

Contribution by Lockheed Martin on Biometric Performance Testing & Reporting
Ron Sutton
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Summary

The following outline includes a straw-man set of requirements and recommendations for inclusion in both the US and international standards on Biometric Testing & Reporting. It also captures information developed in M1.4 regarding the various audiences for biometric test reports and their varying points of view and interests, in the anticipation that these thoughts will prove useful to SC37/WG5 in their deliberations.

The Differing Audiences and Purposes for Biometric Testing

Audiences

Engineers & Scientists developing new biometric technologies (algorithms & sensors)

Assessing viability versus existing products

Evaluating changes to algorithms & sensor technologies

Determining effects of environmental factors on sensors & system performance

Vendors selling products produced by third parties

Selecting products to sell

System Integrators

Selecting components for integration into a system

Evaluating effectiveness of a system

System qualification versus a set of specific requirements

Governments

Access control systems (physical & logical)

Weapon systems (authorization to fire or operate)

Border control systems

Authorization to enter

Record keeping

Stay management

Criminal/Background Check systems

Criminal history

Latent searches

Commercial Customers

Banks

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Access control systems (physical & logical)
Non-deniable identity verification

**Stock trading, credit card transactions, other
financial institutions**

Non-deniable identity verification

Internet-based businesses

Identity verification

Other businesses

*Access control when access audit trail is
required/desired*

Consumers

Access control for computers, PDAs, cars, homes,
networks

Certification Authority

Testing & certification of compliance with
standards (e.g., Common Criteria)

Purposes

Assessment of Developmental Progress (comparison
of successive generations of a component or system)

Comparison of different components or systems

Evaluation of product readiness for release

Qualification/Acceptance testing

Measurement of performance of existing system

Prediction of operational system performance before
fielding

Certification of compliance with standard (e.g.,
Common Criteria)

Test Types

Technology

Object of Test - Biometric Component(s)

Feature extraction algorithm

Sample quality assessment algorithm

Verification algorithm

Identification algorithm

Sensor

Complete (embedded) acquisition/matching
subsystem

Others?

Types of measurements

Feature extraction algorithm

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Compliance with interoperability specification

***Deviation from 'reference' output when
processing a 'reference' set of input data***

***Compliance with interoperability format
specification***

Generation of correct output format

Consistency of extraction

***Ability to consistently identify the same features
in samples of varying quality***

Sample quality assessment algorithm

***Correlation of output metric with specific sample
parameters***

***Correlation with ability of verification or
identification algorithm to successfully use
sample***

Verification algorithm

False Non - Match Rate

False Match Rate

Failure to Accept Sample

ROC/DET

***Parametric measurement of performance versus
threshold***

Subject sensitivities

Friction ridge spacing

Eye color

Facial hair

Glasses/contact lenses

Presentation orientation sensitivities

Image rotation

Image displacement

Sample quality dependencies

***Correlation of FNMR & FMR with publicly
available image/signal quality algorithm output***

Identification algorithm

Cumulative Match Curve

Selectivity (ability to reject non-mate samples)

***Reliability (ability to correctly identify mate
samples)***

***Correlation of Reliability, Selectivity with publicly
available image/signal quality algorithm output***

Sensor

Image or signal quality

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As computed by one or more publicly available image/signal quality algorithms (i.e., not a proprietary algorithm unavailable to others for comparison purposes) that has been qualified for this class of system
As measured by the match accuracy scores of a specific matcher designed for use with that sensor, or a suite of matchers configured for that sensor.

Image or signal repeatability

Image or signal repeatability is measured as stability in the scores generated by one or more matcher(s) designed (or configured) for use with the sensor under test, across designated ranges of environmental and subject variation.

