Call for participation

FVC2006: Fingerprint Verification Competition 2006

WEB SITE: http://bias.csr.unibo.it/fvc2006

The Biometric System Laboratory (University of Bologna), the Pattern Recognition and Image Processing Laboratory (Michigan State University), the Biometric Test Center (San Jose State University) and the Biometrics Research Lab – ATVS (Universidad Autonoma de Madrid) are pleased to announce **FVC2006** (the Fourth International **F**ingerprint **V**erification **C**ompetition).

FVC2006 competition focuses on fingerprint verification software assessment. A subset of fingerprint impressions acquired with various sensors will be provided to registered participants, to allow them to adjust the parameters of their algorithms. Participants will then be requested to provide enroll and match executable files of their algorithms; the evaluation will be conducted at the organizers' facilities using the submitted executable files on a sequestered database, acquired with the same sensors as the training set.

BACKGROUND

The first, second and third international competitions on fingerprint verification (FVC2000, FVC2002 and FVC2004) were organized in 2000, 2002 and 2004, respectively. These events received great attention both from academic and industrial biometric communities. They established a common benchmark, allowing developers to unambiguously compare their algorithms, and provided an overview of the state-of-the-art in fingerprint recognition. Based on the response of the biometrics community, FVC2000, FVC2002 and FVC2004 were undoubtedly successful initiatives. Some key figures and pointers related to these past competitions are summarized in the the following table.

	FVC2000	FVC2002	FVC2004
Number of Participants	**11** 4 industrial, 7 academic	**31** 21 industrial, 6 academic and 4 other	**43** 29 industrial, 6 academic and 8 independent developers
Categories	-	-	Open and Light
No. of Databases and sensors used	**4** Keytronic, ST, Identicator, SFinGe	**4** Identix, Biometrika, Precise Biometrics, SFinGe	**4** CrossMatch, Digital Persona, Atmel, SFinGe
	All included in **Handbook of Fingerprint Recognition** by D. Maltoni, D. Maio, A.K. Jain and S. Prabhakar, Springer, 2003.		Freely available online
Results presented	ICPR 2000; IEEE Trans. PAMI, March 2002	ICPR 2002	ICBA 2004; IEEE Trans. PAMI, Jan. 2006
Website	http://bias.csr.unibo.it/fvc2000	http://bias.csr.unibo.it/fvc2002	http://bias.csr.unibo.it/fvc2004

The interest shown in the previous FVC competitions by the biometrics research community has prompted the organizers to schedule a new competition in 2006. The main changes in FVC2006 with respect to the previous edition are <u>underlined</u> in the rest of this document.

AIM

Continuous advances in the field of biometric systems and, in particular, in fingerprint-based systems (both in matching techniques and sensing devices) require that performance evaluation of biometric systems be carried out at regular intervals.

The aim of FVC2006 is to track recent advances in fingerprint verification, by both academia and industry, and to benchmark the state-of-the-art in fingerprint technology. <u>Further testing, on interoperability and quality related issues, will be performed in a second stage, after the competition is completed.</u>

This competition should not be viewed as an "official" performance certification of biometric systems, since only parts of the system software will be evaluated by using images from sensors not native to each system. Nonetheless, the results of this competition will give a useful overview of the state-of-the-art in this field and will provide guidance to the participants for improving their algorithms.

ORGANIZERS

BIOMETRIC SYSTEM LABORATORY	Prof. D. Maio
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	Dr. R. Cappelli
	Mr. M. Ferrara
PATTERN RECOGNITION AND IMAGE PROCESSING LAB	Prof. A.K. Jain
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BIOMETRICS RESEARCH LAB-ATVS	Prof. J. Ortega-Garcia
UNIVERSIDAD AUTONOMA DE MADRID	Dr. J. Fierrez-Aguilar

PARTICIPANTS

- Participants can be from academia, industry, or independent developers.

- **Anonymous participation will be accepted**: participants will be allowed to decide whether or not they want to publish their names together with their algorithm's performance. Participants will be confidentially informed about the performance of their algorithm before they are required to make this decision. In case a participant decides to remain anonymous, the label "Anonymous organization" will be used, and the real identity will not be revealed.

