GIRIST QUICK START USER GUIDE

v 1.0 beta

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1 Introduction

GIRIST (GRUS IRIS TOOL) is a free iris recognition software by **GRUSOFT,** whose performance is comparable to the best commercial systems. It's based on the novel Giris SDK,

1.1 Some Key Features of GIRIST

- Average Decidability > 6.0
- Average Correct Recognition Rate >95%
- When FAR=0.01%, average FRR=5%
- Average Extraction time <0.4s
- Match rate>50000 irises/second
- Handle noises such as eyelash, eyelids and strong reflections(Figure 16)
- Upper limit of Rotation Angle: ±15 degrees
- No limits on size of iris.
- Unlimited database size
- Three mode: iris authentication, iris identification and iris library verification
- Interactive graphical user interface(Figure 1)

The performance of GIRIST has been verified by the datasets of CASIA, UBIRIS and MMU IRIS. And the testing CPU is Intel Core 2.0 GHz.

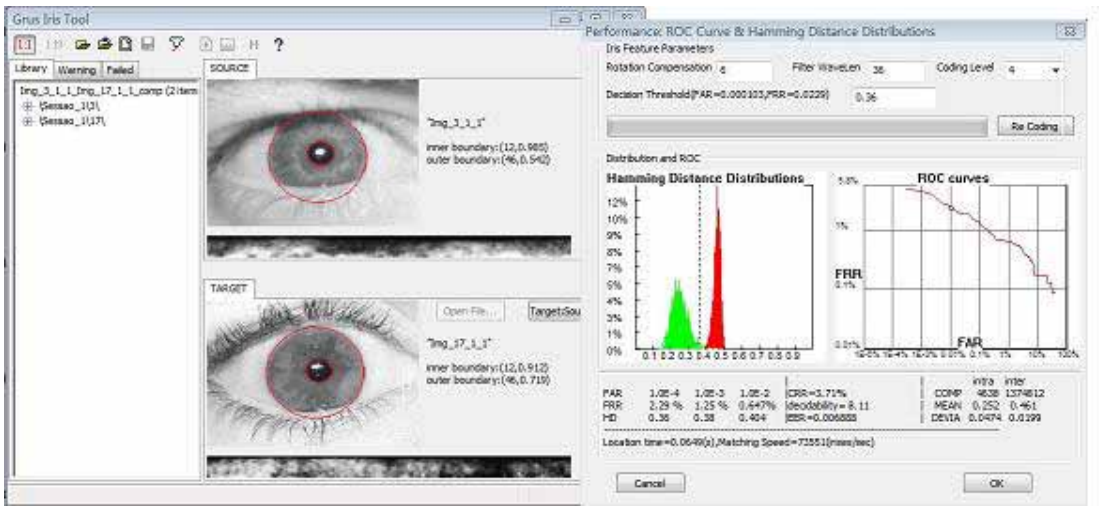

Figure 1 graphical user interface of Girist

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1.2 Iris Recognition Overview

Personal identification based on iris recognition is one of the most reliable biometric identification techniques since the iris of each eye is unique. No two irises are same in their texture detail. Even twins has nearly same DNA, fingerprints, their iris is different. This has been verified by CASIA-twins dataset.

There are some advantages and disadvantages you should know. The following is quoted from http://en.wikipedia.org/wiki/Iris_scan.

1.2.1 Advantages

It is an internal organ that is well protected against damage and wear by a highly transparent and sensitive membrane (the cornea). This distinguishes it from fingerprints, which can be difficult to recognize after years of certain types of manual labour.

The iris is mostly flat and its geometric configuration is only controlled by two complementary muscles (the sphincter papillae and dilator papillae), which control the diameter of the pupil. This makes the iris shape far more predictable than, for instance, that of the face.

The iris has a fine texture that – like fingerprints – is determined randomly during embryonic gestation. Even genetically identical individuals have completely independent iris textures, whereas DNA (genetic "fingerprinting") is not unique for the about 1.5% of the human population who have a genetically identical monozygotic twin.

An iris scan is similar to taking a photograph and can be performed from about 10 cm to a few meters away. There is no need for the person to be identified to touch any equipment that has recently been touched by a stranger, thereby eliminating an objection that has been raised in some cultures against finger-print scanners, where a finger has to touch a surface, or retinal scanning, where the eye can be brought very close to a lens (like looking into a microscope lens).

While there are some medical and surgical procedures that can affect the colour and overall shape of the iris, the fine texture remains remarkably stable over many decades. Some iris identifications have succeeded over a period of about 30 years.

1.2.2 Disadvantages

Iris scanning is a relatively new technology and is incompatible with the very substantial investment that the law enforcement and immigration authorities of some countries have already made into fingerprint recognition.

Iris recognition is very difficult to perform at a distance larger than a few meters and if the person to be identified is not cooperating by holding the head still and looking into the camera.

As with other photographic biometric technologies, iris recognition is susceptible to poor image quality, with associated failure to enroll rates.

As with other identification infrastructure (national residents databases, ID cards, etc.), civil rights activists have voiced concerns that iris-recognition technology might help governments to track individuals beyond their will.