Environmental sensitivities

Temperature
Humidity
Ambient light
Fluorescent light
Noise
Vibration
Radio frequency interference
Power supply voltage
Dirt accumulation & other contaminants

Subject sensitivities

Hand/finger humidity (skin moisture content)
Hand/finger temperature
Hand/finger surface contamination
 Surface perspiration
 Water
 Dust
 Chalk dust
 Motor oil
 Marking pen
 Sugar syrup (maple syrup)
Hand/finger pressure on sensor
Health and medication
Friction ridge spacing
Eye color
Facial hair
Glasses/contact lenses
Skin color
Expression
Health (voice)
Emotional state (voice, handwriting,...)

Environmental operational ranges

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e.g., temperature, humidity

Sensor positioning/mounting issues

Elevation

Orientation (horizontal, vertical)

Angle with respect to subject

Mean time between failures (MTBF)

MTBF in benign (e.g., lab) environment

Environmental/use factors influencing MTBF

Field repairability

Parts capable of in-field repair/replacement

Mean time to repair

Routine maintenance requirements

Cleaning frequency & factors affecting it

Routine replacement of parts

Typical uses for results

Comparison of different components

Assessment of developmental progress

Comparison of successive generations of the same component

Designing systems

Assessing population-specific characteristics

Determining impact of environmental factors

Evaluating user interface (e.g., ergonomics)

Scenario

Object of Test - a Particular System Implementation

Types of measurements

Verification System

False Non-Match Rate

False Match Rate

False Accept Rate

False Reject Rate

Failure to Enroll Rate

Identification System

Selectivity

Reliability (identification system)

Failure to Enroll Rate

User error rates

Presentation errors

Due to user instructions/feedback

Due to location/orientation of sensor

Others?

Biometric transaction time

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Acquisition time

Feature extraction time

Verification/identification time

Enrollment time

Should we be considering “attempts to defeat” testing?

Typical uses for results

Assessment of developmental progress

Prediction of performance of operational system

Comparison of successive generations of system

Determination of impact of environmental factors

Assessment of effectiveness of measures to control relevant environmental factors

Assessment of population-specific performance variations

Evaluation of user interface

Portions of Qualification/Acceptance Testing

FNMR, FTE, FTA measurement

User error rate measurement

Estimation of operational throughput

Throughput may be influenced by the measurement instrumentation/process

Operational

Object of Test - a Fielded System

Types of measurements

Biometric transaction time

End-to-end transaction/throughput

Relate to baseline or other devices

Acquisition time

Feature extraction time

Verification/identification time

Subject acceptance rate

Subject rejection rate

Failure to Enroll

Failure to Acquire (for any reason)

Sensor MTBF (as-fielded/used) (is it appropriate

to limit this to sensors? What about processors?...)

Typical uses for results

Environmental factors (if recorded)

Assessment of effects

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Assessment of effectiveness of efforts to control

Assessment of population-specific performance variations

Possible when test is repeated with disjoint homogeneous populations

Comparison of successive generations of system

Sensor upgrades/replacements

Changes in user instructions/feedback

Changes in sensor deployment

Changes in algorithm(s)

Portions of Qualification/Acceptance Testing

Operational throughput measurement

Sensor MTBF measurement (this begs the question of other reliability metrics, MTTR, Operational Availability, Intrinsic Availability, Mission Reliability,... do we really want/need to go there?)

Verification of maintenance requirements

Verification of FTE requirements

Metric Definitions

To be extracted from other documents to the extent possible

Reporting Requirements & Recommendations

Technology Test

Feature extraction algorithm

Compliance with interoperability specification

Deviation from 'reference' output when processing a 'reference' set of input data

Compliance with interoperability format specification

Generation of correct output format

Sample quality assessment algorithm

Data set disclosure

Standard data set used, if any; otherwise, procedure used to collect data

Size of data set

Number of unique subjects

Number of samples taken from each subject

Elapsed time between data collection events, if not collected on a single occasion

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If any data from the standard or collected data set that was excluded from the test, how much data was excluded and what was the rationale used for exclusion

If standard data set was not used, identify capture device type, manufacturer, revision, firmware version (if applicable), driver version and

operating system used during data set capture
Should we include here environmental conditions, demographic information?

