

CS 4624

New Cloud Modules

Fingerprint Module

(NBIS)

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# Summary

The NIST Biometric Image Software (NBIS) distribution is developed by the National Institute of Standards and Technology (NIST) for the Federal Bureau of Investigation (FBI) and Department of Homeland Security (DHS).

The NBIS utilities fall under six general categories: PCASYS, MINDTCT, NFIQ, AN2K, BOZORTH3, and NFSEG. In this paper I will describe how to use these utilities.

I have also included all the resources for each of the executable included in the NBIS software. They are bundled up in the software folder in the cloud. I will talk more about this in User's Manual.

# About NBIS

The NIST Biometric Image Software (NBIS) distribution is developed by the National Institute of Standards and Technology (NIST) for the Federal Bureau of Investigation (FBI) and Department of Homeland Security (DHS). This software has been determined to be outside the scope of the EAR (see Part 734.3 of the EAR for exact details) as it has been created solely by employees of the U.S. Government; it is freely distributed with no licensing requirements; and it is considered public domain. Therefore, it is permissible to distribute this software as a free download from the internet. It has been determined that the export control restriction did not apply to the NFSEG and BOZORTH3 software, due to both being outside the scope of EAR(see Part 734.3 of the EAR for exact details); they are freely distributed and considered public domain.

The NBIS utilities fall under seven general categories:

- A neural-network based fingerprint pattern classification system called, PCASYS, automatically categorizes a fingerprint image into the class of arch, left or right loop, scar, tented arch, or whorl. This is an updated system that includes the use of a robust Multi-Layered Perceptron (MLP) neural network. It is the only known no cost system of its kind.
- A minutiae detector called, MINDTCT, automatically locates and records ridge ending and bifurcations in a fingerprint image. This system includes minutiae quality assessment based on local image conditions. The FBI's Universal Latent Workstation uses MINDTCT, and it too is the only known no cost system of its kind.
- A fingerprint image quality algorithm, NFIQ, which analyses a fingerprint image and assigns a quality value of 1 (highest quality) 5(lowest quality) to the image. Higher quality images produce significantly better performance with matching algorithms. The ability to retrain the NFIQ weights is provided with the utilities FING2PAT, ZNORMDAT, and ZNORMPAT.
- A reference implementation of the [ANSI/NIST-ITL 1-2007](#) (AN2K) "Data Format for the Interchange of Fingerprint, Facial, Scar Mark & Tattoo (SMT) Information" standard is included. This reference implementation contains a suite of utilities designed to read, write, edit, and manipulate files formatted according to this interchange standard. The utilities support updated and new record types introduced by this latest version of the standard (Record Types 9, 13, 14, & 15).
- A large collection of general-purpose image utilities (IMGTOOLS) are also included to support the processing of fingerprint images. Source code is provided for Baseline JPEG, Lossless JPEG, and the FBI's Wavelet Scalar Quantization (WSQ) encoders and decoders. (The Baseline JPEG code uses the Independent JPEG Group's compression/decompression libraries.) Utilities are also provided that support color component interleaving, color space conversion, and format conversion of legacy files distributed in NIST fingerprint databases.

- A fingerprint matching algorithm, BOZORTH3, which is a minutiae based fingerprint matching algorithm. It will do both one-to-one and one-to-many matching operations. It accepts minutiae generated by the MINDTCT algorithm.
- A fingerprint segmentation algorithm, NFSEG, which will segment the four-finger plain impression found on the bottom of a fingerprint card into individual fingerprint images or it can be used to remove white space from a rolled fingerprint image.

# User's Manual

## Installing the Software

The NIST Biometric Image Software (NBIS) distribution is developed by the National Institute of Standards and Technology (NIST) for the Federal Bureau of Investigation (FBI) and Department of Homeland Security (DHS). To install the software, please go to install the latest version; please go to the following site. The site also displays the previous releases and what improvements have been made to the software over the years.

<http://www.nist.gov/itl/iad/ig/nigos.cfm>

To begin installation of your software, you will need administrative access to the computer that you are installing the software. You will be unable to install the software correctly if you are not the administrator of the computer.

If you want JPEG support with your NBIS software, you will also need to install libtiff software. The file and the instruction on how to install that software can be found on <http://www.libtiff.org/>.

Now decide where you want to install the software, and create a directory there. It does not matter how you name the directory, however for the example, I have created NBIS\_software directory in home folder.

I have included instruction on how to install the software on computer that is running Linux OS on 32-bit system. If you have any other operating system, such as windows or mac, please read INSTALL.txt in the downloaded files.

