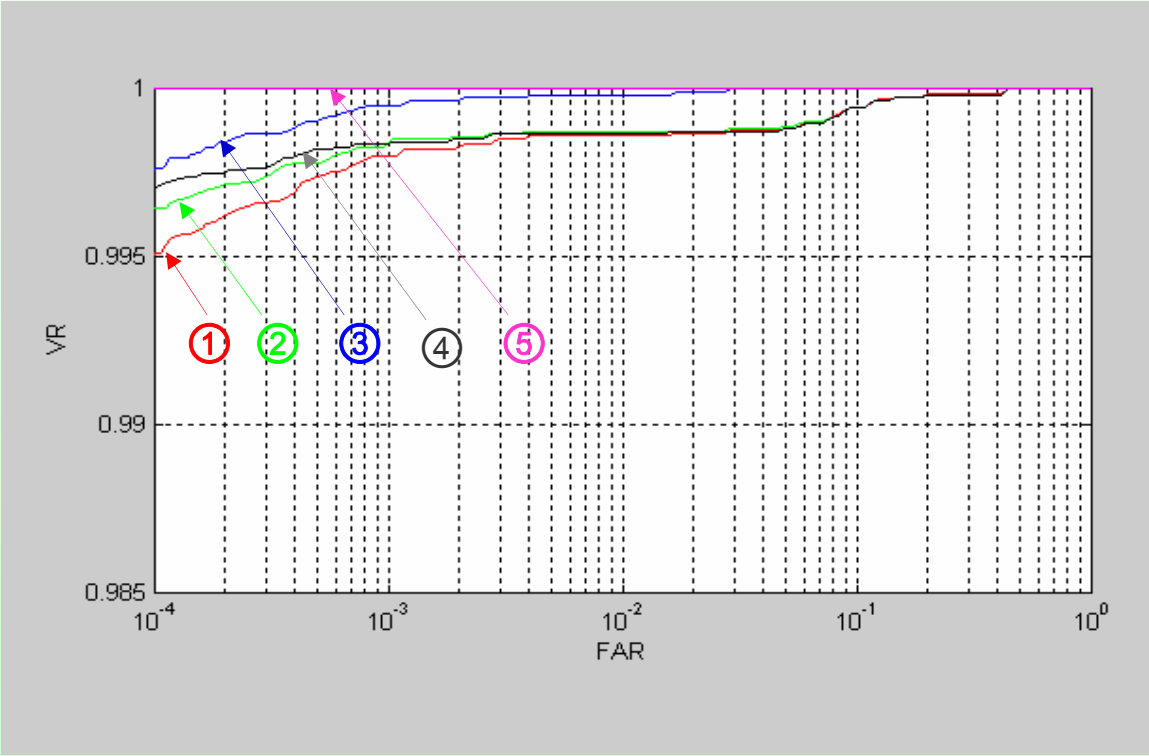
Right Eye Image

	Group1	Group2	Group3	Group4	Group5
EER	0.0054	0.0030	0.0037	0.0048	0.0001
VR@FAR=0.001	0.9928	0.9967	0.9951	0.9938	1.0000

Left Eye Image

Iritech Inc.