Test Methodology

TBD

Required Metrics Reporting

Range of output metric

Correlation of output metric with specific sample parameters

Recommended Metrics Reporting

Correlation of output metric with ability of one or more publicly available verification or identification algorithm(s) to successfully use sample

Verification algorithm

Data set disclosure

Standard data set used, if any; otherwise, procedure used to collect data

Size of data set

Number of unique subjects

Number of samples taken from each subject

Elapsed time between data collection events, if not collected on a single occasion

If any data from the standard or collected data set that was excluded from the test, how much data was excluded and what was the rationale used for exclusion

If standard data set was not used, identify capture device type, manufacturer, revision, firmware version (if applicable), driver version and operating system used during data set capture

Algorithm Version Disclosure

Version of the algorithm used in the test

Was same version used to generate all data; if not, how was this reflected in the test results

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Identification of feature extraction algorithm used in test

Manufacturer

Version

Parameter settings, if any

Image quality algorithm used in test, if any

Manufacturer

Version

Parameter settings, if any

Hardware-based algorithm component(s), if any

Manufacturer

Version

Parameter settings, if any

Firmware version, if any

Driver version

Test Methodology

Were all samples from each subject compared to all enrollment samples from every other subject in order to assess FMR

Were all non-mate samples from each subject compared to the subject's own enrollment samples in order to assess FMR

Were the same number of samples used from each subject; if not, how did data analysis avoid bias

Were enrollment samples from each individual excluded from data used to assess FNMR

Computing equipment used to conduct test

Manufacturer, model

Number of cpus

Cpu clock rate

Amount of memory installed

Operating system & version

Any other non-essential software running on the system at the time of test (e.g., services, daemons, other applications)

Required Metrics Reporting

False Non-Match Rate

False Match Rate

Failure to Accept Sample

Confidence interval for each of the above metrics

Values of any settable parameters used to obtain these results

Recommended Metrics Reporting

Match time

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Mean

Standard deviation

Variation with settable parameters

Variation with changes in test hardware

Parametric measurement of FMR/FNMR versus threshold or at each possible security level setting (and any other settable parameters that influence these results)

Range of scores

Subject sensitivities

Hand/finger humidity (skin moisture content)

Hand/finger temperature

Hand/finger surface contamination

Surface perspiration

Water

Dust

Chalk dust

Motor oil

Marking pen

Sugar syrup (maple syrup)

Hand/finger pressure on sensor

Health and medication

Friction ridge spacing

Eye color

Facial hair

Glasses/contact lenses

Skin color

Expression

Health (voice)

Emotional state (voice, handwriting,...)

Sample quality dependencies

Correlation of FNMR & FMR with publicly available image/signal quality metric

Identification algorithm

Data set disclosure

Standard data set used, if any; otherwise, procedure used to collect data

Size of data set

Number of unique subjects

Number of samples taken from each subject

Elapsed time between data collection events, if

not collected on a single occasion

If any data from the standard or collected data set that was excluded from the test, how much data

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was excluded and what was the rationale used for exclusion

If standard data set was not used, identify capture device type, manufacturer, revision, firmware version (if applicable), driver version and operating system used during data set capture

Algorithm Version Disclosure

Version of the algorithm used in the test

Was same version used to generate all data; if not, how was this reflected in the test results

Identification of feature extraction algorithm used in test

Manufacturer

Version

Parameter settings, if any

Image quality algorithm used in test, if any

Manufacturer

Version

Parameter settings, if any

Hardware-based algorithm component(s), if any

Manufacturer

Version

Parameter settings, if any

Firmware version, if any

Driver version

Test Methodology

What data was used to populate repository, and how large was the repository

What data was used to search the repository, and

how many samples were used from each subject

Were the same number of samples used from each

subject; if not, how did data analysis avoid bias

Computing equipment used to conduct test

Manufacturer, model

Number of cpus

Cpu clock rate

Amount of memory installed

Operating system & version

Any other non-essential software running on the system at the time of test (e.g., services, daemons, other applications)