When you download the files from the nist.gov website, you will have a folder named NBIS. Please go inside the folder and execute the following command

```
./setup.sh /home/NBIS_Software --STDLIBS -32
```

./setup.sh is the script that will set the destination folder, which comes right after the command. In my example, I am installing the software in NBIS\_Software directory which is inside the home directory.

--STDLIBS means that you want to install all the standard libraries. Again for this option to work you would need libtiff installed on the computer. And the final 32 stands for 32-bit operating system.

So far you have set where you want to install the software and set other options. To actually install the software, you will need to run four more commands. Putting “sudo” in front of a command tells the terminal to execute the command as an administrator. When you run the first “sudo” command, the terminal will ask you for the administrator password. Please provide the administrator password for the computer. Run these four commands to finish the installation.

1. sudo make config
2. sudo make it
3. sudo make install
4. sudo make catalog

## Understanding the Manual

I have made this manual, so it is easier for you to understand the software. As mentioned before the NBIS software has six main executable: PCASYS, MINDTCT, NFIQ, AN2K, BOZORTH3, and NFSEG. In the resources folder I have included a folder called “Manual”. Please look at the manual for all of these executable and understand what are their functionalities. If you want a quick reference to what each executable does, please look at description.txt in the resources folder. I have also included that information later in this paper.

The software also includes other executable, which modifies the image. Few of the examples of modifying the image compressing the image, converting and image from one format to the another, or get certain information about the fingerprints from the image. Here is the information about what each executable included in the NBIS software is supposed to do.

## Summary of each Executable

an2k2iaf - Modifies minutiae and fingerprint image records in an ANSI/NIST 2007 file to meet FBI/IAFIS specifications.

an2k2txt - Converts an ANSI/NIST 2007 file to a formatted text file.

an2ktool - Parses, manipulates, and/or writes the results to an ANSI/NIST 2007 file in batch mode.

asc2bin - converts a PCASYS data file from ascii to binary form.

bin2asc - converts a PCASYS data file from binary to ascii form.

bozorth3 - Computes match scores between fingerprints

chgdesc - changes the description string of a PCASYS data file.

chkan2k - check the contents of an ANSI/NIST file.

cjp2k - Compress RAW image into JPEG2000 image format. This is based on the image\_to\_j2k application implemented in the OPENJPEG library.

cjpeg - compress an image file to a JPEG file

cjpegb - compresses a grayscale or color (RGB) image using lossy Base-line JPEG (JPEGB).

cjpegl - compresses a grayscale or color image using Lossless JPEG (JPEGL).

cmbmcs - combines PCASYS mean/covariance data file pairs.

cropcoeff - Read AN2K/AN2K7 file, and crop each Type-14 record.

cwsq - WSQ compresses grayscale fingerprint images.

datainfo - shows the header information of a PCASYS data file.

diffbyts - takes two binary data files and compares them byte for byte, compiling a cumulative histogram of differences.

djp2k - Decompress a JPEG2000 image into either pnm or raw image format. This is based on the j2k\_to\_image application implemented in the OPENJPEG library.

djpeg - decompress a JPEG file to an image file

djpegb - decompresses a Baseline JPEG (JPEGB) grayscale or color image.

djpegl - decompresses a Lossless JPEG (JPEGL) grayscale or color image.

djpeglsd - decompresses a grayscale image that was compressed using the old Lossless JPEG compression distributed with Special Databases 4, 9, 10, and 18. Cjpegl should be used in the future to Lossless JPEG (JPEGL) compress images.

dpyan2k - display image and minutiae contents of an ANSI/NIST file.

dpyimage - displays the image contents of Baseline JPEG, Lossless JPEG, WSQ, IHead, and raw pixmap files.

dwsq - decompresses a WSQ-encoded grayscale fingerprint image.

dwsq14 - decompresses a WSQ14-encoded grayscale fingerprint image from NIST Special Database 14.

eva\_evt - finds a desired number of eigenvalues and eigenvectors.

fing2pat - Takes a list of fingerprint images and creates a feature vector file that can be used in MLP training for the NFIQ algorithm.

fixwts - M-weighted robust weight filter from network activations.

histogen - Parses the text file of an ANSI/NIST 2007 file that is generated by an2k2txt and builds a histogram of Field Numbers.

iaf2an2k - Takes an ANSI/NIST file conforming to FBI/IAFIS specifications and modifies minutiae and fingerprint image records in support of the new 2007 standard.

imgcmp - takes two binary data files and compares them generating metric data.

imginfo - takes a single file and provides basic information about the image.

intr2not - converts an image comprised of pixels with interleaved color components to an image with non-interleaved component planes.