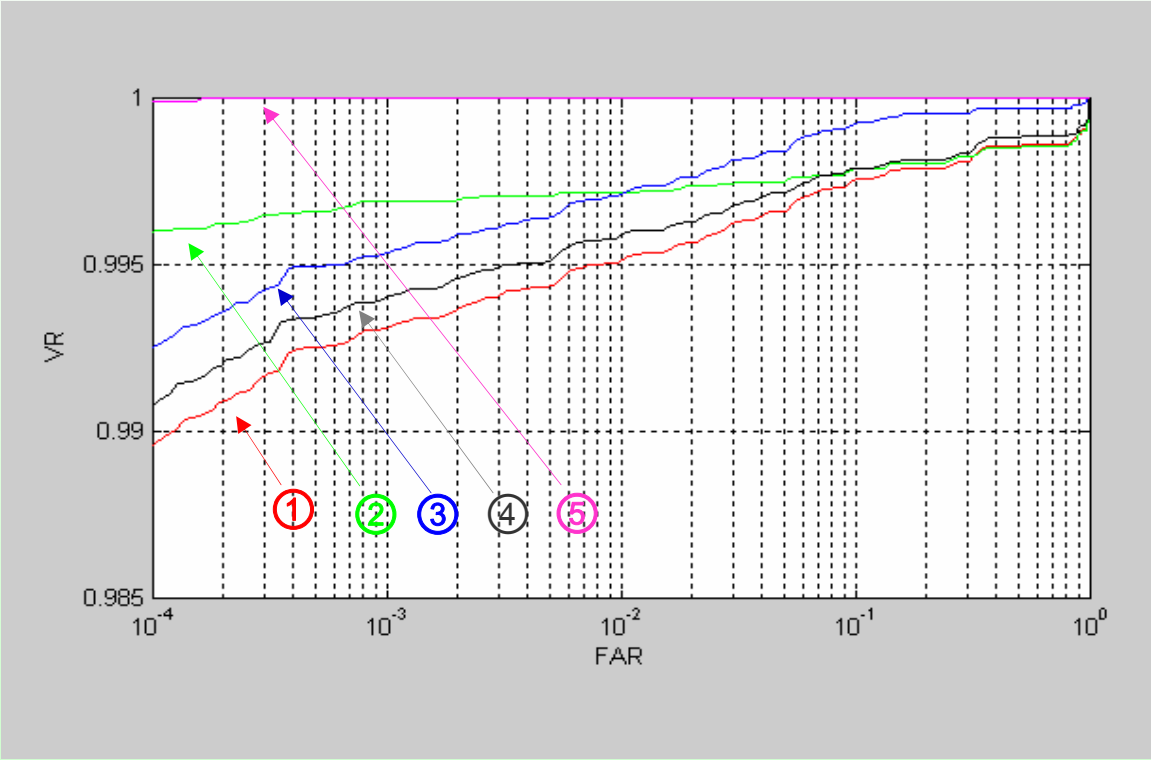
IQ ROC Curve – Right Eye Images



①: Group1
②: Group2
③: Group3
④: Group4
⑤: Group5

Iritech Inc.

IQ ROC Curve – Left Eye images



①: Group1
②: Group2
③: Group3
④: Group4
⑤: Group5

Type B Test

- Pupil/ Iris Border Detection : Automatic
  (Non-circular Boundary)
- Occlusion Location Estimation : Manual
- Image Selection : Manual
  - Group 1: All images
  - Group 2: All images except very blurry ones
  - Group 3: All images except side gazing ones
  - Group 4: All images except severely occluded one
  - Group 5: Intersection of groups 2, 3, and 4 above contains those images not rejected as very blurry, side gazing, or severely occluded

Iritech Inc.

Number of Images Rejected

	Group1	Group2	Group3	Group4	Group5
Right	0	9	5	8	22
Left	0	23	5	14	42

Iritech Inc.

Accuracy

	Group1	Group2	Group3	Group4	Group5
EER	0.0028	0.0025	0.0008	0.0026	0.0003
VR@FAR=0.001	0.9963	0.9970	0.9993	0.9970	0.9997