- <u>Together with their submissions, participants will be required to provide some general, high-level information about their algorithms (similar to those reported in FVC2004, see [R. Cappelli, D. Maio, D. Maltoni, J.L. Wayman and A.K. Jain, "Performance Evaluation of Fingerprint Verification Systems", IEEE Transactions on Pattern Analysis Machine</u>

Intelligence, January 2006]). Whilst this required information will not disclose industrial secrets, since it is a very high level description of the approaches, it could be of interest to the entire fingerprint community.

- FVC2006 organizers will not participate in the contest.

DATABASES

One of the most important and time-consuming tasks of any biometric system evaluation is the data collection. We have created a multi-database, containing four disjoint fingerprint databases, each collected with a different sensor/technology.

- Four distinct databases, provided by the organizers, will constitute the benchmark: DB1, DB2, DB3 and DB4. Each database is **150** fingers wide and **12** samples per finger in depth (i.e., it consists of 1800 fingerprint images). Each database will be partitioned in two disjoint subsets **A** and **B**:

   - subsets DB1-A, DB2-A, DB3-A and DB4-A, which contain the first 140 fingers (1680 images) of DB1, DB2, DB3 and DB4, respectively, will be used for the algorithm performance evaluation.

   - subsets DB1-B, DB2-B, DB3-B and DB4-B, containing the last 10 fingers (120 images) of DB1, DB2, DB3 and DB4, respectively, will be made available to the participants as a development set to allow parameter tuning before the submission.

- During performance evaluation, fingerprints belonging to the same database will be matched against each other.
- The image format is BMP, 256 gray-levels, uncompressed.
- The image size and resolution vary depending on the database (detailed information will be available to the participants).
- Data collection in FVC2006 was performed without deliberately introducing difficulties such as exaggerated distortion, large amounts of rotation and displacement, wet/dry impressions, etc. (as it was done in the previous editions), but the population is more heterogeneous and also includes manual workers and elderly people. The volunteers were simply asked to put their fingers naturally on the acquisition device, but no constraints were enforced to guarantee a minimum quality in the acquired images. The final datasets were selected from a larger database by choosing the most difficult fingers according to a quality index, to make the benchmark sufficiently difficult for a technology evaluation.

CATEGORIES

- Two different sub-competitions (**Open** category and **Light** category) will be organized using the same databases.
- Each participant is allowed to submit only **one** algorithm to each category.
- The **Open** category has no limits on memory requirements and template size. For practical testing reasons, the maximum response time of the algorithms is limited as follows: the maximum time for each enrollment is **5** seconds, the maximum time for each matching is **3** seconds. The test will be executed under Windows XP Professional O.S. on PC INTEL PENTIUM 4 – 3.20Ghz – 1.00GB RAM.
- The **Light** category is intended for algorithms conceived for light architectures and therefore characterized by low computing needs, limited memory usage and small template size. The

maximum time for enrollment is **0.3** seconds and the maximum time for matching is **0.1** seconds. The test will be executed under Windows XP Professional O.S. on PC INTEL PENTIUM 4 – 3.2Ghz – 1GB RAM. The maximum memory that can be allocated by the processes is **4** MBytes. The maximum template size is **2** KBytes. A utility will be made available to the participants to test if their executables comply with these memory requirements.

- Two additional categories (Match-on-Card and Match-on-Device) could be set up depending on the interest and feedback received (see section "MOC/MOD Call for Interest").

SUBMISSION (COMPULSORY EXECUTABLES)

- Each participant is required to submit, for each algorithm, **two** executables in the form of **Win32 console applications**.
- Both executables will take the input from command-line arguments and will append the output to a text file.
- One of the inputs is a database-specific configuration file. Participants are allowed to submit four distinct configuration files db1.cfg, db2.cfg, db3.cfg and db4.cfg (one for each database) in order to adjust the algorithm's internal parameters according to each specific database. Configuration files can be text files or binary files and their I/O is responsibility of the participant code. Configuration files can also contain pre-computed data to save time during enrollment and matching.

