About Warwick Warp

Warwick Warp is an award winning software house supplying system integrators and end-users with state-of-the-art biometric solutions. Founded from the University of Warwick and members of the leading international Signal and Image Processing Research Group, Warwick Warp was born in 2006, out of an interest in three dimensional modelling of fingerprints.

How does our unique fingerprint technology work?

Distortion of a fingerprint can occur when a print is collected, either intentionally such as port of entry, or forensically from a crime scene, in either case a variety of problems can occur when collecting prints; low image contrast, scars, cuts, age, occupation, making the print hard to identify.

Warwick Warp took an inventive mathematical modelling approach to neutralise the effects of ‘hard to capture’ prints and substantially improved the success rate of fingerprint matching. The company has developed a unique and innovative software technology that can be applied to a range of biometric solutions including facial recognition.

Low quality fingerprints cause high failure rates

Poor quality, low contrast images are a problem for any AFIS user, causing failure-to-enrol (FTE) and failure-to-match (FTM). Minimising these failure rates is critical to reduce throughput time and associated costs of AFIS implementation and use.

Conventional image processing techniques are commonly used in AFIS to overcome FTE and FTM but they often struggle to deal effectively with the lowest quality and distorted prints.

Innovative fingerprint identification for fast and accurate biometric solutions

Our modelling technology in fingerprint identification centres on the live-scan or latent fingerprint. The preprocessor identifies and recovers ridge flow information and regularises both the flow and direction of the ridges. It removes scars or scratches and reduces linear and nonlinear deformation aligning the
image to produce a normalized, idealised model of the fingerprint with all its original discriminative features intact.

The technology works by applying a mathematical model to identify the ridge features of interest producing an idealised model with all the salient foreground information intact; contrast, singularities, ridge flow, minutiae and sweat pores, recreating the print as an idealised model that matches the biological reality of the finger.

Figure 1: Two examples of fingerprint enhancement. Top: Severe scratches are removed; Bottom: Low-contrast is equalized across the print and ridge structures are enhanced to better locate minutiae.

Why Warwick Warp?

A major advantage of our modelling technology is that it is far more robust to variation than traditional methods and has a higher chance of producing a successful identification.

Our technology is particularly suited to latent or hard to capture images, coming into its own within the forensic industries.

Warwick Warp continues its research to improve and develop the matching algorithms.

Our research and development team is sourced from a global talent pool and continues to be closely allied to University of Warwick specialists, ensuring we are at the forefront of technology developments.
Products

- **Warwick LiveScan SDK** - Offers speedy implementation, easy deployment, outstanding accuracy and dependable performance on low-quality fingerprints.

- **Warwick AFIS SDK** - Is a highly accurate and reliable AFIS fingerprint enrolment and matching product intended for large-scale AFIS and multi-biometric projects.

- **Warwick Latent SDK** - Designed for law enforcement crime mark identification, where room for error is not an option, Warwick Latent SDK 3.0 works consistently on standard hardware.

- **Warwick Synthesis Simplicity** - One of the only biometric test tool kits on the market, providing realistic life-like data to test against without encountering the hassle of data protection issues.

Markets and applications

- Civil and Criminal ID
- Mobile AFIS
- Physical access control
- Time and attendance
- Financial transactions
- Network logins
- Employee authentications
- Work management
- Database integrity check
- Crime Scene Investigation

Successful Deployments

Below is an indication of the industries in which Warwick Warp’s unique fingerprint technology has been successfully deployed.

- **Construction** - 60 construction sites across the UK with more than fifty thousand uses processed daily by Warwick LiveScan SDK.

- **Port of Entry** - Warwick AFIS SDK has been implemented in European countries as part of biometric passport control security measures and VISA requirements.

- **Humanitarian Projects** - Warwick Latent SDK and AFIS has been implemented in mission critical humanitarian projects in a major African country.