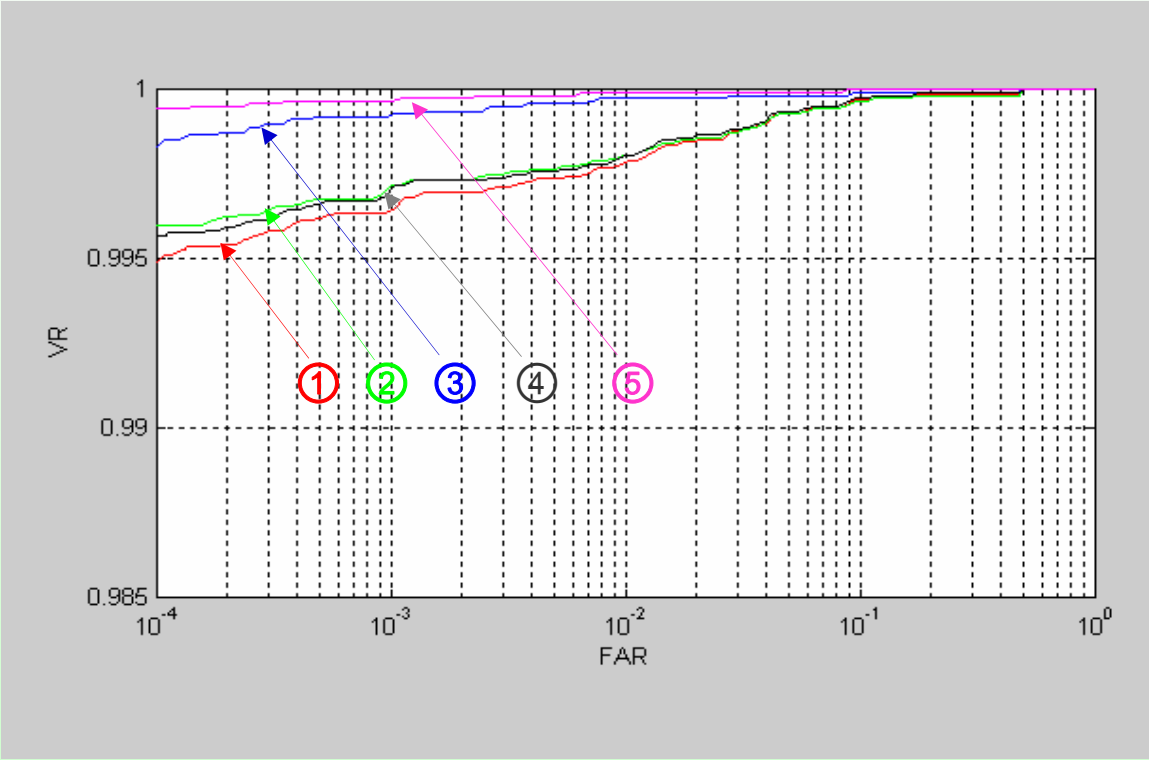
Right Eye Image

	Group1	Group2	Group3	Group4	Group5
EER	0.0070	0.0044	0.0056	0.0051	0.0003
VR@FAR=0.001	0.9910	0.9950	0.9930	0.9937	0.9999

Left Eye Image

Iritech Inc.