Required Metrics Reporting

Selectivity (ability to reject non-mate samples)

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Reliability (ability to correctly identify mate samples)

Confidence interval for each of the above metrics

Values of any settable parameters used to obtain results

Recommended Metrics Reporting

Search time

Mean

Standard deviation

Variation with settable parameters

Variation with changes in test hardware

Cumulative Match Curve

Parametric measurement of Reliability &

Selectivity versus any settable parameters

Filter rate

Sample quality dependencies

Correlation of Reliability & Selectivity with

publicly available image/signal quality metric

Sensor Test

Data Set disclosure

Size of population

Number of samples obtained from each subject

Data excluded from test – how much, rationale for exclusion

Sample population demographics

Subject age, race, and gender distributions

Subject occupational categories distribution

Test location, season, and weather conditions

Device Disclosure

Device Type (technology used to obtain samples)

Manufacturer

Model

Revision

Firmware version (if applicable)

Driver version

Operating system used

Test Methodology

Was same number of samples obtained from each subject; if not, how was bias avoided in results

Number of attempts permitted for each class of operational procedure

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Instructions provided to subjects and how provided

Assistance provided to subjects and rationale used for deciding to provide assistance

Instructions provided to test conductor(s)

Device mounting/placement during data collection

Elevation

Orientation (vertical, horizontal)

Angle with respect to subject

Required Metrics Reporting

Image or signal quality

As computed by one or more publicly available image/signal quality algorithms (i.e., not a proprietary algorithm unavailable to others for comparison purposes) that has been qualified for this class of system

As measured by the match accuracy scores of a specific matcher designed for use with that sensor, or a suite of matchers configured for that sensor.

Environmental sensitivities

Temperature

Humidity

Ambient light

Fluorescent light

Environmental operational ranges

e.g., temperature, humidity, ambient light levels,

presence of RF or other fields

Sensor positioning/mounting issues

Elevation

Orientation (horizontal, vertical)

Angle with respect to subject

Recommended Metrics Reporting

Subject sensitivities

Hand/finger humidity

Friction ridge spacing

Eye color

Facial hair

Glasses/contact lenses

Mean time between failures (MTBF)

MTBF in benign (e.g., lab) environment

Environmental/use/substance exposure factors

influencing MTBF

Field repairability

Parts capable of in-field repair/replacement

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Mean time to repair for each field replaceable

part

Routine maintenance requirements

Cleaning frequency & factors affecting it

Routine replacement of parts

Scenario Test

Verification System

Data set disclosure

Procedure used to collect data

Size of data set

Number of unique subjects

Number of samples taken from each subject

Elapsed time between data collection events, if not collected on a single occasion

Sample population demographics

Subject age, race, and gender distributions

Subject occupational categories distribution

Test location, season, and weather conditions

If any data from the collected data set was excluded from the test, how much data was excluded, the rationale used for exclusion and the influence the excluded data had on the reported results

Identify capture device type, manufacturer, revision, firmware version (if applicable), driver version and operating system used during data set capture

System Description

Algorithm Version Disclosure

Version of the matching algorithm(s) used in the test

Were same versions used to generate all data; if not, how was this reflected in the test results

Identification of feature extraction algorithm used in test

Manufacturer

Version

Parameter settings, if any

Image quality algorithm used in test, if any

Manufacturer

Version

Parameter settings, if any

Hardware-based algorithm component(s), if any

Manufacturer

Version

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Parameter settings, if any
Firmware version, if any
Driver version

Computing equipment used to conduct test

Manufacturer, model

Number of cpus

Cpu clock rate

Amount of memory installed

Operating system & version

Any other non-essential software running on the system at the time of test (e.g., services, daemons, other applications)

Device Disclosure

Device Type (technology used to obtain samples)

