Department of Homeland Security

Importance of Image Quality to US-VISIT and IDENT

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Homeland Security
US-VISIT
Keeping America’s Doors Open and Our Nation Secure
IDENT Summary

IDENT: Biometric processing system for rapid identification and verification utilizing fingerprints

Highlights
- 50 Million People (FINS)
- 65 Million Transactions (Encounters) Processed
- 125,000 Transactions/Day
- Over 10 Million Identifications
- Over 15,000 Wanted Criminals Identified (Including DC Snipers)
- NIST Certified Accuracy*
- Matcher Power of over 100 Million Matches/Sec
- Inputs From Over:
  - 15,000 Users
  - 5,000 Clients
  - 210 Countries
- Automated Synchronization with FBI IAFIS

ENFORCEMENT

Civilian

Biometric Service

Watchlist 1.3M
Recidivist 7.5M
VISIT 41M
Asylum 0.4M
Latent 0.7M

DoS/BCC
US-VISIT
CBP/ICE
Asylum
CIS
New (2006)
- TSA
- IRT

CVT

Text
Photo
Fingerprints

- Wants & Warrants
- Terrorists
- Sexual Offenders
- Criminal Histories
- Deported Felons

Identification (1:many)
Verification (1:1)

US-VISIT
Keeping America's Doors Open and Our Nation Secure
## Applications & Fingerprint Capture Types

<table>
<thead>
<tr>
<th>Application</th>
<th>Purpose</th>
<th>Fingerprint Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>US-VISIT</td>
<td>Entry &amp; EXIT</td>
<td>Live Scan Flat</td>
</tr>
<tr>
<td>Department of State</td>
<td>Identity Check for Visa Issuance</td>
<td>Live Scan Flat</td>
</tr>
<tr>
<td>Enforcement</td>
<td>Border Patrol &amp; Inspections</td>
<td>Live Scan Flat, Live Scan Rolled, Inked Rolled</td>
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<tr>
<td>Customs and Immigration Services</td>
<td>Identity Check for Asylum and Immigration Benefits</td>
<td>Live Scan Flat, Live Scan Rolled prints</td>
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<tr>
<td>Credentialing</td>
<td>Identity Check of Credential Holders</td>
<td>Ten Print Slaps</td>
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</table>
Impact of Image Quality on Matching Accuracy

NIST Studies Results:

- Image Quality Is A Good Predictor of (1:Many) Identification Matching Accuracy
- Good Quality Results In Higher Identification Match Accuracy.
Manual-Auto Capture Modes

- **Manual Capture (Human Assisted)**
  - Used in IDENT Enforcement Applications
  - Works Well If:
    - Operator is Well Trained and Motivated
    - Operator Has The Time to Capture Good Quality Prints From Subjects

- **Auto Capture (Machine Assisted)**
  - Used in US-VISIT application
  - Fast Capture of Good Quality Prints
  - Automated Real-time Image Quality Assessment of Fingerprint Image Frames
  - Decreases Burden On The Operator

**Key Question:** “Is The Human or Machine Better at Image Quality Assessment? Advances In Image Quality Assessment Gives The Edge To The Machine!!"
Auto Capture Process

- Is finger on scanner?
  - No
    - Begin capture
    - Is image “good quality”?
      - No
        - Capture next finger
      - Yes
        - After 5 sec. if no good quality, submit best image
Cogent Image Quality Analysis

16-byte Image Quality Array:

[0] = Noise level for useful area of image, valid values 0-4.
[1] = Image Contrast information, valid values 0-1.
[3] = Core position, valid values 0-1.
[5] = Poor Quality gray image area percentage, valid values 0-100.
[8] = Number of Deleted Low Confidence Minutiae, valid values 0-200.
[9] = Number of Minutiae, valid values 0-126.
[10] = Poor Quality binary image area percentage, valid values 0-100.
[12] = Percentage of Background Image Area, valid values 0-100.
[14] = Re-Map Image Quality Score for Extraction Library 10.7.2
# Image Quality Assurance Process

## Capture Client
- **Operator Training**
- **Auto Capture**
- **Image Quality Feedback**
  - **Enhanced GUI For Capture**

## QA Process
- **Optimize Fingerprint Capture**
  - Image Quality Monitoring
  - Weekly Reports
- **Image Quality Task Force Studies**
  - End to End Process Analysis
  - Identify Problem Areas
  - Rectify Problem
- **Biometric Support Center**
  - Feedback from Examiners

## Backend Process
- **Use of Repeat Visitor Data to Improve Quality:**
  - “Best Finger Substitution”
- **Optimized Image Enhancement and Feature Extraction of Images Prior to Matching.**
- **Use of Advanced Matching Algorithms for Poor Quality Prints**
Image Quality Assurance – Client Side

- Image quality monitoring through weekly capture statistics reports by application, by site, by terminal, by scanner, etc.
- Direct feedback of quality and capture related deficiencies of Client stakeholders to improve quality.
- Integration of DHS best capture practices across the enterprise.
## Fingerprint Quality Reporting Hierarchy

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<tr>
<th>Application</th>
<th>Total Images</th>
<th>Good Quality %</th>
<th>Average Quality %</th>
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<table>
<thead>
<tr>
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Currently dual finger replacement is supported. Considering single finger replacement option in the future.

**Image Quality Assurance – Server Side**

**Best Fingerprint Substitution**

- Maximize fingerprint match accuracy
- Automated fingerprint substitution when new encounter has better quality fingerprint
- Search best possible fingerprint data
- Ensure best fingerprint image stored in database
  - Ensure best fingerprint minutiae stored in matcher subsystem components
- Image Quality score used in criteria for fingerprint substitution
Best Fingerprint Logic – Replacement

Compute Sum of Quality For Left/Right Search Encounter

Determine if Quality Value Lower (Better) Than Enrolled Quality Sum

Yes

Replace New/Improved Minutiae in Matcher

Search Encounter Prints

Left Index

Right Index

Score = 3

Score = 4

Sum = 7

Enrolled Matcher Prints

Left Index

Right Index

Score = 4

Score = 4

Sum = 8

Replace
Solution for Poor Quality Images
Multi-stage Matching

VM or VF PMA Stage 1

SW Matcher Stage 2 (top 20)

Galaxy+ 3rd Level Detail (For Latent Processing) Matcher Stage 3 (candidate)

Results

WL PMA Stage 1

SW Matcher Stage 2 (Score>400)

Results

Achieve Improved Matcher Accuracy Using Galaxy 3rd Level Detail Match Stage
2-Print to 10-Print Transition Challenges

- **Challenges**
  - Smaller footprint slap capture devices
  - Faster Slap Capture
  - Accurate Slap Segmentation

- **Multi-Agency User Group Initiatives**
  - Challenge to Industry to meet user group requirements
  - Industry rising to the challenge to meet the user needs
  - NIST to Conduct Slap Segmentation Algorithm Certification

- **Benefits**
  - Achieve DHS IDENT-DOJ IAFIS Interoperability
  - Improved Identification Performance from 10 Prints
DHS Road Map for the Future

- **Use DHS Best Fingerprint Capture Practices**
  - Ensure optimum quality fingerprint capture

- **Adopt Biometric Capture Standards (BioAPI)**
  - Enable fast scanner interchange capability
  - Enable fingerprint capture technology refresh
    - New technology (Ultra Sound, Touch less) scanners to improve image quality

- **Implement Best Face Capture Practices**
  - Improve facial image capture in the system
  - Facilitate finger-face biometric fusion capability to achieve highest possible identification accuracy