2 Tutorial

There are three modes.

1) Iris authentication (one-to-one matching): that is to distinguish the people whether they are the same person.

2) Iris library verification (many-to-many matching): that is to sure the library is reliable and usable.

3) Iris identification (one-to-many matching): that is to find a person's identity from a library.

This tutorial will use the first section of famous UBIRIS.v1, which can be downloaded from http://iris.di.ubi.pt/ubiris3.zip (UBIRIS[2] is password protected To obtain the **password**, please see http://iris.di.ubi.pt/ubiris1.html .) Unzip all files to disk C. There are two distinct sections and the file folder "C:\UBIRIS_200_150_R\Sessao_1" includes the files of first section.

2.1 Iris Authentication

Press the 1:1 button on the toolbar. Then select two files: one is "C:\UBIRIS_200_150_R\Sessao_1\3\Img_3_1_1.jpg" and the other is "C:\UBIRIS_200_150_R\Sessao_1\17\Img_17_1_1.jpg". Figure 2 shows the authentication result (IRIS_AUTHEN_FAIL.).

There are two results: IRIS_AUTHEN_OK: if they are from one person; IRIS_AUTHEN_FAIL: if they are from two persons (or from two eyes of one person).

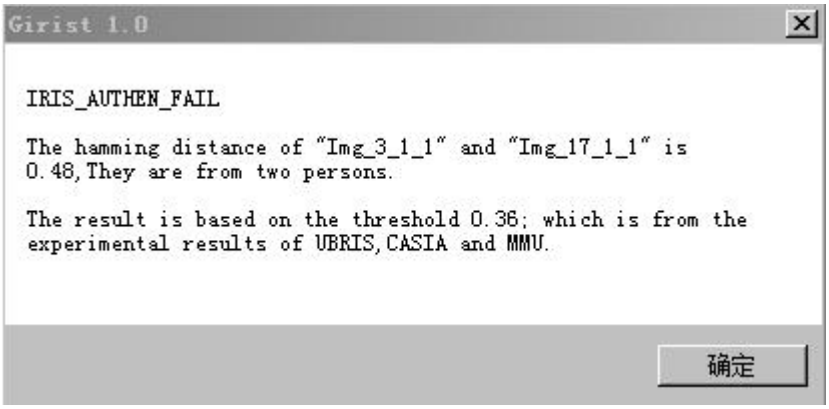


Figure 2 A message box shows the results of iris authentication

Note: The decision threshold is 0.36; which is from the experimental results of UBRIS, CASIA and MMU.

Figure 3 shows interface of iris authentication. You can see both eyes and normalized irises.

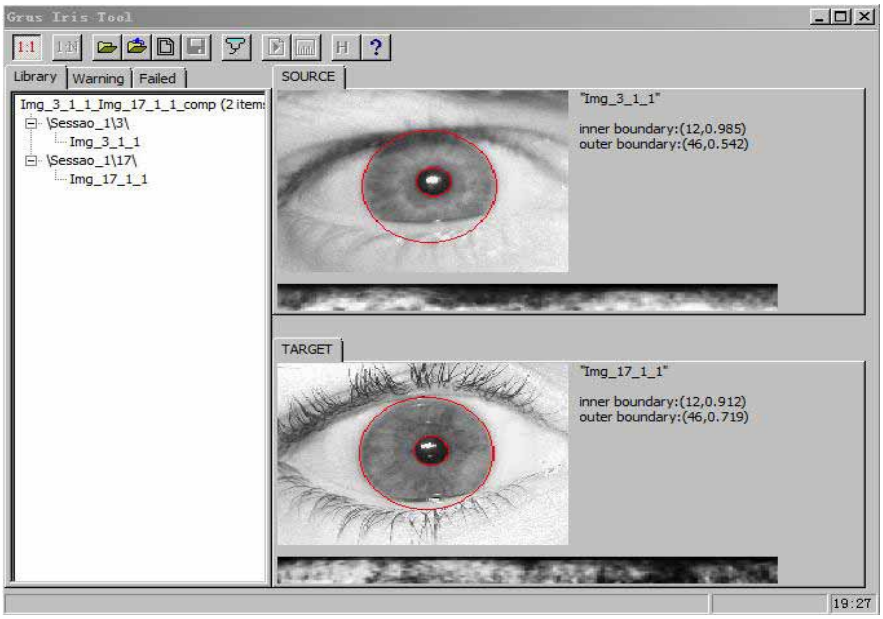


Figure 3 GUI interface of iris authentication

2.2 Iris Library Verification

Basically, iris verification is an important and necessary step before iris identification.

It's hard to guarantee that all pictures are good quality. There will be noises such as eyelash, eyelids and strong reflections, which will reduce recognition rate. So it's important to sure the iris library is reliable and usable. For those libraries with low quality, we can add or remove some pictures to get a much better one.

There are some objects of iris library verification.

First, the uniqueness of iris library should be confirmed, that is, the mean of the inter-class distribution should be around 0.5.

Second, there should be a distinct separation of intra-class and inter-class Hamming distance distributions.

Third, the ROC curves should be reasonable, that is, a reasonable FRR to small FAR.