- The first executable (ENROLL_XXXX) enrolls a fingerprint image and produces a template file; the command-line syntax is:

  `ENROLL_XXXX imagefile templatefile configfile outputfile`

  where:

  `XXXX:`　　　　　is the participant ID assigned by the organizers
  `imagefile:`　　is the input image pathname
  `templatefile:` is the output template pathname
  `configfile:`　is the configuration file pathname
  `outputfile:`　is the output text-file, where a `log string` (of the form `imagefile templatefile result`) must be appended; `result` is "OK" if the enrollment can be performed or "FAIL" if the input image cannot be processed by the algorithm.

- The second executable (MATCH_XXXX) matches a fingerprint image against a fingerprint template and produces a similarity score; the command-line syntax is:

  `MATCH_XXXX imagefile templatefile configfile outputfile`

  where:

  `XXXX:`　　　　　is the participant ID assigned by the organizers
  `imagefile:`　　is the input image pathname
  `templatefile:` is the input template pathname
  `configfile:`　is the configuration file pathname
  `outputfile:`　is the output text-file where a `log string` (of the form `imagefile templatefile result similarity`) must be appended; `result` is "OK" if the matching can be performed or "FAIL" if the matching cannot be executed by the algorithm; `similarity` is a floating point value ranging from 0 to 1

which indicates the similarity between the template and the fingerprint: 0 means no similarity, 1 maximum similarity.

- C-language skeletons for ENROLL_XXXX and MATCH_XXXX are available on-line (http://bias.csr.unibo.it/fvc2006) to reduce the participants' implementation efforts. These source files will perform all the necessary I/O (BMP image loading).

- ***The executables submitted by participants will be kept strictly confidential and will not be used outside of the aims of FVC2006, <u>except as indicated in the next section "Submission (Additional Executables)"</u>***. Furthermore, participants are allowed to protect their executables by using: expiration-date mechanisms, dongles, hardware dependent mechanisms, etc.

SUBMISSION (ADDITIONAL EXECUTABLES)

Providing the two additional executables described below is not compulsory for participating in FVC2006, but we strongly encourage the participants to submit them in order to allow some important experiments to be performed with great benefit to the fingerprint recognition community. In particular, FVC organizers plan to study:
- accuracy of algorithms in extracting minutiae features for creating interoperable ISO 19794-2 templates;
- feasibility of renewing fingerprint databases to avoid parameter overfitting: the same algorithms will be tested on renewed versions (i.e. with slightly perturbed images) of an initial database to measure the stability of the results;
- the relationship between accuracy and quality indicators: the same algorithms will be tested on degraded versions of an initial database to measure the performance drop.

For this purpose, the following two executables should be submitted:
- ISOENROLL_XXXX enrolls a fingerprint image and produces an ISO 19794-2 compliant template file; the command-line syntax is:

  `ISOENROLL XXXX imagefile templatefile configfile outputfile`

  where:

  `XXXX:`   is the participant ID assigned by the organizers
  `imagefile:`   is the input image pathname
  `templatefile:` is the output template pathname
  `configfile:`   is the configuration file pathname
  `outputfile:`   is the output text-file, where a `log string` (of the form `imagefile templatefile result`) must be appended; `result` is "OK" if the enrollment can be performed or "FAIL" if the input image cannot be processed by the algorithm.

- The second executable (MATCHT_XXXX) matches a template (in the participant proprietary format, not in the ISO format) against another fingerprint template (in the proprietary format as well) and produces a similarity score. The aim of this executable is to speed up the evaluation when a huge number of tests has to be carried out. The command-line syntax is:

  `MATCHT XXXX templatefile1 templatefile2 configfile outputfile`

  where:

  `XXXX:`   is the participant ID assigned by the organizers
  `templatefile1:` is the first input template pathname

templatefile2: is the second input template pathname

configfile: is the configuration file pathname

outputfile: is the output text-file where a `log string` (of the form `imagefile templatefile result similarity`) must be appended; `result` is "OK" if the matching can be performed or "FAIL" if the matching cannot be executed by the algorithm; `similarity` is a floating point value ranging from 0 to 1 which indicates the similarity between the template and the fingerprint: 0 means no similarity, 1 maximum similarity.

