WHITE PAPER

IDENTIFICATION FLATS

A REVOLUTION IN **FINGERPRINT BIOMETRICS**

AWARE

Identification Flats: A Revolution in Fingerprint Biometrics

There is a revolutionary change occurring in the way fingerprint biometrics are applied as a result of several strong market drivers that have been in progress for several years and are now reaching critical mass. The result will be the rapid, global spread of the use of ten flat fingerprints, or "identification flats" (ID flats) for several security-related applications requiring biometric identification of civilians.

The key enabler of this capability is new software used in conjunction with optical "live scan" hardware devices that employs advanced image processing technology in real time to perform ultra-fast capture and quality control of ID flats . As a company with deep expertise gained from providing advanced image processing software to the biometrics industry since 1992, Aware is uniquely qualified to deliver a revolutionary software innovation to address this evolving requirement. Where the fingerprint capture process had formerly been performed by trained, experienced professionals and took several minutes, Aware fingerprint capture technology enables the reliable capture of high-quality, compliant ID flats in less than fifteen seconds, making fingerprint-based biometrics highly applicable to a wide range of new and important security applications in both the private and public sectors.

The Demand

Driver #1: Convergence of U.S. immigration and law enforcement fingerprint databases

In the 1990s, there were two primary fingerprint databases used for identifying of individuals:

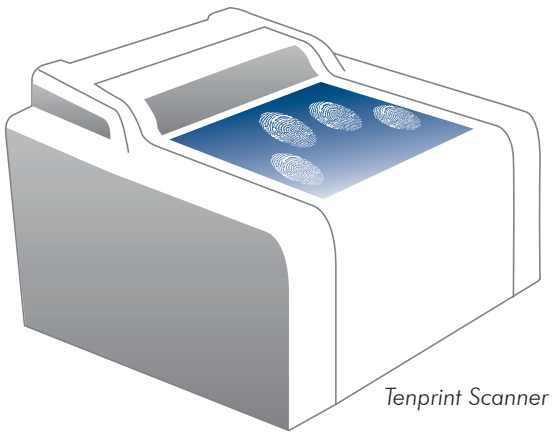
1) the INS IDENT database consisted of two flat fingerprints from individuals and was used for immigration enforcement at U.S. borders.

2) the FBI IAFIS database is made up of fingerprint image records consisting of fourteen images each: rolled prints of each of ten fingers and "slap" prints of four fingers from the left and right hands, and flat prints of thumbs. Capture of these fingerprint image sets must be performed by trained professionals.

This presented a problem when the Justice Department determined that fingerprint data needed to be shared between systems; it became necessary to compare fingerprints collected by the INS at border stations against criminal fingerprints in the FBI database. An integration of the two systems was required.

But the INS performed fingerprint capture in high volumes; they needed to collect prints and return match results quickly. On the other hand, law enforcement personnel – who do most of the capturing of fingerprints that end up in the FBI database – have more time, are well trained, and need to collect more fingerprint data (i.e. more fingerprints and rolled prints). This is because of the size of the database and the need to submit latent prints for search in criminal investigations.

A compromise solution was needed to enable integration of the two systems; one that enabled capture of data sufficient for search against an exponentially growing database, yet could also be performed quickly enough to process high volumes of people as required for civilian applications. The result is a new standard for fingerprint capture; a standard defining a set of ten flat fingerprint images, or "identification flats" captured by taking three images: the left "slap", the right "slap", and a two-thumb image. As a result of this requirement, a nascent market for ID flatscapture solutions emerged.



Tenprint Scanner

Driver #2:
New application for ID flats: civilian border control

The increased threat of terror marked by the September 11th attacks created a need to accompany passport checks with more thorough controls at all U.S. land, air, and sea borders. Among the changes was the introduction of collection of two fingerprints from all visitors upon passport checks, which commenced in 2004. In 2006, upon statistical analysis of match accuracy and published recommendations of NIST, DHS mandated two-print capture systems be replaced with capture of ID flats.

A similar effort was underway at the Department of State, which saw ID flats as a way to improve screening of visas applicants at consulates around the world. The challenges were similar and nearly as demanding as those of border control from a throughput standpoint.

Driver #3:
Global demand

While the U.S. government is currently the largest source of demand for ID flats capture solutions, the threat is just as significant in other parts of the world such as Europe, and thus the need is just as strong for civilian border control and visa applicant screening measures. Many countries in Europe and other geographies are currently in various stages of deploying measures to improve the visa issuance process and border security.