After create an iris library, Girist will build the library. That is, not only extract iris feature and coding, but also compare all to test its performance. GIRIST also shows poor quality pictures and those bad pictures that have no iris! So help users to modify and improve the quality of library.

2.2.1 Create a library

Press the  button on the toolbar to open path dialog. You should select the path where the iris files stores. In this tutorial, its "C:\UBIRIS_200_150_R\Sessao_1". Then GIRIST load all images in the Library tab (see fig.4).

The first line shows that this library has 1214 items.

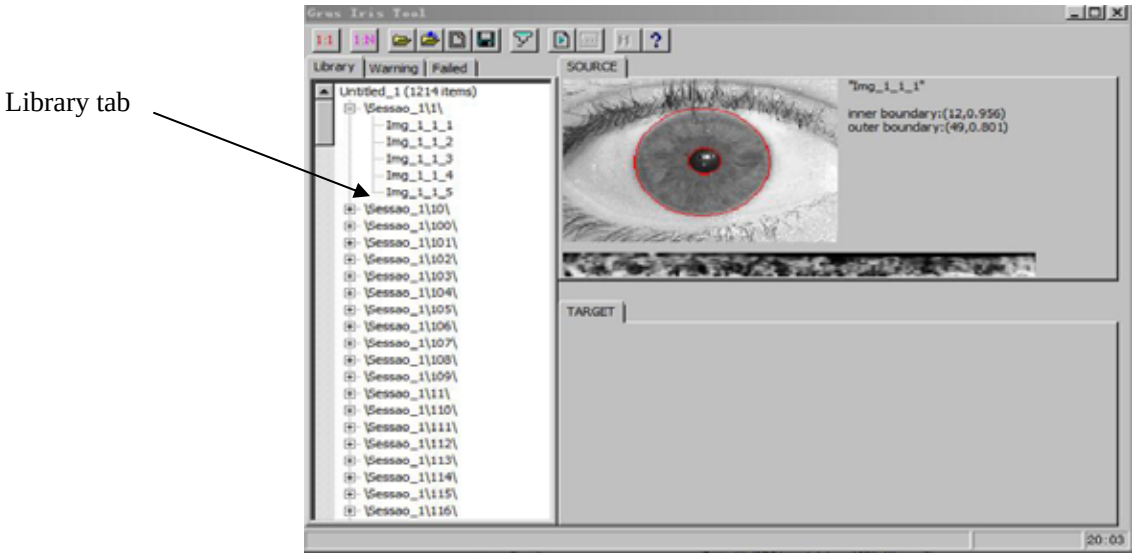


Figure 4 Create a library and open one iris

Note: grayscale images.

GIRIST only support grayscale images now.

Note: one folder-one eye structure.

There is a one folder-one eye structure in the directory of UBIRIS. That is: all the picture of one eye should be in one file folder. And this file folder contains no images of other eye. Both CASIA-3 and MMU also have this one folder-one eye structure.

When use GIRIST, the dataset should have this one folder-one eye structure.

2.2.2 Build library

Press the  button on the toolbar.

The building process includes iris location, normalization, feature extraction, coding and library verification. The progress bar and the information window show the progress of the build process.

There is a performance button to open performance dialog.

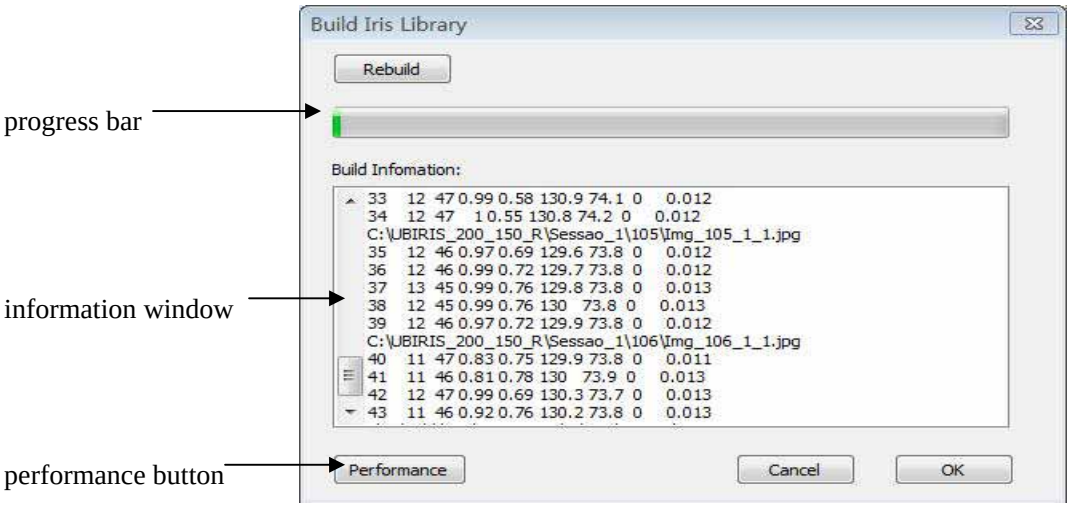


Figure 5 Build a library

2.2.3 Iris Lib performance

Press the  button on the toolbar to open performance dialog

There are two graphs, left is hamming distance distribution and the right is ROC curves. As you see, the mean of the inter-class distribution is 0.461, which confirm the uniqueness of this library. There is a distinct separation of intra-class and inter-class Hamming distance distributions, which is 0.36. It's a good decision threshold. The ROC curve has reasonable FRR with small FAR. That is, let FAR=1.0e-4, then FRR = 2.29%.