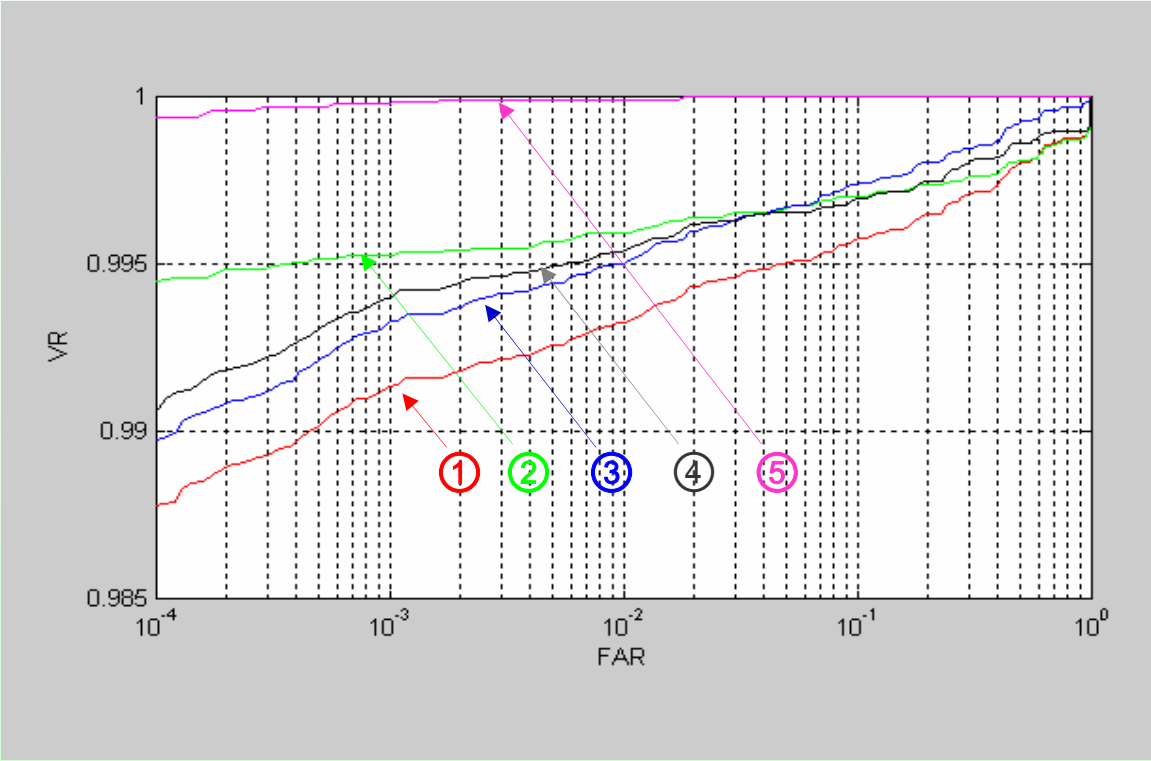
IQ ROC Curve – Right Eye Images



①: Group1
②: Group2
③: Group3
④: Group4
⑤: Group5

Iritech Inc.

IQ ROC Curve – Left Eye Images



①: Group1
②: Group2
③: Group3
④: Group4
⑤: Group5

Type C Test

- Pupil/ Iris Border Detection : Automatic
  (Non-circular Boundary)
- Occlusion Location Estimation : Manual
- Image Selection : Automatic by IQ Measure
  - Group 1: All images regardless of the QM value
  - Group 2: Images whose QM value >= 0
  - Group 3: Images whose QM value >= 1
  - Group 4: Right Images whose QM value >= 800
    Left Images whose QM value >= 750

Iritech Inc.

Number of Images Rejected

	Group1	Group2	Group3	Group4
Right	0	13	18	62
Left	0	10	20	81

Iritech Inc.

Accuracy

	Group1	Group2	Group3	Group4
EER	0.0028	0.0008	0.0007	0.0004
VR@FAR=0.001	0.9963	0.9992	0.9993	0.9997