jp2codec - compresses and decompress images to/from JPEG2000 format.

jpegtran - lossless transformation of JPEG files

kltran - runs a Karhunen-Loeve transform on a set of vectors.

lintran - runs a linear transform on a set of vectors.

meancov - computes mean vector and covariance matrix for a set of feature vectors.

mindtet - detects minutiae from a fingerprint image that is either an ANSI/NIST 2007 formatted file or a WSQ compressed file.

mkoas - makes orientation arrays from fingerprint images.

mktran - makes transform matrix from regional weights and eigenvectors.

mlp - Does training and testing runs using a 3-layer feed-forward linear perceptron Neural Network.

mlpfeats - converts PCASYS formatted feature files into the format compatible with the mlp command line function.

nfiq - evaluates a fingerprint image and returns a quality value for the image on a scale of 1 (highest quality) to 5 (lowest quality). When multiple fingerprint images are selected from an ANSI/NIST file, the record number and fgp number are printed before the quality value.

nfseg - Segments multiple finger plain impressions into individual fingers or removes white space from single finger rolled/plain impressions isolating just the fingerprint portion of the image.

not2intr - converts an image comprised of non-interleaved color component planes to an image with interleaved color component pixels.

oas2pics - makes pictures of orientation arrays.

optosf - optimizes the overall smoothing factor for the PNN classifier.

oprws - optimizes the regional weights for PNN classifier.

pcasys - fingerprint classifier demo, non-graphical version

pcasysx - fingerprint classifier demo, graphical version

rdimgwh - read image width and height directly from within the image data and print them on the standard output

rdjpgcom - display text comments from a JPEG file

rdwsqcom - scans a WSQ-encoded image file for any and all comment blocks, printing their contents to standard output.

AN2K Record Selector - Select particular records from ANSI/NIST data files using metadata in the records.

rgb2ycc - converts a color RGB image to the YCbCr color space and down samples component planes as specified.

rwpics - makes pictures of regional weights or gradients.

sd\_rfmt - takes images from NIST Special Databases 4, 9, 10, 14, and 18 and reformats the compressed data to work with the decompressors djpegl and dwsq.

stackms - stacks PCASYS formatted matrix files together.

txt2an2k - Converts a formatted text file into an ANSI/NIST 2007 file.

wrjpgcom - insert text comments into a JPEG file

wrwsqcom - inserts a specified comment block into a WSQ-encoded image file.

ycc2rgb - converts a color YCbCr image to the RGB colorspace and accounts for downsampling of the YCbCr component planes.

znormdat - Takes a patterns file of (un-normalized) feature vectors and computes and writes the statistics (mean and stddev) to support ZNormalization.

znormpat - Takes a patterns file of (un-normalized) feature vectors and ZNormalizes its feature vectors based on global statistics provided.

## Examples

To understand how a user can execute the executable, I have included Usage folder. That folder contains the information on all the executable and skeleton of how to execute them. It also includes all of the options you can have with the executable.

Sometimes it is easy to understand how to execute the command, if you have few examples. Therefore, with this manual I am including example of main six executable. If you want to look at example of any other executable, please look at Examples folder within the resources folder provided.

```
% pcasys myprsfile
```

- Runs the pcasys demo using parameters set in myprsfile to change the value of the default settings

```
% bozorth3 [options] -p probefile.xyt gallery*.xyt
```

```
% mindtct ../../data/g001t2u.eft g001t2u
```

```
% nfiq ../../data/a001.an2 a001-nfq.an2
```

- copies the input file to a001-nf1.an2, adding NQM values where appropriate, and converting Type-4 records to Type-14 as required to allow for addition of the NQM field.

```
% an2ktool -i 2.12.1.4 A delete.an2 insert.an2
```

- inserts an information item setting the first minutia's type to "A".

# Developer's Manual

Please look at the inventory of the files below and if you, as a developer wish to improve the files, please go ahead and do so.

## Inventory of all files

Examples – Contains the examples of all the executable

Extras – Contains miscellaneous files that were available when software downloaded from website, but were not available after the software was installed.

Manual – Contains manuals for all the executable

Usage – Contains synopsis and options for all the executable

Answers.txt – Contains answers to the questions given

Description.txt – Contains descriptions of all executable

Installing software.ppt – PowerPoint presentation of how to install the NBIS software on linux machine

Questions.txt – Questionnaire for the module

README.txt – information about the website

# Acknowledgements

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# References

*NIST Biometric Image Software*. National Institute of Standards and Technology, n.d. Web. 4 Mar. 2011. <<http://www.nist.gov/itl/iad/ig/nbis.cfm>>.