- **Civil and Military** - Lights out Latent fingerprint matching has been successfully implemented and widely used with the UK military and police forces.
Award Winning Technology

Independent Performance Analysis

The following charts show the effectiveness of our preprocessor on two standard databases: NIST SD 29, which contains 216 x 10 impressions from inked ten-print cards containing both plain and rolled impressions; FVC 2006, DB2_A containing 140 x 12 optical scanned prints at 569 dpi prints. To assess the performance of the preprocessor, the NIST fingerprint image quality scoring mechanism (NFIQ) was used, which is correlated against image features to predict matcher performance. As one of the most widely accepted quality measures, NFIQ score of 1 and 2 indicates excellent or good quality data which would result in high scoring matches; scores of 4 and 5 indicate poor quality data.

In the “before” distributions in figure 2, both databases initially have 40% of their prints measured as having intermediate or poor quality. After preprocessing, for fingerprint impressions in the NIST 29 data, 90% are regarded as excellent or good with only about 6% remaining in the poorest quality category. On optical scanner data, FVC 2006 DB2_A, after preprocessing all prints are seen as excellent or good. Clearly demonstrating the effectiveness of our underlying algorithm technology.

![Figure 2: Distribution of NFIQ score before and after applying preprocessing module](image-url)
To assess the impact of preprocessing on matching performance, the algorithm has been submitted to a number of independent benchmark tests, conducted by the National Institute of Standards and Technology (NIST) in the US and National Physical Laboratory (NPL) in the UK.

NIST PFT tests were conducted on four operation database in the USA from DHS and DOD, consisting of over 5 million subjects. For detail testing analysis, please refer to NIST special report NIST-IR7249. ( http://www.nist.gov/itl/iad/ig/pft_2003.cfm ) The results shown in Table 1, demonstrates that our software has achieved one of the highest accuracy performances even when compared with other established market leaders.

The accuracy performance was also tested by National Physical Laboratory in the UK (NPL). The purpose of the evaluation is to benchmark the verification performance of the algorithms and make comparison against algorithms of other leading fingerprint suppliers. The technology evaluation was conducted in accordance with ISO/IEC 19795-2 2006 using two fingerprint databases collected within the Minutiae Template Interoperability Testing project (MITT). The graph below shows a summary of the accuracy performance which indicates that our software have achieved “best in class” results compared with other leading vendors.

<table>
<thead>
<tr>
<th>Rank (By Company)</th>
<th>Company</th>
<th>AVG</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cogent</td>
<td>0.999375</td>
</tr>
<tr>
<td>2</td>
<td>NEC</td>
<td>0.998825</td>
</tr>
<tr>
<td>3</td>
<td>Warwick Warp</td>
<td><strong>0.998775</strong></td>
</tr>
<tr>
<td>4</td>
<td>L1</td>
<td>0.9987</td>
</tr>
<tr>
<td>5</td>
<td>BioKey</td>
<td>0.998675</td>
</tr>
<tr>
<td>6</td>
<td>Tiger IT</td>
<td>0.998625</td>
</tr>
<tr>
<td>7</td>
<td>Sagem</td>
<td>0.998275</td>
</tr>
<tr>
<td>8</td>
<td>Motorola</td>
<td>0.998100</td>
</tr>
<tr>
<td>9</td>
<td>Neurotech</td>
<td>0.997875</td>
</tr>
<tr>
<td>10</td>
<td>Sonateq</td>
<td>0.997800</td>
</tr>
<tr>
<td>11</td>
<td>Identix</td>
<td>0.997775</td>
</tr>
<tr>
<td>12</td>
<td>Thales</td>
<td>0.996550</td>
</tr>
<tr>
<td>13</td>
<td>Sonda</td>
<td>0.997075</td>
</tr>
<tr>
<td>14</td>
<td>Biokey</td>
<td>0.994575</td>
</tr>
<tr>
<td>15</td>
<td>Eastern Golden Finger</td>
<td>0.988175</td>
</tr>
</tbody>
</table>

Table 1: Average TAR on FAR 0.01
Key Product Features

Accurate Quality Metrics

Warwick Warp quality metrics (WFIQ) assesses the match-ability of a fingerprint, by measuring the number, quality and variety of features found in most fingerprints, namely the amount of good quality minutiae, the presence of cores and deltas and the quality of the ridge pattern. These features are then used by the algorithm to assess the overall likelihood of being able to match against other impressions of the same finger. In addition to the overall quality metrics, a number between 1 and 100, and the quality map is provided by our software. Several of the individual components that contribute to the quality assessment may also be reported individually. The software also provides visually annotated images, with the positions and orientations of the minutia, any cores and deltas detected, etc. to aid an experienced operator whom can make an informed decision.