You can see many parameters in the three columns parameter window. For example, the decidability is 8.11, which is good compared to other commercial software. For the detail of performance dialog, see section 3. The detail of these parameters is explained in the experimental results.

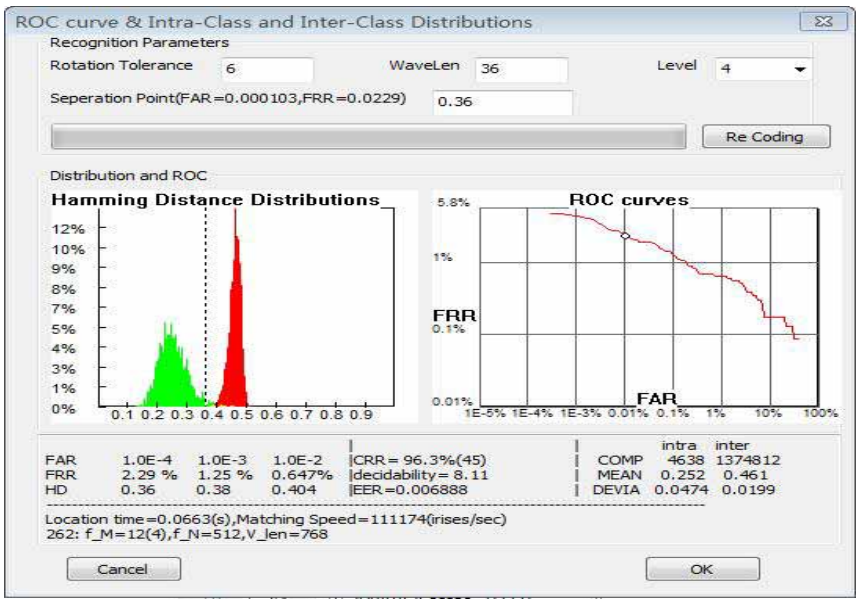


Figure 6 Performance Dialog

There are also two buttons to save lib and close lib.

2.2.4 Save library

Press the  button on the toolbar. Save this library as "UBIRIS_1.ilb".

Note: The suffix of saved library is "ilb".

2.2.5 Close library

Press the  button on the toolbar.

2.3 Iris Identification

Press the  button to open the "UBIRIS_1.ilb". Then press the  button on the toolbar. Then open file "C:\UBIRIS_200_150_R\Sessao_1\11\ Img_11_1_2.jpg". Girist will compare this eye to each eye in the library. Figure 7 Show the result. The iris with minimum hamming distance will be showed in the source tab. If this distance is less than the decision threshold, the identification result is IRIS_IDENTIFY_OK. Otherwise, the result is IRIS_IDENTIFY_FAIL.

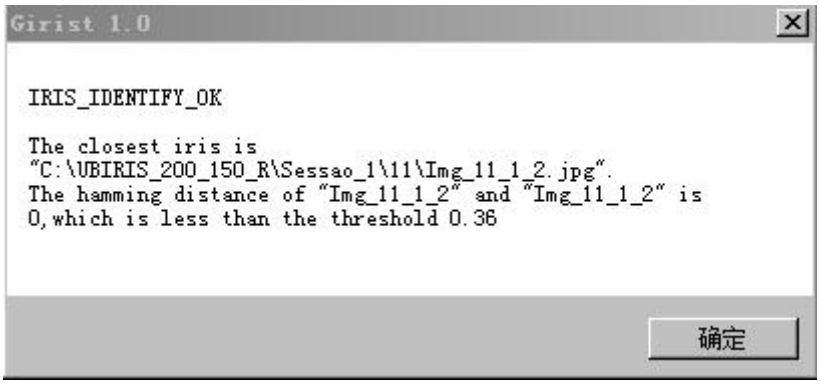


Figure 7 A message box shows the results of iris identification

Note: The result is determined by the threshold of the library. You can change this threshold parameter to change the result.

3 Graphical User Interface

3.1 GIRIST Screen Elements

Fig 8 shows the main elements of GIRIST.