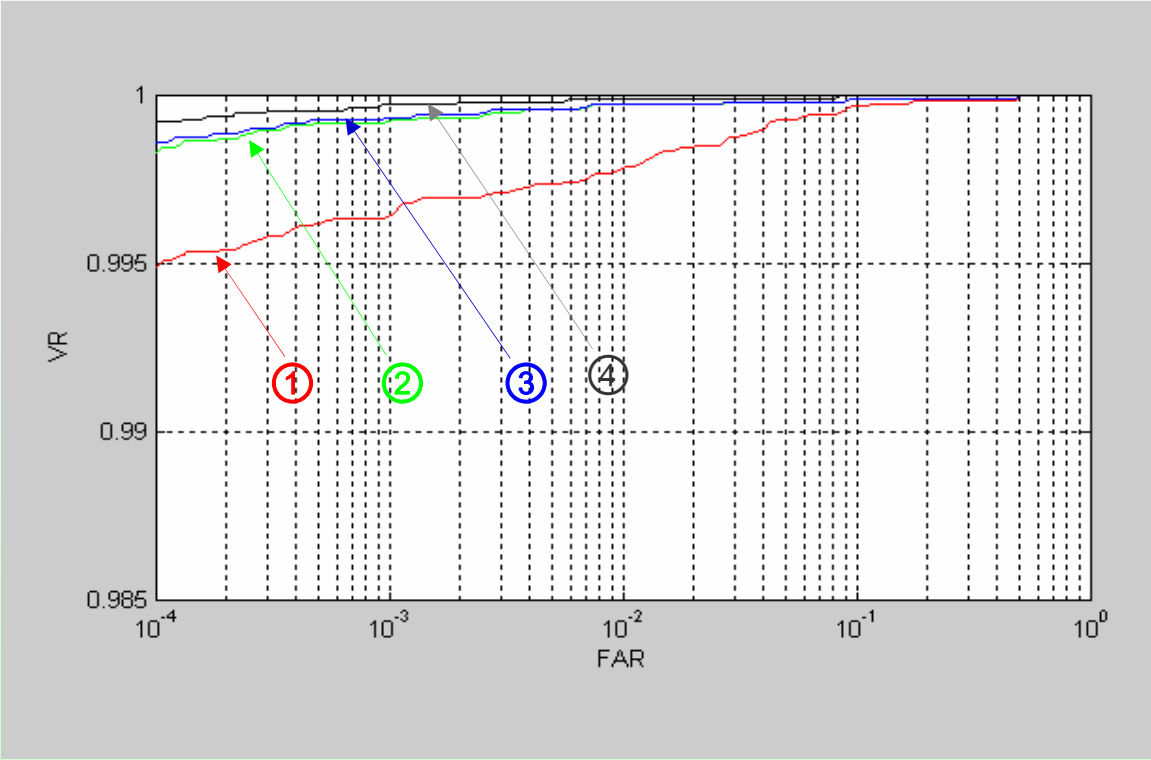
Right Eye Image

	Group1	Group2	Group3	Group4
EER	0.0070	0.0053	0.0044	0.0003
VR@FAR=0.001	0.9910	0.9933	0.9944	0.9998

Left Eye Image

Iritech Inc.

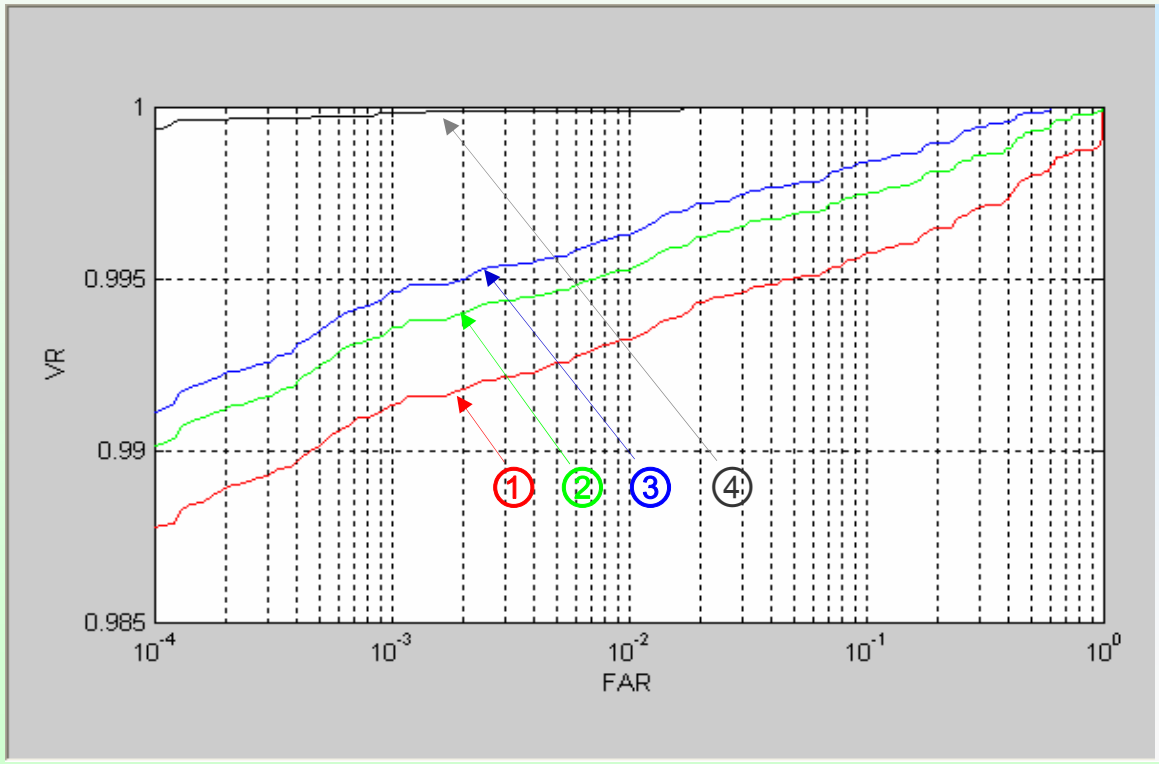
IQ ROC Curve – Right Eye Images



①: Group1
②: Group2
③: Group3
④: Group4

Iritech Inc.

