



FingerCell 2.1 Algorithm Demo

User's guide

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1 Preface

Information about this user's guide

- **Version:** 2.1.0.0
- **Release date:** 2008-12-17

Contacts

If you face troubles while using the FingerCell Algorithm Demo, please contact Neurotechnology (support@neurotechnology.com) or your local distributor.

2 Introduction

Fingerprint identification systems have been usually developed on PC platform, although some tasks required a compact solution. Nowadays various embedded and handheld mobile devices offer enough capabilities to integrate biometrical recognition software into them.

The hardware part of an embedded system is mostly a stand-alone device that contains processor, memory, fingerprint scanner and some output display. This part can be developed according to project's specifics, or a ready-to-use device can be obtained.

Neurotechnology offers the embedded fingerprint identification technology that is suitable to develop a fast and reliable system on embedded or mobile platform.

2.1 Features

FingerCell 2.1 technology is compact, sensor-independent and cross-platform. It offers decent reliability and identification speed for various mobile or embedded devices. The FingerCell algorithm includes these proprietary solutions:

- Full tolerance to fingerprint translation, rotation and deformation.
- Ability to run on low speed processors.
- Ability to recognize a fingerprint from any part of it without any core or delta points.
- Enrollment with features generalization, that combines several samples of the same fingerprint for better quality.
- Identification (1:N) ability.
- Pre-sorting database entries using certain features for faster identification.

2.2 Algorithm

The FingerCell algorithm is similar to the VeriFinger algorithm and includes these features:

- FingerCell is **fully tolerant to fingerprint translation, rotation and deformation**. Such tolerance is achieved by our proprietary fingerprint matching algorithm.
- FingerCell **does not require the presence of fingerprint core or delta points** in the image and can recognize a fingerprint from any part of it.
- FingerCell has fingerprint enrollment with **features generalization mode**. This mode generates a collection of the generalized fingerprint features from a collection of fingerprints of the same finger. Each fingerprint image is processed and features are extracted. Then the collection of features is analyzed and combined into a single generalized features collection which is written to the database. This way, enrolled minutiae are more reliable and the fingerprint recognition quality considerably increases using this enrollment mode.
- FingerCell can use database entries which were **pre-sorted** using certain global features. Fingerprint matching is performed first with the database entries having global features most similar to those of the test fingerprint. If matching within this group yields no positive result, then the next record with most similar global features is selected, and so on until the matching is successful or the end of the database is reached. In most cases there is a good chance that the correct match will be found at the beginning of the search. As a result, the number of comparisons required to achieve fingerprint identification decreases drastically, and correspondingly, the effective matching speed increases.
- The template extraction is adapted for low speed embedded processors to provide fast image processing and feature extraction.

2.3 Why FingerCell?

The FingerCell algorithm, developed on the VeriFinger basis, is designed for embedded biometric systems developers. The algorithm has certain capabilities:

- **Reliability.** As FingerCell is intended for embedded devices, it uses a faster and less powerful fingerprint noise filtration algorithm with a slightly higher False Rejection Rate than a PC running the VeriFinger algorithm. However, the FingerCell algorithm still produces a decent level of recognition reliability, which is acceptable for embedded devices.
- **Low speed processors are supported.** For example, a 75 MHz ARM7 processor performs verification in about 2 seconds when FingerCell algorithm is used.
- **Identification ability.** As FingerCell is developed on the VeriFinger basis, it is suitable not only for fingerprint verification (1:1 matching), but also for identification (1:N matching). FingerCell can match up to **700 fingerprints per second** in 1:N identification mode on 200 MHz ARM family CPU.
- **Image processing speed.** Fingerprint image processing time is **less than 1 second** on 200 MHz ARM processor, which is acceptable for embedded systems.
- **Compact software.** Compiled code and internal data arrays require only **400 Kb of memory** and therefore can be implemented in low memory microchips, thus reducing hardware costs.
- **Portability.** FingerCell Embedded Development Kit is designed for easy implementation into very various and specific applications. The algorithm's **source code** is written in **ANSI C** and is sensor independent; therefore it can be ported to various platforms and hardware.
- **Embedded and PC-based multi-biometric capable technologies from the same vendor.** Combined with our other technologies, FingerCell could be used in developing these advanced systems:
 - Mixed embedded/PC systems, using FingerCell EDK together with VeriFinger Standard or Extended SDKs.
 - Multi-biometric embedded systems, using FingerCell EDK together with FaceCell EDK.
 - Complex multi-biometric embedded/PC systems, using a combination of FingerCell EDK, FaceCell EDK, VeriFinger SDK, VeriLook SDK and VeriEye SDK.