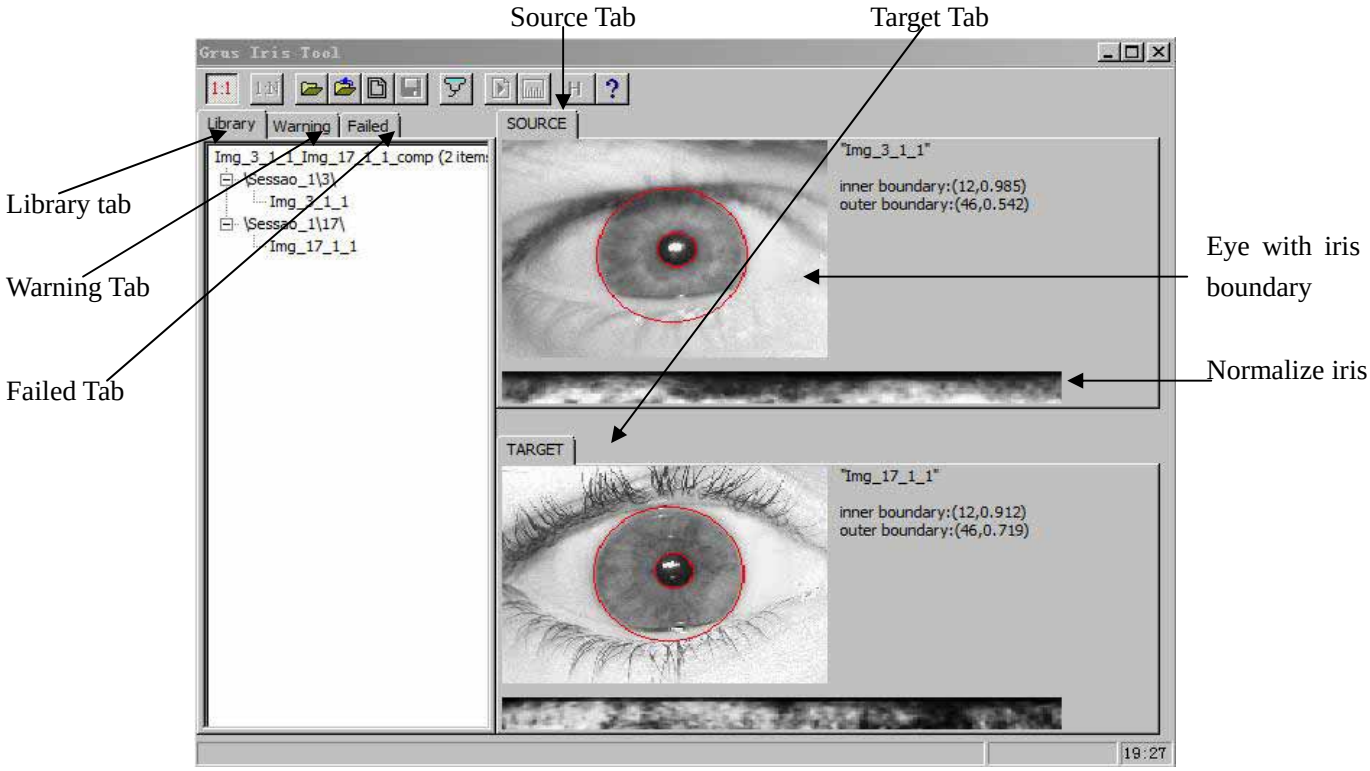


Figure 8 GUI Elements

3.1.1 The Main Toolbar

Iris Authentication

Iris Identification

Open Library

Close Library

Create Library

Save Library

 Library Information

 Build Library

 Library Performance

 Help

 About

There are five tabs, that is:

3.1.2 Library Tab, Warning Tab, Failed Tab

Library Tab lists all eyes of library.

Warning Tab lists eyes that may contain errors.

Failed Tab lists eyes that GIRIST failed to process. User should delete these eyes from library.

3.1.3 Source Tab, Target Tab

Source Tab shows eyes selected by user. It also shows the source of iris Authentication and iris identification.

Target Tab shows the target of iris Authentication and iris identification.

Both tabs show two images. One is the eye with red circle which show the boundary of iris. The other is the normalized iris from which the feature is extracted.

3.2 Performance Dialog

Figure 9 shows the performance dialog

There are 3 feature parameters, which can be modified to get better recognition rate.

1) **Rotation Compensation**:

The orientations of eyes are slightly different. So rotation is needed to get correct distance of tow irises. The default rotation angle is -6~6(degree). The upper limit angle is -15~15(degree).

2) **Filter WaveLen**:

Wavelength is a key parameter of Gabor filer which used to extract features. The default value is 36.