IQ ROC Curve – Left Images



①: Group1
②: Group2
③: Group3
④: Group4

Type D Test : Fully Automatic Test

- Pupil/ Iris Border Detection : Automatic
  (Non-circular Boundary)
- Occlusion Location Estimation : Automatic
- Image Selection: Automatic by IQ Measure
  - Group 1: All images
  - Group 2: Images whose QM value >= 0
  - Group 3: Images whose QM value >= 1
  - Group 4: Right Images whose QM value >= 800
    Left Images whose QM value >= 750

Iritech Inc.

Number of Images Rejected

	Group1	Group2	Group3	Group4
Right	0	13	18	62
Left	0	10	20	81

Iritech Inc.

Accuracy

	Group1	Group2	Group3	Group4
EER	0.0035	0.0016	0.0015	0.0006
VR@FAR=0.001	0.9953	0.9982	0.9984	0.9994

Right Eye Image

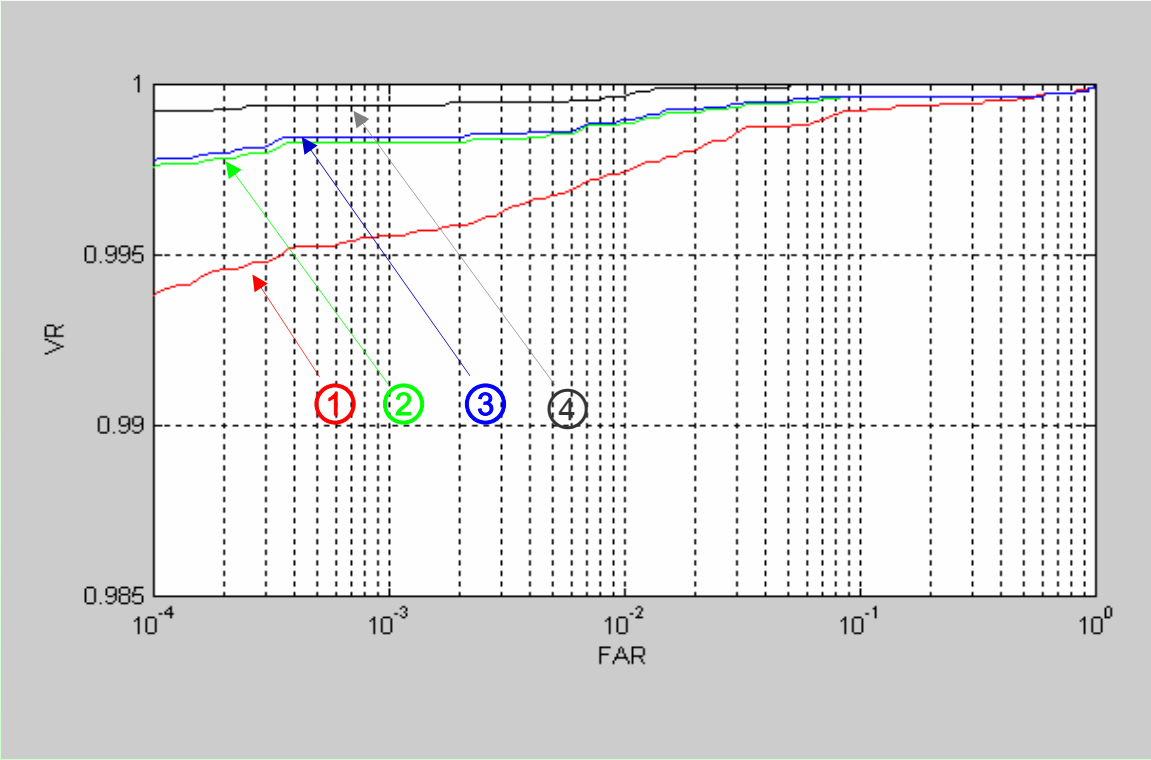
	Group1	Group2	Group3	Group4
EER	0.0069	0.0049	0.0042	0.0007
VR@FAR=0.001	0.9906	0.9939	0.9946	0.9995

Left Eye Image

Type D Test

Iritech Inc.