- C-language skeletons for ISOENROLL_XXXX and MATCHT_XXXX will be available on-line (http://bias.csr.unibo.it/fvc2006/) to reduce the participants' implementation efforts.

- ***The executables submitted by participants will be kept strictly confidential and will only be used to perform additional experiments on the FVC2006 datasets, whose results will be published in a strictly anonymous form (that is, the names of the participants who provided the additional executables will not be disclosed and no participant name or ID will be associated with these results, even if the participant asked to disclose its name in the final FVC2006 results).***

- For the benefit of those participants submitting one or both of the ISOENROLL and MATCHT executable files, selected key results obtained in the aforementioned planned studies will be given in confidential technical reports well in advance of the official publications.

PERFORMANCE EVALUATION

- For each database and for each algorithm:

  - Each sample in subset A is matched against the remaining samples of the same finger to compute the **False Non Match Rate FNMR** (also referred as False Rejection Rate - FRR). If image *g* is matched to *h*, the symmetric match (i.e., *h* against *g*) is not executed to avoid correlation in the scores. The total number of *genuine* tests (in case no enrollment rejections occur) is: $((12*11)/2) * 140 = 9,240$

  - The first sample of each finger in subset A is matched against the first sample of the remaining fingers in A to compute the **False Match Rate FMR** (also referred as False Acceptance Rate - FAR). If image *g* is matched to *h*, the symmetric match (i.e., *h* against *g*) is not executed to avoid correlation in the scores. The total number of *impostor* tests (in case no enrollment rejections occur) is: $((140 \times 139)/2) = 9,730$

- For each participating algorithm, the following performance indicators will be reported:

  - FMR(t)/FNMR(t) curves for each database, where $t \in [0,1]$ is the acceptance threshold.
  - ROC(t) curve for each database.
  - EER (equal-error-rate) for each database.
  - Average EER (AEER) over the 4 distinct databases.
  - Average enrollment time for each database, and over the four databases.
  - Average matching time for each database, and over the four databases.
  - Average size and maximum size of the template created by the enrollment procedure.
  - Maximum memory allocated by the executables

- Performance evaluation will be executed off-line, during the period November – December, 2006. In this way, the organizers will have the time to provide feedback to the participants.

MOC/MOD Call for Interest

While Match-On-Card (MOC) and Match-On-Device (MOD) algorithms could overcome some critical privacy and security problems, as of today no independent data is publicly available on their actual performance in comparison with traditional PC-based algorithms. FVC2004 demonstrated that imposing constraints on computing resources (time, model and memory size) drastically affects the performance. However, FVC2004 (and FVC2006) constraints in the Light category are still far from the typical capability of a smart-card or of a low-priced stand-alone device. It would be certainly of great interest for the scientific community, the biometric vendors, and the final customers to have a clear view of the trade-off accuracy-security-privacy that MOC and MOD offer. Unfortunately, the lack of standards for interfacing such hardware-based solutions, makes it difficult to define an appropriate evaluation protocol. For example, if a proprietary interface is used for a specific device, it would be quite difficult to ensure that the processing is actually executed on the device itself and not (for instance) on the PC by the device driver.
We invite all the interest parties to express their potential interest in such an evaluation and to provide their comments and suggestions in order to agree on a possible protocol for two further distinct categories (MOC and MOD sub-competitions) on the same FVC2006 databases. Please send your expression of interest to: fvc2006@csr.unibo.it.

Registration

- Participants are requested to register on-line at**: http://bias.csr.unibo.it/fvc2006**

- There are no fees for participating in FVC2006.

Important Dates

- Participant registration deadline: **June 30th, 2006**
- Databases subsets B available online by **July 1st, 2006**
- Executable algorithm submission deadline: **October 31st, 2006**
- Expected publication of the results: **January 2007**

For further information, visit: **http://bias.csr.unibo.it/fvc2006**
or send an e-mail to **fvc2006@csr.unibo.it**