The examples below illustrate the type of information which can be obtained from our extended enrollment routines.

Multi Finger Fusion

Our unique algorithms also include a method for combining multiple impressions of the same finger in order to produce a “super-template”. This “super-template” can potentially provide a lower false rejection rate at the same false acceptance
rate, by taking information from a much larger area of the print than would have been available in a single impression enrollment procedure.

The following test demonstrates the efficiency of our merging techniques. Our example database has eight impressions of each print. We performed all within and between class comparisons against a template constructed from a single impression, and again against a template which is constructed from two and three impressions respectively.

<table>
<thead>
<tr>
<th></th>
<th>Single impression enrollment</th>
<th>Two impression enrollment &amp; template merging</th>
<th>Three impression enrollment &amp; template merging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated EER</td>
<td>1.234%</td>
<td>0.666%</td>
<td>0.577%</td>
</tr>
<tr>
<td>FRR@ 1%FAR</td>
<td>1.600%</td>
<td>0.400%</td>
<td>0.600%</td>
</tr>
<tr>
<td>FRR@ 0.1%FAR</td>
<td>2.000%</td>
<td>1.200%</td>
<td>0.800%</td>
</tr>
<tr>
<td>FRR@ 0.01%FAR</td>
<td>2.600%</td>
<td>1.400%</td>
<td>1.000%</td>
</tr>
</tbody>
</table>

Table 2 above shows that making a template from two impressions achieves nearly a 50% error reduction at the EER. The benefit of merging multiple impressions will not continue indefinitely as our matcher handles the matching of partial prints as well. As indicated in the table, the advantage of merging three impressions is considerably lower than the benefit of merging the first two. Once all the possible information is obtained and has been stored in the “super-template”, nothing more will be gained by attempting to merge further impressions.

Warwick Latent SDK

Lights Out Latent Capability

The patented modelling technology extends its capability to match latent fingerprint images fully automatically (“lights out”) so that any incoming fingerprints from enrolment station, access control points or mobile devices will be matched against a watch list which contains both known prints from criminals/suspects and unknown crime scene marks. Intelligence will be automatically fed back to the user in real time.

The system can also perform auto elimination from latent marks against a list of known personnel so that identification speed and operational efficiency can be substantially improved.

The system can be operated on central cloud, base station or laptop devices providing both in base and at scene capability.
Warwick LiveScan SDK

Best in Class Accuracy

LiveScan SDK utilizes Warwick Warp’s innovative technology for accurately matching low-quality fingerprints giving world leading accuracy performance that expands the boundary of traditional fingerprint biometric solutions. Regardless of your user group, such as the elderly, manual labourers, cleaners, or young children, LiveScan SDK ensures satisfactory matching performance. Compared to alternative solutions, LiveScan SDK is the only technology ranked highly in both benchmarks by the National Institute of Standards and Technology (NIST) in the US and the National Physical Laboratory (NPL) in the UK. Choose LiveScan SDK when failure to match is not an option!

Fast Response Time

While matching accuracy is pivotal to the success of any biometric solution, matching speed is equally important if not more so. Unlike most other solutions, LiveScan SDK utilizes patented normalization technology to provide high matching throughput without compromising accuracy, giving you the best of both worlds. Integrated multi-threading allows you to fully utilize modern multi-core processors with no additional development cost.

Warwick Synthesis Simplicity

Unique fingerprint testing tool kit

Synthesis Simplicity is one of the only biometric testing tool kits on the market today. It is able to generate controllable fingerprint images with a variety of qualities, providing realistic data to ensure lifelike testing accuracy.

When failure to match is not an option