IREX III
Performance of 1:N Iris Recognition Algorithms

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IREX III

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Homeland Security
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IREX Team

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» George Quinn
» James Matey
» Elham Tabassi (IREX II lead)

IREX Timeline

» API + CONOPS published Nov 2010
» Algorithm submission from February 2011 → August 2011
» Final report October 2011.
<table>
<thead>
<tr>
<th>When, Where, Who</th>
<th>How, how big</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two algorithm submission phases</td>
<td>Parent Corpus</td>
</tr>
<tr>
<td>• 1. February – June, 2011</td>
<td>• 2212342 people</td>
</tr>
<tr>
<td>• 2. August 2011</td>
<td>• 4333745 eyes</td>
</tr>
<tr>
<td>NIST</td>
<td>• 6142289 images</td>
</tr>
<tr>
<td>• Sequestered data</td>
<td>Enrolment populations</td>
</tr>
<tr>
<td>• Up to 55 blades; Up to 880 cores, each 192GB memory</td>
<td>• 20K, 160K, 1.6M, 3.9M single eye</td>
</tr>
<tr>
<td>11 organizations</td>
<td>• 20K, 160K, 1.6M, two eyes</td>
</tr>
<tr>
<td>• 2 academia, 9 commercial, 0 from NIST</td>
<td>Searches</td>
</tr>
<tr>
<td>Up to 10 algorithms per organization</td>
<td>• 239K mate</td>
</tr>
<tr>
<td>• 92 tested</td>
<td>• 314K nonmate</td>
</tr>
<tr>
<td>Comparisons</td>
<td>Comparisons</td>
</tr>
<tr>
<td>• 239K mate searches</td>
<td>• 239K mate searches</td>
</tr>
<tr>
<td>• 1228 billion nonmate comparisons</td>
<td>• Using $N = 3.9M$ enrollment</td>
</tr>
<tr>
<td></td>
<td>• Using $N = 3.9M$ enrollment</td>
</tr>
</tbody>
</table>
1:N Search

Iris Image

Search Template

N template Enrollment Database

FNIR, aka “Miss Rate”

FPIR
Aka False Alarm Rate

Candidate List

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alice</td>
<td>0.02</td>
</tr>
<tr>
<td>Bob</td>
<td>0.34</td>
</tr>
<tr>
<td>Christophe</td>
<td>0.38</td>
</tr>
<tr>
<td>David</td>
<td>0.39</td>
</tr>
<tr>
<td>Ernie</td>
<td>0.45</td>
</tr>
</tbody>
</table>
Open Set 1:N Search

Operator Adjudication of Search Results

Lights out Identification

Google Search

I'm Feeling Lucky

As retrieved Saturday September 24, 2011, Jim Henson’s 75th birthday
# IREX III :: Measurements

## Accuracy

- **Accuracy**
  - FNIR -- Miss Rate
  - FPIR -- False Alarm Rate
- **Template generation failure**
- **Two eyes much better than one?**
- **Image quality values related to failure?**
- **Interoperability**:
  - Enroll camera A, identify camera B
- **Is iris ageing evident / important?**
- **Effect of geometry**
  - Does dilation make a difference?
  - Iris diameter?
- **Cumulative match**
  - Workload on (forensic) examiner
- **1:N Face vs. 1:N Iris**

## Resources

- **Template size**
  - Enrolment template
  - Search template
- **Time needed for**
  - Template generation
  - Search as function of N.
- **Threaded operation vs. naïve parallelism**
- **Memory usage**
  - Static vs. N
  - Dynamic vs. N
DET of Second Round Algorithms

False Negative Identification Rate, \( N = 3,900,000 \)
Scalability :: Accuracy dependence on N

ONE EYE

TWO EYES

False Negative Identification Rate

False Positive Identification Rate (Algorithm T11B)
But ... control of FPIR

False Negative Identification Rate

False Positive Identification Rate (Algorithm V11B)

ONE EYE

TWO EYES

4M

1.6M

160K

0.02

0.03

0.04

0.05
IREX III – Two Documents under Preparation

Evaluation Report :: Oct 2011
» NIST Interagency Report 8XXX

Improving Iris Recognition
» NIST Interagency Report 8YYY
» Vignettes from empirical IREX III observations
» Guidance to planners, trainers, operators, deployers for real time quality control
  • Potential content for ISO standard amendment.
» Guidance to developers for consideration in algorithm design
Conclusions

» The industry has at least eleven algorithm providers

» Algorithms matter
  • Large variations in accuracy

» Iris can be fast, $10^7$ mps
  • And slow, $10^4$ mps
  • Speed can be traded for accuracy
  • Accuracy statements without speed measurements are limited

» The Daugman *iriscode* template is not the only one
  • Template sizes vary ~250B to 10KB, and up to 20K for search.

» FPIR = N FMR usually
  • But for others, FPIR = constant.
  • Threshold calibration curves

» Failure modes are algorithm dependent
  • Valuable to review high mates
  • Valuable to review low nonmates
IBPC 2012

March 5-9, Gaithersburg, MD

- How to define, get, design for, measure, assure, performance in biometric systems.
- http://biometrics.nist.gov/ibpc2010
- 2012 website coming soon
- Contact ibpc2012@nist.gov

- See slides “The Gulf Between Biometric Research and Biometric Deployments”, Terry Boult, 9/27/11
Published UID Accuracy, N = 20K

Dilation :: Outdoor operation implications
Dilation = $\frac{R_p}{R_i}$

- False rejection via
  - High dilation
  - Low dilation (i.e. constriction)
  - Cross condition

$$\Delta D = 1 - \left( \frac{R_i^{(2)}}{R_i^{(1)}} \right) \left( \frac{R_i^{(1)} - R_p^{(1)}}{R_i^{(2)} - R_p^{(2)}} \right) = 1 - \frac{1 - D^{(1)}}{1 - D^{(2)}}$$
### False Positives

- Vanilla binomial
- \( \text{FPIR}(\tau, N) = 1 - (1 - \text{FMR}(\tau))^N \)
- Which, for small \( \text{FMR}(\tau) \), gives
- \( \text{FPIR}(\tau, N) \sim N \text{FMR}(\tau) \)

### False negatives

- For one enrolled mate
- \( \text{FNIR}(\tau, N) = \text{FNMR}(\tau, 1) \)
- To add a rank requirement in the \( \text{FNIR} \) definition, e.g. “\( \text{HD} = 0.2 \) and rank 5 or better”, see
- Guide to Biometrics, Bolle et al. Springer 2003, or