The Problem

Fingerprint live scan solutions traditionally rely on post-capture quality assessment techniques. That is, while a relatively simple image contrast check might be performed in real time to identify whether a finger is present on the scanner, more robust analysis ensuring the compliance and quality of the images wasn't applied until ***after*** the scanner "takes the picture" of the images. Images often fail the post-scan quality assessment; one or multiple recapture attempts are often required. This introduces a substantial time drain into the capture process that makes it prohibitive for high-volume capture applications.

For example, in the scenario where it takes an average of one minute to collect ID flats from an individual, if an operator can scan ID flats without repeated attempts, that operator can collect 60 sets of ID flats per hour. However, if the operator encounters a more likely scenario of 20% of individuals requiring a single capture reat-

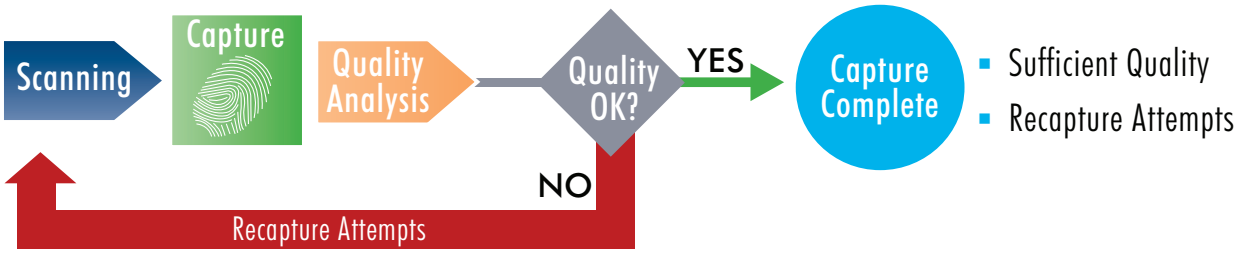
The impact of high recapture rates on cost is as much as 40%

CASE STUDY:
Deployment of a Large-Scale, High-Volume Tenprint Capture Solution

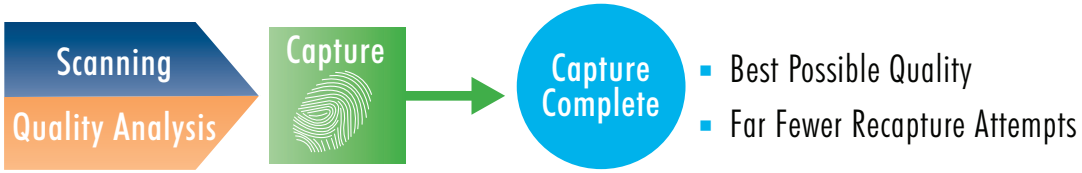
The U.S. Government recently deployed a large-scale tenprint capture solution for border control. A key challenge for this application is throughput; fingerprints must be collected as quickly as possible to prevent delays and long lines at checkpoints. An equally important goal is to collect fingerprints of as high level of image quality as achievable. Each low quality image must be recaptured, so getting good prints the first time substantially improves throughput.

A custom workstation for biometric capture was developed that utilizes several Aware software components. FastCapture performs real-time segmentation, quality scoring, and left/right hand identification so that errors or quality problems can be identified and remedied by the user in real time prior to a capture. For example, an operator might be notified that the user has the wrong hand on the live scan device prior to capture. Following capture, Aware's SequenceCheck software ensures that there are no matches between fingers, which would indicate an incorrect capture. Aware's NISTPack software performs standard-compliant compression of fingerprint images and data formatting so that the fingerprints can be sent to the database.

Performance results indicated a substantial improvement in capture success, as evident from fewer repeat recapture attempts, fewer rejections from the FBI, and ultimately higher throughput. This was primarily the result of applying advanced image analysis technology to generating an accurate assessment of image quality in real time prior to image capture, and ensuring that the best effort was made to capturing the prints on the first capture attempt.



Traditional Fingerprint Scanning



New FastCapture Technique - Substantial Capture Time Savings

tempt, and 5% requiring a double capture reattempt, the throughput of that operator drops substantially to 46 sets per hour. For a facility processing 4000 captures per day, this translates to a need for 11 complete capture stations instead of just 8; or an increased cost of nearly 40%.

Simply by reducing the occurrence of recapture attempts, the throughput of the facility could be dramatically improved and costs decreased.