Manufacturer

Model

Revision

Firmware version (if applicable)

Driver version

Test Methodology

Were the same number of samples used from each subject; if not, how did data analysis avoid bias

Instructions given to test operator(s)

Rules for interventions

Rules for recording discrepancies

Instructions given to subjects

Training given to subjects exclusive of user interface & duration

Test intervals

How much time elapsed between data collection sessions

Was this uniform for all subjects

Sensor deployment

How were sensors deployed

Mounting (vertical/horizontal, fixed/adjustable)

Compensation for physical subject variations, (e.g., height)

Location of sensor relative to subject (e.g., angle with respect to subject position)

Required Metrics Reporting

False Non-Match Rate

False Match Rate

Failure to Accept Sample

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*Confidence interval for each of the above metrics
Values of any settable parameters used to obtain
these results*

Recommended Metrics Reporting

Match time

Mean

Standard deviation

Variation with settable parameters

Variation with changes in test hardware

*Parametric measurement of FMR/FNMR versus
threshold or at each possible security level setting
(and any other settable parameters that influence
these results)*

Range of scores

*Affect of the presence of contaminants likely
present in typical application of this scenario*

Subject sensitivities

Friction ridge spacing

Eye color

Facial hair

Glasses/contact lenses

Others

Sample quality dependencies

Correlation of FNMR & FMR with publicly
available image/signal quality metric

Identification system

Data set disclosure

*Standard data set used, if any; otherwise,
procedure used to collect data*

Size of data set

Number of unique subjects

Number of samples taken from each subject

Elapsed time between data collection events, if
not collected on a single occasion

*If any data from the standard or collected data set
that was excluded from the test, how much data
was excluded and what was the rationale used for
exclusion*

*If standard data set was not used, identify capture
device type, manufacturer, revision, firmware
version (if applicable), driver version and
operating system used during data set capture*

System Description

Algorithm Version Disclosure

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Version of the algorithm(s) used in the test

Were same versions used to generate all data; if not, how was this reflected in the test results

Identification of feature extraction algorithm used in test

Manufacturer

Version

Parameter settings, if any

Image quality algorithm used in test, if any

Manufacturer

Version

Parameter settings, if any

Hardware-based algorithm component(s), if any

Manufacturer

Version

Parameter settings, if any

Firmware version, if any

Driver version

Computing equipment used to conduct test

Manufacturer, model

Number of cpus

Amount of memory installed

Operating system & version

Any other non-essential software running on the system at the time of test (e.g., services, daemons, other applications)

Device Disclosure

Device Type (technology used to obtain samples)

Manufacturer

Model

Revision

Firmware version (if applicable)

Driver version

Test Methodology

What data was used to populate repository, and how large was the repository

What data was used to search the repository, and

how many samples were used from each subject

Were the same number of samples used from each

subject; if not, how did data analysis avoid bias

Required Metrics Reporting

Selectivity (ability to reject non-mate samples)

Reliability (ability to correctly identify mate samples)

Confidence interval for each of the above metrics

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Search time

Mean

Standard deviation

Values of any settable parameters used to obtain results

Filter rate(s)

Threshold(s)

Recommended Metrics Reporting

Search time

Variation with settable parameters

Variation with changes in test hardware

Cumulative Match Curve

Parametric measurement of Reliability & Selectivity versus any settable parameters

Filter rate(s)

Theshold(s)

User error rates

Presentation errors

Due to user instructions/feedback

Due to location/orientation of sensor

Others?