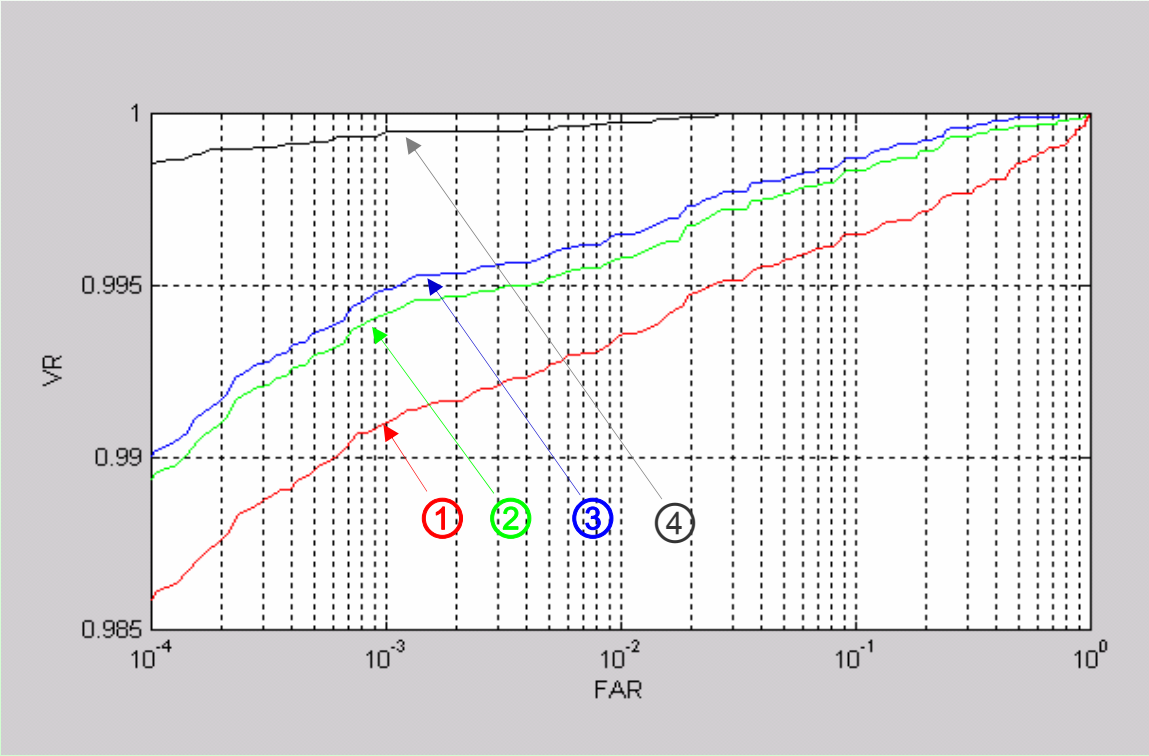
IQ ROC Curve – Right Eye Images



①: Group1
②: Group2
③: Group3
④: Group4

Iritech Inc.

IQ ROC Curve – Left Eye Images



①: Group1
②: Group2
③: Group3
④: Group4

Iritech Inc.

The Conclusion

- Iritech algorithm is rather robust and quite accurate
- Automatic pupil & iris border detection has very minor adverse impact on accuracy
- Automatic occlusion location estimation has minor adverse impact on accuracy
- Image quality has major impact on accuracy
  - Image quality measure still has room for improvement

Iritech Inc.

The Conclusion

- In order to improve the accuracy and robustness of iris recognition, it is necessary to use
  - Both eye
  - Multiple frames
  - Utilize more sophisticated decision process rather than a simplistic single scalar quantity to describe the image quality