Fingerprint sample quality assessment via Ridge Line Count using Laplacian of Gaussian edge finding

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agenda

• intro
• state of the art. in fingerprint quality
• the proposed Ridge Line Count method & alternative
• experimental setup
• results
• questions
introduction

• fingerprint recognition: enrolled template vs. probe sample comparison

• Biometric System performance ~ False Non-Match Rate (FNMR)

• good quality samples give good performance

• poor quality samples are difficult to compare and may increase FNMR

• *improve performance by removing poor quality samples*
fingerprint quality analysis

Quality Measurement Algorithm (QMA)

quality = QMA(sample)

state of the art.:

• Orientation Certainty Level (OCL) – ISO/IEC 29794-4
  • acceptable performance
  • granular output, many quality levels
• NIST Finger Image Quality (NFIQ) – de facto standard
  • good performance
  • only 5 quality levels (ISO/IEC 29794-1 requires 100 levels for compliance)
quality assessment via Ridge Line Count (RLC)

- locally analyze a fingerprint sample and count ridges
- ridge valley cycle is 500µm ~ 600µm for Caucasian adults
- with 500dpi sensors, 2.7 to 3.25 ridges present in a local area 32 x 32px*
- good quality fingerprint samples have more areas with clear ridges
- poor quality samples produce local RLC indication outside expected range

* area size chosen for easy combination with ISO/IEC 29794-4 algorithms & to have at least two full ridges in a good quality block & limit the local curvature present in a block
procedure I (RLC)

1. binarize fingerprint sample using Otsu’s threshold*
2. divide into local areas (32x32 pixel blocks), for each area:
3. determine orientation and rotate; ridges are vertical
4. find edges via Laplacian of Gaussian & Zero Crossings
5. traverse area through vertical middle, count edges
6. no. ridges is half the number of edges
7. \textit{Sample quality is the ratio of areas that have} >2.7 \textit{ridges}

* to minimize intra-class variance of white and black pixels
procedure II (RLC simple)

1. Binarize fingerprint sample using Otsu’s threshold*
2. Divide into local areas (32x32 pixel blocks), for each area:
   3. Determine orientation and rotate so that ridges are vertical
   4. Traverse block middle and count white-black pixel transitions
   5. Quality = mean of local areas indications’

* to minimize intra-class variance of white and black pixels
experimental setup

data preparation (focus on optical sensors)

- *CASIA Fingerprint Image Database Version 5.0 (CASIAFPV5)*
- *DB 1A, Third International Fingerprint Verification Competition (FVC2004DB1A)*

calculation

- *comparison scores*, via 3 vendors’ fingerprint comparators A, B and C (blackbox)
- *quality*, via 2 state of the art. QMAs & the proposed method I & II

assessment

- QMA performance via *Error versus Reject Curves* (by Grother and Tabassi, 2007)
- Inter-method correlation via Spearman’s rho (transformed to [ 0 – 100 ] range: 0 for complementary methods, 100 for identical)
results
results
results

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<th>NFIQ</th>
<th>OCL</th>
<th>RLC</th>
<th>RLC simple</th>
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Inter-method correlation on the quality sets of the FVC2004DB1A dataset. 0 indicates low correlation (complementary methods) 100 indicates identical methods
results

Inter-method correlation on the quality sets of the CASIAFPV5 dataset.
0 indicates low correlation (complementary methods)
100 indicates identical methods

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Summary

- RLC offers biometric performance prediction close to that of NFIQ
- ...but provides more quality levels, finer control of the FNMR reduction
- correlation table shows that the proposed method is complementary to that of OCL
- simplified version of RLC can achieve similar predictive performance at a lower computational cost
- optimization by tuning local area size and improving the algorithm is possible
Thank you

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