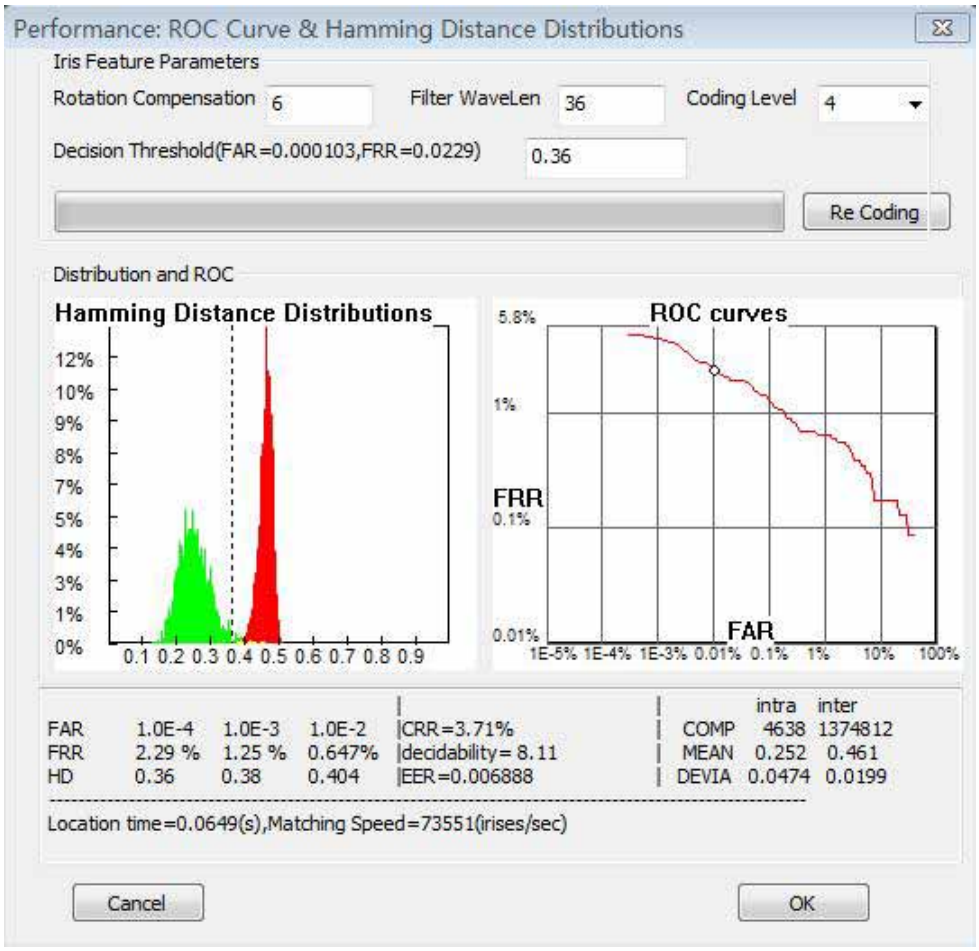
3) **Coding Level**:

There are four levels: 1,2,4,8. Default value is 4. Higher the level, smaller the size of database.

There are many factors related to the library quality. It's hard to decide the best value for all datasets. So user can change these to get best value for their dataset. After change these parameters, user should press "Re Coding" Button to change library.

Feature Parameters

Decision Threshold



ReCoding Button

Parameter Window

Figure 9 Performance Dialog

The default **Decision Threshold** is the hamming distance at which point FAR is 1.0E-4. User can change this value, which will affect the result of iris identification.

The **Hamming Distance Distributions graph** shows the distribution of inter-class (in red color) and intra-class (in green color).

The **ROC curve** shows the relationship between the FRR and FAR.

The Parameter Window list the value of parameters. There are three columns. The first column lists some key point of ROC curves. That is, when FAR=1.0e-4, 1.0e-3, 1.0e-2, the corresponding FRR and hamming distance value. The second column lists CRR, decidability and EER. The third column lists the comparison number of intra-class and inter-class. As you see, it needs millions comparisons to get these parameters. So the speed is an important factor. This column also shows the mean value and deviation of both classes.

4 Experimental Results

4.1 GIRIST Parameters

GIRIST supports follow parameters of iris recognition.

CRR:

Correct Recognition Rate

FAR

The false accept rate (FAR), measures the probability of an individual being wrongly identified as another individual.

FRR

The false reject rate (FRR), measures the probability of an enrolled individual not being identified by the system.

Decision Threshold:

If the hamming distance of two irises greater than this threshold, they are from different eye. Otherwise they are from the same eye. The default value is 0.36, which is from experimental results.

ROC (receiver-operating characteristic)

ROC is a graphical depiction of the relationship between the FRR and FAR. ROC curve helps to demonstrate how increasing or decreasing the decision threshold's value affects tradeoffs between FRR and FAR. The ROC curve is represented in a logarithmic scale.

ERR (Equal Error Rate)

When increase threshold value, the FAR will increase and FRR will decrease. ERR is the value which FAR=FRR.

Decidability

$$d' = \frac{|\mu_S - \mu_D|}{\sqrt{(\sigma_S^2 + \sigma_D^2)}}$$

Decidability *d'* is a distance measured in standard deviations and is a function of the magnitude of difference between the mean of the intra-class distribution μ_D, and the mean of the inter-class distribution μ_s, and also the standard deviation of the intra-class and inter-class distributions, σ_S, σ_D respectively. The higher the decidability, the greater the separation of intra-class and inter-class distributions, which allows for more accurate recognition.

Extraction time

The time of iris location and feature extraction.

Matching rate

The number of iris comparisons in a second.

4.2 Experimental Results

The performance of the GIRIST was tested on 6 datasets, 3 of CASIA*, 2 of UBIRIS and MMU. Table 1 lists the detail of these datasets. Table 2 lists the experimental results. As you see, GIRIST is fast and stable. GIRIST can handle noises such as eyelash, eyelids and strong reflections(Figure 16).