The Solution

Aware has provided advanced software solutions to ensure fingerprint image quality and compliance since the inception of digital fingerprint technology. It is a complex, computationally intensive task, requiring expertise in advanced signal processing techniques such as pattern recognition and compression, specialties of Aware since 1986. Traditionally, the requirement was primarily to ensure the quality and compliance of fingerprint images after capture by live scan equipment. But the need for a high-throughput solution necessitated an innovative approach.

Real-time assessment of fingerprint images virtually assures that the best possible effort was made to capture the prints.

Aware's answer to the problem is its "FastCapture" software, which employs a technology called "Real Time Segmentation and Quality" or RTSQ™ to perform rapid, high-volume fingerprint image capture. RTSQ achieves this by applying several sophisticated image processing and analysis algorithms to a streamed image sequence in real time. These processes include:

1) segmentation of each of the fingerprints or thumbprints from the full slap image in real time

2) quality scoring of each of the prints in real time

3) identification of left or right hand in real time

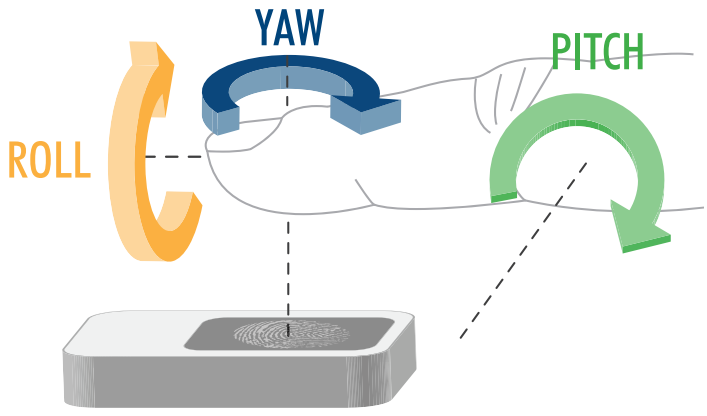
RTSQ includes other innovations that contribute to performance. For example, minimum thresholds for quality may be set for each finger, so that the final image is only captured when it is compliant and of sufficient quality.

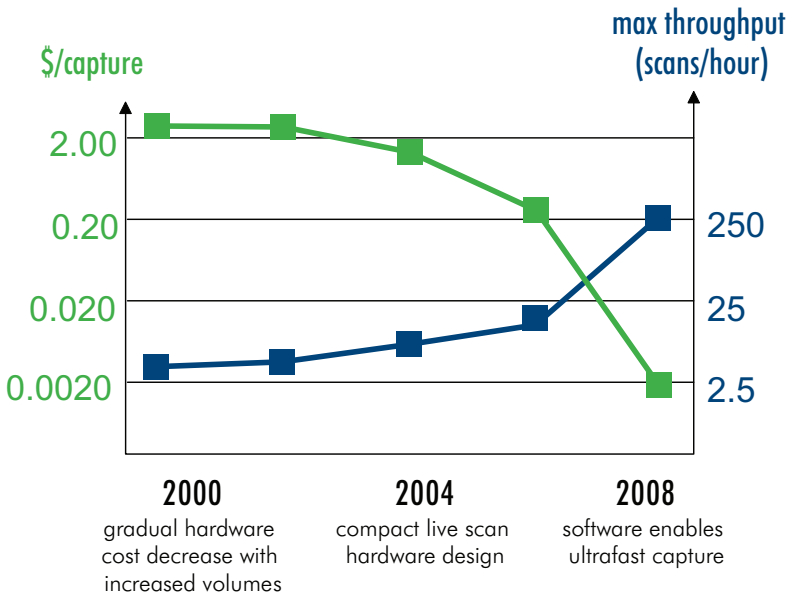
Quality thresholds may also be programmed to go down with time during the capture process, so that even if an individual exhibits particularly poor fingerprint quality beyond the control of the operator or equipment, a fingerprint of maximum possible quality will still be captured. This feature is particularly useful. There will always be fingerprints that are difficult or impossible to capture above a required quality threshold, and in a traditional system these cause a substantial drag on throughput, since several recapture attempts are often made before lower quality images are eventually accepted as "best effort". It is precisely these cases where real-time quality assessment is the most valuable, because it assures that the best possible effort was made on the first attempt.