Operational Test

Verification System

Data set disclosure

Procedure used to collect data

Size of data set

Number of unique subjects

Number of samples taken from each subject

Elapsed time between data collection events, if not collected on a single occasion

Estimated sample population demographics

Subject age, race, and gender distributions

Subject occupational categories distribution

Test location, season, and weather conditions

If any data from the collected data set was excluded from the test, how much data was excluded, the rationale used for exclusion and the influence the excluded data had on the reported results

Identify capture device type, manufacturer, revision, firmware version (if applicable), driver version and operating system used during data set capture

System Description

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Algorithm Version Disclosure

Version of the matching algorithm(s) used in the test

Were same versions used to generate all data; if not, how was this reflected in the test results

Identification of feature extraction algorithm

used in test

Manufacturer

Version

Parameter settings, if any

Image quality algorithm used in test, if any

Manufacturer

Version

Parameter settings, if any

Hardware-based algorithm component(s), if any

Manufacturer

Version

Parameter settings, if any

Firmware version, if any

Driver version

Computing equipment used to conduct test

Manufacturer, model

Number of cpus

Cpu clock rate

Amount of memory installed

Operating system & version

Any other non-essential software running on the system at the time of test (e.g., services, daemons, other applications)

Device Disclosure

Device Type (technology used to obtain samples)

Manufacturer

Model

Revision

Firmware version (if applicable)

Driver version

Test Methodology

Were the same number of samples used from each subject; if not, how did data analysis avoid bias

Instructions given to test operator(s)

Rules for interventions

Rules for recording discrepancies

Instructions given to subjects

Training given to subjects exclusive of user interface & duration

Test intervals

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How much time elapsed between data collection sessions

Was this uniform for all subjects

Sensor deployment

How were sensors deployed

Mounting (vertical/horizontal, fixed/adjustable)

Compensation for physical subject variations, (e.g., height)

Location of sensor relative to subject (e.g., angle with respect to subject position)

Required Metrics Reporting

Subject acceptance rate (don't know if false or true)

Subject rejection rate (don't know if false or true)

Failure to Enroll

Failure to Acquire (for any reason)

Failure to Accept Sample

Biometric transaction times (mean, std deviation)

Acquisition time

Feature extraction time

Verification time

Confidence interval for each of the above metrics

Values of any settable parameters used to obtain these results

Recommended Metrics Reporting

Match time

Variation with changes in settable parameters

Variation with changes in test hardware

Variation with system loading

Sensor MTBF (as-fielded/used)

Identification system

Data set disclosure

Standard data set used, if any; otherwise, procedure used to collect data

Size of data set

Number of unique subjects

Number of samples taken from each subject

Elapsed time between data collection events, if not collected on a single occasion

If any data from the standard or collected data set that was excluded from the test, how much data

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was excluded and what was the rationale used for exclusion

If standard data set was not used, identify capture device type, manufacturer, revision, firmware version (if applicable), driver version and operating system used during data set capture

System Description

Algorithm Version Disclosure

Version of the algorithm(s) used in the test

Were same versions used to generate all data; if not, how was this reflected in the test results

Identification of feature extraction algorithm used in test

Manufacturer

Version

Parameter settings, if any

Image quality algorithm used in test, if any

Manufacturer

Version

Parameter settings, if any

Hardware-based algorithm component(s), if any

Manufacturer

Version

Parameter settings, if any

Firmware version, if any

Driver version

Computing equipment used to conduct test

Manufacturer, model

Number of cpus

Amount of memory installed

Operating system & version

Any other non-essential software running on the system at the time of test (e.g., services, daemons, other applications)

Device Disclosure

Device Type (technology used to obtain samples)

Manufacturer

Model

Revision

Firmware version (if applicable)

Driver version

Test Methodology

What data was used to populate repository, and how large was the repository

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*What data was used to search the repository, and
how many samples were used from each subject
Were the same number of samples used from each
subject; if not, how did data analysis avoid bias*

Required Metrics Reporting

Selectivity (ability to reject non-mate samples)

*Reliability (ability to correctly identify mate
samples)*

Search time

Mean

Standard deviation

Confidence interval for each of the above metrics

*Values of any settable parameters used to obtain
results*

Filter rate(s)

Threshold(s)

Recommended Metrics Reporting

Search time

Variation with changes in settable parameters

Variation with changes in test hardware

Variation with system loading

Cumulative Match Curve