Table 1 iris datasets

database	No of Images	No of Classes	Image size	Intra-Class Comparisons	Inter-Class Comparisons	characteristic
CASIA-IrisV3-Interval	2655	396	320*280	18042	7028328	Very good image quality with extremely clear iris texture details
CASIA-IrisV3-Lamp	16213	819	640*480	306218	262538938	Nonlinear deformation due to variations of visible illumination
CASIA-IrisV3-Twins	3183	400	640*480	24756	10103550	The first publicly available twins' iris image dataset
UBIRIS_1 [2] [3]	1214	241	200*150	4634	1377166	to minimize noise factors, specially those relative to reflections, luminosity and contrast,
UBIRIS_2 [2] [3]	662	241	200*150	1990	301060	to introduce natural luminosity factor. This propitiates the appearance of heterogeneous images with respect to reflections, contrast, luminosity and focus problems.
MMU1 iris[4]	450	90	320*240	1800	200250	

Note There will be small change of Intra-Class Comparisons and Inter-Class Comparisons.

Table 2 Experimental Results

database	CRR	FAR/FRR			decidability	Extraction time(s)	Matching Rate	ERR(SEP)
		0.01%	0.1%	1%				
CASIA-IrisV3-Interval	95.2%	4.8%	2.8%	1.6%	6.26	0.13	114339	0.02(0.417)
CASIA-IrisV3-Lamp	88%	9.2%	5.98%	3.18%	5.3	0.5	111942	0.024(0.42)
CASIA-IrisV3-Twins	90.2%	13.4%	9.09%	5.1%	4.92	0.43	112356	0.03(0.418)
UBIRIS_1	96.3%	2.3%	1.25%	0.65%	8.11	0.07	73551	0.006(0.40)
UBIRIS_2	75%	8.5%	5.04%	2.52%	6.59	0.08	41181	0.02(0.40)
MMU iris	98.9%	9.22%	6.11%	3.67%	5.77	0.1	41625	0.03(0.408)

Note:

1 Due to Rotation Compensation, the mean Hamming distance for inter-class distribution will be slightly lower than 0.5.

2 The Extraction Time is related to image size.

* Portions of the research in this experiments use the CASIA-IrisV3 collected by the Chinese Academy of Sciences' Institute of Automation (CASIA)[1].

3 Poor results of UBIRIS_2: Because it contains much more noise than other datasets. Some pictures of UBIRIS_2 have no iris at all! Fig17 shows some picture that GIRIST failed to recognize. The user's dataset will contain these noises too. So it's important that iris software should have mode of iris library verification.

4 Interesting results of CASIA-IrisV3-Twins: Although no irises of twins are identical. There are still some weak similarities. As you see, all index of twins' dataset are lower than other CASIA datasets. It's reasonable but hard to index. So is there any robust index to identify twins from other people?

Fig 10~ Fig15 list the corresponding ROC curves and Hamming Distance Distribution.