BEST PRACTICES FOR SUCCESSFUL FINGERPRINT CAPTURE

Several practices that contribute to expedient capture of compliant, high-quality fingerprint images are automatically performed by Aware's FastCapture software:

Quality Requirement	Description	Satisfied by FastCapture
Size	Fingerprint images should be as large as possible	✓
Ridge flow	Fingerprints should contain sharp, continuous ridges. This helps the capture application to differentiate between finger images of good and poor quality and between finger images and images that are not fingers (eg. extraneous dark objects).	✓
Real-time viewing and messaging	Operators should be visually notified in real-time of fingerprint flaws, such as darkness or lightness caused by wet or dry fingers, respectively. Solutions might achieve this with numerical or ideally color-coded feedback.	✓
Finger position on sensor **- Finger angle** **- Touching edge of sensor**	Contact between the finger and the sensor should be centered, aligned, and optimized to maximize image size without distortion or cropping. That is, pitch, roll, yaw, and offset of the finger in relation to the sensor must be minimized (see figure below) and the operator should be notified of potential impact on quality in real time.	✓
Correct hand	A quality check should detect the presence of the wrong hand in real time.	✓
Duplicate and sequence checking of all ten fingers	Four-finger images are useful in helping to automatically ensure that fingers are properly identified (eg. Left index finger) as well as detecting the presence of duplicates.	✓
Missing or bandaged fingers	A quality system should automatically detect missing or bandaged fingers and prompt the operator to identify them.	✓
Thumb capture and alignment	Some users may need to submit only one thumb at a time, such as if they are carrying an infant; capture workflow should accommodate this case. Dual thumb images should be parallel and aligned with the sensor, not pointed at one another.	✓
Option to bypass Q/A measures	It may be desirable to capture fingerprint images even if only poor quality is possible. In this case, workflow should enable an operator to bypass quality controls. Alternatively, a quality algorithm might perform a "Dutch auction" by which quality thresholds drop to zero or equivalent with time, thus capturing images for every capture attempt without degrading the capture quality of good fingerprints.	✓





Cost and Throughput Improvements Derived from Live Scan Innovations

TRADITIONAL LIVESCAN

- $50,000 hardware
- 5+ minute capture
- 20% utility
- 10 year lifetime

NEW LIVESCAN

- $4,000 hardware
- 15 second capture
- 80% utility
- 5 year lifetime

The Result

By performing quality assurance of ID flats images in real time as opposed to the traditional method of post-capture assessment, the problem of recapture is substantially reduced. By assessing the quality before "taking the picture", the quality of the ID flats images can be verified upon the first capture attempt, thus vastly reducing the occurrence of required capture reattempts, and throughput is improved.

As a result, the economics of fingerprint live scan have changed dramatically. Consider that traditional fingerprint capture stations for law enforcement cost upwards of $50,000. It takes several minutes for capture, and these systems see about a 20% utility rate over a 10-year lifetime. This translates to a per capture cost of roughly $2.00 per capture.

But new hardware form factors and the software innovations described have reduced the per-capture cost exponentially. The hardware costs $4,000, performs capture in 15 seconds, and can realize 80% utility over a conservatively estimated 5-year lifetime. This translates to a per-capture cost of only $0.0020, or 1/1000 the cost of traditional criminal booking scanning.

Flats-based tenprint cost per capture is 1/1000th of the cost of traditional fingerprint scanning

Going Forward: The Changing Market

The market is now beginning to exploit these economics. By enabling multi-fingerprint technology to be applied to new, high-throughput applications such as visa applicant screening and foreign visitor screening, a market volume threshold is crossed that will drive additional competition to the live scan market, resulting in continuing innovations as well as lower prices of live scan hardware, the largest cost component of a ID flats capture station. These will in turn make the technology available to more price-sensitive applications in the public as well as private sectors. The performance advantage of multi-fingerprint biometrics will ensure that the role of fingerprints as the biometric modality of choice for most applications will not only persist, but will find new use towards applications yet to be conceived.

About Aware, Inc.

Aware has been a leading provider of commercial off-the-shelf (COTS), standards-based biometrics software since 1992. Our products enable solution providers and system integrators with interoperable, standards-compliant, field-proven biometric functionality for applications including credentialing, border management, and criminal justice. Aware continues to build upon this legacy as a leading provider of innovative, high-quality, state-of-the-art biometrics software.

Our suite of software tools are included in solutions deployed by product vendors and system integrators, and then used by federal, state, and local government agencies and enterprises around the world. End users include government agencies such as the FBI and other U.S. Department of Justice agencies, the U.S. Department of State, the Department of Homeland Security, and agencies throughout Europe, Asia, and South America.

AWARE

The information presented in this document is designed as an introduction to the Aware suite of biometric tools. If you would like further information, extended examples, or product manuals please contact Aware at:

help@aware.com
www.aware.com/biometrics