2.4 Specifications

Enrollment time	< 1 second
Enrollment time in features generalization mode	< 3 seconds
Verification time	0.5 seconds
Matching speed	up to 700 fingerprints/second
Template size	300 - 600 bytes
Memory required for code and data arrays	400 kilobytes

You should note, that these specifications were determined on device with 200 MHz ARM family processor.

3 FingerCell Algorithm Demo

FingerCell Demo application is designed with aim to demonstrate the advanced capabilities of FingerCell fingerprint recognition engine. The program is a Windows® Pocket PC operating system application controlled via a pull-down menu system.

Using FingerCell evaluation program mainly involves running fingerprint **enrollment**, **enrollment with features generalization**, **verification** and **identification** procedures, which are described in some detail below.

3.1 Using Algorithm Demo Application

The main FingerCell Demo application window contains a menu bar and three child windows. In the top left window, the original fingerprint image is displayed, in the top right window, the same image after the image filtering/processing/feature extraction is shown with features and their directions marked in red by circles and lines. In the bottom window, enrollment and recognition information (enrolled/recognized file name, fingerprint processing and matching times, number of samples matched, etc.) is displayed. Also individual matching scores between different fingerprints (in identification mode) are displayed.

The application has six operation modes:

1. **Fingerprint enrollment.** Software processes the fingerprint image, extracts features and writes them to the database.
2. **Fingerprint enrollment with features generalization.** This mode generates the generalized fingerprint features collection from three fingerprints of the same finger. Each fingerprint image is processed and features are extracted. Then three collections of features are analyzed and combined into one generalized features collection, which is written to the database. The fingerprint recognition quality considerably increases if fingerprints were enrolled using this mode.
3. **Fingerprint verification.** This mode performs 1:1 fingerprints matching.
4. **Fast verification.** Performs fast fingerprint verification.
5. **Fingerprint identification.** This mode performs 1:N fingerprint matching.
6. **Fingerprint fast identification.** Performs fast fingerprint identification.

You can change mode in "Mode" menu.

FingerCell Demo allows to considerably decrease the recognition time by halting the fingerprint matching process when positive matching result is encountered (successful identification). To turn off this feature go to "Options" dialog (Tools->Options...) and select "Match all database".

3.1.1 Menu Commands

Menu command "File"

1. **"Load image"**. Loads a scanned fingerprint image from file. Bmp and Tiff image formats are supported.
2. **"About"**. Displays FingerCell Algorithm Demo application's information.
3. **"Exit"**. Closes algorithm demo application.

Menu command "Mode"

1. **"Enrollment"**. For the fingerprint enrollment demonstration, select "Mode->Enrollment" from the menu. Then, open file(s) or scan a fingerprint.
2. **"Enrollment with generalization"**. In order to enroll fingerprint with features generalization you should open three fingerprint images.
3. **"Verification"**. In order to verify you should open two fingerprint images. After the verification is done result (similarity score and threshold) is shown on the log window below.
4. **"Fast verification"**. To perform fast fingerprint verification two fingerprints should be opened.
5. **"Identification"**. To perform an identification you should load fingerprint image(s). After the identification FingerCell will output the record names of the most similar fingerprint together with the similarity criterion and various characteristics of the recognition process.
6. **"Fast identification"**. Performs fast fingerprint identification.

Menu command "View"

1. **"Zoom In"**. Zooms in an image shown on a main window.
2. **"Zoom Out"**. Zooms out an image shown on a main window.
3. **"Zoom 1:1"**.
4. **"Show features"**. If checked fingerprint features in window on right is shown.
5. **"Show binary image"**. If checked a fingerprint image in a window on right is shown.

Menu command "Tools"

1. **"Clear Log"**. Removes all messages from a log window.
2. **"Clear DB"**. Removes all records from database.
3. **"Options"**. Opens an "Options" dialog, which allows changing several important features of the program, namely fingerprinting image resolution and finger identifiers generated from files and scanner. Resolution is initially set to 500 dpi. If one wishes to use fingerprint images acquired with lower resolution you can change it here or on prompt when opening a files. Also these parameters can be changed: Extractor mode, matcher mode, maximal rotation (in degrees), generalization FAR, matching FAR, Quality threshold (is used when "Use quality" is checked).

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