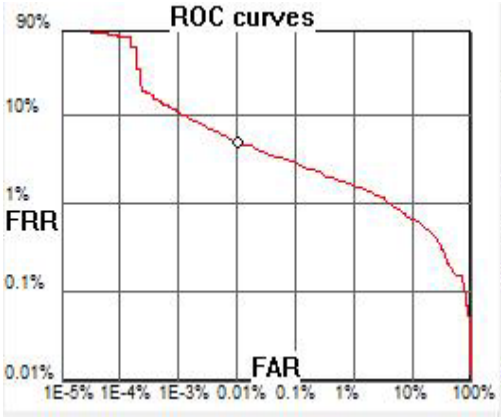


Fig 10 ROC of CASIA-IrisV3-Interval

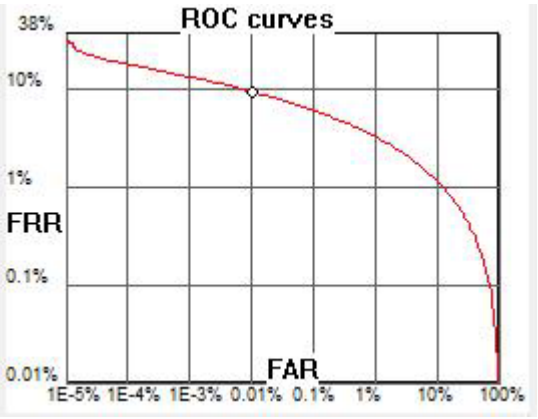


Fig 11 ROC of CASIA-IrisV3-Lamp

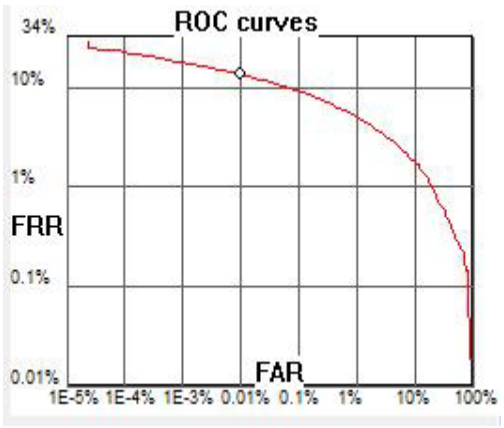


Fig 12 ROC of CASIA-IrisV3-Twins

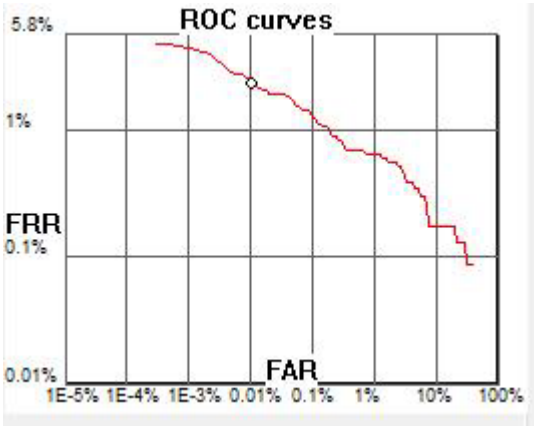


Fig 13 ROC of UBIRIS_1

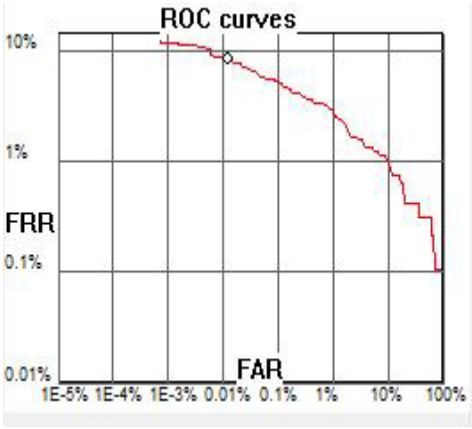


Fig 14 ROC of UBIRIS_2

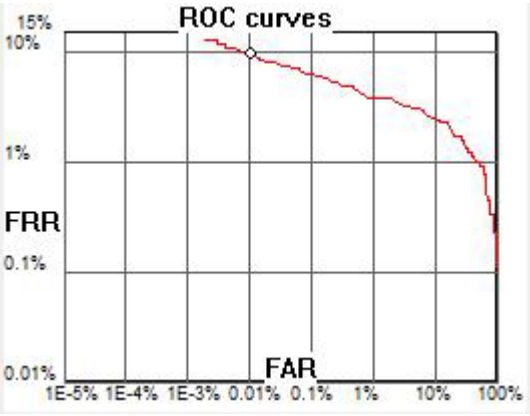


Fig 15 ROC of MMU

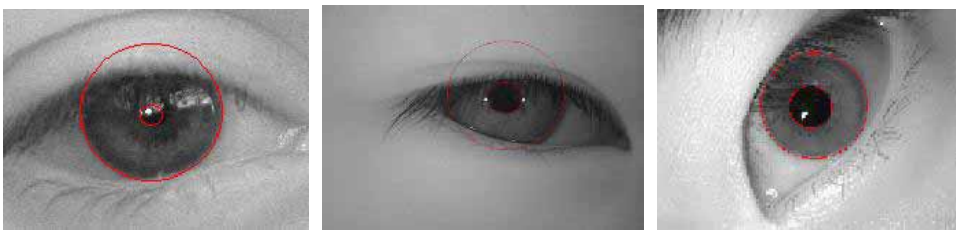


Fig16 Three eyes with strong noises which recognized by GIRIST.

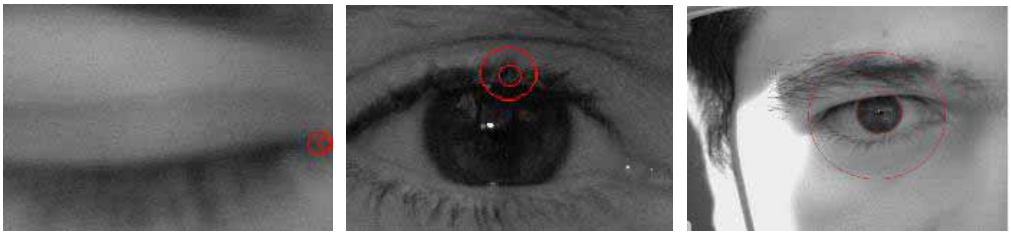


Fig17 Three eyes of UBIRIS_2 which GIRIST failed to recognize

Reference

[1] CASIA-IrisV3, http://www.cbsr.ia.ac.cn/IrisDatabase.htm

[2] UBIRIS.v1, http://iris.di.ubi.pt/

[3] H. Proença and L.A. Alexandre, “UBIRIS: A Noisy Iris Image Database,” Proc. 13th Int'l Conf. Image Analysis and Processing, pp. 970-977.

[4] MMU1 iris database, http://pesona.mmu.edu.my/~ccteo/index.htm

[5] http://en.wikipedia.org/wiki/

Appendix Giris SDK

Giris is a high performance SDK with competitive price. Its high cost performance is shown as follows.

- No limits on user numbers.
- The source code is available to users.
- A powerful tool (Girist) and its source code is available.
- No limits on source code.
- No license fees – forever
- Unlimited database size

The price of Giris SDK is as follows:

	price
Giris SDK	800$
Giris SDK + source code	1800$
Giris SDK + source code + Girist source code	1900$